
SMITHSONIAN INSTITUTION LIBRARIES

PROCEEDINGS
of the
Biological Society of Washington

VOLUME 84
1971

WASHINGTON
PRINTED FOR THE SOCIETY

EDITOR

Paul J. Spangler

All correspondence should be addressed to the Biological Society of Washington, Smithsonian Institution, Washington, D.C. 20560

Allen Press Inc.

Lawrence, Kansas 66044

OFFICERS AND COUNCIL
of the
BIOLOGICAL SOCIETY OF WASHINGTON
FOR 1971–1972

OFFICERS

President

DANIEL M. COHEN

Vice President

ROGER F. CRESSEY

Secretary

ISABEL P. F. CANET

Treasurer

MAUREEN E. DOWNEY

COUNCIL
Elected Members

RICHARD C. BANKS
ROBERT H. GIBBS, JR.
DAVID L. PAWSON
JAMES E. PETERS
VICTOR G. SPRINGER

TABLE OF CONTENTS

Volume 84

BIOLOGICAL SOCIETY OF WASHINGTON
PROCEEDINGS

1043rd Meeting—11 February 1971

NINETY-SECOND ANNUAL MEETING

The 1043rd meeting and 92nd Annual Meeting of the Society was called to order by President Meredith Jones shortly after 2 p.m. in room 43 of the National Museum of Natural History.

The minutes of the previous annual meeting were read by the President, and approved as read.

In his capacity as Acting Treasurer, Meredith Jones presented the financial report, audited by Victor Springer and Daniel Cohen. The report was approved. Jones then called attention to the new policy of billing authors of Proceedings papers for page charges, with an accompanying letter stating that such charges would be waived if the institutions of the authors could not provide such funds. Those papers for which page charges are assured will be published in order of receipt. All others will be published in order of receipt until the Society's publication budget is exhausted.

The report of the editor was read by Jones. The report noted that volume 83 of the Proceedings consisted of 596 pages in 51 papers, and that 39 manuscripts totaling 500 pages, were on hand, 25 of which (319 pages) have been reviewed. It was anticipated that copy of the first issue of the new volume (84) would be sent to press within a week.

The Secretary reported on membership changes in the past year, giving the name of one member who had died and a list of eight lost by resignations. Twenty-one new members were accepted by vote.

Results of the election were announced and all candidates were elected.

The Membership Committee report was given by Robert Gibbs. The Society has 333 dues-paying members (83 in the National Museum of Natural History, 218 others in the USA, 32 in foreign countries), a total of 23 life, emeritus, and associate members, and 213 subscribing institutions (163 in the USA, 50 in foreign countries).

President Meredith Jones then turned his gavel over to the incoming president, Daniel M. Cohen, whose motion of appreciation to Meredith Jones for the time and effort he expended for the Society was unanimously approved.

The meeting was adjourned at 2:45 p.m.

Isabel P. F. Canet
Secretary

Vol. 84, No. 1, pp. 1–6 30 June 1971

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

A NEW *TRITNEPTIS*, WITH A REVISED KEY TO THE NEARCTIC SPECIES OF THE GENUS (HYMENOPTERA: PTEROMALIDAE)

By B. D. Burks
Systematic Entomology Laboratory, Entomology Research Division, Agr. Res. Serv., USDA[1]

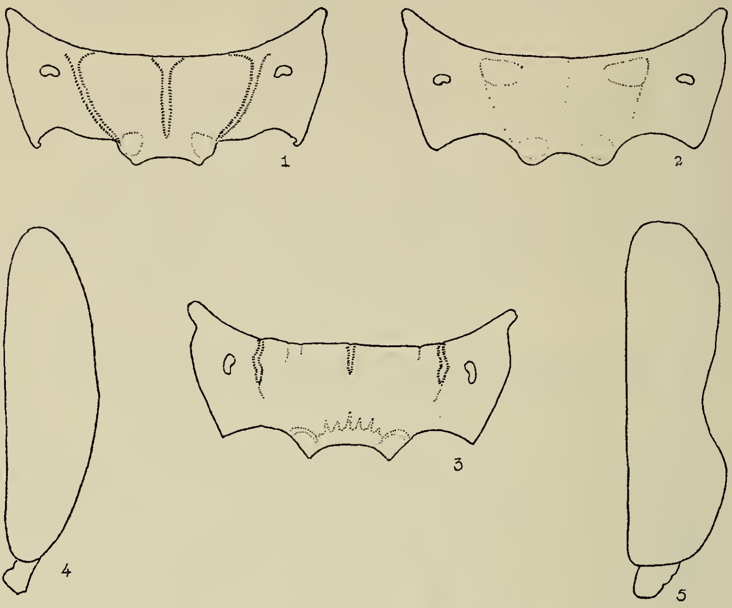
In 1908 A. A. Girault published a lengthy description of his new genus *Tritneptis* and designated *T. hemerocampae* Girault, new species, as type-species. This type-species had been reared from *Hemerocampa leucostigma* S. and A. infesting shade trees in Chicago, Illinois. Sixteen years later (Girault, 1924), in the middle of a paper on Australian chalcid-flies, he inserted the statement, "*Tritneptis hemerocampae* Girault. This is a synonym of *Dibrachys boucheanus* Ratz." Inasmuch as *boucheanus* is type-species of the genus *Dibrachys* Foerster, 1856, this synonymized *Tritneptis* under *Dibrachys.*

In 1938, however, A. B. Gahan restudied these species, and he showed that the synonymy Girault had published 14 years earlier was incorrect. *D. boucheanus* and *T. hemerocampae* were not synonymous nor even congeneric. Consequently he resurrected the genus *Tritneptis*, gave some brief comments about its characters, and keyed out the 5 species he referred to it. Two years later he received for identification a long series of another, undescribed species of *Tritneptis.* He set this species aside in the collection to be described at some future time.

This undescribed species has remained in the USNM collection for the ensuing 30 years, during which period of time additional specimens of it have been received fairly regularly

---

[1] Mail address: Systematic Entomology Laboratory, USDA, c/o U.S. National Museum, Washington, D.C. 20560.



Figs. 1–5. Nearctic *Tritneptis*. 1, propodeum of *T. koebelei*; 2, propodeum of *T. klugii*; 3, propodeum of *T. doris*. 4, male antennal scape of *T. klugii*; 5, male antennal scape of *T. doris*.

for identification—I describe it in this paper. I also present a revised key to the Nearctic species of the genus *Tritneptis* and a recharacterization of the genus.

Tritneptis Girault

Tritneptis Girault, 1908, Psyche, 15: 92. Gahan, 1938, Proc. Entomol. Soc. Wash., 40: 213. Graham, 1969, Bul. Brit. Mus. (Nat. Hist.) Entomol., Suppl. 16, p. 801.

Type-species: Tritneptis hemerocampae Girault, by original designation.

Generic description: Head slightly broader than thorax at tegulae; vertex relatively broad, length of head at meson in dorsal aspect from ⅓ to ⅕ as great as its width; occiput not margined; antennae inserted slightly below level of ventral margins of compound eyes, apex of scape not quite reaching level of anterior ocellus; pedicel long, longer than any funicular segment and usually equal to club; 2 ring segments present, 6 funicular segments present, the first usually slightly the longest; face strongly receding below antennal bases, forming angles of 90 to 115 degrees with posterior margin of compound eye; mandibles symmetrical, each with 4 teeth; clypeal margin straight or with obscure, toothlike projections. Pronotum anteriorly ecarinate; notaulices incomplete posteriorly; forewing with margin vein 1½ to 3 times as long as stigmal vein, postmarginal and stigmal veins almost or quite equal in length; hind tibia with one apical spur; each tarsus with 5 segments. Propodeum strongly sculptured, with or without median carina, lateral carinae present or absent; apical neck absent or poorly developed. Gaster sessile, subequal in length to thorax and propodeum combined, subrectangular in shape. Male with antennal scape and legs stouter than in female; funicular segments shorter than in female; gaster slightly shorter than in female. Males usually greatly in the minority in reared series.

Key to Females

1. Forewing shaded with brown over most of its disc; dorsum of thorax with strong, minute, alveolate sculpture, color deep metallic blue, not shining; propodeum dark purple; marginal vein 3 times as long as stigmal .... *scutellata* (Muesebeck)
   Forewing hyaline; dorsum of thorax black, more or less shining and with weak sculpture, sometimes with faint metallic brassy luster; propodeum not purple; marginal vein not more than 2 times as long as stigmal 2
2. Lateral carinae of propodeum complete and sharply defined, fig. 1 .... *koebelei* Gahan
   Lateral carinae of propodeum incomplete, fig. 3, or not sharply defined, fig. 2 3
3. Head in lateral aspect with face entirely ventral, forming a 90 degree angle with posterior margin of compound eye; sculpture of dorsum of thorax extremely weak, surface almost smooth 4
   Head in lateral aspect with face not entirely ventral, forming more than a 90 degree angle with posterior margin of compound eye; dorsum of thorax with distinct, though shallow, sculpture 5
4. Forewing with short marginal cilia on apical and hind margins; dorsum of thorax moderately shining and black .... *klugii* (Ratzeburg)
   Forewing without marginal cilia; dorsum of thorax black with faint metallic brassy luster .... *doris* new species
5. Pedicel 3 times as long as greatest width; basal cell of forewing bare .... *hemerocampae* (Girault)
   Pedicel 2 times as long as greatest width; basal cell of forewing with numerous weak cilia .... *diprionis* Gahan

Tritneptis doris new species

This species agrees with *klugii* (Ratzeburg) in having the face entirely ventral, lying at a right angle to the posterior margin of the compound eye, and in having the dorsum of the thorax very shallowly sculptured and shining. The two differ in that the forewing of *klugii* has a distinct fringe of short cilia at its apical and posterior margins, while the margins of the forewing in *doris* are bare; the thoracic notum of the female of *klugii* is shining black, but in *doris* it has a distinct metallic brassy luster; the male antennal scape in *klugii* is enlarged, but it is not angularly produced near the base, fig. 4, as it is in *doris*, fig. 5.

Female: Length, 2.0–2.8 mm. Head dull black, thorax black with faint metallic brassy luster, propodeum dull black, gaster dark tan to black; antennal scape, pedicel, ring segments, and all legs beyond coxae, deep yellow to tan; antennal funiculus and club, wing veins, and mandibles, brown; venter of gaster at base may be yellow in some specimens, and propodeum has faint bluish tint in a few specimens. Head closely and finely reticulated; thorax slightly shining, with very shallow sculpture on dorsum; propodeum strongly shagreened; gaster smooth, shining.

Head in dorsal aspect 5 times as wide as long at meson; face entirely ventral, lying at a 90 degree angle to the posterior margin of the compound eye. Malar furrow absent; length of malar space ½ eye height. Ocellocular line ⅗ as long as postocellar line. Eyes bare. Relative lengths of parts of antenna: scape, 25; pedicel, 10; first funicular segment, 5; second to sixth segments, 4 each; club, 10. Mandible with 4 teeth, 2 acute ventral teeth, third tooth subacute, dorsal tooth blunt.

Forewing without fringe of marginal cilia; marginal vein twice as long as stigmal, postmarginal and stigmal veins equal in length; submarginal vein with 11–13 dorsal bristles; basal cell bare. Hindwing with marginal cilia; one straight and 2 recurved hamuli present. Pronotum and mesonotum sparsely setose, mesoscutellum setose only at lateral margins. Prepectus faintly sculptured, almost smooth; mesopleuron and metapleuron with strong, semi-alveolate sculpture except for smooth area just ventral to base of forewing. Femora inflated, at widest point, fore femur ¼ as wide as long, mid femur ⅕ as wide as long, hind femur ⅓ as wide as long.

Propodeum strongly shagreened; median longitudinal carina present and complete, incomplete, or almost absent; lateral carinae present anteriorly, absent posteriorly; areas lateral to spiracles with relatively sparse, long hair. Gaster subequal in length to thorax and propodeum combined.

Male: Length, 1.5–2.3 mm. Head dark with faint metallic green luster; thorax black with faint metallic blue luster on pronotum and mesoscutum, mesoscutellum with bronzy luster; propodeum dark with metallic blue luster; gaster dark brown with faint metallic blue luster visible at base and apex; antennae yellow to tan; femora light brown basally, shading to yellow at apices; tibiae yellow, usually shading to tan at apices; tarsi and wing veins yellow.

Antennal scape enlarged, fig. 5, angularly produced near base; relative lengths of parts of antenna: scape, 18; pedicel, 5; first to sixth funicular segments, 2 each; club, 8. Ocellocular line ⅔ as long as postocellar line. Face not entirely ventral, lying at a 110 degree angle to posterior margin of compound eye. Hind tibia enlarged toward apex, much stouter than in female; tarsi shorter than in female. Gaster slightly shorter than in female.

Type-locality: Upton, Wyoming.

Holotype: Female, USNM no. 71046.

Described from 96 female and 7 male specimens. Holotype, allotype, 86 female and 4 male paratypes from Upton, Wyoming, reared 21 June 1940, from pupae of *Coloradia doris* Barnes (Lepidoptera, Saturniidae), larvae of which fed on *Pinus ponderosa* N. D. Wygant, Hopkins no. 31406-N-1; 9 female, 2 male paratypes, from 10 miles west of Wales, Utah, 13–18 August 1969, reared from *Hemileuca* sp. (Lepidoptera, Saturniidae), pupae from soil beneath *Symphoricarpos* D. R. Christensen, Hopkins no. 53525-B.

LITERATURE CITED

BOUČEK, Z. *in* J. KRATOCHVÍL. 1957. Klíč zvířeny ČSR, Díl II, 9, Chalcidoidea, p. 204–245, 269–288 [English translation pub. by O. Peck as Mem. 34, Entomol. Soc. Canada, 1964, 120 p.].

GAHAN, A. B. 1938. Notes on some genera and species of Chalcidoidea (Hymenoptera). Proc. Entomol. Soc. Wash. 40: 209–227.

GIRAULT, A. A. 1908. A peculiar case of parasitism with *Hemerocampa leucostigma* Smith and Abbot, with description of a new genus and species of Pteromalidae. Psyche. 15: 89–96.

———. 1924. Notes and descriptions of Australian Chalcidflies-II. Ins. Ins. Mens. 12: 172–176.

GRAHAM, M. W. R. DE V. 1969. The Pteromalidae of North-western Europe. Bul. Brit. Mus. (Nat. Hist.) Entomology, Suppl. 16, 980 p.

Vol. 84, No. 2, pp. 7–12 30 June 1971

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

ON THE GRAMMAR OF NAMES FORMED WITH *-SCELUS*, *-SCELES*, *-SCELIS*, ETC.

By George C. Steyskal
Systematic Entomology Laboratory, Entomology Research Division, Agr. Res. Serv., USDA[1]

There are many names in zoology, both genus-group and species-group names, which end in *-scelus*, *-skelus*, *-skelos*, *-sceles*, *-skeles*, *-scelis*, *-skelis*, *-scela*, *-scelia*, *-scelum*, etc. The grammatical usage of these names has been confused, with many emendations and variations in their gender and case-forms. I wish to present here a basis for their correct usage. These names constitute an unusually complex case, with most of the difficulties encountered in the grammar of nomenclature.

Most of the names refer to characters of legs and therefore must be derived from the Greek σκελος *skelos* (leg), a noun of neuter gender[2] equivalent to the Latin *crus*, which is also neuter. If names are formed directly from this noun, they will end in *-scelus* (recommended latinization), *-skelus*, or *-skelos*, be of neuter gender, and have the genitive *-sceli* or *-skeli*. There is also, but unlikely to be found in zoological names, a Latin *scelus*, meaning 'heinous act, crime, sin,' also of neuter gender and with the genitive *sceli*.

Names ending in *-sceles* (Greek form) or *-scelis* (Latin form), as well as the transcriptional variations with *k*, if based upon *skelos*, are adjectives (except *Periscelis*, see below).

Lexicons also cite σκελις *skelis* (feminine gender; genitive σκελιδος *skelidos*) as an Attic dialectical form of σχελις *schelis*

---

[1] Mail address: Systematic Entomology Laboratory, USDA, c/o National Museum, Washington, D.C. 20560.

[2] Article 30a.i.3 of the International Code of Zoological Nomenclature, however, states that "names ending in *-us*, latinized from the Greek endings *-os* (*os*), . . . are masculine. . . ."

(ribs of beef), later in plural form as σκελιδες *skelides* (hams or sides of bacon), or as a variant of σκελλις *skellis* (fem.; gen. σκελλιδος *skellidos*) a late word for ἀγλις *aglis* (a head of garlic).

The Greek noun *skelis* is thus by its meanings irrelevant to zoological names referring to characters of legs, but it has been used to form names referring to characters of the *costa* (Latin for 'rib') and other parts of the wing of insects.

The names formed upon these bases will therefore be treated grammatically in two ways, depending upon their meaning.

Names ending in *-is*, when referring to 'leg,' unless that ending is part of a complete classical derived noun (see *Periscelis*, below), should be considered as latinized compound adjectives similar to *fuscipalpis* (from *palpus*), *fuscipennis* (from *penna*), *fuscicornis* (*from cornu*), or *megalotis* (from ὀυς, *ous*; gen. ὠτος *ōtos*). In their use as genus-group names, these compound adjectives, both in *-is* and in *-es* are used as nouns; their gender according to the Code (Art. 30a.i.2) will be determined in the original publication by statement or by combination with a species-name indicating the gender, otherwise they must be treated as masculine. When used as species-group names, they assume their basic nature of adjectives and will change according to the gender of their genus-name. Adjectives in this class end in *-is* for both masculine and feminine genders, but replace the *-is* with *-e* for neuter.

As shown in the last three lines of the table below, any

		Gender-forms of adjectives (Nominative)		
Ending of name	Genitive (noun or adj.)	Masc.	Fem.	Neut.
-scelus (neuter noun)	*-sceli*	–	–	–
-sceles (basically adjectival)	*-scelis*	*-sceles*	*-sceles*	*-sceles*
-scelis ('leg,' Neo-Latin adj.)	*-scelis*	*-scelis*	*-scelis*	*-scele*
" ('leg,' CLASSICAL derived noun, e.g., *Periscelis*)	*-scelidis*	–	–	–
" ('rib, costa,' fem. noun)	*-scelidis*	–	–	–
" ('rib, costa,' adjective)	*-scelidis*	*-scelis*	*-scelis*	*-scele*
-scela (feminine noun)	*-scelae*	–	–	–
-scelia " "	*-sceliae*	–	–	–
-scelum (neuter noun)	*-sceli*	–	–	–

genus-group name formed upon either of these bases but with a change of gender-ending (to *-a*, *-ia*, *-um*, etc.) will be of the gender indicated by the new ending (*-a*, *-ia*, fem.; *-um*, neuter) and have the regular Latin genitives for those endings.

The genitive forms, needed when forming names of supra-generic taxa and when naming other organisms after the taxa bearing these names, are tabulated along with the gender-forms of the adjectives (species-group names) as in the table above.

The only case wherein a word used as a species-group name ending in *-is* can definitely be considered an adjective is when it is used with a neuter genus-name and in the form *-scele* (3rd and 6th lines of above table).

A few general examples may be adduced:

1) *Campyloscelus* Schoenherr, 1845 (Coleoptera). The author cited the derivation from "καμπυλος, *curvus*, σκελος, *crus*." The sole original species, *C. westermanni*, being a genitive construction, did not indicate the gender, but dictionaries show the gender of *-scelus* as neuter. The genitive is *campylosceli*. The names *Anoploscelus* Pocock, 1897 (Arachnida); *Brachyscelus* Bate, 1861 (Crustacea); *Heteroscelus* Baird, 1858 (Aves); *Platyscelus* Bate, 1861 (Crustacea); and *Plocoscelus* Enderlein, 1922 (Diptera) may be cited as grammatically similar additional examples, regardless of the gender given them by their authors. The sole original species of *Platyscelus* has a name which is an adjective of masculine form, although it should be neuter, and the sole originally included species of *Brachyscelus* is *B. crusculum*, which species-name is a diminutive (neuter) of the neuter noun *crus* in apposition.

2) *Parascela* Baly, 1878 (Coleoptera), and *Bradyscela* Bryce, 1910 (Rotifera) are feminine by ending. *Odontoscelia* Enderlein, 1922 (Diptera), differentiated from a related genus by strong thornlike bristles on its fore femur, is likewise feminine by ending. *Platyscelum* Audouin, 1826 (Arachnida) is neuter for the same reason.

3) *Anoplosceles* Warren, 1896 (Lepidoptera) had no cited derivation, although the hind tibia was characterized as spurless (*anoplo-*). The sole original species is *A. nigripunctata*. This genus-name is an adjective used as a noun, with its gender indicated as feminine by the species-name used with it. *Hyperskeles* Butler, 1883 (Lepidoptera) is grammatically similar; dictionaries cite an adjective ὑπερσκελης *hyperskelēs* and the sole original species is *H. choreutidea*.

4) *Lycosceles* Konow, 1905 (Hymenoptera). The author cited the derivation from λυκος *lykos* + σκελος *skelos*; it is therefore an adjective of Greek form used as a noun, but the gender was not stated. Since the original species is *L. herbsti* (genitive), the gender was not originally indicated either, and the gender according to the Code must be masculine.

5) *Glyptoscelis* Chevrolat *in* Dejean, 1837 (Coleoptera). No derivation was cited, but the name must refer to the characteristically sulcate tibiae of the species. The names of a few previously described species with masculine gender-endings were originally cited, thus indicating a Neo-Latin adjectival *-is* form. Later authors have generally incorrectly treated the genus as feminine. The genitive is identical with the nominative: *glyptoscelis*, and any suprageneric taxon based upon a name such as this would end in *-scelidae*, *-scelinae*, *-scelini*, etc.

6) *Periscelis* Loew, 1858 (Diptera). Since Loew stated that the genus was named for the annulate legs of the species, it must, as Becker (1914, Arch. Naturgesch. 80A:38) pointed out, come from περισκελις *periskelis* (anklet), a classical Greek noun of feminine gender formed with a prepositional prefix, and not a Neo-Latin compound. The genitive of *periskelis* is *periskelidos*, in Latin *periscelidis*. The family name based upon this genus is therefore Periscelididae.

7) *Trixoscelis* Rondani, 1856 (Diptera). This name can only refer to the spines on the wing margin (costa) and therefore must be derived from the noun *skelis*, although no derivation was originally cited. No original binominal combination was made, and the name therefore could be considered fundamentally as either noun or adjective, although in its capacity as a genus-name it must be treated as a noun. It seems logical to give preference to the possibility of its being basically a noun (feminine), as authors have generally done. The genitive is *trixoscelidis*, and the family name is therefore Trixoscelididae, rather than Trixoscelidae.

8) The species-name *leucoscelis*, proposed in *Bembidion* (as *Bembidium*) by Chaudoir, 1850 (Coleoptera) would properly have had the form *leucoscele* if it had been considered an adjective. As a noun it would have to be derived from *skelis* and refer to a 'rib' character, possibly to a white elytral interstria, and have the genitive *leucoscelidis*. But if the name refers to a leg character and therefore is an adjective in an incorrect gender-form, then the genitive would be *leucoscelis*.

All of these time-consuming and frustrating complexities, which are due to two things, the three gender-forms of Latin words and the irregularities of the formation of the genitive case, make one wonder how an improvement might be effected.

A scheme of automatic gender determined solely by the form of the nominative would be but little improvement because of the great number of changes resulting in the million or so names already proposed while doing nothing for the complexities of the gender-forms of adjectives and the genitives.

The usage of the originally proposed form of species-group names, regardless of its grammatical correctness or the gender of any genus to which the name may be transferred, is not an improvement because it leads to a condition wherein the several gender-forms occur in the same genus with reference to the original description as the only means of determining the 'correct' form.

A practical simplification at this stage in the history of nomenclature could, however, be effected in the way that some natural languages have become simpler by the complete abolition of gender, with the use of only one form of adjectival names (? the dictionary-citation form, masculine) together with the simplification by fiat of the formation of the genitive case.

Vol. 84, No. 3, pp. 13–38 30 June 1971

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

PALEOCENE PRIMATES FROM THE SHOTGUN MEMBER OF THE FORT UNION FORMATION IN THE WIND RIVER BASIN, WYOMING

By C. Lewis Gazin
Department of Paleobiology, Smithsonian Institution,
Washington, D.C. 20560

During the summer of 1959, while carrying on a geologic study of the Shotgun Butte area in the western part of the Wind River Basin in Wyoming, W. R. Keefer of the U.S. Geological Survey discovered a fossiliferous horizon in the Fort Union formation remarkably rich in the remains of vertebrate animals, particularly mammalian teeth. A sample collection was sent to me for study and report, and my tentative list of the Mammalia encountered was included in his report of 1961 (see also Keefer and Troyer, 1964). The original locality is in the SE¼ of sec. 30, T. 6 N., R. 3 E. (Keefer, 1965, p. A10), about 220 feet above the base of the upper part of the Fort Union formation which Keefer (1961) named the Shotgun member.

Collections by parties from the Smithsonian Institution in 1961 and 1964 were made at the original locality, where the steeply south dipping bed was found to extend from near the Cottonwood Creek road in the south-central part of Section 30 eastward to the northwest slope of a prominent butte in the SE¼ of section 30. Collecting by parties from the University of Wyoming and the Museum of Comparative Zoology have included localities described (Patterson and McGrew, 1962) as in the NE¼, SE½[1], sec. 31. A collection made by McKenna

---

[1] This has since been corrected by MacIntyre (1966) to read SE¼.

in 1965 for the American Museum is not recorded as to precise locality, but only as coming from low in the Shotgun member. More recently Craig Wood of the Museum of Comparative Zoology has devoted considerable time to a study of this occurrence and has made collections from various localities in the Shotgun member as exposed in Cottonwood Creek-Twin Buttes area, but evidently most of the materials he has obtained are essentially from about the same faunal unit although there is a stratigraphic difference of about 90 feet between his upper and lower levels within the lower part of the member.

At the time of my original listing of the Mammalia represented in Keefer's 1959 collection, David H. Dunkle reported (also in Keefer, 1961) on the fossil fish remains in this collection and I briefly discussed the occurrence and its age in the Wyoming Geological Association Guidebook for 1961. In 1962 Patterson and McGrew in joint papers described arctocyonid creodont and picrodontid insectivore(?) remains from the Shotgun faunal horizon. Subsequently McGrew (1963) discussed the environmental significance of the shark teeth found in the collections and MacIntyre included Shotgun materials in his study of Paleocene miacid carnivores. The present study of the primates was undertaken in a cooperative arrangement with Craig Wood, who in 1967 expressed to me an interest in studying the occurrence as a doctoral thesis at Harvard University. The present study completes my contribution to the faunal investigation.

The age of the Shotgun fauna,[2] as represented in the abundantly fossiliferous zone low in the Shotgun member, appears rather clearly to be upper or late Torrejonian, about intermediate between the essentially middle Torrejonian fauna represented in the Gidley Quarry or the No. 2 level of the Lebo in Montana and the early Tiffanian represented at the lowest or saddle locality in the Bison Basin of Wyoming. This age assignment was made tentatively in 1961, although certain features of the association led me at that time to conclude that further study might demonstrate an early Tiffanian age.

---

[2] Not to be confused with the fauna known from near the top of the member as exposed on Shotgun Butte proper, which I have found to include *Plesiadapis*, cf. *cookei*, *Phenacodus primaevus*, and *Ectocion ralstonensis*, and to represent a late Paleocene or early Eocene age.

Further review of the materials, however, particularly the primates, rather strikingly demonstrates the intermediate character of the greater part of the fauna.

The primates occurring in the Shotgun fauna may be listed as follows:

PLESIADAPIDAE
  Pronothodectes intermedius, n. sp.
  Plesiadapis, sp.

PAROMOMYIDAE
  Palenochtha, cf. *minor* (Gidley)
  Palaechthon woodi, n. sp.
  Palaechthon, near *P. alticuspis* Gidley
  Plesiolestes, cf. *problematicus* Jepsen
  Cf. *Torrejonia wilsoni* Gazin
  Paromomys, near *P. depressidens* Gidley
  Phenacolemur fremontensis, n. sp.
  Phenacolemur, cf. *frugivorus* Matthew and Granger

CARPOLESTIDAE
  Elphidotarsius shotgunensis, n. sp.
  Carpodaptes, sp.

The relative stage represented by the foregoing primate assemblage is perhaps best shown by the intermediate character of the rather abundant materials of *Pronothodectes intermedius* which tends to bridge the gap between *P. gidleyi* of the Lebo and *P. simpsoni* of Bison Basin. The presence of such genera as *Palenochtha*, *Palaechthon*, *Plesiolestes*, *Torrejonia*, *Paromomys*, and *Elphidotarsius* argue strongly for a Torrejonian assignment, noting, however, that certain of these are distinctly more progressive than their Lebo counterpart. On the other hand, *Plesiadapis*, *Phenacolemur*, and *Carpodaptes* are more suggestive of a Tiffanian stage, although one of these, *Phenacolemur fremontensis*, is clearly less progressive than the Melville and Tiffany forms. Certain materials, such as those of *Plesiadapis* sp., *Phenacolemur*, cf. *frugivorus*, and *Carpodaptes* sp., seem advanced over those of closely related forms in the fauna and might suggest a mixture of materials from different levels. A review of the occurrences of each of these forms, although but sparsely represented in any case, show an association in certain restricted localities with one or more forms that are regarded as structurally more indicative of the intermediate position in time. *Plesiadapis* sp., has been found associated with most of the forms, particularly *Pronothodectes intermedius* at the original locality in section 30. *Phenacolemur*, cf. *frugivorus* occurs in an M.C.Z. field locality designated as "Williams extension" associated with *Pronothodectes*, *Palaechthon*, *Torrejonia*, and *Paromomys*. *Carpodaptes* sp., on the other hand, has been found only on certain anthills, but at one of these ("Anthill #1") where it occurs with fairly large teeth of *Plesiadapis* sp., there were also found an upper molar regarded as representing *Phenacolemur fremontensis* and two lower molars of *Pronothodectes intermedius*. Certain of Wood's anthill localities, however, invariably include material of the more advanced forms, suggesting a slightly later stage with possibly relict representation of apparently earlier types, unless, of course, association is due to an admixture of materials through stream washing or reworking during sedimentation.

Acknowledgment is made of the courtesy extended by Dr. Paul O. McGrew of the University of Wyoming, Dr. Malcolm C. McKenna of the American Museum of Natural History, and particularly of Mr. Craig B. Wood of the Museum of Comparative Zoology, in turning over to me for this study the primate materials in their respective collections from the Shotgun Butte area. The pencil-shaded drawings of the specimens, the histogram and other graphic displays included in this report were prepared by Mr. Lawrence B. Isham, staff illustrator for the Department of Paleobiology in the National Museum of Natural History.

PLESIADAPIDAE

Pronothodectes intermedius n. sp.

(Figs. 1–3)

Type: Left ramus of mandible with P_4–M_3, U. of Wyo. No. 3223.

Horizon and locality: Shotgun member of Fort Union formation, near Cottonwood Creek, sec. 30–31, T. 6 N., R. 3 E., northwestern part of Wind River Basin, Wyoming.

Specific characters: Intermediate in size between *Pronothodectes matthewi* Gidley (1923) and *Pronothodectes simpsoni* Gazin (1956). Talonid

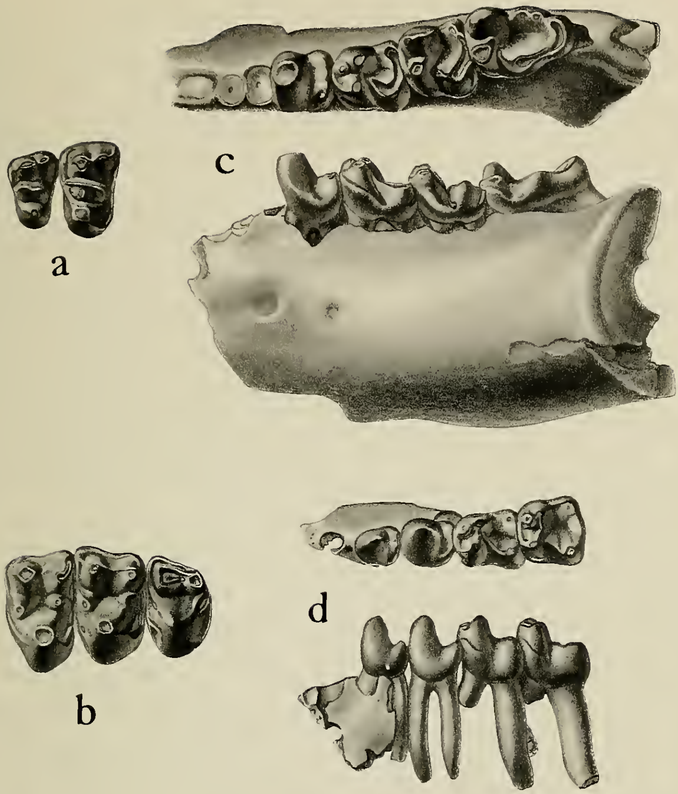


FIG. 1. *Pronothodectes intermedius*, n. sp. a, Lt. P^3 and P^4, M.C.Z. no. 18742, occlusal view. b, Lt. M^1–M^3, A.M.N.H. no. 88308, occlusal view. c, Lt. ramus of mandible with P_4–M_3, U.W. no. 3223 (type), occlusal and lateral views. d, Lt. P_3–M_2 with jaw fragment, U.S.N.M. no. 26339, occlusal and lateral views. All figures ×4.

crest on P_4 slightly broader than in *P. matthewi*. Lower molars relatively broad.

Discussion: In the collections available to me there are ten lower jaw fragments with two or more teeth; two of these have three teeth and two others have four teeth each. However, only two maxillary fragments, one exhibiting P^3 and P^4 (see Fig. 1a), and the other M^1–M^3 (see Fig. 1b), include more than one tooth. Nevertheless, approximately 270 isolated cheek teeth are recognized as representing *P. intermedius*, of which 125 are uppers.

In addition to the maxillary fragment with P^3 and P^4, there are about

22 isolated upper premolars almost evenly divided between third and fourth. P^3 and P^4 are rather alike except that P^3 is a little smaller and more nearly triangular in outline. Both exhibit the prominent conule presumed to be the protoconule. The metacone (or tritocone) is distinct and rather close to the paracone on P^4 but on P^3 it is usually weaker and sometimes imperceptible. The protocone (or deuterocone) is a strongly developed, essentially circular cone on P^4 with a somewhat longer posterior slope. This cusp, though prominent, is relatively smaller on the more constricted talon of P^3. The external cingulum is only weakly developed on P^4 and usually but scarcely evident on P^3. The outer margin of these teeth in occlusal view is gently convex, but occasionally indented on P^4, with rounded anterior and posterior angles. A small parastyle is evident on P^4 at the antero-external angle, and lingual to this the anterior cingulum extends to the base of the protocone and descends to the apex of this cusp as a very weak crest on its antero-external surface. It may also send a branch anterior to the base of the protocone. A posterior cingulum, somewhat concave in occlusal view, extends from the base of the weak posterior crest of the metacone to a position posterolingual to the protocone then descends as a weak crest to the apex of this cusp. The cingula on P^3 are more weakly developed and apparently do not extend down toward the apex of the protocone. A small parastyle may be seen on some P^3's, but not invariably.

In a comparison with smaller *Pronothodectes matthewi* it is seen that certain isolated P^4's of *P. intermedius* come very close in cusp development and arrangement. I note, however, in the type of *P. matthewi,* which is the only specimen at hand with P^4 preserved, the antero-external angle is more acute, although the parastyle is less distinctly developed as a cuspule than is usual in *P. intermedius.* It should be noted, however, that teeth in this type are somewhat worn. P^3 is not included in the material of *P. matthewi* at hand, and no upper premolars of *P. simpsoni* have been seen.

The anterior upper molars of *Pronothodectes intermedius* are nearly quadrate in outline but with the lingual margin more convex and somewhat oblique. M^1 and M^2 are much alike except that M^1 is smaller and relatively shorter transversely and often a little narrower lingually. The paracone and metacone in both are about equal in size, well spaced, and with a subdued anteroposterior crest joining them and extending from these cusps to the cingulum fore and aft. The protocone is noticeably larger than the outer cusps. It is essentially a rounded cone with low but distinct external crests to the small conules and a posterior crest to the cingulum. The conules are sharply set off from the external cusps but a crest extends from the protoconule to the antero-external angle of the tooth. The prominent external cingulum is slightly bilobed to nearly straight, extending around the moderately blunt antero-external and postero-external angles, where it descends slightly to meet the crests from the paracone and metacone respectively. There is no mesostyle but a few teeth show a very weak median cuspule on the external cingulum.

The anterior cingulum extends inward prominently to join the protoconule. A part of the anterior cingulum which terminates lingually anterior to the protocone may join the crest from the protoconule but is often discontinuous at this point. The posterior cingulum extends lingually from the posterior crest of the metacone, becoming decidedly shelflike as it approaches the posterior slope of the protocone where it turns abruptly and descends more subdued to the apex of this cusp. A cingular crest is not developed lingual to the protocone.

M^3 is smaller than M^2 and the outer wall is more oblique with the postero-external angle decidedly obtuse. The external and posterior cingular margins are generally more convex and the anterior margin may be a little more convex than in the anterior molars. The metacone is well spaced from the paracone but noticeably smaller. The protocone is well developed, but the conules, particularly the metaconule, appear more subdued.

The upper molars of *Pronothodectes intermedius* are much like those in the type of *P. matthewi,* except for a slightly more inflated appearance of the cusps and the crests are a little better defined, although as noted above, the teeth in this type show some evidence of wear, as they do in the figured upper molars of *P. intermedius.* In M^1 it is noted that the lingual portion is generally not so narrow relatively and the postero-external angle is usually not so acute as in *P. matthewi,* although the specimen here figured is more like *P. matthewi* in this respect. A single first upper molar in the Bison Basin collection, believed to represent *P. simpsoni,* is seen to be more rounded and relatively a little longer anteroposteriorly. It also shows relatively weaker crests and conules than is usual in the smaller M^1's of *P. intermedius.*

Among the lower jaw fragments only two are sufficiently preserved anteriorly to give indication of the number of teeth represented. The type of *P. intermedius* (Fig. 1c) and a referred specimen (USNM No. 26339, see Fig. 1d) show a strong single root for P_2 and a somewhat smaller alveolus immediately antero-external to P_2, extending downward and outward postero-external to the enlarged incisor. It has a position much as in *P. simpsoni* but noticeably less procumbent. It may well be for the canine (probably not P_1 as suggested by me in 1956). An alveolus in about this position with respect to the large incisor in a specimen of *P. matthewi* (USNM No. 9332) is just ahead of the small canine and thought by Simpson (1937) to be for a vestigial lateral incisor. Other jaws of *P. matthewi* in the U.S. National Museum collections apparently show no indication of this vestige, so that the formula for the lower dentition, except for an occasional vestige of a probable lateral incisor in *P. matthewi,* is essentially the same in all three species.

Although undoubtedly represented, the probable canine and P_2 have not been recognized among the isolated teeth in the collections. About 21 isolated posterior lower premolars have been identified and in one specimen (USNM No. 26339) P_3 and P_4 are associated. In only this specimen and in the type is P_4 found associated with the molars. P_3 and

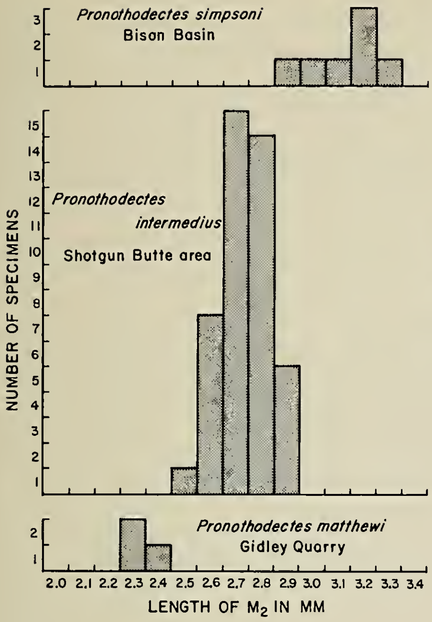
P_4 are very much alike but differ in size and there is a somewhat more inflated appearance to the primary cusp in P_4. There is no evidence of a parastylid or metaconid on either. The length of the talonid appears variable but is generally rather short and exhibits a transverse crest posteriorly which is relatively narrower in P_3. This crest may be smooth and somewhat convex upward or incipiently bicuspid.

P_4 in *P. intermedius*, in addition to its greater size, exhibits a more inflated primary cusp than in *P. matthewi* and the posterior crest of the talonid is not so constricted transversely. P_4 in still larger *P. simpsoni*, though somewhat variable in proportions, appears relatively more elongate than in *P. intermedius* and the talonid may be more distinctly bicuspid. P_3 is not represented in the Gidley Quarry material of *P. matthewi* at hand, and in only a badly worn specimen of *P. simpsoni*.

The lower molars are well represented in *P. intermedius* and there are well over a hundred isolated teeth in addition to the ten lower jaw portions. M_1 is a little shorter than M_2 and both M_1 and M_3 are narrower. M_1 tapers forward somewhat, whereas in M_2 the trigonid and talonid portions are more nearly the same width. The elongate talonid of M_3 may be slightly narrower than the trigonid but in some instances it is broader across the hypoconid and entoconid. The hypoconulid portion of M_3 is generally broad. The outer walls of the trigonids are decidedly sloping, most noticeably in M_1, where the apex of the trigonid is transversely more constricted with the protoconid closer to the somewhat better separated paraconid and metaconid than in M_2. The crista obliqua generally shows a notch or crease immediately anterior to the hypoconid and this crest generally terminates abruptly against the wall of the trigonid posterior to the protoconid, but in M_1 it tends to rise obliquely toward the metaconid. The entoconid in M_1 and M_2 at the postero-internal angle of the tooth is elevated, but a little less so than the hypoconid. The crest between these cusps is somewhat depressed and there is no hypoconulid. The crest forward from the entoconid slopes downward and joins the postero-lingual margin of the trigonid at a sharp angle enclosing a talonid basin that appears relatively short and broad in M_1 and M_2. In M_3 the talonid is decidedly elongate and has a broad crestlike hypoconulid as well as a prominent hypoconid, but the entoconid is often poorly defined or has lost its identity on the lingual crest.

The anterior lower molars are much alike in the three species, although in certain specimens of *P. intermedius*, particularly the type, they appear relatively a little broader than in the other two forms, contributing to the somewhat shorter and broader appearance of the talonid basin. The hypoconulid portion of M_3 is rather variable, but appears generally to be a little less constricted than in *P. simpsoni*, but not invariably so. I note further that, as in *P. matthewi*, the cingulum antero-external to the protoconid in all of the molars tends in general to be a little better defined than in *P. simpsoni*.

Graphs have been prepared showing a comparison between *P. intermedius*, earlier *P. matthewi*, and later *P. simpsoni* in the length of M_2.



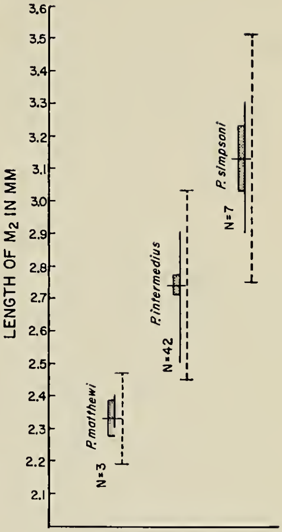


FIG. 2 (left). Histogram of length of M_2 in species of *Pronothodectes* from three horizons of the Paleocene; middle Torrejonian (below), late Torrejonian (middle), and early Tiffanian (above).

FIG. 3 (right). Graphic display of differences in mean, observed range, and theoretical range of the length of M_2 in three forms of *Pronothodectes* from the Paleocene; *P. matthewi* (lower left) from the middle Torrejonian Gidley Quarry, *P. intermedius* (middle) from the later Torrejonian in the Shotgun Butte area, and *P. simpsoni* (upper right) from the early Tiffanian at Bison Basin. The solid vertical line represents the observed range in the length of M_2. The rectangle represents the range of $(M - 2\sigma_m)$ to $(M + 2\sigma_m)$ with the mean marked as a crossbar. The dashed line represents the theoretical range $(M \pm 3\sigma)$. (See Simpson and Roe, 1939, p. 318.)

One of these (Fig. 2) is a display of frequency distributions and shows the intermediate character of this variable in *P. intermedius*. The other (Fig. 3) is a graphic representation of the observed and theoretical ranges in the length of M_2 as well as a comparison of the means, which have been expanded by twice the standard error of the mean above and below its arithmatic value (see Simpson and Roe, 1939, p. 318). In one form, *P. matthewi*, the number of specimens involved for mathematical treatment is clearly inadequate, but from other considerations the separation of *P. intermedius* from *P. matthewi* might seem a little better defined than perhaps its separation from *P. simpsoni.* Nevertheless, in a time sequence of variants, such as involved here, recognition of an intermediate form is by nature arbitrary, but there would here appear to be a reasonable basis, and definition of a separate entity has practical value in discussions of faunal relationships and comparative ages.

Measurements (in mm) of teeth in specimens of *Pronothodectes intermedius.*

	M.C.Z. No. 18742	A.M.N.H. No. 88308
Length of upper molar series	—	6.7
P^3, anteroposterior diameter externally	2.0	—
P^3, transverse diameter perpendicular to outer wall	2.4	—
P^4, anteroposterior diameter externally	2.2	—
P^4, transverse diameter perpendicular to outer wall	3.4	—
M^1, anteroposterior diameter externally	—	2.3
M^1, transverse diameter perpendicular to outer wall	—	3.5
M^2, anteroposterior diameter externally	—	2.4
M^2, transverse diameter perpendicular to outer wall	—	3.7
M^3, anteroposterior diameter through midsection	—	2.1
M^3, greatest transverse diameter	—	3.2

	U. of Wyo. No. 3223 (type)	U.S.N.M. No. 26339	M.C.Z. No. 18741
Length of lower molar series	8.5	—	8.6
P_3, anteroposterior diameter	—	1.7	—
P_3, transverse diameter	—	1.4	—
P_4, anteroposterior diameter	2.1	2.0	—
P_4, transverse diameter	2.0	1.8	—
M_1, anteroposterior diameter	2.4	2.4	2.6
M_1, greatest transverse diameter	2.4	2.2	2.2
M_2, anteroposterior diameter	2.6	2.6	2.7
M_2, greatest transverse diameter	2.5	2.5	2.5
M_3, anteroposterior diameter	3.6	—	3.7
M_3, greatest transverse diameter	2.2	—	2.3

Plesiadapis sp.

Five plesiadapid lower molars, three anterior upper molars, and a premolar are too large to be included with the material of *Pronothodectes intermedius.* Moreover, the relatively greater width of the lower molars, particularly across the talonid portion is quite unlike *Pronothodectes* and strongly suggests *Plesiadapis*. In size they closely approach the Tiffanian forms *Plesiadapis anceps* Simpson (1936) and *Plesiadapis jepseni* Gazin (1956) and the lowers resemble both in the marked outer slope of the trigonid. A third lower molar exhibiting a rather broad talonid suggests *P. jepseni* or *P. gridleyi* rather than *P. anceps*. Also, the upper premolar here included, unlike *P. anceps*, has a well developed conule. The presence or absence of a P_2 cannot, of course, be determined.

Distinct from the foregoing there is a third lower molar from an anthill locality that is quite as large as would be expected in *Plesiadapis rex* (Gidley, 1923).

PAROMOMYIDAE

Palenochtha, cf. *minor* (Gidley)

An exceedingly small primate is represented by five lower teeth, three M_1's and two M_2's. In size they are slightly but not significantly larger than in the type of *Palenochtha minor* (Gidley, 1923) which they strongly resemble. The first molars are almost identical to those of *P. minor* although I note a slightly better defined entoconid in the Shotgun material. In the second molars, believed to represent the same form, the cusps of the trigonid are a little less well defined with the paraconid and metaconid a little closer together.

These teeth also compare well in size with those in the type of *Navajovius kohlhaasae* Matthew and Granger (1921), being only slightly smaller for the most part. A rather distinctive difference, however, is noted in the trigonid of the first molars which, as in *P. minor*, have a much more oblique posterior wall. Also, as noted in the material of *Palaechthon* as well as in *Palenochtha*, the talonid basin does not appear so elongate, with the crista obliqua more oblique, not so forward directed as in *Navajovius*.

So far no upper molars in the collections have been recognized as belonging to this form, although upper molars of *Palenochtha minor* from the Gidley Quarry are rather distinctive.

Palaechthon woodi[3] n. sp.

(Fig. 4a)

Type: Portion of left ramus of mandible with P_4–M_2 (MCZ No. 18740)

Horizon and locality: Shotgun member of Fort Union formation, near Cottonwood Creek, section 30 or 31, T. 6 N., R. 3 E., northwestern part of Wind River Basin, Wyoming.

Specific characters: Size of teeth distinctly smaller than in *Palaechthon alticuspis* Gidley (1923). P_4 with parastylid and metaconid a little less well defined. Primary cusp of P_4 and trigonids of molars relatively a little less elevated.

Discussion: In addition to the type lower jaw (Fig. 4a) there are

---

[3] Named for Craig Wood who found the type specimen.

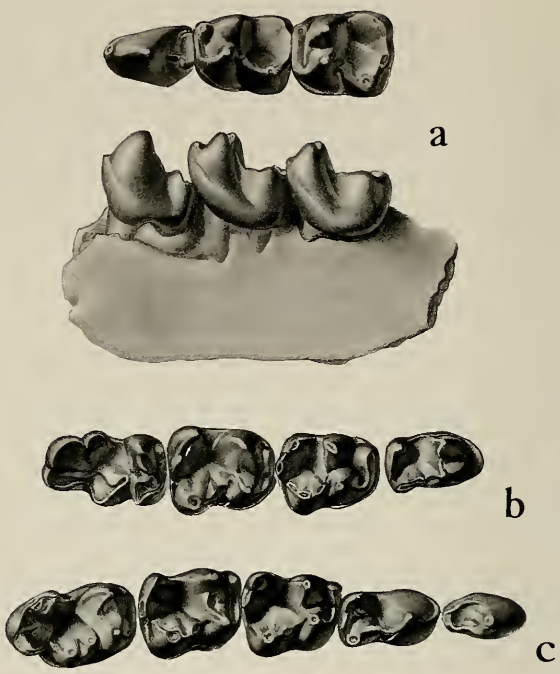


FIG. 4. a, *Palaechthon woodi*, n. sp., Lt. ramus of mandible with P_4–M_2, M.C.Z. no. 18740 (type), occlusal and lateral views, ×8. b, *Plesiolestes*, cf. *problematicus* Jepsen, composite right lower cheek-tooth series: P_4, M.C.Z. no. 18770; M_1, M.C.Z. no. 18771; M_2, M.C.Z. no. 18772; and M_3, A.M.N.H. no. 88313; occlusal view, ×6. c, Cf. *Torrejonia wilsoni* Gazin, composite right lower cheek-tooth series: P_3, M.C.Z. no. 18759 (reversed); P_4, M.C.Z. no. 18760; M_1, M.C.Z. no. 18761; M_2, M.C.Z. no. 18762; M_3, U.W. no. 3251; occlusal view, ×4.

about 13 isolated teeth that appear to represent this form, nine of which are lowers. The teeth are about midway in size between those of *Palaechthon alticuspis* from the Gidley Quarry and much smaller *Navajovius kohlhaasae* Matthew and Granger (1921) from the later Tiffany beds.

Among the four upper teeth believed to represent *Palaechthon woodi* there is a P^4, not represented in the *Palaechthon alticuspis* material at hand, which resembles this tooth in *Navajovius kohlhaasae*. In addition to its greater size it shows a relatively greater transverse width, with the conical deuterocone a little more lingual in position. The cuspate parastyle projects well forward as in *N. kohlhaasae*, and the postero-external angle and the posterior crest from the primary cusp are similarly developed, except that there is indication of a weak tritocone in *N. kohlhaasae* not seen in the tooth referred to *P. woodi.*

Two anterior upper molars, possibly M^1 and M^2, are comparatively small, a little nearer *N. kohlhaasae* in size, but are relatively much wider transversely, as they are in *P. alticuspis.* The outer cusps with the strong postero-external crest from the metacone and configuration of the outer cingulum are very much as in *P. alticuspis.* The outer cingulum on these teeth in *N. kohlhaasae* is noticeably more reduced. The elongate talon of these molars exhibits a large forward placed protocone and a strong posterior cingulum which at its lingual extremity is deflected toward the protocone much as in *P. alticuspis* but does not show the more cuspate development of a hypocone on the relatively weaker posterior cingulum seen in *Navajovius.* It may be noted that in *Palenochtha minor* the elongate talons of the upper molars are rather sinuous in outline. The conules in the *P. woodi* (?) teeth are clearly defined at the outer extremities of the low crests from the protocone. They are triangular in outline and sharply separated from the adjacent outer cusps.

A third upper molar that may belong to *P. woodi* is a little large relative to the anterior molars discussed above but is smaller than in the one specimen of *P. alticuspis* that has this tooth preserved. It has the elongate talon with the strong posterior cingulum exhibited in *P. alticuspis.* The external cingulum, however, is more convex about the paracone and small metacone, and there is less development of the parastyle. In *Navajovius* this tooth with its narrower talon is decidedly more triangular in outline and the cingula are less developed.

Among the isolated lower teeth of *P. woodi* there are two P_4's tentatively assigned, in addition to this tooth in the type lower jaw. P_4 has much the same form as that in *P. alticuspis,* although the primary cusp appears to be relatively a little less elevated than in the type of the latter. It should be noted, however, that there is some variation in the height of this cusp in referred material of *P. alticuspis.* The parastylid and metaconid in P_4 of *P. woodi* are not so well developed as in *P. alticuspis* and are scarcely evident in one of the referred premolars of *P. woodi.* The talonid of P_4 is slightly damaged in the type of *P. woodi* but with the aid of the referred specimens it is seen that there is a high posterior crest, essentially bicuspid, which externally curves forward to join medially the posterior wall of the primary cusp, much as in *P. alticuspis.* In *Navajovius kohlhaasae* the primary cusp has a somewhat more inflated appearance with no cingulum developed, there is no parastylid, and only the slightest evidence of a metaconid. The talonid is relatively much narrower and the posterior crest less evidently cuspate, with the crest forward to the primary cusp joining its posterior wall somewhat more lingually.

The anterior lower molars, represented by six isolated teeth in addition to the type, are essentially similar to those in *P. alticuspis,* although, as noted for the primary cusp of P_4, the trigonid appears a little less elevated in a comparison of the types. Also the metaconid, as well developed as the protoconid in *P. woodi,* appears a little less inflated than in *P. alticuspis.* The antero-external cingulum about the protoconid is much the same. The talonid portions, except for size, are nearly identical, with both showing a small cuspule or swelling on the crista obliqua. The much smaller anterior molars in *Navajovius kohlhaasae* are relatively longer and narrower. This is most noticeable in the talonid basin, and the crista obliqua is smoother and directed more forward, not so oblique as in *P. woodi.* Moreover, there is no development of a cingular crest about the protoconid of M_1, although this is slightly evident on M_2 in *N. kohlhaasae.*

A single isolated M_3, corresponding in size and in the character of the trigonid with anterior molars of *P. woodi,* is much as in referred material of *P. alticuspis* (the type lacks M_3) although again the trigonid appears a little less elevated than in USNM Nos. 9602 and 9486 from Gidley Quarry, and the protoconid as well as the metaconid is less inflated appearing. The talonid is rather similar although a little less constricted across the hypoconulid. In form the M_3 referred to *P. woodi* is not greatly different than that in *N. kohlhaasae,* but it should be noted that in *Palaechthon* M_3 is not nearly so reduced in size relative to M_2 as it is in *Navajovius.*

Measurements (in mm) of lower teeth in species of *Palaechthon.*

	P. woodi MCZ 18740 (type)	*P. alticuspis* USNM 9532 (type)
P_2, anteroposterior diameter		1.2
P_2, transverse diameter		0.8
P_3, anteroposterior diameter		1.2
P_3, transverse diameter		0.7
P_4, anteroposterior diameter	1.6	2.0
P_4, transverse diameter	1.1	1.2
M_1, anteroposterior diameter	1.8	2.1
M_1, greatest transverse diameter	1.3	1.5
M_2, anteroposterior diameter	1.9	2.2
M_2, greatest transverse diameter	1.4	1.6

Palaechthon, near *P. alticuspis* Gidley

Among the isolated teeth are three upper and four lower molars that appear referable to *Palaechthon* and are only slightly larger than *P. alticuspis.* Although there is a close resemblance to *P. alticuspis,* I note that the cusps in both upper and lower teeth are a little blunter. Also, the talon of the anterior upper molars seems broader and the anterior lower molars appear relatively a little wider. In detail the cusps of the trigonid in the lower molars are actually more like *P. woodi* but there is too great a discrepancy in size for this species to be represented.

Plesiolestes, cf. *problematicus* Jepsen
(Fig. 4b)

Approximately 45 isolated teeth are recognized as representing a form of *Plesiolestes*, probably not distinct from *Plesiolestes problematicus* Jepsen (1930). About three-fourths of these are lower teeth which show a range in size closely comparable to that in the Rock Bench material.

Particularly characteristic of *Plesiolestes* is the advanced molariform condition of P_4 (see Fig. 4b), in which the metaconid is large and the talonid has a well developed basin. The paraconid is prominent, though low and well forward, and is sharply deflected lingually from the steeply sloping anterior crest of the protoconid. The talonid in most instances has about the same width as the trigonid and exhibits a well defined hypoconid and entoconid at the posterior angles of the tooth. Where not obscured by wear the posterior crest between the hypoconid and entoconid may show a somewhat flattened hypoconulid, perhaps a little more sharply separated from the hypoconid than from the entoconid. The crista obliqua extending forward to a low point on the posterior wall of the protoconid may show evidence of an incipient cuspule. It is of further interest to note that among the ten P_4's seen, three (those in the American Museum collection from unrecorded localities in the area) show a weaker metaconid, more closely appressed to the protoconid. The larger of these (AMNH No. 88312), which is associated with a P_3, also exhibits a relatively wider talonid than the others. These may represent individual variation, but the possibility that a different species is represented among the materials is not certainly eliminated.

Among the isolated lower molars (see Fig. 4b) it is sometimes difficult to distinguish M_1's from M_2's, evidently because of the molariform condition of P_4. The anterior molars, it is noted, show a high trigonid with well developed cusps. An anterior transverse crest is developed from the anterior slope of the protoconid, terminating lingually in a prominent paraconid, which tends to be a little more forward and less lingual in M_1's. The metaconid is somewhat elongate antero-externally and this is nearly matched by an anterolingual ridge on the protoconid. These projections join about midway between the anterior crest and the posterior wall of the trigonid. The relatively broad talonid exhibits a well developed hypoconid and entoconid at the posterior angles, with their apices conical and raised above their respective crescents. The crista obliqua is generally notched and deeply folded on the lingual side, defining a sometimes prominent cuspule anterolingual to the hypoconid. The posterior crest of the talonid shows an anteroposteriorly flattened hypoconulid more sharply separated from the hypoconid than the entoconid, a little as in the mixodectids. A cingular shelf or ridge is developed around the base of the protoconid, extending around the front of the tooth. Occasionally it extends weakly around the hypoconid.

In M_3, four of which were seen, the trigonid portion is much as in the preceeding tooth and the talonid portion is characterized by well separated, essentially conical cusps, with that on the crista obliqua well defined. The third lobe or hypoconulid portion of the tooth is distinctly bilobed and set off from the hypoconid portion by a rather deep external re-entrant. As in the anterior molars, the cingulum extends across the front, around the protoconid base, and may continue posteriorly around hypoconid.

Upper teeth of *Plesiolestes* have not been described, but assuming a close relationship between *Plesiolestes* and *Palaechthon*, as discussed by Simpson (1937b, p. 143), approximately a dozen Shotgun upper molars showing a resemblance to *Palaechthon alticuspis*, but of a size appropriate for *Plesiolestes problematicus*, have been tentatively included with this material. These show a similar transverse elongation but with somewhat higher cusps and conules. The external cingulum and the crest joining it from the metacone are perhaps a little more outstanding. Also, there is better evidence in certain of the molars for a definable hypocone.

Cf. *Torrejonia wilsoni* Gazin

(Fig. 4c)

About 14 lower teeth and possibly three upper molars represent a primate which appears very close to *Torrejonia wilsoni* Gazin (1968), although slightly larger in size. Originally described from the Torrejon middle Paleocene of New Mexico it has since been tentatively recognized in beds of about that age in the Evanston formation of southwestern Wyoming (Gazin, 1969).

The upper molars are rather questionably referred but show some resemblance to the isolated upper molar from the Torrejon thought to be of *Torrejonia*. They vary somewhat in size and in their relative transverse width, but show the elongate slender talon with less expansion of the postero-internal basin in comparison with *Paromomys maturus*, as does the Torrejon upper molar.

Among the lower teeth are three P_3's and one P_4. These have essentially the same form as in the type but with a slightly better developed talonid. In P_3 the anterior crest extends downward and inward much as in the Torrejon specimen but two of these show an almost imperceptible parastyle at the anterior flexure. In all three there is better development of a postero-internal cusp on the talonid, although it should be noted that the type is slightly damaged at this point. In P_4 (see Fig. 4c) the primary cusp is almost identical in form with that in the type but the posterior wall does not show the weak double flexure near its apex seen in the type. There is no evidence of a metaconid. The talonid has much the same form as in P_4 of the type but is relatively a little longer and broader with a stronger hypoconid and an almost imperceptible hypoconulid. The differences between *Torrejonia wilsoni* and *Paromomys maturus* in the character of P_4 are somewhat emphasized in the Shotgun Butte tooth.

The configuration of the lower molars (see Fig. 4c) is quite as in the type material, but with possibly stronger cusps and crests, although this is less evident in comparison with the Torrejon referred M_2 (USNM No.

25257) which corresponds closer in size to Shotgun Buttes material. Nevertheless, the anterior crest and parastyle are a little better defined than in the Torrejon materials, as is the posterior crest of the talonid and its slightly broader elevation of the hypoconulid portion in M_1 and M_2.

M_3 is not represented in the Torrejon material, but three M_3's in the Shotgun Buttes material are of an appropriate size and exhibit a trigonid so like that in the several M_2's represented that there seems no doubt of their relationship. The talonid portion shows a strongly developed hypoconid with a deep lingual fold on the crista obliqua much as in M_2, and as also noted in *Paromomys maturus*. The entoconid, as in the anterior teeth, is more prominently developed and the hypoconulid portion, strongly bicuspid in at least one of the teeth, is more constricted posterior to the hypoconid than in smaller *Paromomys maturus*. This constriction is emphasized by the relatively greater breadth of the talonid forward across the hypoconid-entoconid portion in the Shotgun Buttes M_3's.

Paramomys, near *P. depressidens* Gidley
(Figs. 5a and b)

Approximately twelve upper teeth and eight isolated lower teeth in addition to a jaw fragment with M_1 and M_2 (AMNH No. 88310, see Fig. 5b) represent a form that appears close to the Crazy Mountain species *Paromomys depressidens* Gidley (1923). The teeth average a little smaller than in that species and in details of structure they appear slightly more progressive in the direction of *Phenacolemur*. Nevertheless, they resemble a little more closely *P. depressidens* than they do contemporary and later materials of *Phenacolemur*. Of the two forms of *Paromomys* known from the Gidley Quarry, *P. depressidens* is distinctly more *Phenacolemur*-like than the genotype, *Paromomys maturus*, particularly in the forward tilt of the trigonid in the lower molars.

It has been possible to select a composite series of upper teeth from P^4 to M^3 that appear to be conspecific (Fig. 5a). These are only slightly smaller than in the type of *P. depressidens*. The relative width of these teeth transversely is decidedly more as in *P. depressidens* than it is, for example, in *Phenacolemur frugivorus* Matthew and Granger (1921). The one P^4 here included has the primary cusp (paracone) and deuterocone (protocone) somewhat less strongly developed than in the type of *P. depressidens*, although a tritocone (metacone) is perhaps a little better defined, but not, however, as in *Phenacolemur*. The outer wall of this tooth is convex as in *P. depressidens*, not bilobed as in *Phenacolemur*, but the gently sloping posterolingual basin is a little better expanded than in the Lebo specimen. The primary cusps of the molars are much as in *P. depressidens* and I see little in the outer wall and cingulum to distinguish them. I note, however, a slightly greater lingual expansion of the postero-internal basin in most of the molars than in the type, giving the lingual margin a slightly bilobed appearance, more distinctly seen in *Paromomys maturus* and certain referred specimens of *P. depressidens*,

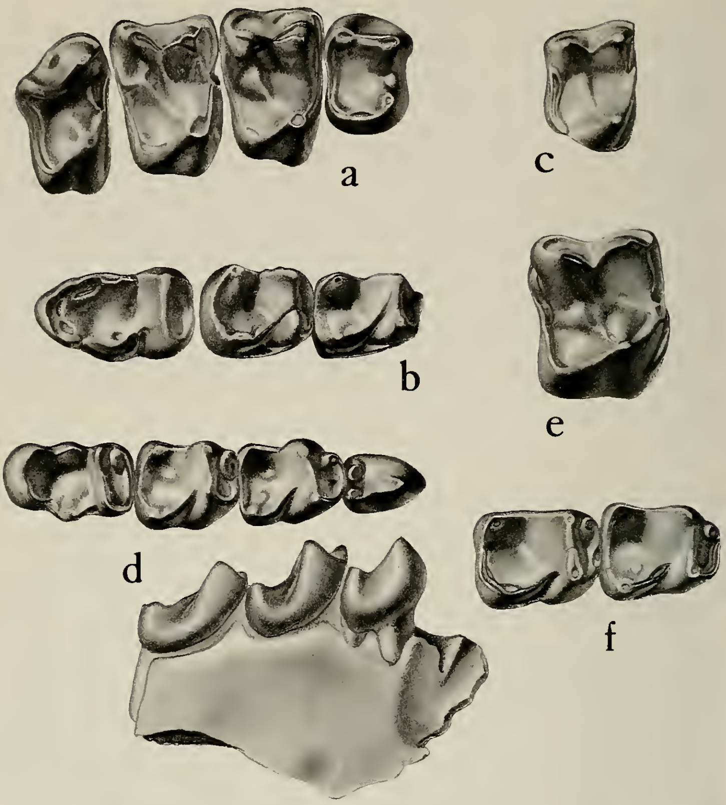


FIG. 5. a and b, *Paromomys*, near *P. depressidens* Gidley. a, Composite right upper cheek-tooth series: P^4, M.C.Z. no. 18764; M^1(?), U.W. no. 3247; M^2, U.W. no. 3248; M^3, U.W. no. 3249; occlusal view. b, Composite right lower cheek-tooth series: M$_1$ and M$_2$, A.M.N.H. no. 88310; M$_3$, M.C.Z. no. 18765. c and d, *Phenacolemur fremontensis*, n. sp. c, Rt. M^2(?), U.W. no. 3250, occlusal view. d, Rt. ramus of mandible with P$_4$–M$_2$, A.M.N.H. no. 88309 (type), occlusal and lateral views (M$_3$ in occlusal view, M.C.Z. no. 18766 reversed, not part of type). e and f, *Phenacolemur*, cf. *frugivorus* Matthew and Granger. e, Rt. upper molar, M.C.Z. no. 18767, occlusal view. f, Composite right anterior lower molars: M$_1$, M.C.Z. no. 18768; M$_2$, M.C.Z. no. 18769; occlusal view. All figures ×8.

but this basin is not developed posteriorly as in *P. frugivorus*. The conules of the upper molars are for the most part rather indistinct or non-existent. The protoconule in the Gidley Quarry materials is a little more evident.

The lower teeth regarded as representing a species close to *P. depressidens* include four M_1's, three M_2's and one M_3, in addition to the jaw fragment with two anterior molars. These all show the forward sloping trigonid, or the phenacolemurid-like appearance of the *P. depressidens* lower molars. The crown of the trigonid in some of the teeth, however, tends to be a little more rectangular than in the earlier material, although I note some variation in this respect. In *P. depressidens* the crown of the M_1 trigonid is essentially triangular and in the succeeding molars the anterior margin is in general distinctly convex forward. In the Shotgun material three of the M_1's (as in Fig. 5b) show an antero-external angle giving the trigonid a less triangular appearance. This portion, however, is not so shortened anteroposteriorly as, for example, in *Phenacolemur frugivorus*. Two of the isolated M_2's, as well as the single third molar shown in Figure 4b, exhibit a trigonid crown a little less convex forward than in most of the *P. depressidens* material. The talonid portions of the lower molars are essentially as seen in the Gidley Quarry materials, except that the third lobe or hypoconulid portion of M_3 appears a little less constricted transversely, but not nearly so broadened as in *Phenacolemur*.

Measurements (in mm) of teeth in *Paromomys*, near *P. depressidens*.

P^4 (M.C.Z. No. 18764),	
anteroposterior diameter externally	1.6
transverse diameter	1.9
M^1(?) (U.W. No. 3247),	
anteroposterior diameter externally	1.8
transverse diameter anteriorly	2.6
M^2 (U.W. No. 3248),	
anteroposterior diameter externally	1.8
transverse diameter anteriorly	2.7
M^3 (U.W. No. 3249),	
anteroposterior diameter perpendicular to anterior wall	1.4
greatest transverse diameter	2.5
M_1 (A.M.N.H. No. 88310),	
anteroposterior diameter	2.0
greatest transverse diameter	1.5
M_2 (A.M.N.H. No. 88310),	
anteroposterior diameter	2.2
greatest transverse diameter	1.6
M_3 (M.C.Z. No. 18765),	
anteroposterior diameter	2.7
greatest transverse diameter	1.6

Phenacolemur fremontensis n. sp

(Figs. 5c and d)

Type: Right ramus of mandible with P_4–M_2 (A.M.N.H. No. 88309).
Horizon and locality: Shotgun member (lower level) of Fort Union

formation, near Cottonwood Creek, sec. 30–31, T. 6 N., R. 3 E., northwestern part of Wind River Basin, Wyoming.

Specific characters: Size of P_4 much smaller than in *Phenacolemur frugivorus.* Lower molars a little smaller and relatively much narrower, with talonid basins relatively longer and narrower.

Discussion: Two isolated upper molars (one shown in Fig. 5c) are referred to this species, and in addition to the type lower jaw (Fig. 5d) there are ten isolated lower molars. These teeth are only a little smaller than those described above as *Paromomys*, near *P. depressidens*, but are distinctly more phenacolemurid appearing.

The isolated upper molars, evidently both M^2's, are shorter anteroposteriorly than in the type of *P. frugivorus* and seem to be relatively a little wider transversely. They show the somewhat oblique (antero-external to postero-internal) elongation, and with the metacone a little smaller than the paracone, much as in the Tiffanian type. While only a little smaller than the M^2 in the material described as more closely related to *P. depressidens*, they show a decidedly more expanded posterolingual basin, as seen in *P. frugivorus.* The crests from the protocone are low, except that enclosing the posterolingual basin, and directed much as in the Tiffany form, with essentially no development of the conules.

P_4 is recognized only in the type lower jaw and is seen to conform closely to this tooth in the Melville lower jaw of *P. frugivorus* figured by Simpson (1936, Fig. 13; and 1955, Pl. 32, Fig. 1) but is relatively much smaller than in this specimen, or that from the Colorado Tiffany (A.M.N.H. No. 17408). The tooth has a simple, single cusped primary portion with a smoothly convex anterior margin, as seen in profile, and a relatively broad bicuspid talonid portion. The anterior molars are only a little shorter than in *P. frugivorus*, but relatively narrower, particularly M_2. This gives the trigonids and talonid basins a more elongate appear-

Measurements (in mm) of teeth in *Phenacolemur fremontensis*, n. sp.

M^2 (U.W. No. 3250),	
anteroposterior diameter externally	1.6
transverse diameter anteriorly	2.5 (est.)
P_4 (A.M.N.H. No. 88309, type),	
anteroposterior diameter	1.3
transverse diameter	0.9
M_1 (A.M.N.H. No. 88309, type),	
anteroposterior diameter	1.7
greatest transverse diameter	1.2
M_2 (A.M.N.H. No. 88309, type),	
anteroposterior diameter	1.7
greatest transverse diameter	1.3
M_3 (M.C.Z. No. 18766),	
anteroposterior diameter	2.3
greatest transverse diameter	1.2

ance anteroposteriorly. The trigonid crowns are more nearly rectangular than in the Shotgun material referred to *Paromomys*, near *P. depressidens*. In M_2 of *P. fremontensis* the width of the trigonid and talonid portions is about equal, whereas in *P. frugivorus* the talonid portion is noticeably wider than the trigonid column. M_3, except for its smaller size, is strikingly like that in the figured lower jaw of *P. frugivorus* (Simpson, 1935, Fig. 7).

Phenacolemur, cf. *frugivorus* Matthew and Granger

(Figs. 5e and f)

Two upper molars and eight isolated lower molars are too large to be included in the materials designated *Phenacolemur fremontensis*. These are entirely comparable in size to teeth in *Phenacolemur frugivorus* Matthew and Granger (1921). One of the upper teeth, an anterior molar (Fig. 5e) is slightly longer anteroposteriorly than either M^1 or M^3 in *P. frugivorus* and is relatively a little wider. It is not nearly so large or relatively wide, however, as in *Phenacolemur pagei* Jepsen (1930) from the Silver Coulee at Polecat Bench, to judge by Simpson's figures (1955, Pl. 33, Figs. 1 and 2) in his comparison between *P. frugivorus* and *P. pagei*. The lower molars (Fig. 5f) appear entirely comparable in size and relative width to those of *P. frugivorus*, although the M_2's show a little less difference in width between the trigonid and talonid than seen in the Tiffany jaw from Colorado (A.M.N.H. No. 17405). The width of the lower molars is not nearly so great relative to length, as observed in Simpson's illustration of *P. pagei* (1955, Pl. 32, Fig. 2).

CARPOLESTIDAE

Elphidotarsius shotgunensis n. sp.

(Figs. 6a and b)

Type: Right ramus of mandible with P_4 and M_1, A.M.N.H. No. 88311.

Horizon and locality: Shotgun member of Fort Union formation near Cottonwood Creek, sec. 30–31, T. 6 N., R. 3 E., northwestern part of Wind River Basin, Wyoming.

Specific characters: Size of M_1 near that of *Elphidotarsius florencae* Gidley (1923), but P_4 relatively a little larger. Primary portion of P_4 shows four cusps as in *E. florencae*, but possibly less well defined. Trigonid of M_1 with paraconid and metaconid more widely separated but both lingually placed with respect to the protoconid.

Discussion: Of particular interest in the type of *Elphidotarsius shotgunensis* (see Fig. 6a) is the portion of the jaw preserved anterior to P_4. Three nearly circular alveoli are seen, evidently for C (with its root), P_2 and P_3, that for P_2 being slightly smaller than the other two. The first of these is not offset lingually as in *Carpodaptes hobackensis* Dorr (1952). More anteriorly there are three grooves, possibly for three incisors with slender roots that are nearly straight or only slightly curved. These would indicate at least one and possibly two more incisors than seen in

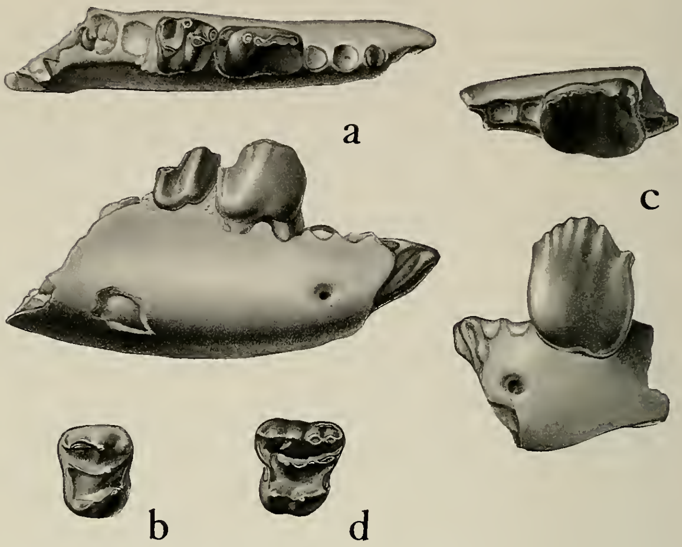


Fig. 6. a and b, *Elphidotarsius shotgunensis*, n. sp. a, Rt. ramus of mandible with P_4 and M_1, A.M.N.H. no. 88311 (type), occlusal and lateral views. b, Rt. upper premolar, M.C.Z. no. 18774, occlusal view. c and d, *Carpodaptes*, sp. c, Lt. ramus of mandible with P_4, M.C.Z. no. 18763, occlusal and lateral views. d, Lt. P^3, M.C.Z. no. 18776, occlusal view. All figures ×6.

C. hobackensis. The lower extremities of the anterior two grooves are close together and appear transversely arranged about beneath the root of the canine. The anterior or inner of the three grooves does not appear as smooth as the second and may not be an alveolus although its configuration is very suggestive. It makes an angle of approximately 45 degrees with the superior margin of the preserved portion of the jaw. The second groove, better formed and less eroded appearing than the first, is most clearly an alveolus. Its size does not appear greatly different than that of the first, but it is less sloping or a little more erect. It is relatively much smaller than the single incisor root in *C. hobackensis.* The posterior and most lateral groove is the smallest and most nearly erect. It is situated immediately anterolateral to the comparatively large alveolus with its preserved root believed to be for the canine. It seems entirely probable that this third groove is an alveolus for a lateral incisor.

P_4 in the type shows a closer correspondence to this tooth in earlier *Elphidotarsius florencae* from Gidley Quarry than to P_4 in the Tiffanian materials of *Carpodaptes* or *Carpolestes.* It appears a little advanced over *E. florencae* in its relatively greater size with respect to the first molar, but not nearly so large as in later genera. The primary portion shows the same four cuspules as in *E. florencae*, although this portion is a little more blunt and the cuspules more subdued, possibly as a result of wear in *E. shotgunensis.* Their alignment is a little better, although the posterior of the four is offset lingually, but not so noticeably as in *E. florencae.* The small talonid portion is much the same in the two forms.

M_1 has a length close to that in *Carpodaptes aulacodon* Matthew and Granger (1923; see also Simpson, 1935) and *Carpodaptes hazelae* Simpson (1936), as well as *Elphidotarsius florencae*, but is not nearly so broad as in these species of *Carpodaptes*, particularly *C. hazelae.* This tooth is comparatively high-crowned, most noticeably on the labial side, with a deep crease separating the column of the hypoconid from that of the higher protoconid. The cusps of the trigonid form a V-shaped pattern which is a little more obtuse than in *E. florencae* but not so nearly aligned anteroposteriorly as in *Carpodaptes.* The short talonid of M_1 with the crista obliqua extending to the summit of the metaconid shows little of significance distinguishing it from that in *E. florencae.* Its basin is not so broad relatively as in *Carpodaptes.*

In addition to the type specimen of *Elphidotarsius shotgunensis* only an isolated M_1 and a right upper premolar, presumably P^4, in the various collections at hand, are thought to represent this species. The M_1 is relatively a little wider than in the type but much less than indicated by Simpson's measurements (1935, p. 12; and 1936, p. 22) for species of *Carpodaptes.* Also, the trigonid is more like that in *E. shotgunensis.*

The upper premolar (Fig. 6b) is much smaller than seen in *Carpodaptes hazelae* (see Simpson, 1936, Fig. 12; and 1937a, Fig. 3) and while upper teeth of *Elphidotarsius* are not known in the Gidley Quarry collections, this tooth would seem to be appropriate in size for *E. shotgunensis.* It is, moreover, somewhat less progressive in its development compared with *C. hazelae* in that there are only three definable outer cusps, the median of which is the largest and well separated from the less elevated antero-external cusp. The latter appears continuous with the weak outer cingulum. The median crest extends from close to the antero-external cusp to the posterior margin of the tooth with the single conule well forward. Lingually, the talon is relatively broad, the deuterocone (protocone) is prominent, and a worn position posterolingually suggests a definable tetartocone (hypocone).

P_4 in the type of *E. shotgunensis* (A.M.N.H. No. 88311) is 1.9 mm long by about 1.2 mm wide. M_2 is 1.5 mm long by about 1.1 mm wide. The referred M_1 (M.C.Z. No. 18775) is 1.6 by about 1.3 mm and the upper premolar (M.C.Z. No. 18774) is 1.5 by 1.8 mm.

Carpodaptes sp.

(Figs. 6c and d)

Two isolated fourth lower premolars from anthill localities are seen to be much too large and high-crowned to represent *Elphidotarsius shot-*

gunensis. In length they are about intermediate between *Carpodaptes aulacodon* and *Carpodaptes hazelae,* but perhaps a little broader than in either. The primary portion of one tooth (M.C.Z. No. 18777) has five cuspules and the other (M.C.Z. No. 18763) has six, a very small cuspule is added on the anterior slope of the latter. Both show a small single cusped talonid, relatively a little smaller and somewhat higher placed than on *E. shotgunensis* but not raised to closely join the cuspules on the crest of the primary portion as in *Carpolestes.*

One of the foregoing fourth lower premolars (M.C.Z. No. 18763, see Fig. 6c) includes a fragment of jaw which exhibits nearly equal sized alveoli for P_2 and P_3. Immediately anterolateral to the first of these is a rather small alveolus, presumably for the canine, which is much smaller appearing than in *Carpodaptes hobackensis.* This is preceeded anteromedially by a large incisor alveolus, only moderately procumbent, with a slope approximating that of the median or second groove in the *Elphidotarsius shotgunensis* jaw.

An isolated third upper premolar (M.C.Z. No. 18774, see Fig. 6d) also from an anthill locality is included here as it closely resembles the tooth figured by Simpson (1937a, Fig. 3) for *Carpodaptes hazelae.* It has the same anteroposterior length as that given in the table of measurements (*ibid.*, p. 8) but is slightly narrower. There are four cusps in the outer row with a small cuspule on the cingulum at the anterior extremity of this row. A somewhat sinuous median crest is exhibited with a well defined cuspule at the anterior extremity, and lingually the talon has two well developed cusps.

LITERATURE CITED

DORR, JOHN A., JR. 1952. Early Cenozoic stratigraphy and vertebrate paleontology of the Hoback Basin, Wyoming. Bull. Geol. Soc. Amer. 63: 59–94.

GAZIN, C. L. 1956. Paleocene mammalian faunas of the Bison Basin in southcentral Wyoming. Smithson. Misc. Coll. 131, No. 6: i–iv, 1–57.

———. 1961. Occurrences of Paleocene Mammalia in Tertiary basins of Wyoming. Wyo. Geol. Assoc. 16th Ann. Field Conf. Guidebook 47–52.

———. 1968. A new primate from the Torrejon middle Paleocene of the San Juan Basin, New Mexico. Proc. Biol. Soc. Wash. 81: 629–634.

———. 1969. A new occurrence of Paleocene mammals in the Evanston formation, southwestern Wyoming. Smithson. Contrib. Paleobiol. 2: 1–17.

GIDLEY, J. W. 1923. Paleocene primates of the Fort Union, with discussion of relationships of Eocene primates. Proc. U.S. Nat. Mus. 63: 1–38.

JEPSEN, G. L. 1930. Stratigraphy and paleontology of the Paleocene of northeastern Park County, Wyoming. Proc. Amer. Philos. Soc. 69: 463–528.

KEEFER, W. R. 1961. Waltman Shale and Shotgun members of Fort Union formation (Paleocene) in Wind River Basin, Wyoming. Bull. Amer. Assoc. Pet. Geol. 45: 1310–1323.

———. 1965. Stratigraphy and geologic history of the uppermost Cretaceous, Paleocene, and lower Eocene rocks in the Wind River Basin, Wyoming. U.S. Geol. Surv. Prof. Paper 495-A: I–IV, A1–A77.

——— AND M. L. TROYER. 1964. Geology of the Shotgun Butte area, Fremont County, Wyoming. Bull. U.S. Geol. Surv. 1157: I–V, 1–123.

MACINTYRE, G. T. 1966. The Miacidae (Mammalia, Carnivora). Part 1. The systematics of *Ictidopappus* and *Protictis*. Bull. Amer. Mus. Nat. Hist. 131: 115–210.

MATTHEW, W. D. AND WALTER GRANGER. 1921. New genera of Paleocene mammals. Amer. Mus. Novit. no. 13: 1–7.

MCGREW, P. O. 1963. Environmental significance of sharks in the Shotgun fauna, Paleocene of Wyoming. Contrib. Geol., Univ. Wyo. 2, no. 63: 39–41.

——— AND BRYAN PATTERSON. 1962. A picrodontid insectivore(?) from the Paleocene of Wyoming. Breviora, Mus. Comp. Zool. No. 175: 1–9.

PATTERSON, BRYAN AND P. O. MCGREW. 1962. A new arctocyonid from the Paleocene of Wyoming. Breviora, Mus. Comp. Zool. No. 174: 1–10.

SIMPSON, G. G. 1935. The Tiffany fauna, upper Paleocene. III. Primates, Carnivora, and Amblypoda. Amer. Mus. Novit. no. 817: 1–28.

———. 1936. A new fauna from the Fort Union of Montana. Amer. Mus. Novit. no. 873: 1–27.

———. 1937a. Additions to the upper Paleocene fauna of the Crazy Mountain field. Amer. Mus. Novit. no. 940: 1–15.

———. 1937b. The Fort Union of the Crazy Mountain field, Montana, and its mammalian faunas. Bull. U.S. Nat. Mus. 169: i–x, 1–287.

———. 1955. The Phenacolemuridae, new family of early primates. Bull. Amer. Mus. Nat. Hist. 105: 411–442.

——— AND ANNE ROE. 1939. Quantitative Zoology. McGraw-Hill Book Co., New York and London. 1st Ed., pp. i–xvii, 1–414.

Vol. 84, No. 4, pp. 39–42 30 June 1971

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

A NEW SPECIES OF THE GENUS *SOLASTER* (ECHINODERMATA: ASTEROIDEA) FROM MARTINIQUE

By Maureen E. Downey
Department of Invertebrate Zoology, Smithsonian Institution, Washington, D.C. 20560

A single specimen of a large handsome new starfish was collected by the Bureau of Commercial Fisheries vessel *Oregon* in Martinique Channel in March 1966. It is so distinctively different from other known species of *Solaster* that, even on the basis of a single specimen, it can safely be said to be undescribed. The family Solasteridae is represented in the Western North Atlantic south of Cape Cod by only two other species, *Solaster caribbaeus* and *Lophaster radians*. This is mainly a boreal family, occurring in shallow to moderately deep waters.

Key to the Caribbean Solasteridae

1. Two distinct and equal series of marginals .... *Lophaster radians* (Perrier, 1881)
   Only inferomarginals distinct 2
2. Rr 2–3[1]; subambulacral spines 6–8 .... *Solaster notophrynus* n. sp.
   Rr 4; subambulacral spines 3–4 .... *Solaster caribbaeus* Verrill, 1915

Solaster notophrynus n. sp.
(Figs. 1A and B)

Rr 2–3; dorsum very inflated, tegument moderately thin; pseudopaxillae low, minute; subambulacral spines 6–8.

Etymology: noto, Greek *notos*—south, and phrynus, Greek *phryne*—toad.

---

[1] R = major radius, from disc center to arm tip; r = minor radius, from disc center to interradial edge of disc.

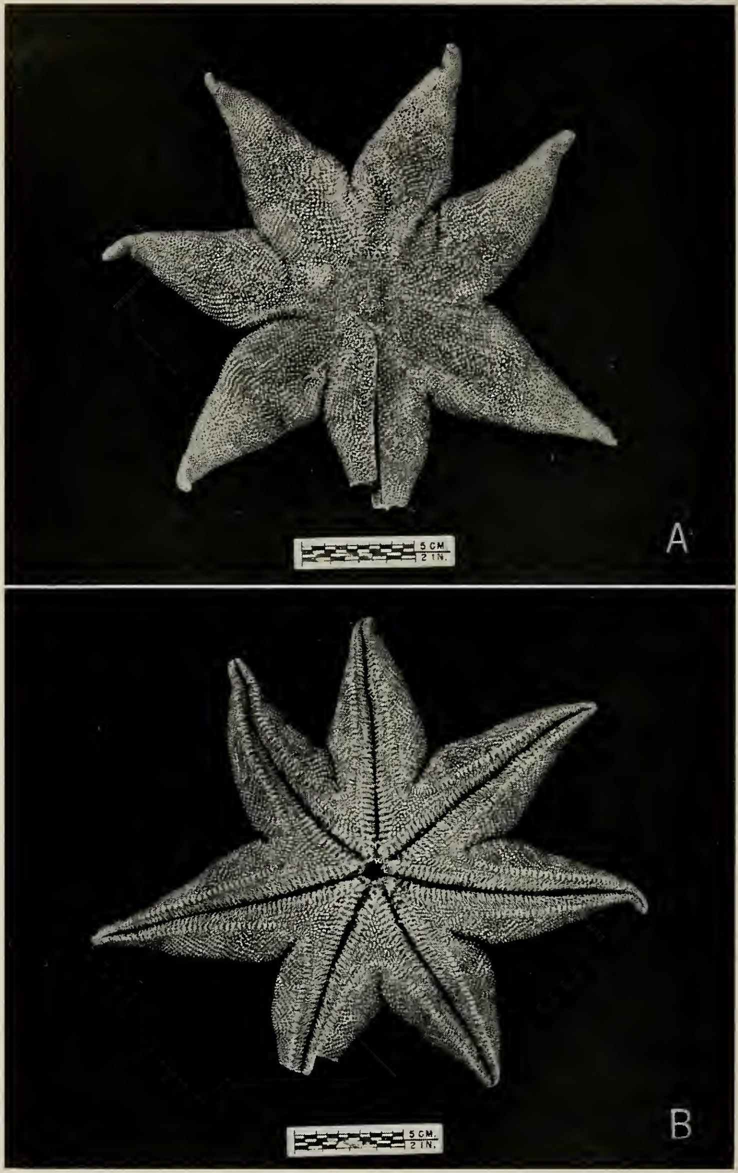


FIG. 1. *Solaster notophrynus*, holotype, USNM (one arm dissected). A. Abactinal, B. Actinal.

Description: R = 114 mm, r = 49 mm; Rr = 1:2.3. Width of arms at base = 48 mm. Arms = 7. Disc broad; arms short, broad, tapering to acute tip. Dorsum inflated, moderately thin. Papular pores numerous, single. Papulae very large. Abactinal plates Y-shaped or cruciform, with long imbricating lobes; no regular arrangement on central disc or mid-arms, but in oblique-transverse rows elsewhere. Pseudopaxilla small, not very high, well-spaced; bearing 10–40 minute thorny spinules. Narrow interradial band with fused plates and few papulae or none. Madreporite minute, nearly hidden by enlarged pseudopaxillae, nearer margin than center, at top of patch of fused abactinals. Superomarginals indistinguishable from adjacent abactinal plates. Inferomarginals confined to actinal surface, about three times as wide as long, high crescentic, bearing numerous small spinules on crest; bare spaces between inferomarginal plates about twice length of plate. Well-spaced actinal plates in irregular chevrons, small, round, or large, elongate, bearing 4–14 spinules; one row extending nearly ¾ of arm. Adambulacral furrow margin curved, bearing four or five setose furrow spines; transverse ridge on actinal face bears six to eight longer, stouter, acute spines. Mouth plates wide, prominent, with eight to ten long tapering webbed oral spines, central pair largest, and a pair of fans of four or five smaller setose spines, one above the other; face of plate covered with setose spinules; suture wide and bare. Internal interradial strut between mouth and body wall a single column of plates embedded in tissue supporting abactinal roof.

Type: Holotype in U.S. National Museum (USNM No. E11383).

Type locality: Martinique Passage, R/V *Oregon* Station 5929, 15°39′N, 61°10′W, 355 fms, March 1966.

Discussion: This species differs from S. *caribbaeus* in the proportion of disc and arms (1:2–3, *vs.* 1:4 for S. *caribbaeus*), in having lower, smaller, and more widely spaced pseudopaxillae, and in having 10–40 very short spinules, while S. *caribbaeus* has six to ten spinules nearly as long as the pedicel. The arms are much shorter and fatter, and the dorsal tegument is thinner and much more inflated. The inferomarginals are confined to the actinal surface entirely, and do not define the actinal ambitus as in S. *caribbaeus*. The transverse row of subambulacral spines numbers six to eight, *vs.* three or four in S. *caribbaeus*, and they are shorter and not as stout. The actinal plates are mostly elongate, with 4–14 small, rather setose spinules, rather than round and bearing two to six relatively robust spinules as in S. *caribbaeus*.

Acknowledgments

I wish to thank Dr. Harvey R. Bullis, of the Bureau of Commercial Fisheries, for supplying the specimen, and Dr. David L. Pawson, of the Smithsonian Institution, for reading the manuscript.

Literature Cited

Perrier, J. Edmund. 1881. Description Summaire des Especes nouvelles d'Asteries. Bull. Mus. Comp. Zool. 9(1): 1–31.

Verrill, A. E. 1915. Report on the Starfishes of the West Indies, Florida, and Brazil, including those obtained by the Bahamas expedition from the University of Iowa in 1893. Bull. Lab. Nat. Hist., Univ. Iowa 7(1): 1–232, 29 pls.

Vol. 84, No. 5, pp. 43–50 30 June 1971

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

TWO NEW SPECIES OF THE GENUS *TAMARIA* (ECHINODERMATA: ASTEROIDEA) FROM THE TROPICAL WESTERN ATLANTIC

By Maureen E. Downey
Department of Invertebrate Zoology, Smithsonian Institution, Washington, D.C. 20560

Two new species of the genus *Tamaria* (Family Ophidiasteridae) have been collected by the Bureau of Commercial Fisheries vessels *Oregon* and *Oregon II* in the tropical Western Atlantic.

The genus *Tamaria* is distinguished by having a rigid body wall, with well-developed abactinal plates in regular longitudinal series; a granulose test; no spines on the abactinal surface of the arms; a small, simple madreporite; and papular areas in 4–6 series, none below the inferomarginal series of plates (a few scattered pores may occur actinally, but there are no regular series of papular areas).

Only one species, *T. floridae*, has been reported from outside the Indo-Pacific region, and H. L. Clark (1921) commented that this might be the basis for erecting a new genus. As *T. floridae* fits well within the definition of the genus as it now stands, there would seem to be little justification for this move, especially in light of the discovery of two additional species from the tropical Western Atlantic.

For convenience, all three of the known species of *Tamaria* from this region are described and figured.

Key to the Western Atlantic species of *Tamaria*

1. Four series of papular areas; arms short, subpetaloid .... *T. passiflora* n. sp.
   Six series of papular areas; arms moderately long, tapering 2

2. Ocular plates small, concealed by granules; average of 3–4 pores per papular area .... *T. floridae* (Perrier)
Ocular plates large, bare; average of 7–8 pores per papular area .... *T. halperni* n. sp.

Tamaria floridae (Perrier)

Ophidiaster floridae Perrier, 1881, p. 9; 1883, p. 221, pl. iv, fig. 1.
Ophidiaster floridae: Verrill, 1915, p. 90.
Tamaria floridae: H. L. Clark, 1921, p. 91.
Hacelia floridae (*pars*): A. H. Clark, 1954, p. 376.

Description: R = 31 mm, r = 7.5; Rr = 4[1]. Disc small, arms five, moderately long, tapering. Carinal, adradial, superomarginal, and inferomarginal plates about equal, similar; no supplementary plates. Six rows of abactinal papular areas, one to seven pores per area (average three or four). Actinal intermediate plates in about three rows, many bearing single flat, appressed, nearly round spine. Adambulacral furrow spines moderately thick, much wider than long. Subambulacral spine nearly round, flat, appressed, with small spinelet or granule at each side of base. Sugar-tongs pedicellariae few, confined to actinal surface, valves very short, sunken in deep alveoli with high, raised, thickened lips. Madreporite small to moderate, triangular, flat, inconspicuous. Oculars small, concealed by granules. Anus very inconspicuous, not much larger than a papular pore, but with about three enlarged surrounding granules.

Material examined: Holotype, MCZ 727, *Blake*, no station, Straits of Florida, 123 ft. Three specimens, *Albatross* Station 2672, 31°31′N, 79° 05′W, 227 fms, May 1886.

Discussion: This rather small species has caused considerable confusion. Perrier gave the locality for the holotype as ". . . remene par la drague de 123 pieds de profondeur dans le detroit de Floride. Communique par M. Alex. Agassiz avant les dragues du "Blake." Verrill (1915) suggested that Perrier meant 123 fathoms, not 123 feet. H. L. Clark (1921) assumed that 123 fathoms was meant, and from this deduced that the locality given was in error, as none of the *Blake* stations listed by Agassiz were at 123 fathoms. He concluded that the holotype was collected from one of two *Bibb* stations off Florida. I can see no reason for either of these assumptions.

Similar confusion exists about the dimensions of the holotype; here Perrier did make a mistake, but Verrill and Clark did not improve matters. I carefully measured the holotype, and the correct dimensions are given above. Finally, A. H. Clark (1954) apparently did not examine the type at all—he called it *Hacelia floridae*, and included in its synonymy three other quite distinct species!

---

[1] R = major radius, from disc center to arm tip; r = minor radius, from disc center to interradial edge of disc.

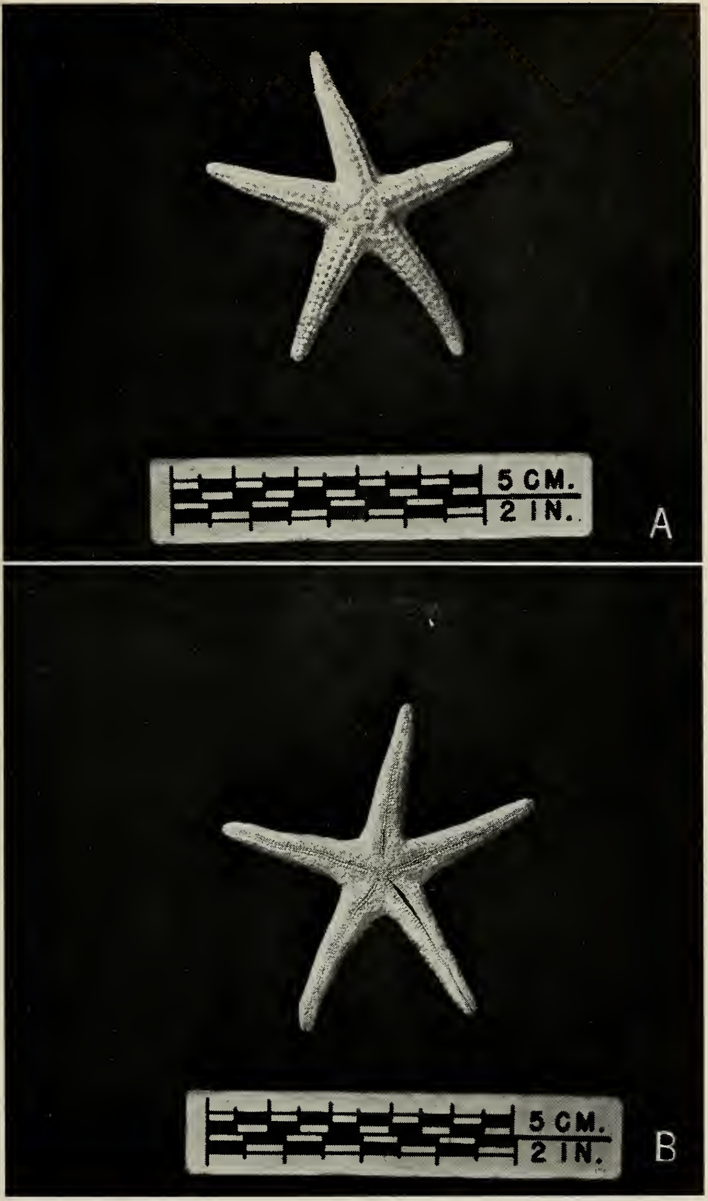


FIG. 1. *Tamaria floridae* (Perrier). A, Abactinal; B, Actinal. USNM No. 18510.

Tamaria halperni n. sp.

Description: Disc of moderate size; arms five, tapering evenly to rounded points. Carinal, adradial, superomarginal and inferomarginal plates slightly tumid, equal, and similar; no secondary plates. Six longitudinal series of papular areas, seven to ten pores per area (fewer in small specimens). All plates with even coating of small granules; few distal marginals usually with central naked area devoid of granules. Four or five rows of actinal intermediate plates, one row extending ⅔ length of arm. Adambulacral furrow spines two, thin, flat, nearly square, very even, regular, and equal. Subambulacral spine oval, longer than broad, flat, appressed (small specimens may have additional small spinule or enlarged granule between subambulacral spines); two subambulacral spines on first adambulacral plate. Mouth plate margin with spines similar to subambulacral spine on actinal face of mouth plate. Pedicellariae numerous, one to each adambulacral plate, plus others scattered on all surfaces; sugar-tongs type, valves short, somewhat triangular, in deep, well-defined alveoli. Madreporite of moderate size, plane, with radiating gyri. Ocular plates large, smooth, oval, raised above general surface. Anus central, conspicuous, surrounded with enlarged granules.

Material examined: 1 specimen, *Oregon* Station 4928, 14°05′N, 81° 21′W, 100 fms, June 1964. R—22 mm, r—5 mm, Rr—4.5.

1 specimen, *Oregon* Station 2643, 18°03′N, 64°27′W, 150–180 fms, October 1959. R—26 mm, r—7 mm, Rr—4.

1 specimen, *Oregon II* Station 10513, 08°26′N, 58°11′W, 100 fms, April 1969. R—36 mm, r—10 mm, Rr—3.5.

1 specimen, *Oregon*, no data. R—20 mm, r—6 mm, Rr—3.5.

3 specimens, *Oregon* Station 6715, 18°36′N, 63°27′W, 110–130 fms, May 1967. R—28 mm, r—6 mm, Rr—4.5.

1 specimen, *Oregon II* Station 10849, 20°50′N, 73°23′W, 170 fms, December 1969. R—53 mm, r—12 mm, Rr—4 (holotype).

1 specimen, *Oregon II* Station 10850, 20°49′N, 73°26′W, 170 fms, December 1969. R—50 mm, r—11 mm, Rr—4.5.

1 specimen, MCZ 3999 (as *Ophidiaster alexandri*), *Atlantis* Station 3480, Cuba: off Bahia de Matanzas, 200 fms.

1 specimen, UMML 40:343, *Pillsbury* Station P-581, 21°05′N, 86°23′W, 146–265 fms, 22 May 1967.

1 specimen, UMML 40:95, *Gerda*, 26°58′N, 79°12.5′W, 280 fms, 5 February 1964.

Types: Holotype (USNM No. E11381) and 8 paratypes in U.S. National Museum. One paratype (MCZ No. 3999) in the Museum of Comparative Zoology, Harvard University.

Type locality: Caribbean, West Indies.

Discussion: This species is apparently widespread in the Caribbean and would undoubtedly have been described previously had it not been confused with *T. floridae*.

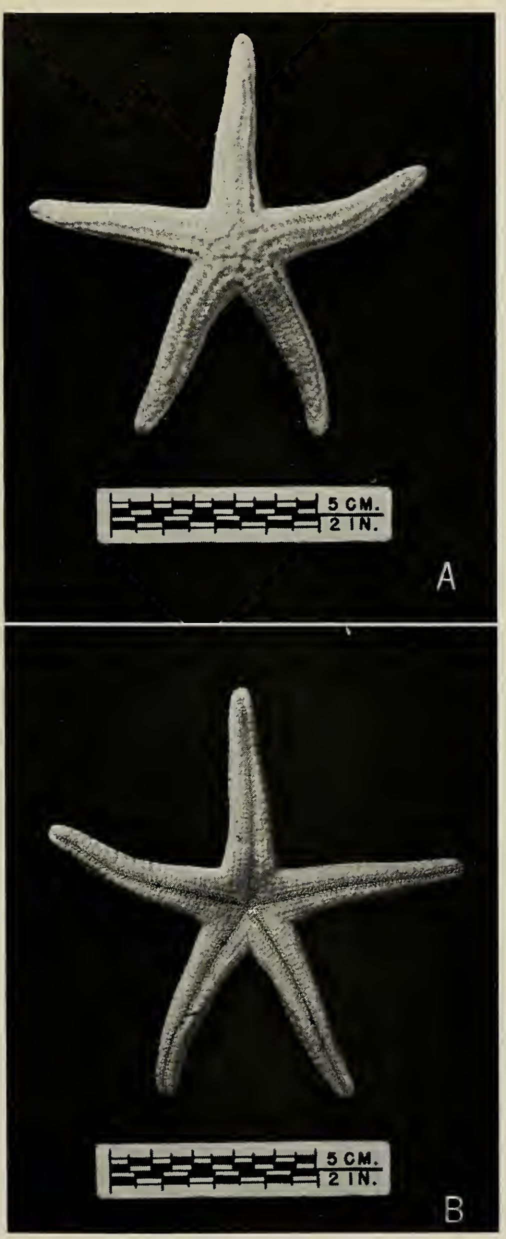


Fig. 2. *Tamaria halperni*, n. sp. A, Abactinal; B, Actinal. Holotype.

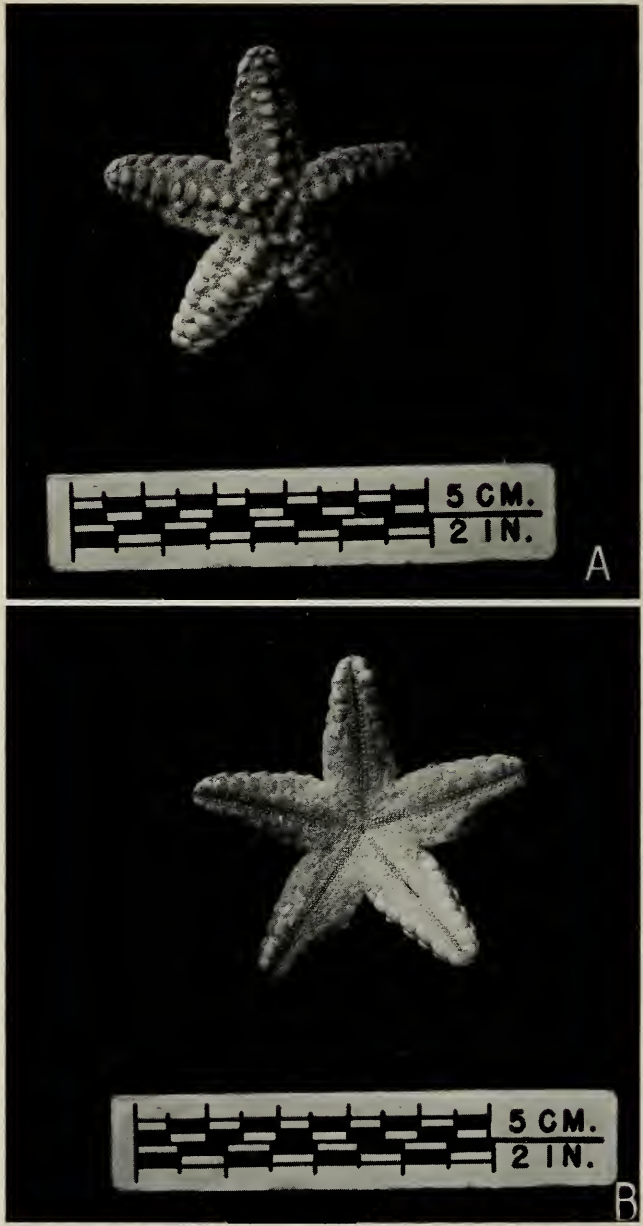


FIG. 3. *Tamaria passiflora*, n. sp. A, Abactinal; B, Actinal. Holotype.

Tamaria passiflora n. sp.

Description: Form heavy, solid; disc small; arms five, short, stubby, massive, slightly constricted at base, high on sides, plane on actinal surface. Carinals, superomarginals, and inferomarginals very large, separated by two series of papular areas, 3–15 pores per area (none below inferomarginals). Between carinals and superomarginals, and between proximal marginals, few small irregular secondary plates. Granules of tegument somewhat squamiform. Actinal surface plane, with numerous small irregular plates, not in regular rows except for row of larger plates adjacent to adambulacral plates, which extend to end of arm, and most of which bear single pedicellaria. Adambulacral furrow spines two, short, broad, thick, somewhat flattened, granuliform, with shorter, smaller spine behind. Subambulacral spine large, flat, leaf-shaped, appressed (similar spine occurs on a few actinal plates). Jaws concealed by large flattened granules and leaf-like spines, bordered by spines similar to adambulacral furrow spines. Sugar-tongs pedicellariae confined to actinal surface; valves short, sunken in deep alveoli with raised, thickened lips. Madreporite small, flat, deeply channelled. Oculars tiny. Anus tiny, inconspicuous, not marked by specialized granules.

Material examined: 1 specimen (holotype), *Oregon II* Station 10858, 22°59′N, 78°43′W, 152 fms, December 1969. R—24 mm, r—8.5 mm, Rr—2.8.

2 specimens, UMML 40:486 *Silver Bay* Station 2426.
35 specimens, UMML 40:117 *Silver Bay* Station ?, 24°18′N, 81°29′W, 125 fms, 28 October 1960.

Type: Holotype, USNM No. E11382. In U.S. National Museum.

Type locality: South edge of Grand Bahamas Bank.

Discussion: According to Halpern (personal communication) numerous specimens of this species have been taken by the University of Miami in the Florida Straits.

LITERATURE CITED

CLARK, A. H. 1954. Echinoderms (other than Holothurians) of the Gulf of Mexico, *in* Gulf of Mexico: its origin, waters, and marine life. Fishery Bulletin 89, U.S. Fish and Wildlife Service 55: 373–379.

CLARK, H. L. 1921. The Echinoderma Fauna of Torres Strait: its composition and its origin. Carnegie Institution of Washington, Dept. of Marine Biology. Vol. X, viii, 223 pp., 38 pls.

———. 1941. Reports on the Scientific Results of the Atlantis Expedition to the West Indies, under the joint auspices of the University of Havana and Harvard University: The Echinoderms (other than Holothurians). Memorias de la Sociedad Cubana de Historia Natural "Felipe Poey" 15(1): 1–154, 10 pls.

PERRIER, EDMUND. 1884. Mémoire sur les étoiles de mer recueillies dans la mer des Antilles et la Golfe du Mexique durant les expéditions de dragage faites sous la direction de M. Alexandre Agassiz. Nouvelles Arch. Mus. d'Hist. Nat., Paris, ser. 2, 6: 127–276.

VERRILL, A. E. 1915. Report on the starfishes of the West Indies, Florida, and Brazil. Univ. Iowa Bull. Lab. Natur. Hist. 7: 3–232.

Vol. 84, No. 6, pp. 51–54 30 June 1971

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

AMPHERASTER ALAMINOS, A NEW SPECIES OF THE FAMILY ASTERIIDAE (ECHINODERMATA: ASTEROIDEA) FROM THE GULF OF MEXICO

By Maureen E. Downey
Department of Invertebrate Zoology, Smithsonian Institution, Washington, D.C. 20560

Among the seastars collected by the Texas A & M University R/V *Alaminos* are 13 specimens of a new species of the genus *Ampheraster* Fisher, 1923. Dr. Willis Pequegnat has been conducting a survey of the deepwater fauna of the Gulf of Mexico for several years, and I am grateful to him for the opportunity to examine the interesting asteroid fauna of this area. I also thank Dr. David L. Pawson, of the U.S. National Museum of Natural History, for reading and commenting on the manuscript.

W. K. Fisher, in 1923, revised the then known genera in the family Asteriidae and provided a very efficient key. In 1928, he provided a key to the five known species of *Ampheraster;* the new species described here, *A. alaminos*, is distinct in having six arms. All of the species previously assigned to this genus by Fisher (1928) are from the Eastern Pacific; *A. alaminos* is the first to be reported from the Atlantic. It seems to be most closely related to *A. hyperoncus* (Clark) from Lower California, but differs strikingly from this and other species in the genus in several important respects, as will be seen from the description below.

Family Asteriidae Gray, 1840

Genus *Ampheraster* Fisher, 1923

Straight pedicellariae unguiculate, no accessory inferomarginal spinelet, adambulacral plates predominantly monacanthid, two enlarged interbrachial superomarginal plates overlapping two corresponding inferomarginal plates, and superomarginals three- or four-lobed. The inferomarginal spines are prominent, conspicuously larger than the superomarginal spines; the first pair of postoral adambulacral plates are narrowly separated or touch only at their adoral corners. The rays are five or six in number, and the species are not fissiparous.

Ampheraster alaminos new species

Etymology: The specific name is for the Texas A & M University R/V *Alaminos*, which collected most of the specimens.

Material examined: Holotype (USNM E11397), *Alaminos* Station 3C/68-A-7, 27°42.2′N, 87°44.5′W, 1500 fms, July 1968. Major radius (R)—62 mm, minor radius (r)—8 mm; Rr—1:7.

Paratypes: One specimen, plus 44 arms, 1 disc, *Alaminos* Station 4E/68-A-7, 25°23.8′N, 86°06.7′W, 1750 fms, July 1968. R—47 mm, r—4 mm; Rr—1:11. Nine specimens, *Alaminos* Station 4A/68-A-7, 25°26.6′N, 86°06′W, 1750 fms, July 1968. R—42 mm, r—4 mm; Rr—1:10. One specimen, *Oregon* Station 2574, 26°34′N, 89°53′W, 1450 fms, July 1959. R—50 mm, r—5 mm; Rr—1:10.

Description: This species has six arms, whereas other species in the genus are regularly five-armed. The skeleton is weaker and more irregular than that of *A. hyperoncus*, and the arms are very weakly attached to the disc. On the abactinal surface, there is a large clear patch of thin uncalcified tissue between the base of the arms and the disc, with, at most, one or two small carinal plates between the arm and the disc. In contrast, the enlarged interbrachial superomarginals form, together with the heavy calcareous interbrachial septa, six very strong and rigid areas around the periphery of the disc. The superomarginals are generally four-lobed and imbricate in straight (not zigzag) series. The upper lobe is usually somewhat reduced, while the lower lobe is greatly elongate, overlapping the corresponding inferomarginal plate. The small disc has a dorsum of thin tissue and a circlet of elongate primary plates, with a few unattached elongate plates in the center. Each plate bears a few short, thorny, aciculate spines, and the madreporite, borne on one of the interradial primaries, is of moderate size, covered with deep coarse gyri and bearing around its periphery a circlet of spines. Elsewhere the disc is covered with large, straight, unguiculate pedicellariae. The surface of the arms is completely covered with small crossed pedicellariae. The small carinal plates are more or less irregular, and there are two series of meshes on either side of the carinal row. The adambulacral plates bear a single (occasionally two) long, ridged, aciculate spine, and the inferomarginal plates bear a similar, somewhat shorter spine; above the inferomarginals, the superomarginals, dorsolaterals, and carinals may bear a single very much shorter spine, or no spine. Straight unguiculate pedicellariae are abundant on the actinal disc interradii, and also occur between the proximal adambulacral plates and the inferomarginals. A few smaller pedicellariae of this type occur within the groove. The long, narrow mouth plates bear two long slender divergent spines on the side of the straight bare apex,

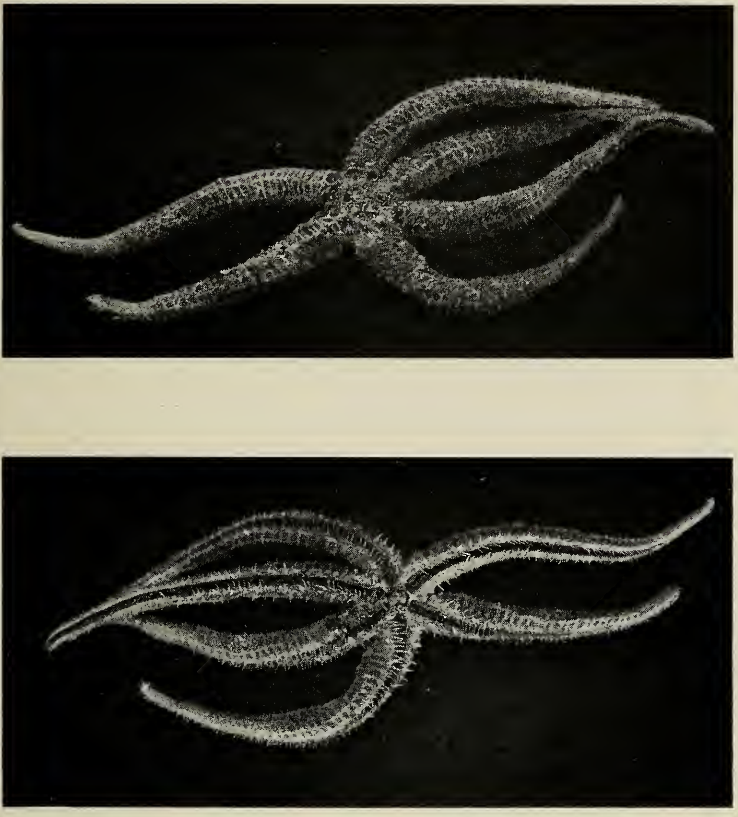


FIG. 1. *Ampheraster alaminos*, holotype. Actual size 124 mm. Abactinal, upper. Actinal, lower.

and two or three similar suboral spines, one behind the other. The mouth plates also bear a number of small unguiculate pedicellariae.

Remarks: Six arms, rather than five, distinguish *A. alaminos* from all other species in the genus. *A. alaminos* differs from *A. atactus* and *A. distichopus* in having the adambulacral plates monacanthid throughout. It differs from *A. marianus* in having two series of meshes on either side of the carinal plates, rather than four. From *A. chiroplus* it differs in having the tubefeet biserial throughout, and from *A. hyperoncus* in having the superomarginals generally four-lobed and imbricating in straight, rather than zigzag series.

All of the specimens of this species are from depths of 1450 to 1750 fathoms in the north central Gulf of Mexico, where the bottom is mainly foraminiferal.

LITERATURE CITED

CLARK, HUBERT LYMAN. 1913. Scientific Results of the Expedition to the Gulf of California in Charge of C. H. Townsend, by the U.S. Fisheries Steamship "Albatross" in 1911. V. Echinoderms from Lower California, with descriptions of new species. Bull. Amer. Mus. Nat. Hist. 32: 201, pl. xliv, figs. 3, 4.

FISHER, W. K. 1923. A Preliminary Synopsis of the Asteriidae, a family of seastars. Ann. Mag. Nat. Hist., ser. 9, 12: 252–253.

———. 1928. Asteroidea of the North Pacific and adjacent waters. Part 2. Forcipulata (part). U.S. National Museum Bulletin 76: 81.

SPENCER, W. K. AND C. W. WRIGHT *in*: Moore, Raymond C., ed., 1966. Treatise on Invertebrate Paleontology. Part U. Echinodermata 3. Asterozoans, p. 76.

Vol. 84, No. 7, pp. 55–58 30 June 1971

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

A NEW GERBIL (GENUS *GERBILLUS*) FROM THE CHAD

BY HENRY W. SETZER AND GARY L. RANCK
Department of Vertebrate Zoology, Smithsonian Institution, Washington, D.C. 20560 and Department of Biology, Regis College, Denver, Colorado 80221

During a study of the rodents of Libya (Ranck, 1968) an undescribed subspecies of *Gerbillus pyramidum* was recognized but because it was extralimital to that study, its description was postponed.

Capitalized color terms are from Ridgway, "Color Standards and Color Nomenclature, 1912," and all measurements are in millimeters.

This new subspecies from the northern Chad may be known as:

Gerbillus pyramidum tibesti new subspecies

Holotype: Adult male, skin and skull, U.S. National Museum No. 319721, from Zouar, Tibesti Mountains, Republic of the Chad; obtained 10 April 1961 by H. W. Setzer, original number 3042.

Specimens examined: Twenty-five, from Chad: Zouar, 16; Ounianga Kebir, 9.

Diagnosis: Dorsum Clay Color to Cinnamon grading to Cinnamon-Buff on sides, subauricular regions and flanks; rostral, mystacial, supra-orbital, circumoral and pectoral areas white; eye ring dark brown; pinna of ear sparsely haired, same color as dorsum and with row of buffy hairs along anterior margin; vibrissae short with both brown and white hairs; fore and hind feet richly haired and bearing five digits, each with a claw; tail relatively long, distinctly bicolored with a distinct median line of Cinnamon hairs which gradually shade into a conspicuous pencil; entire underparts white. Skull: relatively large and massive, braincase relatively flattened; zygomata heavy; supra-orbital beads prominent; anterior palatine foramina relatively long and wide, auditory bullae large and bulbous; rostrum long and narrow.

Measurements: Averages and extremes of eight adult males and seven adult females from the type locality, with the measurements of the type in brackets, are: total length 284.4 (270–300), 268.9 (258–282), [292]; length of tail 165.9 (158–176), 157.7 (146–166), [173]; length of hind foot 35.3 (34–37), 33.9 (32–37), [35]; length of ear 16.6 (15–18), 15.9 (15–18), [17]; occipitonasal length of skull 34.2 (32.7–35.2), 32.6 (31.5–33.9), [35.0]; length of auditory bulla 12.2 (11.9–12.7), 11.9 (11.5–12.5), [12.2]; crown length of upper molariform toothrow 4.2 (4.0–4.3), 4.2 (3.8–4.3), [4.4]; greatest breadth across zygomatic arches 17.9 (17.0–18.7), 17.1 (16.7–17.5), [18.3]; least interorbital breadth 6.6 (6.2–7.1), 6.3 (5.9–6.6), [6.8]; breadth of rostrum at level of antorbital foramina 3.5 (3.4–3.8), 3.4 (3.2–3.5), [3.6]; length of nasals 14.0 (13.0–14.6), 12.8 (12.4–13.2), [14.4].

Comparisons: From representatives of *Gerbillus pyramidum pyramidum* from Imbaba, El Aiyat and Abu Ghalib, Giza Province, Egypt, *Gerbillus pyramidum tibesti* differs in markedly smaller size of body and skull, shorter ears, narrower and relatively longer rostrum, less robust zygomata, and relatively as well as actually longer, more conspicuously bicolored tail with a more prominent pencil. In color, *G. p. tibesti* is generally lighter (more orangish) and has more conspicuous postauricular patches. This new subspecies is smaller in all cranial measurements, being of comparable size only in the length of the auditory bullae and the nasals.

Compared with topotypes of *Gerbillus pyramidum tarabuli* from Sebha, Fezzan Province, Libya, *G. p. tibesti* has a markedly longer tail, a more flattened braincase, heavier zygomata, more prominent supra-orbital beads, longer and more rounded auditory bullae and longer nasals. These gerbils from the Tibesti Mountains are more brilliant in dorsal color (more orangish), have more distinctly bicolored tails and have less suffusion of grayish hairs on the dorsum of the body and tail.

Members of this subspecies can be distinguished from the type and type series of *Gerbillus pyramidum hamadensis* from Derg, Tripolitania Province, Libya, by their markedly larger, more massive skulls, more flattened braincases, longer and wider anterior palatine foramina, less bulbous auditory bullae, more orangish dorsal color and longer and more distinctly bicolored tails with darker pencils. In cranial measurements, *G. p. tibesti* is significantly larger than *G. p. hamadensis* except in the length of the upper molariform toothrow and breadth of the rostrum at the level of the antorbital foramina.

In dorsal color, this subspecies apparently resembles *Gerbillus rosalinda* St. Leger from Abu Zabad, Sudan, but based on measurements of the latter species, as given by Setzer (1956:490), *G. p. tibesti* is significantly larger in all respects.

In their paler dorsal color, longer and more tufted tails, and larger size of all cranial and external characters, these gerbils from the Tibesti Mountains differ markedly from representatives of *Gerbillus pyramidum hirtipes* from Ein Sefra, southwestern Algeria.

Remarks: Members of this subspecies can be distinguished from all others of *Gerbillus pyramidum* by their relatively as well as actually longer tails and more brilliant (orangish) dorsal color.

This subspecies is known from only two localities in the vicinity of the Tibesti Mountains. Owing to the desolate character of the surrounding areas and the inaccessible position of these mountains in the Saharan interior, attempts to collect mammals from here have been sporadic and of brief duration. The mammalian fauna of this region is accordingly poorly known. The specimens now available for study were obtained by the senior author during a trans-Saharan expedition in the spring of 1961.

The range of this subspecies is probably much greater than these few specimens would indicate and probably includes portions of northern Niger, Darfur Province, Sudan, and the Serir Tibesti and northern outliers of the Tibesti Mountains in southern Libya.

The specimens from Ounianga Kebir on the eastern side of the mountains are strikingly similar to those from Zouar on the west side, but differ from the latter in their slightly smaller size of body, tail, hind feet and ears, and slightly darker, more subdued dorsal color. Cranially, the two populations are indistinguishable. Apparently suitable habitat is of widespread occurrence throughout the lower confines of the mountains enabling these gerbils to maintain interbreeding populations and thus insure genetic uniformity.

These specimens represent the first records of *Gerbillus pyramidum* from the Tibesti Mountain area. Dalloni (1936) and Scortecci (1942) published reports on the mammals from this area, but made no mention of this species.

The subspecies name *tibesti* refers to the mountain complex of this name located in the northern Chad.

Literature Cited

Dalloni, Marius. 1936. Mission au Tibesti (1930–31), dirigée par M. Marius Dalloni, Deuxième Memoire. Mém. Acad. Sci. Inst. France, Paris 62(2): 39–76.

Ranck, Gary L. 1968. The Rodents of Libya: Taxonomy, Ecology and Zoogeographical Relationships. U.S. Nat. Mus. Bull. 275, pp. viii + 264, 8 pls., 54 figs.

Scortecci, G. 1942. Le conoscenze Zoologiche sul Tibesti. *In* A. Desio, Il Tibesti Nord Orientale. Roma, pp. 195–197.

Setzer, Henry W. 1956. Mammals of the Anglo-Egyptian Sudan. Proc. U.S. Nat. Mus. 106: 447–587, 10 figs. 28 Nov.

Vol. 84, No. 8, pp. 59–64 30 June 1971

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

THE DESIGNATION OF A HOLOTYPE OF THE WEST AFRICAN PYGMY SQUIRREL, *MYOSCIURUS PUMILIO* (LECONTE, 1857) (MAMMALIA: RODENTIA)

By Clyde Jones and Henry W. Setzer
Bureau of Sport Fisheries and Wildlife and National Museum of Natural History, Washington, D.C. 20560

This report includes a chronological review of the discovery, description, and naming of the African pygmy squirrel, *Myosciurus pumilio*. Also presented is a new description of the type of *Sciurus pumilio*.

The original description of *Sciurus pumilio* Leconte (1857) was brief and included limited details of several conspicuous external morphological features and six external measurements. This was one of several species of mammals described by Leconte (1857) that were received at the Academy of Natural Sciences of Philadelphia from P. B. Du Chaillu.

The description of *Sciurus minutus* Du Chaillu (1860) included limited details of several salient external and dental morphological features, as well as two external measurements; anecdotes with regard to habitats and habits were included also. The aforementioned author did not refer to either specimens or museums where specimens were deposited. Gray (1861), in a critical review of Du Chaillu's work, wrote that, "*Sciurus minutus* is *Sciurus palliatus*, Peters, 1852."

Major (1893) referred to *Nannosciurus minutus* (Du Chaillu) and figured the upper cheek teeth of a specimen from West Africa (Catalog Number 61.7.29.19) in the British Museum (Natural History). Thomas (1906) listed a specimen of *Nannosciurus minutus* (Du Chaillu) among the type specimens included in a collection of mammals from Gabon purchased from

Du Chaillu in 1861 by the British Museum (Natural History) and described by Du Chaillu (1860) as *Sciurus minutus.*

Thomas (1909) established the generic name *Myosciurus* and listed as the type species *Sciurus minutus* de (*sic*) Chaillu, and provided a brief description and geographic range for the new genus. Reasons for the separation of *Myosciurus* from *Nannosciurus* were discussed briefly by Thomas (1909, 1915).

Hollister (1921) proposed a new name, *Myosciurus minutulus*, for *Myosciurus minutus* which he felt was preoccupied by *Sciurus minutus* Lartet, 1851. This name later was proved invalid by Lang (1922), who summarized the history of the discovery and the descriptions of the African pygmy squirrel and pointed out that *Myosciurus pumilio* (Leconte) had priority over all other names. However, Lang (1922) was unable to determine the location of a specimen either in the Academy of Natural Sciences of Philadelphia or in the Museum of Comparative Zoology.

Rosevear (1969) referred to a specimen in the British Museum (Natural History), Catalog Number 61.7.29.19, as the type of *Sciurus minutus* Du Chaillu. In addition, illustrations and descriptions of external and cranial features were presented by Rosevear (1969).

Of the aforementioned publications, only one (Rosevear, 1969) included a specific reference to a type specimen. The type specimen listed by Rosevear (1969) was the same specimen referred to by Major (1893) and presumably by Thomas (1906). However, we feel that this specimen (BMNH No. 61.7.29.19) should be designated as the holotype of *Sciurus minutus* Du Chaillu, 1860.

Information on the known specimens of *Myosciurus* was summarized previously (Jones and Setzer, 1970). However, at that time we were not fully aware of all of the aforementioned confusion with regard to type specimens and nomenclature of the taxon and its synonyms. In addition, some other specimens of *Myosciurus* have come to our attention.

Two specimens of *Myosciurus pumilio* from Cameroon (one from Dume collected by Schipper and one from Attongondama collected by Escherisch) were located in the Museum für

Naturkunde der Humboldt-Universität zu Berlin. A total of 14 specimens of *Myosciurus* is now known from Cameroon.

A specimen of *Myosciurus pumilio* was located in the type collection of mammals at the Academy of Natural Sciences of Philadelphia. This was among the specimens of mammals included in a collection of birds shipped from Africa by Du Chaillu and studied by Leconte (1857). Although it was accessioned some time between April, 1854, and January, 1861, it was not reported previously by either personnel of the Academy of Natural Sciences (Lang, 1922) or recent students of *Myosciurus* (Jones and Setzer, 1970). In addition, the specimen was noted as "missing" on the card for the species in the file of specimens at the Academy of Natural Sciences.

The aforementioned specimen, designated herein as the holotype, is described as follows:

Sciurus pumilio Leconte, 1857

Holotype: Adult, sex unknown, Number 868, Academy of Natural Sciences of Philadelphia.

Description: Specimen apparently originally set up for display, but now unmounted. Skin, with skull inside, stuffed in upright position on rear legs with fore legs extended slightly in front of the chest and tail arched up along the back.

Dorsum of body Raw Umber Brown (color terms from Ridgway, 1912), especially over the scapular area. Some black hairs obvious on the neck between the bases of the ears. Venter of body lighter than the dorsum, Light Cinnamon Buff to Tawny Olive from mouth to base of tail. This coloration of the venter blends with the darker color of the dorsum along a faint line on the insides of the proximal parts of the legs, as well as along a faint lateral line between the front and rear legs.

Tail rich brown like the back, but with more black hairs giving a subtle banded appearance. Hairs at end of tail black with burnished tips and longer than all other hairs.

Head brown like the back of the body and buff below like the ventral surface of the body. A faint mask created by a few black hairs on each side of the rostrum at the base of the vibrissae from an area in line with the eye and tip of the rostrum and extending across the top of the rostrum. A narrow ring of light hairs obvious on the left eyelids, but hardly visible on the right side. A narrow fringe of light hairs along the edge to the base of the right ear and at the rear of the base of the left ear.

Skull in skin with glass eyes in the orbits, lower incisors not directly in line with the upper incisors.

The specimen is damaged as follows: edge of the left side of mouth torn away behind the incisors; entire tip of left ear missing; hairs lacking from the lower side of the right elbow, lower side and outer side of the left elbow, a spot on the left knee, and on a small strip on the outer side of the left shank; digits III and IV are loose on the left front foot.

The pertinent synonymy of the African pygmy squirrel is as follows:

Myosciurus pumilio (Leconte)

1857. *Sciurus pumilio* Leconte, Proc. Acad. Nat. Sci. Philadelphia, 9: 11. (Holotype: adult, sex unknown, Number 868, Academy of Natural Sciences of Philadelphia.)

1860. *Sciurus minutus* Du Chaillu, Proc. Boston Soc. Nat. Hist., 7: 366. (Holotype: adult, sex unknown, Number 61.7.29.19 British Museum (Natural History) from Headwaters of the Ovenga River, Gabon.)

1909. *Myosciurus minutus* Thomas, Ann. Mag. Nat. Hist., 3: 474. (Type species *Sciurus minutus* Du Chaillu.)

1921. *Myosciurus minutulus* Hollister, Proc. Biol. Soc. Washington, 34: 135. (Renaming of *Myosciurus minutus.*)

ACKNOWLEDGMENTS

The authors are grateful to Dr. Frank Gill, Academy of Natural Sciences of Philadelphia, and Dr. Gordon Corbet and A. W. Gentry, British Museum (Natural History), for providing information and access to specimens under their care. Dr. Renate Angermann furnished information on specimens in the Museum für Naturkunde der Humboldt-Universität zu Berlin.

LITERATURE CITED

Du Chaillu, P. 1860. Descriptions of mammals from equatorial Africa. Proc. Boston Soc. Nat. Hist. 7: 296–304, 358–367.

Gray, J. 1861. Zoological notes on perusing M. Du Chaillu's "Adventures in Equatorial Africa." Ann. Mag. Nat. Hist. 7: 463–470, 8: 60–65.

Hollister, N. 1921. A new name for the West African pygmy squirrel. Proc. Biol. Soc. Washington 34: 135.

Jones, C., and H. Setzer. 1970. Comments on *Myosciurus pumilio.* J. Mamm. 51: 813–814.

Lang, H. 1922. The correct name of the West African pygmy squirrel. J. Mamm. 3: 118–119.

Leconte, J. 1857. Descriptions of several new mammals from western Africa. Proc. Acad. Nat. Sci. Philadelphia 9: 10–11.

Major, C. 1893. On some Miocene squirrels, with remarks on the dentition and classification of the Sciurinae. Proc. Zool. Soc. London. pp. 179–215, 4 pls.

Ridgway, R. 1912. Color standards and color nomenclature. Washington, D.C., privately printed, iv + 44 pp., 53 pls.

Rosevear, D. 1969. The rodents of West Africa. British Museum (Natural History), London. 604 pp.

Thomas, O. 1906. Mammals, pp. 3–66. *In* The history of the collections contained in the natural history departments of the British Museum. British Museum (Natural History), London. Vol. 2, 782 pp.

———. 1909. The generic arrangement of the African squirrels. Ann Mag. Nat. Hist. 3: 467–475.

———. 1915. The penis-bone or "Baculum" as a guide to the classification of certain squirrels. Ann. Mag. Nat. Hist. 15: 383–387.

Vol. 84, No. 9, pp. 65–72 30 June 1971

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

NEOCLINUS NUDUS, NEW SCALELESS CLINID FISH FROM TAIWAN WITH A KEY TO *NEOCLINUS*[1]

By John S. Stephens, Jr. and Victor G. Springer
Department of Biology, Occidental College, Los Angeles, California 90041 and Division of Fishes, Smithsonian Institution, Washington, D.C. 20560

The purpose of this report is to describe a new species of *Neoclinus* that we encountered while investigating the osteology of the family Clinidae. The new species is noteworthy for its lack of scales, a character shared in the Clinidae only with five of the six species of *Stathmonotus* Bean (subfamily Labrisominae), a tropical American genus of questionable clinid affinities, and with the South African *Clinoporus biporosus* (Gilchrist and Thompson) (subfamily Clininae).

Hubbs (1953) revised *Neoclinus.* He recognized four species: *stephensae*, *uninotatus*, and *blanchardi*, all known only from California (including Baja California), and *bryope*, known only from Japan. Stephens (1961) extended the range of *N. bryope* to include Okinawa. We regrettably report that a specimen of *Neoclinus* collected from Korean waters and deposited at the University of Michigan Museum of Zoology was lost in the mail in transit to us. This specimen represented a third western Pacific species or a range extension of one of the known species.

Neoclinus nudus new species
(Fig. 1)

Holotype: United States National Museum of Natural History, Division of Fishes USNM No. 205217, ♂, 50.0 mm standard length (SL), col-

---

[1] This study was supported by a grant (SG3372153) from the Smithsonian Research Foundation, V. G. Springer principal investigator.

TABLE 1. Counts and measurements (in mm) of holotype and paratypes of *Neoclinus nudus.*

	Holotype	Paratypes									
	♂	♀	♂	♂	♂	♂	♂	♀	♂	♀	♀
Dorsal fin	XXV-17	XXV-16	XXVI-17	XXV-17	XXVI-17	XXVI-17	XXV-17	XXV-16	XXVI-16	XXV-17	XXV-17
Anal fin	II-29	II-28	II-29	II-29	II-29	II-29	II-29	II-28	II-29	II-29	II-29
Pectoral fin	13/13	14/14	14/14	14/14	14/14	14/14	14/14	14/14	14/14	15/15	15/14
Pelvic fin	I-3	I-3	I-3	I-3	I-3	I-3	I-3	I-3	I-3	I-3	I-3
Caudal fin (segmented rays)	13	13	13	13	13	13	13	13	13	12	13
Lateral line pores (unpaired–paired–unpaired)	1–13–1	0–12–1	1–12–1	2–15–2	2–13–1	2–11–1	0–13–1	0–10–1	1–12–1	0–9–1	0–13–1
Standard length	50.0	50.1	48.9	48.1	47.0	47.2	46.8	48.3	44.0	40.8	40.7
Head length	10.1	10.0	10.0	10.2	9.8	9.9	9.8	9.9	9.6	8.9	8.9
Head width	6.0	5.5	5.0	4.8	4.9	5.0	5.5	5.2	4.8	4.5	4.7
Head depth	5.7	5.5	5.5	6.0	5.8	5.6	5.8	5.9	5.2	4.8	5.1
Upper jaw length	5.0	5.2	5.2	5.8	5.2	5.2	5.2	5.0	5.0	4.6	4.5
Interorbital width	1.2	1.0	1.2	1.0	0.9	0.8	0.9	0.9	0.8	0.8	0.8
Eye diameter	2.5	2.3	2.3	2.4	2.2	2.2	2.1	2.3	2.0	2.1	1.9
Snout length	1.5	1.8	1.8	1.7	1.7	1.8	1.8	1.8	1.8	1.8	1.6
Predorsal length	6.5	6.3	7.0	6.9	6.9	6.7	7.0	7.2	6.7	6.5	6.5
Preanal length	20.0	20.5	18.9	18.0	18.9	18.2	18.1	19.9	17.2	16.8	16.8
Peduncle depth	3.2	3.1	3.2	2.8	2.9	3.0	2.8	2.8	2.8	2.8	2.4
Peduncle length	1.8	2.2	2.8	2.5	2.3	2.6	2.0	2.4	2.2	2.2	2.4
Longest pectoral ray	6.5	5.3	5.9	6.0	6.6	5.0	5.9	5.2	5.6	5.2	5.2
Longest pelvic ray	4.5	4.4	4.5	4.2	4.6	4.5	4.6	4.3	4.1	4.2	3.9
Longest dorsal spine	4.2	4.4	4.5	4.5	4.2	4.7	4.2	4.4	4.0	3.4	3.9

lected by V. G. Springer *et al.* from a cove just southwest of Yeh-liu, northern Taiwan, 25°12′N, 121°41′E, at a depth of about 4 m, 18 May 1968, original field number VGS68-27.

Paratypes: USNM No. 205218, 10 specimens collected with the holotype (one paratype cleared and stained).

Diagnosis: Body lacking scales, 15 or fewer pairs of lateral line pores; no nape cirri; 6–7 pairs of multifid orbital cirri arranged in an outer and inner row, each row usually of 3 cirri; interorbital region with well-developed pair of longitudinal ridges; series of 4 pores along ventral edge of orbit; head small, more than 4.5 in SL; third pelvic ray only slightly shorter than second.

Description: The counts and measurements of the holotype and paratypes are presented in Table 1. The cranial pore counts used here are cited in Stephens (1970). Preoperculomandibular series: middorsal commissural pore present, 5 occipital, 4–6 temporal, 7–9 preopercular, 6 mandibular, 1–2 postorbital. Supra-orbital series: 3–4 frontal, 1 nasal. Infraorbital series: 6 postorbital, 6 suborbital. Lateral line series: 0–2 unpaired + 9–15 paired + 1–2 unpaired.

Upper jaw with 18 teeth on each side in outer row, anteriorly 8 moderate to large teeth, posterolaterally 10 smaller teeth; 2 lateral bands of minute teeth posterior and medial to outer row. Lower jaw with 7 anteromedial large teeth in outer row, eighth tooth a moderately developed canine, 8–10 posterolateral teeth; subcircular patch of small (but not minute) teeth posteromedial to posterolateral teeth; subcircular patch bordered posteriorly by somewhat enlarged row of about 7–8 teeth. Vomer with 4–7 small teeth. Palatine with 9–10 teeth in single row. Gill rakers of first arch 5–7 + 10–13 = 15–20. Vertebrae 13–14 + 33–35 = 47–48.

Dorsal fin low, not or slightly incised between last spine and first ray; rays usually longer than posterior spines; fin rounded posteriorly; proximal third of last ray bound by membrane to peduncle. Anal fin spines shorter than rays; rays subequal in length but last four becoming shorter; proximal fourth of last ray bound by membrane to peduncle. Caudal fin rounded. Pectoral fin slightly pointed, middle four rays longest, membrane incised between lower four elements. Pelvic fin with middle ray longest, anterior ray shortest, membrane incised between anterior two rays; spine short, bound to first ray, visible only in dissection. Cirri: 6–7 orbital cirri in two relatively parallel longitudinal rows, 3 in outer row at margin of orbit, 3–4 in inner row; cirri multifid, bushlike, with common base; cirri never longer than orbit, usually about half orbital diameter; no sexual dimorphism in cirrus length; single multifid nasal cirrus about equal in length to orbital cirri.

Color in alcohol: Male: head and anterior region of body to posterior tip of pectoral dark brown to almost black, indistinctly marked. Circumorbital region and edge of preopercle slightly paler. Branchiostegal membrane mottled and darker. About 6–7 indistinct black bars along dorsal fin base, sometimes weakly coalescing with dark mid-longitudinal band; about 10 dorso-ventral pairs of whitish blotches border band, each pair sometimes faintly joining across band; ventral member of each pair about twice size of dorsal member. Venter dark brown, remainder of body brown to tan. Dorsal fin black anteriorly but generally unpigmented posterior to level of anus except that faint, indistinct brown bars may be present. Distal edge of anal fin black on anterior 4–7 elements; fin membrane unpigmented posteriorly but some melanophores along fin elements. Faint brown blotch on base of caudal fin. Some dark pigment on caudal and pectoral fin rays. Pelvic fins black. Orbital cirri dusted with melanophores; nasal cirrus unpigmented. Female: similar to male except head and body paler in color. Body bands consist primarily of large (larger anteriorly) brown blotches below midline, weakly connected dorsally to dorsal bars and continuing ventrally to base of anal fin. Each bar occasionally completely paired. Fins generally with less pigment than in males.

Habitat: All the specimens were taken in a single collection in a relatively narrow U-shaped cove. The eastern and western boundaries of the cove were rocky; the southern end was cobbly. There was much encrusted rock and algae on the bottom of the cove, but very little coral. The specimens were taken from a depth of approximately 4 m and came from a single rock in the middle portion of the cove. Although several collections were made in the same cove on different days before and after the day the specimens were obtained, no other specimens of *Neoclinus* were taken or observed. Another clinid, *Clinus xanthosoma* Bleeker, was common in the algae along the rocky shores of the cove.

Comparisons and discussion: Neoclinus nudus differs from all other species of *Neoclinus* in completely lacking scales. Reduced scalation is, however, a characteristic of the genus; the degree of squamation appearing superficially more similar to that of the Clininae than the Labrisominae. It is interesting that the specimens of *N. bryope* from Okinawa, a locality intermediate between Japan and Taiwan, appear to be less scaled than those from Japan (Stephens, 1961). *Neoclinus nudus* also has the fewest lateral line pore pairs in the genus and the most numerous orbital cirri. *Neoclinus nudus* seems to form a natural group with *N. bryope* of Japan and *N. stephensae* from California. All three are small (to 100 mm) species showing no obvious morphological sexual dimorphism and all three inhabit rocky substrata. The other species group includes the larger (to 280 mm) species, *N. blanchardi* and *N. uninotatus*, which show well-developed morphological sexual dimorphism (Hubbs, 1953) and are residents of sand, shell, and mud wall habitats. The following key to the species includes data from California specimens recently collected by Stephens *et al.* (1970).

Key to the species of *Neoclinus*

1. Head length 3.5–3.8 in SL; gill-rakers 12–14; orbital cirri simple or multifid on distal ½; adults greater than 100 mm SL; pectoral rays modally 15 (13–16); usually more than 20 pairs

of lateral line pores (Table 2); upper jaw 2.5–6.5 in SL (less than 5.1 in sexually mature specimens). Sexual dimorphism present in predorsal length, median fin heights, body depth, orbital cirrus length and upper jaw length 2

Head length 4.2–5.3 in SL; gill-rakers 14–20 (rarely 14); orbital cirri multifid from base; adults rarely attaining 90 mm SL (adults mature at about 40 mm); pectoral rays modally 14 (12–15); usually less than 20 pairs of lateral line pores (Table 2), *bryope* occasionally has 20–21; upper jaw 6.8–9.5 in SL; morphological sexual dimorphism absent 3

2. One ocellus anteriorly on dorsal fin, none between dorsal spines 5–9, anteriormost orbital cirrus multifid at tip, longer than orbit; adult upper jaw length 5.0–5.8 in SL *N. uninotatus* Hubbs 1953, Monterey, California to northern Baja California

Two ocelli on dorsal fin, one anteriorly, second between dorsal spines 5–9; all orbital cirri simple, shorter than orbit; adult upper jaw length 2.5–4.5 in SL *N. blanchardi* Girard 1858, San Francisco, California, to northern Baja California

3. Scales present on body; head moderately large 4.2–4.5 in SL; usually more than 14 pairs of lateral line pores; 3–4 orbital cirri in single row above eye 4

Scales absent; head small 4.5–5.1 in SL; usually less than 14 pairs of lateral line pores; 5–7 orbital cirri in two parallel rows (see Fig. 1) *N. nudus* new species, Taiwan

4. No dorsal fin ocellus; nape cirri present; 3 pairs of multifid orbital cirri; modally 16 (14–18) pairs of lateral line pores; upper jaw more than 7 in SL *N. stephensae* Hubbs 1953, Pt. Conception to Baja California

Dorsal fin ocellus present; no nape cirri; usually 4 (3–4) pairs of multifid orbital cirri; modally 20 (18–21) pairs of lateral line pores; upper jaw 6.0–6.8 in SL *N. bryope* (Jordan and Snyder 1903), Japan and Riu Kiu Islands

There is considerable overlap in counts of all meristic characters of all the species except counts of the paired lateral line pores. The greatest range for all meristic characters is exhibited by *N. stephensae* but this species is represented by the largest number of specimens and the ranges may reflect this. In the following tabulation the range and mean are presented for each count (for *N. nudus* see Table 1): *N. stephensae* (59 specimens), total dorsal fin elements 40–45 (42.2), dorsal fin spines 23–27 (25.1), dorsal fin rays 14–19 (17.0), anal fin rays 27–33 (30.3), pectoral fin rays 13–15 (14.1); *N. bryope* (32 specimens), total dorsal fin elements 40–44 (42.4), dorsal fin spines 24–27 (25.2), dorsal fin rays 16–19 (17.3), anal fin rays 28–32 (30.3), pectoral fin rays 13–15 (14.0); *N. uninotatus* (20 specimens), total dorsal fin elements 40–43 (42.3),

TABLE 2. Frequency distributions of number of pairs of lateral line pores in *Neoclinus*.

	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
N. nudus	1	1	1	3	4	–	1	–	–	–	–	–	–	–	–	–
N. stephensae	–	–	–	–	–	2	8	20	17	10	–	–	–	–	–	–
N. bryope	–	–	–	–	–	–	–	–	–	1	4	8	4	–	–	–
N. uninotatus	–	–	–	–	–	–	–	–	–	–	2	6	6	4	1	1
N. blanchardi	–	–	–	–	–	–	–	–	–	–	–	4	3	3	–	–

dorsal fin spines 23–27 (25.5), pectoral fin rays 14–16 (14.8); *N. blanchardi* (10 specimens), total dorsal fin elements 40–42 (41.4), dorsal fin spines 23–24 (24.1), dorsal fin rays 17–18 (17.3), anal fin rays 28–30 (28.9), pectoral fin rays 14–15 (14.9). The total vertebral number varied from 46–49 for the genus, 12–14 precaudals, 33–36 caudals. The variations in vertebral numbers exhibited by the species do not appear to be significantly different, but the number of specimens radiographed is small for most of the species.

Stephens (1963) noted the resemblance of *Neoclinus* to the Chaenopsidae and believed that *Neoclinus* was closest to the clinid stock that gave rise to the chaenopsids. Zoogeographically *Neoclinus* lies well removed from any of the chaenopsids, which are tropical-subtropical forms with only *Chaenopsis alepidota* occurring north of Bahia Magdalena, Baja California, the break between the temperate and tropical faunas. It is possible that *Neoclinus*, which occupies a niche (worm tubes, mollusc holes) similar to that of the chaenopsids, was replaced by the chaenopsids in the tropics. It may also be that the chaenopsids branched off from a *Neoclinus*-like stock and invaded the tropics. If the former hypothesis is true one would expect the present zoogeographical situation to exist as it is often true that the less anatomically specialized forms of a group inhabit the cooler, peripheral areas. While it is not our purpose to discuss the comparative osteology of *Neoclinus* and the Chaenopsidae, we can state that our investigations strongly indicate that the chaenopsids are a uniformly much more specialized group than is *Neoclinus*.

The close morphological similarity between *N. bryope, stephensae*, and *nudus* may indicate a similar ecology. The biology of *N. stephensae* is well known (Stephens *et al.*, MS). This species is strictly tubiculous, living in pholadid clam, *Lithophaga*, burrows (Stephens *et al.*, 1970). Assuming a similar situation for *N. nudus*, the loss of scales would appear to be a further specialization (Gosline, 1959) for this niche. In this respect the morphological similarity between the tube living *Neoclinus* and the tubiculous chaenopsids may represent ecological convergence.

Comparative material examined: Neoclinus bryope, Japan, USNM 71529 (30 specimens of a large series), 199523 (5), UCLA 57-23 (1); Okinawa, USNM 132808 (1), 195823 (1); *Neoclinus stephensae*, Cali-

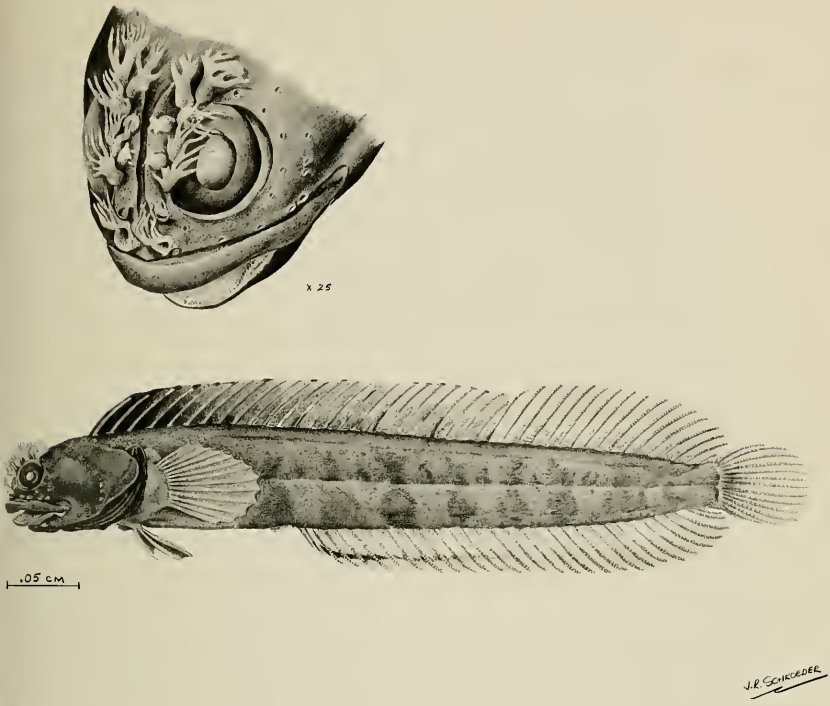


FIG. 1. Holotype of *Neoclinus nudus*, including an enlarged view of the head to show the disposition of the cirri.

fornia, Palos Verdes, Occidental College (OXY) 67-10-25 (17), OXY 68-6 (43); *Neoclinus uninotatus*, California, OXY 68-7-31 (7), OXY 69-16 (3), OXY 69-25 (2), OXY 70-7-31 (5), University of California, Los Angeles (UCLA) 51-98 (1), UCLA 51-214, UCLA 53-318, UCLA 53-236; *Neoclinus blanchardi*, California, OXY 68-7-31 (2), OXY 69-9 (1), UCLA 52-266 (1), UCLA 55-264 (1), UCLA 57-62 (1).

LITERATURE CITED

GOSLINE, W. A. 1959. Mode of life, functional morphology, and classification of modern teleostean fishes. Syst. Zool. 8(3): 160–164.

HUBBS, CLARK. 1953. Revision and systematic position of the blennioid fishes of the genus *Neoclinus*. Copeia 1: 11–23.

STEPHENS, J. S., JR. 1961. Range extension of the temperate blennioid fish, *Neoclinus bryope*, into the tropical western Pacific. Copeia 4: 484–485.

———. 1963. A revised classification of the blennioid fishes of the American family Chaenopsidae. Univ. Calif. Publ. Zool. Vol. 168, 164 pp.

———. 1970. Seven new chaenopsid blennies from the western Atlantic. Copeia 2: 280–309.

———, R. K. JOHNSON, G. S. KEY, AND J. E. MCCOSKER. 1970. The comparative ecology of three sympatric species of California blennies of the genus *Hypsoblennius* gill (Teleostomi, Blenniidae). Ecol. Monogr. 40: 213–233.

Vol. 84, No. 10, pp. 73–80 30 June 1971

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

TWO NEW SPECIES OF *GONODACTYLUS* (CRUSTACEA, STOMATOPODA), FROM ENIWETOK ATOLL, PACIFIC OCEAN

BY RAYMOND B. MANNING
Department of Invertebrate Zoology, Smithsonian Institution, Washington, D.C. 20560

In September and October of 1969 the Smithsonian Institution sponsored an expedition to Eniwetok Atoll in the Marshall Islands, with the support of the Atomic Energy Commission through the University of Hawaii and the Smithsonian Oceanography and Limnology Program. Participants included Porter Kier, Thomas Phelan, Erle Kaufman, Thomas Waller, and C. Allan Child from the National Museum of Natural History; Richard Grant and John Pojeta, U.S. Geological Survey; and C. E. Dawson, Gulf Coast Research Laboratory. Representative collections of marine organisms were made by hand, with 10 percent rotenone, and with dynamite in shallow water to a depth of about 115 feet. Forty stations were occupied; complete station data are on file in the Division of Crustacea, National Museum of Natural History, Smithsonian Institution.

Stomatopods were collected at nine stations (Table 1). Of the eight species collected, three, *Gonodactylus chiragra* (Fabricius), *G. falcatus* (Forskål), and *G. platysoma* Wood-Mason, have extensive ranges in the Indo-West Pacific region; they are known from scattered localities between Oceania and the western Indian Ocean (Manning, 1968). *Gonodactylus smithii* Pocock has been recorded from localities between the South China Sea and Australia to the western Indian Ocean (Manning, 1968); although it was not known from the central Pacific Ocean, its occurrence there is not unexpected inasmuch as it has been found in the coral habitat throughout its range.

TABLE 1. Station data for Eniwetok Atoll Expedition and list of species collected.

Sta. no.	Date	Station data	Species	
6-69	22 Sept.	11°25′27″N, 162°23′15″E Muti (David) Island, sand and rock tidepools ca. 100 yds. E of SW corner of island; low flood tide; 0–3 ft.; 10% rotenone; C. E. Dawson	*Gonodactylus chiragra* (Fabricius)	2♂, 1♀
			Gonodactylus smithii Pocock	1♂
			Haptosquilla glyptocercus (Wood-Mason)	3♀
7-69	23 Sept.	11°22′50″N, 162°10′30″E Grinem (Keith) Island, lagoon side, scattered small coral heads on 75 ft. bottom of coral sand; C. A. Child	*Gonodactylus falcatus* (Forskål)	1♀
10-69	23 Sept.	11°21′43″N, 162°21′20″E Eniwetok (Fred) Island, NE end, ocean side tide flat and quarry, 100–200 yds. from shore; tide pools 1–4 ft. depth; 10% rotenone; C. E. Dawson	*Gonodactylus platysoma* Wood-Mason	2♀
			Gonodactylus smithii Pocock	1♂, 1♀
13-69	24 Sept.	11°21′43″N, 162°21′20″E Eniwetok (Fred) Island, NE end, ocean side, outlet to quarry; 200–300 yds. from shore; coral rock channel; 0–3 ft. depth; 10% rotenone; C. E. Dawson	*Gonodactylus childi* n. sp.	2♀
			Gonodactylus smithii Pocock	1♂, 1♀
			Haptosquilla glyptocercus (Wood-Mason)	1♂, 1♀
15-69	25 Sept.	11°24′05″N, 162°19′05″E Parry (Elmer) Island, lagoon side, coral pinnacle due W, marked with buoy "Int Qk Fl R" on chart HO 6090; buoy marked "CR"; pinnacle of live corals of about 1 acre; stomatopod from 80–115 ft. depth; C. A. Child, T. Waller	*Gonodactylus micronesica* n. sp.	1♀
19-69	26 Sept.	11°27′40″N, 162°05′50″E Rigili (Leroy) Island; tide pools in lagoon reef edge; 2–4 ft.; 10% rotenone; C. E. Dawson	*Gonodactylus platysoma* Wood-Mason	1♂
21-69	27 Sept.	11°21′43″N, 162°21′20″E Eniwetok (Fred) Island, outer reef rim and surge channels along northern third of island; 10% rotenone; C. E. Dawson	*Gonodactylus chiragra* (Fabricius)	1♂
			Haptosquilla glyptocercus (Wood-Mason)	1♀
35-69	8 Oct.	11°32′47″N, 162°21′56″E Runit (Yvonne) Island; tide pool in rock tide flat ca. 100 ft. inside reef edge; surface to 3 ft. depth; 10% rotenone; C. A. Child	*Gonodactylus childi* n. sp.	5♂
			Haptosquilla glyptocercus (Wood-Mason)	1♂
38-69	10 Oct.	11°20′52″N, 162°20′36″E Eniwetok (Fred) Island; ocean side, surge channel and blow hole about 20 ft. behind outer reef edge, ca. 200 ft. N of end of runway; 0–2 ft. depth, surge channel habitat 15–20 ft. depth; 10% rotenone; C. A. Child	*Gonodactylus childi* n. sp.	8♂, 3♀
			Gonodactylus espinosus Borradaile	1♀
			Gonodactylus platysoma Wood-Mason	1♀
			Gonodactylus smithii Pocock	2♂, 4♀
			Haptosquilla glyptocercus (Wood-Mason)	1♂

One species, *G. espinosus* Borradaile, is known to occur in the central Pacific Ocean, where it has been recorded from several localities between Palmyra Island and the Tuamotu Archipelago (Manning, 1967), and another, *Haptosquilla glyptocercus* (Wood-Mason), is largely restricted to the Pacific Ocean; it has also been taken in the Andaman Islands (Manning, 1969).

Two of the species of *Gonodactylus* in the collection apparently represent undescribed species. One, represented by a large series of specimens, was taken in shallow water at several stations. The other, represented by a single specimen, was taken at the deepest station, at a depth of 80–115 feet. Illustrations and descriptions of both of these latter two species are given below, and a key to the species of the *demanii* section of the genus is presented.

Terms used in the descriptive accounts and measurements have been discussed in detail in earlier papers (Manning, 1967, 1968). The illustrations were drawn by my wife Lilly. All specimens are in the Division of Crustacea, National Museum of Natural History, Smithsonian Institution (USNM).

Gonodactylus childi new species

(Figure 1)

Holotype: 1 ♂, 32 mm; Runit (Yvonne) Island, Eniwetok Atoll; station 35-69; USNM No. 135624.

Paratypes: 2 ♀, 15–19 mm; Eniwetok (Fred) Island, Eniwetok Atoll; station 13-69; USNM No. 135626.—4 ♂, 15–23 mm; data as for holotype; USNM No. 135625.—8 ♂, 9–16 mm; 3 ♀, 14–19 mm; Eniwetok (Fred) Island, Eniwetok Atoll; station 38-69; USNM No. 135627.

Description: Rostral plate with long apical spine, basal portions of plate rounded anterolaterally (Fig. 1*a*). Ocular scales small, erect, flattened dorsally. Mandibular palp and five epipods present. Lateral processes of sixth and seventh thoracic somites rounded, process of sixth somite broader than that of seventh somite (Fig. 1*b*). Carinae of sixth abdominal somite inflated, each usually with small apical spine. Telson broader than long, with three pairs of marginal teeth, submedians with movable apices. Intermediate teeth of telson well developed, apices sharp. Lateral teeth of telson distinct, apices not projecting laterally much beyond outline of telson. Telson without dorsal spinules or tubercles. Median carina inflated in both sexes (at all sizes available for study), usually completely obscuring accessory median carinae and knob; occasionally portion of accessory median carinae marked by posterolateral dimples on median carina (Fig. 1*c*). Accessory median carinae, if dis-

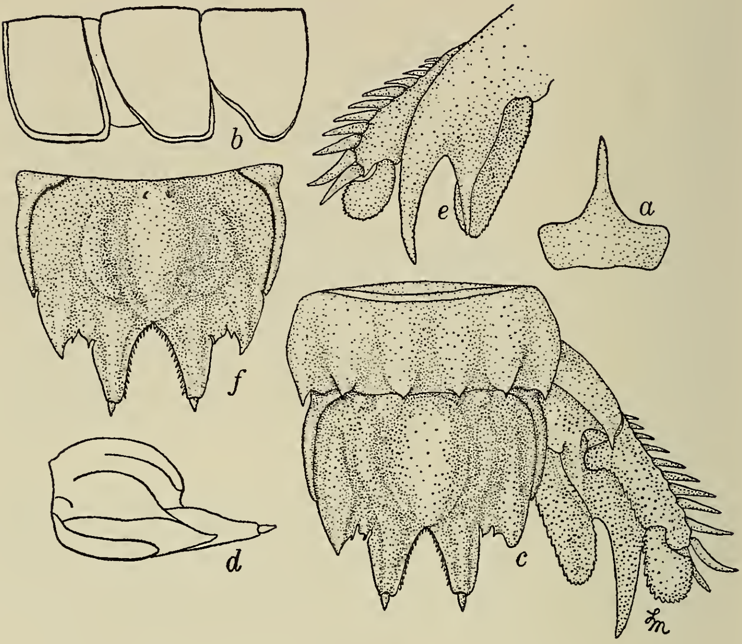


FIG. 1. *Gonodactylus childi* new species. Male paratype, TL 16 mm, station 38–69: *a*, rostral plate; *b*, outline of lateral processes of fifth, sixth, and seventh thoracic somites, left side; *c*, sixth abdominal somite, telson, and uropod; *d*, outline of telson, lateral view; *e*, uropod, ventral view. Female paratype, TL 19 mm, station 38–69: *f*, telson. Setae omitted.

tinct, not extending anteriorly beyond posterior fourth of median carina. Anterior submedian carinae inflated, posterior portion unarmed, curved mesially, with posterior depression in some specimens. Carinae of submedian and intermediate teeth of telson inflated; marginal carinae sharper. Telson with 14–15 submedian and two sharp intermediate denticles, intermediates recessed anteriorly, inner set on rounded lobe. Ventral surface of telson lacking carinae. Uropod with 10–11 slender, movable spines on outer margin of proximal segment of exopod, distalmost overreaching distal segment; proximal segment of exopod with distal fixed spine ventrally. Margins of uropod with complete complement of setae, arranged in one series. Spines of basal prolongation of uropod subequal in length, inner slenderer.

Color: Some specimens marked with black chromatophores on posterior portion of carapace, sixth thoracic somite, first and to lesser extent remainder of abdominal somites, and with four anterior black spots on telson. Dactylus of raptorial claw blue. Display spot on merus of claw white, merus with scattered black chromatophores proximal to display spot. Abdomen, telson, and uropods with indistinct blue markings in preservative. Proximal segment of uropodal exopod with distal yellow spot. All pigment faded in most specimens.

Size: Males, total length 9–32 mm; females, total length 14–19 mm. Other measurements, in mm, of male holotype: total length 32, carapace length 6.5, fifth abdominal somite width 4.8, telson length 3.4, telson width 4.1.

Discussion: Gonodactylus childi is the sixth species of the *demanii* section of the genus to be recorded from the Pacific Ocean. It resembles *G. confinis* de Man, *G. espinosus* Borradaile, *G. micronesica* n. sp., and *G. incipiens* Lanchester and differs from *G. demanii* Henderson in lacking numerous dorsal spinules and tubercles on the telson. It differs from *G. espinosus* in having the intermediate teeth of the telson distinctly separated from the lateral margin, with the intermediate denticles recessed anteriorly; *G. espinosus* also has several series of setae rather than a single series on the uropodal endopod. *Gonodactylus childi* differs from *G. confinis* and *G. incipiens* in the shape of the anterior submedian carinae of the telson. In the latter two species the anterior submedians are broadly inflated and oval in shape; the inner edge of the anterior submedians almost extends to the lateral edge of the median carina. In *G. childi*, the anterior submedians, although inflated, are narrow and elongate, distinctly separated from the median carina, and they curve posteriorly toward the apex of the median carina. The median carina of the telson is not flask-shaped but is broadly oval in all three species; only in *G. confinis* is the swollen median carina armed posteriorly with three small but distinct spinules. *Gonodactylus childi* differs from *G. micronesica*, described below, in having shorter accessory median and intermediate carinae on the telson and in lacking the strong apical spine on the median carina of the telson.

As in some of the other small species of the *demanii* section of the genus, the lateral process of the sixth thoracic somite is broader and more truncate than that of the seventh somite, and, as in several of these species, the height of the telson, seen in lateral view, is comparatively great. The telson height in *G. childi* is equal to one-half of the median length.

The species is named for C. Allan Child, Division of Crustacea, National Museum of Natural History, who made special efforts to collect stomatopods during the expedition.

Gonodactylus micronesica new species

(Figure 2)

Holotype: 1 ♀, 18 mm; Parry (Elmer) Island, Eniwetok Atoll; station 15-69; USNM No. 135628.

Description: Rostral plate with long apical spine, basal portion of plate rounded anterolaterally (Fig. 2*a*). Ocular scales small, erect. Mandibular

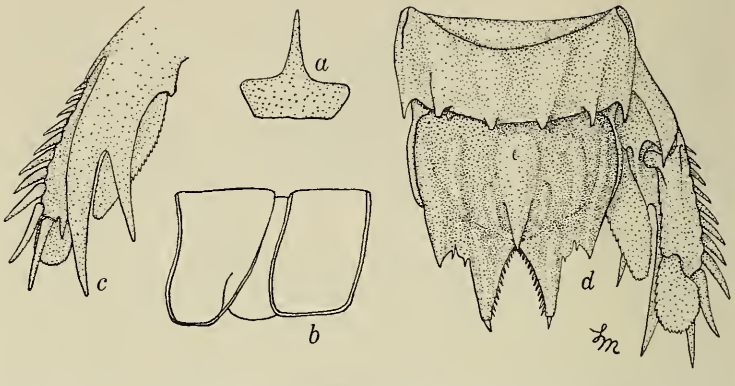


FIG. 2. *Gonodactylus micronesica* new species. Female holotype, TL 18 mm, station 15–69: *a*, outline of rostral plate; *b*, outline of lateral processes of sixth and seventh thoracic somites, right side; *c*, uropod, ventral view; *d*, sixth abdominal somite, telson, and uropod. Setae omitted.

palp and five epipods present. Lateral processes of sixth and seventh thoracic somites rounded, process of sixth somite broader than that of seventh somite (Fig. 2*b*). Carinae of sixth abdominal somite inflated anteriorly, each with strong posterior spine. Telson about as broad as long, with three pairs of marginal teeth, submedians with movable apices. Intermediate teeth of telson well developed, apices sharp. Lateral teeth distinct (on one side only in this specimen), apices not projecting laterally much beyond outline of telson. Telson without dorsal spinules or tubercles. Median carina flask-shaped, not markedly inflated in female, terminating in strong apical spine. Accessory median carinae well-defined, extending anteriorly almost to midlength of telson, posteriorly curving mesially to fuse under apex of median carina. Anterior submedian carinae slender, unarmed, curved posteriorly toward median carina. Carinae of submedian and intermediate teeth sharp, slender, intermediate carinae extending anteriorly to base of median carina; marginal carinae sharp. Telson with 13–14 submedian and two sharp intermediate denticles, intermediates recessed anteriorly, inner set on rounded lobe. Ventral surface of telson lacking carinae. Uropod with 10–11 slender, movable spines on outer margin of proximal segment of exopod, distalmost overreaching distal segment; proximal segment of exopod with distal fixed spine ventrally. Margins of uropod with complete complement of setae, arranged in one series. Spines of basal prolongation of uropod slender, outer longer.

Color: Faded.

Size: Only specimen examined, female holotype, total length 18 mm.

Other measurements, in mm: carapace length 3.3, fifth abdominal somite width 2.4, telson length 2.0, telson width 2.1.

Discussion: Gonodactylus micronesica is the Pacific counterpart of *G. segregatus* Lanchester from the central and western Indian Ocean (Manning, 1968). The new species differs from *G. segregatus* in lacking posterior spinules on the accessory median and anterior submedian carinae of the telson. As in *G. segregatus* the accessory median carinae and the intermediate carinae of the telson are slender and elongate.

The name is derived from the general area of the type-locality, Micronesia.

Key to species of *demanii* section of *Gonodactylus*

1. Inner margin of uropodal endopod largely or completely devoid of setae, margin smooth 2
   Inner margin of uropodal endopod completely fringed with setae, margin serrate at insertion of setae 5
2. Ventral surface of each submedian tooth of telson with 2 longitudinal carinae .... *Gonodactylus bicarinatus* Manning, 1968; Madagascar
   Ventral surface of each submedian tooth of telson with at most 1 longitudinal carina 3
3. Uropodal endopod very broad, width more than ½ length .... *Gonodactylus crosnieri* Manning, 1968; Madagascar, Comoro Islands
   Uropodal endopod slender, width not exceeding ⅓ length 4
4. Rostral plate with sharp anterolateral angles. Inner margin of uropodal endopod completely devoid of setae .... *Gonodactylus hendersoni* Manning, 1967; Burma to Hawaii
   Rostral plate with rounded anterolateral angles. Inner margin of uropodal endopod with 1–10 proximal setae .... *Gonodactylus demanii* Henderson, 1893; western Indian Ocean
5. Telson with dorsal spinules or spines 6
   Telson smooth dorsally 7
6. Telson broader than long, dorsal spinules large. Lateral marginal teeth prominent .... *Gonodactylus lanchesteri* Manning, 1967; western Indian Ocean
   Telson as long as broad, dorsal spinules small. Lateral marginal teeth obscure .... *Gonodactylus spinosus* Bigelow, 1893; western Indian Ocean
7. Proximal segment of uropodal exopod lacking fixed distal spine on ventral surface .... *Gonodactylus choprai* Manning, 1967; western Indian Ocean
   Proximal segment of uropodal exopod with fixed distal spine on ventral surface 8
8. Apices of intermediate marginal teeth of telson appressed to outer margin of submedian teeth, intermediate denticles set posterior to apex of teeth. Uropodal setae in several series on

margin of endopod ....
.... *Gonodactylus espinosus* Borradaile, 1898; central Pacific Ocean

Apices of intermediate marginal teeth of telson separate, not appressed to outer margin of submedian tooth, intermediate denticles recessed anteriorly. Uropodal setae in 1 series on endopod 9

9. Accessory median carinae of telson long, extending anteriorly to midlength of median carina 10

Accessory median carinae of telson, if visible, short, not extending anteriorly beyond posterior ¼ of median carina 11

10. Accessory median and anterior submedian carinae of telson each with posterior spinule ....
.... *Gonodactylus segregatus* Lanchester, 1903; central and western Indian Ocean

Accessory median and anterior submedian carinae of telson unarmed posteriorly .... *Gonodactylus micronesica* new species

11. Median carina very inflated, obliterating accessory medians, with 3 posterior spinules ....
Gonodactylus confinis De Man, 1902; Ternate, Molucca Islands, Indonesia

Median carina variously inflated, unarmed posteriorly 12

12. Anterior submedian carinae of telson oval, broadly inflated, lateral surface of submedians not widely separated from lateral margin of median carina ....
.... *Gonodactylus incipiens* Lanchester, 1903; central Pacific Ocean

Anterior submedian carinae of telson slender, curved posteriorly toward median carina, lateral surface of submedians distinctly separated from lateral surface of median carina ....
.... *Gonodactylus childi* new species

LITERATURE CITED

MANNING, RAYMOND B. 1967. Notes on the *demanii* section of genus *Gonodactylus* Berthold with descriptions of three new species. Proc. U.S. Nat. Mus. 123(3618): 1–27, figs. 1–8.

———. 1968. Stomatopod Crustacea from Madagascar. Proc. U.S. Nat. Mus. 124(3641): 1–61, figs. 1–16.

———. 1969. Notes on the *Gonodactylus* section of the family Gonodactylidae (Crustacea, Stomatopoda), with descriptions of four new genera and a new species. Proc. Biol. Soc. Washington 82: 143–166, figs. 1–8.

Vol. 84, No. 11, pp. 81–94 30 June 1971

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

NEW CRAYFISHES OF THE GENUS *PROCAMBARUS* FROM ALABAMA AND TEXAS (DECAPODA, ASTACIDAE)

By Horton H. Hobbs, Jr.
Department of Invertebrate Zoology, Smithsonian Institution, Washington, D.C. 20560

The two species described here belong to different sections of the genus *Procambarus*, that from Alabama to the Barbatus Section (Hobbs, 1942: 33), and that from Texas to the Blandingii Section (Ortmann, 1905: 98). The latter occurs within the previously known limits of the range of the Section, and the localities from which the former was collected extend the northwestern part of the range of the Barbatus Section by less than 50 miles.

One of the diagnostic characteristics cited for the Blandingii Section (see Hobbs, 1962: 280) is the possession of asymmetrical first pleopods by the male. While indeed most of the members assigned to it do have distinctly asymmetrically arranged pleopods, or they are not mirrored images of one another, a few exceptions have been observed recently, and in *P. texanus*, described below, the pleopods are almost completely symmetrical. A review of the infrageneric groupings of the genus is currently being undertaken, and revised diagnoses of such taxa will be presented in that study.

I should like to acknowledge with thanks the assistance of Martin A. Hollingsworth of Georgia State University who aided me in collecting the specimens from Alabama, and of James L. Larimer of the University of Texas who secured all of the specimens of the species from Texas. I am also grateful to my colleague, Fenner A. Chace, Jr., for his criticisms of the manuscript.

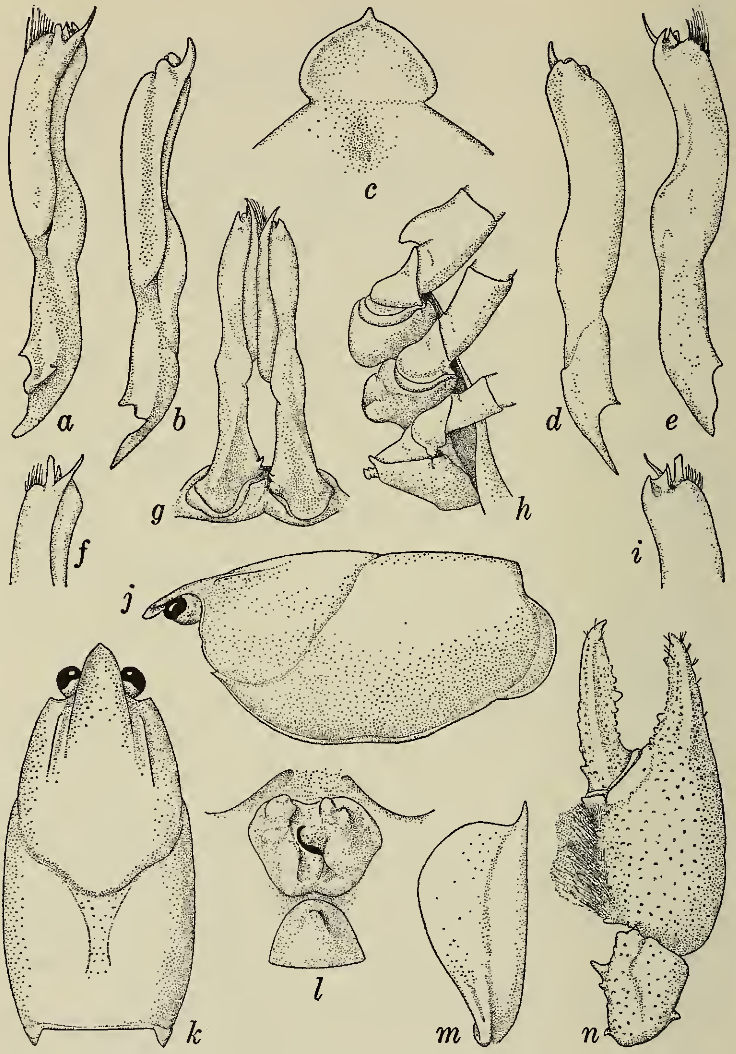


FIG. 1. *Procambarus capillatus* new species (pubescence removed from all structures illustrated except in Fig. 1a, e, and n). a, mesial view of first pleopod of holotype; b, mesial view of first pleopod of morphotype; c, cephalic portion of epistome of holotype; d, lateral view of first pleopod of morphotype; e, lateral view of first pleopod of holotype; f, mesial view of distal portion of first pleopod of male from ditch adjacent to Escambia River on State Route 17, Escambia County, Alabama; g, caudal view of

Procambarus capillatus new species
(Figure 1)

Diagnosis: Body and eyes pigmented. Rostrum without marginal spines or tubercles, acumen not delimited basally. Areola 31.2 to 33.7 percent of entire length of carapace, and 5.4 to 6.6 times longer than wide. Cervical spines lacking. Suborbital angle obsolete. Postorbital ridges lacking tubercles or spines. Antennal scale approximately 2.3 times longer than wide, broadest distal to midlength. Mesial surface of palm of chela of male hirsute; longitudinal ridges on fingers poorly developed. Ischium of third pereiopods, and occasionally that of fourth, with simple hooks. First pleopods asymmetrical, extending cephalically almost to base of second pereiopods, with prominent shoulder on cephalic surface at base of cephalic process, and with subapical setae confined to distal margin of shoulder; distal extremity bearing four corneous elements: (1) subspiculiform mesial process directed caudodistally and somewhat laterally and extending distally beyond other elements; (2) short, distally rounded cephalic process situated mesially at cephalic base of mesial process; (3) short, acute, recurved, caudal process arising from distal caudolateral surface of appendage and extending distally only slightly beyond end of cephalic process; and (4) subtriangular (in mesial and lateral aspects) central projection, centrally situated and extending distally to level of distal end of caudal process. Annulus ventralis freely movable, with broad deep longitudinal trough flanked cephalically by high irregular ridges and containing S-shaped sinus; latter extending along caudal two-thirds of annulus; sternite between bases of fifth pereiopods produced cephaloventrally into conelike prominence. Sternum cephalic to annulus steeply vaulted, unadorned, and not overhanging annulus.

Holotypic male, Form I: Body (Fig. 1j, k) subovate, compressed laterally. Abdomen narrower than thorax (10.5 and 12.4 mm). Width of carapace equal to height at caudodorsal margin of cervical groove. Areola 5.4 times longer than wide with two or three punctations across narrowest part. Cephalic section of carapace twice as long as areola (length 33.4 percent of entire length of carapace). Rostrum excavate dorsally with slightly thickened convergent margins, lacking spines or tubercles, with usual submarginal row of setiferous punctations, and finely rugose basally with few prominent punctations; acumen not delimited basally from remainder of rostrum. Subrostral ridges moderately well developed and evident in dorsal aspect along posterior half of rostrum. Postorbital ridges prominent, grooved dorsolaterally, and lacking spines or tubercles. Sub-

---

←

first pleopods of holotype; h, proximal podomeres of third, fourth, and fifth pereiopods of holotype; i, lateral view of pleopod in Fig. 1f; j, lateral view of carapace of holotype; k, dorsal view of carapace of holotype; l, annulus ventralis of allotype; m, antennal scale of holotype; n, dorsal view of distal podomeres of cheliped of holotype.

TABLE 1. Measurements (mm) of *Procambarus capillatus.*

	Holotype	Allotype	Morphotype
Carapace:			
Height	12.4	12.6	11.6
Width	12.4	12.7	11.3
Length	24.3	26.9	25.0
Areola:			
Width	1.5	1.4	1.3
Length	8.1	8.8	7.8
Rostrum:			
Width	3.7	4.3	3.5
Length	4.6	4.7	4.7
Chela:			
Length of inner margin of palm	7.7	6.7	6.0
Width of palm	8.0	7.8	6.3
Length of outer margin	19.4	17.3	15.5
Length of dactyl	11.0	10.0	8.7

orbital angle obsolete. Branchiostegal spine moderately strong. Carapace punctate dorsally and granulate laterally with well defined row of granules along ventral border of cephalic portion of cervical groove; cervical tubercle only slightly larger than neighboring ones on branchiostegites and hepatic areas of carapace. Abdomen longer than carapace (25.5 and 24.3 mm). Cephalic section of telson with two spines in each caudolateral corner, mesial pair movable. Uropods with two well developed spines on basal podomere; inner ramus with strong distolateral spine and smaller apical one on median ridge, latter not reaching distal margin of ramus; outer ramus with row of small spines immediately proximal to transverse suture with one larger one adjacent to lateralmost member. Cephalic portion of epistome (Fig. 1c) subminarette-shaped with prominent fovea proximally; surface subplane, slightly elevated medially, and with elevated (ventrally) margins. Antennules of usual form with prominent spine on ventral surface slightly distal to midlength; mesial border of entire peduncle with plumose setae, conspicuously developed on ultimate podomere. Antennae extending caudally almost to base of telson. Antennal scale (Fig. 1m) about 2.3 times longer than broad, greatest width distal to midlength, lamellar portion much broader than thickened lateral portion; latter terminating in moderately long spine.

Third maxillipeds with ventral surface of proximal podomeres through basal half of merus and peduncle of exopod conspicuously hirsute.

Right chela (Fig. 1n) moderately short and heavy, subovate in cross section, moderately depressed. Mesial surface of palm with conspicuous brush of long plumose setae obscuring several rows of tubercles (mesialmost consisting of approximately 11); lateral surface with row of setiferous punctations, and upper and lower surfaces with squamous tubercles, mesially situated ones largest, all becoming more depressed laterally, proximolateral ones replaced by setiferous punctations; lower surface with prominent tubercle distolateral to articular condyle at base of dactyl. Fixed finger with broad rounded longitudinal ridge dorsally and ventrally, flanked by setiferous punctations, lateral surface very weakly costate, and opposable margin with row of six evenly spaced tubercles along proximal two-thirds, third from base largest, and large tubercle projecting from lower level at base of distal fifth; single row of minute denticles extending between and distal to tubercles. Dactyl with weak dorsal and ventral submedian longitudinal ridges flanked proximally by tubercles and distally by setiferous punctations; mesial surface with row of six tubercles in proximal half and setiferous punctations distally; opposable surface with row of six tubercles along proximal two-thirds, fourth from base largest and marking distal end of proximal excised portion of margin, single row of minute denticles between and distal to tubercles.

Carpus of right cheliped longer than broad (7.3 and 5.2 mm) with mesial, dorsomesial, and ventromesial surfaces tuberculate, otherwise punctate; dorsal surface with sinuous, oblique depression; mesial surface with one major tubercle and smaller one at its proximal base; lower portion of mesial surface with row of four tubercles extending proximodorsally from mesial ventrodistal angle; ventral surface with large tubercle at base of condyle on distolateral angle and two or three smaller ones proximolateral to oblique row of tubercles on lower mesial surface.

Merus of right cheliped tuberculate dorsally and ventrally, dorsal tubercles progressively larger distally, and sparsely punctate mesially and laterally; ventral surface with mesial row of 13 tubercles and lateral one of six proximal to bifurcation, and each ramus with four, those in mesial ramus much more conspicuous than those in lateral. Ischium with row of five tubercles, proximalmost largest.

Hooks on ischia of third and fourth right pereiopods, that on left fourth pereiopod reduced to tubercle (Fig. 1h); hooks simple and both overreaching distal extremities of corresponding basis. Coxa of fourth pereiopod with caudomesial boss virtually obsolete; that on fifth prominent, subacute, and obliquely flattened.

Sternum between third, fourth, and fifth pereiopods moderately deep and bearing heavy fringe of plumose setae on ventrolateral margins.

First pleopods (Fig. 1a, e, g) as described in diagnosis.

Allotypic female: Description of holotype applicable to allotype except for secondary sexual characters and following: epistome lacking cephalomedian prominence; third maxilliped slightly less hirsute; chela proportionately shorter and mesial surface of palm lacking conspicuous brush of plumose setae, revealing several irregular rows of tubercles; lateral margin of propodus more distinctly costate; merus of right cheliped somewhat unusual as compared with other females, bearing four minor tubercles on mesial surface with one distal to major tubercle and three proximal to it, lower mesial surface with tubercles more irregularly arranged. See measurements.

Annulus ventralis (Fig. 1l) as described in diagnosis, deeply embedded in sternum.

Morphotypic male, Form II: Differing from holotype in following respects: third maxillipeds and mesial surface of palm of chela not so conspicuously hirsute, but brush on latter markedly more strongly developed than in allotype, obscuring most tubercles in area; opposable margin of propodus and dactyl of chela with rows of five and seven tubercles, respectively; mesial surface of carpus with one additional small tubercle proximally; ischia of third pereiopods only with hooks, those much reduced in size; coxae of fourth pereiopods with scarcely trace of caudomesial boss whereas those of fifth with similar, well developed, although less acute, prominences.

First pleopods (Fig. 1b, d) extending cephalically almost to bases of second pereiopods with shoulder on cephalic surface much more weakly developed than in holotype; terminal elements as in latter, but none corneous, all more inflated and less sharply defined.

Color notes: Spotted Phase—Ground color of body and appendages olive green with brown flecks dorsally and dorsolaterally. Branchiostegites with paired dorsolateral irregular stripes extending from caudal margin of carapace along caudal two-thirds of areola. Stripes continuing onto abdomen in form of paired, dark, rectangular patches on anterior portion of each segment, patches becoming progressively smaller caudally. Abdomen also with narrow longitudinal dark stripe extending along line of junction of terga and epimera. Basal podomeres of pereiopods and lower surfaces of distal podomeres of cheliped suffused with pale pink. Plumose setae on palm of chela straw brown.

Striped Phase—Differs from spotted phase chiefly in possessing broad, dorsomedian, pinkish-tan stripe extending caudally from level of gastric region to base of telson, flanked laterally by continuous dark stripes; margins of latter, particularly ventral ones, irregular on gastric and hepatic regions of carapace.

Size: The largest specimen available is a female having a carapace length of 27.9 mm. The largest and smallest first-form males have corresponding lengths of 27.7 and 24.3 mm.

Type-locality: Drainage ditch adjacent to Burnt Corn Creek (Escambia River drainage) on State Route 41, northwest of Brewton, Escambia County, Alabama. The adult specimens were dug from complex burrows in sandy clay soil adjacent to a wooded area supporting *Liquidambar styraciflua* L., *Quercus* sp., *Pinus* sp., and with *Salix* sp. growing abundantly along the ditch.

Types: The holotypic male, form I, allotypic female, and morphotypic male, form II (Nos. 131454, 131455, 131456, respectively) are deposited together with the paratypes (2 ♂ I, 9 ♂ II, 13 ♀, 38 juv. ♂, and 43 juv. ♀) in the National Museum of Natural History, Smithsonian Institution.

Range: Insofar as is known, this crayfish is confined to the Escambia

River basin in Escambia and Conecuh Counties, Alabama, and perhaps Escambia County, Florida. The type-series has been selected from the type-locality and from a roadside ditch, 4 miles south of the junction of U.S. Highways 31 and 84 in Conecuh County, Alabama. Atypical specimens tentatively assigned to the species were collected in three additional localities: a drainage ditch adjacent to the Escambia River on State Route 17, and a similar habitat on a farm road 3 miles northeast of Flomaton, both in Escambia County, Alabama, and from a drainage ditch at Bluff Springs, Escambia County, Florida.

Variations: While there are minor variations in the numbers of tubercles on the various podomeres of the cheliped, there is remarkable uniformity among those specimens constituting the type-series. The presence of a hook on the ischium of the dextral fourth pereiopod of the holotype probably represents an atavistic occurrence, for it is lacking on the sinistral member, and, in the remaining males, hooks occur only on the third pereiopods.

Unfortunately, among the three lots of specimens excluded from the type-series, there is only one first-form male. Whereas it is similar in most respects to *P. capillatus*, there are distinct differences. Among them are: the coxa of the fourth pereiopod is provided with a moderately well developed boss; the lateral surface of the distal portion of the first pleopod is straight rather than curved mesially,' the cephalic process is much more elongate, extending beyond the tip of the central projection, and the caudal process is shorter, less acute, and more intimately associated with the central projection than in typical *capillatus* (Fig. 1f, i).

Relationships: Procambarus capillatus has its closest affinities with *P. rathbunae* (Hobbs, 1940: 414), its ecological counterpart in the adjacent Yellow River basin in Florida, and more distantly with other members of the Barbatus Group, all of which are primary or secondary burrowers. All of the species of the group have markedly similar gross morphological features, and the primary differences between them are to be found in the arrangement and disposition of the terminal elements of the first pleopod of the male. The combination in males of possessing an acute, corneous, distally directed caudal process and with chelae bearing barbate palms will distinguish this crayfish from all other members of the genus.

Life history notes: All of the specimens definitely assigned to this species were collected during April, 1970, when first-form males were obtained. No ovigerous females or those carrying young have been observed.

Procambarus texanus new species
(Figure 2)

Diagnosis: Body and eyes pigmented. Rostrum with marginal spines or tubercles delimiting base of acumen. Areola 34.2 to 37.0 percent of entire length of carapace, and 8.5 to 16.4 times longer than wide. Single cervical spine present or absent, often so small as to be unrecognizable. Suborbital angle rudimentary or absent. Postorbital ridges terminating cephalically in small spines or tubercles. Antennal scale approximately

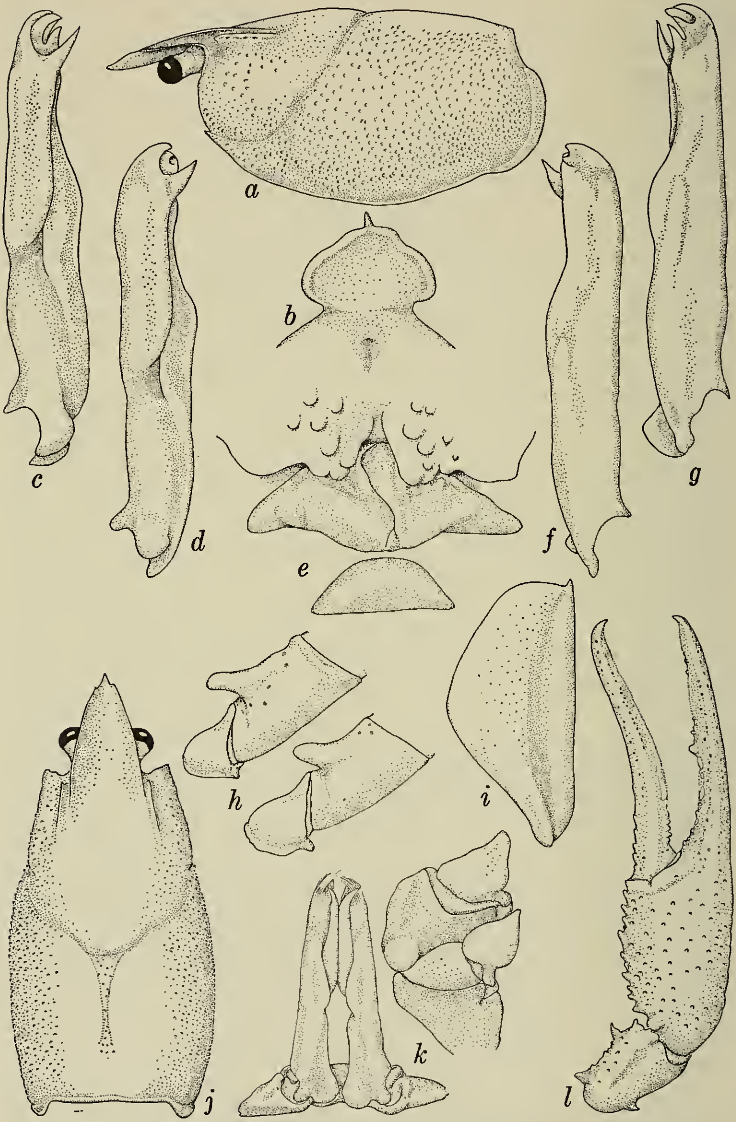


FIG. 2. *Procambarus texanus* new species (pubescence removed from all structures illustrated). a, lateral view of carapace of holotype; b, cephalic portion of epistome of holotype; c, mesial view of first pleopod of paratypic male, form I; d, mesial view of first pleopod of morphotype; e,

2.1 times longer than wide, broadest at or slightly proximal to midlength. Mesial surface of palm of chela of male not hirsute but bearing row of six to eight tubercles; longitudinal ridges on fingers not sharply defined. Ischium of third and fourth pereiopods with simple hooks. First pleopods almost symmetrical or with base of dextral pleopod slightly overlapping that of sinistral member, extending cephalically to base of third pereiopods, lacking strong cephalic shoulder but provided with subapical setae obscuring, in lateral aspect, parts of terminal elements; distal extremity bearing four corneous elements: (1) long, tapering mesial process directed caudodistally and somewhat laterally, not reaching level of tip of central projection; (2) cephalic process contiguous along its caudal length to central projection and curved caudally with tip directed at 90 degree angle to axis of appendage; (3) caudal process subtriangular, directed caudodistally and reaching no farther distally than level of tip of mesial process; and (4) central projection bent caudally paralleling cephalic process, its tip extending caudally to level of tip of caudal process. Setiferous caudal knob situated at lateral base of cephalic process. Annulus ventralis overhung (ventrally) by multituberculate lobes from sternum immediately cephalic to it, subovate with greatest length in transverse axis, weakly sculptured, and with median S-shaped sinus extending from cephalic margin almost to caudal margin; sternite between bases of fifth pereiopods gently rounded and not produced.

Holotypic male, Form I: Body (Fig. 2a, j) subcylindrical, only slightly compressed laterally. Abdomen narrower than thorax (21.6 and 26.4 mm). Width of carapace slightly greater than depth at caudodorsal margin of cervical groove. Areola about 15 times longer than broad with two punctations across narrowest part. Cephalic section of carapace about 1.6 times as long as areola (length 36 percent of entire length of carapace). Rostrum excavate dorsally with non-thickened convergent margins bearing rudiments of marginal tubercles; upper surface with widely scattered punctations between usual submarginal rows; acumen subtriangular, reaching slightly beyond base of ultimate podomere of antennule; subrostral ridges rather weakly developed and not evident in dorsal aspects. Postorbital ridges only moderately well developed with shallow dorsolateral furrow, and terminating in short, subacute, corneous tubercles. Suborbital angle rudimentary and obtuse. Branchiostegal spine short and heavy. Carapace punctate dorsally and conspicuously granulate laterally; single cervical tubercle only slightly larger than adjacent

---

←

annulus ventralis of allotype; f, lateral view of first pleopod of morphotype; g, lateral view of first pleopod of paratypic male, form I; h, basis and ischium of third and fourth pereiopods of holotype; i, antennal scale of holotype; j, dorsal view of carapace of holotype; k, caudal view of first pleopods and basal podomeres of fourth and fifth pereiopods of holotype; l, dorsal view of distal podomeres of cheliped of holotype.

TABLE 2. Measurements (mm) of *Procambarus texanus.*

	Holotype	Allotype	Morphotype
Carapace:			
Height	24.6	21.3	21.3
Width	26.4	21.5	22.3
Length	53.3	45.4	45.0
Areola:			
Width	1.2	1.6	1.3
Length	18.3	15.5	15.5
Rostrum:			
Width	8.7	7.7	9.1
Length	14.6	12.5	12.3
Chela:			
Length of inner margin of palm	18.0	8.6	14.5
Width of palm	14.9	9.3	10.9
Length of outer margin	58.8	26.9	45.5
Length of dactyl	35.4	16.7	27.6

granules. Abdomen subequal in length to carapace (53.7 and 54.2 mm). Cephalic section of telson with three abraded spines in each caudolateral corner, caudal section subtruncate with slight caudomedian emargination. Uropods with two short, acute, corneous tubercles on basal podomere; inner ramus with short distolateral spiniform tubercle and ante-apical one on median ridge; outer ramus with usual row of small spines immediately proximal to transverse suture, lateral two larger than others. Cephalic portion of epistome (Fig. 2b) with sinuous, rounded cephalolateral, somewhat elevated margins and conspicuous cephalomedian projection; fossa prominent and deep. Antennules of usual form with moderately strong ventral spine near midlength. Antennae broken but in other specimens extending caudally to fourth abdominal tergum. Antennal scale (Fig. 2i) approximately 2.1 times longer than broad, greatest width approximately at midlength, lamellar portion much broader than thickened lateral part; latter terminating in abraded moderately developed spine.

Third maxillipeds with basis and ischium moderately setose over much of postaxial surface, more distal podomeres distinctly more sparsely setiferous.

Right chela (Fig. 2l) distinctly elongate, subovate in cross section, rather strongly depressed. Mesial surface of palm with single row of seven prominent tubercles subtended above by four subparallel rows of smaller tubercles and below by irregularly placed ones; remaining surfaces of palm with squamous tubercles, those on lateral and dorsolateral surfaces strongly squamous, tubercles progressively more elevated mesially on both dorsal and ventral surfaces; conspicuous tubercle present on distoventral margin at base of dactyl. Fixed finger with lateral margin bearing row of squamous tubercles proximally, row continuing distally in punctations set in shallow trench; dorsal and ventral surfaces with submedian longitudinal, rounded elevation flanked by punctations; opposable margin with row of 16 tubercles, fourth from base largest, along proximal two-thirds of finger, and one prominent tubercle on lower level at base of distal third, latter tubercle with smaller one immediately proximal to it; minute denticles between tubercles in row and band of denticles beginning above distal major tubercle extending to base of corneous tip of finger. Dactyl with upper and lower surfaces similar to those of fixed finger except few tubercles present basally on both surfaces; mesial surface with row of three tubercles along basal fifth and punctations distally; opposable surface with upper row of approximately 20 small tubercles along basal two-thirds and lower row of four larger ones in proximal half; proximal member of lower row conspicuously larger than other tubercles on opposable surface.

Carpus of right cheliped longer than broad (15.3 and 9.0 mm), tuberculate mesially, dorsomesially, and ventromesially, otherwise punctate and with shallow oblique furrow dorsally; mesial surface with one major tubercle, dorsomesial distal angle with another; distoventral margin with prominent tubercle on articular condyle and another at mesial angle.

Merus of right cheliped tuberculate dorsally, ventrally and distomesially, otherwise polished and with scattered punctations; terminal tubercle on dorsal surface conspicuously larger than others; tubercles on ventral surface arranged, for most part, in two rows of 19 tubercles each, mesial row flanked distomesially by more irregular row of seven tubercles. Ischium with row of five tubercles.

Hooks on ischia of third and fourth pereiopods (Fig. 2h), both simple and extending proximally beyond distal extremity of corresponding basis. Coxa of fourth pereiopod with prominent, rounded, vertically disposed caudomesial boss; that on fifth smaller and somewhat compressed in longitudinal plane of body (Fig. 2k).

Sternum between third, fourth, and fifth pereiopods moderately deep and bearing comparatively weak fringe of plumose setae on ventrolateral margins.

First pleopods (Fig. 2c, g, k) as described in diagnosis.

Allotypic female: Description of holotype applicable to allotype except for secondary sexual characters and following: areola distinctly broader, 10.3 times longer than wide; mesial surface of palm of right chela with row of eight tubercles; opposable margin of fixed finger with row of nine tubercles (11 on left), third from base largest, along proximal half of finger, single prominent tubercle at level below row and slightly proximal to base of distal third; opposable margin of dactyl with single row of 15 tubercles along basal two-thirds, sixth from base largest; carpus of right chela with moderately large tubercle immediately proximal to major tubercle on mesial surface; merus of right cheliped with ventromesial row of 12 tubercles and ventrolateral one of nine, ischium with row of three tubercles (see measurements).

Annulus ventralis (Fig. 2e) as described in diagnosis.

Morphotypic male, Form II: Differs from holotype in following respects: rostrum with well-defined, corneous, marginal tubercles; cephalic section of telson with only two spines in each caudolateral corner; epistome with cephalic margin nearly transverse and cephalomedian projection with two small tubercles; mesial surface of palm of right chela with single row of eight tubercles flanked by two moderately well-defined rows above and below; opposable margin of fixed finger with upper row of 16 tubercles (fifth from base largest) and lower row of 11 (penultimate largest) along basal two-thirds of finger; opposable margin of dactyl with upper row of 20 small tubercles and lower of 10 larger ones, fifth from base conspicuously larger than others on margin; carpus as in morphotype except major tubercle on mesial surface much slenderer; merus of right cheliped with ventromesial row of 15 tubercles and ventrolateral one of 12; hooks on ischia of third and fourth pereiopods much reduced, neither reaching proximad of distalmost margin of corresponding basis; prominences of coxae of fourth and fifth pereiopods also much reduced. (See measurements.)

First pleopods (Fig. 2d, f) extending cephalically to bases of third pereiopods, lacking shoulder on cephalic surface; terminal elements essentially as in holotype but all except mesial process much reduced, and none corneous.

Color notes: (Based on specimens preserved in alcohol for about 2 weeks.) Dorsal surface of carapace reddish brown tending toward greenish blue in region of dorsal part of cervical groove; branchiocardiac grooves pale tan. Lateral surface of branchiostegites with dark, reddish-brown band on each side corresponding to "lateral horn" of saddle in such forms as *Procambarus pictus* (see Hobbs, 1958: 74); area below horn on branchiostegite pinkish cream with cream to whitish tubercles; hepatic area only slightly lighter in color than dorsal portion of carapace. Rostral margins and postorbital ridges black. Abdomen with median, broad, dark band extending from base to caudal margin of fifth tergite and two pairs of light, cream-pink, irregular splotches occurring from second to fifth tergite on cephalolateral portion immediately above epimera; epimera purplish red, that of second segment with pale-pinkish area in middle, others concolorous except for pale cephalic margins. Uropods and telson uniformly scarlet with buff fringe. Antennal scale bluish gray laterally, thickened portion pinkish, lateral portion of lamellar area red, fading to pinkish cream toward mesial and distal margins. Chelipeds reddish to orange above with mesial part of palm and upper surface of fingers suffused with gray; tubercles on palm and mesial surface of dactyl dark basally, and lighter, sometimes cream colored, distally; lower surface of palm and fingers similar to upper although grayish suffusion not nearly so prominent. Dorsal surface of middle podomeres of ambulatory pereiopods pinkish lavender, remainder of appendages pinkish cream.

Size: The largest specimen is a first-form male having a carapace length of 54.6 mm. The smallest first-form male has a corresponding length of 45.0 mm.

Type-locality: Fish Hatchery near Smithville, Bastrop County, Texas.

Types: The holotypic male, form I, allotypic female, and morphotypic male, form II (Nos. 131457, 131458, 131459, respectively) are deposited together with the paratypes (5 ♂ I, 1 ♀) in the National Museum of Natural History, Smithsonian Institution.

Range: This species is known only from the type-locality where it was collected with *Procambarus clarkii* (Girard, 1852: 91) and *Procambarus acutus* subsp.

Variations: There are few variations among the specimens except those derived from abrasions. None of them is devoid of injured or beveled tubercles. The morphotype appears to have molted more recently than the others for it shows fewer mutilations. In one or two of the specimens the acumen reaches to or slightly beyond the distal end of the peduncle of the antennule and the marginal tubercles on the rostrum are more prominent; correspondingly, the tubercles elsewhere are not nearly so worn as in the holotype. Excluding regenerated appendages, the variations pointed out in the above descriptions mark the limits of those observed.

Relationships: Procambarus texanus is more similar to *P. acutus* (Girard, 1852: 91), its subspecies and variants, and to *P. lecontei* (Hagen, 1870: 47) than to other members of the genus. The fact that it occurs in the same habitat with a crayfish that I believe to be a variant of the former suggests its specific status, and certainly it is distinct from the typical form of *P. a. acutus*, differing chiefly in the shorter, less twisted terminal elements of the first pleopod of the male (also the much reduced caudal knob), and in the more nearly closed sinus of the annulus ventralis, the latter partially obscured by prominent multituberculate prominences projecting posteriorly from the sternum immediately cephalic to it. It differs from *P. lecontei* in that the mesial process of the first pleopod is directed more distally than caudally, not at right angles to the main axis of the appendage. While the annulus ventralis is very similar to that of *P. lecontei* much more of it is hidden by the prominences from the sternum cephalic to it. Too, the areola is distinctly narrower in *P. texanus* and bears fewer punctations than does that of *P. lecontei.*

Life history notes: All of the specimens were collected during the late spring and early summer and judging by the relative conditions of the males (the second form appearing to have undergone the most recent molt), it is probable that the adult males were in the first form throughout the winter and spring months. No females with eggs or young have been observed.

LITERATURE CITED

GIRARD, CHARLES. 1852. A revision of the North American Astaci, with observations on their habits and geographical distribution. Proc. Acad. Nat. Sci., Philad. 6: 87–91.

HAGEN, HERMANN A. 1870. Monograph of the North American Astacidae. Ill. Cat. Mus. Comp. Zool., Harvard Coll. (3): 1–109, 11 pls.

HOBBS, HORTON H., JR. 1940. Seven new crayfishes of the genus *Cambarus* from Florida, with notes on other species. Proc. U.S. Nat. Mus. 89(3097): 387–423, figs. 14–22.

———. 1942. The crayfishes of Florida. Univ. Fla. Pub., Biol. Series 3(2): 1–179, 346 figs.

———. 1958. The evolutionary history of the Pictus Group of the crayfish genus *Procambarus*. Quart. Journ. Fla. Acad. Sci. 21(1): 71–91, 20 figs.

———. 1962. Notes on the affinities of the members of the Blandingii Section of the crayfish genus *Procambarus* (Decapoda, Astacidae). Tulane Studies in Zool. 9(5): 273–293, 72 figs.

ORTMANN, A. E. 1905. The mutual affinities of the species of the genus *Cambarus*, and their dispersal over the United States. Proc. Amer. Philos. Soc. 44: 91–136, pl. III.

Vol. 84, No. 12, pp. 95–102 30 June 1971

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

A NEW CRAWFISH OF THE SPICULIFER GROUP OF THE GENUS *PROCAMBARUS* (DECAPODA, ASTACIDAE) FROM CENTRAL MISSISSIPPI

By J. F. Fitzpatrick, Jr. and Horton H. Hobbs, Jr.
Randolph-Macon Woman's College, Lynchburg, Virginia 24504 and Department of Invertebrate Zoology, Smithsonian Institution, Washington, D.C. 20560

The members of the Spiculifer Group of the crawfish genus *Procambarus* inhabit lotic habitats in the Coastal Plain and Piedmont provinces of the southeastern United States. Although only five of the 15 described species have allopatric ranges, only four species have been previously reported as occurring in the same locality with another member of the Group: *P. elegans* Hobbs, 1969: 329, and *P. vioscai* Penn, 1946: 27, in Louisiana, and *P. spiculifer* (LeConte, 1856: 401) and *P. versutus* (Hagen, 1870: 51) in Alabama and Florida (Hobbs, 1969: 347). To such associations we can now add that of *P. spiculifer* and *P. raneyi* Hobbs, 1953: 412, in Big Flat Creek, a tributary to the Alcovy River, Walton County, Georgia. The range of the species described here, while seemingly allopatric, is almost completely surrounded by that of a yet undescribed member of the group which fills the apparent hiatus in the range between *P. ablusus* Penn, 1963: 121, and other species of the group: *P. versutus* and *P. lagniappe* Black, 1968: 5, to the east; *P. penni* Hobbs, 1951: 273, to the south; and *P. vioscai* to the west.

Procambarus lylei new species

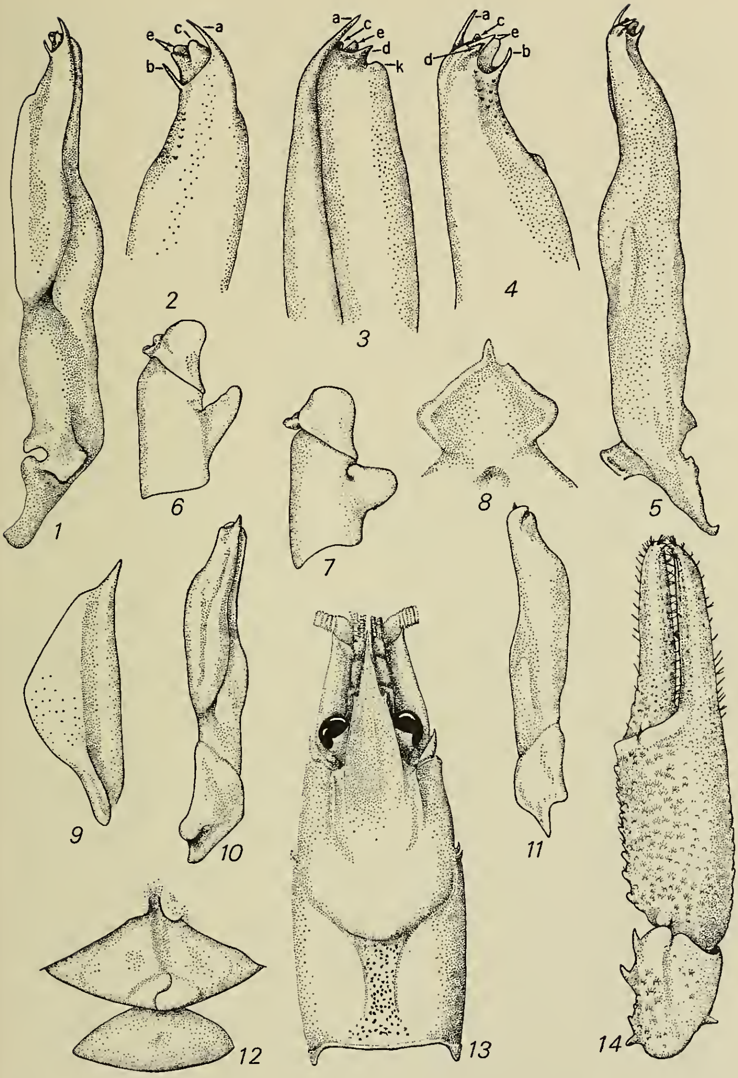
(Figures 1–14)

Diagnosis: Body pigmented, eyes well-developed. Rostrum with convergent margins bearing pair of marginal spines; acumen long and slender. Areola 2.5 to 5.3 times longer than wide and constituting 25.0 to 30.2 percent of entire length of carapace. Carapace with two cervical spines on each side. Suborbital angle obsolete. Postorbital ridges terminating in spines. Antennal scale approximately 2.3 times longer than wide, broadest proximal to midlength. Mesial margin of palm with seven or eight tubercles, and both fingers provided with moderately well-defined longitudinal ridges. Ischia of third and fourth pereiopods with hooks, those of the third markedly more acute; coxae of fourth and fifth pereiopods with prominences. First pleopods asymmetrical, with weakly defined shoulder on cephalic surface, reaching cephalad to cephalic margin of coxae of third pereiopods, and provided with subterminal setae; distal extremity bearing five elements: (1) slender acute mesial process, (2) shorter but slender and acute cephalic process, (3) rounded, unobtrusive caudal knob bearing strong caudal process medially, (4) short, corneous central projection, and (5) stout, broadly subtriangular adventitious process situated cephalomesial to central projection extending subparallel to it but not quite so far distally; all terminal elements recurved cephalodistally; cephalic process not visible in caudal aspect of appendage.

Holotypic male, Form I: Body subovate. Abdomen narrower than thorax (13.2 and 14.6 mm). Width of carapace slightly greater than height at caudodorsal margin of cervical groove (14.6 and 14.0 mm). Areola 4.1 times longer than wide with four or five punctations across narrowest part. Cephalic section of carapace 2.7 times as long as areola (latter 27.7 percent of entire length of carapace). Rostrum excavate dorsally with unthickened margins subparallel at base but becoming convergent at level of caudal margin of orbit; upper surface of rostrum with usual submarginal setiferous punctations and others scattered sparsely between; well-developed marginal spines present at base of acumen; acumen long and spiniform, constituting approximately 39 percent of entire length of rostrum. Subrostral ridges weak and scarcely visible in dorsal aspect. Postorbital ridges prominent, grooved dorsolaterally, and terminating cephalically in strong acute spines. Suborbital angle obsolete. Branchiostegal spine prominent and acute. Carapace punctate dorsally, tuberculate cephalolaterally, and granulate ventrolaterally. Two cervical spines present on each side of carapace subequal in size. Abdomen longer than carapace (34.9 and 33.3 mm). Cephalic section of telson with three spines in right and four in left caudolateral corner. Epistome (Fig. 8) about as broad as long; margins slightly elevated and converging to subacute apical projection. Antennules of

→

FIGS. 1–14. *Procambarus lylei* new species (pubescence removed from all structures illustrated). 1, Mesial view of first sinistral pleopod of holotype. 2, Cephalomesial aspect of apical portion of first pleopod of holotype. 3, Caudal aspect of apical portion of first pleopod of holotype. 4, Lateral aspect of apical portion of first pleopod of holotype. 5, Lateral view of first pleopod of holotype. 6, Basipodite and ischiopodite of third pereiopod of holotype. 7, Basipodite and ischiopodite of fourth pereiopod of holotype. 8, Epistome of holotype. 9, Antennal scale of holotype. 10,



Mesial view of first pleopod of morphotype. 11, Lateral view of first pleopod of morphotype. 12, Annulus ventralis of allotype. 13, Dorsal view of carapace of holotype. 14, Dorsal view of distal podomeres of cheliped of holotype. Abbreviations—a, mesial process; b, cephalic process; c, adventitious process; d, caudal process; e, central projection; k, caudal knob.

Table 1. Measurements (mm) of *Procambarus lylei.*

	Holotype	Allotype	Morphotype
Carapace:			
Height	14.0	13.9	11.1
Width	14.6	12.9	9.3
Length	33.3	31.5	24.4
Areola:			
Width	2.2	3.4	2.0
Length	9.1	8.4	6.1
Rostrum:			
Width	4.8	5.0	3.8
Length	13.8	12.9	10.5
Left chela:			
Length of inner margin of palm	11.6	5.5	5.1
Width of palm	7.2	4.5	3.1
Length of outer margin of chela	25.3	13.8	11.4
Length of dactyl	11.9	7.2	6.1

usual form with prominent spine on ventral surface of basal third of proximal segment. Antennae broken, length indeterminate. Antennal scale (Fig. 9) about 2.3 times longer than broad, broadest proximal to midlength with widest lamellar area 1.9 times wider than thickened lateral portion, latter terminating in strong acute spine.

Right chela (Fig. 14) moderately depressed with palm somewhat inflated; lateral margin with row of squamous tubercles along proximal half; upper and lower surfaces of palm with numerous tubercles, mesial margin with row of eight tubercles subtended dorsolaterally by irregular row of about nine less prominent tubercles, lower surface without prominent tubercle at base of dactyl. Fixed finger with moderately well-defined, submedian dorsal ridges flanked by setiferous punctations; opposable margin with row of five small and one prominent tubercle in basal half and crowded minute denticles along almost entire length; lower surface with moderately prominent, submedian, longitudinal ridge flanked by setiferous punctations. Dactyl with weak submedian ridge flanked by setiferous punctations above and below; mesial surface with 12 tubercles arranged in three irregular rows in proximal third and setiferous punctations distally; proximal half of opposable margin with upper row of six subequal tubercles and more prominent lower row of one small, one large, and two small tubercles, and with crowded minute denticles along almost entire length.

Carpus of right cheliped longer than broad (8.0 and 4.7 mm), with mesial and dorsomesial areas tuberculate, and area lateral to dorsal diagonal furrow mostly punctate; distal dorsomesial surface with one prominent spine; mesial surface with one spiniform tubercle near midlength and several smaller tubercles proximal to it; proximal dorsomesial surface with less acute and smaller spiniform tubercle; lower surface with two distal spines, lateral one on ventral articular condyle and other more mesially situated.

Merus of right cheliped punctate over most of surface; upper margin with row of six spiniform tubercles in proximal half becoming double row of seven each in distal half, most distal in each row strong and acute; lower lateral margin with row of 11 spiniform tubercles and mesial row of 13. Ischium with row of one large and two small spiniform tubercles on mesial surface.

Hooks on ischia of third and fourth pereiopods (Figs. 6, 7) simple, that on fourth somewhat bulbous. Coxa of fourth pereiopod with prominent rounded boss caudomesially; that of fifth with small slender projection ventrolateral to penis papilla.

Sternum between second through fifth pereiopods moderately deep and bearing prominent fringe of setae on ventrolateral margins.

First pleopods (Figs. 1–5) as described in diagnosis.

Morphotypic male, Form II: Subadult male. Differences from holotype minor except in chela and first pleopod. Chela markedly shorter and less tuberculate; mesial margin of palm with row of seven tubercles subtended dorsolaterally by row of only three poorly developed tubercles; tubercles on opposable margins of fingers much reduced; right chela missing. (See measurements.) First pleopod (Figs. 10, 11) reaching only to middle of coxa of third pereiopod; terminal elements non-corneous, subparallel to main axis of shaft of pleopod, and restricted to stoutly acute mesial process, blunt caudal knob, and central projection; suture clearly delimiting basal segment. Coxa of fourth pereiopod lacking boss; ventromesial projection of coxa of fifth pereiopod much less developed and more ventral in position than in holotype. Third pereiopods missing.

Allotypic female: Differing from holotype principally in secondary sexual characters. Abdomen proportionately much wider as compared with width of carapace (11.8 and 12.9 mm). Chela shorter and stouter; submedian ridges of fingers less pronounced; dactyl with only one large tubercle in proximal region of antepenultimate fourth of lower opposable margin and upper row of five subequal tubercles; tubercles of upper and lower surfaces of palm much reduced. Antennae reaching fourth abdominal tergum. (See measurements.)

Annulus ventralis (Fig. 12) movable, with shallow submedian trough in cephalic two-thirds; sinus originating in caudal portion of trough and winding in reversed sigmoid curve to caudal margin of annulus, bisecting rounded caudal eminence; remainder of ventral surface nearly plane. Thoracic sternum lacking deep excavation and not conspicuously setose; sternum overhanging cephalic margin of annulus ventralis and with one pair of caudally projecting tubercles.

Type-locality: Shutispear Creek, 2.7 miles south of State Route 8 on

State Route 9, Calhoun County, Mississippi. At the time of the collection, the stream had a sluggish current and a bottom of sticky mud, on which there were sticks and other detritus. The stream was some five feet in width, three feet deep, and was surrounded by wooded banks, the preponderant element of which was *Salix nigra* Marsh.

Disposition of types: The holotypic male, Form I, the allotypic female, and the morphotypic male, Form II, are in the collection of the National Museum of Natural History, Smithsonian Institution, nos. 131533, 131534, and 131535, respectively. Topoparatypes and paratypes are in the personal collection of the senior author.

Range and crawfish associates: Procambarus lylei is known from only two localities in Calhoun County, Mississippi, both in the Yalobusha River drainage: type-locality, 2 April 1966 (1 ♂ I, 2 ♂ II, 3 ♀, 6 juv. ♂, 3 juv. ♀), L. E. Fleming and J. F. Fitzpatrick, Jr., coll., with *P. a. acutus* (Girard, 1852: 91), *P. hayi* (Faxon, 1884: 108), *Cambarus diogenes* subsp., and an undescribed species of *Orconectes*. Toposhaw Creek, 1.9 miles west of Calhoun City (junction State Route 9) on State Route 8, 4 August 1967 (2 ♀), S. M. Chien and W. G. Anding, coll., with *P. a. acutus*, *P. hayi*, and an undescribed species of *Orconectes*. Diligent search of the area has not revealed additional localities in which the species occurs.

Variation and size: Aside from the usual variations associated with sex and maturity, few significant variations were encountered. The fourth spine in the left caudolateral corner of the cephalic section of the telson of the holotype is clearly an accessory spine, appearing only in this specimen. Three females which are larger than the allotype have the cephalolateral margins of the annulus ventralis elevated, the degree of elevation apparently increasing with size; in juvenile specimens, the annulus is proportionately shorter, apparently resulting from lesser development of the cephalic portion. One female possesses an accessory tubercle cephalic to the left tubercle on the sternum cephalic to the annulus. One of the larger females has chelae which are longer and more slender than those of the other females, and the palm is more strongly tuberculate. Although we possess too few specimens for establishing a definite correlation, the width of the areola (expressed as a ratio of its length) seems inversely related to cephalothorax length. The row of tubercles that subtends the mesialmost row on the palm is irregular and variable in number (two to nine in mature specimens). The largest specimen is a female of 52.3 mm cephalothorax length; the next largest specimen is also a female with a corresponding length of 39.4 mm.

Relationships: Procambarus lylei is most closely related to *P. ablusus*, *P. elegans* Hobbs, 1969: 329, and *P. natchitochae* Penn, 1953: 5, with which it shares a simple but complete complement of terminal elements on the first pleopod of the male and a relatively unornamented caudal margin of the thoracic sternum in the female. As in *P. elegans*, a prominent caudal process arises distinctly from the caudal knob, and, considering that all of the known females of *P. elegans* are juvenile, the annuli ventrales are very similar in shape and configuration as are the sterna immediately cephalic to the annuli. Too, in *P. elegans* there is a distinct hint of the cephalic curvature of the distal portion of the first pleopod of the male that is characteristic of *P. lylei*. In both species, the subapical tuft of setae arises principally from the cephalic surface of the appendage. Similarly, *P. natchitochae* is probably closer to *P. lylei* than is *P. ablusus*. *Procambarus penni* and *P. vioscai* are less closely related; in the former, the caudal knob fuses imperceptibly with the caudal process, and the sternum immediately cephalic to the annulus is multituberculate; the latter species is easily distinguished from *P. lylei* by its stout, decidedly non-setiform cephalic process and by the marked flexure of the mesial process. In other members of the Spiculifer Group that retain the cephalic process on the first pleopod, the sternum of the female is multituberculate, and, in some, extends caudad well past the midlength of the annulus. Only *P. lylei* of this group of crawfishes exhibits the marked cephalodistal curvature of all terminal elements of the first pleopod of the male, and it is unique among the members of the Spiculifer Group in possessing a distinct shoulder on the cephalic margin of the pleopod. The subterminal setae arise from as far proximally as the level of this shoulder but do not occur on it.

Etymology: We are pleased to name this new crawfish in honor of Dr. Clay Lyle in recognition of his work with Mississippi crawfishes.

Acknowledgments: We wish to thank W. G. Anding, S. M. Chien, and L. E. Fleming for assistance in field work and Fenner A. Chace, Jr., and Raymond B. Manning for their criticisms of the manuscript.

LITERATURE CITED

BLACK, JOE B. 1968. A new crawfish of the genus *Procambarus* from Mississippi (Decapoda, Astacidae). Tulane Studies in Zool. and Botany 15(1): 5–9, 12 figs.

FAXON, WALTER. 1884. Descriptions of new species of *Cambarus*, to which is added a synonymical list of known species of *Cambarus* and *Astacus*. Proc. Amer. Acad. Arts and Sci. 20: 107–158.

GIRARD, CHARLES. 1852. A revision of the North American Astaci with observations on their habits and geographical distribution. Proc. Acad. Nat. Sci., Philadelphia 6: 87–91.

HAGEN, HERMANN A. 1870. Monograph of the North American Astacidae. Illus. Cat. Mus. Comp. Zool., Harvard Coll. (3): 1–109, 11 pls.

HOBBS, HORTON H., JR. 1951. A new crayfish of the genus *Procambarus* from Louisiana, with a key to the species of the Spiculifer Group. Journ. Wash. Acad. Sci. 41(8): 272–276, 11 figs.

———. 1953. On the ranges of certain crayfishes of the Spiculifer Group of the genus *Procambarus*, with the description of a new species (Decapoda, Astacidae). Journ. Wash. Acad. Sci. 43 (12): 412–417, 13 figs.

———. 1969. Two new species of the crayfish genus *Procambarus*

(Decapoda, Astacidae) with keys to the members of the Spiculifer Group. Proc. Biol. Soc. Wash. 83: 329–348, 38 figs.

LeConte, John. 1856. Descriptions of new species of *Astacus* from Georgia. Proc. Acad. Nat. Sci., Philadelphia 7: 400–402.

Penn, G. H., Jr. 1946. A new crawfish of the genus *Procambarus* from Louisiana. Journ. Wash. Acad. Sci. 36(1): 27–29, 6 figs.

———. 1953. Two new crawfishes of the genus *Procambarus* from Texas, Louisiana and Arkansas. Amer. Mus. Novitates (1636): 1–10, 19 figs.

———. 1963. A new crawfish from the Hatchie River in Mississippi and Tennessee (Decapoda, Astacidae). Proc. Biol. Soc. Wash. 76: 121–126, 10 figs.

Vol. 84, No. 13, pp. 103–112 30 June 1971

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

DESCRIPTION OF SIX NEW SPECIES OF MUSCIDAE (DIPTERA) FROM THE ETHIOPIAN REGION

By Eberhard Zielke
*South African Institute for Medical Research,
Johannesburg, South Africa*

Among the unidentified Muscidae loaned to me by the Smithsonian Institution I found the following six new species: *Musca spangleri* new species (Muscinae), *Musca setulosa* new species (Muscinae), *Morellia cerciformis* new species (Muscinae), *Phaonia eos* new species (Phaoniinae), *Spilogona ugandensis* new species (Phaoniinae), *Dimorphia thoracica* new species (Phaoniinae).

All of the specimens were collected by Dr. P. J. Spangler during 1968 in Kenya and Uganda.

Musca spangleri new species
(Figure 1)

This species runs in van Emden's (1939) key to *Musca sorbens* Wd., but it is easily distinguishable by the rather strong sigmoid posterior cross-vein, the mainly black thorax, the two weak anterior post *dc*, the dark calyptera, and the hypopygium.

Male: Head with face black though parafacialia and buccae in certain light with little grey pollinosity. Proboscis and palpi black, latter slightly curved. Antennae and antennal groove black. Arista with long rays, longest ones at least three times as long as width of third antennal segment. Frons black, at narrowest point not much wider than anterior ocellus. Frontal stripe reduced to a line. Parafrontal setae small and cruciate, becoming stronger towards antennal groove. Ocellar triangle without strikingly strong bristles, only one pair of long postverticals present. Eyes bare, facets of upper part enlarged.

Thorax in greatest portion blackened. On dorsal surface a median longitudinal vitta of grey pollinosity extends to postsutural portion of mesonotum. Humeral calli and lateral parts of postsutural portion of mesonotum grey dusted. Lateral portions of thorax dark brown to black in addition to the little grey dusted posterior portions of the mesopleuron and sternopleuron. Anterior thoracic spiracle white.

Chaetotaxy: acrostical bristles = 0 + 1, dorsocentrals = 2 + 4, anterior two post *dc* hardly distinguishable from clothing hairs, posthumerals = 2, humerals = 3, notopleurals = 2, sternopleurals = 1 + 2, mesopleuron with posterior row of about six to seven strong setae and one anterior one. Hypopleuron with some fine hairs above hind-coxa. Prosternum hairy. Wings brownish, membranae uniformly covered with microtrichia. Media sharply bent upwards, r_{4+5} at ventral base with some small light hairs. Upper calyptera brownish transparent with dark brown margin, lower calyptera yellow-brown. Halteres yellow. Legs dark brown to black; fore-tibia without posteroventral seta at middle; mid-tibia with four posteroventrals, lower two distinctly stronger; hind-tibia with two anteroventral bristles beyond middle and, just above middle, one strong anterodorsal and one posterodorsal bristle in addition to smaller dorsal setae. Pulvilli yellow to brownish.

Abdomen with yellow ground-color. Tergites I + II with small median brown patch, tergite III with narrow brown longitudinal vitta, widening at base and apex, tergite IV only at base and at apex with median brown patches. Last tergite darkened at middle, laterally yellow. Tergites IV and V laterally with small yellow pollinose spots. Sternite yellow, apical corners of last one dark brown. Hypopygium (Fig. 1) with broad cerci and paralobi.

Length: about 5.5 mm.

Female: Unknown.

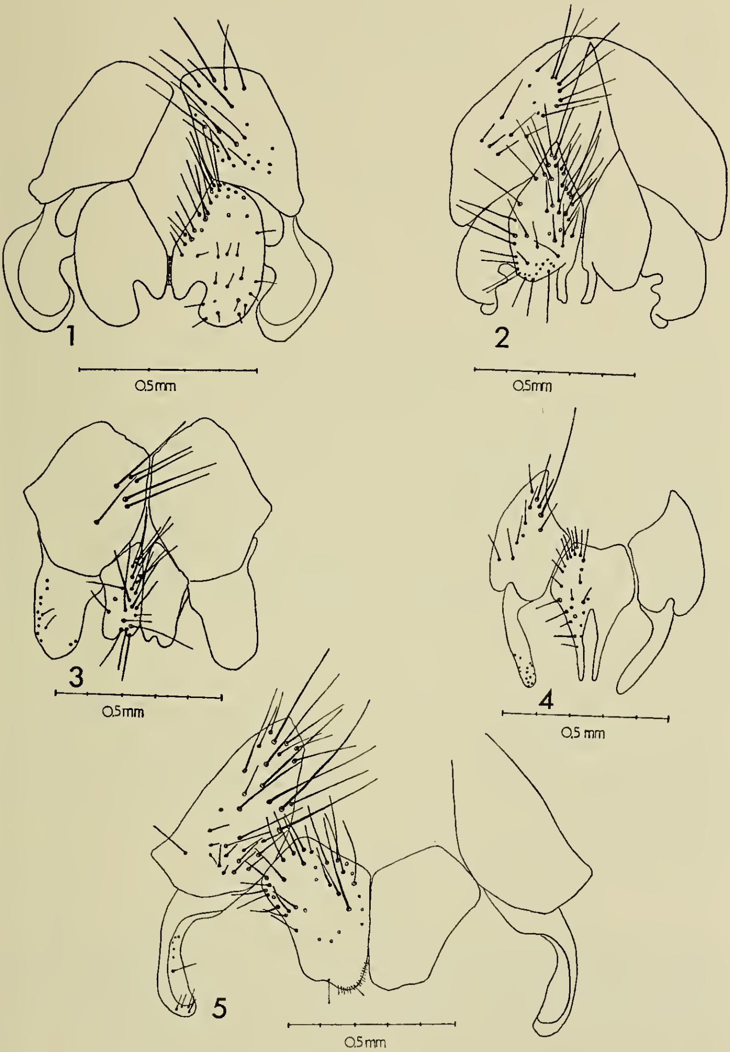
Locality: Kichwamba, Ankole (District), Uganda, 23–29 April 1968; 1 ♂, leg. P. J. Spangler.

Types: Holotype ♂ (USNM No. 70922) in the collection of the Smithsonian Institution, Washington.

Musca setulosa new species

Using van Emden's (1939) key this species leads to *Musca munroi* Patton, but it differs in the following points: *Musca setulosa* is bigger and appears darker, the contrast of the pattern on the abdomen is much more striking, the sternites are all black and just above the suprasquamal ridge there are black bristles.

Female: Head with black ground-color, buccae and parafacialia densely grey dusted. Proboscis and palpi black, antennae and antennal groove black, though in certain light last antennal segment and antennal groove with greyish reflection; arista with long rays. Frons black, at vertex about 0.4 times as wide as length of eyes. Width of frontal stripe at middle about half as wide as frons. About 10 pairs of strong and cruciate parafrontal setae, two pairs of short but distinct proclinate fronto-orbital bristles as well as some short bristles distributed irregularly on parafrontalia. Ocellar triangle black with one pair of proclinate long ocellars just above anterior ocellus, inner and outer verticals well-developed and long. Eyes bare.



FIGS. 1–5. Cerci and paralobi, dorsal view. 1, *Musca spangleri* new species. 2, *Morellia cerciformis* new species. 3, *Phaonia eos* new species. 4, *Spilogona ugandensis* new species. 5, *Dimorphia thoracica* new species.

Thorax black, but at least dorsally greatest portion grey dusted. The presutural portion of mesonotum with four black longitudinal vittae, fusing behind suture to two. Scutellum grey dusted with black patch at middle. Sternopleuron, mesopleuron and the anterior part of pteropleuron with grey pollinosity. Anterior thoracic spiracle white.

Chaetotaxy: acrosticals = 0 + 1, dorsocentrals = 2 + 4, all strong, posthumerals = 2, humerals = 3, notopleurals = 2, sternopleurals = 1 + 2, mesopleuron with a posterior row of about six strong setae and one anterior one. Hypopleuron bare, prosternum hairy. Suprasquamal ridge without erect bristly hairs, but black bristles just above ridge. Wings brownish, membrane uniformly covered with microtrichia; posterior cross-vein slightly sigmoid, media bent up sharply with a distinct inward dip beyond bend; r_{4+5} ventrally covered with short setae over nearly all length, stem-vein dorsally with three to five fine long hairs. Inner part of the upper calyptera transparent with yellow margin and fine black hairs on margin, outer portion white with yellow margin and yellow hairs; lower calyptera whitish, partly brownish. Halteres yellow. Legs black; femora with little whitish pollinosity; fore-tibia without posteroventral bristle; mid-tibia with four to five posteroventral bristles, two apical ones stronger than others; hind-tibia with two anteroventral bristles beyond middle, a row of anterodorsal bristles with strongest ones in apical half and two posterodorsal bristles beyond middle. Pulvilli short and brownish.

Abdomen with black ground-color and striking pattern; tergites I + II black without grey pollinosity, last three tergites with broad black apical and basal bands as well as black median longitudinal vittae, remaining parts with grey pollinosity. Sternites all black.

Length: about 8 mm.

Male: Unknown.

Locality: 25 miles south of Kichwamba (Kalinzu Forest, Ankole District), Uganda, 28 April 1968; 2 ♀♀, leg. P. J. Spangler.

Types: Holotype ♀ (USNM No. 70923) in the collection of the Smithsonian Institution, Washington; 1 paratype ♀ in the collection of the South African Institute for Medical Research.

Morellia cerciformis new species

(Figure 2)

In Peris' (1961) key this species leads to *Morellia longiseta* van Emden and *Morellia nilotica* (Lw.). The male is at once distinguishable from the latter by its lower calyptera, which is dark brown, including the margin, as well as the presence of about five strong anteroventral setae on the apical third of the hind-tibia. From *Morellia longiseta* this species differs by the four to five posteroventral setae in the apical part of the fore-tibia and in the absence of the long posteroventral setae of the hind-tibia.

Male: Head with face black, parafacialia and buccae grey dusted. Proboscis and palpi black. Antennae black, antennal groove black though in certain light with grey reflections, arista long, longest rays about 1.5

times as long as width of third antennal segment. Frons black, at narrowest point not much wider than anterior ocellus. Parafrontal setae numerous and of unequal length and thickness, becoming stronger towards antennal groove. Fronto-orbital bristles wanting. Ocellar triangle without strikingly long setae. Only one strong pair of verticals present. Eyes with some very short hairs. Facets all of nearly same size, only outer ones smaller.

Thorax of black ground-color, in certain light with blue reflections. Presutural part of mesonotum with white dusted median longitudinal vitta, extending to middle of postsutural part of mesonotum. One very small grey spot on each side of this vitta on presutural portion. Humeral calli and area behind white dusted. Pleura dark in addition to grey dusted sternopleuron and lower portion of mesopleuron. Anterior thoracic spiracle black.

Chaetotaxy: acrostical bristles = 0 + 3, anterior ones rather weak and hairlike, dorsocentrals = 0 + 3, posthumerals = 2, humerals = 5, notopleurals = 2, sternopleurals = 1 + 2, mesopleuron with a posterior row of five to six strong setae in upper half followed by smaller setae in lower half. Hypopleuron and prosternum bare. Wing-membrane brownish and uniformly covered with microtrichia; media slightly curved upwards; r_{4+5} ventrally and dorsally with a row of short setae, extending at least to anterior cross-vein r–m. Inner part of upper calyptera brownish transparent, outer portion white with yellow margin; lower calyptera including margin dark brown. Halteres yellow. Legs dark brown to black; fore-coxa white dusted; fore-tibia with about five fine hairlike posteroventral setae on apical third, longest not much longer than twice diameter of apical portion of tibia; mid-femur with a weak dorso-apical thickening, covered with some strong setae; mid-tibia with about five posteroventral setae, irregularly distributed over whole length, strongest ones at apical half; hind-tibia with five anteroventral setae in apical third and a row of anterodorsal setae, strongest ones beyond middle forming the end, a posterodorsal bristle in basal third and a very long one at apical third. Pulvilli long and brownish.

Abdomen black, tergites III and IV only laterally and ventrally with grey pollinosity, tergite V dorsally golden-yellow dusted. Sternites black. Hypopygium (Fig. 2) with a striking elongation on cerci.

Female: With respect to color of body, female resembles male though fifth tergite is black. Frons at narrowest point 0.45 times as wide as length of one eye. Frontal stripe well-developed and dilating above, lower part black, upper part golden yellow. Buccae, parafacialia and parafrontalia grey dusted. Parafrontal setae strong, two pairs of proclinate fronto-orbitals present, ocellar triangle with three pairs of well-developed bristles, anterior one strongest. Upper calyptera whitish, lower one whitish to brownish, both with orange to brownish margins. Fore-tibia without long posteroventral setae; mid-femur without dorso-apical thickening; hind-tibia with anteroventral setae, not longer than diameter of tibia.

Length: about 8 mm.

Locality: Ngong Forestry Station, Kenya, 13–20 April 1968, Malaise trap; 1 ♂, 1 ♀, leg. P. J. Spangler.

Types: Holotype ♂ (USNM No. 70924) and paratype ♀ in the collection of the Smithsonian Institution, Washington.

Phaonia eos new species

(Figure 3)

In van Emden's (1943) key, this species ends at *Phaonia muscinoides* van Emden, but it differs from this species by its orange abdomen and yellowish palpi.

Male: Head grey dusted, though of dark ground-color. Proboscis brown, palpi yellowish, antennae bright yellow, especially last segment. Arista with long rays. Frons at its narrowest point about 1.5 times as wide as anterior ocellus. Only lower half of parafrontalia with about six pairs of strong reclinate setae. One pair of small proclinate setae in front of anterior ocellus and one pair of slightly stronger but reclinate ones at level of ocellus. First pair of ocellars long and stronger than parafrontals. Verticals not strikingly long-developed. Eyes without conspicuous hairs and enlarged facets.

Thorax of dark brown to black ground-color. Dorsally with greyish pollinosity. The presutural part of mesonotum with two dark longitudinal vittae, postsutural part with irregular pattern. Scutellum yellowish, with fine setae ventrolaterally. Most parts of mesopleuron, sternopleuron, hypopleuron and pteropleuron dark brown or black, remaining parts yellow. Anterior thoracic spiracle yellow.

Chaetotaxy: acrosticals = 3 + 4, dorsocentrals = 2 + 3, posthumerals = 2 and one anterior shorter one, humerals = 3, notopleurals = 2, the posterior one shorter than the pre-alar bristle, postalars = 2, sternopleurals = 1 + 2, mesopleuron with posterior row of 5–6 setae and one anterior one. Wings hyaline, the membrane covered with microtrichia, the veins yellowish to brownish. First longitudinal vein (r_1) only dorsally, r_{4+5} dorsally and ventrally covered with fine setulae. Upper calyptera transparent, lower calyptera yellowish, both with yellow margins. Legs all yellow; fore-tibia without distinct posteroventral bristle; mid-femur with some posteroventral setae in basal half, mid-tibia with two posterior setae in basal half and a third seta in apical half; hind-femur with row of anterodorsal setae as well as row of anteroventral setae, apically short row of three to five strong curved dorsal bristles; hind-tibia with four anteroventral bristles in apical two-thirds, the two apical ones much stronger, one well-developed anterodorsal at middle and one very long posterodorsal seta in apical third.

Abdomen yellow, last two tergites brownish and each with a row of rather strong marginal setae. Sternites yellow. Hypopygium as in Fig. 3.

Length: about 6 mm.

Female: Unknown.

Locality: Kichwamba, Ankole (District), Uganda, 23–29 April 1968; 1 ♂, leg. P. J. Spangler.

Types: Holotype ♂ (USNM No. 70925) in the collection of the Smithsonian Institution, Washington.

Spilogona ugandensis new species

(Figure 4)

Spilogona ugandensis resembles *Spilogona semifasciata* van Emden but differs from it in its thoracic pattern as well as the presence of complete transverse rows of discal setae on the fourth and fifth tergites.

Male: Head densely grey dusted, frontal stripe well-developed with black ground-color. Frons at narrowest point about 1.5 times as wide as width of ocellar triangle. Proboscis, palpi and antennae dark brown, last antennal segment grey dusted. Frons with four pairs of strong cruciate parafrontal setae. Anterior pair of ocellar bristles well-developed, but never as long as parafrontals. Eyes not conspicuously haired. Facets all of same size.

Thorax cinerous grey. Dorsal presutural portion of mesonotum with a narrow median dark longitudinal vitta extending to suture, another dark vitta extending to posterior presutural dorsocentral seta and a short vitta along posthumerals. The two short vittae fusing in front of anterior dorsocentrals. Postsutural part of mesonotum with a broad transverse brown band, extending from suture to second postsutural dorsocentral seta. Scutellum at basal half with a semicircular brown patch. Laterally only hypopleuron darkened.

Chaetotaxy: acrosticals = 0 + 1, the anterior ones numerous but all very small and hairlike, dorsocentrals = 2 + 3, anterior presutural one at most half as long as posterior one, postalars = 2, posthumerals = 2, humerals = 2, notopleurals = 2, posterior notopleural one much smaller than prealar bristle, sternopleurals = 1 + 2, mesopleuron with a posterior row of six strong setae and one smaller anterior one, hypopleuron and prosternum bare. Wings brownish, the membrane covered with microtrichia; veins brown and bare; media straight. Upper and lower calyptera yellowish white, halteres pale. Legs with femora dark brown, apex usually yellow orange; tibiae yellow to brown; tarsal segments brown. Fore-tibia with a distinct submedian posteroventral bristle; mid-femur with some strong anterior setae in basal half, but without an anterior subapical one; mid-tibia with two posterior setae in middle third; hind-femur with a row of anterodorsal setae over entire length and a short row of anteroventral setae in apical half; hind-tibia with two well-developed anterodorsal setae and two anteroventral setae, all in apical half.

Abdomen yellow to brown. Tergites I + II in anterior part brown, the posterior part yellow; tergite III with a more or less distinct triangularly developed dark patch in middle; tergites IV and V brown with grey pollinosity, both tergites with complete transverse row of long, strong marginal and discal setae. Hypopygium as in Fig. 4.

Length: About 5.5 mm.

Female: Unknown.

Locality: Kichwamba, Ankole (District), Uganda, 23–29 April 1968; 2 ♂♂, leg. P. J. Spangler.

Types: Holotype ♂ (USNM No. 70926) in the collection of the Smithsonian Institution, Washington; 1 paratype ♂ in the collection of the South African Institute for Medical Research.

Dimorphia thoracica new species

(Figure 5)

Using van Emden's (1951) key, this species runs to *Dimorphia tristis* (Stein), but it is distinguishable by the dark brownish wings and in the male by the completely dark thorax and the dark brown tips of the front femora.

Male: Buccae and parafacilia grey dusted, parafrontalia black. Proboscis, palpi and antennae dark brown, third antennal segment with little grey pollinosity. Antennal groove grey. Frons at its narrowest point about same width as ocellar triangle and with 8–10 pairs of strong long cruciate parafrontal setae, longest one above antennal groove. Parafrontals below vertex small and proclinate. Anterior pair of ocellars longer than longest parafrontal. Verticals rather weak. Eyes without conspicuous hairs.

Thorax of black ground-color. Dorsal surface and pleura with little grey pollinosity. Two black longitudinal vittae on presutural portion of mesonotum. Scutellum ventrolaterally yellow. Anterior thoracic spiracle yellow to brown.

Chaetotaxy: acrosticals $= 0 + 1$, dorsocentrals $= 2 + 4$, humerals $= 3$, anterior one smaller than others, posthumerals $= 2$, notopleurals $= 2$, postalars $= 2$, sternopleurals $= 1 - 2 + 2$, mesopleuron with a row of six to eight posterior setae and two anterior ones. Wings dark brownish, the membrane covered with microtrichiae. Veins dark brown, radial sector and subcosta with small setae dorsally and ventrally at base; media with some fine setae dorsally and ventrally over nearly entire length; cubitus with some fine setae only ventrally at base. Basicostal scale yellow, upper calyptera brownish transparent with a dark brown margin, lower calyptera yellowish brown, with a light brown margin. Halteres yellow. Legs all bright yellow, tarsal segments brown to dark brown, especially hind tarsal segments; fore-femur with a dark dorso-apical patch, in some specimens even on all femora. Fore-tibia without a posteroventral seta, in apical half numerous short fine golden-brownish hairs, forming a brush; mid-femur with about four anterior bristles at middle as well as two apical ones at apical third, in basal half some strong ventral setae and subapically about four strong posteroventral ones; mid-tibia usually with two long posterior setae in apical half; hind-tibia with one anterodorsal at middle and one anteroventral beyond middle.

Abdomen with yellow ground-color. Tergites I + II yellow, tergite III dorsally with a dark brown median longitudinal vitta, widening apically and forming an apical band in some specimens. Two to three marginal setae on each side; tergite IV dark brown dorsally, only anterior lateral portions yellow, a complete row of strong marginals; tergite V brown dorsally (some specimens with a narrow yellow apical band) and with a row of strong marginals as well as a row of strong discals. Sternites yellow, last one brown. Hypopygium as in Fig. 5.

Female: Frons at narrowest point about 0.45 times as wide as length of one eye. Frontal stripe well-developed, greyish-black. Two pairs of strong verticals. Thorax dorsally and upper portion of mesopleuron black, humeral calli and other pleura yellow. Femora without dark apex. Legs and wings as in male, but setae of veins stronger and more numerous. Abdomen dark brown to black, only tergite I + II yellow; tergite V with a narrow yellow apical band. Sternites orange to brown.

Length: about 8.5 mm.

Locality: Ngong Forestry Station, Kenya, 13–20 April 1968; 5 ♂♂, 1 ♀ Malaise trap, leg. P. J. Spangler.

Types: Holotype ♂ (USNM No. 70927), 2 paratypes ♂♂ and 1 paratype ♀ (USNM No. 70927) in the collection of the Smithsonian Institution, Washington; 2 paratype ♂♂ in the collection of the South African Institute for Medical Research.

Acknowledgments: I wish to thank Dr. R. J. Gagné, Systematic Entomology Laboratory, USDA, for making these specimens available for study and for reading the manuscript. I am also indebted to Dr. F. Zumpt, Head of the Department of Entomology, South African Institute for Medical Research, for encouraging my studies on this group of flies.

LITERATURE CITED

PERIS, S. V. 1961. Una nueva especie de *Morellia* de Camarones y sinopsis de las especies etiopicas (Dipt. Muscidae). Eos 37: 349–359.

VAN EMDEN, F. 1939. Muscidae: Muscinae and Stomoxydinae. Ruwenzori Expedition 1934–1935, 2(3): 49–90.

———. 1943. Keys to the Muscidae of the Ethiopian region: Phaonia-group. Ann. Mag. nat. Hist. 10(11): 73–101.

———. 1951. Muscidae: Scatophaginae, Anthomyiinae, Lispinae, Fanniinae and Phaoniinae. Ruwenzori Expedition 1934–1935, 2 (6): 325–710.

Vol. 84, No. 14, pp. 113–118 30 June 1971

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

EKKENTROPELMA BRYCHIA N.G., N.SP., AN ANTARCTIC PSOLID HOLOTHURIAN WITH A FUNCTIONALLY LATERAL SOLE

By David L. Pawson
Department of Invertebrate Zoology, Smithsonian Institution, Washington, D.C. 20560

In holothurians of the family Psolidae, the soft sole is ventral, occupying the greater curvature of the body, which is approximately U-shaped, with mouth and anus upturned. A fundamental plane of bilateral symmetry passes through the middle of the sole (midventral radius), the middorsal interradius, the mouth and anus, and certain internal structures, including the genital duct, and radial and interradial pieces of the calcareous ring. A striking exception to this situation was found in a collection of holothurians from off the northwest coast of the Antarctic Peninsula. The collection includes 32 specimens of a U-shaped psolid species in which the sole is eccentrically placed, and does not occupy the greater curvature of the body. The sole is morphologically ventral as usual, but the plane of bilateral symmetry does not now include the mouth and anus. These two structures are displaced, and they lie in a plane which is at an angle of 90 degrees to the fundamental plane. Thus, the sole is functionally lateral in position, and apparently the animal is well adapted to attaching itself to vertical surfaces. The specimens represent a new genus in the Family Psolidae, and a formal description is given below.

Type material is deposited in the collections of the National Museum of Natural History, Smithsonian Institution. Support for study of Antarctic holothurians has been received from the National Science Foundation through the Office of Environmental Sciences, Smithsonian Institution.

Order Dendrochirotida Grube, 1840
(restricted Pawson and Fell, 1965)

Family Psolidae Perrier, 1902

Ekkentropelma new genus

Diagnosis: As for the species.

Type-species: E. brychia new species (by monotypy).

Etymology: The generic name is of neuter gender, derived from Greek *ekkentros,* eccentric, and *pelma,* sole of the foot.

Ekkentropelma brychia new species
(Figures 1–3)

Diagnosis: Body rigid, U-shaped; well-defined sole does not occupy greater curvature of body. Mouth and anus lie in plane perpendicular to usual plane of bilateral symmetry. Calcareous deposits of sole buttons only, no cups.

Description: Total length of body 8.5–18.5 mm. Body more or less U-shaped, mouth and anus upturned. Body wall firm to touch owing to

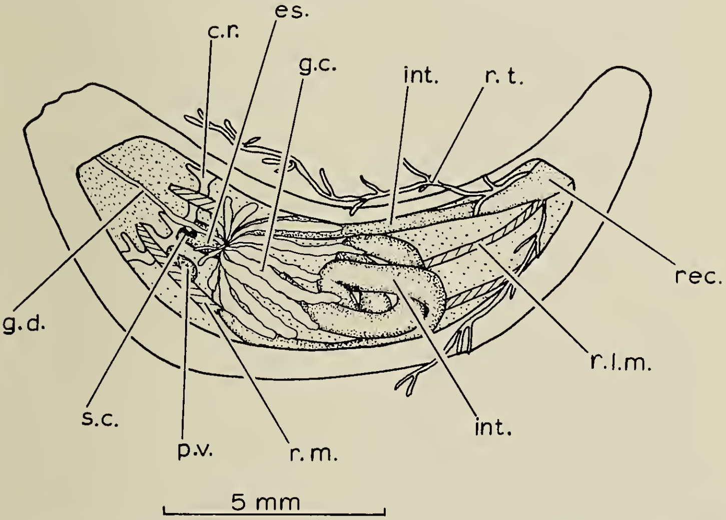


FIG. 2. *Ekkentropelma brychia* n.g., n.sp., dissected from dorsal side (partly diagrammatic). Abbreviations: c.r., calcareous ring; es., esophagus; g.c., genital caecum; g.d., genital duct; int., intestine; p.v., polian vesicle; rec., rectum; r.l.m., radial longitudinal muscle; r.m., retractor muscle; r.t., respiratory tree; s.c., stone canal.

←

FIG. 1. *Ekkentropelma brychia* n.g., n.sp. Upper, holotype (total length 17 mm) ventral aspect. Middle, holotype, dorsal aspect. Lower, paratype (total length 13 mm), ventral aspect.

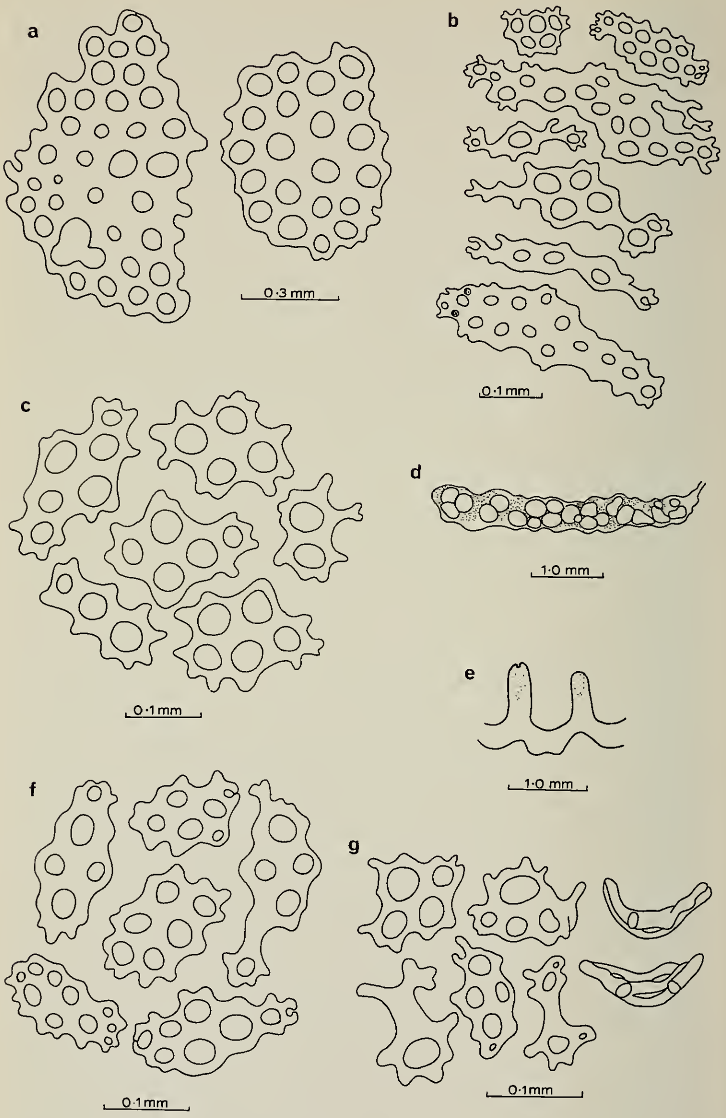


FIG. 3. *Ekkentropelma brychia* n.g., n.sp. a, plates from body wall; b, tentacle deposits; c, buttons from sole; d, genital caecum with large eggs; e, radial and interradial pieces of calcareous ring; f, tube foot deposits; g, cups from dorsal body wall.

investment of plates which form a test. Oral (anterior) end considerably thicker than anal (posterior) end. All specimens with well-developed soft sole surrounded by conspicuous suctorial tube feet. Dissection shows that while sole does not occupy greater curvature of body it is indeed ventral in position; center of sole occupied by midventral radius, edges of sole defined by right and left ventral radii. Mouth and anus displaced, lying in plane perpendicular to plane containing midventral radius and middorsal interradius. Fourteen specimens with sole to left of mouth-anus plane, 18 with sole to right.

Tube feet around sole large, conspicuous, with general tendency for number of feet to increase with increase in size of body (see Table 1). Midventral radius usually naked except anteriorly and posteriorly, but two specimens with feet in midventral radius. In one specimen of 10 mm total length, four feet scattered in midventral radius; in other specimen of 14 mm total length continuous row of 18 midventral feet present. Tube feet elsewhere minute, rudimentary, scattered all over body wall, passing between overlapping plates in body wall, and appearing under low magnification as small projections.

TABLE 1. Relationship between number of tube feet around sole and size of body of *Ekkentropelma brychia* n.g., n.sp.

Total length (to nearest mm)	No. feet	No. specimens
9	24	1
10	25	4
11	26	5
13	30	1
14	30	5
15	31	4
16	34	6
17	35	1
18	33 (2 with sole damaged)	4
19	38	1

Tentacles retracted in all specimens. Eight to ten subequal tentacles, sparsely branched, tending to be digitate rather than dendritic.

Calcareous ring (Fig. 3e) fragile; posterior margin undulating, with no projections. Anterior projections of radial and interradial pieces similar, radials notched anteriorly, while interradials smoothly rounded.

Short, thin-walled esophagus gives rise to thick-walled stomach. Intestine complexly coiled in center of body (Fig. 2), expanding posteriorly to form thin-walled rectum. Two respiratory trees with few branches; left tree extends for half length of body, right tree extends past level of calcareous ring. Stone canal in dorsal mesentery, short, terminating in irregularly shaped madreporite. Single bulbous polian vesicle. Sexes separate. Gonad a tuft of unbranched vesicles. In female, largest vesicles contain a few large yolky eggs (Fig. 3d) approximately 0.2 mm in diameter. Genital duct short, arising from gonad immediately posterior to calcareous ring.

Radial longitudinal muscles equally developed, thin, flat straps. Retractor muscles attach to radial muscles at level of anterior part of gonad. Circular muscles apparently rudimentary.

Apart from sole, body invested in test of overlapping plates (Fig. 3a) up to 1.1 mm in diameter. Plates polygonal to circular, flat, thick, with few large perforations. All consist of single layer of calcite; none carry spires. Overlying plates, sparsely scattered, are concave rudimentary cups (Fig. 3g), variable in shape and number of perforations (usually four). Edges carry short, rounded projections.

Soft sole with numerous buttons of average length 0.18 mm, with varying number of large perforations (Fig. 3c). Typical number of perforations four, but buttons with from one to six perforations extremely numerous. Tentacles with curved and flat plates of various sizes in large numbers; some plates with minute knobs (Fig. 3b). Tube feet surrounding sole with fragmented endplates; walls of feet contain small plates (Fig. 3f) with four or more perforations.

Etymology: The specific name is derived from Greek *brychios*, deep.

Material examined: Holotype, USNM Catalog No. E11384; USNS *Eltanin* Station 268, 64°01′S, 67°45′W to 64°08′S, 67°44′W; 20 October 1962, 2763–2818 meters, 10-foot Blake trawl. Nearest available hydrographic data (at depth of 2385 meters), temperature 0.30 degrees C, salinity 34.667 parts per thousand.

Paratypes, USNM Catalog No. E11385, 31 specimens, locality data as above.

Remarks: It is probable that fully mature specimens of this species have ten tentacles. The sparsely branched tentacles suggest affinities with the dactylochirote holothurians, but presence of a well defined test necessitates referral of the genus to the Family Psolidae. Within the Psolidae, the genus falls close to *Psolidium* Ludwig, 1886, but differs in lacking cups from the sole, and in the eccentric position of the sole. The only other psolid genus with scattered tube feet in the body wall is *Lissothuria* Verrill, 1867, which is apparently restricted to the Eastern Pacific and Caribbean. *Lissothuria* has dorsal deposits which include unique hourglass-shaped deposits and/or towers (Pawson, 1967).

The depth at which this species was collected is apparently the greatest from which an Antarctic psolid has been taken; most psolids occur in depths of less than 1000 meters, but four species of *Psolidium* have been recorded from depths in excess of 2000 meters in other areas.

Literature Cited

Pawson, D. L. 1967. The psolid holothurian genus *Lissothuria*. Proc. U.S. Nat. Mus. 122: 1–17, figs. 1–5.

Vol. 84, No. 15, pp. 119–128 30 June 1971

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

PLATYSQUILLA HOROLOGII (STOMATOPODA, LYSIOSQUILLIDAE), A NEW SPECIES FROM THE GULF OF MEXICO, WITH AN EMENDATION OF THE GENERIC DEFINITION

By David K. Camp
Marine Research Laboratory, Florida Department of Natural Resources,[1] *St. Petersburg, Florida 33731*

The stomatopod genus *Platysquilla* Manning, 1967, now contains two species, *P. eusebia* (Risso, 1816) and *P. enodis* (Manning, 1962). The new species described herein was discovered while examining stomatopod crustaceans from Project Hourglass, a 28-month biological sampling program conducted on the west Florida shelf by the Marine Research Laboratory of the Florida Department of Natural Resources (Joyce and Williams, 1969). This new species does not agree in all respects with Manning's (1968) diagnosis and later (Manning, 1969) definition of *Platysquilla.* I have examined representatives of *P. eusebia* and *P. enodis*, and have found that none of the *P. eusebia* examined agree fully with the generic definition. An emendation of the generic definition of *Platysquilla* and the description of the new species is presented here.

Total length was measured with vernier calipers along the dorsal midline from the anterior margin of the rostral plate to the posterior margin of the dorsal projection of the telson. This measurement is cited for each specimen under Material. All other measurements were made with an ocular micrometer. Telson length was measured along the dorsal midline from the anterior margin to the posterior margin of the dorsal projection. Other measurements and terminology generally follow Man-

---

[1] Contribution No. 166.

ning (1969). The generic definition presented herein is after Manning (1969, p. 90), with the addition of necessary alterations.

I would like to express my gratitude to Dr. Raymond B. Manning, Chairman, Department of Invertebrate Zoology, Smithsonian Institution, (USNM), for confirming this new species, for loaning specimens of *P. eusebia* and *P. enodis* for comparative purposes, for offering technical advice, and for critically reviewing the manuscript. My appreciation goes to Dr. L. B. Holthuis, Rijksmuseum van Natuurlijke Historie (RMNH), Leiden, The Netherlands, who loaned specimens of *P. eusebia* and examined other specimens at my request. I thank my colleagues at the Marine Research Laboratory (FSBC I), Mr. Robert W. Topp and Mr. Stephen P. Cobb, for advice and comments on the manuscript, and especially Mr. William G. Lyons whose advice and critical reading of the manuscript is heartily appreciated.

Platysquilla Manning, 1967

Platysquilla Manning, 1967, p. 238.—Holthuis, 1967, p. 26 [references]. —Manning, 1968, p. 111 [key and text].—Manning, 1969, p. 90.

Material: Platysquilla euesbia (Risso, 1816): 1 ♀, 45.6 mm; Naples, Italy, Zoological Station; no other data; USNM 23207. 1 ♀, 53.9 mm, 1 ♂, 57.3 mm; Gulf of Naples, Italy; May, 1924; G. Stiasny; RMNH 73. *Platysquilla enodis* (Manning, 1962): 1 ♀, 57.5 mm; off Vineyard Sound, 31–49 m, U.S. Fish Commission Stations 1247–1251; from the stomach of a flounder; S. I. Smith; 1887; holotype, USNM 12787. One broken ♀; off North Carolina, 35°35′20″N, 74°58′45″W, 49 m, Albatross Station 2296; paratype, USNM 8816.

Platysquilla new species: material listed under species description.

Definition: Size moderate to small, total length 75 mm or less. Body smooth, depressed, loosely articulated. Eyes of moderate size, cornea faintly bilobed, set obliquely on stalk. Rostral plate subquadrate or cordiform, with or without apical spine. Antennal protopods with ventral papillae, with or without mesial papillae. Carapace narrowing anteriorly, without carinae or spines; cervical groove indicated on lateral plates only. Thoracic somites without dorsal carinae, lateral margins truncate; eighth thoracic somite with low, inconspicuous tubercle on ventral midline. Epipods three to five. Mandibular palp absent. Raptorial claw slender; dactylus armed with nine or more teeth, inferior margin notched basally; propodus fully pectinate, with four movable spines at base, first longest, second shortest; carpus with distal, dorsal spine; ischiomeral articulation terminal; merus slender, elongate, longer than ischium. Endopods of walking legs two-segmented, distal segment of first two endopods ovate, that of third more splender. Abdomen depressed, loosely articulated; anterolateral plates with complete suture. Sixth abdominal somite with or without posterolateral spines, with curved, ventrally directed process on each side anterior to articulation of uropods; ventral surface with or without paired, submedian, posteriorly directed spines. Telson broad, with obtuse, triangular, median posterior projection; marginal armature on each side of midline a row of slender, submedian denticles, one movable tooth, and four fixed lateral teeth, with or without a denticle between each fixed tooth. Basal segment of uropod with two dorsal carinae, medial terminating in slender spine; proximal segment of exopod with short dorsal carina, lateral margin of exopod with slender, movable spines; endopod triangular, proximal portion of lateral edge folded over; spines of basal prolongation triangular in cross-section, mesial spine longer.

Type-species: Squilla eusebia Risso, 1816, by original designation.

Remarks: Manning (1963), in erecting the genus *Heterosquilla*, noted that two species, *Squilla eusebia* Risso, 1816, and *Lysiosquilla enodis* Manning, 1962, differed sufficiently from their congeners to warrant being placed in a separate genus. In a preliminary account (Manning, 1967), they were removed from *Heterosquilla* and placed in a new genus, *Platysquilla*. Manning (1968) presented a diagnosis of the new genus, and later (Manning, 1969) presented the generic definition.

The new species described herein differs from *P. eusebia* and *P. enodis* by lacking the mesial papillae on the antennal protopods and the apical spine on the rostral plate, by having a cordiform rather than subquadrate rostral plate, and by possessing only three epipods.

Manning (1969, pp. 11–12, 19) discussed the importance of the antennal papillae and epipods in recognizing genera and species within the Lysiosquillidae. These features are generally constant among congeners of western Atlantic lysiosquillids. Members of *Platysquilla* depart from this constancy, however, in that numbers of epipods and antennal papillae vary significantly. The eastern Atlantic *P. eusebia* has five epipods, *P. enodis* has four, and the new species has three. *Platysquilla eusebia* has two mesial and two ventral papillae, *P. enodis* has one mesial and two ventral papillae, and the new species has no mesial and two ventral papillae.

None of the specimens of *P. eusebia* examined had denticles between all lateral fixed teeth of the telson. One male, total length 57.3 mm (RMNH 73), had inconspicuous tubercles between each fixed tooth. One female, total length 46.5 mm (USNM 23207), had a denticle between only the first and second fixed teeth. Another female, total length 53.9 mm (RMNH 73), had only one minute tubercle between the first and second fixed teeth.

At my request, Dr. L. B. Holthuis has kindly examined other specimens of *P. eusebia* from the Gulf of Naples and has informed me that the denticles between the four fixed teeth of the telson are variable. They are either entirely absent, or are small between the first and second teeth, very small between the second and third, and visible only as a minute tubercle between the third and fourth teeth.

Platysquilla horologii new species

(Figure 1)

Lysiosquilla excavatrix: Lunz, 1935, p. 153 [part].—Chace, 1954, p. 449 [part, listed] [not *Lysiosquilla excavatrix* Brooks, 1886, p. 48].
Platysquilla undescribed species: Manning, 1969, p. 93.

Holotype: 1 ♀, 16.2 mm; about 65 miles west of Egmont Key, Pinellas County, Florida, 27°37′N, 83°58′W, 55 m; trawl, Robert F. Presley on R/V *Hernan Cortez*; 9 September 1966; USNM 128831.

Paratypes: 1 broken ♀, about 15.6 mm; about 85 miles west of Egmont Key, Pinellas County, Florida, 27°37′N, 84°13′W, 73 m; scrape dredge, R. F. Presley on R/V *Hernan Cortez*; 2 August 1966; USNM 128832. One ♂, 13.1 mm; same locality; 3 March 1967; FSBCI 7268. One broken ♀, about 14 mm; off Charlotte Harbor, Charlotte County, Florida, 26° 47′30″N, 83°25′15″W, 51.2 m; *Albatross* Station 2410; USNM 9825.

Diagnosis: Antennal peduncle without mesial papillae, with two ventral papillae; three epipods present; rostral plate cordiform, without apical spine; dactylus of raptorial claw with eleven teeth; telson with four pairs of fixed marginal teeth, mesial two pairs sharp.

Description: Eyes of moderate size, cornea faintly bilobed, set obliquely on stalk; lateral margin of stalk without obtuse projection. Ocular scales with bases fused, apices appressed. Eyes exceeding first segment of antennular peduncle.

Antennular peduncle short, slightly longer than one-half carapace length. Antennular processes produced into slender, curved, anteriorly-directed spines.

Antennal scale short, less than one-half carapace length. Antennal peduncle with no mesial and two ventral papillae.

Rostral plate broader than long, lateral margins evenly convex, anterolateral angles broadly rounded, anterior margins sloping to an obtuse apex. Plate covering base of eyestalks, not extending to cornea.

Dactylus of raptorial claw slender; superior margin with eleven teeth; inferior margin evenly convex, with strong basal notch. Propodus of claw stout, fully pectinate, with four movable spines at base, first longest, second shortest. Dorsal ridge of carpus terminating in a slender spine. Ischiomeral articulation terminal; merus longer than ischium, grooved inferiorly throughout its length for reception of propodus.

Mandibular palp absent, three epipods present.

Fifth thoracic somite without apparent lateral or ventral projections. Sixth thoracic somite with lateral processes truncate, anterolateral angles more rounded than posterolateral angles. Seventh thoracic somite broader, lateral margins more rounded than sixth. Eighth thoracic somite with inconspicuous median ventral tubercle. Lateral spine at base of walking

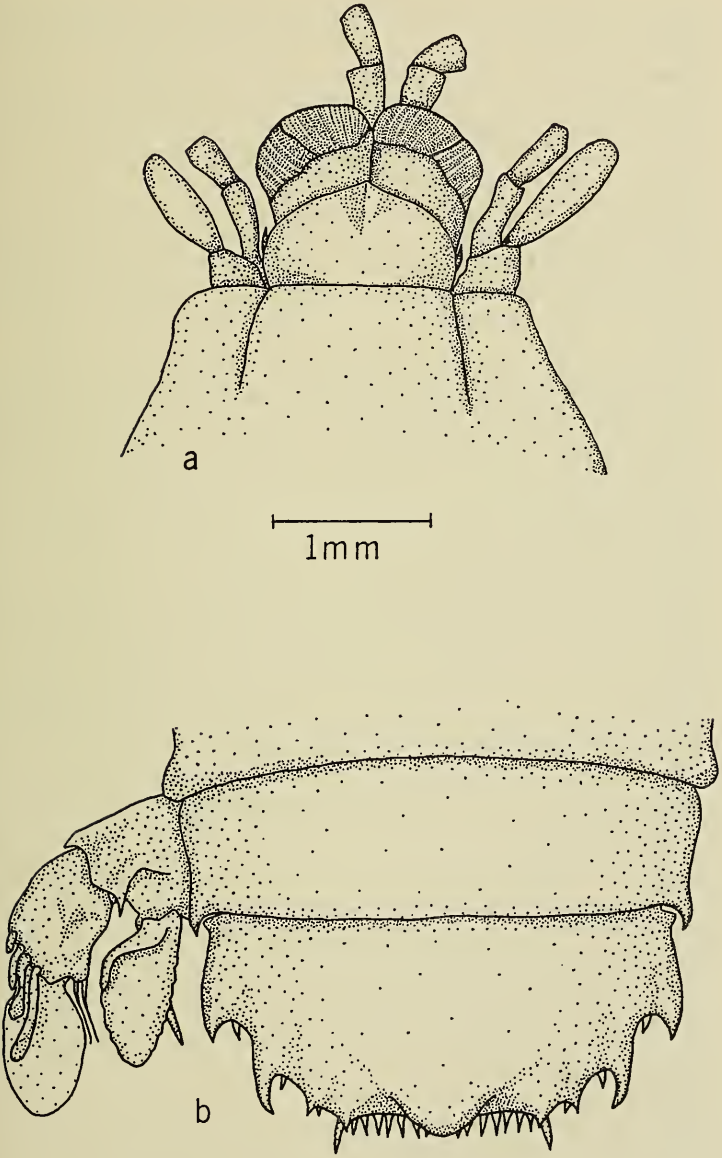


FIG. 1. *Platysquilla horologii* n. sp., female paratype (USNM 128832), total length about 15.6 mm, off Egmont Key, Florida. a, anterior portion of body; b, sixth abdominal somite, telson, and uropod (setae omitted).

legs more slender than mesial spine; endopods of walking legs ovate, third most slender. Length of walking legs unequal, first shortest, last longest.

Abdomen smooth, depressed, loosely articulated. Anterolateral plates with complete suture. Sixth abdominal somite with single spines at posterolateral angles; spine at underside of anterolateral angles immediately anterior to articulation with uropods ventrally-directed, short; ventral surface otherwise unarmed.

Telson broader than long; dorsal surface with broad, triangular median marginal projection, otherwise smooth. Marginal armature on each side of midline a transverse row of seven or eight slender, movable denticles, one movable submedian tooth, and four sharp, fixed teeth, with one slender denticle between each; first fixed tooth above movable submedian tooth.

Basal segment of uropod with mesial and lateral carinae, mesial carina incomplete proximally, terminating distally in sharp spine. Proximal segment of uropodal exopod with short dorsal carina; lateral margin with four or five spatulate spines, last two recurved; mesial margin with distal, rounded lobe bearing two or three stiff setae. Distal segment of uropodal exopod subequal to proximal, ovate, more setose on lateral margin. Uropodal endopod triangular, proximal portion of lateral margin folded over. Spines of basal prolongation of uropod triangular in cross-section; mesial spine about ten times longer than lateral spine.

Color: Unknown in life, mostly faded in preservative. Dark patch on dorsum of antennal peduncle and adjacent margin of carapace. Scattered spots on dorsum of carapace and anterior abdominal somites.

Measurements: Female holotype, total length, 16.2 mm; carapace length, 2.8 mm; cornea width, 0.7 mm; rostral plate length, 0.7 mm, width, 1.1 mm; fifth abdominal somite width, 2.9 mm; telson length, 1.4 mm, width 2.4 mm. Male paratype, total length, 13.1 mm; carapace length, 2.6 mm; cornea width, 0.7 mm; rostral plate length, 0.8 mm, width, 1.1 mm; fifth abdominal somite width, 2.7 mm; telson length, 1.4 mm, width, 2.0 mm.

Discussion: Platysquilla horologii, new species, most closely resembles *P. enodis,* differing from the latter as follows: 1) there are eleven teeth on the dactylus of the raptorial claw rather than nine; 2) there is no obtuse projection on the lateral margin of the eyestalk; 3) the inner two pairs of fixed teeth on the telson are sharp rather than spatulate; 4) the process on the sixth abdominal somite anterior to the articulation of the uropod is short and almost inconspicuous rather than prominent; 5) the rostral plate, antennal papillae, and epipods differ as mentioned in the generic remarks.

The lack of submedian spines on the ventral surface of the sixth abdominal somite, the presence of fewer than four papillae on each antenna, fewer than five epipods, fewer than thirteen teeth on the dactylus of the claw, a strong rather than faint proximal notch on the dactylus of the claw, posterolateral spines on the sixth abdominal somite, a narrower posterior projection on the dorsum of the telson, and spatulate rather than sharp spines on the uropodal exopod will distinguish the western Atlantic *P. enodis* and *P. horologii* from the eastern Atlantic *P. eusebia.*

The number of spines on the proximal segment of the uropodal exopod is variable. The male paratype and one female paratype (USNM 128832) have four spines on each exopod, whereas the holotype has four spines on one exopod and five on the other.

Submedian denticles on the telson vary as follows: the holotype has eight denticles on each side of the midline; both paratypes from off Egmont Key have seven denticles on one side and eight on the other; the female from off Charlotte Harbor has seven denticles on each side.

Type-locality: About 65 miles west of Egmont Key, Pinellas County, Florida, in 55 meters.

Biology: The holotype and two paratypes (USNM 128832 and FSBCI 7268) of *P. horologii,* new species, were collected during the Hourglass cruises (Joyce and Williams, 1969). Gould and Stewart (1956) describe the lithified bottom sediments in this collection area as a continuous blanket of calcareous algae, primarily *Lithothamnion* and other genera. They describe the unconsolidated sediments in this area as a thin veneer of algal sand overlying limestone bedrock, with essentially no quartz evident. The unconsolidated sediments in the area of *Albatross* Station 2410, from which the second paratype was collected, is medium texture shell sand. Joyce and Williams (1969) briefly describe the bottom at the type-locality, Hourglass Station D. It is primarily *Lithothamnion,* crushed shell, and brown silt, with foraminifera tests abundant.

When the holotype was collected, bottom temperature was 22.0 degrees C and salinity was 36.16 parts per thousand. Bottom temperature at this locality ranged from 25.0 to 18.0 degrees C and averaged 20.2 degrees C over a 24-month period. Salinity ranged from 36.00 to 32.54 parts per thousand and averaged 36.26 parts per thousand.

When the female paratype from off Egmont Key was collected, bottom temperature was 19.0 degrees C and salinity was 36.28 parts per thousand. When the male paratype from that area was collected, bottom temperature was 19.0 degrees C and salinity was 36.36 parts per thousand. Bottom temperature at that location ranged from 26.0 to 17.5 degrees C and averaged 20.3 degrees C. Salinity ranged from 36.55 to 32.65 parts per thousand and averaged 35.99 parts per thousand.

Analysis of the fauna associated with *P. horologii* is incomplete. Other stomatopods associated with this species include *Meiosquilla quadridens* (Bigelow, 1893), *Squilla deceptrix* Manning, 1969, *Eurysquilla plumata* (Bigelow, 1901), *Parasquilla coccinea* Manning, 1962, and *Gonodactylus bredini* Manning, 1969. These stomatopods have predominantly tropical Caribbean distributions (Manning, 1969). *Eurysquilla plumata* has not previously been reported in the Gulf of Mexico north of Tortugas. Mr. William G. Lyons (personal communication), who is investigating the mollusks from Project Hourglass, estimates that a majority of the mollusks associated with *P. horologii* are Caribbean species. Dawes and Van

Breedveld (1969) cite the predominance of tropical genera and species of benthic marine algae as a general feature of the offshore Hourglass stations. Dawson (1966) lists 23 of the 32 genera of benthic chlorophyta, phaeophyta, and rhodophyta associated with *P. horologii* as tropical Atlantic genera. Whether *P. horologii* has tropical Caribbean affinities is yet unknown.

Development: Unknown.

Sexual dimorphism: None was observed.

Type: The holotype and two female paratypes are in the Division of Crustacea, National Museum of Natural History, Smithsonian Institution. The male paratype is in the Invertebrate Reference Collection of the Marine Research Laboratory, Florida Department of Natural Resources.

Etymology: The name refers to the biological sampling program (Hourglass = *Horologium*) which yielded the holotype and two paratypes.

Distribution: Known only from the eastern Gulf of Mexico, off Egmont Key, Florida, in 55 and 73 meters, and off Charlotte Harbor in 51 meters, on crushed shell and algal sand.

LITERATURE CITED

BROOKS, W. K. 1886. Report on the Stomatopoda collected by H. M. S. Challenger during the years 1873–76. Rep. Sci. Res. Voy. Challenger, Zool. 16: 1–116, pls. 1–16.

CHACE, FENNER A., JR. 1954. Stomatopoda. *In* Gulf of Mexico, its origin, waters, and marine life. U.S. Fish Wildl. Serv. Fish. Bull. 89: 449–450.

DAWES, CLINTON J., AND JACK F. VAN BREEDVELD. 1969. Benthic marine algae. Memoirs of the Hourglass Cruises, Vol. I, Part II. Fla. Dept. Nat. Resources Mar. Res. Lab. 1–47, 5 pls., 12 figs, 13 tables.

DAWSON, E. YALE. 1966. Marine botany, an introduction: i–xii, 1–371, text-figs. 1–123, 5 tables, 2 appendices. Holt, Rinehart and Winston, New York.

GOULD, HOWARD R., AND ROBERT H. STEWART. 1956. Continental terrace sediments in the northeastern Gulf of Mexico. Soc. Econ. Paleontol. Mineral., Spec. Publ. 3: 1–19, figs. 1–6.

HOLTHUIS, L. B. 1967. Fam. Lysiosquillidae et Bathysquillidae. Stomatopoda I. *In* H. E. Gruner and L. B. Holthuis, eds., Crustaceorum Catalogus, 1 (edit. a): 1–28. W. Junk, The Hague.

JOYCE, EDWIN A., JR., AND JEAN WILLIAMS. 1969. Rationale and pertinent data. Memoirs of the Hourglass Cruises, Vol. I, Part I. Fla. Dept. Nat. Resources Mar. Res. Lab. 1–50, 12 figs., 26 tables.

LUNZ, G. ROBERT, JR. 1935. The stomatopods (mantis shrimps) of the Carolinas. J. Elisha Mitchell Sci. Soc. 51(1): 1–19, figs. 1–10.

MANNING, RAYMOND B. 1962. Seven new species of stomatopod crustaceans from the northwestern Atlantic. Proc. Biol. Soc. Wash. 75: 215–222.

———. 1963. Preliminary revision of the genera *Pseudosquilla* and *Lysiosquilla* with descriptions of six new genera (Crustacea: Stomatopoda). Bull. Mar. Sci. Gulf Carib. 13(2): 308–328.

———. 1967. Preliminary account of a new genus and a new family of Stomatopoda. Crustaceana 13(2): 238–239.

———. 1968. A revision of the family Squillidae (Crustacea, Stomatopoda), with the description of eight new genera. Bull. Mar. Sci. 18(1): 105–142, figs. 1–10.

———. 1969. Stomatopod Crustacea of the western Atlantic. Stud. Trop. Oceanogr. Miami 8: i–viii, 1–380, text-figs. 1–91.

RISSO, ANTOINE. 1816. Histoire naturelle des crustaces des environs de Nice, p. 112–116, pl. II, figs. 1–8. Paris. [Not seen.]

Vol. 84, No. 16, pp. 129–136 30 June 1971

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

THE FRESHWATER CRAYFISHES OF SOUTH AMERICA

By Edgar F. Riek
Division of Entomology, CSIRO,
Black Mountain, Canberra, Australia

The freshwater crayfish fauna of South America is very inadequately known: the relatively few collections are mostly from localities close to the major areas of settlement. The Parastacidae are, however, apparently restricted to the more southern regions of the continent. It would appear, also, that their distribution has been influenced by that of the Aegleidae which are widely distributed and common in many streams. Most of the crayfishes are apparently burrowing species in contrast to species living in permanent streams and lakes.

Crayfishes are recorded only from two relatively restricted areas: southern Chile, and from Uruguay and the adjoining Rio Grande do Sul province of Brazil (30°–35°S). Freshwater crayfishes range north in Chile, as far as is recorded, only to Valparaiso (about 33°S). The most southern collections are from the Taitao Peninsula (about 47°S). There is an incursion of the Chilean fauna into the Lake Nahuel-Huapi area of the Argentinian Cordilleras.

The most comprehensive revision of the crayfishes of South America is that of Faxon (1898) but he was either unable to recognize or unaware of the species of earlier authors. Eight species are recognized in this review; two undescribed species are known in collections but the material is inadequate for specific description.

The species were all previously referred to *Parastacus* but they separate into two very distinct groups recognized most readily by the manner in which the chelae are held. *Parastacus* embraces the burrowing species with the chelae moving vertically whereas the stream and lake inhabiting species with chelae moving horizontally are referred to a new genus, *Samastacus.*

These two genera belong to different generic groupings within the Parastacidae, and each genus can be compared with genera occurring in other continents of the Southern Hemisphere, especially Australia.

The Parastacidae are recorded from South America, New Zealand, Australia, including Tasmania and New Guinea, and from Madagascar. None is recorded from Africa or India. Freshwater crayfishes of this family differ from those of the northern hemisphere Astacidae mainly in secondary sexual attributes, especially those of the male.

Key to genera

1. Cervical groove tending to be V-shaped at meson; dactylus of first pereiopod moving more or less in a vertical plane; male genital papilla a mesal calcified projection from the coxopodite; all individuals with both male and female genital apertures .... *Parastacus*

   Cervical groove U-shaped at meson; dactylus of first pereiopod moving obliquely, almost horizontally; male genital papilla a separately movable, long, narrow, calcified ring; individuals normally with either male or female genital apertures (no partial gynandromorphs known) .... *Samastacus*

Genus *Parastacus* Huxley

Parastacus Huxley 1878: 771.

Type species: Astacus pilimanus von Martens, 1869: 15. (Subsequent designation by Faxon, 1898: 683.)

Diagnosis: Parastacid with cervical groove deeply impressed, tending to be V-shaped at meson, as in the Australian *Engaeus.* Postcervical groove so close to cervical groove as to be almost indistinguishable. Branchiocardiac groove appearing to merge laterally with cervical groove. Postorbital ridges either well developed or subobsolete. Chelae (first pereiopods) shaped more or less as in *Engaeus*: dactylus moving more or less in a vertical plane; propodus expanded in a vertical plane when articulation between merus and carpus is horizontal, and with dactylus articulating vertically; carpus with tubercles on inner margin, anterior one either slightly enlarged or not enlarged. Abdomen large, pleura of first segment well developed. Merus of third maxilliped with entire lower surface covered with dense setae. Male genital papilla a calcified

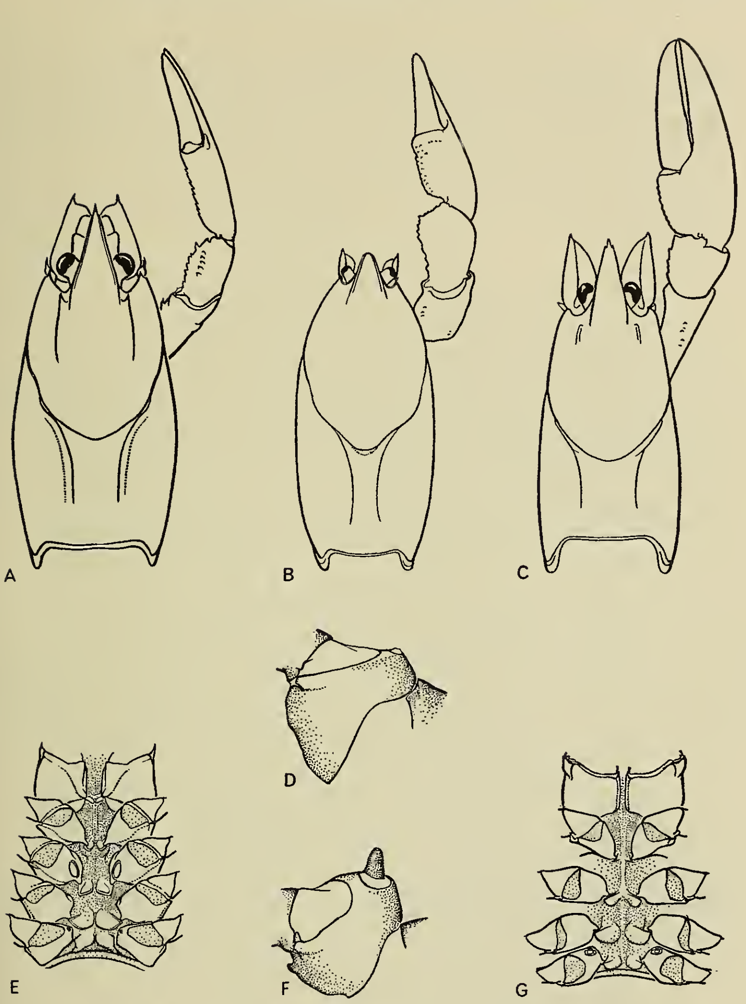


FIG. 1. A, D, E. *Parastacus varicosus*: A, cephalothorax and chela; D, male, coxa of fifth pereiopod, caudal; E, sternum. B. *Parastacus pugnax*: Cephalothorax and chela. C, F, G. *Samastacus spinifrons*: C, cephalothorax and chela; F, male, coxa of fifth pereiopod, caudal; G, sternum.

process, as in *Engaeus*. All specimens with both male and female genital apertures.

The genus is close to the long-abdomened species of *Engaeus*, especially to *lyelli*. It is distinguished from the Australian genus mainly on the approximation of the postcervical and cervical grooves and the very unusual development of gynandromorphic genitalia. Supernumerary genital apertures occur only rarely in other Parastacidae. There is considerable variation in *Parastacus* in the development of the postorbital ridge, comparable with that which occurs in the Australian genus *Cherax*. The species are all apparently strong burrowers. The genus is recorded from Chile and the Argentinian Cordilleras, and from Uruguay and southern Brazil.

Key to the species of *Parastacus*

1\. Postorbital ridges distinct, usually ending anteriorly in a spine; 5th pereiopods slightly closer than 4th pereiopods; carpus with a deep, longitudinal groove above; suborbital margin with a distinct spine; carpus with an enlarged spine on mesal margin (antennal scale very broad, widest beyond the middle; cephalon less than twice as long as thorax; processes to 4th pereiopods broad, appearing almost as wide as long) ---- 2

Postorbital ridges subobsolete; 5th pereiopods distinctly closer than 4th pereiopods; carpus with only a shallow, longitudinal groove above, suborbital margin with only a small spine; carpus without an enlarged spine on mesal margin (basal lobe of exopodite of uropod rounded; propodus above with a double row of tubercles; antennal scale without a spine at outer apical margin of its basal article) ---------------- 4

2(1). Basal lobe of exopodite of uropod rounded; postorbital ridge ending anteriorly without a raised spine or tubercle; mesal margin of propodus without a mat of hair but with hairs along cutting edges of dactylus and propodus (rostrum with more or less straight lateral margins) (Brazil) -------- *pilimanus*

Basal lobe of exopodite of uropod produced to a spine; postorbital ridge ending anteriorly in a spine; mesal margin of propodus with a mat of long hairs ---------------- 3

3(2). Rostrum extending slightly beyond antennal scale; areola with parallel sides; merus, above, with the spine towards apex only slightly larger than the other spines of the upper surface; marginal suborbital spine small, continuous with margin of carapace (Uruguay) ---------------- *saffordi*

Rostrum not quite reaching as far as antennal scale, with lateral margins distinctly convex over posterior half; areola with sides converging slightly over anterior third; merus with a large spine above towards apex; marginal suborbital spine distinct (East Uruguay) ---------------- *varicosus*

4(1). Rostral carinae ending anteriorly before apex, rostrum ending in a median blunt spine (carpus with one row of tubercles above, large species) (Chile) ---------------- *pugnax*

Rostral carinae appearing to meet anteriorly and forming the rounded apex of the rostrum ---------------- 5

5(4). Carpus with two rows of tubercles above, large species (Chile) .... *nicoleti*
Carpus with one row of tubercles above, small species (Uruguay and Brazil) .... *defossus*

Parastacus pugnax (Poeppig)

Astacus pugnax Poeppig 1835: 314.
Astacus chilensis Milne-Edwards 1837: 333.
Parastacus hassleri Faxon 1898: 687 and figure.
Parastacus chilensis: Holthuis 1952: 81 (references).
Parastacus pugnax: Holthuis 1952: 84 (in part).

Type: There is apparently no type of *pugnax.* Holotype of *chilensis* in Mus. Hist. Nat., Paris. (Photographs of type examined.) Holotype of *hassleri* in M.C.Z.

Type locality: Chile. The label with the dry mount of the type of *chilensis* bears the locality name Valparaiso. The type locality for *hassleri* is Talcahuano.

Distribution: Valparaiso; Concepción-Talcahuano area and south to the Taitao Peninsula, Chile.

Parastacus nicoleti (Philippi)

Astacus chilensis: Nicolet 1849: 211, *non* Milne-Edwards 1837.
Astacus Nicoleti Philippi 1882: 624.
Parastacus nicoletii Faxon 1898: 689 (as sp. nov.).
Parastacus pugnax: Holthuis 1952: 84 (in part).
Parastacus nicoleti: Bahamonde 1958: 186.

Type: Location not known (type not examined).

Type locality: Valdivia, Chile.

Distribution: Valdivia area, Chile.

Note: Although the type has not been examined, illustrations of specimens from Valdivia by Bahamonde, show that this species is very distinct, and easily separated from the more widespread *pugnax.*

Parastacus pilimanus (von Martens)

Astacus pilimanus von Martens 1869: 15.
Astacus brasiliensis von Martens 1869: 16 (syn. nov.).
Parastacus pilimanus: Huxley 1878: 771.
Parastacus brasiliensis: Huxley 1878: 771.

Types: Of both species in the Berlin Museum (types not examined).

Type locality: Porto Alegre, Brazil, for both species.

Distribution: The species is known only from the Rio Grande do Sul region of Brazil with the exception of that part adjoining East Uruguay. There are specimens in the U.S. National Museum from Uruguayana, Est Rio Grande do Sul.

Parastacus saffordi Faxon

Parastacus saffordi Faxon 1898: 683 and figure.

Type: Holotype in U.S. National Museum, 12,581 (type examined).
Type locality: Montevideo, Uruguay.
Distribution: The species is known only from the Montevideo area.

Parastacus varicosus Faxon

Parastacus varicosus Faxon 1898: 685 and figure.

Type: Holotype in the U.S. National Museum, 4,133 (type examined).
Type locality: Colima, Mexico, in error.
Distribution: There are specimens in the U.S. National Museum from a ditch near the River Rocha, East Uruguay, and from Bagi River, and Pelotas, Rio Grande do Sul, Brazil.

Parastacus defossus Faxon

Parastacus defossus Faxon 1898: 686.

Type: Holotype in U.S. National Museum, 19,647 (type examined).
Type locality: Montevideo, Uruguay.
Distribution: There are specimens in the U.S. National Museum from Saõ Leopoldo, Rio Grande do Sul, Brazil.

Genus **Samastacus** gen. nov.

Type species: Astacus spinifrons Philippi 1882.
Diagnosis: Parastacid with cervical groove deeply impressed, U-shaped at meson, as in the Australian genus *Geocharax*; the groove almost interrupted midlaterally and with marked changes in direction over this zone. Postcervical groove separated from, but very close to cervical groove, the two parallel and meeting below, at midlateral cephalothorax, rather abruptly; the groove sometimes continued mesad of the branchiocardiac groove. Branchiocardiac groove merging angularly with postcervical groove, but sometimes also continued lateroventrally parallel to it. Postorbital ridges defined, ending anteriorly in a spine or tubercle. Rostrum long and pointed. Chela (first pereiopod) tuberculate, shaped more or less as in *Engaeus* and *Geocharax*: dactylus moving obliquely, almost horizontally; propodus expanded in a more or less horizontal plane when articulation between merus and carpus is horizontal, and with dactylus articulating horizontally; carpus, as in *Parastacoides* and *Geocharax*, with an enlarged tooth on mesal side, but with other small spines, too. Abdomen large, pleura of first segment well developed. Merus of third maxilliped with very dense hairs over all lower surface. Male genital papilla a very long, narrow, calcified ring (more produced than in *Astacoides*). Sexes discrete, with either male or female genital apertures.

The genus differs from the Australian *Geocharax*, the most similar described genus, mainly in the closeness of the postcervical and cervical grooves, the more rounded cervical groove, at meson, and the cervical groove almost interrupted midlaterally and with marked changes in direction over this zone; also in male genitalia and the setation of the third maxillipeds.

The genus is recorded only from Chile.

Key to the species of *Samastacus*

1. Rostrum tapering regularly to apex, the lateral carinae ending anteriorly in a tubercle; postorbital ridge defined but ending anteriorly, at most, in a tubercle; inner margin of antennal scale tapering regularly to apex; basal lobe of exopodite of uropod ending in a spine .... *spinifrons*

   Rostrum U-shaped, lateral carinae ending without spine or tubercle; postorbital ridges absent; antennal scale very broad, inner margin tapering abruptly to apex; basal lobe of exopodite of uropod rounded .... *araucanius*

Samastacus spinifrons (Philippi) **New Combination**

Astacus spinifrons Philippi 1882.
Astacus bimaculatus Philippi 1894: 378.
Parastacus agassizii Faxon 1898: 670 and figure.
Parastacus spinifrons: Holthuis 1952: 81 (for full synonymy).

Types: The location of the types of *spinifrons* and *bimaculatus* is unknown. Holotype of *agassizii* in M.C.Z.; paratype USNM No. 12,045 (paratype examined).

Type locality: spinifrons from Llico and Valdivia (*vide* Bahamonde, 1951); *bimaculatus* from Chile; and *agassizii* from Talcahuano, Chile.

Distribution: Talcahuano area south to Taitao Peninsula, including Island of Chiloé.

Habitat: In streams and lakes.

Note: The specimens from the Lake Nahuel-Huapi area of the Argentinian Cordilleras represent an undescribed species, determined as *spinifrons* by Faxon, 1914, who used the name *bimaculatus* for the Chilean species.

Samastacus araucanius (Faxon) **New Combination**

Parastacus araucanius Faxon 1914: 353.

Type: In M.C.Z. (type examined, on my behalf, by Horton H. Hobbs).

Type locality: Corral, Valdivia, Chile.

Distribution: The species is known only from the type.

Note: The specimens determined as *spinifrons* from Valdivia (*vide* Bahamonde, 1951) may be this species. If this is so then Llico could be considered the type locality for *spinifrons*.

ACKNOWLEDGMENTS

I am most grateful to Horton H. Hobbs, Jr. and the Smithsonian Institution for the opportunity and the facilities for the study of the South American crayfishes in their collection. I am further indebted to Horton Hobbs for illustrations and for examination of the holotype of *Parastacus araucanius* Faxon in the Museum of Comparative Zoology, Harvard. Dr. J. Forest very graciously supplied photographs of the dried holotype of *Astacus chilensis* Milne-Edwards in the Muséum National d'Histoire Naturelle, Paris. Dr. Gustavo Augusto S. de Melo, São Paulo supplied details of distribution and specimens from Brazil. The illustrations of the genital papillae and sterna were prepared by Miss Sybil Curtis.

LITERATURE CITED

BAHAMONDE, N. 1951. Nuevos datos sobre el *Parastacus spinifrons* (Philippi), 1882. Boletin Museo Nacional de Historia Natural. 25: 85–96.

———. 1958?. Sobre la Validez Taxonomica de *Parastacus nicoleti* (Philippi), 1882, y algunos aspectos de su biologia. Invert. Zool. Chilensis 4: 183–198.

FAXON, W. 1898. Observations on the Astacidae in the United States National Museum and in the Museum of Comparative Zoology, with descriptions of new species. Proc. U.S. Nat. Mus. 20: 643–694.

———. 1914. Notes on the crayfishes in the United States National Museum and the Museum of Comparative Zoology, with descriptions of new species and subspecies, to which is appended a catalogue of the known species and subspecies. Mem. Mus. Comp. Zool. Harvard 40: 351–427.

HOLTHUIS, L. B. 1952. The Crustacea Decapoda Macrura of Chile. Lunds Universitets Årsskrift N. F. Avd. 2 Bd. 47, No. 10, 109 pp.

VON MARTENS, E. 1869. Südbrasilische Süss-und Brackwasser Crustaceen. Arch. f. Naturgesch. 35: 15–16.

HUXLEY, T. H. 1878. On the classification and the distribution of the crayfishes. Proc. zool. Soc. London. 1878: 752–787.

MILNE-EDWARDS, H. 1837. Histoire Naturelle des Crustacés, comprenant l'anatomie, la physiologie et la classification de ces animaux. Vol. 2, pp. 1–532.

PHILIPPI, R. A. 1882. Zoología chilena. Sobre los *Astacus*. An. Univ. Chil. 61: 624–628.

———. 1894. Carcinologische Mittheilungen. Zool. Anz. 17: 264–266.

POEPPIG, E. 1835. Reise in Chile, Peru und auf dem Amazonenstrome während der Jahre 1827–1832. Vol. 1, pp. i–xviii, 1–466.

Vol. 84, No. 17, pp. 137–146 30 June 1971

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

NEW ENTOCYTHERID OSTRACODS OF THE GENERA *ANKYLOCYTHERE* AND *DACTYLOCYTHERE*[1]

By H. H. Hobbs III
*Department of Zoology, Indiana University,
Bloomington, Indiana*

Three new species of entocytherid ostracods belonging to the genera *Ankylocythere* and *Dactylocythere* are described from Indiana, Kentucky, and Mississippi, and a description of the previously unknown female of *D. ungulata* (Hart and Hobbs, 1961), together with additional locality records for it, are included. Keys to the previously described members of the two genera are available in Hobbs (1966) and Hobbs and Hobbs (1970).

I am grateful to Dr. Horton H. Hobbs, Jr. for his assistance in the preparation of this manuscript and to Dr. David G. Frey for his helpful criticisms. Supported in part by NSF Grant GB-4719 to J. F. Fitzpatrick, Jr., and NSF Grant GB-7585 to Gulf Coast Research Laboratory.

Anklylocythere burkeorum new species

(Fig. 1a–c)

Male: Eyes pigmented, situated one-fourth shell length from anterior margin. Shell (Fig. 1c) subovate and somewhat vaulted dorsally at midlength; margins entire; submarginal setae scarce, absent dorsally, present anteriorly, posteriorly, and ventrally. Range of shell size of three specimens recorded in Table 1.

Copulatory complex (Fig. 1a) with elongate peniferum; ventral portion of peniferum slightly enlarged, terminating distally in cleft; anteroventral portion drawn into acute prominence; penis small, situated in distal seventh of peniferum; clasping apparatus (Fig. 1a, b) clearly divisible into vertical and horizontal rami, former approximately twice length of latter; horizontal ramus slender, bearing single tooth-like prominence on

---

[1] Contribution No. 854, Department of Zoology, Indiana University.

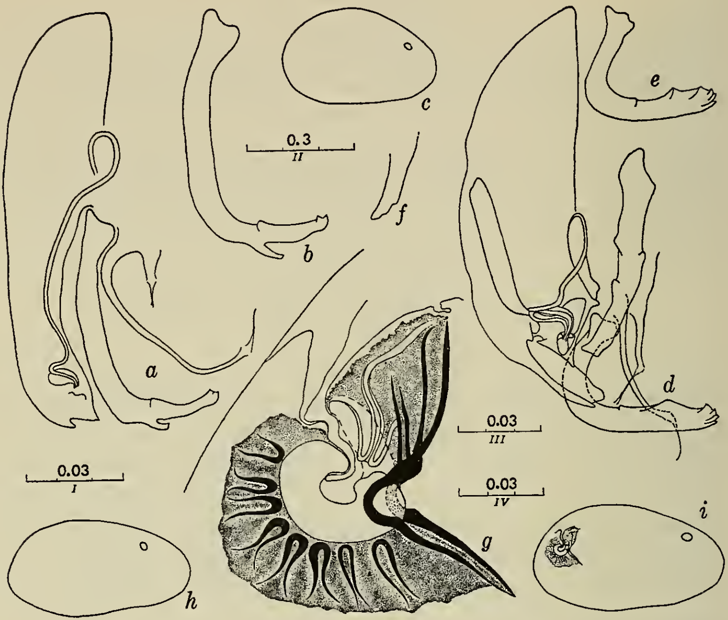


Fig. 1a–c. *Ankylocythere burkeorum* new species; Fig. 1d–i. *Dactylocythere ungulata* Hart and Hobbs; a, d, mesial views of entire male copulatory complexes; b, e, clasping apparatus; f, finger guard; c, h, lateral views of right valve of males; i, lateral view of right valve of female; g, female genitalia; a, b to scale I; c, h, i to scale II; d, e, f to scale III; g to scale IV; scales in mm.

internal border proximal to midlength; distal extremity terminating in 2 teeth; external border bearing talon arising proximal to, or at level of, tooth on internal border and extending subparallel to horizontal ramus; talon reaching distally ⅓ to ⅙ distance between distal margin of base and apex of ramus; external and internal borders of vertical ramus entire, with dorsal fifth directed anterodorsally; dorsal and ventral fingers slender, former terminating in 2 setae, latter in single seta.

Female: Unknown.

Type-locality: Collected from crayfish in burrows along bank of Tallahatta Creek, near Duffee, Newton County, Mississippi.

Disposition of types: The holotypic male and dissected male paratype are deposited in the National Museum of Natural History (Smithsonian Institution), nos. 135617 and 135618, respectively. Paratypes are in the collection of the author.

Hosts: Cambarus diogenes diogenes Girard and *Cambarus striatus* Hay.

TABLE 1. Measurements (in millimeters).

	Holotype	Males	Allotype	Females
Ank. burkeorum				
Number of specimens		3		0
Length (range)	0.36	0.35–0.36	–	–
mean		0.36		
Height (range)	0.22	0.21–0.22	–	–
mean		0.21		
D. susanae				
Number of specimens		6		10
Length (range)	0.52	0.48–0.52	0.55	0.54–0.58
mean		0.50		0.56
Height (range)	0.27	0.26–0.29	0.30	0.30–0.37
mean		0.27		0.33
D. charadra				
Number of specimens		3		3
Length (range)	0.49	0.48–0.49	0.51	0.48–0.51
mean		0.48		0.49
Height (range)	0.28	0.27–0.28	0.33	0.29–0.33
mean		0.27		0.31

Entocytherid associates: Entocythere internotalus Crawford, 1959, *Uncinocythere simondsi* (Hobbs and Walton, 1960), and *Ornithocythere gypodes* Hobbs III, 1970 (Noxubee County, Mississippi).

Range: In addition to the type locality, this species is known from crayfish burrows in roadside ditch 1.0 miles W of junction of State Route 14 and U.S. Hwy. 45 on State Route 14, Noxubee County, Mississippi.

Relationships: Ankylocythere burkeorum has its closest affinity with *Ankylocythere copiosa* (Hoff, 1942) in that the vertical ramus of the clasping apparatus is long, the talon of moderate length, and the peniferum is bifid terminally. *A. burkeorum* can be distinguished from this species by the shallow bifid ventral portion of the peniferum, the more distally located penis, and by the slender horizontal ramus of the clasping apparatus. *Ankyolcythere harmani* Hobbs, 1966 and *A. hobbsi* (Hoff, 1944) also are close relatives. The similarities are noted in the long vertical ramus of the clasping apparatus. *A. burkeorum* can be distinguished from these species by possessing a bifid ventral margin of the peniferum rather than an undulating one. The talon is much shorter and the horizontal ramus of the clasping apparatus is more slender in *A. burkeorum* than in other species. It also differs from *A. hobbsi* by lacking a thickened area in the distal portion of the horizontal ramus of the clasping apparatus.

Etymology: It is a pleasure to name this ostracod in honor of my good friends and collectors of this species, Elizabeth and William David Burke.

Dactylocythere susanae new species

(Fig. 2a–f)

Male: Eyes pigmented, located approximately one-fourth shell length from anterior margin. Shell (Fig. 2d) subovate, with greatest height posterior to midlength; margins entire; submarginal setae present in limited numbers anteriorly, posteriorly, and ventrally. Sternal spine lacking. Range of shell size of six specimens recorded in Table 1.

Copulatory complex (Fig. 2a) possessing straight finger guard, terminating distally without tubercles, anterior margin incised short distance proximal to apex; peniferum elongate with distal anteriorly directed flange; posteroventral portion tapering to semi-acute prominence; accessory groove long, extending one-third its length beyond dorsal extremity of spermatic loop; apex of peniferal groove wider than least diameter of vertical ramus of clasping apparatus; penis L-shaped, greater than half width of peniferum, and situated in ventral third of peniferum; clasping apparatus (Fig. 2b, c) extending ventrally beyond peniferum, nearly C-shaped, not clearly delimited into horizontal and vertical rami, and with proximal and distal portions directed at angle of approximately 75 degrees; external border of vertical ramus strongly convex posteriorly, external and internal borders entire; internal border of horizontal ramus bearing three teeth, proximal one most pronounced and rounded, distal one small and subacute, and that between almost obsolete; distal extremity of horizontal ramus terminating in three denticles; dorsal and ventral fingers slender, former terminating distally in two setae, latter in single seta.

Triunguis female: Eyes pigmented, situated one-fourth shell length from anterior margin. Shell (Fig. 2e) subovate with entire margins; range of shell size of 10 specimens recorded in Table 1; submarginal setae like those of male. Genital complex (Fig. 2f) posterodorsal and consisting of coiled J-shaped rod and amiculum; upper portion of J-shaped rod bifid with genital papilla situated between rami; amiculum surrounding coil, supported by U-shaped ribs; rami of ribs extending away from coil; anterodorsalmost pair of supporting ribs with one ramus extending dorsally and other anteriorly.

Type-locality: Murray Spring Cave, Orange County, Indiana, SE¼, NW¼, NW¼, Sec. 6, T. 1 N, R. 1 E (Paoli Quadrangle).

Disposition of types: The holotypic male, allotype, and dissected male paratype are deposited in the National Museum of Natural History (Smithsonian Institution), nos. 135619, 135620, and 135621, respectively. Paratypes are in the collections of C. W. Hart, Jr. (1 ♂, 1 ♀), the Smithsonian Institution (1 ♂, 2 ♀), and the author (1 ♂, 10 ♀).

Hosts: Cambarus laevis Faxon from the type locality, Buckner's Cave, Connerly's Cave, Fredericksburg Cave, Weaver Springs Cave, Jack's Defeat Creek from Indiana; *C. tenebrosus* Hay, *Orconectes inermis inermis* Cope, and *O. australis packardi* Rhoades from Kentucky.

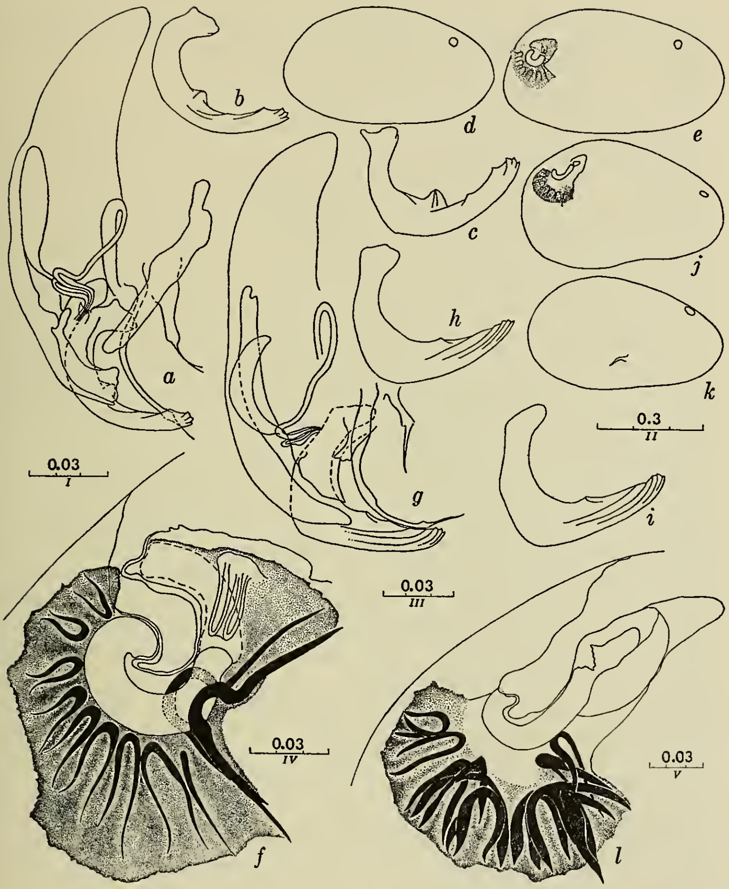


Fig. 2a–f. *Dactylocythere susanae* new species; Fig. 2g–l. *Dactylocythere charadra* new species; a, g, mesial views of entire male copulatory complexes; b, c, h, i, clasping apparatus of males; d, k, lateral views of right valve of males; e, j, lateral views of right valve of females; f, l, female genitalia; a, b, c, to scale I; d, e, j, k to scale II; g, h, i to scale III; f to scale of IV; l to scale V; scales in mm.

Entocytherid associates: Indiana: *Donnaldsoncythere donnaldsonensis* (Klie, 1931) from the type locality, Buckner's Cave, Connerly's Cave, Fredericksburg Cave and Jack's Defeat Creek; *Uncinocythere simondsi* from Buckner's Cave, Weaver Springs Cave, and Jack's Defeat Creek; Kentucky: *Dactylocythere amphiakis* Hart and Hart, 1966 (Cooch

Webb Cave); *Dactylocythere ungulata* (Hart and Hobbs, 1961) from Pine Hill Cave; an undescribed species of *Dactylocythere* from Bandy and Cumberland Crystal Caves (Sloan's Valley Cave); and *Sagittocythere barri* (Hart and Hobbs, 1961) from Cooch Webb Cave.

Range: In addition to the type locality, *Dactylocythere susanae* has been collected from the following localities in INDIANA: Buckner's Cave, Monroe County, NE¼, SW¼, SE¼, Sec. 17, T. 8 N, R. 2 W (Whitehall Quadrangle); Connerly's Cave, Lawrence County, NE¼, SW¼, SE¼, Sec. 4, T. 3 N, R. 2 W (Huron Quadrangle); Fredericksburg Cave, Washington County, SE¼, NW¼, SE¼, Sec. 4, T. 1 S, R. 3 E (Fredericksburg Quadrangle); Weaver Springs Cave, Monroe County, NE¼, NE¼, SE¼, Sec. 19, T. 7 N, R. 2 W (Stanford Quadrangle); Jack's Defeat Creek, Bloomington, Monroe County, 1.5 miles NE of junction of Woodyard Road and Curry Pike on Woodyard Road; KENTUCKY: Bandy Cave, 3.0 miles S of Irvington, Breckinridge County; Cooch Webb Cave, 0.4 miles N of Bear Wallow, Hart County; Cumberland Crystal Cave at Sloan's Valley, Pulaski County; Pine Hill Cave, at Pine Hill on U.S. Hwy. 25, Rockcastle County.

Relationships: Dactylocythere susanae has its closest affinities with *D. steevesi* (Hart and Hobbs, 1961) and *D. ungulata.* All three species possess elongate penifera which taper ventrally to terminate in a flange and a semi-acute prominence at anteroventral angle. Likewise, all possess a rather straight finger guard, which terminates distally without tubercles. *D. susanae* can easily be distinguished from these two species in that it bears an accessory groove which extends dorsally well beyond the level of the spermatic loop. Likewise, the internal border of the horizontal ramus of the clasping apparatus of *D. susanae* bears a large proximal tooth which is greatly reduced in the other two species. *D. susanae* is also related to *D. arcuata* (Hart and Hobbs, 1961). The ventral portion of the peniferum in both is markedly similar, and the accessory grooves extend dorsally above the spermatic loop. *D. arcuata*, however, has a very slender elongate finger guard and lacks an enlarged proximal tooth on the horizontal ramus of the clasping apparatus.

Etymology: I am pleased to name this species in honor of my wife, Susan Krantz Hobbs.

Dactylocythere charadra new species

(Fig. 2g–l)

Male: Eyes pigmented, located approximately one-fifth shell length from anterior margin. Shell (Fig. 2k) subovate with greatest height posterior to midlength; margins entire; submarginal setae present in limited numbers anteriorly, ventrally, and posteriorly, absent dorsally. Sternal spine present, short, directed posteroventrally. Shell size of 3 specimens recorded in Table 1.

Copulatory complex (Fig. 2g) possessing finger guard tapering from broad base and flaring distally in 3 tubercles, posterior margin markedly concave; peniferum elongate, posteroventral portion gently rounded;

accessory groove short, not reaching ventralmost level of spermatic loop; peniferal groove very long, extending dorsally beyond level of dorsalmost portion of spermatic loop; apex of peniferal groove narrower than least diameter of vertical ramus of clasping apparatus; penis horizontally situated in distal one-fourth of peniferum and slightly curved ventrally at distal end, less than half width of peniferum; clasping apparatus (Fig. 2h, i) extending ventrally beyond peniferum and clearly divisible into horizontal and vertical rami, proximal and distal portions directed at angle of approximately 80 degrees; external border of vertical ramus with subangular bend distally, otherwise external borders of both rami and internal border of vertical ramus entire; internal border of horizontal ramus with prominent, acute, proximal tooth and two more distal rudimentary ones; apex of ramus terminating in three acute denticles; both dorsal and ventral fingers slender and terminating in single seta.

Triunguis female: Eyes pigmented, located approximately one-seventh shell length from anterior margin. Shell (Fig. 2j) subovate with greatest height posterior to midlength; ventral margin with shallow concavity anterior to midlength, otherwise entire; submarginal setae like those of male. Genital complex (Fig. 2l) located posterodorsally, composed of distinct J-shaped rod and amiculum; amiculum consisting of amorphous mass suspended from lower third of J and supported by U-shaped ribs; anteriormost pair of supporting ribs with rami extending anteriorly; dorsal portion of J-shaped rod bifid, appearing cracked and angled anterodorsally, with no apparent genital papilla.

Type-locality: Sinking Creek in "Hoss Cove" near Johnson City, Washington County, Tennessee. This species is known from no additional localities.

Disposition of types: The male holotype and allotype are deposited in the National Museum of Natural History (Smithsonian Institution) no. 135622. Paratypes are in the collection of C. W. Hart, Jr. (1 ♂, 1 ♀), and the author (2 ♂, 1 ♀).

Host: Cambarus sp.

Entocytherid associates: Dactylocythere falcata (Hobbs and Walton, 1961); *Donnaldsoncythere* sp.; and *Thermastrocythere rioja* (Hoff, 1943).

Relationships: Dactylocythere charadra is most closely allied to *D. chalaza* (Hobbs and Walton, 1962), from which it differs most conspicuously by the much enlongated peniferal groove; it can further be distinguished from *D. chalaza* by the presence of 2 reduced teeth located distally on the internal border of the horizontal ramus of the clasping apparatus; *D. charadra* possesses a sternal spine suggesting a not too remote relationship to other members of the genus that possess this character: *D. amicula* Hart and Hart, 1966; *D. brachytrix* Hobbs and Walton, 1966; *D. chalaza*; *D. Chelomata* (Crawford, 1961); *D. daphnoides* (Hobbs, 1955); *D. exoura* Hart and Hart, 1966; *D. pachysphurata* Hobbs and Walton, 1966; *D. runki* (Hobbs, 1955); *D. spinata* Hobbs and Walton, 1970; *D. xystroides* Hobbs and Walton, 1963. Although closely allied, *D. charadra* may be distinguished from these species by the distinct characters of the accessory groove, finger guard, shape of peniferum, and clasping apparatus.

Etymology: Charadra (Greek) = mountain stream, referring to type-locality where this species was collected—a swift, rocky bottomed stream in a mountainous area.

Dactylocythere ungulata (Hart and Hobbs, 1961)
(Fig. 1d–i)

Entocythere ungulata Hart and Hobbs, 1961: 177, figs. 9–11.
Dactylocythere ungulata.—Hart, 1962: 131.

At the time of the original description, the female of the species was unknown and thus was omitted from the description. Subsequently, many specimens (both male and female) have been collected from two additional localities in Kentucky and Tennessee. The acquisition of these specimens permits a description of the triunguis female of the species. The male of the species from Pine Hill Cave, Kentucky is also illustrated here (Fig. 1d, e, f, h).

Triunguis female: Eyes pigmented, situated one-fifth shell length from anterior margin. Shell (Fig. 1i) subovate with margins entire; length—0.49 mm, range and average of 10 specimens, 0.46–0.53 mm and 0.49 mm, respectively; height—0.28 mm, range and average of 10 specimens, 0.26–0.32 mm and 0.28 mm, respectively; submarginal setae present in limited numbers anteriorly, ventrally, and posteriorly, absent dorsally; genital complex (Fig. 1g) situated posterodorsally, composed of coiled J-shaped rod and amiculum; amiculum consisting of amorphous mass surrounding subcircularly curved rod and supported by U-shaped ribs; rami of ribs radiating from rod; anterodorsalmost pair of supporting ribs with one ramus extending dorsally, other anteriorly; pair of accessory ribs parallel and posterior to dorsal arms of anterodorsal supporting ribs; upper portion of J-shaped rod bifid, with genital papilla positioned between rami.

Range: In addition to the three localities reported by Hart and Hobbs this species has been collected from: Pine Hill Cave at Pine Hill on U.S. Hwy. 25, Rockcastle County, Kentucky (on *Orconectes australis packardi*); small stream along County Route 42, 0.5 miles S Kentucky-Tennessee state line in NE corner of Pickett County, Tennessee (on *Cambarus tenebrosus*).

Entocytherid associates: In addition to those associates reported by Hart and Hobbs, *Dactylocythere ungulata* has been found with *D. susanae* in Pine Hill Cave, Kentucky.

LITERATURE CITED

CRAWFORD, EDWARD A., JR. 1959. Five new ostracods of the genus *Entocythere* (Ostracoda, Cytheridae) from South Carolina. Univ. South Carolina Publ., Ser. III, Biol. 2: 149–189, pls. 1–5.

———. 1961. Three new species of the genus *Entocythere* (Ostracoda, Cytheridae) from North and South Carolina. Amer. Midl. Nat. 65: 236–245.

Hart, C. W., Jr. 1962. A revision of the ostracods of the family Entocytheridae. Proc. Acad. Nat. Sci. Philadelphia 114: 121–147, figs. 1–18.

——— and Dabney G. Hart. 1966. Four new entocytherid ostracods from Kentucky, with notes on the troglobitic *Sagittocythere barri*. Notulae Naturae 338: 1–10, 13 figs.

——— and Horton H. Hobbs, Jr. 1961. Eight new troglobitic ostracods of the genus *Entocythere* (Crustacea, Ostracoda) from the eastern United States. Proc. Acad. Nat. Sci. Philadelphia 113: 173–185, 32 figs.

Hobbs, Horton H., Jr. 1955. Ostracods of the genus *Entocythere* from the New River System in North Carolina, Virginia, and West Virginia. Trans. Amer. Micros. Soc. 74: 325–333, 10 figs.

———. 1966. An illustrated key to the species of the genus *Ankylocythere* with a description of a new species from Louisiana (Ostracoda, Entocytheridae). Proc. Louisiana Acad. Sci. 29: 67–75, 18 figs.

——— and H. H. Hobbs III. 1970. New entocytherid ostracods with a key to the genera of the subfamily Entocytherinae. Smithsonian Contributions to Zoology 47: 1–19.

——— and Margaret Walton. 1960. Three new ostracods of the genus *Entocythere* from the Hiwassee drainage system in Georgia and Tennessee. Journ. of Tennessee Acad. Sci. 35(1): 17–23, 20 figs.

———. 1961. Additional new ostracods from the Hiwassee drainage system in Georgia, North Carolina, and Tennessee. Trans. Amer. Micros. Sci. 80(4): 379–384, 8 figs.

———. 1962. New ostracods of the genus *Entocythere* from the Mountain Lake Region, Virginia (Ostracoda, Entocytheridae). Virginia Journ. Sci., new series 13(2): 42–48, 12 figs.

———. 1963. Three new ostracods (Ostracoda, Entocytheridae) from the Duck River drainage in Tennessee. Amer. Midl. Nat. 69(2): 456–461, 10 figs.

———. 1966. A new genus and six new species of entocytherid ostracods (Ostracoda, Entocytheridae). Proc. U.S. Nat. Mus. 119 (3542): 1–12, 2 figs.

———. 1970. New entocytherid ostracods from Tennessee and Virginia. Proc. Biol. Soc. Washington 82: 851–863, 3 figs.

Hobbs, H. H. III. 1970. New entocytherid ostracods of the genus *Ornithocythere* and the description of a new genus. Proc. Biol. Soc. Washington 83(15): 171–182.

Hoff, Clayton C. 1942. The subfamily Entocytherinae, a new subfamily of fresh-water cytherid ostracods with descriptions of two new species of the genus *Entocythere.* Amer. Midl. Nat. 27: 63–73, 1–13 figs.

———. 1943. Two new ostracods of the genus *Entocythere* and records of previously described species. Journ. Washington Acad. Sci. 33(9): 276–286, 2 figs.

———. 1944. New American species of the ostracod genus *Entocythere.* Amer. Midl. Nat. 32(2): 327–357, 33 figs.

KLIE, W. 1931. Campagne spéologique de C. Bolivar et R. Jeannel dans l'Amérique du Nord (1928). 3. Crustacés ostracodes. - Biospeologica: Archiv. Zool. Exp. et Gen. 71: 333–344, 20 figs.

Vol. 84, No. 18, pp. 147–162 30 June 1971

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

TAXONOMIC NOTES ON SOUTH AMERICAN *COLOSTETHUS* WITH DESCRIPTIONS OF TWO NEW SPECIES (AMPHIBIA, DENDROBATIDAE)

By Stephen R. Edwards
University of Kansas, Lawrence, Kansas 66044

The family Dendrobatidae can be divided into two groups —those species lacking maxillary teeth (*Dendrobates*) and those species having maxillary teeth (*Phyllobates* and *Colostethus*). Savage (1968) studied Central American dendrobatids and separated *Phyllobates* from *Colostethus* as follows: *Phyllobates* has scattered "punctations" of black pigment in the flesh; the dorsal and ventral ground color is black; and the skin is poisonous. *Colostethus* lacks black pigmentation in the flesh; the dorsal ground color is dark brown, and the venter is white to yellow (males of some species have a black wash on the throat); and the skin is non-poisonous. The criteria of ventral coloration utilized by Savage to distinguish *Colostethus* must be amended to include species with extensive black coloration of the venter. Some of those species that Savage considered to be in the genus *Colostethus* were named in the genera *Prostherapis* and *Hyloxalus*, both of which are now placed in synonymy of *Colostethus*. Therefore, by implication, all those South American species originally described in *Prostherapis* and *Hyloxalus* also must be referred to *Colostethus*. Savage also indicated that many South American species named in the genus *Phyllobates* belong in *Colostethus*. Examination of type specimens, study of preserved specimens, and critical analysis of original descriptions has led me to refer the following 43 nominal species to the genus *Colostethus* (the original generic allocation is given in parentheses):

alagoanus (*Phyllobates*) Bokermann, 1967
alboguttatus (*Phyllobates*) Boulenger, 1903
anthonyi (*Phyllobates*) Noble, 1921
beebei (*Hylixalus*) Noble, 1923
bocagei (*Hyloxalus*) Jiménez de la Espada, 1871
bromelicola (*Phyllobates*) Test, 1956
brunneus (*Prostherapis*) Cope, 1887
capixaba (*Phyllobates*) Bokermann, 1967
carioca (*Phyllobates*) Bokermann, 1967
chocoensis (*Hylixalus*) Boulenger, 1912
collaris (*Hylixalus*) Boulenger, 1912
dunni (*Prostherapis*) Rivero, 1961
festae (*Prostherapis*) Peracca, 1904
fuliginosus (*Hyloxalus*) Jiménez de la Espada, 1871
granuliventris (*Hylixalus*) Boulenger, 1919
herminae (*Prostherapis*) Boettger, 1893
infraguttatus (*Phyllobates*) Boulenger, 1898
inguinalis (*Prostherapis*) Cope, 1868
intermedius (*Phyllobates*) Andersson, 1945
kingsburyi (*Phyllobates*) Boulenger, 1918
latinasus (*Phyllobates*) Cope, 1868
mandelorum (*Phyllobates*) Schmidt, 1932
marchesianus (*Phyllobates*) Melin, 1941
mertensi (*Phyllobates*) Cochran and Goin, 1964
neblina (*Prostherapis*) Test, 1956
olfersioides (*Eupemphix*) Lutz, 1925
palmatus (*Phyllobates*) Werner, 1899
peruvianus (*Phyllobates*) Melin, 1941
pratti (*Phyllobates*) Boulenger, 1899
pulchellum (*Phyllodromus*) Jiménez de la Espada, 1871
ranoides (*Dendrobates*) Boulenger, 1918
riocosangae (*Phyllobates*) Andersson, 1945
riveroi (*Prostherapis*) Donoso-Barros, 1964
shrevei (*Prostherapis*) Rivero, 1961
subpunctatus (*Prostherapis*) Cope, 1899
sylvatica (*Phyllobates*) Barbour and Noble, 1920
taeniatus (*Phyllobates*) Andersson, 1945
trilineatus (*Phyllobates*) Boulenger, 1913
trinitatus (*Phyllobates*) Garman, 1888

variabilis (*Prostherapis*) Werner, 1899
vergeli (*Hyloxalus*) Hellmich, 1940
vertebralis (*Phyllodromus*) Boulenger, 1899
whimperi (*Prostherapis*) Boulenger, 1882

The purpose of this paper is to establish a working foundation of specific taxonomy in the genus *Colostethus* in South America, to describe two new species, and to redescribe *Colostethus vertebralis* (Boulenger). The three species are considered together because of their similar distributions in high Andean, southern Ecuador. In the past there has been a paucity of information available on the widespread species, *C. vertebralis.* Recent collections from throughout the range of this species now make it possible to consider the geographic variation of a number of characters.

Colostethus elachyhistus new species
(Figs. 1a, 2a, 3, 4, and 6)

Holotype: KU 120540, from Loja, Loja Province, Ecuador, 2150 m, collected on 9 June 1968 by John D. Lynch.

Paratypes: KU 120515–539, collected with the type; and KU 120541, from 9 km E Loja, Loja Province, Ecuador, 2660 m, collected by John D. Lynch.

Diagnosis: The following numerical designations are given for the purpose of standardizing diagnoses in forthcoming descriptions: (1) medium-sized *Colostethus*, 18.0 to 25.7 (mean 22.4) mm in snout-vent length; (2) sexual dimorphism in color and size absent; (3) skin granular dorsally and laterally, smooth ventrally; (4) tympanum distinct; (5) supratympanic fold heavy, covering dorsal one-third of tympanum; (6) first finger longer than second; (7) finger discs subequal in size, not expanded; (8) third finger of males not swollen; (9) digital scutes (? glands) distinct; (10) tarsal fold oblique, extending from inner metatarsal tubercle along inner margin of distal half of tarsus; (11) toes webbed basally, continuous with lateral fringes extending along both margins of all toes; (12) toe discs slightly expanded, subequal in size; (13) dorsolateral stripe yellow to gray-white, extending from upper eyelid to groin, bordered above and below by irregular black reticulations; (14) dorsal ground color pale yellow-gray to gray-black; (15) venter creamy white to yellow, with or without white on black marbling extending medially across the chest; (16) thighs, shanks and feet marked by irregular dark gray bars, interspaces gray to yellow-gray; (17) free-swimming tadpole small, body length 11.2 to 14.2 (mean 12.7) mm, tail length 21.0 to 24.5 (mean 22.4) mm in stages 31 to 41; (18) mouth directed anteroventrally, not umbelliform; (19) tooth rows 2/3 with second upper and first lower

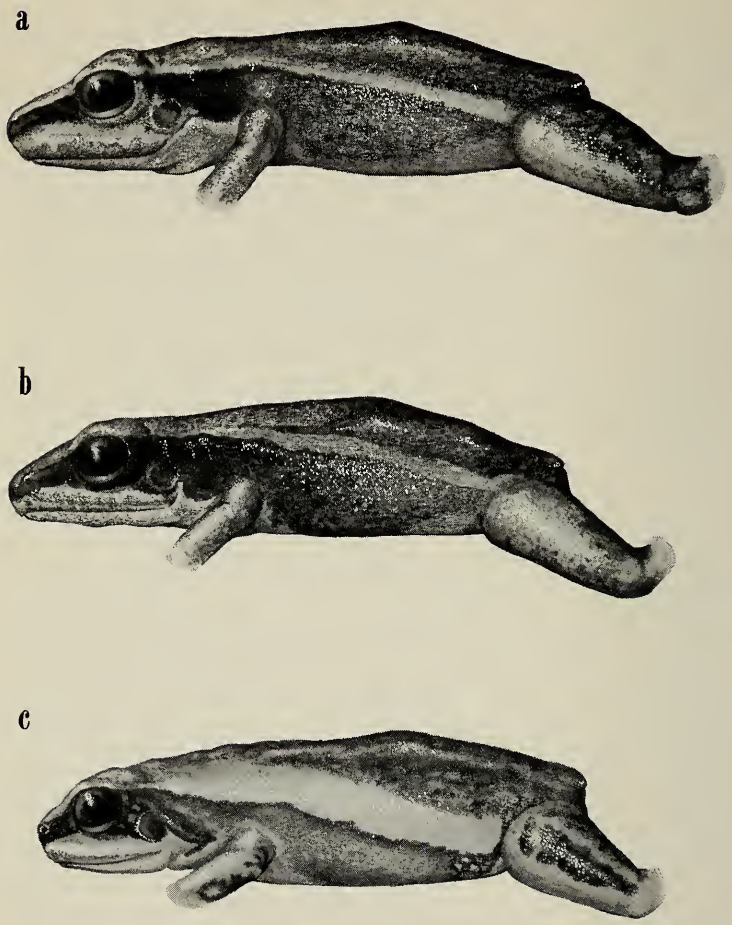


FIG. 1. Lateral views of (a) *Colostethus elachyhistus* (KU 120536), (b) *C. anthracinus* (KU 120637), and (c) *C. vertebralis* (KU 120613), × 5.0.

rows divided; (20) labial papillae in two rows posteriorly and anterolaterally, one row laterally; (21) upper lip bare medially.

Description and variation: (Figs. 1a, 2a, 2b, and 6). Head as wide as long, and as wide as, or narrower than, body; ratio of head width to snout-vent length 0.331–0.389 (mean 0.364); snout rounded, sloping in lateral profile; canthus rostralis moderately well defined, slightly concave; loreal region concave; nostrils lateral, closer to tip of snout than to eye;

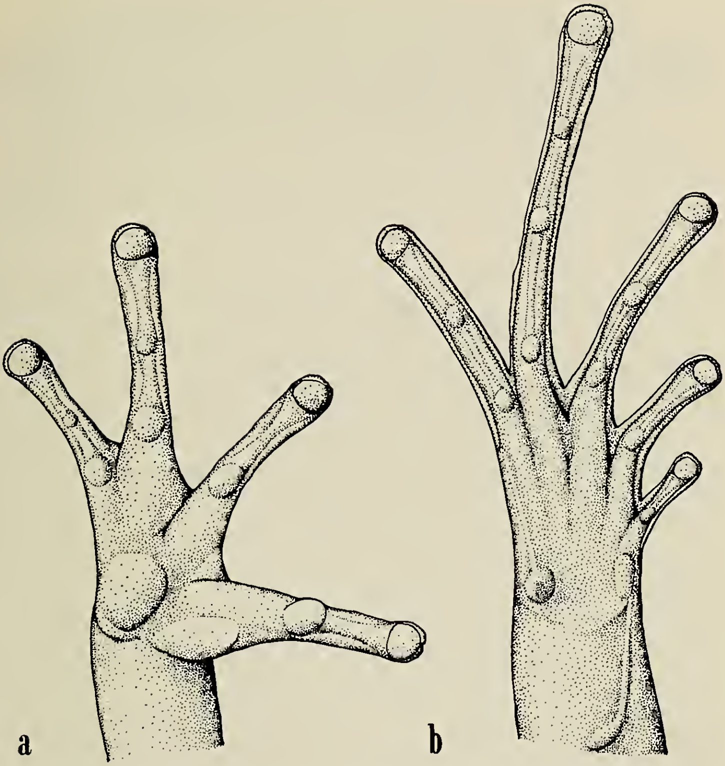


Fig. 2. (a) Palmar surface of hand of *Colostethus elachyhistus* (KU 120534), (b) plantar surface of foot of *C. elachyhistus* (KU 120525), × 7.8.

length of eye greater than or equal to distance from eye to nostril; tympanum oval, distinct; ratio of tympanum width to eye diameter 0.516–0.678 (mean 0.598); supratympanic fold heavy, covering dorsal one-third of tympanum; tongue oval, notched or entire behind, posterior three-fourths free; choanae large, round, partially hidden by maxillae when viewed from directly below; males having conspicuous elongate vocal slits and median subgular vocal sac.

Skin of dorsum and flanks granular (rarely smooth) becoming more tuberculate around vent; venter and dorsal surface of thighs smooth; anal opening unmodified; forearm lacking tubercles; outer palmar tubercle round, slightly raised, larger than, or equal to, oval inner palmar tubercle; subarticular tubercles round, distinctly raised, simple; fingers lacking webbing and lateral fringes; width of digital pad of third finger one-fourth diameter of tympanum; first finger longer than second; third finger of males not swollen.

Ratio of shank to snout-vent length 0.378–0.548 (mean 0.500); inner tarsal fold short, oblique, present on distal half of tarsus, thickened and curving abruptly near end of fold; inner metatarsal tubercle ovoid; outer metatarsal tubercle conical, subequal in size to inner metatarsal tubercle; supernumerary tubercles absent; subarticular tubercles simple, round; digital pads slightly expanded, larger than those of fingers; webbing between toes vestigial; lateral fringes extending to bases of discs along both margins of all toes; webbing and lateral fringes indistinct or absent in juveniles.

Coloration: In preservative, dorsal ground color of adults pale yellow-gray to gray-black with irregular black blotches in two parallel rows along back from shoulder to vent, barely visible in darker specimens; canthal stripe black, narrowing or terminating near tip of snout; labial stripe indistinct, formed by enamel white flecks; lips with or without patches of gray; dorsolateral stripe narrow anteriorly, broad posteriorly, yellow to gray-white, extending from upper eyelid to groin, continuous with pale stripe of same color along anterior surface of thigh; dorsolateral stripe bordered above and below by dark gray to black reticulations, most extensive below; upper arm with or without gray to black stippling or mottling dorsally; longitudinal black stripe along anterior margin of proximal one-third of arm; forearm colorless or dark gray, mottled or not; thighs, shank, tarsus, and foot marked dorsally by irregular transverse black bars, with yellow to creamy interspaces; venter creamy to yellow, with or without white on black marbling extending medially across chest; yellow patch on chin and in groin in some specimens.

In preservative, juveniles having a more pustular dorsum, with dark gray to black ground color; dorsolateral stripe faint; venter lacking marbling; transverse bars on legs more distinct with creamy-white interspaces; forearm, and tail-stub when present, faintly barred.

In life dorsal ground color of adults pale olive to reddish brown with brown to black flecks; few specimens have reddish-brown spots dorsally; dorsolateral stripes pale cream to creamy yellow, bordered by greenish brown to dark brown; limbs dull gray-green with black spots or bands; groin and light areas on hind limbs yellow to brown; venter pale yellow-green with white spots, or solid white, with or without pale gray mottling; lips bronze; iris coppery bronze with black reticulations.

The above description is based on specimens from Loja. Those specimens from 9 km E of Loja were similarly colored, except that they had a distinct black area above the dorsolateral stripe, and the throat was dull yellow.

Tadpoles: (Figs. 3 and 4). Description based on a series of tadpoles from developmental stages 31 to 41 (free-swimming). Developmental stages for embryos and tadpoles are based on the system proposed by Gosner (1960).

Body depressed, flattened ventrally for half body length; dorsal contour

FIG. 3. Lateral view of free-swimming tadpole of *Colostethus elachyhistus* (one of series KU 121377), × 7.2.

sloping gradually posterior to eyes, curving abruptly anterior to eyes to tip of snout; snout rounded to subovoid in dorsal view; body abruptly expanded laterally just anterior to eyes; body widest at midpoint; eyes distinct, moderately separated medially, directed dorsolaterally; nostrils slightly closer to eyes than to tip of snout; spiracle sinistral, slightly below midline at about midlength of body; anal tube distinct, median to slightly dextral; caudal musculature gradually tapering in width and depth from body, extending nearly to tip of narrowly rounded tail; dorsal fin tapering from point just posterior to tail insertion to deepest point at about midpoint of tail; dorsal fin extending onto body; ventral fin narrower than dorsal fin.

Mouth small, anteroventral, bordered anterolaterally and posteriorly by two rows of papillae on fleshy lips; tooth rows 2/3, equal in length; second upper and first lower rows divided medially, second upper tooth row separated medially by beak; beak rough, edges serrated.

In preservative: black above, dark gray to black below, becoming pale gray anterior to eyes; papillae and lips unpigmented; caudal musculature creamy white with black reticulations concentrated into small blotches anteriorly on dorsal half of tail; dorsal fin with fine reticulations of black pigment; ventral fin colorless, except for a few black flecks on distal fourth.

Etymology: From the Greek *elachys*, meaning little, and *histos*, meaning web, referring to the rudimentary webbing on the feet.

Natural history: The specimens from the vicinity of Loja were collected by day in or around small pools of water. Males were heard calling by night and day. No amplexing adults were found. A single male was found guarding a clutch of 19 eggs beneath a rock 9 km E of Loja. The embryos were in developmental stages 19 and 20; the yolk sac was visible and the head and tail were well developed.

Comparisons: The presence of basal webbing between the toes readily distinguishes *Colostethus elachyhistus* from those species which lack webbing (*anthonyi, bromelicola, infraguttatus, intermedius, kingsburyi, marchesianus, nubicola, olfersioides, pratti, ranoides, riocosangae, talamancae, taeniatus, tricolor*, and *vertebralis*) and from those species which have the toes more than one-third webbed (*bocagei, chocoensis, collaris, dunni, fuliginosus, granuliventris, palmatus, riveroi*, and *vergeli*).

Those species having the toes webbed basally are distinguished from

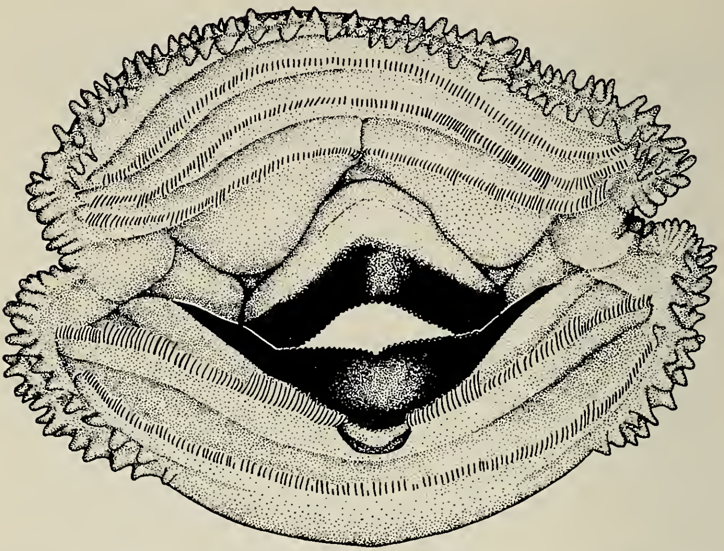


FIG. 4. Mouth parts of *C. elachyhistus* tadpole (one of series KU 121377), × 26.

elachyhistus as follows: *Colostethus capixaba* and *carioca* from Brasil differ from *elachyhistus* on the basis of their small size (14 to 18 mm snout length) and webbing is present only between the third and fourth toes. The Brasilian *C. alagoanus* is much smaller (15 mm snout-vent length) than *elachyhistus* and has webbing only between the outer four toes. *Colostethus trinitatus* and *alboguttatus* differ from *elachyhistus* in having the first finger shorter than the second, an indistinct tympanum, and differences in the dorsal color pattern. Both *C. inguinalis* and *trilineatus* differ from *elachyhistus* by having concealed tympani. Furthermore *inguinalis* is larger (greater than 30 mm snout-vent length), whereas *trilineatus* is smaller (15 to 20 mm snout-vent length). *Colostethus festae* lacks a tarsal fold, and the skin on the dorsum of the head and body is coarsely granular; *C. neblina* possesses three plantar tubercles, the skin of the dorsum is roughly granular and that surrounding the vent and of the dorsal surface of the thighs is tuberculate. Although *C. brunneus* has vestigial webbing on the toes, it has a concealed tympanum, and lacks lateral fringes on the toes; the first and second fingers are subequal in length.

Barbour and Noble (1920) reported over 1000 specimens of *C. infraguttatus* from northern Peru and one locality in the lowlands of Ecuador. These localities are in two distinct physiographic provinces (relatively dry upper Río Marañón drainage, Peru; wet Pacific lowlands, Ecuador).

The specimen from the wet Pacific lowlands (MCZ 3214, Río Chanchan, Chimborazo Province, Ecuador) is indistinguishable from *C. ingraguttatus.* This specimen is referred to *infraguttatus* because of the unique ventral color pattern consisting of distinct round white spots on a light brown ground color, and the distinctly expanded discs on the toes. This identification is supported by data taken on the types of *infraguttatus* by William E. Duellman.

The majority of the specimens reported by Barbour and Noble were from localities at 500 to 800 m elevation in the relatively dry upper Río Marañón drainage. I have examined specimens from each of the localities reported by Barbour and Noble (total 30 specimens) and found that none of these is the same as *infraguttatus.* The poor condition of the Barbour and Noble specimens that I have examined precludes specific identification; however, as a group, they can be distinguished from *elachyhistus* on the basis of the unbarred legs, the narrower and frequently discontinuous dorsolateral stripe, the greatly expanded discs on the fingers, and the broadly blunt snout when viewed in dorsal profile.

Distribution: Colostethus elachyhistus has a known distribution along the western fringe of the Andes at elevations from 1500 to 2660 m, from 4 degrees S to 5 degrees 30′ S latitude. Specimens examined: ECUADOR: *Loja*: KU 120515 (holotype), KU 121516–540 (paratopotypes), KU 121379 (20 juveniles), KU 121373–376 (adherent tadpoles), KU 121377–378 (free-swimming tadpoles); 9 km E Loja, KU 120541, 121380 (eggs); 3 km SW Malacatos, MCZ 56256–257; 10 km N Celica, MCZ 56259, 56265.

Colostethus anthracinus new species

(Figs. 1b, 5, and 6)

Holotype: KU 120639, from Páramo de Raranga, 12 km S Cutchil, Morona-Santiago Province, Ecuador, 3400 m, collected 18 June 1968 by John D. Lynch.

Paratypes: KU 120640–658, collected with the holotype.

Diagnosis: (1) Small *Colostethus*, 17.2 to 19.9 (mean 18.3) mm snout-vent length; (2) sexual dimorphism exhibited in ventral coloration of males; (3) skin granular anterodorsally, pustular to areolate in area around vent and on dorsal surfaces of thights; (4) tympanum indistinct, completely covered in some males; (5) supratympanic fold well developed; (6) first finger longer than second; (7) discs of fingers not expanded; (8) third finger of males not swollen; (9) digital glands distinct, with enamel white pigmentation; (10) tarsal fold sigmoid, not associated with inner metatarsal tubercle; (11) webbing and lateral fringes of toes absent; (12) discs of toes not expanded; (13) dorsolateral stripe yellow to gray, narrow, most conspicuous in females; (14) dorsal ground color pale gray to dark brownish black; (15) venter yellow to creamy white in females, dark gray to solid black with yellow groin in males; (16) limbs colored like dorsum, with or without dark bars restricted to thighs.

Description and variation: (Figs. 1b, 5a, 5b, and 6). Head wider than long, same width as body; ratio of head width to snout-vent length 0.335–0.403 (mean 0.368); snout rounded, blunt, slightly projecting in lateral profile; canthus rostralis obtusely angular, slightly constricted; loreal region slightly concave; nostrils lateral, much closer to tip of snout than to eye; diameter of eye much greater than distance from eye to nostril; tympanum indistinct, one-half to fully covered by heavy supratympanic fold; tongue round to oval, entire behind, posterior one-half to three-fourths free; choanae small, not visible when viewed from directly below; males with a single, median, subgular vocal sac; vocal slits short, oblique, near base of tongue.

Skin of dorsum finely granular anteriorly; dorsal ridges of folds absent; skin surrounding vent and on dorsal surfaces of thighs coarsely granular; venter smooth; anal opening unmodified; forearm lacking tubercles; two palmar tubercles; outer tubercle rounded to subtriangular; inner tubercle oval, equal in size to outer tubercle; subarticular tubercles round, simple, larger proximally; first finger longer than second; third finger of males not swollen.

Ratio of shank to snout-vent length 0.430–0.488 (mean 0.459); inner tarsal fold short, sigmoid, not associated with inner metatarsal tubercle; inner and outer metatarsal tubercles oval, slightly elevated, equal in size; supernumerary tubercles absent; subarticular tubercles simple, round; toes lacking webbing and lateral fringes; toe discs slightly expanded or not.

Coloration: In preservative, males from Morona-Santiago Province solid dark gray to black dorsally; indistinct black vertebral stripe visible in paler specimens; dorsal coloration of single male from Loja Province pale gray with large black spots at level of scapula; black lateral stripe in this specimen extending from groin to level of arm, being separated from black flanks by a narrow, dorsolateral creamy white stripe extending anteriorly from groin.

Females from both localities paler dorsally; dorsal ground color dark brown with black vertebral stripes (Morona-Santiago Province) or gray with dorsal black blotches (Loja Province); distinct dorsolateral stripe of light yellow present on all females; black canthal stripe, extending around snout, present in all females and single male from Loja Province; upper lip and labial area yellow with enamel white spots in all females and some males from Morona-Santiago Province; remaining males having black lips; upper surfaces of limbs dark gray to black in all males from both localities; females with yellow-gray to black forearms (Morona-Santiago Province) or pale gray with darker transverse bars along dorsal thighs and shanks (Loja Province); anterior surface of arms yellow in some females.

Ventral coloration sexually dimorphic, irrespective of locality; females having yellow-white venter, with gray wash on ventral surfaces of limbs; males having varying degrees of uniform black pigmentation on chin, throat, and chest as isolated spots (lighter specimens), or extending over entire venter, excluding groin and proximal portion of ventral thighs

Fig. 5. Diagrammatic ventral views of *Colostethus anthracinus* showing extremes in ventral coloration in males.

(darker specimens); ventral parts of hands, feet, arms, and distal portion of legs black in all males examined; palmar and plantar tubercles unpigmented.

In life, dorsum deep chocolate brown (Morona-Santiago Province), yellow brown (females from Loja Province), or bronze brown (males from Loja Province) with varying amounts of flecking or spotting; dorsolateral stripe creamy bronze, posterior half of stripe bordered dorsally by black in all specimens from Morona-Santiago Province and females from Loja Province; males from Loja Province with reddish bronze labial stripe; flanks of all specimens blue-gray to black with blue or green flecking; venter of males from both localities black, with orange on ventral surface of thighs and in groin; venter of females yellow to orange; axillae of both males and females orange; thighs variably black to brown with black flecking; iris reddish bronze.

Etymology: From the Latin *anthracinus* meaning "coal-black," in reference to the ventral coloration in the males.

Natural history: The type locality, at an elevation of 3400 m, is in páramo; the vegetation consists of short grasses and cushion plants. All specimens in the KU collections were collected from beneath stones along rivulets by day, during cold, rainy conditions with 100 percent cloud cover. A second locality, 500 m lower in elevation, is subpáramo with vegetation consisting of small bushes and grasses. Specimens were found under rocks adjacent to a small, water-filled ditch. There was no sign of breeding activity.

Distribution: Colostethus anthracinus has an Andean distribution in southern Ecuador at elevations between 2500 and 3500 m, and 3 degrees S and 4 degrees S latitude. Specimens examined: ECUADOR: *Morona-Santiago*: Páramo de Raranga, 12 km S Cutchil, KU 120639 (holotype), KU 120640–658 (paratopotypes); *Loja*: 13 to 14 km E Loja (by road), KU 120635–638; *Azuay*: vicinity of Gualaceo, CAS 94772.

Comparisons: Colostethus anthracinus can be distinguished from all previously described species in the genus except *C. talamancae*, *nubicola*, and *pratti* (all of Central America) on the basis of the black ventral coloration in the males. *Colostethus nubicola* can be distinguished on the basis of the reduced ventral coloration, and inconsistency in the color dimorphism; Savage (1968) described the venter of males as being immaculate in some specimens. *Colostethus pratti* differs in having the third finger of the males swollen, and a mottling on the throat. *Colostethus talamancae* is larger (males to 22 mm and females to 24 mm snout-vent length) and lacks a tarsal fold; furthermore, the nostril lies one-half the distance between the eye and the tip of the snout, and the dorsum is smooth.

Colostethus vertebralis (Boulenger)

1899 *Phyllodromus vertebralis* Boulenger, Ann. Mag. Nat. Hist., London (7)4: 456—Cañar (8400 ft), Ecuador.

1904 *Prostherapis vertebralis*—Peracca, Bol. Mus. Zool. Anat. Comp. Torino (456)19: 17.

1920 *Phyllobates vertebralis*—Barbour and Noble, Bull. Mus. Comp. Zool., Cambridge 63: 401.

(Figs. 1c and 6)

Diagnosis: (1) Small to medium *Colostethus* 14.6 to 19.7 (mean 17.1) mm; (2) sexual dimorphism in size, males being smaller than females; (3) skin smooth dorsally, becoming areolate around vent in some specimens; (4) tympanum indistinct; (5) supratympanic fold heavy, covering dorsal half of tympanum; (6) first finger equal to, or slightly longer than second; (7) discs of fingers slightly expanded; (8) third finger of males not swollen; (9) digital glands distinct; (10) inner tarsal fold indistinct, present on distal half of tarsus, extending from inner metatarsal tubercle bending abruptly at midpoint; (11) webbing and lateral fringes absent from toes; (12) discs of toes expanded, greater than discs of fingers; (13) dorsolateral stripe broad, greenish yellow, extending from posterior margin of eye to groin, passing over upper eyelid to tip of snout or not; (14) dorsal ground color lemon yellow to yellow-gray, with or without pale cream vertebral stripe; (15) venter greenish yellow with gray or black specks of varying densities extending from flanks to throat and chest; (16) thighs and shanks colored as dorsum with black spots or flecks, tarsi and feet with indistinct dark gray bars.

Description and variation: (Figs. 1c, 6; Table 1). Males smaller than females; head width equal to or narrower than body width; ratio of head

Table 1. Intraspecific morphometric variation in *Colostethus vertebralis* from different localities, illustrating sexual dimorphism with respect to size (means in parentheses).

Locality	Sex	N	Elev. (m)	Snout-vent length (mm)	Shank
					Snout-vent length
Cuenca, Azuay Province	♂♂	6	2540	15.6–17.6 (16.7)	0.436–0.493 (0.473)
	♀♀	3		18.1–19.7 (18.8)	0.441–0.456 (0.448)
8 km S Cutchil, Morona-Santiago Province	♂♂	8	3040	14.6–17.2 (15.9)	0.430–0.493 (0.456)
	♀♀	7		15.8–18.5 (17.5)	0.403–0.453 (0.429)
8–9 km N San Lucas, Loja Province	♂♂	10	3100	14.4–17.0 (15.7)	0.430–0.490 (0.460)
	♀♀	16		17.0–19.7 (17.7)	0.410–0.477 (0.437)
Laguna de Zurucuchu, Azuay Province	♂♂	4	3200	15.1–17.6 (16.3)	0.430–0.481 (0.451)
	♀♀	6		16.9–19.6 (18.3)	0.413–0.443 (0.430)

width to snout-vent length 0.30–0.40 (mean 0.348); snout rounded in dorsal view, blunt in lateral profile; canthus rostralis moderately well defined, concave; loreal region concave; nostrils lateral, much closer to tip of snout than to eye; distance from eye to nostril about three-fourths diameter of eye; tympanum indistinct, evidenced by a slight depression; ratio of tympanum width to eye diameter 0.388–0.823 (mean 0.556); supratympanic fold broad, indistinct; tongue large, ovoid, generally not blotched behind, posterior three-fourths free; choanae small, wholly or partially hidden by maxillae when viewed from directly below; males having conspicuous vocal slits and median, subgular vocal sac.

Skin of dorsum smooth to finely granular becoming areolate around vent; venter finely granular laterally and in area of groin, smooth medially; weak middorsal fold present in some specimens; anal opening unmodified; forearm of a few specimens from 8–9 km N San Lucas bearing one or two poorly defined tubercles, absent in all other specimens; outer palmar tubercle ovoid, equal to or slightly larger than inner palmar tubercle; two or three supernumerary tubercles infrequently present; subarticular tubercles round, distinct, larger proximally; fingers lacking webbing or lateral fringes; digital pads slightly expanded; dorsal digital glands distinct; digital pad of third finger about half diameter of tympanum; first finger equal to or slightly longer than second.

Ratio of shank to snout-vent length 0.403–0.493 (mean 0.448); tarsal fold indistinct, extending from inner metatarsal tubercle, bending abruptly at midpoint; outer metatarsal tubercle conical, equal to inner metatarsal tubercle; subarticular tubercles of toes simple, round, larger proximally; toe pads slightly expanded, more so than pads of fingers; toes lacking webbing or lateral fringes.

Coloration: In preservative, dorsal ground color of adults yellow-gray to brownish black; lighter brown color occurs in specimens from Laguna de Zurucuchu and Cuenca; specimens from 8–9 km N San Lucas darker; specimens from 8 km S Cutchil exhibit both extremes in coloration; middorsal thin creamy white stripe present in darker specimens; canthal stripe solid black; lips colorless; gold stripe extending below eye in all specimens; flanks flecked with light to dark gray.

Dorsolateral stripe distinct, broad, greenish yellow, extending from posterior margin of eye to groin where it expands slightly; dorsolateral strips extending across upper eyelid to tip of snout or not, forming a dorsal border to black canthal stripe; forearm colorless in lighter specimens and speckled with dark gray in darker specimens; upper arm colored as forearm, with or without black longitudinal stripe at elbow; thighs and shanks pale yellow to dark brown, with varying amounts of dark flecking; tarsi and feet indistinctly barred in lighter specimens; venter greenish yellow with gray to black flecking extending medially across throat and chest from flanks; two distinct black spots on chest at level of pectoral girdle in most specimens from Laguna de Zurucuchu; chest spots absent in all other specimens.

In life, dorsum pale rose to light brown; specimens from 8–9 km N San Lucas with black vertebral and paravertebral stripes, with or without a creamy white middorsal stripe; specimens from 8 km S Cutchil have black, irregular spots on dorsum; dorsolateral stripe broad, creamy white, expanding in groin as bright lemon yellow flash color in all specimens; flanks pale blue-gray to blue-green; sides of head chocolate brown, labial stripe white to bronze; specimens from 8 km S Cutchil have yellow throat and pale green-yellow venter; specimens from 8–9 km N San Lucas have off-white throat and venter, with pale gray wash; posterior surface of thighs pale green to creamy yellow with brownish-gray reticulations; iris bronze, lacking reticulation.

Natural history: Specimens of *Colostethus vertebralis* were found under rocks or in open areas, usually near small streams, and at high altitudes. Actively calling males were observed only at 8–9 km N San Lucas, Loja Province, by day.

Distribution: Colostethus vertebralis has an inter-Andean distribution from 2 degrees 30′ S to 40 degrees S latitude at elevations between 2500 m and 3200 m. Specimens examined: ECUADOR: *Loja*: 8–9 km N San

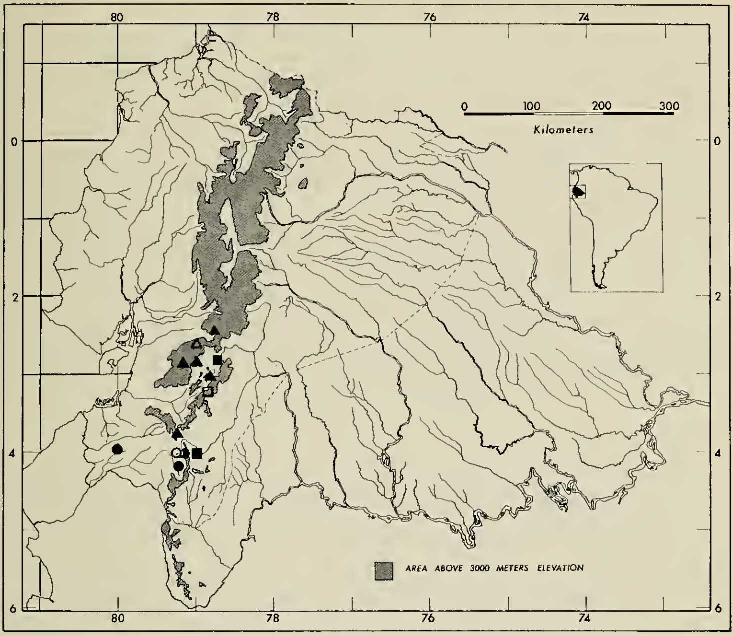


FIG. 6. Locality records for *C. elachyhistus* (circles), *C. anthracinus* (squares), and *C. vertebralis* (triangles)—open symbols denote type localities.

Lucas, KU 120545–569. *Azuay*: Cuenca, KU 120603–611; Laguna de Zurucuchu, KU 120612–631. *Morona-Santiago*: 8 km S Cutchil, KU 120570–602. *Chimborazo*: 30 miles S (by road) Alausi, CAS 85179.

Comparisons: Absence of toe webbing distinguishes *C. vertebralis* from those species which possess webbing (for species involved see "Comparisons" under *C. elachyhistus*). Of those species which lack toe webbing, all but four can be distinguished from *vertebralis* on the bases of their larger size (greater than 20.0 mm snout-vent length) and/or the distinct difference in lengths of the first and second fingers. These species are: *anthonyi, bromelicola, infraguttatus, intermedius, kingsburyi, marchesianus, nubicola, olfersioides, ranoides, talamancae,* and *tricolor.*

The remaining four species can be separated from *Colostethus vertebralis* as follows: 1) *Colostethus riocosangae* and *taeniatus,* from the Amazonian slopes of the Andes, are slightly larger. The legs are distinctly barred, and the dorsal color pattern consists of a series of blotches or elongate spots. The skin of the dorsum is smooth. 2) *Colostethus pratti,* from Panamá and Colombian Choco, has a swollen third finger and a gray wash on the throat in males. 3) *Colostethus brunneus,* from the

Amazon Basin, is slightly smaller, lacks a distinct dorsolateral stripe in most specimens (if present, it does not pass obliquely from the eye to the groin as it does in *vertebralis*. The legs are distinctly barred. The black canthal stripe is continuous posterior to the eye along the flanks to the groin.

Acknowledgments: I am indebted to Ernest E. Williams of the Museum of Comparative Zoology, Harvard University (MCZ) and Alan E. Leviton of the California Academy of Sciences (CAS) for the loan of specimens, and to William E. Duellman who furnished notes on type specimens in the British Museum (Natural History). Specimens in the collection of the University of Kansas, Museum of Natural History are identified as KU. I am also grateful to John D. Lynch and William E. Duellman who critically reviewed the manuscript and presented numerous valuable suggestions, and to Linda Trueb who supplied much of her time in helping me prepare the figures.

LITERATURE CITED

BARBOUR, T., AND G. K. NOBLE. 1920. Some amphibians from northwestern Peru, with a revision of the genera *Phyllobates* and *Telmatobius*. Bull. Mus. Comp. Zool. 63(8): 396–427 + 2 plates.

BOULENGER, G. 1899. Descriptions of new reptiles and batrachians collected by Mr. P. O. Simons in the Andes of Ecuador. Ann. Mag. Nat. Hist., London (7)9: 454–457.

GOSNER, K. L. 1960. A simplified table for staging anuran embryos and larvae with notes on identification. Herpetologica 16: 183–190.

SAVAGE, J. M. 1968. The dendrobatid frogs of Central America. Copeia 1968(4): 745–776.

Vol. 84, No. 19, pp. 163–170 30 June 1971

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

THE FROG GENUS *LEPTODACTYLUS* IN ECUADOR

By W. Ronald Heyer and James A. Peters
*Department of Biology, Pacific Lutheran University,
Tacoma, Washington 98447*

*Division of Reptiles and Amphibians, Smithsonian Institution,
Washington, D. C. 20560*

Identification of the frogs of the diverse Ecuadorian fauna has always been complicated by the number of available names. Recent collections from Ecuador and re-examination of type material now allow proper association of names and populations in the genus *Leptodactylus*, in most cases. The purpose of this report is to indicate the present status of names that have been used for members of that genus in Ecuador, and to present information on ecology and distribution collected by one of us (Peters) during field work in Ecuador.

The following curators have provided type material or information concerning types (the abbreviations used for museum names follow in parentheses): James Böhlke, Academy of Natural Sciences, Philadelphia (ANSP); Javier Castroviejo, Instituto "José de Acosta" de Zoologia, Museo Nacional de Ciencias Naturales, Madrid, Spain (MNM); Alice G. C. Grandison, British Museum (Natural History), London (BMNH); and Greta Vestergren, Naturhistoriska Riksmuseet, Sektionen for Vertebratzoologi, Stockholm, Sweden (NRS). The abbreviation used for National Museum of Natural History specimens is USNM; material from the James A. Peters collection, which is deposited in the USNM, is labelled JAP. Field work in Ecuador by Peters was supported by the National Science Foundation, Grant No. G-21010. The work by Heyer was done while he was a National Science Foundation Graduate Trainee at the University of Southern California.

CURRENTLY RECOGNIZED ECUADORIAN SPECIES

Leptodactylus discodactylus Boulenger

This species, described by Boulenger (1883: 637) from Yurimaguas, Huallaga River, Peru, has been reported from Ecuador by Peracca (1904: 34). Peracca mentioned 2 localities, Papallacta and the valley of the Río Santiago. The first is almost certainly either an erroneous locality or an erroneous identification, since Papallacta lies at an altitude of about 3000 meters, on the upper edge of the cloud forest, and shares no reptile or amphibian species with the tropical rain forest. Peracca's second locality is probably valid. Heyer (1970: 7) has recently redescribed this species and discussed it in detail.

This species lives in open wet areas, such as swampy meadows, where it occurs sympatrically with *L. wagneri.* The latter is usually the more abundant species.

Leptodactylus hylaedactylus (Cope)

The *Marmoratus* species group is composed of at least 2 species (Heyer and Silverstone, 1969: 142). Only 1 species of the group is represented in recent Ecuadorian collections, and the name *hylaedactylus* is appropriate for this population.

This species, although geographically sympatric with both *L. discodactylus* and *L. wagneri,* is not ecologically sympatric with them. It is usually found in fairly heavy rain forest, often hiding in the litter of the forest floor or beneath rocks and logs, but it can also be found actively moving about on the forest floor during daylight hours. It is sometimes found under and among rocks along larger streams. It seems to be more active during rain storms.

Leptodactylus labrosus Espada

Leptodactylus labrosus was described by Espada (1875: 36) on the basis of 2 females from Pimocha, on the Río Daule, in Guayas Province, Ecuador. Only 1 specimen is still extant at the National Museum of Madrid, although their records indicate that at one time they had both specimens. The extant specimen of *L. labrosus* is not the specimen described in detail by Espada. The surviving syntype of *L. labrosus* agrees completely in taxonomic details with recent specimens from the vicinity of Guayaquil, Ecuador. It is a member of the *Fuscus* species group, which shows the following characters: 1) without a light longitudinal stripe on the posterior thigh, 2) with a smooth tarsus and sole of the foot, 3) with 2 dark outlined dorsolateral folds, and 4) usually with an inguinal gland. *Leptodactylus curtus* Barbour and Noble (1920: 405) from northwestern Peru shares these same characters. Comparison of USNM 75990, a paratype of *L. curtus*, with the recent series of *L. labrosus* indicates that they are synonymous. In order to fix the name taxonomically, we hereby designate the extant MNM syntype (no specimen or jar number), an adult female, body length 50.5 mm, as the lectotype of *Leptodactylus labrosus.*

L. labrosus inhabits the xeric parts of southwestern Ecuador and northwestern Peru, and is the only species of *Leptodactylus* known from this arid habitat. In this area, however, it is completely restricted to wet areas. A specimen from Cuatro Hermanitos, 4 km WNW of Guayaquil, in Guayas Province (JAP 1743), was collected on an experimental farm, which had been irrigated to learn what exotic plants could be grown in the xeric area. It was taken in the same barrel as the holotype of *Ceratophrys stolzmanni scaphiopeza* Peters (1967: 105) and a specimen of *Rana palmipes.* The area around Machala, El Oro Province, although showing a low rainfall record, nevertheless is moist enough to support banana plantations and a scrub forest. The source of the moisture is the *Garua,* a wet wind blowing in from the Pacific, which keeps the coastal area foggy and moist, even though it does not deposit enough of its moisture to register much on the rain gauges. Specimens of this species were taken on the floor of scrub forest as well as in and about drainage ditches and bushes at the Standard Fruit hacienda in Machala.

Leptodactylus melanonotus (Hallowell)

This species has been thoroughly reviewed by Heyer (1970: 9). This species is widespread in Central America. It occurs only in the rain forest of the northwestern corner of Ecuador. The reptile and amphibian fauna of this area is strongly Central American in its relationships.

In the list of specimens examined, Heyer (1970: 41) misspelled Cachabé (also spelled in the literature as Cachaví or Cachabí), the locality for JAP 2888–89.

Leptodactylus mystaceus Spix

This species has not been recorded previously in Ecuador, although its known distribution in the Amazonian Basin made its occurrence there likely. We add it to the fauna on the basis of specimens in the collection of the Museum of Natural History, University of Kansas.

Leptodactylus pentadactylus Laurenti

This wide-spread, easily recognized frog is the only species in the genus to occur on both sides of the Andes in Ecuador. It is ubiquitous in the rain forests. There is a marked ability for metachrosis in the adults. The juveniles are quite differently patterned than the adults, regardless of the color change sequence in the latter. The frog has a disconcerting ability to scream with the mouth wide open, producing a noise very reminiscent of the raucous "caw, caw" of a young crow.

Leptodactylus rhodomystax Boulenger

This species in Ecuador is apparently confined to altitudes below 350 to 400 meters on the Amazonian slopes. We have not had personal field experience with it.

Leptodactylus ventrimaculatus Boulenger

Leptodactylus ventrimaculatus was described by Boulenger (1902: 53) on the basis of 3 specimens from Bulun, Ecuador. We have examined all 3 type specimens (BMHN 1947.2.17.78–80), which are in good condition. The species belongs to the *Fuscus* group. Our fresh material from northwestern Ecuador agrees with the types in having: 1) a pair of dorsolateral folds, 2) the posterior surface of the thigh dark with scattered light round or elongate spots, and 3) very prominent white tubercles profused over the tarsus and the sole of the foot. Citations concerning *L. ventrimaculatus* in the literature since the type description do not appear to have been based on additional specimens. The species has been confused with *L. rhodonotus* in at least 1 collection, which may account for Ecuadorian records of that species. We have not seen *rhodonotus* from Ecuador, although the species is to be expected there. Boulenger's original description of *L. ventrimaculatus* was based on BMNH 1947.2.17.78, so we hereby designate this specimen, a female, 57 mm. body length, as the lectotype of the species. The type locality is almost certainly the town called Pulún, in Esmeraldas Province. It is located at 1°05′N, 78°40′W. The name has been variously given in the literature as Bulun, Bulú, Bulúm, Pulú and Pulún.

Leptodactylus wagneri (Peters)

This species, originally described as *Plectromantis wagneri* by Peters (1862: 232), from the "Westseite der Anden in Ecuador," is found in Ecuador only on the eastern slopes of the Andes in the Amazonian basin. It is widespread in South America east of the Andes (Heyer, 1970: 20). The holotype is lost, and Heyer (1970: 21) designated the holotype of *Eleutherodactylus leptodactyloides* Andersson as the neotype of *wagneri* Peters.

The following description of the color in life was made by Peters in 1954: Dorsum olive green, with slightly lighter spots, which are almost indistinct. An indistinct triangle between eyes, outlined in black, with a lighter line between eyes anterior to triangle. Irregular black line on dorsolateral area. Very faint reddish cast on lighter green sides. Groin, thighs and lower sides faintly yellowish. Mottling on cream belly is brownish. Light areas on lip are slightly tinged with pink. A reddish-orange streak from corner of mouth and tympanum to shoulder. Scattered black spots on sides. Iris greenish golden, speckled with black.

The species is very abundant in Ecuador, and is easily collected. It lives under rocks and logs along the banks of swiftly flowing streams, and often escapes by diving into the torrent. It is also frequently found in grassy, swampy meadows near streams. There is a not too distinct ecological separation of age groups, with juveniles and young adults on the river banks, and larger, older adults in the meadows, more distant from the streams.

PRESENT ALLOCATION OF TAXA DESCRIBED AS *LEPTODACTYLUS* FROM ECUADOR

Leptodactylus caliginosus Girard

Boulenger (1882: 248) recorded this species from Sarayacu. Parker (1934: 266) listed a specimen from Zamora. Both of these references are to specimens of *L. wagneri* (Peters).

Leptodactylus curtus Barbour and Noble

Parker (1938: 442) recorded frogs from both the Catamayo Valley and the Marañon Valley as belonging to this species. The specimens probably belong to the species *L. labrosus* Espada, at least on the Pacific slope. *L. labrosus* occurs in the dry intermontane valleys of northwest Peru in both Atlantic and Pacific drainages. At the present time we have no evidence that *labrosus* occurs on both slopes in Ecuador, and we have not re-examined Parker's specimens.

Leptodactylus goliath Espada

Boulenger (1882: 240) synonymized this taxon with *Leptodactylus pentadactylus* on the basis of the original description, in which Espada (1875: 57) mentioned 4 specimens from Quijos, Ecuador. We have been able to locate only 1 of these in the National Museum in Madrid. The specimen is in good condition, is probably the individual on which Espada based most of his description, and is unquestionably a *L. pentadactylus*. We hereby designate MNM specimen in jar number 328, an adult female with body length of 156.6 mm, as the lectotype of *Leptodactylus goliath* Espada, thus verifying Boulenger's synonymy, and preventing future use of the name for a different taxon if another syntype were found to belong to a different species.

Leptodactylus hemidactyloides Andersson

Andersson (1945: 53) described this species on the basis of 4 specimens. The specimens are unquestionably members of the very distinctive *Lithodytes lineatus* (Schneider). The largest specimen in the type series in the Naturhistoriska Riksmuseet in Stockholm is hereby designated as the lectotype of Andersson's species. It is a female, 58 mm snout to vent length, from the Río Pastaza, Ecuador.

Eleutherodactylus leptodactyloides Andersson

This taxon, erroneously described as an *Eleutherodactylus* by Andersson (1945: 43), has been shown to be a synonym of *L. wagneri* (Peters) by Heyer (1970: 22), who selected the holotype of Andersson's species as the neotype of *Plectromantis wagneri* Peters (*l.c.*: 21).

Leptodactylus lineatus (Schneider)

This name has been used for frogs from Ecuador by several authors. The species is currently regarded as belonging to the genus *Lithodytes*. It is widespread on the lower Amazonian slopes of Ecuador.

Leptodactylus nigrescens Andersson

This species, described by Andersson (1945: 57) from the Río Napo watershed of Ecuador, has been shown to be a junior synonym of *Leptodactylus discodactylus* Boulenger by Heyer (1970: 8). Andersson based his description on 3 specimens, 2 of which appear to belong to a second genus. Heyer (*l.c.*: 8) has designated the single specimen of *L. discodactylus* as lectotype to prevent future confusion.

Leptodactylus pulcher Boulenger

This taxon, described by Boulenger (1898: 122), has been made the type species of the monotypic genus *Barycholos* Heyer (1969a: 6).

Leptodactylus rubido (Cope)

Boulenger (1882: 243) used this name for specimens from Canelos, Ecuador. Heyer (1969b: 3) demonstrated that this species is a synonym of *L. rhodonotus* Guenther, which has been found only in Peru. We are not certain what species Boulenger had in hand from Canelos.

Leptodactylus pentadactylus rubidoides Andersson

The holotype of this subspecies is unquestionably a specimen of *L. pentadactylus.* The variation throughout the entire range of the species must be studied before certain populations can be defined as taxonomic entities. Since we recognize no subspecies within the species at the present time, *rubidoides* becomes a synonym of *pentadactylus.*

Leptodactylus stenodema Espada

This species was described by Espada (1875: 64) on the basis of 2 specimens, which we have examined. Boulenger (1882: 242) suggested that this might be a synonym of *Leptodactylus pentadactylus*, but indicated with a question mark that he was not certain concerning the action. We find that both syntypes are subadult *L. pentadactylus.* One specimen, MNM jar number 189, has been dissected, and formed the basis for the osteological comparisons published by Espada. The other specimen is in good condition, and was the basis of his description of external morphology. We designate this latter specimen, in MNM jar number 190, measuring 105 mm in body length, as the lectotype of *Leptodactylus stenodema* Espada.

Leptodactylus tuberculosus Andersson

L. tuberculosus Andersson (1945: 59) was based on eight specimens. The dorsum is extremely warty and tuberculate, as indicated by the specific name. The degree of rugosity seen in this series is characteristic of very few species of frogs. The distinctive combination of a warty-tuberculate dorsum, toes without webbing, and the toes not expanded into disks at the tips indicate that this species is a junior synonym of *Eleutherodactylus quixensis* (Espada).

KEY TO THE ADULT *LEPTODACTYLUS* OF ECUADOR

1. Toes with distinct lateral fringes 2

   Toes smooth or with lateral ridges, never with fringes 4

2. Toes without distinct disks; if toe tip swollen, never with longitudinal grooves on upper toe tip surface 3

   Toes with distinct disks, upper disk surface with longitudinal grooves .... *discodactylus*

3. Smaller frogs, males to 33 mm, females to 40 mm; posterior surface of thigh never with light longitudinal stripe; Western Ecuador only .... *melanonotus*

   Larger frogs, males to 61 mm, females to 81 mm; posterior surface of thigh with or without light longitudinal stripe; Eastern Ecuador only .... *wagneri*

4. Ventral aspect of tarsus and sole of foot with conspicuous large white tubercles 5

   Ventral aspect of tarsus and sole of foot smooth or with small black horny tubercles, never with large white tubercles 7

5. Posterior surface of thigh mottled or spotted, never with a distinct light longitudinal line 6

   Posterior surface of thigh with a distinct light longitudinal line .... *mystaceus*

6. Smaller frogs, males to 23 mm, females to 25 mm; vomerine teeth in transverse series .... *hylaedactylus*

   Larger frogs, males to 55 mm, females to 65 mm; vomerine teeth in curved series .... *ventrimaculatus*

7. Groin and posterior surface of thigh not strikingly darker than upper thigh surface, mottled, never with distinct spots 8

   Groin and posterior surface of thigh very dark with distinct light spots .... *rhodomystax*

8. Smaller frogs, males to 58 mm, females to 61 mm; males without a black horny thumb spine .... *labrosus*

   Larger frogs, males to 145 mm, females to 150 mm; males with single black horny spine on each thumb .... *pentadactylus*

LITERATURE CITED

ANDERSSON, L. G. 1945. Batrachians from East Ecuador, collected 1937, 1938 by Wm. Clarke-Macintyre and Rolf Blomberg. Arkiv for Zoologi. 37A (2): 1–88.

BARBOUR, THOMAS AND G. K. NOBLE. 1920. Some amphibians from northwestern Peru, with a revision of the genera *Phyllobates* and *Telmatobius*. Bulletin of the Museum of Comparative Zoology. 63 (8): 395–427.

BOULENGER, G. A. 1882. Catalogue of the Batrachia Salientia s. Ecaudata in the Collection of the British Museum, Second Edition. London, 1882, pp. xvi + 503, 30 pls.

————. 1883. On a collection of frogs from Yurimaguas, Huallaga

River, northern Peru. Proceedings of the Zoological Society of London. 1883: 635–638.

————. 1898. An account of the reptiles and batrachians collected by Mr. W. F. H. Rosenberg in western Ecuador. Proceedings of the Zoological Society of London. 1898: 107–126.

————. 1902. Descriptions of new batrachians and reptiles from northwestern Ecuador. Annals and Magazine of Natural History. (7) 9: 51–57.

DE LA ESPADA, MARCOS JIMENEZ. 1875. Vertebrados del viaje al Pacifico. . . .Batracios. Madrid, 1875, pp. 1–208, 6 pls.

HEYER, W. RONALD. 1969a. Studies on the genus *Leptodactylus* (Amphibia, Leptodactylidae) III. A redefinition of the genus *Leptodactylus* and a description of a new genus of Leptodactylid frogs. Los Angeles County Museum Contributions in Science. 155: 1–14.

————. 1969b. Studies on frogs of the genus *Leptodactylus* (Amphibia, Leptodactylidae). V. Taxonomic notes on *L. latinasus*, *rhodonotus*, *romani*, and *wuchereri*. Herpetologica. 25: 1–8.

————. 1970. Studies on the frogs of the genus *Leptodactylus* (Amphibia: Leptodactylidae). VI. Biosystematics of the *melanonotus* group. Los Angeles County Museum Contributions in Science. 191: 1–48.

HEYER, W. R. AND PHILIP A. SILVERSTONE. 1969. The larvae of the frog *Leptodactylus hylaedactylus* (Leptodactylidae). Fieldiana-Zoology. 51: 141–145.

PARKER, H. W. 1934. Reptiles and amphibians from southern Ecuador. Annals and Magazine of Natural History. (10) 14: 264–273.

————. 1938. The vertical distribution of some reptiles and amphibians in southern Ecuador. Annals and Magazine of Natural History. (11) 2: 438–450.

PERACCA, M. G. 1904. Viaggio del Dr. Enrico Festa nell'Ecuador e regioni vicine. Rettili ed amfibii. Bollettino dei Musei di Zoologia ed Anatomia comparata della R. Universita di Torino. 465: 1–41.

PETERS, JAMES A. 1967. The generic allocation of the frog *Ceratophrys stolzmanni* Steindachner, with the description of a new subspecies from Ecuador. Proceedings of the Biological Society of Washington. 80: 105–112.

PETERS, WILHELM C. H. 1862. Eine neue Gattung von Laubfroeschen, *Plectromantis*, aus Ecuador. Monatsberichte der Koeniglich-Preussischen Akademie der Wissenschaften zu Berlin. 1862: 232–233.

Vol. 84, No. 20, pp. 171–174 30 June 1971

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

RATTUS TURKESTANICUS (SATUNIN, 1903), THE VALID NAME FOR *RATTUS RATTOIDES* HODGSON, 1845 (MAMMALIA: RODENTIA)

By Duane A. Schlitter and Kitti Thonglongya[1]
African Mammal Project, Division of Mammals,
Smithsonian Institution, Washington, D.C. 20560

Hodgson (1845: 267) described *Mus rattoides* in a report on some rodents and shrews from central Nepal. However, Sherborn (1930: 5437) listed *Mus rattoides* Pictet and Pictet, 1844, immediately above *Mus rattoides* Hodgson, 1845. To our knowledge the status of the Pictet and Pictet name has never been clarified.

Pictet and Pictet (1844) named and described three new rodents in a report on a collection of rodents from Bahia, Brazil. Two of these, *Mus cinnamomeus* (*loc. cit.*: 64) and *Mus maculipes* (*loc. cit.*: 67), were named in a section concerning rodents native to the Americas. For the status of these names see Hershkovitz (1960).

In a section dealing with rodents introduced into Brazil from the Old World, Pictet and Pictet (1844) reported the presence of two species: *Mus decumanus* Pallas [= *Rattus norvegicus* (Berkenhout)] and *Mus musculus* Linnaeus; and described a new species, *Mus rattoides* (*loc. cit.*: 45). This new species was supposedly closely allied to and scarcely distinct from *Mus rattus* Linnaeus, *Mus tectorum* Savi [= *Rattus rattus*] and *Mus leucogaster* Pictet [= *Rattus rattus*]. From the description, measurements, and plates of two specimens in a life-like pose plus lower cheek teeth given by Pictet and

---

[1] Visiting Research Associate, Division of Mammals, Smithsonian Institution. Present address: Curator of Terrestrial Vertebrate Zoology, Centre for Thai National Reference Collection, Applied Scientific Research Corporation of Thailand, Bangkhen, Bangkok—9: Thailand.

Pictet (1844), we believe that the name *Mus rattoides* Pictet and Pictet is a junior synonym of *Rattus rattus* (Linnaeus). In any event, the characters given by Pictet and Pictet (1844) in their description of this new species, especially the presence of a long and unicolored tail, preclude *Mus rattoides* Pictet and Pictet from being a senior synonym of *Mus rattoides* Hodgson. In addition, to our knowledge, *Mus rattoides* Hodgson, 1845, has been reported only from a relatively restricted area of southcentral Asia and never as an exotic or commensal species from anywhere else in the world.

Since the name *Mus rattoides* Hodgson (1845) is preoccupied by and consequently a homonym of *Mus rattoides* Pictet and Pictet (1844), the next available name for this species is *Rattus turkestanicus* (Satunin, 1903). A brief synonymy for the species as we recognize it follows:

Rattus turkestanicus (Satunin, 1903)

1845. *Mus rattoides* Hodgson, Ann. Nat. Hist., 15: 267, April (type locality: Nepal).

1903. *Mus turkestanicus* Satunin, Ann. Mag. St. Petersburg, 7: 588, April (type locality: Assam-bob, Fergana, Uzbekistan S.S.R.).

1903. *Mus vicerex* Bonhote, Ann. Nat. Hist., 11: 473, May (type locality: Simla, Himachal Pradesh, India) [recognized as a valid subspecies].

1913. *Epimys rattus shigarus* Miller, Proc. Biol. Soc. Washington, 26: 198, 13 October (type locality: Shigar, Baltistan, Kashmir) [recognized as a valid subspecies.]

Until a taxonomic review is made of *R. turkestanicus*, we prefer to recognize only three subspecies formerly assigned to *R. rattoides*. Of the holotypes of these three taxa we have examined only that of *R. t. shigarus* (Miller, 1913).

The nominate subspecies occurs in the U.S.S.R. in Tadzhikistan, Uzbekistan, southern and western Khirgiz and in southern Khazakhstan (Bobrinskii, *et al.*, 1965: 299); in northern and eastern Afghanistan (Hassinger, 1968: 74); and in extreme eastern Iran (Etemad, 1964: 652). *Rattus turkestani-*

cus turkestanicus is characterized by stiff, brownish dorsal and whitish ventral fur.

Rattus turkestanicus shigarus (Miller, 1913) is a pale colored, whitish bellied, spinous-furred subspecies generally restricted to the extremely xeric parts of northern Kashmir and northern West Pakistan. Also included in this subspecies may be specimens from comparable xeric areas of Afghanistan.

Rattus turkestanicus vicerex (Bonhote, 1903), occurring in Sikkim, Nepal, northern India, and adjacent parts of West Pakistan south of the range of *R. t. shigarus*, has darker brown, soft dorsal and grayish ventral fur.

Ellerman and Morrison-Scott (1951: 588) and Ellerman (1961: 594) included the name *Mus vicerex* Bonhote (1903) as a synonym of *Rattus rattoides turkestanicus* based on a division of the species into a dull or gray-bellied race (nominate *rattoides* from Nepal) and white-bellied race (*turkestanicus* from Russia, West Pakistan, and northern India). We prefer to retain the name *vicerex* for those animals from the eastern part of the range of *R. turkestanicus* until such time as a critical review of the species is completed. If specimens from West Pakistan and northern India, here assigned to *vicerex*, are referrable to the nominate subspecies as proposed by earlier authors and specimens from Nepal and Sikkim prove to be racially distinct, then it will be necessary to propose a new name for those animals from the eastern portion of the range of the species. The occurrence and taxonomic status of this species in Tibet and Sinkiang Province, China, is unclear at this time.

Acknowledgment is given to Dr. D. H. Johnson for first drawing our attention to this problem and to Dr. H. W. Setzer for commenting on the manuscript. Financial support for the senior author was received from U.S. Army Medical Research and Development Command Contract No. DA-49-193-MD-2738 and for the junior author through a visiting research appointment from the Office of Academic Programs, Smithsonian Institution.

LITERATURE CITED

BOBRINSKII, N. A., B. A. KUZNETSOV, AND A. P. KUZYAKIN. 1965. Opredelitel Mlekopilmshchikh SSSR, Moscow. Second Edition. 382 pp., 129 figs., 111 maps.

ELLERMAN, J. R. 1961. The Fauna of India including Pakistan, Burma, and Ceylon. Mammalia (second edition), Volume 3, Rodentia, Part 2. Pp. xxxi–xxxv, 483–884, xxxvii–lii, 69 tabls., 20 figs., folding map (30 September).

——— AND T. C. S. MORRISON-SCOTT. 1951. Checklist of Palaearctic and Indian Mammals. Brit. Mus. (N. H.) Publ., London. 810 pp., folding map.

ETEMAD, E. 1964. On three new mammals from Iran (one rat and two bats). Mammalia 28(4): 652–654 (December).

HASSINGER, J. D. 1968. Introduction to the mammal survey of the 1965 Street expedition to Afghanistan. Fieldiana: Zool. 55(1): 1–81, 1 tabl., 25 figs. (28 June).

HERSHKOVITZ, P. 1960. Mammals of northern Colombia. Preliminary report no. 8: arboreal rice rats, a systematic revision of the subgenus *Oecomys*, genus *Oryzomys*. Proc. U.S. Nat. Mus. 110 (3420): 513–568, 6 figs., 12 pls.

HODGSON, B. H. 1845. On the rats, mice, and shrews of the central region of Nepal. Ann. Nat. Hist. 15: 266–270 (April).

PICTET, F., AND C. PICTET. 1844. Notices sur les animaux nouveaux ou peu connus du musee de Geneve. Description des rats envoyees de Bahia au Musee de Geneve. Privately printed. Pp. 41–82, pl. 12–23.

SHERBORN, C. D. 1930. Index animalium 1801–1850, part XXII, pp. 5349–5702 (June).

Vol. 84, No. 21, pp. 175–176 30 June 1971

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

RECTIFIED TYPE LOCALITY FOR TWO MILLIPEDS FORMERLY CREDITED TO PANAMA

By H. F. Loomis
Miami, Florida 33156

In working on the large Haitian collection that resulted in my 1936 paper, "The millipeds of Hispaniola, with descriptions of a new family, new genera, and new species," Bull. Mus. Comp. Zool. 80: 1–191, two vials of millipeds were found, labeled only, "1923, Haiti ?, O. F. Cook." The vials contained an unidentifiable female *Chondrodesmus* and specimens of two rhachodesmids of different genera. Since no representatives of the two Central American families involved were known from Haiti, Dr. Cook was asked if he could give any explanation to account for the presence of the vials in the collection. His reply that "Collections also had been made in the Canal Zone that year and it seems probable that the material was from there." was the basis for my including the two rhachodesmids as possible members of the Panamanian fauna in the paper on "New and previously known millipeds of Panama." Proc. U.S. Nat. Mus. 113: 77–124, 1961, extending the distribution of the family southward from Costa Rica.

In going through a jar of unidentified Nicaraguan millipeds several months ago, I came upon a number of specimens of what unquestionably are *Aceratophallus quadratus* Loomis, one of the above species attributed to Panama. These had been collected by me on 13 June 1923, at Amaya, a railroad stop between Corinto and Chinandega, while a member of one of the U.S. Department of Agriculture field parties directed by Dr. Cook from the Canal Zone. No other milliped collecting was done in Nicaragua.

It now seems likely that upon my return to Panama, Dr.

Cook extracted specimens from the Amaya collection for examination but failed to label their vials until a later date when he apparently had forgotten their origin and guessed that they came from Haiti. On the assumption that this was the case, Amaya, Nicaragua, should be considered as the type locality of *Aceratophallus quadratus.* Although no specimens of *Teinorhachis tenuis* Loomis, the second rhachodesmid, were among those in the Amaya collection, the specimens on which its description had been based had been associated with the originals of *A. quadratus* and almost certainly had the same type locality.

The original description of *A. quadratus* states that the pregenital male legs are unmodified, as in females. However, re-examination of a paratype male and other males from Amaya shows that joint 6 of legs 1–3 is definitely thicker than in females and is densely beset with rather short, spinose, distally directed setae along its entire ventral surface.

Vol. 84, No. 22, pp. 177–188 4 November 1971

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

SERIOLA CARPENTERI, A NEW SPECIES OF AMBERJACK (PISCES: CARANGIDAE) FROM TROPICAL WESTERN AFRICA[1]

By Frank J. Mather, III
Woods Hole Oceanographic Institution
Woods Hole, Massachusetts 02543

Seriola carpenteri, a new species of amberjack from the eastern Atlantic, is described and compared with its congeners. This species is very similar to its zoogeographical counterpart in the eastern tropical Pacific, S. *peruana* Steindachner. Among the Atlantic species, it is intermediate between S. *dumerili* (Risso) and S. *rivoliana* Cuvier in many characters.

Seriola carpenteri new species

Figure 1

Guinean amberjack

Synonymy: No previous author has recognized the distinctiveness of this species. It has previously been misidentified as S. *fasciata*, S. *lalandi* and S. *dumerili*, as noted below.

Seriola fasciata, Fowler, 1919: 228 (USNM 42320, 13 specimens 80–100 mm standard length (SL) from 06°38′ N, 13°40′ W). Fowler, 1936: 679 (USNM 42320 re-recorded).

Seriola lalandi, Postel, 1950: 67, photo 18, schémas 23–24 (five specimens 687–832 mm SL from vicinity of Cape Verde). Williams, 1968: pp. 223–254 (part).[2]

Seriola dumerili, Cadenat, 1950: 167, fig. 97 (mostly 500–700 mm, markets, Senegal) (probably S. *carpenteri*, data insufficient to confirm identity). Furnestin et al., 1958: 447, fig. 51 (one specimen 602 mm

---

[1] Contribution No. 2559 from the Woods Hole Oceanographic Institution.

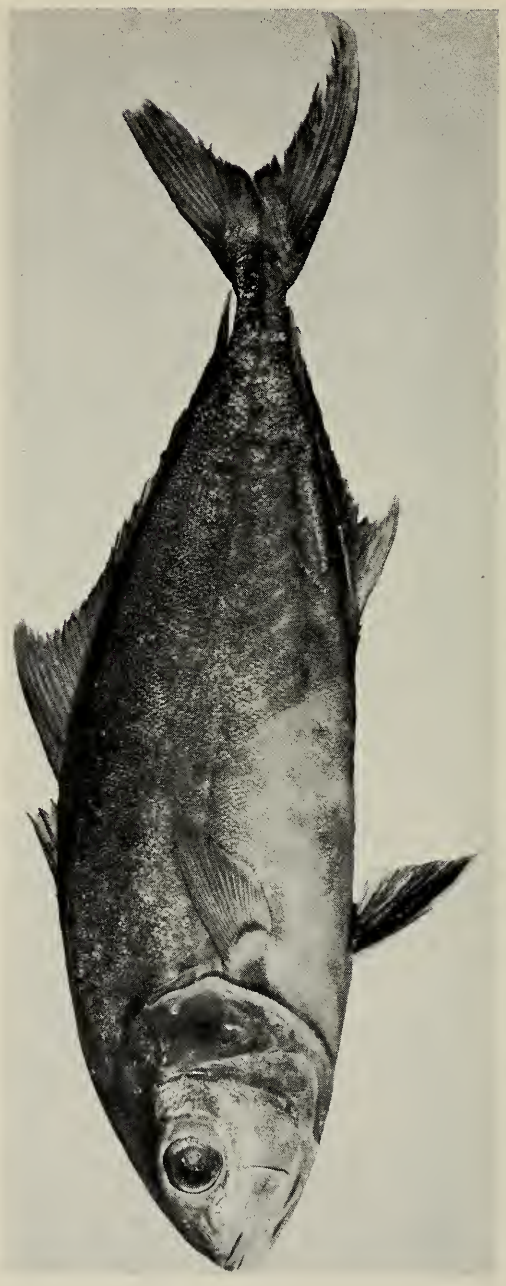


Fig. 1. *Seriola carpenteri*, holotype, 437 mm SL, Luanda, Angola, USNM 205000 (formerly TABL 103725).

total length from between Agadir and Cape Rhir, Morocco, identified as S. *carpenteri* from figure). Williams, 1968: pp. 223–254 (part).[2]

Holotype: U.S. National Museum (USNM) 205000; formerly Tropical Atlantic Biological Laboratory (TABL), National Marine Fisheries Service, 103725, mature male of 437 mm SL. Specimen purchased at fishing boat docks, Luanda, Angola (latitude 8°47′ S), by George C. Miller on 29 February 1968; presumably caught in local waters.

Description of holotype: Counts: Dorsal VII-I, 32. Anal II-I, 20. Pectoral (both sides) I, 19. Pelvic (both sides) I, 5. Gill rakers 8 upper (including raker at angle of arch), 14 lower, including two rudiments at anterior end of lower limb. Vertebrae 10 precaudal, 14 caudal.

Measurements were taken as defined by Hubbs and Lagler, 1958 (*) and Marr and Schaefer, 1949 (†) with modifications and additions. For many measurements, these definitions differ in wording only. The "origin" of Hubbs and Lagler is equivalent to the "insertion" of Marr and Schaefer. Hubbs and Lagler's "height" of the the second-dorsal and anal fins is called "length" by Marr and Schaefer. The terms "pelvic" (fin) and "upper jaw" of Hubbs and Lagler correspond to "ventral" and "maxillary" of Marr and Schaefer. The "eye" of Hubbs and Lagler is the same as the "iris" of Marr and Schaefer. In the following measurements, total length was taken as in Hubbs and Lagler, but without squeezing the caudal rays together, and fork length as the "total length" of Marr and Schaefer, but without depressing the fleshy flap at the posterior margin of the caudal. Head length was taken as in Hubbs and Lagler, without depressing the fleshy flap at the posterior margin of the opercle. Body width (maximum) always occurred at or near the insertion of the pectorals, and was only slightly, if at all, greater than the "head width" of Hubbs and Lagler. The base of the first dorsal was measured as the length of the slot into which that fin folds. Except in large individuals this is the same as the method of Marr and Schaefer. Snout to insertion of anal, height of anal, and length of anal base were measured as in Hubbs and Lagler, except that the insertion of the anal fin was arbitrarily taken to be the point where the posterior edge of the second anal spine meets the ventral profile. The first two spines of the anal fin are attached to the main part of the fin by membrane in small (less than 50 mm) *Seriola*, but become detached with growth of fish; the first or both may be subcutaneous in large individuals. Diameter of orbit is used in preference to "length of orbit" of Hubbs and Lagler, but is the same measurement. Additional measurements were made as described in the following presentations.

Measurements (in mm followed by % SL in parentheses): SL 437. Fork length 474 (108.5). Total length* 541 (123.8). Head length* 135 (30.9). Body depth*† [maximum near middle of base of first dorsal]

---

[2] I have examined 19 *Seriola* specimens from the Guinean Trawling Survey (see list of paratypes) and all were *S. carpenteri*, but it is, of course, possible that other species of *Seriola* were taken.

125 (28.6). Body width [maximum] 64 (14.6). Depth at posterior margin of opercle 118 (27.0). Depth of caudal peduncle*† 18.8 (4.30). Length of caudal peduncle [average of distances from caudal pits to terminations of second-dorsal and anal fins] $\frac{25.2 + 26.8}{2} = 26.0$ (5.96). Width of caudal peduncle [at mid-length] 26.6 (6.08). Snout to insertion of pectoral 137 (31.4). Snout to insertion of first dorsal† 175 (40.0). Snout to insertion of pelvic† 143 (32.7). Snout to insertion of second dorsal† 217 (49.7). Snout to insertion of anal 280 (64.1). Longest first dorsal spine*† [4th] 27.6 (6.32). Length of first dorsal base 43.8 (10.0). Height of second dorsal*† 77.2 (17.6). Length of terminal second-dorsal ray* 26.4 (6.05). Length of second-dorsal base*† 201 (46.0). Height of anal 60.7 (13.8). Length of terminal anal ray* 29.3 (6.71). Length of anal base 117.4 (26.9). Length of pectoral fin*† 76.4 (17.5). Length of pelvic fin* 81.6 (18.7). Spread of caudal 111 (25.3). Length of upper caudal lobe from dorsal pit 135 (30.9). Length of lower caudal lobe from ventral pit 132 (30.2). Insertion of pelvic fin to vent 114.5 (26.2). Tip of pelvic fin to vent 26.9 (6.15). Snout length* 48.6 (11.2). Length of upper jaw*† 58.9 (13.5); upper jaw reaches to perpendicular through mid eye. Maximum vertical width of upper jaw 21.2 (4.85). Maximum height of supramaxillary 6.5 (1.49). Width of fleshy interorbital [between dorsal margins of orbits] 46.5 (10.6). Diameter of bony orbit 32.6 (7.46). Diameter of fleshy orbit* 26.1 (5.98). Diameter of eye*† 24.0 (5.49). Orbit to angle of preopercle* 50.9 (11.6). Longest gill raker 22.5 (5.15). Maximum girth 312 (71.4). Testes [both sides] 90 × 13 (20.6 × 29.7).

Dentition: Vomer arrow-shaped with an elongated shaft tapering posteriorly, covered with granular teeth. Palatine and pterygoid dentition consisting of bands of granular teeth with a few irregular small patches between them on each side. Upper and lower jaws with bands of granular teeth broader anteriorly, tapering posteriorly. Tongue slender with median bands of granular teeth and an irregular pattern of similar teeth laterally.

Paratypes: USNM 42320, 06°38′ N, 13°40′ W, 21 Oct. 1889, 13 specimens (80–100 mm SL), USS *Eclipse*, collector H. W. Brown. Museum National d'Histoire Naturelle, Paris (MNHN), Laboratoire des Pêches Coloniales, French West Africa (682). MNHN 1967-834, 06°05′ N, 01°38′ E, 2 (179–186). Woods Hole Oceanographic Institution (F. J. Mather 454), 04°55′ S, 11°38′ E, 1 March 1967, trawl at 75 meters (190), *Ombango*. Nineteen specimens from the Guinean Trawling Survey (Williams, 1968), of which 17 were collected by trawl at the depths indicated, or between those depths and the surface, and two were dip netted at surface as follows: TABL 107362, 09°24′ N, 15°26′ W, 28 November 1963, surface (dip net) (115 mm SL); TABL 107361, 07°54′ N, 13°56′ W, 19 November 1963, 30 meters, 2 (135–144); TABL 107360, 07°32′ N, 13°21′ W, 17 November 1963, 200/210 meters

(180); TABL 107356, 05°43′ N, 10°22′ W, 6 November 1963, 100 meters, 2 (101–109); TABL 107358, 05°39′ N, 00°14′ E, 27 February 1964, 30 meters (250); TABL 107357, 05°38′ N, 00°14′ E, 25 February 1964, 40 meters, 2 (202–203); TABL 107359, 05°12′ N, 04°53′ E, 31 March 1964, 105 meters (160); USNM 205001, 09°24′ N, 15°26′ W, 28 November 1963, surface (dip net) (145); USNM 205002, 04°44′ N, 00°53′ W, 5 September 1963, 50 meters (182); USNM 205003, 03°06′ N, 09°43′ E, 19 April 1964, 40 meters, 2 (192–199); USNM 205004, 03°05′ N, 09°42′ E, 19 April 1964, 50 meters (209); USNM 205005, 01°13′ N, 09°14′ E, 29 April 1964, 50 meters, 2 (180–199); USNM 205006, 02°34′ S, 09°38′ E, 16 May 1964, 30 meters (191); USNM 205007, 02°41′ S, 09°32′ E, 16 May 1964, 50 meters (219). The data for USNM 205004 and 205006 may have been interchanged.

Description: Counts: First dorsal VII (8 specimens) or VIII (28) in individuals 80–440 mm SL, decreasing externally to VI or V in larger individuals. Pterygiophores below first dorsal spines 7 (32), 8 (2). Supraneurals 3 (34). Second dorsal I, 28 (3), I, 29 (5), I, 30 (9), I, 31 (12), I, 32 (7), I, 33 (1). Pterygiophore below first element of second dorsal between 5th and 6th neural spines (34). Anal II-I, 19 (10), II-I, 20 (27). Pectoral I, 18 (1), I, 19 (11), I, 20 (4), I, 21 (2). Pelvic I, 5 (9). Gill rakers [specimens 80–250 mm SL]: upper 7 (14), 8 (21), 9 (1), 10 (1); lower 15 (6), 16 (21), 17 (8); total 22 (5), 23 (7), 24 (7), 25 (5), 26 (1). Rudimentary gill rakers (included with above counts): upper 0 (30), 1 (5); lower 0 (10), 1 (13), 2 (10), 3 (2); total 0 (11), 1 (10), 2 (12), 3 (2), 4 (1); [437 mm] 8 + 14 (2 lower rudiments); [682 mm] 8 + 16 (1 upper and 2 lower rudiments). Vertebrae 10 precaudal + 14 caudal = 24 (34).

As in other *Seriola* species, the number of external first dorsal spines often decreases as the fish attain large sizes, because one or more of the terminal spines may become subcutaneous in older fish. The largest specimen examined (682 mm SL) had 5 external spines; it was not dissected or X-rayed to determine the total count. Postel (1950) reported the count of 6 for 5 individuals of 687–832 SL. Radiographs of 34 specimens 80–440 mm SL were examined; in some individuals a terminal first dorsal spine which had not been detected by external examination was revealed. The first spine of some of the individuals with first dorsal counts of 8 was very small and also difficult to detect except in X-rays. The number of pterygiophores below the first dorsal spines also varied, but less frequently. All but two of the individuals with 8 spines had 2 above the first pterygiophore, and those with 7 had only 1 above this element. S. *carpenteri* is the only *Seriola* species with such variations in the verified (internal) counts of first dorsal spines and pterygiophores. In the other species, variations from their usual counts of 6, 7, or 8 spines are lacking, or so rare as to appear aberrant. No variations from the counts of 6 first dorsal pterygiophores for S. *quinqueradiata* and 7 for the other species have been noted. The 2 anterior spines of the anal fin of the largest specimen examined (682 mm SL) had been absorbed into the body, as often occurs in large *Seriola* of other species.

The number of gill rakers also declined with growth of fish in the size range examined, as also occurs in other *Seriola* species. The highest numbers of gill rakers occurred in the 13 smallest individuals examined (80–100 mm SL), and the counts for these were 7–8 + 14–16 = 22–25, including one or two rudiments in 10 individuals. Probably smaller individuals than these have the above counts with fewer rudiments, or none. With growth of the fish, the rudiment often found at the anterior end of the upper limb disappears, but evidently there is no further degeneration of the upper rakers until SL exceeds 500 mm. Thus the decline in the total number of gill rakers with growth is due mainly to the degeneration of lower gill rakers, which is indicated by the decreasing raker count and the increasing number of rudiments on this limb. More examinations are needed to determine the usual count for large individuals, but the count of 6 + 16 = 22 given for 687–832 mm fish by Postel (1950) may be representative.

Measurements [% SL at 100 mm and 250 mm, from lines fitted visually to scatter diagrams for individuals 80–250 mm SL, and at 437 mm (holotype) and 682 mm, from measurements of individual specimens]: Head length 32.0, 31.0, 30.9, 28.6. Body depth 34.5, 32.8, 28.6, 25.4. Body width 15.7, 15.7, 14.6, 15.8. Depth of caudal peduncle 6.1, 5.3, 4.3, 4.1. Length of caudal peduncle 6.1, 6.5, 6.0, 6.3. Width of caudal peduncle 4.0, 6.0, 6.1, 5.8. Snout to insertion of first dorsal 40.0, 39.2, 40.0, 37.1. Snout to insertion of pelvic 35.0, 33.4, 32.7, 32.2. Snout to insertion of second dorsal 51.0, 51.0, 49.7, 46.3. Snout to insertion of anal 67.0, 64.0, 64.1, 62.7. Longest first-dorsal spine 6.8, 6.5, 6.3, 5.2. Length first-dorsal base 11.2, 11.8, 10.0, 8.7. Height of second dorsal 18.5, 17.5, 17.6, 15.4. Length of terminal second-dorsal ray 6.7, 6.7, 6.1, 5.1. Length of second-dorsal base 46.0, 46.0, 46.0, 44.8. Height of anal 13.9, 13.9, 13.8, 14.0. Length of terminal anal ray 6.8, 6.8, 6.7. Length of anal base 29.5, 29.5, 26.9, 26.6. Length of pectoral fin 17.0, 17.0, 17.5, 15.2. Length of pelvic fin 23.5, 22.0, 18.7, 17.1. Insertion of pelvic fin to vent 25.0, 25.0, 26.2, 24.6. Tip of pelvic fin to vent 0, 4.8, 6.2, at 7.5. Snout length 10.8, 10.8, 11.2, 10.7. Length of upper jaw 13.0, 13.0, 13.5, 12.8. Upper jaw reaches to vicinity of perpendicular through anterior edge of fleshy orbit in 80–100 mm specimens and usually to vicinity of perpendicular through middle of eye in larger specimens. Maximum vertical width of upper jaw 4.9, 4.9, 4.9, 4.9. Height of supramaxillary 1.5, 1.5, 1.5, 1.5. Width of fleshy interorbital 10.0, 10.0, 10.6, 9.4. Diameter of fleshy orbit 6.7, 6.7, 6.0, 4.8. Length of longest gill raker 4.7, 4.7, 5.1, 4.1.

Color: I have not observed the coloration of freshly caught specimens. Fowler (1919) stated "Color in alcohol brown above, paler below. Back with six pairs of close-set obscure deeper brown cross bars. Broad brown band from upper hind eye edge to spinous dorsal. Dorsals dusky or blackish-brown, paler basally on soft fin and edge broadly contrasted in young. Apex of soft dorsal pale or whitish. Anal pale brown with

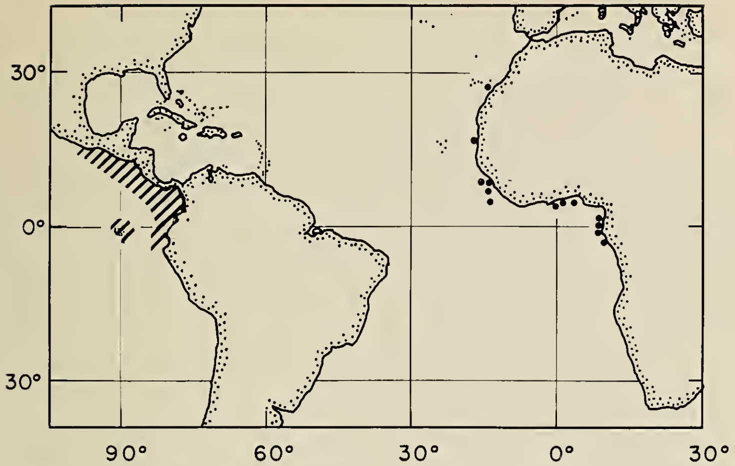


FIG. 2. Capture location records for *Seriola carpenteri* and known distributional range for S. *peruana.*

broad marginal dark band. Ventral blackish; rays and lower surfaces whitish. Pectoral and caudal brownish. Thirteen examples, 98 to 120 mm" (USNM 42320). Traces of this pattern remain in these specimens, and similar markings were observed in others up to 130 mm SL. There usually are six bands, with the last encircling the caudal peduncle. They are split and irregular, do not extend into the membranes of the second dorsal and anal fins, and become less distinct with increasing size of fish. The nuchal bar is variable, extending from the eye to the dorsal profile at a point varying between the origin of the first dorsal and a point halfway from there to the nape. The nuchal bar is lacking in preserved individuals over 200 mm long. Postel (1950) described the large specimens he examined as being old rose ("vieux rose"), fading to an indeterminable grey after 24 hours.

Distribution: *Seriola carpenteri* occurs off the tropical coasts of western Africa from 08°37′ S (Luanda, Angola) to 14°00′ N (Cape Verde), and a single specimen has been reported (as S. *dumerili*) from near Agadir, Morocco, (Furnestin et al., 1958: 447; herein identified from Fig. 51). Its distribution may be influenced by the seasonal movements of the 18°–27°C temperature fronts existing along the African coast (Longhurst, 1962). Postel (1950) reported that S. *lalandi* (actually S. *carpenteri*) occur off Cape Verde in the warm months, when the water temperatures exceed 25°C, only. The specimens from the Guinean Trawling Survey were taken in waters with surface temperatures of from 25°–30°C (Williams, 1968), except for one taken where the surface temperature was between 23° and 24°C. The surface temperatures of the waters frequented by S. *peruana*, along the American coasts from

Table 1. Frequency distributions for numbers of dorsal and anal soft rays for the 5 species of *Seriola* which occur in the eastern Atlantic (p = probability that *S. carpenteri* is indistinguishable from species listed on the basis of the respective characters).

Dorsal soft rays

Species	27	28	29	30	31	32	33	34	35	x̄	n	p
S. carpenteri		3	5	9	12	7	1			30.5	37	
S. dumerili			7	27	63	72	35	19	1	31.7	224	.02
S. rivoliana	4	12	29	34	16	1	3			29.6	99	.10
S. fasciata		3	12	22	19	15	1			30.5	72	>.50
S. lalandi				2	5	6	4	6		32.3	23	.01

Anal soft rays

Species	17	18	19	20	21	22	x̄	n	p
S. carpenteri			10	27			19.7	37	
S. dumerili		5	47	103	45	2	20.0	202	>.50
S. rivoliana		1	15	50	24	4	20.2	94	.10
S. fasciata	3	10	39	14			19.0	66	.05
S. lalandi			8	11	3	1	19.9	23	>.50

Peru to the Gulf of Tehuantepec and around the Galapagos Islands, also generally exceed 25°C. The habitats of the two species are quite similar in this respect as well as being located in nearly the same latitudes on the eastern sides of the respective oceans and being enriched by upwelling.

Etymology: This species is named for my friend William K. Carpenter of Fort Lauderdale, Florida. Mr. Carpenter, an outstanding big game fisherman, has long been the President and leading sponsor of the International Game Fish Association. His dedicated support of marine science includes generous financial contributions and outstanding personal participation in research activities.

Differentiation from other species: Zoogeographically, *S. carpenteri* is closely equivalent to *S. peruana* of the eastern tropical Pacific. Although these species are superficially similar, *S. peruana* has more numerous gill rakers (29–33 against 20–25) and a shorter snout (8.7–10.4, average 9.2, against 9.6–11.6, average 10.8% SL). These species share a juvenile characteristic (distinctive up to about 190 mm SL for *S. carpenteri*, possibly to somewhat smaller sizes for *S. peruana*)—predominantly dark membranes of the soft dorsal and anal fins—which has not been observed in any of their congeners. Juvenile *S. hippos* have not been examined. Juvenile Atlantic *S. lalandi* have likewise not been described, but the soft dorsal and anal membranes of eastern Pacific specimens are only lightly pigmented.

Of the seven other *Seriola* species, three are extralimital to *S. carpen-*

Table 2. Frequency distribution of number of gill rakers (total on first arch including rudiments), for species of *Seriola* occurring in the eastern Atlantic. All counts are from Atlantic or Mediterranean specimens except Pacific *S. lalandi.* Numbers for the first 4 *Seriola* species and Pacific specimens of *S. lalandi* are from specimens of 50–100 mm SL; numbers for *S. lalandi* from the Atlantic are from specimens of 300–499 mm. (p = probability that *S. carpenteri* is indistinguishable from species listed on the basis of this character.)

	Gill rakers											
Species	21	22	23	24	25	26	27	28	29	$\bar{x}$	n	p
S. carpenteri		2	4	5	1	1				23.6	13	
S. dumerili	4	8	9	1						22.3	22	.05
S. rivoliana					1	7	8	1		26.5	17	<.01
S. fasciata			1	2	6	1				24.7	10	.10
S. lalandi (Pacific)							3	2	3	28.0	8	<.01
S. lalandi (Atlantic)				2			5	1	1	26.7	9	<.01

teri. These differ from *S. carpenteri* as follows. *S. quinqueradiata* (western North Pacific) has more gill rakers (29–34 against 20–25), one more supraneural (4 against 3), fewer first dorsal spines (6 against 7 or 8), fewer pterygiophores below the first dorsal spines (6 against 7 or 8) and a different vertebral count distribution (11 + 13 against 10 + 14). *S. hippos* (Australia and vicinity) has fewer gill rakers and dorsal and anal soft rays (11–13, 22–25 and 16–17 against 20–25, 28–33, and 19–20, respectively). *S. zonata* (western Atlantic) has a shorter anal base (22 against 27–29% SL). *S. zonata* also has a distinctly different color pattern in the smaller sizes, with prominent solid dark bands, some of which extend into the membranes of the soft dorsal and anal fins, in contrast to the much less distinct irregular bands of *S. carpenteri*, none of which extend into the membranes of the above fins. The vertebral counts are 11 + 13 for *S. zonata* and 10 + 14 for *S. carpenteri.*

The remaining four *Seriola* species, *S. fasciata* (western Atlantic, rarely in eastern Atlantic), *S. lalandi* (southern hemisphere, also eastern and western coasts of the North Pacific), *S. rivoliana* (circumglobal) and *S. dumerili* (nearly circumglobal) (Mather, 1958), have been recorded from the eastern Atlantic, and may occur within the range of *S. carpenteri. S. carpenteri* may have either 7 or 8 first dorsal spines, whereas *S. fasciata* consistently has 8 and the other three species consistently have 7. Thus *S. carpenteri* with the more usual count of 8 may be separated from *S. dumerili, S. rivoliana* and *S. lalandi*, and those with the less frequent count of 7 can be separated from *S. fasciata*, which evidently is very rare in the eastern Atlantic. As noted previously, internal examination may be necessary to establish this count, especially in large individuals. The numbers of dorsal and anal soft rays (Table 1) show modal differences,

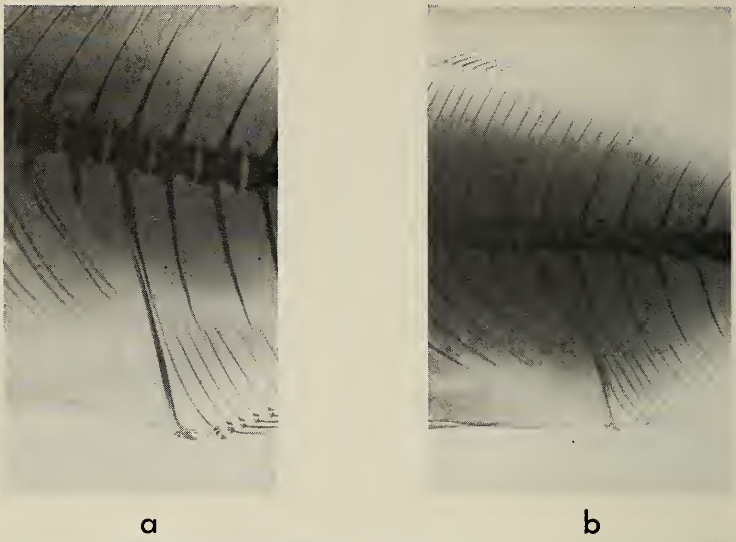


FIG. 3. X-rays of first anal pterygiophores of (a) *Seriola rivoliana* (228 mm specimen from Terceira, Azores, USNM 94489) and (b) *S. carpenteri* (190 mm specimen from 04°55′ S, 11°38′ E, WHOI, F. J. Mather No. 454).

but the dorsal count of S. *lalandi* is the only one which is distinguishable from the corresponding count of S. *carpenteri* at a confidence level of 1 percent. S. *rivoliana* differs at this level in gill raker count for small individuals (Table 2) from S. *carpenteri*, and S. *lalandi* does also if the count for small eastern Pacific individuals is typical of those in the Atlantic. Since no small Atlantic S. *lalandi* have been examined, counts for small eastern Pacific specimens, and for larger Atlantic specimens (300–499 mm SL) are shown. Large (over 500 mm SL) S. *dumerili* have fewer functional gill rakers (usually 3 upper and 10 lower) than were found in a 682 mm specimen of S. *carpenteri* (7 upper and 14 lower) or reported by Postel (1950) (6 upper and 16 lower) for five large specimens (687–832 mm). S. *lalandi* has 1 more vertebra ($11 + 14 = 25$) than the other four eastern Atlantic species ($10 + 14 = 24$).

In specimens longer than 80 mm SL, the configuration of the first anal pterygiophore of S. *rivoliana* differentiates it from S. *carpenteri* and its other congeners. It is straight in the former (Fig. 3a), and distinctly curved in S. *carpenteri* (Fig. 3b) and the others.

S. *carpenteri* also differs from its four sympatric congeners in several morphometric characters, although there is some overlapping, especially at the smallest and largest sizes. The head of S. *carpenteri* is longer (30% SL 80–437 mm, 28.6% at 682 mm) than that of S. *lalandi*

(27% SL). The body depth of S. *carpenteri* (34% SL 80–150 mm, decreasing to 33% at 250 mm; 28.5% at 437 mm; 25.8% at 682 mm) is greater than that of S. *lalandi* (25% SL at 300 mm, 23.2% at 700 mm) and less than those of S. *rivoliana* (39% SL 50–270 mm, decreasing to 34% at 450 mm and 31% at 700 mm) and S. *fasciata* (39% SL 50–185 mm, decreasing to 32% at 300 mm). The height of its second-dorsal fin (17.5–20.0% SL) is less than that of S. *rivoliana* (18.0–25.0% SL), but greater than those of the other three species (12.8–19.0% SL). The intermediate development of this fin is shown more vividly in the photograph of a 602 mm TL specimen (Furnestin et al., 1958, Fig. 51) than in any of the specimens examined. The height of the anal fin of S. *carpenteri* is also less than that of S. *rivoliana* but greater than those of the other species. The longest gill raker of S. *carpenteri* (about 5.2% SL at all sizes) is longer than those of the four other species (about 2.3–4.5% SL).

The color pattern of young 80–120 mm specimens as described by Fowler and observed on our material is generally similar to S. *dumerili* and S. *rivoliana*. The second dorsal and anal webs, however, are predominantly dark, a characteristic which it shares in the genus only with its eastern Pacific counterpart, S. *peruana*. The pattern of young S. *carpenteri* also differs distinctly from those of S. *fasciata* and S. *lalandi* in other respects. Both of the latter have more numerous bands, those of the first extend into the webs of second-dorsal and anal fins, the nuchal bar of S. *fasciata* curves upward to the nape, and S. *lalandi* has no nuchal bar at all. In small S. *carpenteri*, the nuchal bar is variable, extending from the eye to the origin of the first dorsal fin in some individuals, as in small S. *dumerili* and S. *rivoliana*, and curving toward a point nearer the nape in others, somewhat as in small S. *fasciata*. Postel's (1950) description and my observations indicate that the nuchal bar in large S. *carpenteri* is less persistent than in large S. *dumerili* and S. *rivoliana*.

Acknowledgments: The revision of the genus *Seriola* was supported mainly by the National Science Foundation (grants G-2102, G-6172, G-19601 and GB-3464). Much additional information, including that which led to recognition of S. *carpenteri*, was obtained incidentally to work carried out under contracts (contracts 14-17-007-272, -547, -975 and -1110) from the National Marine Fisheries Service. Important supplemental support has been received from the Charles W. Brown, Jr., Memorial Foundation, The Sport Fishing Institute, Tournament of Champions through its 1967 and 1968 winners, Mrs. Ann Kunkel and E. D. Martin, the Lou Marron Science Fund, and numerous sport fishing clubs and individual sportsmen. I am most grateful to the organizations and individuals who financed this research.

In addition, I am indebted to the National Sea Grant Program, National Oceanic and Atmospheric Administration, Department of Commerce (Grant GH-82), for support while this paper was being finalized, and for covering the costs of publication.

Frederick H. Berry provided most valued assistance in preparing this paper, as well as important data and material. Drs. Robert H. Gibbs and Frank Williams contributed very helpful reviews of this paper. Specimens or data, or both, were also made available by Drs. T. Abe, J. Blache, M. Boeseman, R. H. Gibbs, E. Lachner, M. F. Poinsard, F. H. Talbot, and L. W. Walford and Mme. M. L. Bauchot, G. C. Miller and the late Al Pflueger. Numerous specimens were examined by my colleagues M. R. Bartlett, H. L. Clark, D. Shores, and Mrs. M. E. Watson. Mrs. Watson, Bartlett, Shores, A. Konnerth, and P. Heemstra X-rayed many specimens. I was also assisted in this study by fellowship students R. L. Haedrich, L. Chen, and G. Pesch. J. P. Wise provided the statistical analysis of the meristic data. I am most deeply grateful to these scientists for their most valued assistance.

LITERATURE CITED

CADENAT, J. 1950. Poissons de mer du Sénégal. Initiations Africaines III, Inst. Fr. Afr. Noire, Dakar: 1–345.

FOWLER, H. W. 1919. Fishes of the U.S. *Eclipse* expedition to west Africa. Proc. U.S. Nat. Mus., 56(2294): 195–292.

————. 1936. The marine fishes of west Africa. Bull. Amer. Mus. Nat. Hist., 70(Pt. 2): 607–1493.

FURNESTIN, J., J. DARDIGNAC, D. MAURIN, A. VINCENT, R. COUPÉ, H. BOUTIÈRE. 1958. Données nouvelles sur les poissons du Maroc atlantique. Rev. Trav. Inst. Pêches Marit., 22(4): 379–493.

HUBBS, C. L. AND K. T. LAGLER. 1958. Fishes of the Great Lakes Region. Cranbrook Inst. Sci. Bull., 26: 186 pp.

LONGHURST, A. R. 1962. A review of the oceanography of the Gulf of Guinea. Bull. Inst. Fr. Afr. Noire, Dakar, Tome XXIV, sér. A. No. 3: 633–663.

MARR, J. C. AND M. B. SCHAEFER. 1949. Definitions of body dimensions used in describing tunas. U.S. Fish Wildlife Serv. Fish. Bull. 47, vol. 51: 241–244.

MATHER, F. J., III. 1958. A preliminary review of the amberjacks, genus *Seriola*, of the western Atlantic. Intern. Game Fish Conf., Intern. Oceanogr. Found. and Gulf Carib. Fish. Inst., Miami Beach, Florida, November 19, 1958, 12 pp.

POSTEL, E. 1950. Pêche sur les côtes d'Afrique occidentale. II. Poissons de surface. Dakar: 1–77.

WILLIAMS, F. 1968. Report on the Guinean Trawling Survey. Org. Afr. Unity. Sci. Techn. Res. Commission P.B.M. 2359, 3 vols.

Vol. 84, No. 23, pp. 189–200 4 November 1971

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

A NEW SPECIES OF SUBTERRANEAN ISOPOD CRUSTACEAN (ASELLIDAE) FROM THE CENTRAL APPALACHIANS, WITH REMARKS ON THE DISTRIBUTION OF OTHER ISOPODS OF THE REGION

By John R. Holsinger and Harrison R. Steeves, III
Department of Biology, Old Dominion University,
Norfolk, Virginia 23508 and
Department of Biology, Virginia Polytechnic Institute and
State University, Blacksburg, Virginia 24061

For the past 10 years extensive collecting in the caves of the central Appalachians, principally in western Virginia and eastern West Virginia, has accelerated the accumulation of new data on the subterranean fauna of this significant karst area. Additional collecting has also been carried out in the caves of adjacent Maryland and Pennsylvania, both by the senior author and other speleologists. One of the most common cave forms of this area are isopods of the genus *Asellus* s. lat., representatives of which occur in almost every suitable cave habitat in the four-state area.

The rich subterranean isopod fauna of the central Appalachian cave region has been treated previously by Levi (1949), Bresson (1955), Chappuis (1957), Steeves (1963a, 1963b, 1965, 1966, 1969), and Bowman (1967). Despite this proliferation of published information on the group in recent years, field investigations have continued to result in the discovery of new species and the acquisition of new localities and range extensions for previously known species. Some of these new data, along with the description of one of the new species, are reported in this paper.

The most common subterranean isopod species of this region is *Asellus pricei*, described by Levi (1949) from Reftons Cave in Lancaster County, Pennsylvania. Two other subterranean forms, *Asellus conestogensis* Levi, 1949, and *Asellus condei* Chappuis, 1957, were also described from the same general area, but on the basis of a comparison of pertinent material these species are being synonymized with *A. pricei*. Because *A. pricei* is a significant subterranean species that has not been treated in detail since its original description by Levi, it is discussed at some length below.

Although there is a current trend among freshwater isopod specialists to divide the widespread Holarctic genus *Asellus* into subgenera and even separate genera (Matsumoto, 1962, 1963; Birstein, 1951; Henry and Magniez, 1968, 1970), we have not assigned the species treated in this paper to any of these more narrowly defined groups. Nevertheless, we are in agreement with the recent attempt of Henry and Magniez (1968, 1970) to subdivide the genus *Asellus* into natural groups that more clearly reflect phylogenetic lineages. These workers have recognized three separate genera of asellids from North America: *Asellus* Geoffroy, 1762 (restricted); *Conasellus* Stammer, 1932 (new status); and *Pseudobaicalasellus* Henry and Magniez, 1968, 1970 (new genus). The latter, as defined by Henry and Magniez (1968, 1970), should contain the eight species assigned to the *cannulus* group by Steeves (1969). All other described species of *Asellus* that occur east of the Rocky Mountains, including the new species described in this paper, should be assigned to *Conasellus*. The two species of *Asellus* which occur west of the Rocky Mountains should be retained in the genus *Asellus* (as restricted by Henry and Magniez). The newly erected genera, *Conasellus* and *Pseudobaicalasellus*, are endemic to North America, while *Asellus* s. str. is represented by species in Europe and Asia.

To us, this attempt to revise and subdivide the genus *Asellus* is one of the most logical to date. However, the problem with applying this new system to North American forms is the lack of comprehensive revision and critical comparison of North American asellids in general. Williams (1970), in a recent monograph on epigean asellids of North America, discussed some of the difficulties of dividing the genus *Asellus* into subgenera. Apparently Laurence Fleming, who is currently revising many of the North American hypogean species, has also decided against subdividing the genus at this time (L. Fleming, pers. comm. and in preparation). Temporarily, until many of the systematics problems currently plaguing students of the North American asellid complex have been resolved satisfactorily, we have elected to retain the genus *Asellus* s. lat. for the species treated in this paper.

Acknowledgments: We are grateful to the following persons who assisted with the field work on which much of this paper is based: Roger Baroody, Ronald Brunette, William Cline, John Cooper, Richard Franz, David Newson, Russell Norton, John Stellmack, Tom Vigour, Lynn Vinzant, and Hermine Zotter. We also thank the numerous cave owners, especially Bradford Cobb, owner of Massanutten Caverns, and the management of Endless Caverns, Inc., for allowing us to collect on their property.

This work was partially supported by Grants to Holsinger from the Old Dominion University Education Foundation and the Research Advisory Committee of the National Speleological Society.

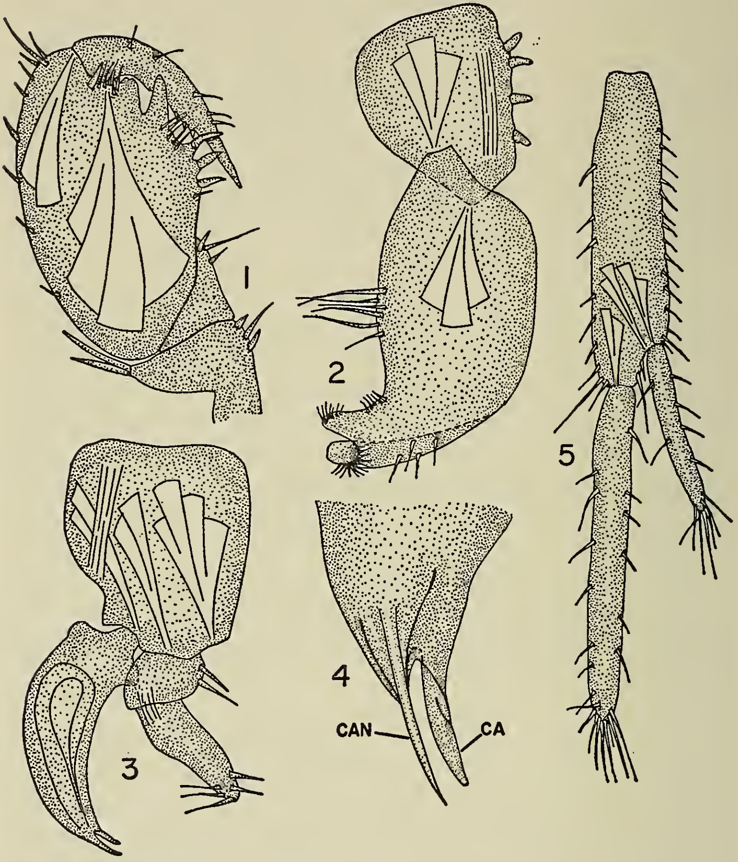
Asellus franzi new species

Figures 1–5

Asellus species B.—Steeves, 1969, pp. 55–56.

Material Examined: PENNSYLVANIA—Centre County: Millers Cave, holotype male, allotype, and 45 paratypes, J. R. Holsinger and J. A. Stellmack, 18 May 1965. MARYLAND—Garrett County: Crabtree Cave, R. Franz, 2 January 1967. The holotype and allotype are deposited in the United States National Museum of Natural History. Paratypes are in the collections of the authors.

Diagnosis: Albinistic, without eyes. Maximum body length 7.0 mm. Palm of propodus of male gnathopod (Fig. 1) with two processes: (1) median process large and acute, and (2) distal process small, bidentate and located near the opposable distal angle; opposable margin of dactyl without processes, but with small spines on entire length; carpus with 3 setae and 1 small spine near distal postaxial border. First pleopod (Fig. 2) with 4 coupling hooks; distal podomere approximately 1.6 times as long as proximal one; lateral margin with large setae on mid-region and smaller setae dispersed in scattered groups toward distal margin; terminal



Figs. 1–5. *Asellus franzi* new species. 1, mesial view of distal podomeres of left gnathopod. 2, cephalic view of right first pleopod. 3, cephalic view of left second pleopod. 4, cephalic view of tip of endopodite of left second pleopod; CAN, cannula, CA, caudal process. 5, dorsal view of right uropod.

setae sparsely placed on distal margin; lateral margin bi-lobed distally. Second pleopod (Figs. 3, 4) without setae on mesial margin of basal segment; basal portion of endopodite without apophyses; tip of endopodite (Fig. 4) terminating in 2 distinct parts: (1) caudal process (CA) forming an elongate, sub-acute projection, and (2) endopodial groove extending in the form of an acute cannula (CAN). Uropod (Fig. 5) approximately 1.6 times as long as pleotelson; endopodite approximately

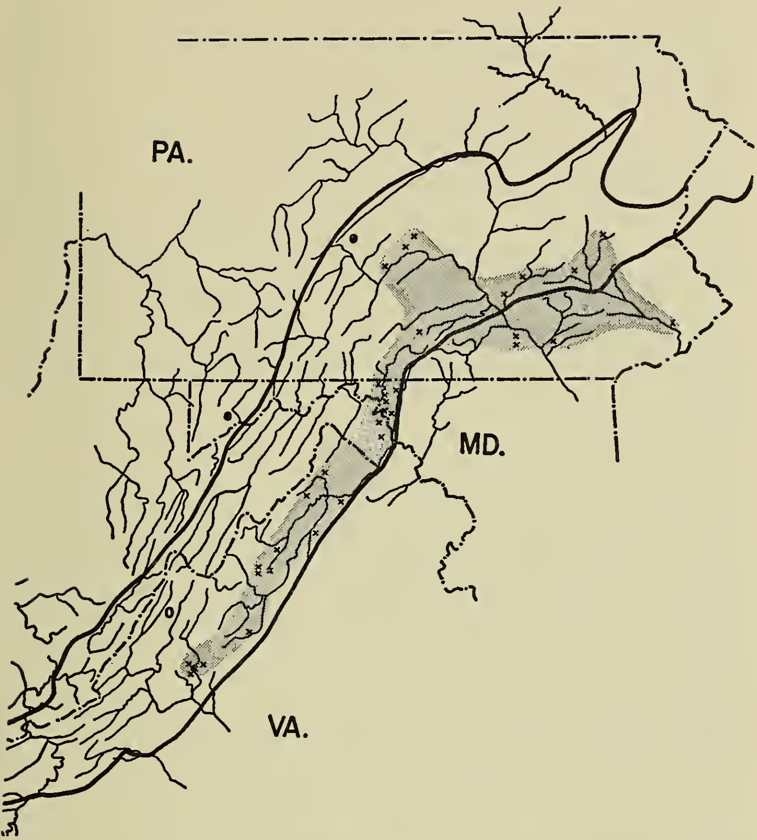


FIG. 6. Distribution of *Asellus pricei*, *A. franzi* new species, and new locality record for *A. holsingeri*. Solid circles are localities for *A. franzi*, open circle is new Virginia locality for *A. holsingeri*, and X's are localities (excluding Graham Spring) for *A. pricei*. Shaded area marks the presently known range of *A. pricei*. Heavy solid lines approximately delim' the Appalachian valley (= Valley and Ridge province).

1.1 times as long as peduncle; exopodite approximately 0.5 times as long as endopodite.

Distribution and Ecology: The two cave localities for this species (shown in Fig. 6) are separated by a linear distance of approximately 115 miles, a number of prominent valleys and ridges, and a major drainage divide (between the Potomac and Susquehanna river basins). Millers Cave (the type locality) is a small cave located less than 1 mile east of

Rockspring, Pennsylvania, and is developed in Ordovician limestone which crops out just west of Tussey Mountain. Crabtree Cave is a relatively large cave located in the Appalachian Plateau of western Maryland and is excavated in Mississippian limestone of the Greenbrier series (Davies, 1950). In both caves, *A. franzi* was collected from under gravels in small streams where it was associated with subterranean amphipods of the genus *Stygonectes*.

Relationships: Morphologically, *A. franzi* is related to species of the *stygius* group of *Asellus* (Steeves, 1963a, 1965, 1966) and is being tentatively assigned to this group. In the male, this relationship is indicated by similarities in the armature of the palmar margin of the gnathopod and the structure of the endopodial tip of the second pleopod. However, *A. franzi* can be distinguished from most other species of the *stygius* group by the absence of the mesial process on endopodial tip of the male second pleopod and from all other species of this group by the presence of the distinct, bi-lobed outer margin of the distal segment of the male first pleopod.

It is perhaps zoogeographically significant that all other species of the *stygius* group occupy contiguous or overlapping ranges in the southern Appalachians, Interior Low plateaus, and Ozark Plateau (Steeves, 1966, fig. 8), while *A. franzi* is disjunctly distributed much farther east and northeast in a small part of the upper-central Appalachians. Moreover, a part of the area between the range of *A. franzi* and the ranges of other species of the *stygius* group is occupied by species of the *cannulus* group of *Asellus* (Steeves, 1965, 1966, 1969) which occur in caves in eastern West Virginia and west-central Virginia.

Etymology: It is a pleasure to name this new species in honor of Mr. Richard Franz, a director of the Maryland Cave Survey, who has been very active in the biological exploration of Maryland caves.

Asellus holsingeri Steeves

Asellus holsingeri Steeves, 1963b, pp. 462–464, figs. 1–5 [Type locality: Organ-Hedricks Caves (= Greenbrier Caverns), Greenbrier County, West Virginia].—Steeves, 1965, p. 84.—Steeves and Holsinger, 1968, p. 81.—Steeves, 1969, p. 56.

Material Examined: VIRGINIA—Bath County: Butler Cave, 19 females and 16 males, J. Holsinger, T. Vigour and L. Vinzant, 2 November 1968.

Distribution and Ecology: This species was collected from under gravels and flat rocks in a stream in Butler Cave (Butler-Sinking Creek Cave System), where it is commonly associated with snails (*Fontigens orolibas* Hubricht) and rarely with amphipods (*Stygonectes conradi* Holsinger).

Extensive field work in central Appalachian caves has considerably extended the range of *A. holsingeri* since its description by Steeves (1963b). In a more recent paper on cave isopods, Steeves (1969) gave the range of this species as extending from the extreme western part of

Maryland southward through eastern West Virginia to Monroe County. The material from Butler Cave marks the first Virginia record for this species and extends its range 25 miles to the east (see Fig. 6).

Asellus pricei (Levi)

Asellus new species.—Dearolf, 1941, pp. 170–171.
Caecidotea pricei Levi, 1949, pp. 1–6, figs. 1–3, 7–10 [Type locality: Refton Cave, Lancaster County, Pennsylvania].—Nicholas, 1960a, p. 131.—Nicholas, 1960b, pp. 51–52.
Asellus pricei (Levi).—Dearolf, 1953, p. 227.—Mackin, 1959, p. 876.—Holsinger, 1963, p. 29.—Steeves, 1963b, p. 462.—Holsinger, 1964, p. 60.—Steeves, 1969, pp. 53, 55.
Caecidotea conestogensis Levi, 1949, p. 3, figs. 4–6, 11–13 [Type locality: Hammer Creek, about 2 miles from Buffalo Springs, Lebanon County, Pennsylvania.]. NEW SYNONYMY.—Nicholas, 1960a, p. 131.—Nicholas, 1960b, pp. 51–52.
Asellus conestogensis (Levi).—Steeves, 1963b, p. 463.—Steeves, 1969, p. 53.
Asellus condei Chappuis, 1957, pp. 37–43, figs 1–8 [Type locality: Ogdens Cave, Frederick County, Virginia]. NEW SYNONYMY.
Asellus richardsonae (Hay).—Dearolf, 1937, p. 45 (in part).
Caecidotea stygia Packard.—Richardson, 1905, p. 434 (in part).—Nicholas, 1960a, p. 132 (in part).—Nicholas, 1960b, p. 51–52 (in part).

Recorded Localities: MARYLAND—Washington County: Dam Number Four, Fairview, Jugtown, Natural Well, Rohrersville, and Spring caves. PENNSYLVANIA—Berks County: Hobo and Schofer caves; Cumberland county: Carnegie Cave; Dauphin County: Brownstone Cave; Lancaster County: Refton Cave (Type locality); Lebanon County: Hammer Creek near Buffalo Springs; Mifflin County: Aitkin, Goss and Johnson (upper and lower) caves; Montgomery County: well (200 feet deep) in Conshohocken; York County: Bootlegger Sink and North York caves. VIRGINIA—Augusta County: Barterbrook Springs Cave; Frederick County: Ogdens Cave; Page County: Will Mauck Cave; Rockbridge County: Bathers, Billy Williams (now closed by highway construction), Showalters, and Tolleys caves and Grahams Spring; Rockingham County: Endless Caverns, Florys Spring, and seeps in front of Massanutten Caverns and on south side of Harrisonburg; Shenandoah County: Flemmings Cave; Warren County: Skyline Caverns. WEST VIRGINIA—Jefferson County: Ditmers and Molers caves.

Most of the localities listed above are based on material examined by the writers; a few were taken from the literature but fall within the established limits of the range. Grahams Spring was listed by Richardson (1905, p. 434) as a locality for *Caecidotea stygia* (*A. pricei*, in part) but could not be positively identified during recent field work. However, it is probably one of several limestone springs located near the town of Lexington, Virginia.

Variation: Despite the wide range of this species, little morphological variation was discernible in different population samples. For example, the morphology of the endopodite of the second pleopod of the male, a structure of singular diagnostic value among species of *Asellus*, remained relatively constant throughout the range. There was, however, a slight degree of variation in the armature of the palmar margin region of the propods of the male gnathopods, ranging from reduced or incompletely developed processes in some to well developed in others. However, this variation did not show a geographic pattern and was not different from the palmar margin variation found in some other species of the genus.

Distribution and Ecology: The range of this species (see Fig. 6) extends from Montgomery County, Pennsylvania, west across the Piedmont into the Valley and Ridge province of central Pennsylvania, and then southwestward through the "Great Valley" of central Maryland, northeastern West Virginia, and western Virginia to Rockbridge County in west-central Virginia. *Asellus pricei* occurs in parts of four major drainage basins, including the Delaware, Susquehanna, Potomac, and James (Steeves, 1969).

Asellus pricei is usually found under rocks, gravels, and small pieces of wood in cave streams and pools, although occasionally it is found in small springs and groundwater seeps during the spring of the year. Specimens were found to be very abundant in a number of caves visited by the senior author; especially in Reftons Cave (type locality), where a population numbering in the thousands was observed clinging and crawling on pieces of submerged wood in a large pool. Another large population was observed in submerged leaf litter just beyond the resurgence of a temporary spring (seep) in front of Massanutten Caverns in the spring of 1965.

Although primarily known from cave waters, *A. pricei* is by no means a strict cavernicole. Apparently this species can occupy almost any groundwater biotope within its range. In Rockingham County, Virginia, *A. pricei* was collected from two spring-seeps developed in Ordovician-aged Martinsburg shale. These collections were made in April after heavy rainfall had effected a temporary rise in the groundwater table. This species was also collected from a deep well located in lower Cambrian-aged metamorphic rock in southeastern Pennsylvania.

Most of the recorded cave localities for *A. pricei* occur in Paleozoic limestones (Cambrian and Ordovician), but the free movement of this species from one cave to another over any extended distance under the geological conditions imposed by the nature of the limestones of the Great Valley region of the Appalachians is improbable. Most of the caves in this part of the Appalachians are small and isolated, and the amount of cave interconnectivity is greatly restricted by relatively narrow strike bands, intense folding, and extensive faulting.

The potential ability of small troglobitic (or phreatobitic) crustaceans such as amphipods and isopods to move through superficial groundwater habitats developed close to the surface and often in noncavernous strata or in overlying mantle has been discussed previously in detail by Holsinger (1967, 1969), Steeves and Holsinger (1968), and Steeves (1969). This theoretical mode of dispersal has been termed "interstitial dispersal" and its application to explain the wide range and vagility of *A. pricei* seems feasible in view of the evidence at hand.

Relationships: To date it has been impossible to assign *A. pricei* to any of the species groups established within the genus *Asellus* by Steeves (Steeves, 1969). The morphological combination seen in the structure of the gnathopods and pleopods in the male is apparently unique in North American cave asellids and probably represents a separately evolved lineage. Only one other North American species appears closely related morphologically, this being *A. kenki*, a subepigean species described by Bowman (1967) from springs in the Virginia-Maryland area surrounding Washington, D.C., and from two caves in southwestern Pennsylvania. Although pigmented and eyed, *A. kenki* is, as pointed out by Bowman (1967), in some respects intermediate between the epigean and troglobitic species of *Asellus*. In contrast to *A. pricei*, *A. kenki* is predominately an inhibitant of permanent springs. *A. pricei*, on the other hand, is an unpigmented, eyeless form primarily restricted to subterranean groundwater habitats. Theoretically, these two species may have overlapping ranges, but they have never been taken from the same immediate area. A large disjunction in the bicentric range of *A. kenki* occurs between the southwestern Pennsylvania localities on the west and the Virginia-Maryland localities on the east. Although this disjunction is possibly the result of inadequate collecting it is nevertheless partially filled by the range of *A. pricei*. The fact that *A. pricei*, and not *A. kenki*, has been taken from this area suggests a scarcity or absence of the latter rather than inadequate collecting. It also may be significant that *A. kenki* inhabits springs in the eastern part of its range and caves in the western part, whereas *A. pricei* inhabits caves in between.

In view of the proximity of ranges, similarity in structure, and overlapping ecologies, one might be persuaded to speculate on the possible evolutionary relationship between these two species. There are at least two possible relationships indicated by the available data. One, that *A. kenki* is closely related to, or represents the remnant surface form of, an ancestral stock that invaded subterranean waters and subsequently evolved into *A. pricei*. Two, that both species were derived from a common epigean ancestor in the not too distant past. Undoubtedly, both of these explanations are oversimplified, and before either are pursued any further, a critical comparison of the morphology and ecology of these two species should be made.

LITERATURE CITED

BIRSTEIN, J. A. 1951. Fauna of U.S.S.R., Crustacea, Freshwater Isopods (Asellota), vol. 7, no. 5. Zool. Inst. Acad. Sci. U.S.S.R., Moscow, pp. 1–148.

BOWMAN, T. E. 1967. *Asellus kenki*, a new isopod crustacean from springs in the eastern United States. Proc. Biol. Soc. Washington 80: 131–140.

BRESSON, J. 1955. Aselles de sources et de grottes d'Eurasie et d'Amerique du Nord. Archives de Zoologie Expérimentale et Générale, Notes et Revue 92(2): 45–77.

CHAPPUIS, P. A. 1957. Un asellide nouveau de l'Amérique du Nord. Notes Biospéologiques 12(1): 37–43.

DAVIES, W. E. 1950. The caves of Maryland. Dept. Geology, Mines and Water Resources, Bull. 7, pp. 1–70.

DEAROLF, KENNETH. 1937. Notes on cave invertebrates. Proc. Pennsylvania Acad. Sci. 2: 42–47.

———. 1941. The invertebrates of 37 Pennsylvania Caves. Proc. Pennsylvania Acad. Sci. 15: 170–180.

———. 1953. The invertebrates of 75 caves in the United States. Proc. Pennsylvania Acad. Sci. 27: 225–241.

HENRY, JEAN-PAUL AND GUY MAGNIEZ. 1968. Sur la systématique et la biogéographie des asellides. Comptes Rendus, Acad. Sci. Paris 267(ser. D): 87–89.

———. 1970. Contribution a la systématique des asellides (Crustacea Isopoda). Ann. Spéléol. 25(2): 335–367.

HOLSINGER, J. R. 1963. Annotated checklist of the macroscopic troglobites of Virginia with notes on their geographic distribution. Bull. Nat. Speleological Soc. 25: 23–36.

———. 1964. The biology of Virginia caves, pp. 57–74. *In* H. H. Douglas, Caves of Virginia.

———. 1967. Systematics, speciation, and distribution of the subterranean amphipod genus *Stygonectes* (Gammaridae). Bull. U.S. Nat. Mus. 259: 1–176.

———. 1969. Biogeography of the freshwater amphipod crustaceans (Gammaridae) of the central and southern Appalachians, pp. 19–50. *In* P. C. Holt (ed.), The distributional history of the biota of the southern Appalachians. Part I: Invertebrates. Research Division Monograph 1, Virginia Polytechnic Institute.

LEVI, HERBERT W. 1949. Two new species of cave isopods from Pennsylvania. Notulae Naturae 220: 1–6.

MACKIN, J. G. 1959. Malacostraca (Isopoda), pp. 872–876. *In* W. T. Edmondson (ed.), Ward and Whipple's freshwater biology.

MATSUMOTO, K. 1962. Two new genera and a new subgenus of the family Asellidae of Japan. Annotationes Zoologicae Japonenses 35(3): 162–169.

———. 1963. Studies on the subterranean Isopoda of Japan with notes on the well-water fauna of Japan, Part I, No. 1. Supplement of the Annual Report, XIII, Tokyo-to Lab. for Med. Sci., pp. 1–77.

NICHOLAS, BROTHER G. 1960a. Checklist of macroscopic troglobitic organisms of the United States. Amer. Midl. Nat. 64(1): 123–160.

————. 1960b. Troglobites of Pennsylvania. The Netherworld News 8(4): 50–53.

RICHARDSON, H. 1905. A monograph of the isopods of North America. Bull. U.S. Nat. Mus. 54: 1–740.

STEEVES, H. R., III. 1963a. The troglobitic asellids of the United States: the *stygius* group. Amer. Midl. Nat. 69(2): 470–481.

————. 1963b. Two new troglobitic asellids from West Virginia. Amer. Midl. Nat. 70(2): 462–465.

————. 1965. Two new species of troglobitic asellids from the United States. Amer. Midl. Nat. 73(1): 81–84.

————. 1966. Evolutionary aspects of the troglobitic asellids of the United States: the *hobbsi, stygius* and *cannulus* groups. Amer. Midl. Nat. 75(2): 392–403.

————. 1969. The origins and affinities of the troglobitic asellids of the southern Appalachians, pp. 51–65. *In* P. C. Holt (ed.), The distributional history of the biota of the southern Appalachians. Part I: Invertebrates. Research Division Monograph 1, Virginia Polytechnic Institute.

————, AND J. R. HOLSINGER. 1968. Biology of three new species of troglobitic asellids from Tennessee. Amer. Midl. Nat. 80(1): 75–83.

WILLIAMS, W. D. 1970. A revision of North American epigean species of *Asellus* (Crustacea: Isopoda). Smithsonian Contrib. Zool. 49: 1–80.

Vol. 84, No. 24, pp. 201–202 4 November 1971

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

A NEW SUBSPECIES OF CHIPMUNK FROM THE DOOR PENINSULA, WISCONSIN (MAMMALIA: RODENTIA)

By Charles A. Long

Museum of Natural History and Department of Biology, Wisconsin State University, Stevens Point, Wisconsin 54481

The assignment (Jackson, Mammals of Wisconsin, Univ. Wisconsin Press, p. 149, 1961) of pale chipmunks from the Door Peninsula, Wisconsin, to *Tamias striatus peninsulae* Hooper pointed to the question of how such a disjunct distribution could have resulted. Comparison of specimens from the Door Peninsula with specimens of *T. s. peninsulae* from lower Michigan revealed the presence of an unnamed subspecies, which may be named and described as follows.

Tamias striatus doorsiensis new subspecies

Holotype: Adult male, skin and skull (terminal nasal processes broken), No. 1633, Wisconsin State Univ. Mus. Nat. Hist., from Peninsula State Park, Door County, Wisconsin, obtained 28 September 1969, by John Small (orig. no. 15).

Description: Rump pale (tending to ochraceous, not to rust); pelage between dorsal stripes grayish agouti; median stripe dark and distinct; white postauricular patches large and conspicuous; cheeks ochraceous; tail elongate, frosted heavily with white intermixed with dark brown or black, having terminal hairs elongate and underside pale ochraceous; antiplantar surface of pes bright ochraceous; cranium robust and inflated having widened nasals, zygoma, rostrum, and processes of dentary; infraorbital canal large; incisors massive (see *Measurements* and *Comparisons*).

Comparisons: Compared with *T. s. peninsulae*, *T. s. doorsiensis* is as pallid, and two worn pelages taken in July are exceptionally pale. In *doorsiensis* the postauricular patches are much more prominent (especially in fresh pelage), the tail is longer, frosted more with white and more heavily intermixed with black, the dorsal pelage more grayish, the cheeks having less cinnamon and more ochraceous, the feet averaging less reddish, and the underside of the tail being a shade paler. Furthermore, the skull in *doorsiensis* is more robust and inflated, has wider nasals, rostrum, and zygoma, and the teeth are more massive. The lengths of the nasals and incisive foramina, and the external measurements are greater than observed in specimens of *peninsulae.*

Compared with *T. s. griseus* from central, eastern, and northern Wisconsin, *T. s. doorsiensis* hardly differs in cranial form, but the pelage is markedly paler overall, especially on the rump, the underside of the tail, the cheeks, and the feet. The tail is slightly more frosted with white, and the skull seems slightly more broad.

Measurements: Mean external measurements of the holotype and four lactating adults from Door County, Wisconsin, are as follows: Total length, 259 (251–265); length of tail, 95 (85–105); hind foot, 36 (36–37); ear from notch, 20 (19–23). Mean cranial measurements of five old adults and eight young adults from Door County are, respectively, as follows: Condylobasal length, 39.4 (39.1–39.8), 38.3 (37–39.2); zygomatic breadth, 23.5 (23.1–24.1), 22.6 (21.8–23.7); mastoid breadth, 17.0 (16.8–17.2), 16.6 (16.3–17.1); maxillary tooth-row, 6.6 (6.4–6.8), 6.6 (6.4–7.5); length of nasals, —, 13.9 (13.2–14.8) (five specimens).

Remarks: The eastern chipmunk on the Door Peninsula is well differentiated in numerous characters described above, but the skull resembles that of *T. s. griseus.* These two subspecies are closely related and interbreed freely on the base of the Peninsula, and to a lesser degree farther inland. The hypothesized intergradation (Hooper, Occas. Papers Mus. Zool., Univ. Michigan, No. 461, 1942) between *griseus* and *peninsulae* in upper Michigan may now be ascribed in large part to intergradation between *griseus* and *doorsiensis.*

A female from Peninsula State Park, taken on 11 July 1970, was lactating, contained four embryos (25 mm. c.r. length), and showed evidence of molt.

Acknowledgment: Professor Emmet T. Hooper of the University of Michigan kindly lent specimens of *Tamias striatus peninsulae* used in this study.

Specimens examined: Total, 87 (77 in Wisconsin State Univ. Mus. Nat. Hist.). *Tamias striatus doorsiensis*: 3 mi. N Baileys Harbor, on Hwy 57, 1; Approx. 2 mi. N Jacksonport, at wayside, 2; Peninsula State Park, 16; Fish Creek, 1; Sturgeon Bay, 2; 6 mi. W. Sturgeon Bay, 5; 5 mi. SE Peninsula "center," 1. *Tamias striatus peninsulae* (Univ. Michigan): St. James, Charleroix Co., Beaver Island, lower Michigan, 10. *Tamias striatus griseus*: 8 mi. N Marinette, Marinette Co., 1; Within 1 mi. Manitowoc, 7; Pickerel Lake, Forest Co., 4; Hayward, Sawyer Co., 1; Drummond, Bayfield Co., 3; Crandon, 2; 1 mi. N. Tony, Rusk Co., 1; 1 mi. W Rhinelander, Oneida Co., 1; Amco Park, Rib River, Marathon Co., 1; Rib Hill, 1; Pittsville, Wood Co., 2; 3 mi. NW Arpin, Wood Co., 1; various localities in Portage Co., 24.

.0673

Vol. 84, No. 25, pp. 203–212 4 November 1971

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

ON A NEW SPECIES OF CALIFORNIA EARTHWORM, *HAPLOTAXIS ICHTHYOPHAGOUS* (OLIGOCHAETA, ANNELIDA)[1]

By G. E. Gates
Zoology Department, University of Maine, Orono 04473

Earthworms, on hooks, have been used, at least for one millenium by man as bait to catch fish. In California, the worm has turned, according to Briggs (1953), and even gets its fish as food without human assistance. Such worms may prove to be of considerable economic importance and should be of general interest because of the unusual diet and adaptation thereto.

Several examples received directly or indirectly from Briggs in 1951 were juvenile. Further material was requested in hope of securing adults to enable description of the genitalia. Again only juveniles were provided. Various subsequent efforts to obtain additional specimens all were futile.

Fortunately, researches of the last quarter century have shown that somatic megadrile anatomy, previously derogated or ignored by oligochaetologists of the classical school, is, rather generally, much more conservative phylogenetically than the genitalia. Accordingly a very short esophagus comprising parts functioning as a pharynx and as a gizzard, the long but simple intestine, presence of only two longitudinal vascular trunks, absence of hearts but presence of a pair of long and much looped, lateral (in sensu stricto) commissures in each segment, enabled assigning the Californian juveniles to the presently monogeneric family Haplotaxidae. Furthermore, pedestals of Timm under the nerve cord indicate to

---

[1] The worms were studied during research financed by the National Science Foundation.

which one of the few, little-known species of that family the new form seems most likely to be related.

Haplotaxis ichthyophagous new species

Material examined: California, Humboldt County. Prairie Creek near Orick, from 8 inches below gravel surface and under 6 inches of water near stream center, 15 March 1951, 8-0-0. J. C. Briggs (in part per Dr. C. Berkeley). Subsequently, 165-0-0. J. C. Briggs. Types and permanent transverse and longitudinal sections, at the Tall Timbers Research Station, Tallahassee, Florida.

External characteristics: Length at first could only be estimated as each worm was in a tightly coiled mass of loops 30–40 mm long, straightening then (1951) impossible without breaking the body wall. Length in mm/segment number (in 1961 by which time formalin as well as spirit specimens could be straightened without rupture), 205/339, 210/412, 250/433, 270/462. Diameter (maximum), of most specimens 2–2½ mm. Near the hind end thickness decreases to less than a millimeter. Color (formalin material), greyish in regions where gut contains black granules but elsewhere, i.e., in much of the body and most worms, only cuticular iridescence and muscular sheen is recognizable. A yellowish to brownish color, lacking in 1951, now (1961) characterizes specimens kept in spirit since receipt. Head, neck and dorsal pores, lacking. Mouth, ventral, 1 + mm from anterior end of body, transversely elliptical, always open, closure probably impossible but the anterior part of the body can be bent ventrally so as to conceal it from view. Anus, very small, perfectly circular, terminal. Annulation, intersegmental furrows obvious, one secondary presetal furrow in each metamere from v back for some distance but gradually becoming less obvious and finally unrecognizable in the posterior portion of the body. The presetal annulus is slightly less than half the length of the next portion of the segment.

Three furrows are recognizable in front of the first setae. The foremost is completely circumferential and marks off a large lobe distinguished by a pebbled appearance of its surface. A second furrow ends ventrally at the lateroanterior margins of the mouth. The third, though unrecognizable in the ventrum behind the mouth, elsewhere seemingly forms the anterior boundary of the first setigerous segment and so should be intersegmental furrow 1/2 unless deviation from normal is involved. Confirmation for that interpretation seemingly is provided by gonad locations in the usual haplotaxid segments x–xiii, if the first setigerous segment really is ii. But then, segment i is very short in the ventrum. However, three haplotaxid species supposedly do have a bipartite prostomium, perhaps somewhat as in the Californian worms. Here the anterior section is about twice the length of the other portion, and the two-part prostomium is about three times the length of the peristomium even dorsally. On the largest worms, length of the region from the anterior end to the postoral furrow (1/2) about equals combined lengths of ii–iii and presetal annulus of iv or even all of ii–iv.

Setae, four to two per segment, located about at the equators of the longer secondary annuli. Even in the last few segments where secondary annulation is lacking, the setae are nearer the posterior than the anterior intersegmental furrows. For convenience only, the dorsal setae are assumed to be the *d* shafts (which of course implies that the *b* and *c* setae had disappeared) thus enabling characterization of setal intervals as, AA ca. $= DD < AD$. The ventral setae are larger, protuberant to the exterior, with simply pointed tip posteriorly directed. A major ental portion of the shaft, from the nodulus just within the parietes, is nearly straight. The shorter external portion beyond the nodulus is slightly curved so as to be faintly suggestive of a shape characterizing *a* and *b* setae posteriorly (*cf.* Omodeo, 1958, fig. 4, p. 20) in *Pelodrilus falcifer.* A considerable portion of the shaft between the nodulus and the ectal tip is ornamented with frequently and irregularly interrupted circles of fine serrations. Dorsal setae are within the parietes and are lacking behind the 250th segment if not also from some more anterior level. Tips are simply pointed. No ornamentation was recognized.

Nephropores and genital apertures are unrecognizable. No indications of possible sites could be distinguished, even in microscope mounts of the cuticle. Nor is any trace of a clitellum distinguishable. Accordingly, all specimens were rated as juvenile.

Longitudinal greyish lines mL and mV, like similar lines sometimes visible at *A* and *D*, presumably are due to gaps in the longitudinal musculature.

The cuticle, in 1951, was firmly adherent and could not be removed without damage to the epidermis. Ten years later the cuticle of formalin material is wholly free of the epidermis but from alcoholic specimens still comes away with occasional bits of tissue attached. The cuticle is tough (cuts with difficulty), strong (does not tear easily) and seems to be thicker than in most megadriles. It is continued into the buccal cavity and to the hind end of the esophagus as well as into the parietes to form a lining of the setal follicles. Within the gut the cuticle seems to be thinner than externally. Inner ends of cuticular tubes lining the follicles are smooth and appear to have been in the region of the nodulus. Walls of the *a* tubules are thicker than those of the *d* tubules. Posteriorly very small dorsal tubules were without setae which presumably had been dehisced as the follicles atrophied. Thus, in cuticle of the 200th to 203d segments of one specimen only a single tube was found and no seta.

In the mounted cuticle, small markings like a plus sign each comprising four short and straight, dark lines from a dark dot, appeared to be scattered about in a random manner. They certainly are less numerous than the epidermal fenestrae. Pinkish patches, that appeared under the 16 mm objective of the inverting microscope to be circular spots of thinness, do have a more regular arrangement, being in equatorial circles in both segmental annuli, more numerous in the setal annuli, in several cephalic segments in bands rather than circles. The patches, under 4 mm objective, are resolved into closely crowded dark or pinkish dots in regular parallel rows so that each area now has a squarish or rectangular outline. Those patches probably are present throughout the body as they still are recognizable, though fewer in number, in cuticle from segments in front of the anus.

The epidermis is perforated, except in immediate vicinity of follicle apertures and at primary and secondary furrows, by small, closely crowded fenestrae so that the epidermis has a rather honeycomb appearance. Through those fenestrae circular muscle fibers are distinguishable. Each fenestra presumably indicates site of a unicellular mucus gland contents of which had disappeared completely. No trace of nephrophores or of genital apertures was recognized, either in cuticle or epidermis and even in vicinity of the follicle apertures. Because of location of the supposed nephridial ducts, possibility of their opening into setal follicles was considered but no evidence for it was recognized in cuticular tubes lining the follicles.

Internal anatomy: Septa, present at least from 5/6 which is somewhat funnel-shaped and bulged posteriorly, none especially thickened. The circular muscle layer is thin, seemingly only 3–5 fibers thick. The longitudinal muscle layer, in transverse section, certainly cannot be called pinnate and so presumably should be termed fasciculate. The size of the discrete muscle blocks varies from small to large and also from one section to another. The number of blocks may be as many as 20 or even more. Setal follicles protrude into coelomic cavities, the *d* follicles much less conspicuously. Two bandlike retractor muscles pass, close to the parietes, from each *a* follicle to the *d* follicle of its own side and segment. A single functional shaft is associated with each follicle aperture but *a* follicles often have one or two reserve setae, the smallest seen being no longer than the thickness of the functional shaft. A single reserve rarely is associated with a *d* follicle.

The digestive system comprises three macroscopically distinguishable regions, the buccal cavity, the next portion which is called esophagus and the intestine. Calciferous glands, caeca, typhlosoles and supraintestinal glands are lacking. The buccal cavity is large and its thin wall is firmly adherent to the parietes. The esophagus is white, thick-walled, with a slight flange at the posterior end on which is the insertion of septum 5/6, with but little external indication of demarcation into a pharynx and gizzard. The anterior portion (presumably to be regarded as pharyngeal) is circular in cross section. The posterior portion (presumably gizzard) is squarish in cross section and thereby distinguished from the circular cross section of most megadrile gizzards. Numerous muscle bands pass posterolaterally from the esophagus to the parietes. The gut behind 5/6, being of uniform calibre and without regional differentiation presumably is to be considered as all intestine. Chlorogogen may first be recognizable in vii in which case the intestine of vi is white like the esophagus. On each side of the intestine, slightly lateral to mD, a longitudinal ridge, seemingly uninterrupted for considerable distances, protrudes conspicuously into the gut lumen. The ridge is rounded, never lamelliform. In other regions of some specimens longitudinal ridges, also rounded, are protuberant from the dorsal surface of the gut, instead of into the intestinal lumen. These protuberances, in either case, always are filled with blood. These longitudinal sinuses, often elliptical to nearly circular in cross section, are so constant and regular as to seem to require special structure of the channel walls. They must contain most of the blood of the gut and perhaps a large portion of the total amount of the animal.

The vascular system has only two longitudinal trunks each of which runs from one end of the body to the other. The dorsal is slender, circular or nearly so in cross section, with a thick opaque wall seemingly covered with chlorogogen. The ventral trunk, usually much larger, thin-walled, and transparent, elliptical in cross section, deeply constricted in region of each septal insertion, bifurcates behind the mouth. Black bodies, seemingly aggregations of small granules, are just behind each of the constrictions. A small blood vessel was seen at anterior end of the prostomium but was not traceable to one of the major trunks. A pair of slender commissures just in front of each septum connects the dorsal and ventral trunks. Each commissure is much longer than height of the coelom and is looped, one long loop with closed end ventrally almost reaches the ventral parietes on lateral face of the *a* follicle. A vessel on the median face of each nephridium passes off ventrally and to the posterior septum where it becomes unrecognizable. Only the nephridial vessels and the dorsal spaces in the intestine were red, other vessels were colorless or perhaps slightly yellowish. Hearts are lacking.

Nephridia are lacking in the first 15 or 16 segments and are small (vestigial?) in xvii–xviii or xix. Posteriorly these holoic organs nearly fill coelomic cavities. Tubular structure is unrecognizable and if present is concealed by massive distention (by metabolites?) of the investing peritoneal cells. A slender cord (duct?) from the lower side of a nephridial mass passes ventrally, almost on the anteroventral face of an *a* follicle, and into the parietes. Nephric funnels were not seen.

The bilobed brain is pre-oral, nearly filling the coelomic cavity of its annulus which is assumed to be the hinder portion of the prostomium. Circum-oral commissures are long, slender, and unite at mV behind the mouth. Shortly behind the commissural junction the nerve cord is widened into two obvious ganglia that are fairly close to each other. Posteriorly the cord is ribbon like and with little indication of ganglionic widenings. Three pairs of nerves probably do pass out from the cord in each segment. Only a single giant fibre was recognized dorsally in cross sections of the cord. Nerve cord pedestals (organs of Timm) are present.

Gonads, fairly large, are present in x–xiii at the usual megadrile sites. Distal ends of those in xii and xiii are continued into three discrete and gradually narrowing processes. Such continuations were not seen in x–xi but could have been broken off and unrecognized. Rudiments of male and female funnels, gonoducts, seminal vesicles and ovisacs, or of any sort of genital glands were not seen.

Growth: Four small juveniles were available. Length, 76–113 mm. Maximum diameter, 1 mm. Setigerous segments, 184, 197, 210, 237. A metamerically undifferentiated region behind the last setigerous segment is little more than one tenth of a millimeter thick though 1–1+ mm long. Several slight furrows (possibly rudimentary intersegmentals?) may be indicated. The anus is of the usual pin-prick sort.

Post embryonic growth, in *H. ichthyophagous*, presumably involves production of new segments.

Regeneration: Tail regenerates: 1) Small, conical bud, much narrower than the substrate, metamerically undifferentiated, anus terminal, at 260/261. 2) Tail had been lost at 265/266 along with ventral halves of 263'd to 265th segments. Missing ventral tissues had been replaced but were marked off into 7 setigerous segments. Remainder of the regenerate comprised 13 setigerous segments and a terminal region with several rudimentary intersegmental furrows but no setae. 3) At 277/278, regenerate with 15 setigerous segments followed by two asetal segments and the periproct. 4) Tail had been lost at 284/285 along with left half of the 284th segment. Regeneration bud, distal and bluntly rounded, without indications of metameric differentiation, had been growing posterolaterally from left side of the 284th segment. 5) At 327/328, a regenerate about 2½ times length of last substrate segment, without metameric differentiation. 6) At 330/331, regenerate with six setigerous segments, and a terminal region in which rudimentary intersegmental furrows are recognizable but no setae. 7) At 347/348 a 24 segment regenerate, the proximal segment and the periproct without setae. 8) At 356/357, a regenerate about 1 mm long apparently marked off by rudimentary furrows into several segments none of which is setigerous.

The anus is terminal, in each case, and of the usual pin-prick sort. At distal end of regenerate No. 5, there is a slight transverse cleft at bottom of which is the anal aperture.

Some specimens, perhaps nearly a dozen, may be unregenerate posterior amputees. (Posterior ends of 23 worms had been broken off at time of collection or subsequently.)

Abnormality: Metameric abnormality should be easily recognizable as intersegmental furrows are distinct. Only two abnormal segments were noted, in the middle of the body of two specimens. No. 1. Segment with setae but length about equal only to the posterior secondary annulus of neighboring metameres. No. 2. Segment without setae, about half as long as adjacent metameres, somewhat asymmetrical as the left side is shorter. No. 3. A caudal growth of 12 setigerous segments and periproct from right-side of 264th and 265th segments of a worm with 285 segments and a short area with rudimentary intersegmental furrows but no setae recognizable. A branch from the gut of the main axis passes through the outgrowth to a terminal anus of the usual sort. The nerve cord of the appendage emerges from the parietes well lateral to the main cord and apparently as a thickening of a lateral nerve. No. 4. Anus of one worm longitudinally slitlike, dorsal, lateral margins in apposition, without a terminal lobe.

Ingesta: The gut usually was empty except for black granules in a short pre-anal region.

Biology: *H. ichthyophagous* lives at unknown depths in the gravel of northern California streams. It is believed (Briggs, 1953) to be able to detect presence of salmon eggs from considerable distances. During February–May, the worms aggregate to a depth of a foot in the redds where salmon and trout had deposited their eggs, 400 + worms having been found in a single redd. The worms give off mucus copiously and that was thought to kill the fish embryos more by oxygen deprivation than by toxicity. No mechanical damage to fish eggs was evident and worms were believed to feed on the yolk only after decomposition had ruptured the tough outer chorion.

A very strong odor proved that these worms really had been associated with fish.

The species presumably should be called limocolous rather than aquatic. Haplotaxids have been thought to be inhabitants of wells or other subterranean waters primarily because most specimens known were secured from just such or similar situations. However, Thienemann (1912) and Hesse (1923) maintained that *H. gordioides* really is terrestrial and breeds only in earth.

Remarks: The formalin specimens provided a control for color which appeared only in alcoholic material. References to golden, yellow, and yellowish-brown color of earthworm specimens in classical descriptions then are likely to have no taxonomic significance. Long enough stay in alcohol sometimes does produce a browning of tissues in which little optical differentiation is recognizable. A yellow color at posterior end of the body of certain megadriles may be due to accumulation in coelomic cavities of detached chloragog cells.

When first received the completely circumferential furrow marking off the prostomium into two segments was invariably obvious. That furrow, as one result of the softening and relaxation that has taken place during the last 19 years, now seems less distinct or even in part lacking. Reports as to intraspecific variation of the furrow may then have little significance. Apparent absence in any species with an elongated prostomium may also be an artefact.

The mouth of most megadrile oligochaetes is terminal. If the oral segment of the California worms is the same as the buccal segment of other megadriles, then the prostomium has been enlarged, extended anteriorly and demarcated into two portions. The mouth also has been enlarged at the expense of the peristomium which is very short ventrally.

Histological structure of the short esophagus may be quite different from that of most megadriles in which case adequate histological characterization may provide additional differences of systematic importance.

Mention now is made of only one of the interesting questions posed by the species: Is presence of the brain in the prostomium, instead of somewhere in the pharyngeal region of ii–iv as in most megadriles, primitive or secondary?

Systematics: The California worms are distinguished from those of all other megadrile families by several unusual characters. Unfortunately none of them was allowed any importance in the past when oligochaete systematics was mainly concerned with setae and genitalia. In the latest key to species of the Haplotaxidae (Brinkhurst, 1966, p. 44), the present form runs down to *H. gordioides* (Hartmann, 1821). That species now has been recorded from Denmark, Germany, Poland, Russia, Belgium, France, Switzerland, CSR, Jugoslavia, Hungary, Italy, Corsica, Central Asia, Siberia (including Kamchatka), Japan, and Washington, Illinois, Indiana, Ohio, Virginia and New York states. All other earthworm ranges presently equalling or approximating that of *H. gordioides* were attained as a result of transportation by man. No records have been found of interception of haplotaxids. However, the European *Criodrilus laccum* Hoffmeister, 1845, also never intercepted, was introduced to North America at least once though probably without attainment of domicile. Furthermore, mud along with aquatic plants is known to have been carried around the world.

If, however, the present range of *H. gordioides* was self-attained the time involved, especially in view of the restricted habitat, would seem to have been much greater than that which would have allowed considerable speciation in so wide a domain. Such evolution of course should be expected first of all in the reproductive system.

From *H. gordioides* as now defined, the Californian taxon is distinguished, in absence of so much data about somatic systems, only by the setal ratio $AA = DD < AD$ instead of $aa = al$, $al >$ or $= ld$, $aa = \frac{1}{2}dd$.

Information also is lacking about segment number in *H. gordioides.* Neither Michaelsen (1900) nor Brinkhurst (1966) mention that character in their definitions nor in those of one other pre-1900 species. The California taxon is defined tentatively by its somatic anatomy alone as follows.

Digestive system, with a transversely elliptical, permanently open mouth, large buccal cavity in ii with its wall firmly adherent to the parietes, a short, thick-walled esophagus in iii–v without obvious external demarcation into pharynx and gizzard, an intestinal origin in vi, a terminal pin-hole anus, but without intestinal caeca and typhlosoles or calciferous and supra-intestinal glands. Vascular system, with complete dorsal and ventral but no other longitudinal trunks, with a large vascular space in intestinal roof on either side of mD, with long, looped, segmental vessels connecting longitudinal trunks but without hearts. Excretory system, of holoic nephridia (avesiculate?), lacking in interior segments, with investing peritoneal cells distended by metabolites, ducts passing into parietes in region of *A*. Nephropores, inconspicuous, (in vicinity of *A*?). Nervous system, with brain in prostomium, two ganglia in anterior end of nerve cord but little evidence of ganglionic widenings elsewhere, with but one small dorsal giant fibre. Pedestals of Timm, present. Septa, present from 5/6, none especially thickened. Circular muscle layer, thin. Longitudinal muscle layer, fasciculate, muscle blocks numerous and with marked variation in size and number. Setae, four per segment, two dorsal, small and disappearing posteriorly, two ventral, much larger, with posteriorly directed, simply pointed tip, anteriorly AA ca. $= DD < AD$. Head, neck and dorsal pores, lacking. Prostomium, long, marked off by an annular furrow into two segments. Segments, to 462, with posthatching production of new metameres. Size to 270 by 2½ mm.

Some of those characters will be definitive at genus if not at family level. Little is to be gained by guessing as to which characters and at what level. Good generic characters are those which are invariant in all species of the genus, just as good species characters are those that are invariant in all normal individuals of the taxon. What is invariant in one megadrile genus may vary interspecifically or even intraspecifically elsewhere. However, the author is inclined to think that some vascular characters may prove to be definitive at the family level.

According to Stephenson (1930, p. 803) "The interest of the family lies in its probably having given origin to all the families of the Megadrili—'the earthworms'. The scattered distribution represents the remains of a formerly general occurrence of the family, and the surviving members are relicts." The Haplotaxidae, according to Brinkhurst (1966), "may be regarded as primitive or, more reasonably, as descendants of a primitive group of oligochaetes." The esotery on which the classical system was based is now known to have been erroneous. *Eohippus* could not give rise to *Equus* while remaining *Eohippus* (cf. Stephenson, 1930, p. 711). The sole reason previously for believing haplotaxids to be ancestral or even primitive is the possession of only four pairs of gonads located in segments x–xiii. Evidence accumulating slowly since 1907 indicates that such an octogonadal battery is by no means primitive and that early megadriles are likely to have had a much longer series of gonads perhaps extending through v–xx or even further back.

Megadrile, as indicated above in the quotation from Stephenson, means earthworms. They are in the following families: Acanthodrilidae, Alluroididae, Criodrilidae, Eudrilidae, Glossoscolecidae, Haplotaxidae, Hormogastridae, Lumbricidae, Megascolecidae, Microchaetidae, Moniligastridae, Ocnerodrilidae, Octochaetidae, Sparganophilidae. Those megadrile families in formal classifications are called by Michaelsen (1930) Oligochaeta opisthopora or by Yamaguchi (1953) Opisthopora diplotesticulata. Non-earthworm oligochaetes are microdriles. The size indications are in general valid even though a few megadriles are smaller than an occasional large microdrile. Ectoparasitic worms formerly regarded as oligochaete now are in distinct groups, the Acanthobdellida and Branchiobdellida.

The Haplotaxidae, along with the Alluroididae, and to a lesser extent the Moniligastridae, are of interest because of certain characters shared with microdriles, such as: 1) Seminal vesicles and ovisacs, when present, are simple, unpartitioned, posteriorly directed outpocketings of the septa. 2) Ova, large and yolky. 3) A supposedly unilayered condition of the clitellum though that has been denied for at least one of the families. 4) Location of male pores in front of the female pores. However, it should be noted that in one rather common morph of a widely distributed European lumbricid, the parthenogenesis has enabled a return to the microdrile condition.

LITERATURE CITED

BRIGGS, J. C. 1953. The behavior and reproduction of salmonid fishes in a small coastal stream. State of California Department of Fish and Game, Marine Fisheries Branch, Fish Bull. No. 94, pp. 62.

BRINKHURST, R. O. 1966. A taxonomic revision of the family Haplotaxidae (Oligochaeta). Jour. Zool. London, 150; 29–51.

HESSE, E. 1923. Sur l'habitat de *Haplotaxis gordioides* G. L. Hartmann. Bull. Soc. Zool. France, 48; 138–140.

MICHAELSEN, W. 1900. Oligochaeta. Das Tierreich, 10, pp. xxix + 575.

————. 1930. Oligochaeta. IN: Kukenthal & Krumbach, Handbuch der Zoologie, 2, (2–8); 1–118.

STEPHENSON, J. 1930. The Oligochaeta. Oxford, xiii + 978 pp.

THIENEMANN, A. 1912. *Haplotaxis gordioides* G. L. Hartmann als terrestrischer Wurm. Arch. Hydrobiol. 19; 377.

YAMAGUCHI, H. 1953. Studies on the aquatic Oligochaeta of Japan. VI. Jour. Fac. Sci. Hokkaido Univ. (6, Zool.), 11; 277–342.

Vol. 84, No. 26, pp. 213–224 4 November 1971

PROCEEDINGS

OF THE

BIOLOGICAL SOCIETY OF WASHINGTON

TARDIGRADA FROM THE BARRANCA DEL COBRE, SINALOA AND CHIHUAHUA, MEXICO

By Robert O. Schuster
Department of Entomology,
University of California, Davis, 95616

Tardigrades from four localities along the Barranca del Cobre were collected by T. A. Sears, R. C. Gardner, and C. S. Glaser in July, August, and September of 1969[1]. The four towns around which the collections were made are: Choix, Sinaloa, 275 m elevation; Temoris, Chihuahua, 1,370 m; Cuiteco, Chihuahua, 1,710 m; and Creel, Chihuahua, 2,195 m. No climatological records are available for these localities, but local habitat information is summarized in the discussions for each tardigrade species.

Over 150 samples consisting mainly of lower plants were processed. These samples were washed in the field; the specimens were fixed in boiling water and preserved with formalin. The tardigrades subsequently were mounted on slides in an iodine-Hoyer's medium. All descriptions, measurements, and illustrations are from these slide-mounted specimens.

The important characteristics of each species are briefly discussed or illustrated. The Tardigrada of Mexico are essentially unknown, and compilation of this information for the fauna of one area may both stimulate and facilitate further inquiry.

Echiniscus Schultze, 1840

Echiniscus viridis Murray, 1910

Figures 1, 2

This species is distinguished by a dark green color, by a polygonal cuticular pattern (Fig. 2), and by the short (30 μ–40 μ) lateral spine A (Fig. 1,a).

---

[1] T. A. Sears and R. C. Gardner were in Mexico with support from an American Philosophical Society Grant, 5192 Penrose Fund.

Five specimens with lengths between 175 μ and 300 μ were recovered from a lichen and a small bromeliad, *Tillandsia recurvata* (L.) L., growing on the face of a cliff at Cuiteco, 14 September 1969. A single specimen was taken from lichen on a tree in Creel, 8 September 1969.

Echiniscus tamus Mehlen, 1969

Figures 3–6

Emended description. Length to 235 μ exclusive of legs IV. Eyes absent. Cuticle of anterior half of plate pairs I and II, anterior margin of median plate II, and median plate III of separate, raised polygons (Fig. 3); remaining plates with pores of about 1 μ diameter, cuticle between pores consisting of minute rounded tubercles, appearing as uniformly neutral background with irregular dark spots at high magnification (Fig. 4), neutral with fine dark stipple and irregular pores at low magnification (Fig. 5); ventral surface smooth. Head plate divided into small anterior and large transverse posterior pieces; scapular plate incised posterior to spine A; end plate incised, not facetted. Internal buccal cirrus (Fig. 3, i) basally enlarged, about 14 μ long; papilla about 8 μ (Fig. 3, p); external cirrus (Fig. 3, e) basally enlarged, about 22 μ long. Leg I with small spine, II and III with minute papilla, IV with basal papilla, faintly sculptured, with dentate collar of about 8 teeth; internal claws of legs I–IV with weak basal spur, external claws simple (all claws of holotype simple).

The only previous record of the species is the type locality in College Station, Texas. The type was collected from lichen on *Quercus stellata* Wangenh. and is deposited as number 38917 in the Division of Worms, National Museum of Natural History. Nineteen examples were collected at Cuiteco, Chihuahua, Mexico on 14 September 1969, from bromeliads, *Tillandsia recurvata* (L.) L., on the face of a rock cliff. Four additional specimens were taken at the same locality from a lichen, *Usnea hirta* (L.) Wigg. These specimens vary in length from 180 μ to 235 μ.

This species is unique within the *E. arctomys* group because of the structure and distribution of the two types of cuticular patterns. It is

---

→

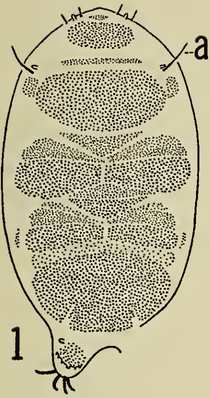
FIGS. 1, 2. *Echiniscus viridis.* 1. Dorsal view. 2. Detail of cuticular pattern.

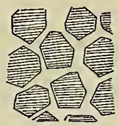
FIGS. 3–6. *Echiniscus tamus.* 3. Dorsal view. 4 and 5. Cuticular pattern (fine stipple on Fig. 3). 4. High magnification. 5. Low magnification. 6. Cuticular pattern (coarse stipple on Fig. 3).

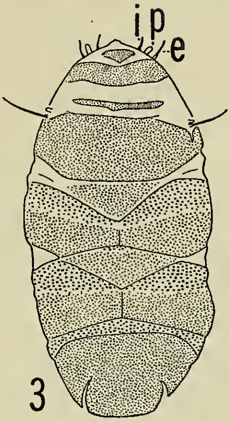
FIGS. 7–9. *Pseudechiniscus* sp. 7. Dorsal view. 8. Cuticular pattern (area is 0.085 μ sq.). 9. Bilobed pseudosegmental plate.

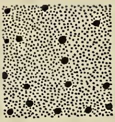
FIG. 10. *Pseudechiniscus suillus facettalis.* Cuticular pattern.

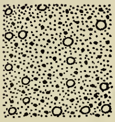
FIGS. 11–13. *Macrobiotus richtersi.* 11. Egg. 12. Claws of leg IV, unpaired claw is lateral view. 13. Buccal tube and placoids.


1

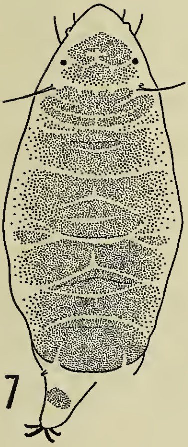

2

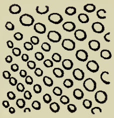

3


4


5

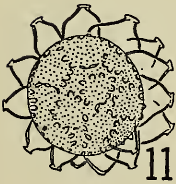

6

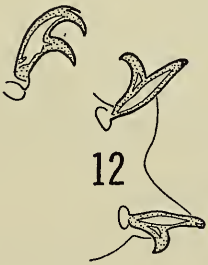

7

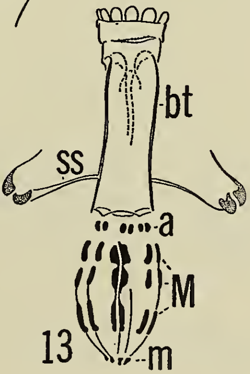

8


9


10


11


12


13

somewhat similar to *E. rufoviridis*, which I have not seen but that species is described as having a partially green cuticle as well as claws without basal spurs.

Pseudechiniscus Thulin, 1911

Two species of this genus were collected at Cuiteco. Both belong to the *P. suillus* group which is characterized by the absence of lateral spines except in position A. The species from Cuiteco have similar dorsal facies (Fig. 7).

The *P. suillus* group needs revision, and I am unable to identify one of the two species present in the Cuiteco collections.

Pseudechiniscus species

Figures 7–9

This species is recognized by the following characters: granulation of cuticle (Fig. 8) uniform, circular, 0.85 μ or less in diameter; posterior margin of pseudosegmental plate weakly bilobed (Fig. 9); buccal papillae very short.

Of the two described species in which the pseudosegmental plate is bilobed, *P. ramazzottii* Maucci has coarse cuticular granulation and globose buccal papillae, and *P. scorteccii* Franceschi has two conical processes on the terminal plate. This species keys to *P. ramazzottii* in Ramazzotti's monograph (1965), but is incompatible with the description of that species.

Thirteen specimens are from Cuiteco, 11 September 1969, and were collected in lichens on northerly exposed rocks near a stream. The shortest is 135 μ long and the longest is 200 μ.

Pseudechiniscus suillus facettalis Peterson, 1951

Figure 10

This species is easily distinguished from the previous by the granulation of the cuticle which is polygonal, the granules often in excess of 1.0 μ in diameter, and at times faintly interconnected (Fig. 10). The cephalic and terminal plates are sharply deflexed laterally, giving these plates a facetted appearance.

Specimens identified by previous workers have not been seen, and the determination is based on literature. The species has been reported from Greenland, Italy, and Tierra del Fuego. Thirty specimens ranging in lengths from 135 μ to 205 μ were recovered at Cuiteco, 11 September 1969, from lichens on a bank of rocks with a north exposure. Although the collections were from the same site at which the preceding species was found, the two species were mutually exclusive in seven out of eight samples.

Macrobiotus Schultze, 1834

The genus *Macrobiotus* is distinguished by the buccal tube (Fig. 13, bt) having a ventral support (Fig. 19, vs), and the two double claws of each leg being of similar size and shape. The closely related genus *Hypsibius* has dissimilar claws and the buccal tube usually lacks the ventral support. The one exception considered here is *Hypsibius evalinae* Marcus, a species with a well-developed buccal tube support. The species of *Macrobiotus* from the Barranca del Cobre are quite distinctive and can be recognized by the proportions of length to width of the buccal tube and by the number and shape of the placoids (Fig. 13, M = macroplacoid, m = microplacoid).

Macrobiotus richtersi Murray, 1911

Figures 11–13

Macrobiotus richtersi is recognized by a wide buccal tube with the stylet supports (Fig. 13, ss) attached basally. The pharynx contains the apophyses (Fig. 13, a), three macroplacoids, and microplacoids. Eye spots are absent. The egg (Fig. 11) is of value in the identification of this species.

M. richtersi is represented by 26 specimens, and is apparently restricted to moist habitats. Nine samples from four areas contained this species. These were: Temoris, 4.8 km SSW, 28 August 1969, lichen on oak log in wet, shady forest; Cuiteco, 6 September 1969, mixed lichen and moss on rock in seepage from a spring; Cuiteco, 10 September 1969, club moss in crevices in wet bank; Cuiteco, lichen on rocks near stream.

Macrobiotus areolatus Murray, 1907

Figure 14

The buccal tube and macroplacoids are similar to those of *M. richtersi*, but the stylet supports are attached more anteriorly, and microplacoids are absent. Eye spots are present.

One-hundred fourteen specimens were collected at 1.6 km NE, 3.2 km N, 4.8 km SE, and 4.8 km SSW Temoris, at Cuiteco, and at Creel. Eighteen samples in which this species was found were of lichens, mosses, mushrooms, and bromeliads, and were from both wet and dry situations. Body length ranged between 200 μ and 800 μ.

Macrobiotus harmsworthi coronatus Barros, 1942

Figures 15, 16

The stylet supports of this species are attached at a distance from the base of the buccal tube of at least one diameter of the tube. The pharynx contains small apophyses, three macroplacoids of which the third is slightly longer, and elongate microplacoids. Eye spots are absent. The egg is about 100 μ in diameter and has processes as illustrated in figure 15.

This animal is the same as that reported from the Galàpagos by Schuster and Grigarick (1966), and from Santa Cruz Island, California, (Schuster and Grigarick, 1970). It differs from the nominate subspecies mainly by the absence of eyes, and by the processes of the egg which are more elongate and sometimes distally bifurcate.

The variation of characters attributed to this species, especially characters of the eggs, is greater than should be expected. When specimens become available from more localities, *M. harmsworthi* might well be re-evaluated.

Sixty-eight specimens were found in one sample from Temoris and 17 samples from Cuiteco. The Cuiteco samples were all from moist or shaded habitats, specifically: moss and *Selaginella* on wet banks, mosses and lichens on rocks near a stream, and lichen on a boulder in a deep canyon.

Macrobiotus hufelandii Schultze, 1833

Figures 17, 18

The pharynx of *M. hufelandii* contains the apophyses, two macroplacoids with the first incised near middle, and microplacoids. Eye spots are present. Sixty-one specimens ranged in length from 260 μ to 470 μ. The buccal tubes are between 38 μ and 50 μ in length and 4 μ to 7 μ in width. Increased length and width measurements of the buccal tube are fairly well correlated to the overall length of the specimen. Eggs of this species were not found.

These specimens were from one sample at Temoris and 17 samples at Cuiteco. The species was found in the same habitats as *M. harmsworthi* and, with few exceptions, in the same samples.

Macrobiotus intermedius Plate, 1888

Figures 19, 20

This species is recognized by a thin (2.5 μ diameter for a tube length of 30 μ) buccal tube that is deflexed anteriorly, and the stylet supports which are attached near the middle. The round pharynx contains apo-

---

→

Fig. 14. *Macrobiotus areolatus.* Buccal tube, placoids, eye spots.

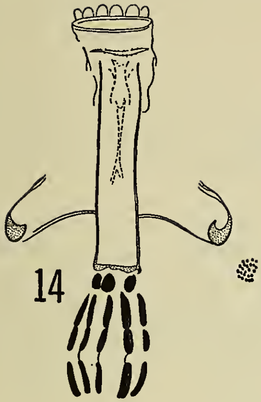
Figs. 15, 16. *Macrobiotus harmsworthi coronatus.* 15. Processes of egg. 16. Buccal tube and placoids.

Figs. 17, 18. *Macrobiotus hufelandii.* 17. Claws of leg IV. 18. Buccal tube, placoids, and eye spots.

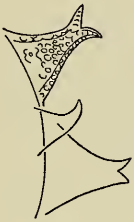
Figs. 19, 20. *Macrobiotus intermedius.* 19. Buccal tube, placoids, and eye spots. 20. Claws of leg IV.

Figs. 21–24. *Hypsibius* sp. 21. Claws of leg IV. 22. Detail of gibbosities. 23. Dorsolateral view. 24. Buccal tube and placoids.

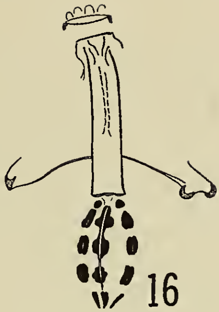
Figs. 25, 26. *Hypsibius evalinae.* 25. Buccal tube and placoids. 26. Claws of leg IV.



14

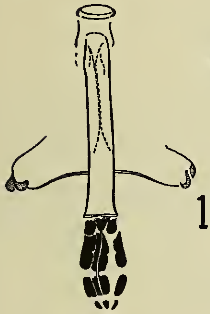


15

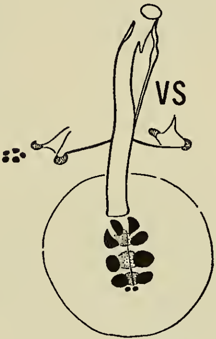


16

17



18



19

20

21

22

23

24

25

26

physes of a size subequal to the first macroplacoids, two macroplacoids, and microplacoids. Eye spots are present but small. The range for body length was between 150 μ and 310 μ.

The distinction between three species, *M. ascensionis*, *M. intermedius*, and *M. subintermedius* is based on the morphology of the egg. Unfortunately the egg stage was not recovered. I have tentatively determined these specimens as *M. intermedius*, a common North American species as discussed by Riggin (1962).

Although *M. intermedius* was found in 18 samples, it was not abundant and only 72 specimens were recovered. One collection was from 3.2 km N of Temoris, 19 July 1969, one was from 6 km SW of Temoris, 2 September 1969, and 16 were from Cuiteco, on various dates from 30 August to 21 September 1969. Specimens were recovered from both dry and wet situations, and plant associations include lichens, mosses, *Selaginella*, and bromeliads.

Hypsibius Ehrenberg, 1848

Hypsibius (? *Isohypsibius*) species

Figures 21–24

A considerable number of *Hypsibius* species have been based on the number, size, and location of dorsal gibbosities in various ranks and files. A single specimen in our material is a poor preparation and the number and placement of the gibbosities cannot be determined. The specimen, 170 μ long, was collected at Cuiteco, 6 September 1969, from *Selaginella* in a rocky, spring fed seep.

Hypsibius (*H.*) *evalinae* Marcus, 1928

Figures 25, 26

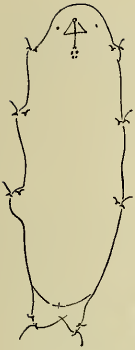
The buccal tube of this species is deflexed in lateral view (Fig. 25), and the pharynx contains the apophyses and two macroplacoids, with the first placoid incised at the middle. Eye spots are present. Each leg has a gibbosity anterolaterally; those of smaller individuals are smooth and those of larger specimens are slightly tuberculate.

The gibbose areas of the legs are not as markedly tuberculate as indicated in the literature for either European or Brazilian populations, but the difference is in degree of development and is probably not specific.

→

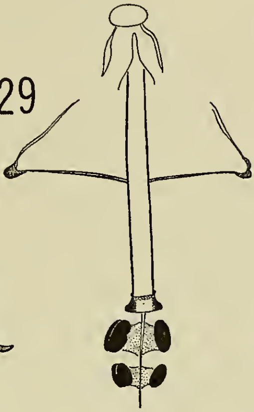
Figs. 27–29. *Hypsibius convergens.* 27. Dorsal view. 28. Claws of leg IV. 29. Buccal tube, placoids, and eye spots.

Figs. 30, 31. *Itaquascon umbellinae.* 30. Buccal tube. 31. Claws of leg III.



27

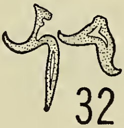
29



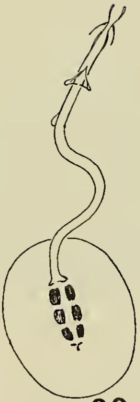
28

30

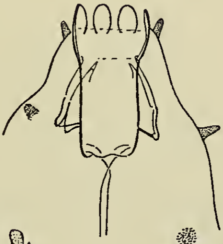
31



32



33



34

35

Figs. 32, 33. *Hypsibius chilenensis.* 32. Claws of leg IV. 33. Buccal tube and placoids.

Figs. 34, 35. *Milnesium tardigradum.* 34. Buccal tube and eye spots. 35. Claws of leg IV.

Forty-five specimens of lengths between 170 μ and 445 μ were collected at Cuiteco, 11 September 1969. The specimens were found in 10 samples of mosses and lichens collected from a northerly exposed bank of rocks near a stream.

Hypsibius (*H.*) *convergens* (Urbanowicz, 1925)

Figures 27–29

A very thin buccal tube (2.1–2.8 μ) with the stylet supports attached near the middle, and a pharynx containing apophyses and two unequal macroplacoids (Fig. 29) are characteristic of this species. The interior surface of the first macroplacoid is weakly incised. Eye spots are present.

Single specimens were collected at Temoris, 10 September 1969, from the base of an oak stump, and at Cuiteco, 11 September 1969, from a bank of rocks near a stream. Seventeen specimens were collected at Creel, 8 September 1969, in open oak and pine forest. The shortest specimen is 185 μ long and the longest is 280 μ.

Hypsibius (*Diphascon*) *chilenensis* Plate, 1888

Figures 32, 33

The buccal tube is very thin, 23 μ long and 1.7 μ diameter for a specimen 200 μ long (Fig. 33). The pharyngeal tube is the same diameter and about 30 μ long. The pharynx is oval and contains apophyses, three macroplacoids of equal length, microplacoids, and a septulum. Eye spots are absent.

Two specimens, 200 μ and 210 μ long, were collected at Cuiteco, 9 August 1969 from a sample of shelf fungus on a dead oak branch; the tree was in a small arroyo with a northerly exposure.

Itaquascon Barros, 1939

Itaquascon umbellinae Barros, 1939

Figures 30, 31

The buccal tube (Fig. 30) is very thin, approximately 2 μ in diameter, and the posterior end is not annulate.

Two specimens, 190 μ and 300 μ long, were collected at Cuiteco, 11 September 1969 from moss on a rocky bank near a stream. All of the New World collections of *Itaquascon* have been referred to *umbellinae*, mainly because the buccal tubes have a diameter of less than 2½ μ.

Milnesium Doyére, 1840

Milnesium tardigradum Doyére, 1840

Figures 34, 35

Specimens of *M. tardigradum* are recognized by the two pairs of cephalic papillae, a short, wide buccal tube, and the absence of placoids

(Fig. 34). One of each pair of double claws has only a single branch (Fig. 35).

A common and cosmopolitan species, 103 specimens of *M. tardigradum* were present in 21 separate samples from Temoris, Cuiteco, and Creel. *Milnesium* was found in a variety of habitats, which for Cuiteco included shelf fungus on dead oak; liverwort in crevices of wet bank; lichens and mosses in many situations on living and on dead trees, on rocks in spring seepage, in drier areas in filtered sun beneath oaks, and on rock cliffs.

Discussion: The 158 samples were distributed as follows: Choix 6, Temoris 85, Cuiteco 55, and Creel 12. Fifteen species of tardigrades were recovered from these samples. I expect that a few additional species would have been found if the areas around Choix and Creel had been sampled as extensively as Cuiteco and Temoris. One or two aquatic species should also occur in the streams, but the interstitial habitat was not examined.

Seven of the 15 species from the Barranca del Cobre are cosmopolitan. These species are *Macrobiotus richtersi*, *M. areolatus*, *M. hufelandii*, *M. intermedius*, *Hypsibius convergens*, *H. chilenensis*, and *Milnesium tardigradum.* Five of the remaining species are widespread, occurring on two or more continents. This group includes: *Echiniscus viridus*, *Pseudechiniscus suillus facettalis*, *Macrobiotus harmsworthi coronatus*, *Hypsibius evalinae*, and *Itaquascon umbellinae.* Two of the species are unidentified, and only one, *Echiniscus tamus*, is known from only North America.

There is no indication of endemism for this assemblage of species and, because the tardigrade fauna of Central America is so poorly known, the species composition cannot be compared with that of adjacent areas.

Acknowledgments: Dr. William A. Weber, University of Colorado, and Drs. Lyman B. Smith and Amy Jean Gilmartin, National Museum of Natural History, kindly identified the plant species of *Usnea* and *Tillandsia.*

LITERATURE CITED

RAMAZZOTTI, G. 1965. Il Phylum Tardigrada (1° Supplemento). Mem. Ist. Ital. Idrobiol. 19: 101–212.

RIGGIN, T. G., JR. 1962. Tardigrada of southwest Virginia: with the addition of a description of a new marine species from Florida. Virginia Agr. Exp. Sta. Tech. Bull. 152: 1–145.

SCHUSTER, R. O., AND A. A. GRIGARICK. 1966. Tardigrada from the Galapàgos and Cocos Islands. Proc. Calif. Acad. Sci. 34(5): 315–328.

————. 1970. Tardigrada of Santa Cruz Island, California. Pan-Pacific Entomol. 46(3): 184–193.

Vol. 84, No. 27, pp. 225–230 4 November 1971

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

LYSIOSQUILLA PANAMICA, A NEW STOMATOPOD CRUSTACEAN FROM THE EASTERN PACIFIC REGION

By Raymond B. Manning
Smithsonian Institution, Washington, D.C. 20560

In 1940 Waldo L. Schmitt referred to two specimens of a *Lysiosquilla* collected by the 1933 Allan Hancock Pacific Expedition at La Libertad, Ecuador, which he identified with *Lysiosquilla maculata* (Fabricius). He noted that this species had a wide Indo-Pacific distribution but had not been recorded previously from east of the Marquesas or Hawiian Islands. Subsequently, Edward F. Klima, then associated with the Inter-American Tropical Tuna Commission, forwarded to me a *Lysiosquilla* collected in the Gulf of Panama. During a review of the Indo-West Pacific species of *Lysiosquilla*, the specimens mentioned by Schmitt and that received from Klima were compared with the large series of *L. maculata* in the Division of Crustacea, National Museum of Natural History (USNM) and were found to represent a distinct species which is described below.

I thank Edward F. Klima for his aid in obtaining collections of stomatopods from the Pacific coast of Panama and from Ecuador as well; Janet Haig, Allan Hancock Foundation (AHF), for the loan of one of the specimens originally recorded by W. L. Schmitt; L. G. Abele, School of Marine and Atmospheric Sciences, University of Miami, for making available material collected off both coasts of Panama; and Horton H. Hobbs, Jr., for his comments on the manuscript. The illustrations were made by my wife Lilly. The support of the Research Awards Program of the Smithsonian Institution is acknowledged.

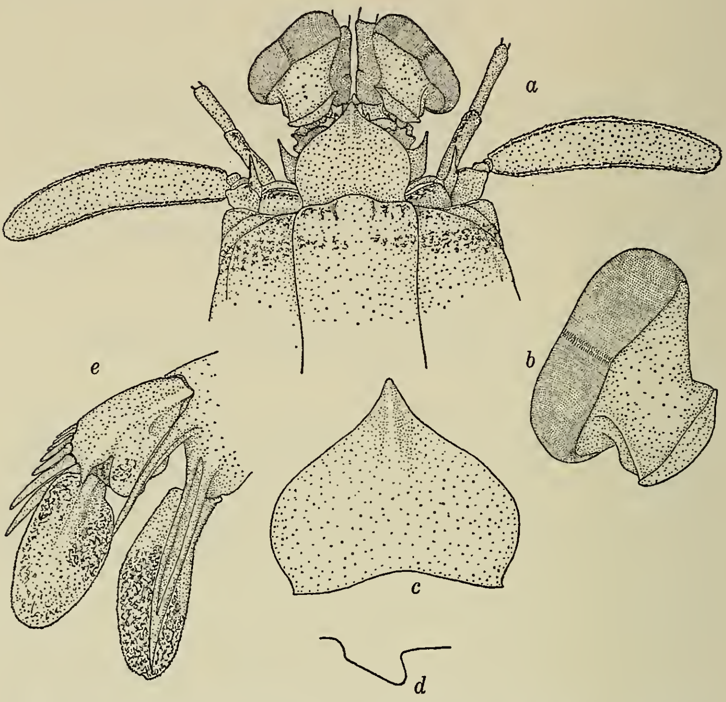


FIG. 1. *Lysiosquilla panamica* new species, male paratype: *a*, anterior portion of body; *b*, eye, enlarged; *c*, rostral plate, enlarged; *d*, outline of ventral keel of eighth thoracic somite; *e*, uropod, ventral view. (Setae omitted; anterolateral angles of carapace wrinkled).

Lysiosquilla panamica new species

Figure 1

Lysiosquilla maculata.—Schmitt, 1940: 190, figure 21 [not *L. maculata* (Fabricius)].

Holotype: ♂, total length 163 mm; Pacific Ocean, Panama, Gulf of Panama; 08°40′ N, 79°40′ W; 50 feet, mud; commercial shrimp trawler; Inter-American Tropical Tuna Commission; 30 June 1959; USNM 136689.

Paratypes: 1 ♂, total length 105 mm; La Libertad, Ecuador; dip net at night light; F. Ziesenhenne, Allan Hancock Pacific Expedition station 17–33; 20 January 1933; USNM 68582.—1 ♀, total length 95 mm; same data; AHF 337.—1 ♂, total length 92 mm; Pacific Ocean, Panama, Gulf of Panama, Gulf of Chiman at mouth of river and out around islets; 3–8 meters; mud; L. G. Abele, col.; 27 May 1969; USNM 137111.

Description: Eye large, cornea bilobed, set slightly obliquely on stalk. Eye extending about to end of second segment of antennular peduncle. Ocular scales erect, triangular, apices inclined anteriorly. Corneal indices 291 to 404 in specimens with carapace lengths of 16.2 to 29.5 mm.

Antennular peduncle half or slightly more than half as long as carapace. Dorsal processes of antennular somite visible lateral to rostral plate as sharp, anteriorly-directed spines.

Antennal scale slender, curved, length more than 3 times greatest width (length/width ratio ranging between 3.25 and 3.76), more than half as long as carapace; scale outlined by dark pigment. Antennal peduncle extending about to anterior margin of eye. Antennal protopod with sharp, triangular anterior projection, directed anterolaterally, above articulation of antennal peduncle; protopod with 1 mesial and 2 ventral papillae.

Rostral plate cordiform, broader than long, apex slightly deflexed. Low median carina present on anterior third.

Dactylus of raptorial claw with 11 teeth, proximal very small, outer margin of dactylus slightly sinuate. Propodus of claw longer than carapace; propodal indices 073–087 in males, 081 in females. Dorsal tooth of carpus of claw directed along longitudinal axis of claw, apex not noticeably deflexed.

Mandibular palp and 5 epipods present.

Ventral keel of eighth thoracic somite produced into erect, triangular projection, apex unarmed, inclined posteriorly.

Abdomen smooth, unarmed dorsally. Sixth somite smooth medially, submedian areas irregularly wrinkled, with broad, smooth lateral boss on each side flanked mesially by longitudinal groove. Sixth somite with triangular projection ventrolaterally anterior to articulation of each uropod.

Telson broader than long, with low, raised, smooth, triangular median boss and 2 lower, eroded submedian bosses; posterior surface between bosses and area lateral to submedian bosses pitted. Anterior ridge of telson with 1–3 low tubercles laterally on holotype, surface irregular in female paratype. Lateral margin of telson with well-defined lateral carina extending almost to base of lateral tooth. Posterior margin of telson with 4 pairs of fixed projections, outer sharp, inner pairs rounded.

Basal segment of uropod with dorsal spine. Proximal segment of exopod with 7–8 movable spines, distalmost extending to or slightly overreaching midlength of distal segment. Distal segment of exopod longer than proximal. Endopod broad, ovate, length less than 3 times greatest width; apex of endopod dark. Basal prolongation consisting of 2 spines, trefoil in cross-section, inner longer. Ventral surface of uropodal protopod unarmed or with small spinule or tubercle at articulation of endopod.

Color: Largely faded in available specimens. Margin of antennal scale outlined by dark pigment. Merus of claw with thin, vertical dark bar distally on outer surface. Carapace with 3 narrow dark bands. Posterior

3 thoracic and all abdominal somites with broad, diffuse anterior bands and narrower, darker posterior ones. Telson with broad dark bar extending across dorsal surface, divided into 3 large spots on female. Proximal half of dorsal margin and most of anterior margin of proximal segment of uropod dark. Uropodal exopod with large dark spot overlapping distal segments, apex of exopod light. Distal ⅔–⅘ of uropodal endopod dark.

Measurements: Males, total length 105–163 mm; only female examined, total length 95 mm. Other measurements in mm of male holotype, TL 163 mm: carapace length 29.5; cornea width 7.3; rostral plate length 7.2, width 8.4; antennal scale length 17.9, width 5.5; raptorial propodus length 40.4; fifth abdominal somite width 36.8; telson length 23.7, width 34.6.

Discussion: *Lysiosquilla panamica* is the fifth species of the genus to be recorded from American waters and is one of two species found in the tropical eastern Pacific region. It can be distinguished from *L. desaussurei* (Stimpson), the other eastern Pacific species, by the absence of: (a) a spine on the ventral keel of the eighth thoracic somite, (b) a spine on the ventral surface of the uropodal protopod at the articulation of the endopod (an inconspicuous tubercle or spinule may be present in *L. panamica*), and (c) dorsal tubercles and spinules on the sixth abdominal somite and telson. The new species resembles *L. desaussurei* in having a slender antennal scale, outlined by dark pigment, as well as an anterior projection on the antennal protopod. The two western Atlantic species with a non-tuberculate sixth abdominal somite and telson, *L. glabriuscula* (Lamarck) and *L. campechiensis* Manning, both have fewer (6–7 rather than 11) teeth on the dactylus of the raptorial claw (Manning, 1969). The other western Atlantic species, *L. scabricauda* (Lamarck), resembles *L. desaussurei* and differs from *L. panamica* in having a spinulose sixth abdominal somite and telson. The American species can be distinguished in the key given below. The western Atlantic species were reviewed by Manning (1969), and Manning (in press) redescribed *L. desaussurei.*

Lysiosquilla panamica differs from *L. maculata* from the Indo-West Pacific region in having a triangular anterior projection on the antennal protopod, a slender antennal scale, with the margin outlined by dark pigment, and an angular projection on the ventral keel of the eighth thoracic somite. The antennal scale in *L. maculata* is broader, its length about 2½ times its greatest width, and it is ornamented with a dark patch of pigment; the margin of the scale in *L. maculata* is never outlined by dark pigment.

In many respects, *L. panamica* resembles *L. tredecimdentata* Holthuis, a species that has been recorded from several localities in the western Indian Ocean (Manning, 1968). Both species have a slender antennal scale, a sharp anterior projection on the antennal protopod, and 10 or more teeth on the dactylus of the raptorial claw (11 in *panamica*, 10–13 in *tredecimdentata*). Furthermore, some specimens of *L. tredecimdentata* and *L. panamica* as well may have a small spinule or tubercle on the ventral surface of the uropodal protopod at the articulation of the endopod.

The Indian Ocean species differs from *L. panamica* in having the ventral keel of the eighth thoracic somite produced into a sharp posterior spine.

There is no indication in the present material of secondary sexual modifications in the shape, spination, and setation of the raptorial claw as recorded for *L. glabriuscula* and *L. scabricauda* by Manning (1969) or for *L. maculata* by Kemp (1913).

Etymology: The specific name is derived from the type-locality, the Gulf of Panama.

Distribution: Eastern Pacific region, from La Libertad, Ecuador, and the Gulf of Panama at a depth of 50 feet.

KEY TO AMERICAN SPECIES OF *Lysiosquilla*

1. Antennal protopod with triangular projection on anterior margin. Antennal scale slender, length 3 or more times greatest width 2

Antennal protopod smooth anteriorly, lacking triangular projection on anterior margin. Antennal scale broad, length about 2½ times greatest width 4

2(1). Dorsal surface of sixth abdominal somite and telson at most pitted and eroded, lacking erect spinules and denticles (Tip of uropodal endopod dark. Dactylus of claw with 11 teeth) .... *L. panamica* new species

Dorsal surface of sixth abdominal somite and telson ornamented with numerous erect spinules and denticles 3

3(2). Ventral keel of eight thoracic somite produced into posteriorly directed spine. Uropodal protopod with spine on ventral surface at articulation of endopod (Tip of uropodal endopod dark. Dactylus of claw with 12 teeth) .... *L. desaussurei* (Stimpson)

Ventral keel of eighth thoracic somite not produced into posterior spine, forming at most an erect angular lobe. Uropodal protopod usually unarmed at articulation of endopod (occasionally with minute tubercle) (Tip of uropodal endopod dark. Dactylus of claw with 8–11 teeth) .... *L. scabricauda* (Lamarck)

4(1). Sixth abdominal somite smooth dorsally and laterally. Uropodal protopod unarmed ventrally at articulation of endopod. Tip of uropodal endopod light (Dactylus of claw with 6–7 teeth). .... *L. glabriuscula* (Lamarck)

Sixth abdominal somite wrinkled, rough laterally. Uropodal protopod with spine ventrally at articulation of endopod. Tip of uropodal endopod dark (Dactylus of claw with 7 teeth) .... *L. campechiensis* Manning

LITERATURE CITED

KEMP, S. 1913. An account of the Crustacea Stomatopoda of the Indo-Pacific region, based on the collection in the Indian Museum. Mem. Indian Mus., 4: 1–217, 10 text-figures, plates 1–10.

MANNING, RAYMOND B. 1968. Stomatopod Crustacea from Madagascar. Proc. U.S. Nat. Mus., 124(3641): 1–61, figures 1–16.

————. 1969. Stomatopod Crustacea of the western Atlantic. Stud. trop. Oceanogr. Miami, 8: viii + 380, figures 1–91.

————. in press. Stomatopod Crustacea. Eastern Pacific Expeditions of the New York Zoological Society, Zoologica.

SCHMITT, WALDO L. 1940. The stomatopods of the west coast of America, based on collections made by the Allan Hancock Expeditions, 1933–1938. Allan Hancock Pacific Expeds., 5 (4): 129–225, figures 1–33.

Vol. 84, No. 28, pp. 231–234 4 November 1971

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

SINIOTROCHUS PHOXUS NEW GENUS, NEW SPECIES, A MYRIOTROCHID HOLOTHURIAN NEW TO THE UNITED STATES EAST COAST

By David L. Pawson
Smithsonian Institution, Washington, D.C. 20560

The essentially deep-sea family Myriotrochidae includes apodous holothurians whose calcareous deposits consist of wheels of a unique type. The representatives are generally small, up to 60 mm in total length, and the group is especially well represented in the Arctic, where all three genera comprising the family occur. *Myriotrochus* Steenstrup, 1851, now comprises 14 species (Belyaev, 1970) and extends southwards in the Pacific Ocean to northern New Zealand. The monotypic genera *Acanthotrochus* Danielssen and Koren, 1879, and *Trochoderma* Theel, 1877, have not as yet been found south of latitude 60° N.

Through the courtesy of Miss Cathy A. Salmons of the University of North Carolina and Dr. W. Kirby-Smith of the Duke University Marine Laboratory, I received for study a small collection of holothurians taken by the Duke University vessel R/V *Eastward* off North Carolina. The collection included three incomplete specimens of the new myriotrochid described below. This is the first record of the family from the Western Atlantic south of 45° N; it is probable that myriotrochids are rather more widespread in the Atlantic than has formerly been supposed.

Type material is deposited in the National Museum of Natural History, Smithsonian Institution. I am grateful to Miss Salmons and Dr. Kirby-Smith for access to the material.

ORDER APODIDA BRANDT, 1835

Family Myriotrochidae Oestergren, 1907

Siniotrochus new genus

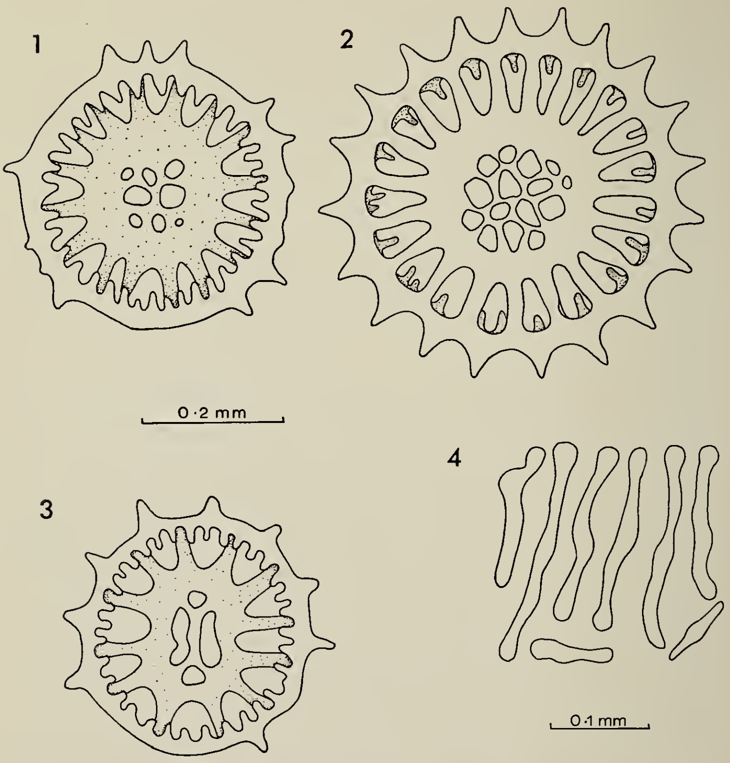
Diagnosis: As for the species.

Type-species: S. *phoxus* new species.

Etymology: Generic name masculine, derived from Greek *sinion*, a sieve, and *trochos*, a wheel. Specific name from *phoxos*, pointed. Names refer to unique structure of wheels, with marginal spines and perforated hubs.

Siniotrochus phoxus new species

Diagnosis: Wheels concave, circular to oval, 0.42 mm in average diameter. Rim with an average of 18 blunt spines projecting outwards



Figs. 1–4. 1, wheel, outer aspect; 2, wheel, inner aspect; 3, wheel, outer aspect; 4, tentacle deposits.

FIG. 5. Left, Holotype, dorsal aspect; right, Paratype 1, ventral aspect.

and an average of 40 broad, blunt spines projecting inwards. An average of 17 spokes radiate from a wide hub, which has 4–15 angular perforations.

Type-locality: R/V *Eastward* Station 15712, 3 Nov. 1970, off North Carolina, 34°00′ N, 74°14′ W to 33°59.3′ N, 74°12.9′ W, 3985–4000 meters, Blake trawl.

Type-specimens: Three incomplete specimens. Holotype (E11394) 35 mm in length, greatest width 8 mm (anterior end missing); Paratype 1 (E11395) 31 mm in length, greatest width 7 mm (anterior end missing); Paratype 2 (E11396) fragment, consisting of calcareous ring and associated structures.

Description: Body essentially cylindrical; color in alcohol greyish. Holotype and paratype 1 lack calcareous ring, tentacles, gonad, Polian vesicles and related structures. Paratype 2 is fragment of anterior end of body with approximately ten macerated tentacles whose structure cannot be accurately determined. Calcareous ring solid, 6.6 mm in diameter, apparently directed ventrally.

Dorsal body wall coriaceous due to presence of single layer of wheels. Wheels closely aggregated anteriorly and posteriorly, slightly separated near middle of body, where there are approximately 5 wheels per mm^2. Ventral body wall with far fewer wheels than dorsal, and relatively smooth, except at anterior and posterior extremities where wheels are as numerous as they are dorsally.

Calcareous deposits of body wall exclusively wheels (Figs. 1–3) of one type; they are concave, lying in body wall with concave surface facing the exterior. Rim with up to 20 (average 18) outwardly projecting spines with broad bases, tapering rapidly to a blunt point. Projecting inwards from rim are up to 45 (average 40) short, broad, blunt spines. Up to 19 (average 17) spokes radiate from the broad, saucer-shaped hub to meet the rim. The hub or center of each wheel carries 4–15 angular perforations. Wheels vary greatly in size (average diameter 0.42 mm) and shape, ranging from circular to oval. The number of spokes and spines also vary considerably. No developmental stages of wheels found.

Tentacles contain numerous minute rods 0.07–0.25 mm in length. Rods essentially straight, with central swelling and rounded ends (Fig. 4). No wheels found in tentacles.

Remarks: The wheels in this species differ from those of other myriotrochids in several important respects. In *Myriotrochus* wheels, there are no outwardly directed projections; *Trochoderma* has such, but lacks inwardly directed projections; *Acanthotrochus* has wheels of two types, one type similar to those of *Myriotrochus*, the other with outwardly directed projections only. The most conspicuous feature of the *Siniotrochus* wheels is the consistent presence of perforations in the hub. In other myriotrochids the hub is solid, without perforations. An unusual wheel illustrated by Belyaev (1970) and referred by him to "*Myriotrochus* sp" has central perforations, but otherwise is typical of *Myriotrochus*.

The affinities of this new genus are not clear. The family is known to range from the Triassic onward (as Family Theeliidae—see Frizzell and Exline, 1966, p. U668), and is represented by wheels of several types. None, however, approach the *Siniotrochus* condition.

Literature Cited

Belyaev, G. 1970. The ultraabyssal holothurian genus *Myriotrochus* (order Apoda, Family Myriotrochidae). Trudy Instituta Okeanologii 86: 458–486, 15 text-figs., 2 plates. (In Russian).

Frizzell, D. L., and H. Exline. 1966. Holothuroidea—fossil record. Pp. U646–U672, figs. 519–534, in R. C. Moore (ed.), Treatise on Invertebrate Paleontology, Part U Echinodermata 3. University of Kansas Press, Lawrence.

.06 /3

Vol. 84, No. 29, pp. 235–244 4 November 1971

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

NOTES ON FISHES OF THE GENUS *EUSTOMIAS* (STOMIATOIDEI, MELANOSTOMIATIDAE) IN BERMUDA WATERS, WITH THE DESCRIPTION OF A NEW SPECIES

By Robert H. Gibbs, Jr.
Smithsonian Institution, Washington, D.C. 20560

This study is based on 69 specimens of 14 species of the genus *Eustomias* Vaillant, collected between 1968 and 1970 in Bermuda waters on 10 cruises of the Ocean Acre program (Gibbs and Roper, 1971). In their comprehensive treatment of North Atlantic *Eustomias*, Regan and Trewavas (1930) recorded only one species, *E. obscurus*, from the immediate vicinity of Bermuda. Borodin (1930) described a second species, *E. radicifilis*, from this area. Beebe and Crane (1939) reported on 24 specimens of nine species collected in 1,574 nets, mostly during 1929–1931, raising to 10 the number of species known from the area. Grey (1955) recorded four species collected in 1948, all of which had been treated by Beebe and Crane, but her specimen identified as *E. obscurus* has proved to be an eleventh Bermuda species, *E. enbarbatus* (Morrow and Gibbs, 1964: 407). Eight of these 11 species are recorded here from the Ocean Acre collections, together with six previously unrecorded species, one of which is described as new. The additions raise the total number of *Eustomias* species known from the vicinity of Bermuda to 17.

Ocean Acre collections have been made in March, April, June, July, September, October, November and December. The single November and December cruises were abortive, and the few collections yielded no *Eustomias* specimens. One or more species were taken during each of the other eight cruises, between March and October. One cruise used a 6-foot (2 m)

Fig. 1. *Eustomias decoratus* new species, Holotype, USNM 205494, 255.5 mm SL.

Isaacs-Kidd Midwater Trawl (IKMT); all others used a 10-foot (3 m) IKMT. On four cruises, the discrete-depth cod-end sampler described by Aron et al. (1964) was used successfully with the IKMT. Much larger Engel trawls (the largest about 58-m wide at the mouth) were used for 10 tows on one cruise. A total of 197 trawls has been made as of this writing.

BERMUDA SPECIES OF *EUSTOMIAS*

Eustomias decoratus new species

Figure 1

Holotype: National Museum of Natural History (USNM) 205494, a female with flattened, transparent gonads and very small eggs, standard length 255.5 mm, USNS Sands, Acre 6-17P, 29 April 1969, 32°19′ N, 63°37′ W, 0–235 m, 0300–0420 hrs. zonal time, 10′IKMT.

Description: Dorsal rays 24; anal rays 44; pectoral rays 14 (left) or 15 (right); pelvic rays 8 on both sides. Photophores: IP 7, PV 30, VAV 13, ending over anal ray 10, OV 31, VAL 13, AC 23. Premaxillary teeth on left side 12, numbers 1,2,4–6, and 8–12 depressible; on right side 13, numbers 2,4–6, 9–13 depressible; second tooth longest. Maxilla with small serrae. Mandibular teeth on left side 18, numbers 2–5, 7–11, 13–18 depressible; on right side 17, numbers 2–5, 7–9, 11, 13–17 depressible; number 11 longest, but only slightly longer than number 2. No teeth on vomer or palatines. Three pairs of teeth on basibranchials. No gill rakers or teeth. Branchiostegal photospores 11. Vertebral centra unossified just behind cranium, leaving space about three times length of first ossified, vertically-oriented centrum, followed by another longer space, followed by a continuous row of one small ossification and 60 well-developed centra.

Measurements, followed by percent of standard length in parentheses: snout to dorsal origin 222.0 (86.8), snout to anal origin 180.2 (70.5), snout to pelvic insertion 141.7 (55.4), greatest depth, just behind head 15.3 (6.0), caudal peduncle depth 3.7 (1.4), head length 29.4 (11.5), snout to fleshy orbit 9.3 (3.6, 31.6% of head length), fleshy orbit length 4.5 (1.8, 15.3% of head length), bulb of postorbital organ 2.3 (7.8% of head length, 51% of fleshy orbit), upper jaw length 24.5 (9.6, 83.3% of head length), longest premaxillary tooth 3.8 (12.9% of head length), longest mandibular tooth (No. 11) 2.7 (9.2% of head length), barbel overall length 130.9 (51.5, 445% of head length), barbel main stem overall length 95.2 (37.2, 324% of head length), barbel stem to origin of branches 28.4 (11.1), length of longest (middle) branch of barbel 102.5 (40.1), length of terminal bulb on main stem 4.1 (1.6, 13.9% of head length), length of largest bulb in middle branch 5.1 (2.0, 17.3% of head length), pectoral-fin length 41.5 (16.2), pelvic-fin length 22.8

(8.9), length of dorsal-fin base 26.8 (10.5), length of anal-fin base 68.1 (26.6).

Barbel with three branches arising from main stem. Middle branch about as thick as adjacent main stem, thicker than two side branches, extending beyond main stem, with a prominent bulb near its midlength, and with numerous filaments of various sizes. Two side branches about half as long as middle branch, relatively simple with fewer filaments than middle branch, each branch ending in a very small bulb. Michael J. Keene recorded that the barbel bulbs were colored yellow in the freshly-caught specimen.

Head and body black, without visible patches of lighter material. All fin-rays dark, the membranes, now damaged, apparently transparent. Main stem of barbel mostly black except the distal end; terminal bulb and distal three-fifths of main stem beyond branches surrounded by translucent tissue. Middle branch and its larger filaments black except for bulbs; side branches pigmented, but much lighter than middle branch.

Comparisons: This new species is easily identified by its high pectoral-ray count (14–15 rays), 8 pelvic rays, and unique barbel configuration.

The count of 14–15 pectoral rays is approached only by *E. macrurus* (up to 11) and *E. braueri* (up to 16); both species have shorter barbels than *E. decoratus*, seldom twice as long as the head, and lacking branches; *E. macrurus* is the only species of *Eustomias* with an opaque tissue mass (luminous body) in the ventral lobe of the caudal fin in specimens larger than about 100 mm.

Most species of *Eustomias* normally have 7 pelvic rays. Other than *E. decoratus* (presuming 8 rays to be its usual complement), only *E. braueri* (see preceding paragraph), and four other species, usually or always have 8 pelvic rays. Of these four species, *E. tenisoni*, *E. furcifer*, and *E. drechseli* have barbels somewhat similar in structure to that of *E. decoratus*, although shorter (up to about 35% of SL compared to about 50% in *E. decoratus*), and have only 4 to 8 pectoral rays. The fourth species, *E. radicifilis*, has an entirely different barbel, with very long branches arising from the stem at the base of the terminal bulb, and has 7 pectoral rays.

In barbel structure, nine other presently recognized species resemble *E. decoratus* in having three branches either arising together from the main stem or arising from a single short trunk (Morrow and Gibbs, 1964: 382–383). None of these has more than three pectoral rays.

Etymology: The name *decoratus* is a Latin adjective alluding to the spectacular barbel of the new species.

Annotations on each of the remaining species will be in the following order: (1) number of specimens taken during Ocean Acre cruises 1–10 (range of standard lengths in mm); (2) months when specimens were caught; (3) depth range and number of specimens caught in that range based on daytime hours or combined night and dusk hours (for non-discrete samples, the depth range is for the greatest trawling depths, with the possibility that specimens may have been caught at any point between the greatest depth and the surface); (4) reference to Beebe and Crane (1939) and Grey (1955); (5) miscellaneous comments.

Eustomias bibulosus: 8 (62–136), June–October. No daytime samples. Night and dusk discrete depths: 50–100 m (3), 400–500 m (1). Night and dusk non-discrete depths: 400–500 m (2), 1250–1750 (2). Beebe and Crane reported eight specimens (42–123 mm SL), April–September, from daytime non-discrete depths of 914–1646 m. Grey reported one specimen (125 mm), July, non-discrete 260–275 m at night.

Eustomias bigelowi: 3 (81–136), March and September. All three taken at night in non-discrete samples: 150–200 m (1), 200–300 m (1), 300–400 m (1). Beebe and Crane reported two specimens (108 and 134 mm), May and August, from daytime non-discrete depths of 1280 and 1463 m. Grey reported one specimen (103 mm), August, non-discrete 200 m at night. It is possible that *E. binghami* and *E. silvescens* (see below) are synonymous with *E. bigelowi*; their identifications here are tentative and the three should be considered together.

Eustomias binghami: 2 (69 and 135), June. No daytime samples. Night discrete depth: 50–100 m (1). Night non-discrete depth: 200–300 m (1). Not previously reported from Bermuda. These specimens possibly referable to *E. bigelowi*.

Eustomias silvescens: Not taken by Ocean Acre cruises. Beebe and Crane reported one specimen (140 mm), September, from the daytime non-discrete depth of 1829 m. This specimen possibly referable to *E. bigelowi*.

Eustomias dubius: 3 (47–110), June and October. Night and dusk discrete depths: 50–100 m (1). Dusk non-discrete depth: 150–200 m (1). Beebe and Crane reported three specimens (43–115 mm), May to October, from the daytime non-discrete depth of 1097 m.

Eustomias enbarbatus: 11 (47–128 mm), March to October. Daytime discrete depth: 700–800 m (2). Night and dusk discrete depths: 50–100 m (3), 100–150 m (1). Night and dusk non-discrete depths: 0–50 m (2), 100–150 m (1), 200–300 m (2). Grey reported one specimen (as *E. obscurus*) (120 mm), August, night non-discrete 500–550 m. This is the second most numerous species of *Eustomias* in the Ocean Acre collections.

Eustomias filifer: 3 (46–133), July and October. Daytime discrete depth: 500–600 m (1). Night non-discrete depths: 600–700 m (1), 1750–2000 m (1). Not previously reported from Bermuda waters.

These three specimens of *E. filifer* differ in the morphology of their barbels from all other specimens of this species that I have examined. Specimens from the northeastern Atlantic, Gulf of Mexico, southwestern Atlantic, and Indian Ocean, as well as illustrations of the holotype of *E. filifer* Gilchrist, all have a barbel with three variable branches arising from the main stem, beyond which is an ovoid or ellipsoidal swelling, followed by a long, slender continuation of the stem that ends in a small terminal bulblet (see Morrow and Gibbs, 1964: 389, Fig. 105). In the Bermuda specimens (Fig. 2) distal to the three short branches is an elongate,

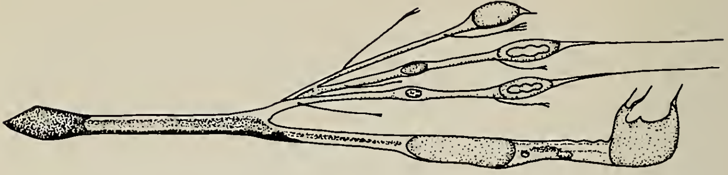


FIG. 2. Barbel of *Eustomias filifer*, 130.2 mm SL, from Ocean Acre, cruise 3, trawl 1.

somewhat irregular swelling, beyond which a short section of stem, undiminished in width, precedes a large terminal bulb of distinctive shape. In all other respects, the Bermuda specimens are indistinguishable from other *E. filifer*.

Eustomias longibarba: 2 (102, 116), September. Night discrete depth: 150–200 m (1). Night non-discrete depth: 300–400 m (1). Not previously reported from Bermuda waters.

Eustomias macrurus: 1 (165), April. Daytime non-discrete depth: 800–900 m (1). Not previously reported from Bermuda waters.

Eustomias obscurus: 27 (67–207), March–September. Night and dusk discrete depths: 0–50 m (2), 150–200 m (1), 800–900 m (1). Night and dusk non-discrete depths: 0–50 m (3), 50–100 m (1), 100–150 m (5), 150–200 m (2), 200–300 m (2), 300–400 m (2), 400–500 m (5), 500–600 m (1), 700–800 m (1). Beebe and Crane reported five specimens (51–98 mm), May to September from daytime non-discrete depths of 914–1280 m. The specimen reported by Grey has been reidentified as *E. enbarbatus*. *Eustomias obscurus* is by far the most abundant species of *Eustomias* in the Ocean Acre collections.

Eustomias parri: 1 (128), September. Night non-discrete depth 100–150 m (1). Not previously reported from Bermuda waters.

Eustomias radicifilis: 2 (183–192), September. Night and dusk non-discrete depths: 150–200 m (1), 200–300 m (1). Known previously only from the holotype, also collected near Bermuda at 33° N, 64′ W.

The following are counts of the two Ocean Acre specimens (both females), those of the 182.5 mm specimen followed by those of the 191.7 mm specimen. Dorsal rays 23,21. Anal rays 41,40. Pectoral rays 7,7. Pelvic rays 8,8. Photophores: IP 7,7; PV 29,27; VAV 12,13; OV 29,27; VAL 13,14; AC 22,20. Premaxillary teeth 12,12. Mandibular teeth 17–19, 18. Because the head of the 191.7 mm specimen is damaged, measurements of only the 182.5 mm specimen are given (in mm). Snout to dorsal origin 159.2, snout to anal origin 137.5, snout to pelvic insertion 108.6, head length 24.0, barbel length to end of terminal bulb 44.8, length of pre-bulbar branches 45.2, length of terminal bulb 2.5, length of single distal filament of terminal bulb 13.0, snout to fleshy orbit 11.1, fleshy orbit 3.9, length of postorbital organ (bulb) 1.6, distance from postorbital organ to fleshy orbit 1.4, upper jaw length 18.2, depth of body behind head 11.8, greatest body depth 13.2, caudal peduncle depth 2.4, pectoral length 41.9, pelvic length (broken) at least 12.7. Length of dorsal base 19.5, length of anal base 45.5. Tooth sizes vary from left to right side. On the left side, longest premaxillary tooth (No. 6) 2.8, longest mandibular tooth (No. 11) 2.6. On the right side, longest premaxillary tooth (No. 2) 2.6, longest mandibular tooth (No. 10) 2.4.

The barbel in both specimens is similar to that of the holotype (Gibbs and Morrow, 1964: 388, Fig. 103).

Eustomias schmidti: 2 (95–202), March and October, Dusk discrete depth: 100–150 m (1). Night non-discrete depth: 50–100 m (1). Beebe and Crane reported two specimens (55–118 mm), July and September, from daytime non-discrete depths 1280 and 1463 m. Grey reported one specimen (39 mm), July, night and dusk non-discrete depth of 730–820 m.

Eustomias simplex: 3 (100–118), June. Night discrete depth: 50–100 m (3). Beebe and Crane reported one specimen (91 mm), May, from the daytime non-discrete depth of 1097 m.

Eustomias lipochirus: Not taken by Ocean Acre cruises. Beebe and Crane reported one specimen (50 mm), September, from the daytime non-discrete depth of 914 m.

Eustomias fissibarbis: Not taken by Ocean Acre cruises. Beebe and Crane reported one specimen (130 mm), September, from the daytime non-discrete depth of 1463 m.

Size: Of the 69 Ocean Acre *Eustomias* specimens, 16 (23%) are between 46–75 mm SL; 42 (61%) are 75–150 mm; 11 (16%) are 150–258 mm. Of 23 specimens larger than 125 mm, the majority (13, 57%) were taken in seven hauls by the very large Engel trawls towed at night between 125 and 520 m in September. Of eight specimens larger than 175 mm, six (75%) were taken in three of these same Engel trawls. From this it is apparent that our IKMT's are not sampling the larger individuals adequately.

All four specimens (of three species) smaller than 50 mm were taken in October with the smaller (2-m) IKMT, suggesting the possibility that this net samples smaller specimens better than does the 3-m IKMT. All four, however, are 46 to 50 mm SL, and their presence only in October may indicate an earlier breeding peak.

Vertical Distribution: Some inferences concerning the vertical distribution of *Eustomias* may be considered, even though the numbers of any given species are small. In spite of considerable daytime trawling in the upper 500 m, only five specimens have been taken in daytime trawls. Of these, three were taken at known depths: one at 500–600 m, two at 700–800 m. Two others were taken in open nets that fished horizontally at 700–900 m. It appears, therefore, that *Eustomias* almost certainly does not normally occur above 500 m during the daylight hours. About one-third as much daytime trawling has been done between 500–1000 m, where all five specimens were caught. Gibbs and Roper (1971) indicated that the largest daytime fish concentrations in the Ocean Acre, in terms of volume or of species, are between 600–1100 m. Daytime trawling effort about equal to that in the 500–1000 m stratum, mostly with open nets, has been expended below 100 m, mainly between 1000–2000 m, but no *Eustomias* were caught. It thus seems highly probable that most *Eustomias* individuals live at 600–1100 m during the day.

The main night distribution of *Eustomias* is clearly in the upper 200 m. Of 20 night-caught specimens taken at known depths, 18 were in this upper stratum; one was taken at 400–500 m and one at 800–900 m. The open-net catches are not conclusive. Of 44 specimens, 19 were taken in the upper 200 m, 19 in trawls fished between 200–500 m, and six in trawls fished deeper than 500 m (500–800 m, three specimens; 1250–2000 m, three specimens). Eleven of the 14 species in the Ocean Acre collections have been taken in the upper 200 m at night, of which two species were taken in the upper 50 m and seven between 50 and 100 m.

Seasonal Abundance: Only three species are represented in the Ocean Acre collections by more than three specimens: *E. obscurus* (27), *E. enbarbatus* (11), and *E. bibulbosus* (8). The following interpretations are suggested concerning their seasonal abundance.

Eustomias obscurus, which is the dominant species of the genus, occurs only in the Atlantic, both north and south, and it has been the most abundant species overall in Atlantic collections. In the Ocean Acre area, it was taken from March to September. Because November and December cruises were abortive, it is not certain whether the species is present, rare, or absent from November through February; it may be that *E. obscurus* leaves the area during the winter. Two extensive cruises were made at almost exactly the same date in early September 1968 and 1969; in 1968 no *E. obscurus* were caught, whereas in 1969, 10 specimens were taken. It is suggested that *E. obscurus* disappears from the area about this time, and did so earlier in 1968 than in 1969. On an extensive cruise in late October, 1967, no *E. obscurus* were taken.

Nine of the 11 specimens of *E. enbarbatus* were taken in June (5) or late October (4). Although three cruises undertook collecting, only a single specimen was taken between June and October; and three cruises (two of them extensive) in March and April collected only a single specimen. If there are peaks of abundance in June and October, the reasons are not clear.

One or two specimens of *E. bibulbosus* were taken on each of the five cruises between June and October. These allow no conjecture as to seasonal abundance.

Acknowledgments: The Ocean Acre program has been supported by the U.S. Navy through contract N00140-69-C-0166. Background information on systematics and ecology of stomiatoid fishes was obtained with support from National Science Foundation grant G-18001 and Smithsonian Research Foundation awards 3309, 3362, and 3514. Michael J. Keene recorded color observations on the freshly caught holotype of *E. decoratus*. Illustrations were made by W. R. Schroeder.

LITERATURE CITED

ARON, W., N. RAXTER, R. NOEL, AND W. ANDREWS. 1964. A description of a discrete depth plankton sampler with some notes on the towing behavior of a 6-foot Isaacs-Kidd midwater trawl and a one-meter ring net. Limnol. Oceanogr. 9(3): 324–333.

BEEBE, W. AND J. CRANE. 1939. Deep-sea fishes of the Bermuda Oceanographic Expeditions. Family Melanostomiatidae. Zoologica, New York, 24(2): 65–238.

BORODIN, N. 1930. Some more new deep-sea fishes. Proc. New Engl. Zool. Club 11: 87–92.

GIBBS, R. H., JR. AND C. F. E. ROPER. 1971. Ocean Acre: preliminary report on vertical distribution of fishes and cephalopods. *In* Proceedings of an International Symposium on Biological Sound Scattering in the Ocean. Maury Center for Ocean Science, Dept. of Navy, Rept. 005: 120–135.

GREY, M. 1955. Notes on a collection of Bermuda deep-sea fishes. Fieldiana: Zool. 37: 265–302.

MORROW, J. E., JR. AND R. H. GIBBS, JR. 1964. Family Melanostomiatidae. *In* Fishes of the western North Atlantic. Sears Found. Mar. Res. Mem. 1(4): 351–511.

REGAN, C. T. AND E. TREWAVAS. 1930. The fishes of the families Stomiatidae and Malacosteidae. Dana-exped. 1920–22, Rep. 6: 143 pp.

Vol. 84, No. 30, pp. 245–252 4 November 1971

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

POLYCHAETA NEW TO NEW ENGLAND, WITH ADDITIONS TO THE DESCRIPTION OF *ABERRANTA ENIGMATICA* HARTMAN[1]

By Katharine D. Hobson[2]
Systematics-Ecology Program, Marine Biological Laboratory,
Woods Hole, Massachusetts 02543

Specimens of polychaete species not previously reported from New England were discovered during examination of material collected from Buzzards Bay and Cape Cod Bay, Massachusetts. This material was collected from Buzzards Bay by G. R. Hampson, by J. F. Grassle, and by D. K. Young, and from Cape Cod Bay by the staff of the Biotic Census. Additional specimens of *Aberranta enigmatica* Hartman were collected on the shelf off New England by H. L. Sanders. The material is deposited at the following locations: Smithsonian Institution (USNM), Gray Museum of the Systematics-Ecology Program (SEP), the collection of Howard L. Sanders at the Woods Hole Oceanographic Institution (HLS), and the author's collection (KDH).

I wish to thank Dr. M. H. Pettibone for helpful criticism of the manuscript.

PILARGIDAE

Cabira Webster

Cabira incerta Webster

Cabira incerta Webster 1879, p. 267, figs. 155–157.—Pettibone 1966, p. 178, figs. 11–12.

Material examined: Massachusetts, Buzzards Bay, about 1 mile NW of

---

[1] Contribution No. 216 from the Systematics-Ecology Program. This study was aided by Contract Nonr 3070(03) between the Office of Naval Research, Department of the Navy, and the Systematics-Ecology Program, Marine Biological Laboratory.

[2] Present address: Marine Biology Division, B. C. Provincial Museum, Victoria, British Columbia, Canada.

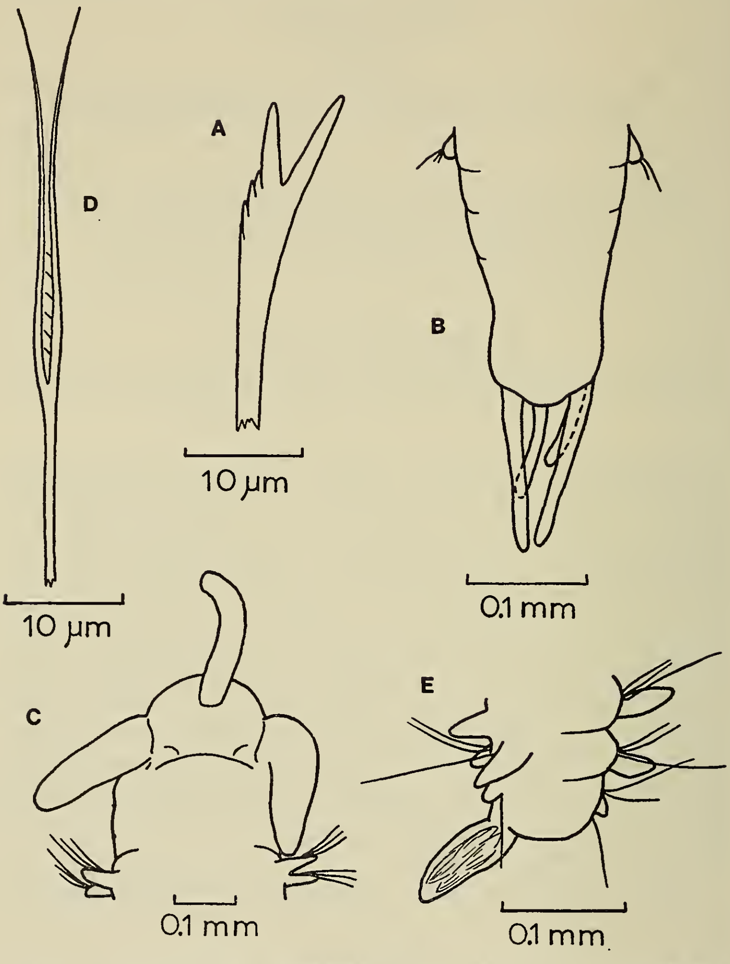


FIG. 1. *Protodorvillea gaspeensis* (USNM 43516): A, furcate seta from setiger 8; B, dorsal view of posterior end. *Aberranta enigmatica* (USNM 43519): C, posterodorsal view of anterior end; D, furcate seta from median neuropodium; E, dorsal view of pygidium slightly from left.

Quissett Harbor, sand, 14 meters, station 4, October 1968, D. K. Young, collector—1 specimen (USNM 43515).

Description: The specimen is incomplete and is about 10 mm long, 1.2 mm wide at the anterior end, and has 31 setigers. The head has one pair of small antennae, one pair of palps with a small papillar "style," and two pairs of small tentacular cirri. The boundary between the prostomium and peristomium is well marked. There is no dorsal cirrus, but a small papilla occurs slightly ventral to and behind the hooked notoseta. The stout recurved notopodial hook first appears at setiger 7. The ventral cirrus is a small papilla. A few simple capillary setae occur in the neuropodium. The proboscis is not everted.

Distribution: Massachusetts and Virginia, in 13–14 meters.

DORVILLEIDAE

Protodorvillea Pettibone

Protodorvillea gaspeensis Pettibone

Figure 1 A, B

Protodorvillea gaspeensis Pettibone 1961, p. 178, fig. 6.

Material examined: Quebec, Gulf of St. Lawrence at Grande-Rivière, Gaspé South—holotype (USNM 30008). Massachusetts, Buzzards Bay, 41°30′ N, 70°53′ W, mud, 20 meters, station R, 15 July 1969, G. R. Hampson, collector—4 specimens (USNM 43516[2]; SEP 2098[1]; HLS[1]); vicinity of Wild Harbor, muddy sand, 6 meters, September and October 1969, J. F. Grassle, collector—12 specimens (HLS).

Description: Three of the specimens from Buzzards Bay are complete, up to 4.5 mm long and consisting of 26 to 30 setigers. There is no pigmentation (preserved in alcohol). The prostomium bears two short biarticulate palps and two shorter clavate antennae. The jaws are barely visible and were not dissected. Each parapodium lacks a dorsal cirrus, has a small ventral cirrus, and has three kinds of setae: (1) one to three simple capillary setae, (2) one (rarely two) simple furcate seta, (3) three compound setae. The setae of the holotype and of the Buzzards Bay specimens are as described by Pettibone (1961), except that the furcate setae are laterally serrated (Fig. 1A). The furcate setae seem to have fewer serrations in the posterior region. The pygidium has two long dorsal anal cirri and two shorter ventral anal cirri (Fig. 1B). Large yolky eggs are present in two of the specimens from station R, from setiger 12 through 24 in one specimen and from setiger 11 in the incomplete specimen.

Distribution: Gulf of St. Lawrence, Quebec and Massachusetts, intertidal to 20 meters.

PARAONIDAE

Aricidea Webster

Aricidea wassi Pettibone

Aricidea wassi Pettibone 1965, p. 135, figs. 9–11.

Material examined: Massachusetts, Cape Cod Bay, 41°48.5′ N, 70°8′ W, sand, 10 meters, station 2012, 11 December 1968—6 specimens (USNM 43518[3], SEP[2], KDH[1]).

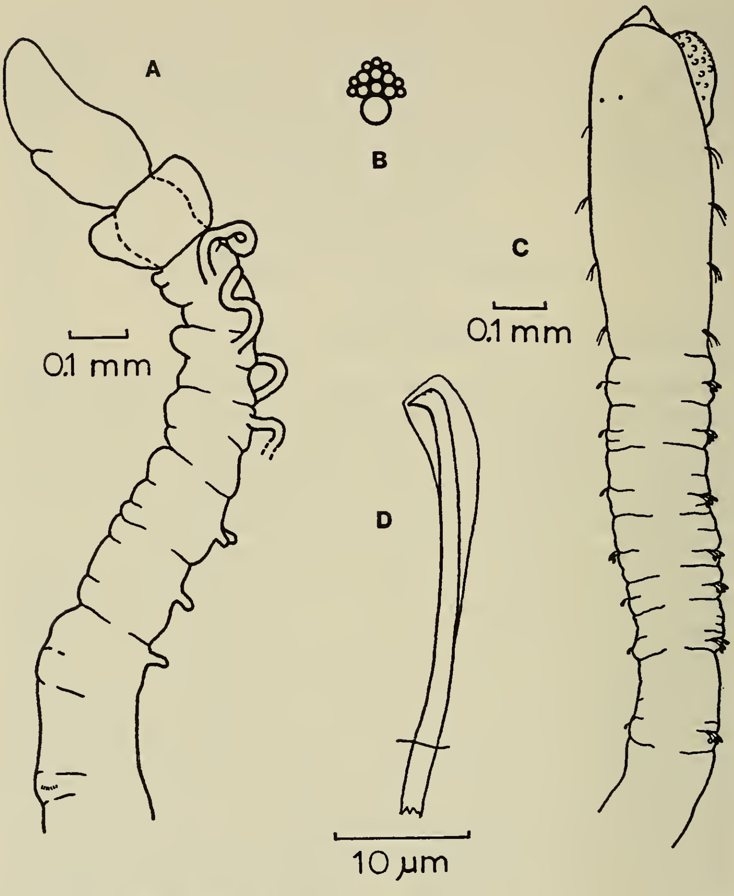


Fig. 2. *Psammodrilus balanoglossoides* (USNM 43517): A, lateral view of anterior end; B, diagrammatic frontal view of abdominal seta. *Mediomastus ambiseta* (SEP 2098): C, dorsolateral view of anterior end; D, slender hooded hook from abdominal notopodium.

Description: The specimens are small, up to 8 mm long, and are as described by Pettibone (1965). The median antenna is long, reaching as far back as setiger 4, and distinctly jointed. The branchiae begin on setiger 4, and there are 9 to 11 pairs. The notopodia have only capillary setae. The neuropodia have capillary setae; in median and posterior segments, the ventral-most capillary setae are replaced by thicker curved setae with a subterminal hairlike appendage arising from the concave side.

In both sexes, the sexual products are found in median and posterior segments, from about setiger 20-30 to about the 15th last setiger. In females, each of these segments has two large oval yolky eggs about 220 μm in diameter. Sperm appear as opaque whitish masses.

Distribution: Massachusetts and Chesapeake Bay, in 10–40 meters.

FAMILY UNKNOWN

Aberranta Hartman

Aberranta enigmatica Hartman

Figure 1 C–E

Aberranta enigmatica Hartman 1965, p. 155, pl. 32, fig. g–h.

Material examined: Shelf off New England, 40°34′ N, 70°51′ W, mud, 68 meters, station 171, 28 November 1967, H. L. Sanders, collector—17 specimens (USNM 43519[8]; SEP 2099[5]; HLS[3]; KDH[1]).

Description: The following may be added to the description of *Aberranta enigmatica*. A complete specimen has 26 setigers. A smooth, slender median antenna is inserted in the middle of the prostomium and may be up to twice the length of the prostomium (Fig. 1C). The median antenna is easily lost and is present on only two of the specimens. Each neuropodium has one or two very slender furcate setae with branches of equal length (Fig. 1D). Some very faint spines arise from one (or possibly both) of the branches. Anal cirri (Fig. 1E) are lanceolate, larger than the postsetal lobes, and with spindle-like inclusions as figured by Hartman for the postsetal lobes. However, they are easily lost and are present on only one specimen.

Distribution: Off New England in 68–300 meters.

PSAMMODRILIDAE

Psammodrilus Swedmark

Psammodrilus balanoglossoides Swedmark

Figure 2 A, B

Psammodrilus balanoglossoides Swedmark 1952, p. 159, fig. 1–3; 1955, p. 141, figs. 1–19, pl. 3.

Material examined: Massachusetts, Cape Cod Bay, 41°49.5′ N, 70°32′ W, clean sand, 5.5 meters, station 1930, November 1967—2 specimens (USNM 43517); 41°46′ N, 70°7′ W, clean sand, intertidal, station 2212, May 1968—1 specimen (SEP).

Description: The specimens are up to 9 mm long and 0.2 mm wide. The head is bluntly pointed and is followed by a collarlike pharyngeal region (Fig. 2A). The six thoracic segments each bear a pair of ciliated filiform appendages, those of the first three segments being the longest and most conspicuous. The abdominal region consists of up to about 30 setigers. The abdominal uncini number up to 11 in a torus, and in profile the uncini appear to have 4 teeth (as in Swedmark's figure 3, 1952). Actually an uncinus consists of a large main tooth surmounted by about 13 smaller teeth (Fig. 2B). It is difficult to determine the exact number and arrangement of the smaller teeth, even under oil immersion, because of the small size of the uncini. There are large ovoid yolky eggs (100 μm in greatest dimension) situated laterally in the abdomen of the specimen collected in May.

Distribution: Massachusetts, Baltic Sea, North Sea, English Channel, and France. Intertidal to 5.5 meters depth.

CAPITELLIDAE

Mediomastus Hartman; emended Hartmann-Schröder

Mediomastus ambiseta (Hartman)

Figure 2 C, D

Capitita ambiseta Hartman 1947, p. 409, pl. 45; 1969, p. 369, figs. 1–4.—Reish 1968, p. 89.

Mediomastus ambiseta.—Hartmann-Schröder 1962, p. 143, pl. 18, fig. 119 A.

Material examined: Massachusetts, Buzzards Bay, 41°30′ N, 70°53′ W, mud, 20 meters, station R, 15 July 1969, G. R. Hampson, collector—many specimens (USNM 43520, SEP, HLS, KDH); vicinity of Wild Harbor, muddy sand and soft mud, 2 and 6 meters, October 1969 and June 1970, J. F. Grassle, collector, about 60 specimens (HLS, KDH).

Description: The largest specimens are about 20 mm long, up to 0.3 mm wide at the thorax, and have up to 50 segments. However, most specimens are smaller (less than 0.2 mm wide) and have about 40 segments. A pair of faint subdermal eyes is barely visible dorsally (Fig. 2C). The first segment lacks setae, segments 2–5 have only limbate capillary setae, and segments 6–10 have only hooded hooks. The boundary between the thorax and abdomen is usually indistinct, and segment 11 appears to be transitional. All abdominal neurosetae are hooded hooks that consist of a large tooth surmounted by 3 smaller teeth. The first 9–11 abdominal notopodia have only hooded hooks; in the next 1–4 notopodia the hooded hooks are usually replaced by 1 (occasionally 2) very slender hooded hook (Fig. 2D) and 1 (occasionally 2) capillary seta. However, in some worms, a notopodium in this region may have a normal hooded hook and a capillary seta or slender hooded hook; or hooded hooks may disappear as soon as capillary setae appear. The last 15–26 notopodia have only a single capillary seta. There is a digitate caudal appendage ventrally on the pygidium. Specimens collected in June and July have polygonal (20–50 μm diameter) or oval (60 μm diameter) eggs in the body.

Distribution: Massachusetts, southern California and Lower California, in intertidal and shelf depths.

SABELLIDAE

Laonome Malmgren

Laonome kroyeri Malmgren

Laonome kroyeri Malmgren 1866, p. 400, pl. 27, fig. 85.—Banse 1963, p. 204, fig. 3a-b.—Fauvel 1927, p. 322, fig. 112 a–i.

Material examined: Massachusetts, Cape Cod Bay, 41°47.5′ to 42°4′ N, 70°7′ to 70°31′ W, sand, muddy sand, and sandy mud, 15.6 to 60 meters, 18 stations, 1967–1968—28 specimens (USNM 43521–5[7]; SEP[20]; KDH[1]). Buzzards Bay, 41°30′ N, 70°53′ W, mud, 20 meters, station R, 15 July 1969, G. R. Hampson, collector—1 specimen (SEP 2098).

Description: The specimens are up to 70 mm long and usually have 8 thoracic setigers; however, one large worm has 13 thoracic setigers. There are 5 to 8 pairs of radioles with pinnules and 1 to 2 pairs without pinnules in the branchial crown. The radioles lack eyes, have long bare filiform tips, and may or may not have faint bands of brownish pigment. The collar has long ventral lobes; in some specimens there is a wide dorsal gap in the collar (as in Fig. 85 E by Malmgren, 1866); but in other specimens the dorsal gap is narrow. Notosetae of the thorax are limbate and spatulate; the neurosetae are avicular uncini as figured by Banse (1963, fig. 3 A, B) rather than Fauvel (1927, fig. 112 i).

Distribution: Massachusetts, northern Europe, Sea of Japan, Kamchatka, Washington. In 15–60 meters.

LITERATURE CITED

BANSE, K. 1963. Polychaetous annelids from Puget Sound and the San Juan Archipelago, Washington. Proc. Biol. Soc. Wash., 76: 197–208.

FAUVEL, P. 1927. Polychètes Sédentaires. Faune de France. 16: 1–494.

HARTMAN, O. 1947. Palychaetous annelids. Pt. 7. Capitellidae. Allan Hancock Pac. Exped., 10: 391–481.

————. 1965. Deep-water benthic polychaetous annelids off New England to Bermuda and other Atlantic areas. Allan Hancock Foundation Publ. Occas. Pap., 28: 1–378.

————. 1969. Atlas of the Sedentariate Polychaetous Annelids from California. Allan Hancock Foundation, University of Southern California, Los Angeles. 812 pp.

HARTMANN-SCHRÖDER, G. 1962. Zweiter Beitrag zur Polychaetenfauna von Peru. Kieler Meeresforsch. 18: 109–147.

MALMGREN, A. J. 1866. Nordiska Hafs-Annulater. Oefv. K. Vetensk. Akad. Förh., 22: 355–410.

PETTIBONE, M. H. 1961. New species of polychaete worms from the Atlantic Ocean, with a revision of the Dorvilleidae. Proc. Biol. Soc. Wash., 74: 167–186.

———. 1965. Two new species of *Aricidea* (Polychaeta, Paraonidae) from Virginia and Florida, and redescription of *Aricidea fragilis* Webster. Proc. Biol. Soc. Wash., 78: 127–140.

———. 1966. Revision of the Pilargidae (Annelida: Polychaeta), including descriptions of new species, and redescription of the pelagic *Podarmus ploa* Chamberlin (Polynoidae). Proc. U.S. Nat. Mus., 118: 155–208.

REISH, D. J. 1968. A biological survey of Bahia de Los Angeles, Gulf of California, Mexico. II. Benthic polychaetous annelids. Trans. San Diego Soc. Nat. Hist., 15: 67–106.

SWEDMARK, B. 1952. Note préliminaire sur un polychète sédentaire aberrant, *Psammodrilus balanoglossoides* n. gen., n. sp. Ark. Zool. 4: 159–162.

———. 1955. Recherches sur la morphologie, le développement et la biologie de *Psammodrilus balanoglossoides.* Arch. Zool. Exp. Gén. 92: 141–220.

WEBSTER, H. E. 1879. Annelida Chaetopoda of the Virginia coast. Trans. Albany Inst., 9: 202–272.

Vol. 84, No. 31, pp. 253–258 4 November 1971

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

TWO NEW ARGULIDS (CRUSTACEA: BRANCHIURA) FROM THE EASTERN UNITED STATES

By Roger F. Cressey
Smithsonian Institution, Washington, D.C. 20560

During the course of work designed primarily to produce a key to the argulids of the United States two collections were sent to me which contained two new species of the genus *Argulus*. These new species are described below.

Argulus meehani new species

Figures 1–7

Argulus n. sp.—Kolipinski, 1969, pp. 39–49.

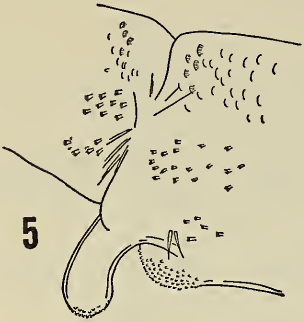
Material studied: Holotype female (USNM 137492), allotype (USNM 137493), and 90 paratypes (USNM 137494), collected by M. C. Kolipinski from the Florida gar *Lepisosteus platyrhinchus* De Kay at Royal Palm Pond, Everglades National Park, Florida.

Female: Body form of the typical argulid type. Total body length greater than width at a ratio of 8:5. Carapace slightly longer than wide at a ratio of 6:5. Total length and greatest width of one ovigerous specimen was 6.3 mm × 4.1 mm.

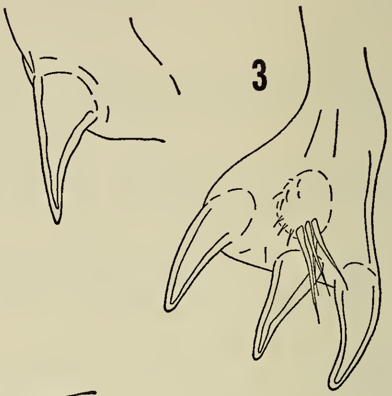
Abdomen slightly longer than wide (3.4 mm × 3.3 mm in one ovigerous specimen).

Caudal rami small, bearing 5 setae and attached along inner edges of posterior abdominal lobes.

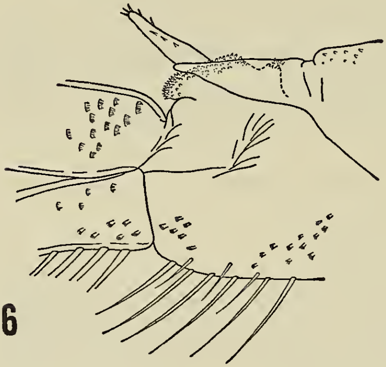
First antenna first segment without posterior spine, second segment with prominent anterior spine, medial spine, and terminal claw (Fig. 1); remaining segments non-prehensile and extending laterally nearly to tip of claw. Second antenna (Fig. 1) with prominent posterior spine and hyaline bubblelike process bearing several short setae on first segment; second segment with hyaline flange near distal end; remaining segments non-prehensile and bearing a few short setae at distal ends. Postantennal spine well developed. Sclerotized rods around periphery of sucker as in Figure 2. Mouth tube about twice as long as wide and without ornamentation at base. Second maxilla basal plate as in Figure 3; remaining



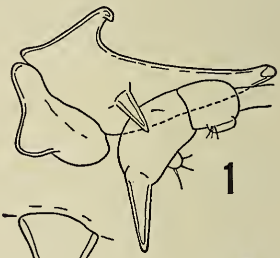
5



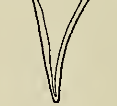
3



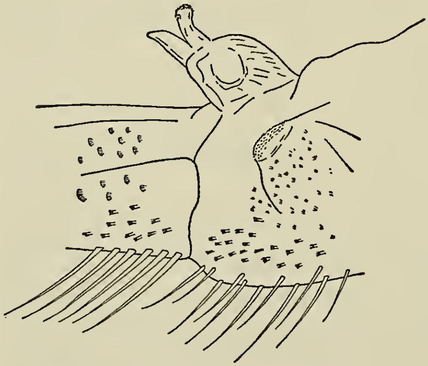
6



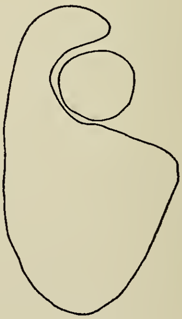
1



2



7



4

segments of second maxilla with unidentate, bidentate, or tridentate spinules on ventral surface.

Respiratory areas (Fig. 4) with neck of larger nearly surrounding smaller within its inner margin.

Legs 1 and 2 with fringed scales on surface of first 2 segments; scales mixed with unidentate spinules on third segment; unidentate spinules only on ventral flagellum. Legs 3 and 4 with only fringed scales on surface of segments. All legs bearing plumose setae on flagella. Natatory lobe with fringed scales in addition to long setae; lobe slightly more than 3 times as long as wide, shoelike in appearance, distal portion extending to lateral margins of abdomen.

Male: Body form and appendages as in the female except for modifications on basal portions of legs 2, 3, and 4 as shown in Figures 5, 6, and 7.

Color: In preserved specimens no pigmentation was present.

Discussion: This species may be separated from all other species of *Argulus* except *A. lepidostei* and *A. nobilis* by the shape of the respiratory areas. It can be separated from *A. lepidostei* by the presence of scales on the basal plate of the second maxilla of *lepidostei*. It can be separated from *nobilis* since the sclerotized rods in the suckers of *nobilis* contain more than 10 elements whereas in *meehani* there are less than 10. The new species can be further separated from the above 2 species by the presence of the hyaline areas on the second antenna of *A. meehani*.

An excellent account of the effects of this parasite on its host was published by Kolipinski in 1969.

Argulus chesapeakensis new species

Figures 8–14

Argulus laticauda.—Dutcher and Schwartz, 1962, pp. 213–215.

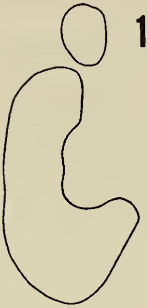
Material studied: Holotype female (USNM 137495), allotype (USNM 137496), and 89 paratypes (USNM 137497), collected by F. Schwartz, from the toadfish, *Opsanus tau* (Linn.) at Chesapeake Biological Laboratory, Solomons, Maryland.

Female: Body form of the typical argulid type. Total body length greater than width at a ratio of 7:5. Carapace somewhat longer than wide at a ratio of 6:5. Total length and greatest width of one ovigerous specimen was 5.55 mm × 3.90 mm.

←

FIGS. 1–7. *Argulus meehani* new species, female: 1, first and second antenna; 2, sclerotized rod of sucker; 3, basal plate and accessory spine of second maxilla; 4, respiratory areas. Male: 5, ventral surface of base of leg 2; 6, ventral surface of base of leg 3; 7, ventral surface of base of leg 4.

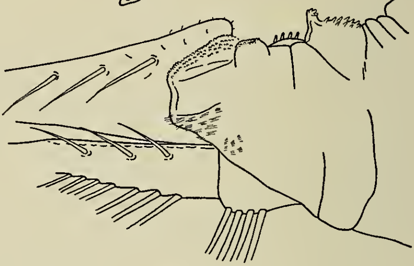
11



12

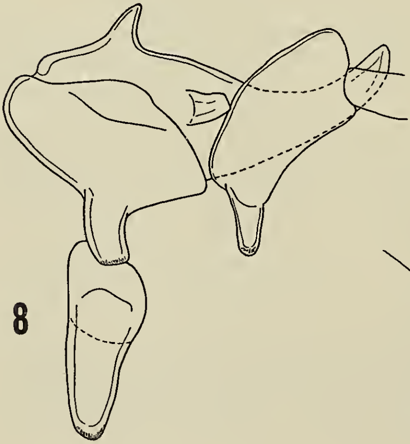
9

13

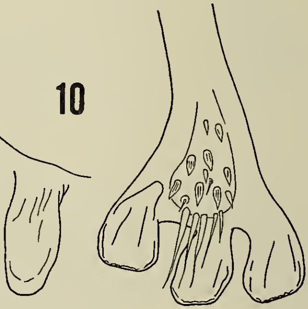


14

8



10



Abdomen wider than long (1.1 mm × 0.9 mm in one ovigerous specimen), widest across middle.

Caudal rami small, bearing 5 setae, and attached along inner edges of posterior abdominal lobes.

First antenna (Fig. 8) first segment with well-developed posterior spine, second segment with moderately developed anterior spine, well-developed median spine, and terminal claw; remaining segments non-prehensile, extending nearly to tip of claw, each with short setae. Second antenna 4-segmented; first segment with prominent posterior spine; remaining non-prehensile segments with several setae. Postantennal spine well-developed. Sclerotized rods around periphery of sucker as in Figure 9. Mouth tube only slightly longer than wide and without ornamentation at base. Basal plate of second maxilla as in Figure 10, remaining segments with numerous multidentate spinules on surface.

Respiratory areas as in Figure 11.

Legs 1–4 with unidentate spinules on surface of segments in addition to plumose setae. Natatory lobe with ventral surface covered with pyriform scales in addition to plumose setae. Area between natatory lobes with patch of prominent pyriform scales.

Male: As in female except for modified areas at bases of legs 2–4 as in figures 12–14.

Color: Pigmentation present in a tranverse band across mid-area of carapace and on dorsal surface of thoracic segments.

Discussion: This species may be separated from all others except *A. flavescens* and *A. laticauda* on the basis of the shape of the respiratory areas. In *A. laticauda* the 3 spines on the basal plate of the second maxilla are cuspidate and the antennal spines are spatulate. In *A. flavescens* the posterior spine on the first segment of the first antenna is digitate and the 3 spines on the basal plate of the second maxilla are longer than wide.

An excellent account of the host-parasite relationship was published by Dutcher and Schwartz in 1962.

For comparison with other species see Meehan, 1940.

LITERATURE CITED

DUTCHER, B. W. AND F. J. SCHWARTZ. 1962. A preferential parasitic copepod-oyster Toadfish association. Chesapeake Sci. 3 (3): 213–215.

KOLIPINSKI, M. C. 1969. Gar infested by *Argulus* in the Everglades. Quart. Jour. Fla. Acad. Sci. 32 (1): 39–49.

←

FIGS. 8–14. *Argulus chesapeakensis* new species, female: 8, first and second antenna; 9, sclerotized rod of sucker; 10, basal plate and accessory spine of second maxilla; 11, respiratory areas. Male: 12, ventral surface of base of leg 2; 13, ventral surface of base of leg 3; 14, ventral surface of base of leg 4.

MEEHAN, O. L. 1940. A review of the parasitic crustacea of the genus *Argulus* in the collections of the United States National Museum. Proc. U.S. Nat. Mus. 88 (3087): 459–522.

Vol. 84, No. 32, pp. 259–264 4 November 1971

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

NEW BATS OF THE GENUS *LAEPHOTIS* FROM AFRICA (MAMMALIA: CHIROPTERA)

By H. W. Setzer
Smithsonian Institution, Washington, D.C. 20560

The Smithsonian Institution African Mammal Project has had field parties collecting small mammals and their ectoparasites in southern Africa since 1963.

These field teams obtained two specimens of the genus *Laephotis* from South West Africa and one specimen from northwestern Botswana. None of these individuals agree with other known taxa in the genus *Laephotis*. We have made repeated efforts to obtain additional specimens, especially from South West Africa, but have been unsuccessful.

All measurements are in millimeters and capitalized color terms are from Ridgway "Color Standards and Color Nomenclature, 1912."

Owing to the degree of distinctness of these specimens two new taxa are here proposed and may be known as:

Laephotis namibensis new species

Holotype: Adult female, skin and skull, U.S. National Museum no. 342152, from Namib Research Station, Gobabeb, South West Africa; obtained 22 November 1963 by Ronald E. Cole, original no. 270.

Specimens examined: Two from the type locality.

Measurements: The measurements of the holotype with those of a female paratype (USNM 342153) in parentheses are: Total length 106 (104); length of tail 47 (46); length of hind foot 8 (8); length of ear 25 (24); length of forearm (dry) 38.2 (38.6); greatest length of skull 16.5 (16.5); greatest breadth across zygomatic arches 9.0 (–); least postorbital breadth 3.2 (3.6); greatest breadth of braincase 7.5 (7.6); depth of braincase 4.7 (4.9); length of maxillary toothrow 4.9 (5.0); postpalatal length 5.9 (6.0); breadth of palate across M^2-M^2 5.2 (5.4); breadth of palate across C-C 4.0 (4.0).

Diagnosis: Upper parts Light-Drab; flight membranes near Olive Brown; underparts noticeably paler than dorsum, individual hairs black at base, a narrow band (1–2 mm) of pure color (near Light-Drab), and tipped (2–3 mm) with white. Ears exceptionally large; tragus and antitragus well developed. Skull large for the genus; relatively long and narrow; upper toothrows nearly parallel; palate relatively long and narrow; auditory bullae remarkably inflated ventrally.

Comparisons: Compared with the holotype of *Laephotis wintoni*, *L. namibensis* is markedly paler in color; markedly larger ears, especially across the base (10.9 dry); and markedly larger tragus. The skull is longer; the postorbital constriction is less; the braincase is somewhat more domed; the auditory bullae are more inflated; the zygomatic arches are more markedly bowed dorsad; and the maxillary toothrows are more nearly parallel.

From a specimen of *Laephotis angolensis* from 35 km. E Dande, Angola, in the American Museum of Natural History (AMNH 87244), *L. namibensis* differs in markedly larger size; paler color; and strikingly larger ears. The skull, in all respects is decidedly larger and more robust.

Remarks: These specimens were taken in a mist net over a water hole in the bed of the Kuiseb River near the Namib Desert Research Station.

The name proposed for this new taxon is in reference to the Namib Desert of South West Africa.

Laephotis botswanae new species

Holotype: Adult female, skin and skull, U.S. National Museum no. 425349, from 50 mi. W, 12 mi. S Shakawe, Botswana. Obtained 24 May 1967 by S. W. Goussard, original no. 691.

Referred Specimens: British Museum (Natural History) 55.1134 and BM(NH) 55.1135 from Solwezi Boma, Zambia, obtained 28 April 1952 by W. H. F. Ansell; BM(NH) 57.436 and BM(NH) 57.438 from Mumene, 40 km. E Elizabethville, Congo (Kinshasa), obtained 28 December 1955 by the Hygiene Service of the Congo.

Measurements: The measurements of the holotype are: Total length 96; length of tail 41; length of hind foot 8; length of ear from notch 21; length of forearm (dry) 37.3; greatest length of skull 14.5; greatest breadth across zygomatic arches 8.3; least postorbital breadth 3.4; greatest breadth of braincase 7.0; depth of braincase 4.7; length of maxillary toothrow 4.7; postpalatal length 5.2; breadth of palate across M^2-M^2 5.4; breadth of palate across C-C 4.4.

Diagnosis: Upper parts near Buffy Brown; flight membranes near Clove Brown; underparts somewhat paler than dorsum, individual hairs black at base (5 mm), a narrow band (1 mm) of pure color and tipped (2 to 3 mm) with buffy. Ears moderate in size; tragus and antitragus moderately developed. Skull average in size for the genus; relatively narrow; rostrum relatively long and narrow; zygomatic arches fragile;

TABLE 1. Measurements of four species of *Laephotis*.

	External measurements						Cranial measurements								
Specimens examined	Total length	Head and body length	Tail length	Foot length	Ear length	Forearm length	Greatest length	Zygomatic breadth	Postorbital breadth	Braincase breadth	Braincase depth	Maxillary toothrow length	Postpalatal length	Palatal breadth (m^3-m^3)	Palatal breadth (c-c)
wintoni (BMNH 1.5.6.5)	–	–	–	–	17	37.3	14.5	–	3.4	7.2	4.8	4.4	5.4	5.5	4.0
namibensis (USNM 342152)	106	59	47	8	25	38.2	16.5	9.0	3.2	7.5	4.7	4.9	5.9	5.2	4.0
botswanae (USNM 425349)	96	54	41	8	21	37.3	14.5	8.3	3.4	7.0	4.7	4.7	5.2	5.3	4.4
angolensis (AMNH 87244)	82	46	36	–	15	32.4	13.7	6.7	3.4	6.6	4.4	4.3	5.4	4.9	4.0

toothrows diverging slightly posteriorly; palate markedly arched dorsally; auditory bullae moderately sized.

Comparisons: From *Laephotis wintoni* as known by a specimen in the Royal Ontario Museum (ROM 36368) from Namanga, Kenya, *L. botswanae* differs in lighter color throughout; smaller ears; somewhat shorter forearm; and smaller, less curved tragus. The skull is smaller in all respects; auditory bullae smaller; palate more concave; upper toothrows more divergent posteriorly; and bony palate less projecting posteriorly.

Laephotis botswanae differs from the holotype and paratype of *L. namibensis* in smaller size; darker color; markedly smaller ears and tragus; and in having a shorter forearm. The skull is markedly smaller with a broader, shorter rostrum; occipital region more rounded; palatal region shorter, broader and more concave; auditory bullae less inflated; and foramen magnum markedly smaller.

Compared with *Laephotis angolensis* as known by a specimen from 35 mi. E Dande, Angola (AMNH 87244), *L. botswanae* differs in somewhat paler color; larger ears; and longer forearm. The skull is markedly larger; rostrum more massive; occipital crest less projecting posteriorly; palate broader but not as deeply concave; upper toothrows more divergent posteriorly; and auditory bullae, relatively as well as actually, smaller.

Remarks: With the recognition of these two new taxa, four species are now known in the genus *Laephotis*. There is reasonably close relationship between *L. wintoni* and *L. botswanae* but the relationship of *L. angolensis* and *L. namibensis* with the others is somewhat obscure.

When the skulls are arranged according to their greatest length, *namibensis* is largest, followed by *wintoni*, *botswanae*, and finally *angolensis*. The same applies when greatest breadth of braincase is examined; *wintoni* is the largest, *namibensis* next, followed by *botswanae* and *angolensis* (Table 1).

Forearm measurements are rather distinctive for *L. namibensis* and *L. angolensis*, the measurement of the former being over 38 while the measurement of the latter is not known to exceed 33. The same measurement overlaps between *L. botswanae* and *L. wintoni*. If, however, one adds to the preceding differences, the size and configuration of the tragus (Fig. 1), *L. wintoni* and *L. namibensis* show the closest relationship while *L. angolensis* and *L. botswanae*, which might possibly occur together, show striking differences in the tragi.

If one assumes *L. namibensis* to be the most specialized in shape and size of the ears; shape and size of the tragus; size of the auditory bullae; and in the shape and size of the rostrum; one is tempted to group the other taxa on the same morphological bases. When this is done it seems reasonable to place *L. wintoni* and *L. namibensis* as being closely allied, even though they are separated from each other by some 24° of latitude and some 30° of longitude. The other two species, occupying this hiatus of latitude and longitude can be readily separated on the basis of length of tragus, length of forearm and greatest length of skull. It would seem

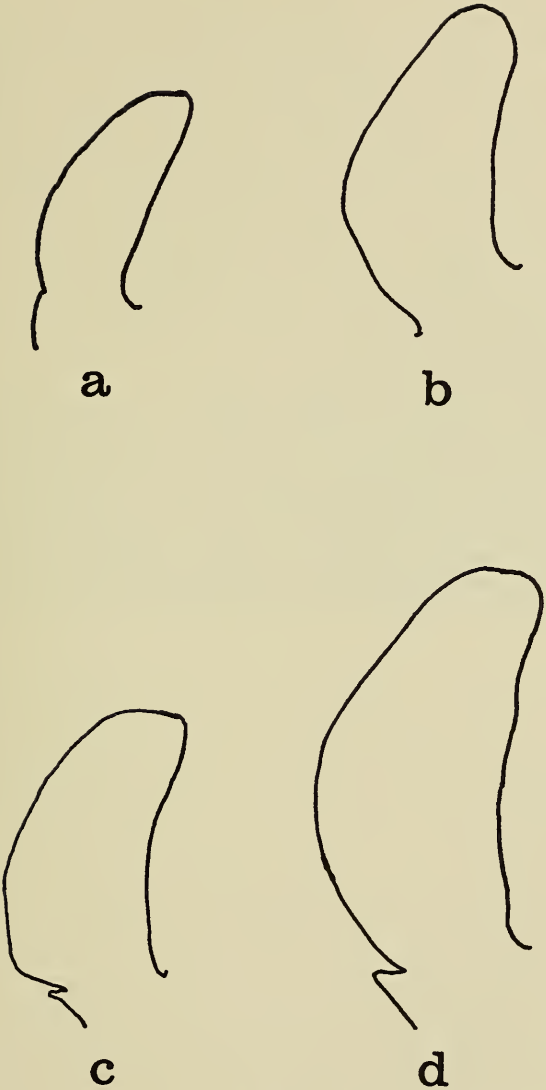


Fig. 1. Right tragi of four species of *Laephotis*; a. *angolensis*, b. *botswanae*, c. *wintoni*, d. *namibensis*.

that an arrangement from least to most specialized based on several morphological features *L. angolensis* might be the least specialized; *L. botswanae* next with *L. wintoni* and *L. namibensis* in that order.

Peterson (MS, 1971) suggests that the populations of *Laephotis* represented by specimens from Botswana, Zambia and the southeastern Congo (Kinshasa) might represent a new species if female specimens of true *L. wintoni* were known. I suggest that since the holotype of *L. angolensis* is a female and that the measurements of a single male of the same taxon from 35 km. E Dande, Angola (AMNH 87244) show no real differences, there is no significant sexual variation involved. Examination of the external and cranial measurements of the series of specimens in the British Museum from Mumene, Musonge, Congo, as presented by Peterson, reveals that sexual variation is slight but that females do average a bit larger than males.

I would like to express my appreciation to Dr. R. L. Peterson of the Royal Ontario Museum for making available to me, not only a specimen of typical *L. wintoni* but also his manuscript reporting this specimen; to Dr. Gordon Corbet and Mr. J. E. Hill of the British Museum, and Drs. Sydney Anderson and Karl Koopman of the American Museum of Natural History for making available to me the specimens of the genus *Laephotis* in their care. Special credit must go to the Department of the Army, Office of the Surgeon General, for making available the funds under Contract DA-49-193-MD-2738 by which these specimens were obtained.

Vol. 84, No. 33, pp. 265–270 4 November 1971

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

THE POSTLARVA OF THE STOMATOPOD CRUSTACEAN *HETEROSQUILLA POLYDACTYLA* (VON MARTENS)

By Raymond B. Manning
Smithsonian Institution, Washington, D.C. 20560

The postlarva of stomatopod crustaceans, the single transitional stage between the free-swimming larvae and the benthic adults, is rare in collections in comparison with either larvae or adults. Consequently, postlarvae are very poorly known and their identification with adults has often proved difficult. Recent studies on young stomatopods, including work by Alikunhi (1967) on various species, Bigelow (1931) on *Pseudosquilla*, Manning (1962) on *Alima*, Manning (1969a) on *Pseudosquillopsis*, and Michel and Manning (in press) on *Chorisquilla* have demonstrated that postlarvae often exhibit enough adult characters to allow their identification with certainty. Although postlarvae have been identified for several species in different genera, these stages apparently are not known for members of the lysiosquillid genus *Heterosquilla* which now includes 12 species in two subgenera.

In 1970, E. L. Bousfield, National Museum of Natural Sciences, Ottawa, a participant in the Hudson 70 Oceanographical Expedition to Cape Horn, collected 10 specimens of a lysiosquillid at Navarino Island, Chile. These specimens proved to be the postlarvae of *Heterosquilla polydactyla* (Von Martens), the only lysiosquillid known to occur in that area (Manning, 1969). Adults of this species have been taken at several localities between Valparaiso, Chile, and Golfo Nuevo, Argentina; other authors recently reporting this species include Schmitt (1940) and Bahamonde (1957, 1968).

I thank E. L. Bousfield for allowing me to work with these specimens and for depositing some of them in the collection of the Division of Crustacea, National Museum of Natural History, Smithsonian Institution, and W. Duane Hope for reviewing the manuscript. The illustrations were made by my wife Lilly. Studies on larval and postlarval stomatopods have been supported through the Research Awards Program of the Smithsonian Institution.

Heterosquilla (*Heterosquilla*) *polydactyla* (Von Martens)

Figure 1

Heterosquilla (*Heterosquilla*) *polydactyla*.—Holthuis, 1967, p. 11 [complete synonymy].—Manning, 1969, p. 45, figure 8 [older references].
Heterosquilla polydactyla.—Bahamonde, 1968, p. 112, figures 3, 4.

Material: 10 postlarvae, total length 19–21.5 mm; Banco de Las Tacas, eastern Navarino Island, Chile; 55°05′ S, 67°04.5′ W; fine sand beach; E. L. Bousfield, Station F12; 5 February 1970.

Description: Eye of moderate size, cornea trilobed (appearing bilobed in dorsal view, inner lobe bilobed dorsoventrally), outer lobe the largest; eyes not extending to end of antennular peduncle. Ocular scales erect, completely fused along midline. Antennular peduncle half or slightly less than half carapace length; dorsal processes of antennular somite visible lateral to rostral plate as small, triangular projections; antennular flagella about half again as long as stalk, dorsomesial branch comprising 25-26 articles, stouter, shorter ventrolateral branch comprising 8 articles. Antennal scale suboval, about half as long as carapace; antennal peduncle not extending beyond eye; antennal flagellum about 1.3 times as long as scale, comprising about 15 articles; antennal papillae not visible. Rostral plate triangular, longer than broad, apex acute but rounded, deflexed mesially; plate completely covering ocular scales and bases of eyes. Carapace smooth, unarmed; gastric grooves distinct; lateral plates strongly narrowing anteriorly. Raptorial claw slender, dactylus armed with 14–17 teeth; propodus subequal to carapace in length, outer edge of opposable margin completely pectinate, inner edge of opposable margin with 4 movable spines; carpus of claw with sharp, dorsal ridge terminating in slender tooth; merus more than half again as long as ischium; basal segment of claw with prominent, ventrally projecting spine. Mandibular palp and 5 epipods present. Thoracic somites smooth dorsally; lateral margins of sixth and seventh somites subtruncate; ventral surface of sixth, seventh and eighth somites with ventral projection laterally, mesial to base of each walking leg; seventh and eighth thoracic somites with median ventral spine, sharper on seventh somite. Posterior margin of basal segment of each walking leg with inner and outer spines, projecting ventrally, sharpest on anterior two legs. Abdomen smooth, depressed, anterior 5 somites unarmed; articulated anterolateral plates present; sixth somite with strong posterolateral spines, lacking ventral spine in front of

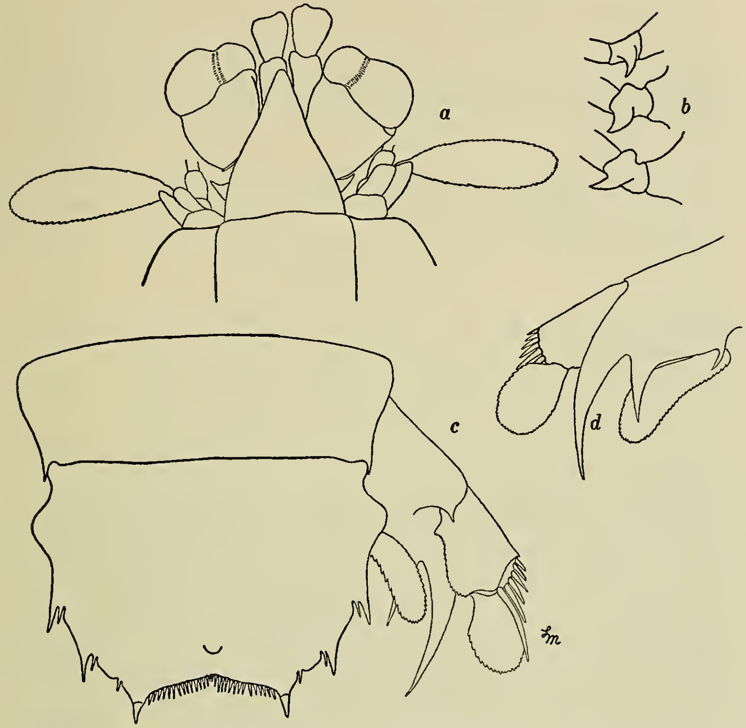


FIG. 1. Postlarva of *Heterosquilla polydactyla* (Von Martens): *a*, anterior portion of body; *b*, basal segments of walking legs; *c*, sixth abdominal somite, telson, and uropod; *d*, uropod, ventral view. (Setae omitted in all).

articulation of each uropod. Telson flattened, broader than long, with 3 pairs of marginal teeth, submedians with movable apices; lateral margins with broad, rounded lobe anteriorly; 14–15 slender submedian, 2 intermediate, and 1 lateral denticles present; dorsal surface of telson with low, inconspicuous longitudinal median boss, visible in some specimens, boss terminating in low, rounded median projection; submedian projections absent. Uropod flattened, basal segment with dorsal spine at articulation of exopod; proximal segment of exopod longer than distal, with 6–7 movable spines on outer margin, distalmost not extending to apex of distal segment; endopod slender, curved; basal prolongation of uropod consisting of 2 curved spines, outer larger, with smaller spine on inner margin at articulation of endopod. Color faded in most specimens, but one ornamented with scattered dark chromatophores on body, arranged in bands on thoracic and abdominal somites.

Measurements: Measurements, in mm, of selected specimens are as follows:

Total length	19.5	20	20	20.5	21
Carapace length	3.8	3.8	3.8	3.9	3.8
Cornea width	1.1	1.1	1.0	1.1	1.1
Rostral plate length	1.8	1.6	1.6	1.6	1.8
Rostral plate width	1.4	1.4	1.4	1.4	1.5
Fifth abdominal somite width	4.5	4.5	4.4	4.4	4.3
Telson length	3.1	3.1	3.0	3.0	2.9
Telson width	4.0	3.8	3.8	3.9	3.8
Teeth on claw	16	15	17	14	15
Uropod spines	7	6	7	6	7
Submedian denticles	14	14	15	15	14–15

Discussion: These specimens are readily identifiable as the postlarvae of *Heterosquilla polydactyla*: the long, triangular rostral plate and the large number of teeth on the dactylus of the claw are diagnostic for the species. Although identifiable with *H. polydactyla*, these specimens show several differences from the adults, a function of their immaturity. The eyes are of the postlarval type, trilobed rather than bilobed as in the adult; as pointed out by Manning (1969a), the secondary subdivision of one lobe of the eye is characteristic of the postlarvae of *Pseudosquillopsis*; it may help in recognizing postlarvae of *Heterosquilla* as well. The postlarvae lack the antennal papillae of adults; apparently they develop at some subsequent stage. Several features of the postlarva are absent or modified in the adult: the strong ventrally projecting ischial spine and the ventrally projecting thoracic spines found in the postlarvae are absent in the adult (the median ventral spine on the eighth thoracic somite of the postlarva is present as a low rounded keel in adults), and adults have but one rather than two basal spines on the walking legs. Lastly, the median and submedian bosses of the telson, well developed in adults, are represented by at most a low median boss terminating in a rounded posterior projection.

The characteristically banded color pattern of the adult is visible on one of the 10 specimens studied; presumably it first appears at this stage.

Usually it is possible to sex postlarvae, for the buds of the male copulatory tubes are visible at the bases of the last pair of walking legs. In these specimens the male copulatory tubes (if present) cannot be seen. The tubes may be obscured by the spines on the thoracic sterna and at the bases of the walking legs.

According to information supplied by E. L. Bousfield, the beach on which these specimens were collected had a very gentle slope; the substratum was fine to very fine dark sand of sedimentary rock and shell origin. The collections were made at mid-water level at low tide. The animals were living in burrows in the sand, and those collected had left their burrows and had been trapped or blown away by drying winds. Associated organisms included small phoxocephalid and haustoriid amphipods and a large serolanid isopod. The surface temperature of the water was 9.5°C.

Distribution: Southern portion of South America, where it has been reported from scattered localities between Maullin Island (near Chiloe Island), Chile, to Chubut Province, Argentina.

LITERATURE CITED

ALIKUNHI, K. H. 1967. An account of the post-larval development, moulting, and growth of the common stomatopods of the Madras coast, pp. 824–939, figures 1–194, plates 1–3. *In* Proceedings of the Symposium on Crustacea, Marine Biological Association of India, Part II: iv + 945 pp.

BAHAMONDE N., NIBALDO. 1957. Sobre la distribución geográfica de *Lysiosquilla polydactyla* Von Martens, 1881 (Crustacea, Stomatopoda). Invest. Zool. Chil. 3(5–7): 119–121, figures 1–3.

————. 1968. Bosquejo taxonomico sobre los estomatopodos de Chile (*Crustacea, Stomatopoda*). Rev. Univ., Univ. Cat. Chile, no. 31: 107–120, figures 1–8.

BIGELOW, R. P. 1931. Stomatopoda of the southern and eastern Pacific Ocean and the Hawaiian Islands. Bull. Mus. Comp. Zool. Harvard, 72 (4): 105–191, figures 1–10, plates 1–2.

HOLTHUIS, L. B. 1967. Fam. Lysiosquillidae et Bathysquillidae. Stomatopoda I. *In*: Gruner, H.-E., and L. B. Holthuis, eds., Crustaceorum Catalogus, ed. a, pars 1: 1–28.

MANNING, RAYMOND B. 1962. *Alima hyalina* Leach, the pelagic larva of the stomatopod crustacean *Squilla alba* Bigelow. Bull. Mar. Sci. Gulf & Carib., 12 (3): 496–507, figures 1–4.

————. 1969. Stomatopod Crustacea of the western Atlantic. Stud. trop. Oceanogr. Miami, 8: vii + 380 pp, figures 1–91.

————. 1969a. The postlarvae and juvenile stages of two species of *Pseudosquillopsis* (Crustacea, Stomatopoda) from the eastern Pacific region. Proc. Biol. Soc. Washington, 82: 525–537, figures 1–4.

MICHEL, A., AND RAYMOND B. MANNING. In press. The pelagic larvae of *Chorisquilla tuberculata* (Borradaile, 1907) (Stomatopoda). Crustaceana.

SCHMITT, WALDO L. 1940. The stomatopods of the west coast of America based on collections made by the Allan Hancock Expeditions, 1933–38. Allan Hancock Pacific Exped., 5 (4): 120–225, figures 1–33.

Vol. 84, No. 34, pp. 271–282 4 November 1971

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

THE CAMBALIDAE IN MEXICAN CAVES, WITH DESCRIPTIONS OF THREE NEW SPECIES OF *MEXICAMBALA* (DIPLOPODA: CAMBALIDA)

By Nell B. Causey
Department of Zoology and Physiology,
Louisiana State University,
Baton Rouge, Louisiana 70803

Cambaloid millipedes, seldom collected in Mexico, are represented there by two families, the Cambalidae and the Leioderidae. The nearest relatives are the United States species of these families.

All known epigean cambaloid millipedes in Mexico have been assigned to three species of the family Leioderidae. They are scarce, none having been reported since the original descriptions were published (Loomis, 1968). I have new records of one of them, *Ergene setosus* Chamberlin, 1943, from a relatively small area in two northeastern states. Tamaulipas: C. Victoria, ♂; Hwy 85, Km 627–628, about 35 mi S of the Tropic of Cancer, ♂; El Venadito, Hwy 85, 8 mi S of Antiguo Morelos, ♂. San Luis Potosí: Hwy 85, 8 mi N of C. Valles, ♂. An immature female from El Tinieble, Hwy 25, Km 99, between Victoria and Matamoros, Tamaulipas, has fewer body setae than specimens from the previously listed sites and may represent another species. Immature specimens from Túxpan, Veracruz, probably represent an undescribed genus.

All known Mexican members of the Cambalidae are troglobites and can be assigned to either *Cambala* or *Mexicambala*. In Mexico, this family is much better known than the Leioderidae because of the zealous collecting by speleologists.

The troglobitic specimens reported on here were collected by members of the Association for Mexican Cave Studies, to whom I am grateful for the opportunity of studying the material. Caves were located by using the maps of Russell and Raines (1967). Holotypes and paratypes of the new species described here have been deposited in the type collection of the National Museum of Natural History. The male holotype and female paratype of *Mexicambala russelli* Causey, 1964, are in the American Museum of Natural History. The remaining specimens are in my collection.

KEY TO THE MEXICAN CAMBALIDAE BASED ON THE MALE

1. Sides of collum are low and slightly flared, allowing antennae to fit under anterior margin; dorsal crests are not notched; peritremes are no higher than dorsal crests; viewed from above, paraprocts are slightly visible ectad of epiproct; apical margin of coxite of anterior gonopods is broad and slightly concave, and sternite is longer than wide .... *Cambala speobia*

1′. Sides of collum are high, not flared, and have a notch in which margin of vertex articulates; dorsal crests have 1 or 2 notches, dividing them into 2 or 3 angular or rounded teeth; peritremes are higher than dorsal crests; viewed from above, paraprocts are not visible ectad of epiproct; apex of coxite of anterior gonopods is narrowed and rounded, and sternite is wider than long 2

2. Maximum length is about 34 mm; dorsal crests have 3 conspicuous angular teeth; peritremes are conspicuous and subcylindrical; apex of epiproct is rounded and asetose; paraprocts have setae (about 9) along mesial margin only; telopodite of anterior gonopods is as long as coxite .... *Mexicambala fishi* new species

2′. Maximum length is about 26 mm or less; teeth (2 or 3) of dorsal crests are either rounded or angular and are less conspicuous; peritremes (either conical or subcylindrical) are less conspicuous; apex of epiproct is either rounded or peglike and either setose or asetose; few to many setae are scattered over paraprocts; telopodite of anterior gonopods is distinctly shorter than coxite 3

3. Dorsal crests have 2 notches, and teeth are mostly angular; peritremes are subcylindrical; apex of epiproct is rounded and asetose .... *M. russelli*

3′. Dorsal crests have 1 notch, and teeth are mostly rounded; peritremes are either subcylindrical or conical; apex of epiproct is varied 4

4. Peritremes are usually high and conical; apex of epiproct bears a conspicuous setose peg .... *M. blandus* new species

4′. Peritremes are lower and subcylindrical; apex of epiproct is rounded and seldom is setose .... *M. inopis* new species

Genus *Cambala* Gray

Cambala.—Causey, 1964.—Shear, 1969.
Mexicambala.—Shear, 1969.

This predominantly epigean North American genus also has troglophilic and troglobitic species. The only Mexican record is of *C. speobia*, from a cave which drains into the Río Grande. It is improbable that additional search will extend the range significantly into Mexico.

Cambala speobia (Chamberlin)

Figures 1a, 2a

C. speobia.—Causey, 1964.

Diagnosis: A troglobitic species characterized by absence of ocelli and details of gonopods.

An occasional immature specimen has one or more ocelli. Mature males have a conspicuous, rounded lobe on ventral surface of article 4 of legpairs 6 and 7. Legpair 1 has pretarsi. Segments 2 and 3 have no traces of dorsal crests, which begin on segment 4. Peritreme-pore crests and 4 dorsal crests are on all remaining segments; none have distinct notches (Fig. 1a). Ventral crests are represented by some 18 to 20 distinct but narrow ridges. Apex of epiproct is rounded; from a dorsal view paraprocts are slightly visible lateral to epiproct. Each paraproct has 2 setae on its mesial margin. Local variations in body length are common; maximum is about 33 mm. Specimens from La Cueva de los Lagos tend to be small, with maximum length about 19 mm.

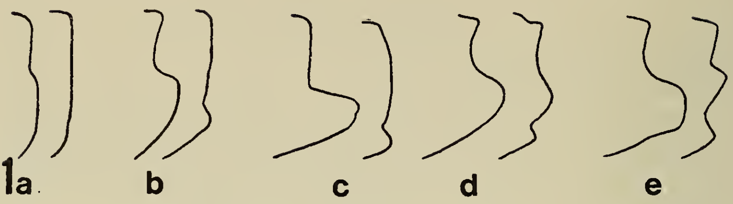
C. speobia occurs in many caves in the Edwards Plateau of central and southwest-central Texas (Causey, 1964). Bull and Mitchell (in press) pointed out that they are all either in the Balcones Fault or are within 50 miles of the Fault and postulated that the ancestors of *C. speobia* survived in the epigeum after the early Pleistocene. No other cambaloid millipede is troglobitic in the Edwards Plateau. The shorter legs and antennae of *C. speobia* suggest that this species did not become troglobitic as early as species of *Mexicambala* did.

Record of C. speobia *in Mexico*: Coahuila: Cueva de los Lagos, 15 mi. W of Acuña, 2 mi. S of the Río Grande; many specimens, 24 Jan. 1964, 14 Nov. 1964; J. Reddell, D. McKenzie, T. Raines. This cave was later flooded by the Amistad Reservoir. The polydesmoid genus *Speodesmus*, which is usually represented in Edwards Plateau caves with *C. speobia*, was not collected.

Genus *Mexicambala* Causey

Mexicambala Causey, 1964.
Cambala.—Shear, 1969.

Shear (1969), who regards *Mexicambala* as a junior synonym of *Cambala*, has ignored the well-defined somatic and sexual characters which separate the two species groups composing these genera.



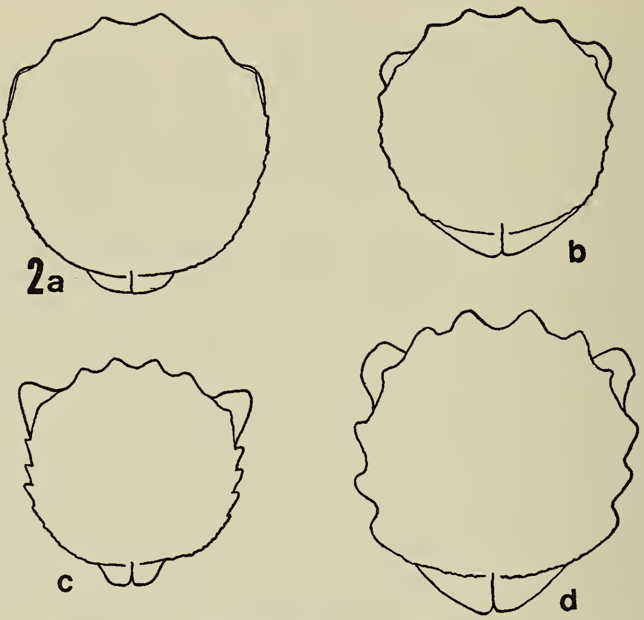


FIG. 1. Lateral view of peritreme-pore crest (first in each pair) and dorsal crest (second in each pair) of middle body segments. a, *Cambala speobia*; b, *Mexicambala inopis*; c, *M. blandus*; d, *M. russelli*; e, *M. fishi.*

FIG. 2. Caudal margin of segment 7 of male. a, *Cambala speobia*; b, *Mexicambala blandus*; c, *M. russelli*; d, *M. fishi*. From this view, *M. inopis*, which is not shown, is essentially like *M. russelli.*

Diagnosis: Eyeless, troglobitic, small cambalids characterized by prominent peritremes and notched dorsal crests. Near *Cambala*, differing as follows: sides of collum are higher, closer to head, and have a notch in which margin of vertex articulates; antennae are longer, reaching to segment 5, and have large sensory areas on distal margin of articles 5 and 6; dorsal crests are divided by 1 or 2 notches into 2 or 3 rounded or angular teeth; epiproct covers paraprocts when viewed from above; apical margin of coxite of anterior gonopods is narrowly rounded and undivided.

Length 21–26 mm, segments 39–47. In life, depigmented except for red stink pores; in alcohol, flesh colored or grayish, quickly losing red pigment. Body is slightly narrowed behind head. Segment 7 of male is not swollen. Collum is length of segments 2 and 3; dorsal surface is smooth. Segments 2 and 3 have well-developed, slightly developed, or no crests. Segment 4 has well-developed crests without notches. Dorsal crests of segment 5 may have notches. By segment 9 crests have reached their maximum size and typical shape (Fig. 1b–d). Pores and pore crests begin on segment 5; distal part of pore crests is thin, resembling dorsal crests; anterior part with pore (peritreme) is either subcylindrical or conical and much higher than dorsal crests (Fig. 2b–d). Crests are lower on last 2 segments and absent on epiproct. Surface between crests is smooth and shining. Some 5 to 8 lateral crests, much thicker than in *Cambala*, are below pore crests; all or only upper ones may have 1 tooth, which is in line with middle tooth of dorsal crests. Apex of epiproct is either rounded or produced in a prominent peg with several setae. Paraprocts have a few setae along mesial margins only or scattered over their surface. Legpair 1 has pretarsi. Mature males have rounded lobes on ventral surface of article 3 and 4 and sometimes 5 of legpairs 6 and 7. Pretarsus of male is approximately one-half as long as tarsus, and in female it is one-third as long.

From an anterior view, apical region of telopodite of anterior gonopods is narrowed less than coxite; from a lateral view, telopodite is usually blunt and wider than coxite; sternite is shorter than it is wide from an anterior view (Figs. 3c, 4b). Posterior gonopods (Fig. 3d) are essentially as in *Cambala*; as in all species of *Cambala*, telopodite is composed of 2 articles; division between articles is less distinct in *Mexicambala* than in *Cambala*.

Distribution: Caves in mountains of Tamaulipas, San Luis Potosí, and Oaxaca.

Species: 4.

Speciation: The species have a north-south range, with *inopis* the most northern, followed by *blandus*, *russelli*, and *fishi*. There is a clinal variation in the surface sculpture, suggesting that the lengthening of the peritremes and the enlargement and notching of the crests coincided with the southern movement of the genus. *M. fishi* is easily distinguished from the northern species by its stronger surface sculpture and gonopods. The three northern species, which have contiguous ranges, resemble each other in that they have identical gonopods and have setae scattered over the paraprocts rather than only along the mesial margins. They comprise the *russelli* superspecies, differing from each other in the development of the surface sculpture, the length of the epiproct, and the abundance of the setae on the paraprocts. These characters, although somewhat variable, are reliable enough to be used to separate the species. *M. blandus* and *M. inopis* are especially variable, with the populations of some caves distinctive enough to be recognizable.

Mexicambala inopis new species

Figure 1b

Diagnosis: Distinguished from other members of the *russelli* superspecies by the relatively inconspicuous body sculpture. Resembles *M. russelli* in that apex of epiproct is rounded and peritremes are subcylindrical; differs in that there is only 1 notch on the dorsal crests.

Description of holotype: Male, length 22.5 mm, width 1.3 mm, segments 45. Articles 3, 4, and 5 of legpairs 6 and 7 have large ventral lobes. No dorsal crests are on segment 2. Dorsal crests are weakly indicated on segment 3. On segment 4, 10 distinct crests are on dorsum and sides. Dorsal crests of typical body segments have one small notch (first is on segment 9), and tooth in front of it is small and subangular (Fig. 1b). Peritremes are subcylindrical and relatively low. Lateral crests are low and number 6 to 8. Epiproct is rounded and lacks apical setae. Setae are scattered sparsely over paraprocts.

Gonopods are as in other members of the *russelli* superspecies.

Description of female paratype: Length 25.5 mm, segments 46. Setae are more numerous on paraprocts than in holotype.

Variations of paratypes from three caves: Length 20–33 mm, segments 34–46. No paratypes from Sótano de la Joya have setae or a swelling on the apex of the epiproct, and all have the dorsal crests as in the holotype. Specimens from the other 2 caves, which are nearer Rancho del Cielo, show a little intergradation with *M. blandus*. This is indicated by the slightly angular anterior tooth of the dorsal crests, the presence of a few setae on the epiprocts, and, in a female of 43 segments from Mine Cave, a slight swelling on the apex of the epiproct.

Range: Three caves within a distance of some 8 miles in the Sierra de Guatemala, southern Tamaulipas. This is northwest of and contiguous to the range of *B. blandus*.

Type locality and specimens: TAMAULIPAS: Sótano de la Joya de Salas, W of Rancho del Cielo about 6 mi.; 5 ♂, including holotype, 2 ♀; 3 June 1965, J. Fish, H. Russell.

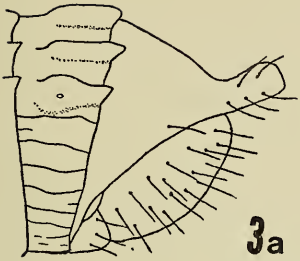
Other localities and specimens: Cueva de los Leones, ♂, ♀; 5 June 1965, M. McKenzie. Mine Cave, 6 mi. NW of Gómez Farías, 1 immature, 9 Mar. 1966, J. Redell; ♂, ♀; 3 June 1967, R. Mitchell.

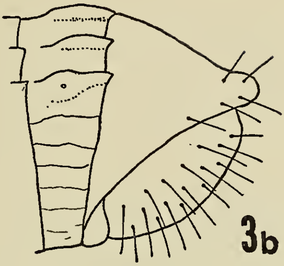
Deposition of specimens: Holotype (undissected) and ♀ paratype from type locality; paratypes of both sexes from Cueva de los Leones and Mine Cave; National Museum of Natural History.

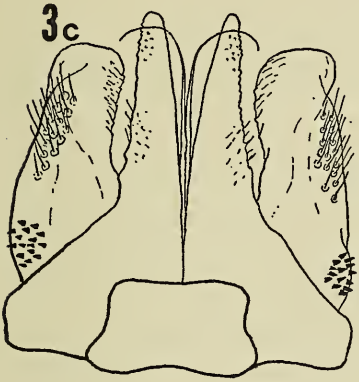
Mexicambala blandus new species

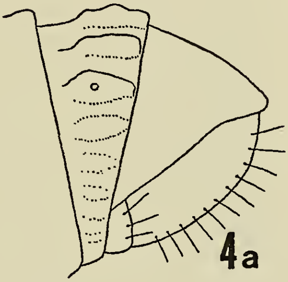
Figures 1c, 2b, 3

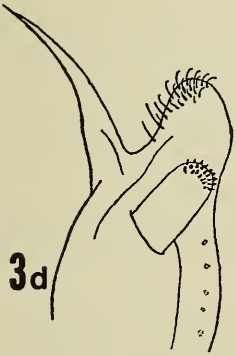
Diagnosis: Distinguished from other members of the *russelli* superspecies by the peg on the apex of the epiproct and the prominent conical











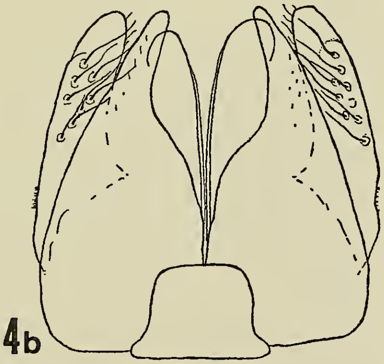


Fig. 3. *M. blandus.* a, hind end of female (Crystal Cave); b, hind end of female (Bee Cave); c, anterior view of anterior gonopods (Crystal Cave); d, subcephalic view of left posterior gonopod (Cueva del Agua).

Fig. 4. *M. fishi.* a, hind end of holotype; b, anterior view of anterior gonopods of paratype.

peritremes. Resembles *M. inopis* in that dorsal crests have only 1 small notch and are low.

Description of holotype: Male, length 18.5 mm, width 1.1 mm, segments 38. Thick, rounded lobes are on ventral surface of articles 3, 4, and 5 of legpairs 6 and 7. Crests are weakly indicated on segment 2. On segments 3 and 4 crests are well formed. Dorsal crests of typical segments have 1 small notch (first is on segment 7), which is preceded by a small, angular tooth and followed by a slightly convex ridge. Peritremes are conical, salient, with pore near apex. Most segments have 7 lateral crests, of which upper 3 are thickened. Caudal peg is setose, blunt, and a little shorter than peg of female shown in Fig. 3a. Setae are more sparsely arranged on paraprocts than in female.

Anterior gonopods (Fig. 3c) and posterior gonopods (Fig. 3d) are like those of other members of the *russelli* superspecies.

Description of female paratype from Harrison's Sinkhole: Length 23 mm, width 1.7 mm, segments 40. Surface sculpture is as in holotype. Caudal peg (Fig. 3a) is slightly longer and paraprocts are slightly more setose than in holotype.

Variations of paratypes from all localities: Length 18–23 mm, segments 38–43. The characters which are so conspicuous in this species, the caudal peg and conical peritremes, are largest in the northern part of the range in the caves at Rancho del Cielo. Both structures diminish in size along a north-south cline and reach their maximum reduction at Bee Cave, near Chamal (Fig. 3b, female of 40 segments).

The length of the caudal peg also varies ontogenetically and sexually. In the early stadia it is represented by setae and a thickened ridge, and it does not reach its maximum size until specimens have molted to about 40 segments. In mature females at Rancho del Cielo the peg tends to be from one-fourth to one-third longer than in mature males. In the southern part of the range the sexual variation in the length of the caudal peg is less marked because the peg is so much shorter there.

Range: Six caves with a north-south range of 21 miles in the Sierra del Abra of southern Tamaulipas. This is between the ranges of *M. inopis* to the northwest and *M. russelli* to the south.

Type locality and specimens: TAMAULIPAS: Harrison's Sinkhole, Rancho del Cielo, 1♂, 2♀, 5 June 1964, on decaying organic matter, J. Reddell et al.; 7♂, including holotype, 30♀, 25 Mar. 1967, R. W. Mitchell.

Other localities and specimens (*in order of north-south distribution*): TAMAULIPAS: Crystal Cave, Rancho del Cielo, ♂, ♀, immatures, Aug. 1966 and Mar. 1967, R. W. Mitchell; ♂, ♀, June 1964, J. Reddell et al. Sótano de Gomez Farías, 6 mi. NW of Gomez Farías, ♂, ♀, 12 June 1964; 6 Dec. 1964, T. Raines. Cueva del Nacimiento del Río Frío, 3 mi. S of Gómez Farías, ♀, 11 Mar. 1969, J. Reddell. Bee Cave, 6 mi. N of Chamel, ♂, ♀, 29 Jan. 1968 and 26 May 1968, J. Reddell. Grutas del Puente, 5 mi. SE of Ocampo, ♂, ♀, 13 July 1967, J. Reddell.

Deposition of specimens: Holotype (undissected) and paratypes of both sexes from Crystal Cave and Bee Cave; National Museum of Natural History.

Mexicambala russelli Causey

Figures 1d, 2c

M. russelli Causey, 1964.

Diagnosis: Distinguished from other members of the *russelli* superspecies by the more angular middle tooth of the dorsal crests. Resembles *M. inopis* in that apex of epiproct is rounded and peritremes are subcylindrical; differs in that surface sculpture is more strongly developed and setae are more numerous on paraprocts.

Length 20–26 mm, width 1.3–1.6 mm, segments 38–45. Lobes on legpairs 6 and 7 are smaller than in *M. inopis*. Dorsal crests are very faintly developed on segments 2 and 3 and a little more strongly on segment 4; by segment 8 they have their typical form (Fig. 1d). Most segments have 8 lateral crests; upper one has a small middle tooth. Surface sculpture is most like that of *M. fishi*, differing in that peritremes and teeth of dorsal crests are a little smaller and lateral crests are much smaller. Apex of epiproct is rounded and asetose; paraprocts are most thickly setose of genus.

Anterior gonopods are as shown for *M. blandus* (Fig. 3a). The previously published figure (Causey, 1964) shows apex of telopodite too broad; apex normally has this appearance from a lateral view, but from an anterior view apex appears broad only when pressure is applied. Posterior gonopods are as in congeners.

Range: Eight caves in the Sierra Madre Oriental in the vicinity of Aquismón and Xilitla, eastern San Luis Potosí. North-south extent of range is 24 miles. Nearest congener is *M. blandus*, some 108 miles north.

Type locality: San Luis Potosí: Cueva de la Parra, 3 mi. N of Xilitla.

Other localities and specimens (*in order of north-south distribution*): Cueva de San Miguel, 10 mi. W of Aquismón, ♂, ♀, immatures, Sept. 1967, J. Fish and W. Russell. Cueva del Agua, 8 mi. NW of Aquismón, ♂, ♀, April 1964, W. Russell. Cueva de Ahuate #2, 1.5 mi. SW of Xilitla, ♀, 7 June 1964, D. McKenzie and J. Reddell. Cueva del Salitre, Xilitla, ♂, ♀, 24 April 1966, T. Raines. Cueva de Poca Ventana, 0.6 mi. W of Xilitla, ♀, Jan. 1968, T. Raines. Sótano de Tlamaya, near Xilitla, ♀, 31 July 1964, 8 July 1967, T. Raines. Cueva de Potrerrillos 1 mi. W of Ahuacatlan, ♂, 12 July 1967, J. Reddell et al.; ♀, 25 Nov. 1967, J. Fish.

Deposition of specimens: Holotype (undissected) and female paratype, American Museum of Natural History (New York). Topotypes and specimens of both sexes from La Cueva del Agua, National Museum of Natural History.

Mexicambala fishi new species

Figures 1e, 2d, 4

Diagnosis: Characterized by gonopods and very conspicuous surface sculpture. Resembles *M. russelli* in that middle tooth of dorsal crests is angular; differs from all congeners in that telopodite of anterior gonopods is as long as coxite, paraprocts have setae only along mesial margin, and body is larger.

Description of holotype: Male, length 33 mm, width 1.8 mm, segments 46. Articles 3 and 4 of legpairs 6 and 7 are slightly enlarged. Distinct crests are on dorsum and sides of segments 2, 3, and 4. Dorsal crests of segment 5 and all following segments have 2 notches. On typical segments teeth of dorsal crests are large and angular and peritremes are high and cylindrical (Figs. 1e, 2d). On most segments there are 5 lateral crests, each one with a thick, blunt middle tooth. Apex of epiproct is rounded and asetose; paraprocts bear 9 setae along mesial margin (Fig. 4a).

Anterior gonopods are characterized by relatively long and apically narrowed and rounded telopodite; from a lateral view apical region of telopodite is rounded and about as broad as from anterior view. On posterior surface of distal one-third of coxite there is a series of short setae; there are longer setae, 8 or 9 in 2 irregular series, on both anterior and posterior surfaces of distal one-half of telopodite. Posterior gonopods are as in congeners.

Description of female paratype: Length 34 mm, width 2.1 mm, segments 47. Surface sculpture is as in holotype.

Variations of paratypes: 6 males: length 24–33 mm, segments 43–46. 14 females: length 30–36 mm, segments 43–47.

Range: Known only from the type locality in the mountains of northern Oaxaca. This is about 265 miles south of the nearest collection site of *M. russelli.*

Type locality and specimens: OAXACA: Cueva Arriba de Río Iglesia, 4 mi. E Huautla, lat 18°20′ N, long 96°45′ W, 1700 m alt; 7♂, including holotype, 14 ♀, 3 immatures; J. Fish, H. Russell.

Deposition of specimens: Holotype (undissected), 3 ♂ paratypes, 8 ♀ paratypes, National Museum of Natural History.

LITERATURE CITED

BULL, EDDIE, AND ROBERT W. MITCHELL. (in press). Temperature and relative humidity responses of two Texas cave-adapted millipedes, *Cambala speobia* and *Speodesmus bicornourus* (Diplopoda). Southwestern Nat.

CAUSEY, NELL B. 1964. New cavernicolous millipeds of the Family Cambalidae (Cambalidea: Spirostreptida) from Texas (U.S.A.) and Mexico. Inter. Jour. Speleology 1: 237–246, pls. 58, 59.

Loomis, H. F. 1968. A checklist of the millipeds of Mexico and Central America. U.S. Nat. Mus. Bull. 266: 1–137.

Russell, William H., and Terry W. Raines. 1967. Caves of the Inter-American Highway. Assoc. for Mexican Cave Studies Bull. 1: 1–126.

Sheer, William A. 1969. A synopsis of the cave millipeds of the United States, with an illustrated key to genera. Psyche 76(2): 126–143.

Vol. 84, No. 35, pp. 283–292 4 November 1971

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

TWO NEW SPECIES OF *EUSCEPTIS* HÜBNER AND NOTES ON OTHER SPECIES (LEPIDOPTERA: NOCTUIDAE)

By E. L. Todd
Entomology Research Division, Agric. Res. Serv.
U.S. Department of Agriculture[1]
Washington, D.C

During the fall of 1965 I located a considerable number of specimens of the genus *Eusceptis* Hübner in the unidentified material of the British Museum (Natural History) and in the Rothschild collection at Tring. At the time, my revision of the genus (1966 [1967], Proc. U.S. Nat. Mus. 119 (3546): 1–22) was in press and the additional data could not be incorporated. In addition, other specimens of the genus have been collected in South and Central America during the intervening years by staff members of the U.S. National Museum and by others. The purpose of the present paper is to record the new distributional data, to describe two new species and to correct a serious misidentification existing in the generic revision.

At the beginning of my investigation of the genus, prior to 1965, the name *Eugraphia effusa* Druce was applied primarily to series of specimens from México and Guatemala in collections. Specimens of the species so identified exhibit a marked sexual difference in the shape of the dark marginal band of the hindwing. The type of *effusa*, a specimen from Volcán de Chiriqui, Panamá, was presumed to be a female because in the original illustration the marginal band of the hindwing seemed to indicate that sex. The distribution of the species was cited in the literature as México to Panamá. The existence of a species complex was not suspected. Shortly before completion of

---

[1] Mail address: c/o U.S. National Museum, Washington, D.C. 20560

my study of the genus, I located three female specimens from Costa Rica in the miscellaneous unidentified material in the U.S. National Museum. They differed in several respects from females previously identified as *effusa*, but it was not until two males, also, from Costa Rica, were received from the Carnegie Museum in Pittsburgh, Pa., that the specimens were recognized as representing a distinct species. The species from Costa Rica was then described as *Eusceptis atriora* Todd. The original description and illustration of *effusa* were not rechecked. Even so, I was puzzled by the absence of typical "*effusa*" in Costa Rica and discussed this point in the treatment of that species. Among the specimens of "*atriora*" now before me are a female from Chiriqui, Panamá, and a male and female from Lino, Panamá. These specimens prompted me to recheck the original description and illustration of *Eusceptis effusa* (Druce). It is now obvious that I misidentified the species. The specimen illustrated by Druce is a male, not a female as presumed in the past, of the species I described as *Eusceptis atriora* new species. The type locality and the statement in the original description of *effusa*, ". . . ; fringe of the primaries greenish-black, that of the secondaries white; . . . ," confirm that opinion. Therefore, *Eusceptis atriora* Todd must be placed in the synonymy of *Eusceptis effusa* (Druce) and the species occurring in Texas, México and Guatemala previously misidentified as *effusa* must be described as a new species. A third species of the *effusa* complex is now known and is described herein.

The species of the *effusa* complex differ from the other species of the genus in which the ground color of the hindwing is orange, yellow or white, in that the forewing distad of the postmedial band (excluding the costal pale spot) is dark, lacking the yellow or orange line that extends from tornus toward apex in the terminal area of the forewing of the other species. Species of the *effusa* complex also have a medial line of metallic scales in the distal, black costal mark of the forewing and the hindwings of the males are modified, the inner margin of the hindwing is expanded, upturned and curved over the abdomen forming a concavity on the ventral surface and containing a tuft of long hairs. The following key is provided for separation of the species of the *effusa* complex.

1. Basal costal mark of forewing with a median line of metallic scales; sacculus of left valve of male genitalia more than half as long as valve, terminal process of sacculus directed toward costal margin of valve 2

   Basal costal mark of forewing completely black; sacculus of left valve of male genitalia about half as long as valve, terminal process of sacculus directed toward apex of valve .... *Eusceptis incomptilinea* new species

2. Apex of fringe of hindwing between veins Rs and Cu_1 white; dark marginal band of hindwing of male tapering toward anal angle, width at vein Rs about twice width at Cu_2; same band of female reaching anal angle; costal spine of sacculus of right valve of male genitalia shorter than distance from its base to apex of sacculus; sacculus of left valve distinctly wider than sacculus of right valve .... *Eusceptis effusa* (Druce)

   Fringe of hindwing yellowish-orange; dark marginal band of hindwing of male nearly uniform in width; same band of female usually terminating at about Cu_2; costal spine of sacculus of right valve longer than distance from its base to apex of sacculus; sacculus of left valve only slightly wider than sacculus of right valve .... *Eusceptis flavifrimbriata* new species

Eusceptis effusa (Druce)

Figures 1 and 2

Eugraphia effusa Druce, 1889, *in* Godman and Salvin, Biologia Centrali-Americana, Insecta, Lepidoptera, Heterocera, vol. 1, p. 304, table 28, fig. 12; 1898, ibid., vol. 2, p. 492.—Hampson, 1910, Catalogue of the Lepidoptera Phalaenae in the British Museum, vol. 10, p. 794.—Strand, 1913, Arch. Naturg., vol. 79(A), nos. 7–9, p. 62.—Draudt, 1939, *in* Seitz, Gross-Schmetterlinge der Erde, vol. 7, p. 397. (in part)

Eusceptis effusa (Druce).—Todd, 1967, Proc. U.S. Nat. Mus. 119 (3546): 7. (in part)

Eusceptis atriora Todd, 1967, Proc. U.S. Nat. Mus. 119 (3546): 8–10. [NEW SYNONYMY]

A detailed description of the species may be found in my generic revision, pages 8–9 under *atriora* and does not need to be repeated here. In that description the name, *flavifrimbriata*, should be inserted in each instance that the name, "*effusa*," was used. The male genitalia were illustrated in the generic revision, figure 23 as "*atriora*."

Distribution: Costa Rica to Bolivia. Twenty specimens from the following localities have been examined. Costa Rica: Sixaola River, Guapiles, Peralta, San Vito, Santa Clara Valley, Avangarez and Pejevalle [Pejivalle ?]. Panamá: Lino and Chiriqui. Colombia: Muzo. Bolivia: Rio Songo [Rio Zongo ?].

Figs. 1–6. Dorsal view of adults of *Eusceptis* species: 1, *effusa*, male, Pejevalle, Costa Rica; 2, *effusa*, female, Sixaola River, Costa Rica (Type of *atriora* Todd); 3, *flavifrimbriata*, male, paratype, "C.A."; 4, *flavifrimbriata*, female, paratype, Misantla, México; 5, *incomptilinea*, male, type, Villavicencio, Colombia; 6, *incomptilinea*, female, paratype, Tarapoto, Perú.

Eusceptis flavifrimbriata new species

Figures 3 and 4

Eugraphia effusa Druce.—Draudt, 1939, *in* Seitz, Gross-Schmetterlinge der Erde, vol. 7, p. 397. (in part)

Eusceptis effusa (Druce).—Todd, 1967, Proc. U.S. Nat. Mus. 119 (3546): 7. (in part)

Head with proboscis well developed; labial palpi small, very slightly curved dorsad, apical segment slightly exceeding ventral margin of frons, third segment very short, second segment four times as long, vestiture mainly of appressed, pale yellow scales except longer and less appressed along ventral margin, especially first segment and base of second segment, dorsal and dorsolateral area of second segment dark brown or black except extreme apex; frons smooth, slightly exceeding anterior margin of eye, vestiture of appressed, down and incurved pale yellow scales; eyes large, hemispherical, naked, about equal to frons in width; ocellus small, adnate to upper margin of eye immediately caudad of base of antenna; antenna black, filiform, spiculate laterally and ventrally, spicules minute, about twice as long in male as in female. Vestiture of patagia, tegulae and thorax a mixture of pale yellow hair and scales; a slight decumbent, metathoracic crest present. Abdomen orange dorsally and laterally; segments 3 to 7 of females mostly black or dark brown ventrally, segment 1 + 2 white or pale yellow, a narrow basal band of white scales on other segments, males with more white scaling on segments 3 to 7; apex of abdomen of males with long tufts of hair around genital capsule, dorsal and lateral hairs pale orange, ventral hairs black. Pectus clothed with large, pale yellow or white scales and long, sparse, white hair; tympanum shielded dorsally by a very large alular fan of broad pale yellow scales. Legs banded with dark brown and pale yellow or white scales, dark brown scales highly iridescent in certain lights; foreleg with tibia and tarsus clothed with dark brown scales except some pure white scales at apex of first tarsomere, scales of distal four-fifths of femur dark brown, scales of basal part white, trochanter clothed with longer, less appressed, pale yellow scales; middle leg similar to foreleg except tibia with a broad median ring of loose pale yellow or white scales, dark scales at apex longer, less appressed, white scales at base of femur extending along dorsum to apex, tibial spurs dark brown except extreme apex of long, inner spur white; hindleg similar to middle leg except scales of tibia appressed, pale median part white and extending to base along dorsum, tibial spurs dark basally, white apically except inner basal spur all white. Venation of wings as for genus, accessory cell very small and narrow as in *effusa*. Wing shape and pattern of maculation as illustrated (Figs. 3 and 4), male with inner margin of hindwing modified, upcurved over abdomen and bearing a tuft of long hairs in the pocket formed on the ventral surface. Ground color of basal part of forewing pale yellow; terminal part of dark brown scales with some rust brown patches along outer margin of pale costal spot and immediately distad of postmedial line, especially distad of junction of transverse lines, a small yellow spot sometimes present in rust brown patch; Y-shaped transverse line of metallic gray scales heavily bordered by dark brown scales. Hindwing yellow orange except dark brown marginal band, fringe dark at apex of wing orange from vein Rs to anal angle. Ventral surface of forewing with pale basal half orange, concolorous with pale part of hindwing; apical costal orange spot of hindwing of female larger than spot on dorsal surface; transverse lines of forewing absent except costal part of postmedial band. Length of forewing: male, 13 to 15 mm; female, 14 to 15 mm.

Male genitalia as illustrated (Todd, 1967, Fig. 24, as *effusa*), very similar to that of *effusa* (Todd, 1967, Fig. 23, as *atriora*) except sacculus of left valve not distinctly wider than sacculus of right valve, dorsally directed process of sacculus of left valve extending toward costal margin of valve at a point just below corona, costal spine of sacculus of right valve longer than distance from its base to apex of sacculus, and costal angle of apex of right sacculus not forming a short, triangular projection. Female genitalia very similar to those of *effusa* except right lobe of seventh abdominal sternite sclerotized to base of median emargination, left lobe of seventh abdominal sternite lacking medial basal projection and dorsal sclerotization of vaginal chamber about three times as long as wide.

Type male, 2 mi. N. Tamazunchale, S.L.P., México, 400 ft., July 16–18, 1963, Duckworth and Davis (U.S.N.M. 64646); 1 male and 1 female paratypes, same data; 1 male and 1 female paratypes, 7 mi. SW. Poza Rica, Ver., México, 200 ft., July 20–22, 1963, Duckworth and Davis; 1 male paratype, Quirigua, Guatemala, May, Schaus and Barnes; 2 male and 2 female paratypes, Cayuga, Guatemala, Aug., Schaus and Barnes; 1 male and 4 female paratypes, same place and collectors, June; 1 male paratype, C. A. [Central America] no date or collector; 1 male paratype, Brownsville, Texas, May 26, 1956, P. A. Glick and 1 female paratype, Misantla, México, May, 1909, R. Müller, in the U.S. National Museum, Washington, D.C. One male paratype, Southern México, Townsend, in the Carnegie Museum, Pittsburgh, Pa. One female paratype, Misantla, Ver., México, June, 1912, W. Gugelmann; 1 female paratype, same place and collector, April–May 1912, and 1 female paratype, Tabasco, México, ler trimestre, 1914, W. Guglemann, in the British Museum (Natural History), London, England.

Eusceptis incomptilinea new species

Figures 5–7

Very similar to *effusa* and *flavifrimbriata*, but differing from both in that the basal transverse band of the forewing is reduced to a simple black line, the median line of metallic scales present in that band of the other species nearly completely absent, at most only a few scattered scales remaining. In addition the male genitalia are specifically distinct. This species agrees with *effusa* in the white color of the apical half of the fringe scales in the middle part of the termen of the hindwing and in the greenish iridescence of the dark brown scales of the apical part of the forewing. The marginal band of the dorsal surface of the hindwing extends a little nearer the anal angle in the male than in *effusa* and in the female it is more diffuse basad than in *effusa*. Four of the five specimens possess a small pale yellow spot immediately distad of the postmedial band of forewing level with the junction of the transverse lines. The fifth specimen is rubbed on both wings in the area of the small spot and I can not determine whether it was so marked or not. A few specimens of *flavifrimbriata* also possess a small pale yellow spot in the same area of the forewing, but none of the twenty examples of *effusa* that I have studied are so marked.

FIG. 7. Male genitalia, *E. incomptilinea* new species.

Male genitalia as illustrated (Fig. 7). Very similar to the genitalia of *effusa* and *flavifrimbriata* but the sacculus of the left valve shorter than in those species, barely exceeding half the length of the valve, the terminal process of sacculus of left valve narrow, sinuous, directed toward apex of the valve not toward the costal margin; clasper of left valve with a large dorsal tooth at base; hair tuft of left sacculus prominent; costal spine of right sacculus slightly shorter than distance from base of spine to apex of sacculus. Female genitalia similar to the other species of the complex, but with the ventral plate of the seventh abdominal segment much less modified, the posterior margin of the ventral plate only slightly emarginate medially and not strongly sclerotized, the depth of the emargination about one-third the length of the apophyses anteriores.

In the other species of the complex the depth of the emargination of the ventral plate equals or exceeds the length of the apophyses anteriores.

Type male, Villavicencio, Colombia, 400 m., Fassl; 1 female paratype, same data as type; 1 female paratype, Sarayacu, Ecuador, C. Buckley; 1 female paratype, Tarapoto, Perú, May to Aug., 1888, M. de Mathan and 1 male paratype, Bolivia, ex Germain in the collection of the British Museum (Natural History), London, England.

Eusceptis irretita Hübner

Eusceptis irretita Hübner, 1823, Zuträge zur Sammlung exotischer Schmettlinge [sic], Zweites Hundert, p. 21, figs. 305, 306.

Twelve additional specimens of this species, 7♂♂ and 5♀♀ were located in the unplaced material in the British Museum (Natural History). All the specimens are via the Oberthür collection and include a male and female from the Guenée collection. Six males and three females are labeled; Cachimbo, Prov. de Bahia, 1890, Ch. Pujol, one female is labeled S. Antonio da Barra, Prov. de Bahia, 11-22.88, Gounelle, the male from Guenée, Brésil and the female from his collection lacks a locality.

Remarks: These additional specimens provide support for the opinion that the species is probably restricted to the northeastern part of Brazil. The females are the first I have studied of these species. On maculation they appear indistinguishable from *Eusceptis koehleri* Todd.

Eusceptis splendens (Druce)

Eugraphia splendens Druce, 1896, Ann. Mag. Nat. Hist., ser. 6, vol. 18, p. 42.

Twenty-one additional specimens have been examined. They are from Colombia and Venezuela. The following localities have not been previously recorded. Colombia: Muzo; Pacho; Honda; Cananche, Cundinamarca. Venezuela: San Estevan, near Puerto Cabello.

Eusceptis lelae Todd

Eusceptis lelae Todd, 1967, Proc. U.S. Nat. Mus. 119 (3546): 16, figs. 13, 14, 25, 26.

One male from Tabasco, México, 1913, via the Oberthür collection was located at the British Museum (Natural History).

Eusceptis extensa (Strand)

Eugraphia extensa Strand, 1913, Arch. Naturg., vol. 79 (A), nos. 7–9, p. 62.

Nineteen specimens, 14♂♂ and 5♀♀, have been examined. The specimens are labeled, Villavicencio, Colombia, 400 m., Fassl (12♂♂ and 3♀♀), Upper Rio Negro, Colombia, 800 m., Fassl (1♂), Bolivia, Germain (1♀), Anhaugahy, Sao Paulo, November 1926, R. Spitz (1♂)

and Cachimbo, Prov. de Bahia, 1890, Ch. Pujol (1♀). The specimens were located in the British Museum (Natural History) and at Tring.

Remarks: The records from Colombia and Bahia extend the known range of the species well to the north in eastern and in western South America.

Eusceptis robertae Todd

Eusceptis robertae Todd, 1967, Proc. U.S. Nat. Mus. 119 (3546): 18, figs. 9, 10, 31, 32.

Two males and one female all from Tucumán, Argentina, Dr. R. Schreiter were located at Tring. The female has the hindwing uniformly orange like the males.

Eusceptis paraguayensis Draudt

Eugraphia splendens f. *paraguayensis* Draudt, 1939, in Seitz, Gross-Schmetterlinge der Erde, vol. 7, p. 397.

Five females were located in the Rothschild material at Tring. They are labeled as follows: Sapucay, n. Villa Rica, Dec., 07, Foster; Sapucay, Paraguay, 29-IX-03, W. Foster; same place and collector, 7-XI-07; Villarcia, Paraguay, 17-1-25, F. Schade; and Villa Ana, Sta Fe, Argentina, February, 1927, K. J. Hayward.

Remarks: One female from Sapucay, Paraguay, has the hindwings nearly entirely orange with only a small black apical spot present. The oblique bar of the forewing resembles that of *E. robertae* Todd, but that species is known only from Tucumán, Argentina, and I have not seen females with an apical spot on the hindwing.

Vol. 84, No. 36, pp. 293–300 4 November 1971

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

A NEW SUBSPECIES OF *CYNOPTERUS SPHINX* (CHIROPTERA: PTEROPODIDAE) FROM SERASAN (SOUTH NATUNA) ISLAND, INDONESIA

By John L. Paradiso
Bureau of Sport Fisheries and Wildlife, National Museum of Natural History, Washington, D.C. 20560

While examining *Cynopterus* material in the collections of the National Museum of Natural History, I became aware that five specimens from Serasan (South Natuna) Island, Indonesia, which were classified as *C. brachyotis angulatus* Miller, were markedly different from that subspecies, and from other named *Cynopterus*, and constituted a previously unrecognized form. This paper describes the Serasan Island specimens and names them as a new subspecies of *Cynopterus sphinx* Vahl.

The first specimens of *Cynopterus* from Serasan Island were reported by Thomas and Hartert (1894), who assigned four skins, collected by E. Everett, to *Cynopterus marginatus* Geoffroy, 1810 (type locality: Bengal), now considered a synonym of *C. sphinx sphinx* Vahl, 1797. Matschie (1899) placed the Serasan Island *C. marginatus* of Thomas and Hartert, 1894, in the synonymy of *C. montani* Robin (= *C. montanoi* Robin, 1881, type locality: Malacca). Miller (1901: 137) examined five specimens from Serasan Island, and followed Matschie in considering them to be *C. montanoi* Robin.

Andersen (1912) placed *C. montanoi* Robin in the synonymy of *C. brachyotis brachyotis* D. Müller, 1838, the range of which he described as: "Borneo (probably including the Natuna Islands), extending northward over the whole of the Philippines, east to Celebes, southwest and west to Sumatra (including Banka and Biliton), the Rhio-Linga Archipelago, Malay Peninsula, and lower Siam (Trong)," and with type locality: "'eene diepe kalksteen-spelonk, aan den oever van de rivier Dewej' South Central Borneo." He listed the Serasan Island *C. montanoi* of Miller, 1901, in the synonymy of *C. brachyotis brachyotis* but the Serasan Island *C. marginatus* of Thomas and Hartert, 1894, and the Serasan Island *C. montani* of Matschie, 1899, were placed in the synonymy of *C. brachyotis angulatus* Miller, 1898. However, he listed two skulls from Serasan Island among specimens of *C. b. angulatus* examined, and thus undoubtedly felt that Serasan Island *Cynopterus* were referable to *C. b. angulatus.* Chasen (1940) also placed the Natuna Islands within the range of *C. b. angulatus.*

The reason that the Serasan Island *Cynopterus* was not recognized earlier as being a distinct form seems to have been a lack of comparative material. Where there were sufficient specimens from Serasan Island to make an appraisal of their affinities, there was insufficient comparative material from elsewhere; where there was sufficient material from adjacent areas, workers had only a few specimens from Serasan Island for comparison. Thus, Thomas and Hartert had only four skins from Serasan Island; Matschie apparently worked from the literature, at least with regard to the Serasan Island specimens; Miller, who had a sufficient number of Serasan Island specimens, had only a skin and two bleached alcoholics from Singapore, which he thought represented *C. montanoi,* for comparative purposes (he did, however, distinguish the Serasan Island specimens from *C. angulatus* which he had named in 1898); Andersen listed only two specimens from Serasan Island that he examined; and Chasen apparently did not examine any Serasan Island *Cynopterus,* but merely followed Andersen in including the island within the range of *C. b. angulatus.*

Before proposing a name for the Serasan Island population, a note is necessary concerning the present taxonomic status of several species within the genus *Cynopterus.* The genus is generally considered to be comprised of two sections distinguishable on the basis of dental details. The "Niadius" section (*C. horsfieldi* and *C. harpax*) is characterized by the presence to some degree of a surface cusp on lower M1 and P4, and by shorter, broader, more subrectangular or subquadrate cheek teeth. The "Cynopterus" section lacks entirely the surface cusp on lower M1 and P4, and has longer narrower cheek teeth. The Serasan Island specimens lack any trace of a surface cusp on M1 and P4, and obviously belong to the "Cynopterus" section of the genus, of which two species are currently recognized in the literature: *C. sphinx* and *C. brachyotis*. Ellerman and Morrison-Scott (1951: 98–99) gave the approximate distribution of these species as: *C. sphinx*: Hainan, peninsular India, Ceylon, Bengal, Kumaon, Sikkim, Bhutan Duars, Burma, Indo-China, Siam, and on the islands of Sumatra, Java, Bali, Lombok, and Timor. *C. brachyotis*: southern China, Ceylon, Andaman and Nicobar Islands, Tenasserim, Burma, Assam, Siam, Malay States, Sumatra, Java, Borneo, and adjacent small islands, Celebes, and Philippine Islands. The range of the subspecies *C. b. angulatus* was given as: Kindat (Chindwin), western Burma, Tenasserim, Siam (Nan, Bangkok, Chiengmai, etc.), Cambodia, and Annam, Natuna Islands, Anamba Islands, and various small islands off the coast of Siam.

Mr. John Edwards Hill of the British Museum (Natural History) and Mr. Kitti Thonglongya of the Applied Scientific Research Corporation of Thailand, have recently completed a study (in press) of the genus *Cynopterus* in Thailand, and Mr. Hill has kindly given me permission to cite some of their conclusions regarding *C. sphinx* and *C. brachyotis* that affect the nomenclature used in the present paper. Mr. Hill stated (personal communication): "It is only recently . . . that specimens from the critical area of southern Thailand have come to hand. These have led to the conclusion that although two species are involved, as Andersen thought (*C. sphinx* and *C. brachyotis*), the form *angulatus* is not a subspecies of *C. brachyotis* as Andersen considered, but instead of *C. sphinx* . . . The two species can be separated as a rule by the combination of two parameters, the length of the forearm and the length of the ear. In *C. sphinx* the forearm generally exceeds 65 mm in length and the ear 19.0 mm; specimens of *C. brachyotis* have forearm and ear lengths rarely exceeding these values."

Since the forearms of the Serasan Island specimens are within the size limits of *C. sphinx* rather than *C. brachyotis*, and the ears appear large, comparable to those in *sphinx*, and larger than in *brachyotis*, I consider them to represent a race of *C. sphinx*. This race may be known as:

Cynopterus sphinx serasani new subspecies

1894. *Cynopterus marginatus*: Thomas and Hartert, First Glimpses of the Zoology of the Natuna Islands. III. List of the first collection of mammals from the Natuna Islands. Novitates Zoologiae, Vol. 1, p. 655.

1899. *Cynopterus montani* (part): Matschie, Die Megachiroptera des Berliner Museums für Naturkunde, p. 75, August.

1901. *Cynopterus montanoi*: Miller, Mammals collected by Dr. W. L. Abbott on the Natuna Islands, Proc. Washington Acad. Sci., Vol. III, p. 137, March 26.

1912. *Cynopterus brachyotis angulatus* (part): Andersen. Catalogue of the Chiroptera in the collection of the British Museum, p. 614.

Holotype: U.S. Nat. Mus. no. 104744, adult male, skin and skull, collected June 10, 1900, by W. L. Abbott, on Serasan Island, Natuna Islands, Indonesia.

Measurements of holotype (in mm): Forearm, 72.0; greatest length of skull, 30.9; interorbital breadth, 6.9; condylobasal length, 29.5; zygomatic breadth, 20.0; palatal length (from posterior margin of right palatine foramen to end of palate), 13.6; width across crowns of M1 (externally), 8.8; length of maxillary toothrow (from anterior edge of alveolus of canine to posterior edge of alveolus of M1), 10.1; maximum breadth of braincase, 12.7.

Measurements of topotypes: Forearm, 73.3 (dry skin), 65.2 (dry skin), 71.3 (alcoholic), 72.3 (alcoholic); greatest length of skull, 30.2, 29.8, 30.9, 30.1; interorbital breadth, 7.0, 6.5, 6.8, 6.5; condylobasal length, 28.8, 27.9, 29.5, —; zygomatic breadth, 19.8, 19.5, 19.5, —; palatal length, 14.4, 13.6, 13.6, 13.2; width across crowns of M1 (externally), 8.8, 8.4, 8.9, 9.3; length of maxillary toothrow, 9.5, 9.8, 10.0, 10.2; maximum breadth of braincase, 12.3, 12.2, 12.5, —.

Richard C. Banks kindly took some measurements for me of the two specimens from Serasan Island in the British Museum (Natural History). These specimens measure cranially as follows: Greatest length of skull, 31.4, 29.8; zygomatic breadth, 20.1, 19.5; interorbital breadth, 6.7, 6.5; breadth of braincase, 12.3, 12.6. John Edwards Hill informs me that the forearm length of these specimens is 69.3 and 68.6, respectively. Their ear lengths are 19.7 and 18.3.

Distribution: At present known only from Serasan Island, Natuna Islands, Indonesia.

Comparisons: *C. s. serasani* differs from all races of *C. brachyotis* in its larger size. Externally this is evident in the length of the forearm: *C. brachyotis* has a forearm length generally under 65 mm in length. As can be seen in the measurements section, all specimens from Serasan Island have forearm measurements considerably in excess of 65.0 mm. In addition to the longer forearm, Serasan Island specimens have larger

TABLE 1. Mean, extremes and sample size of *C. s. serasani* and Bornean specimens of *C. b. brachyotis* for greatest length of skull and zygomatic breadth.

	Greatest Length of Skull	Zygomatic Breadth
C. s. serasani	30.4(29.8–31.4), N = 7	19.7(19.5–20.1), N = 6
C. b. brachyotis	28.5(27.5–29.7), N = 48	18.4(17.0–19.8), N = 53

ears than any race of *brachyotis*. The size difference is difficult to demonstrate in cold figures, but is evident on comparison of specimens. In both forearm length and ear size, *C. s. serasani* shows a close approach to *C. s. angulatus*.

Cranially, *C. s. serasani* differs from all races of *C. brachyotis* in large size; relatively as well as actually broader interorbital region; greater development of frontal sinuses; more strongly marked development of postorbital process of frontals; M1 decidedly smaller than P4 (equal to or only slightly smaller in *brachyotis*); palate longer and relatively narrower. In Table 1, *C. s. serasani* is compared with *C. b. brachyotis* (which occurs on the island of Borneo less than 50 miles distant) for greatest length of skull and zygomatic breadth to illustrate the much larger cranial size of *serasani*.

C. s. serasani differs from all races of *C. sphinx* (except *C. s. angulatus*) in being distinctly smaller. Andersen (1912: 600, 629) gives the range of measurements of greatest length of skull and forearm respectively for the races of *C. sphinx* as follows: *C. s. sphinx* 31.5–34.5, 66.0–73.5; *C. s. gangeticus* 33.0–36.0, 73.0–78.0; *C. s. titthaecheilus* 35.5–38.5, 74.5–83.0; *C. s. major* (which Andersen regarded as a full species) 34.0–35.8, 75.6–82.0.

Cynopterus s. serasani is about the same size cranially and externally as *C. s. angulatus* but differs in the following cranial details: Much broader interorbital region, with greater development of frontal sinuses; greater development of postorbital process of frontals; braincase narrower, less inflated; palate narrower with cheek teeth smaller; M1 decidedly smaller than P4 (equal to or only slightly small in *angulatus*). In Table 2, *C. s. serasani* is compared with *C. s. angulatus* (specimens from Thailand, Cambodia, and South Vietnam) for interorbital breadth, width of braincase and palatal breadth.

Coloration: As noted by Andersen (1912: 592) coloration in *Cynopterus* is variable and apparently of only slight taxonomic value. The Serasan skins available to me are quite dark in coloration, considerably darker than most *C. brachyotis* that I have examined. Probably the only race of *C. brachyotis* that compares with *serasani* is *C. b. altitudinus* Hill, a very dark montane race from the highlands of Malaya, specimens of which I have not examined. Specimens of *serasani* resemble *C. s. angulatus* in coloration, but are even darker than most representatives of that

TABLE 2. Mean, extremes and sample size of *C. s. serasani* and South Vietnamese, Thai and Cambodian *C. s. angulatus* for interorbital breadth, breadth of braincase and palatal width.

	Interorbital Breadth	Breadth of Braincase	Palatal Width (across M1–M1, crown)
C. s. serasani	6.7(6.5–7.0), N = 7	12.4(12.2–12.7), N = 6	8.8(8.4– 9.3), N = 5
C. s. angulatus			
South Vietnam	5.9(5.3–6.5), N = 59	13.7(12.7–14.5), N = 58	9.5(9.1–10.0), N = 59
Thailand	5.9(5.4–6.4), N = 19	13.3(12.9–13.7), N = 19	9.5(9.1–10.0), N = 18
Cambodia	5.7(5.4–6.1), N = 4	13.3(13.1–13.6), N = 4	9.1(8.9– 9.5), N = 4

form. The three dry skins from Serasan Island in the National Museum of Natural History collections have pronouncedly dark (almost black) heads, and seem to differ in this respect from all *C. brachyotis* and *C. s. angulatus* that I have examined. In the latter two forms, the coloration of the head does not differ markedly from the coloration of the back. Larger series will be necessary to determine whether these differences in coloration have any taxonomic significance.

Specimens examined: *C. brachyotis babi*, INDONESIA—Sumatra: Babi Island, 2 (one the type). *C. brachyotis brachyotis*, INDONESIA—Kalimantan: Batudjurung, 1; Kendawangan River, 1; Klumpeng Bay, 1; Landak River, 2; Mahakan River, 16; Mankol, 4; Pari, 2; Sangau, 1; Segah River, 15; Simpang River, 3. Sumatra: Bangka Island, 4; Belitung Island, 6; Bengkalis Island, 3; Bulan Island, 1; Dumai, 2; Kepahiang, 2; Kindur Island, 2; Makapan Island, 1; Mandau River, 9; Merbau Island, 1; Pini Island, 3; Setoko Island, 2; Sugi Island, 6; Tapanuli Bay, 9; Tarusan Bay, 2. MALAYSIA—Malaya: Kuala Lumpur, 16 mi. N, 1; Siribuat Island, 1. Sebah: Jesselton area, 32; Mt. Kinabalu, 4. SINGAPORE—4. THAILAND—Khlum Island, 2; Kut Island, 1. *C. brachyotis insularis*, INDONESIA—Kalimantan: Matisiri Island, 2. *C. brachyotis javanicus*, INDONESIA—Java: no exact locality, 3; Bogor, 6; Depok, 1. *C. brachyotis minutus*, INDONESIA—Sumatra: Nias Island, 1 (the type). *C. brachyotis pagensis*, INDONESIA—Sumatra: North Pagi Island, 2 (one the type). *C. brachyotis scherzeri*, INDIA—Car Nicobar Island, 1. *C. harpax*, MALAYSIA—Malaya: Kuala Lumpur, 16 mi. N, 1. *C. horsfieldi lyoni*, INDONESIA—Sumatra: Atjeh Melowak, 1; Siak River, 1 (the type of *Niadias minor*, Lyon). *C. horsfieldi princeps*, INDONESIA—Sumatra: Nias Island, 3 (one the type). *C. sphinx angulatus*, CAMBODIA—Demrey Phong, 2 km. SE, 9; Sipora Island, 1. CHINA—Hainan Island, 1. INDONESIA—Sumatra: Kepachiang, 2; Lahat, 1; Siberut Island, 2; Sipora Island, 1. MALAYSIA—Malaya: Johore, Jambu Luang, 1. SOUTH VIETNAM—An Khe Military Base, 4; Blao, 4 km. W, 1; Caryu Danar, 1; Cau Da, 8; Dak Sut, 5; Da Nang (vicinity), 3; Fyan, 2; Me Thout, 7 km. NW, 1; Mt. Son Tra (vicinity), 13; Polei Kleng, 5; Xuan Phu, 2 km. S, 15. THAILAND—Bangkok, 7; Ban Tha Din Daeng, 1; Chang Island, 1; Chiang Saen, 1; Chiang Mai, 1; Kaulak, 2; Nakon Pathom, 3; Nakhon Sawan, 1; Pakphayun District (no exact locality), 1; Rat Buri, 3; Trong, 7. *C. sphinx major*, INDONESIA—Sumatra: Nias, 5 (one the type). *C. sphinx serasani*, INDONESIA—Serasan Island (including two at the British Museum [Nat. Hist.] examined for me by John Edwards Hill and Richard C. Banks), 7. *C. sphinx sphinx*, BURMA—Myithyina, 1. INDIA—Coimbatore, 3. *C. sphinx tittlaecheilus*, INDONESIA—Java: western Java (no exact locality), 31; Banten, 1; Bagor, 7.

All specimens examined are in the collection of the National Museum of Natural History, unless otherwise noted.

ACKNOWLEDGMENTS: I am extremely grateful to Mr. John Edwards Hill for measuring specimens for me and for clarifying several taxonomic problems. I am also indebted to Mr. Hill and to Mr. Kitti Thonglongya for permitting me to cite some of their as yet unpublished data on the genus. I want to thank Dr. Richard C. Banks for measuring specimens for me in the British Museum (Natural History), and for offering advice on the manuscript. Drs. Clyde J. Jones and John W. Aldrich also read the manuscript and offered valuable comments and suggestions for which I am grateful.

LITERATURE CITED

ANDERSEN, K. 1912. Catalogue of the Chiroptera in the collection of the British Museum. British Museum (Nat. Hist.), London. 854 pp.

CHASEN, F. N. 1940. A handlist of Malaysian mammals. Bull. Raffles Mus., Singapore, No. 15. 209 pp.

ELLERMAN, J. R., AND T. C. S. MORRISON-SCOTT. 1951. Checklist of Palearctic and Indian mammals. 1758–1946. British Museum (Nat. Hist.), London. 810 pp.

MATSCHIE, P. 1899. Die Megachiroptera des Berliner Museums für Naturkunde. Berlin. 102 pp.

MILLER, G. S., JR. 1901. Mammals collected by Dr. W. L. Abbott on the Natuna Islands. Proc. Washington Acad. Sci., Vol. III, p. 137.

THOMAS, O., AND E. HARTERT. 1894. First glimpses of the zoology of the Natuna Islands. Novitates Zoologicae, Vol. 1, pp. 652–660.

Vol. 84, No. 37, pp. 301–306 4 November 1971

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

NEW SPECIES OF *CHEUMATOPSYCHE* FROM THE SOUTHEASTERN UNITED STATES (HYDROPSYCHIDAE, TRICHOPTERA)[1]

Herbert H. Ross, John C. Morse, and Ann Elizabeth Gordon
Department of Entomology, University of Georgia
Athens, Georgia 30601

During the course of limnological studies in the southeastern states, two previously undescribed species of *Cheumatopsyche* were collected. These additions to the genus indicate that it forms a diverse and abundant element of the southeastern caddisfly fauna. We are indebted to Dr. J. Bruce Wallace of the University of Georgia and Dr. W. L. Peters of Florida A. & M. University and their colleagues for collecting much of the material.

Types are deposited in the University of Georgia insect collection.

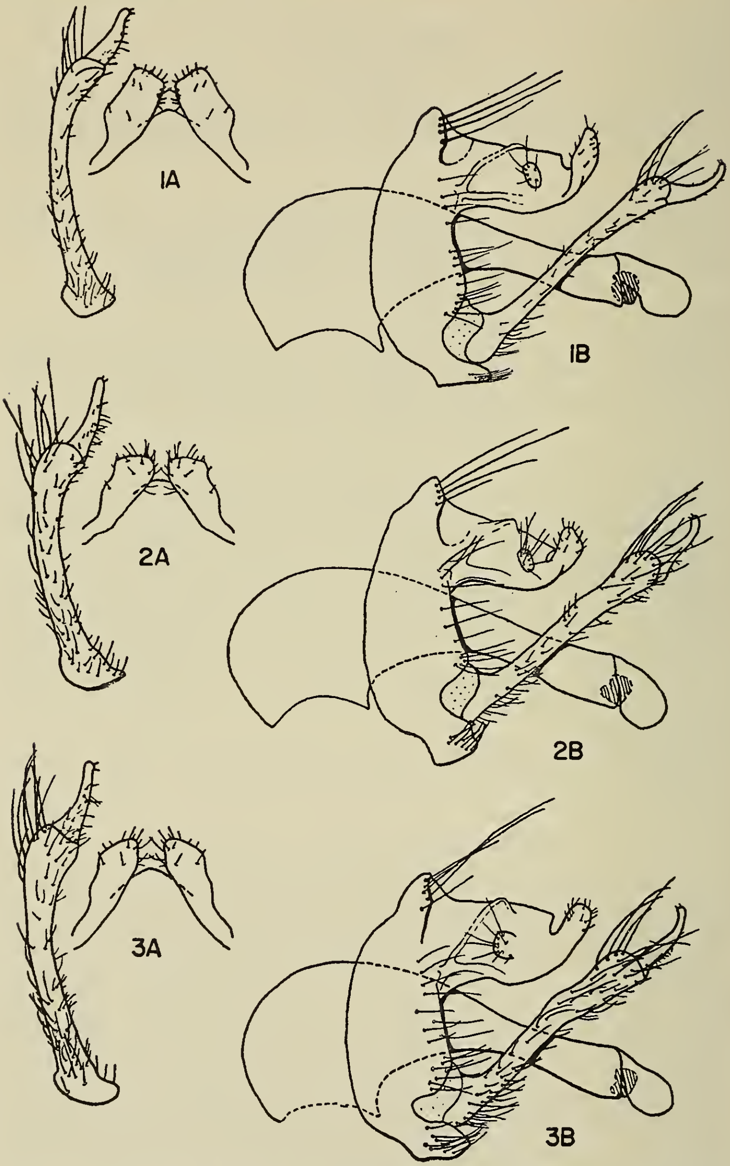
Cheumatopsyche enigma new species

The extreme variability exhibited by the apical lobes of the male tenth tergite makes it difficult to compare this species with any particular one of its congeners. Specimens in which these lobes are almost truncate are suggestive of *gracilis* Banks, from which *enigma* differs in having the basal segment of the clasper relatively slender; specimens with these lobes approaching a rounded apex are suggestive of *aphanta* Ross, from which *enigma* differs in the shorter apical segment of the clasper and longer tenth tergite; and specimens with the lateral dorsal angles of the lobes produced into a somewhat pointed shoulder are suggestive of *gyra* Ross, from which *enigma* differs in having the lateral lobes more obliquely angled and contiguous. From all three of these species, *enigma* differs in the elongate male tenth tergite.

Male: Length 6 mm. Color of head, body, and appendages dark

---

[1] This project was supported by a research grant from the National Science Foundation.



FIGS. 1–3. Male genitalia of *Cheumatopsyche enigma.* A, posterior aspect of clasper and apical lobes of tenth tergite; *B*, lateral aspect of entire structure. 1, holotype; 2 and 3, two paratypes from Wildcat Creek, Clemson, S. C.

brown, the antennae, mouthparts, and legs with pale areas, forewings without light spots. General structure typical for genus. Genitalia as in figure 1. Ninth segment annular, dorsally with a pair of lateral lobes bearing several long setae. Tenth tergite long, with a small lateral pair of setose lobes situated before apex, the apex divided into a pair of prominent dorsally projecting lobes. In lateral view these lobes project in front of the mesal profile of the segment and appear pointed at the tip. In posterior view they are large and broad, definitely shouldered at base, and truncate at apex, moderately well separated from each other at the apex. Clasper with basal segment long and narrow; apical segment narrow, ¼ the length of the basal segment. Aedeagus with bulbous base large, apex with a pair of movable platelike processes.

Female: Length, color, and general structure as in male. Ninth segment as in figure 6. Clasper receptacle fairly large, with a ventral lip extending to about the mid point of the tenth segment; the groove leading to the receptacle sharply delineated antero-ventrally, this margin sometimes projecting slightly over the groove giving the visual appearance of a flange.

Holotype: Georgia, Union Co., 3.5 mi. N Neels Gap, Wolf Creek, 30 August 1945, P. W. Fattig.

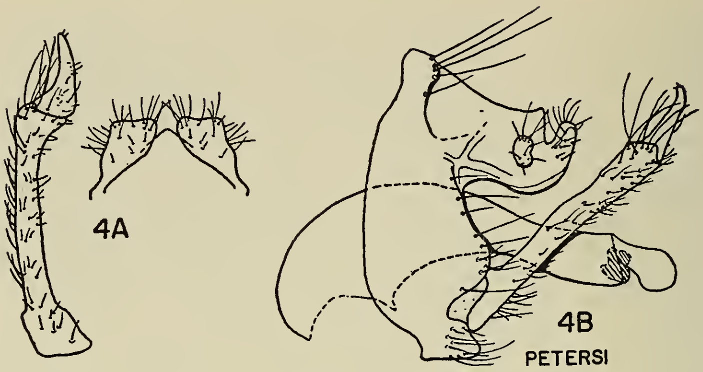
Paratypes: Georgia: Same data as holotype, 47♂, ♀; small cr. at junction highways 53 and 183, nr. Dawsonville, 1 April 1944, W. E. Ricker, 2♂. South Carolina: Pickens Co., Wildcat Cr., Clemson, 12 April 1968, P. Carlson, 1♂; same but 14 June, 2♂. Pickens Co., Eastatoe Cr., 17 May to 25 October 1969, H. Douglass and J. Morse, 66♂, ♀; South Saluda R., Table Rock, 28 April 1969, J. Morse, 3♀.

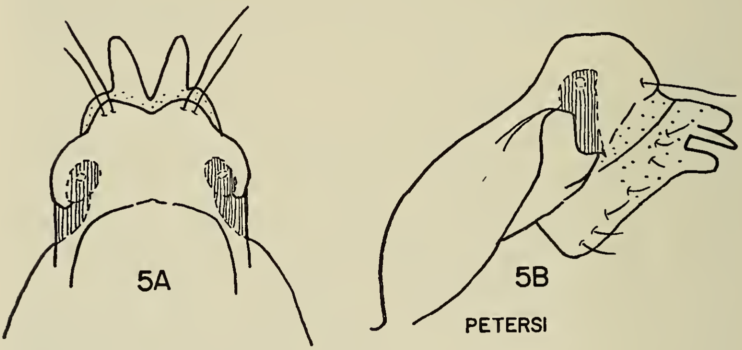
The variability in this species is unusually great. The above description and figure 1 are drawn from the holotype. In other males the tenth tergite may have prominent mound-like projections near the middle of the segment, one on each side of the meson and extending above it. The shape of the apical lobes of the tenth tergite also varies greatly, as illustrated in figures 2 and 3. Part of this difference is due to the fact that in most specimens these lobes are folded back laterally to a variable extent. A considerable range of variation is exhibited in the individuals collected at the same time and at any one locality; the collections from Wolf Creek and Wildcat Creek each exhibit an intergrading series of forms between these extremes in which the differences in character states of several characters occur randomly with respect to each other.

We know of no other species in the genus exhibiting this range of variability. It is highly suggestive of a situation in which two formerly isolated populations evolved morphological differences but no genetic incompatibility, then dispersed into each others ranges, the result being a highly variable hybrid mixture of character states.

Cheumatopsyche petersi new species

This species appears to be a close relative of *analis* Banks, from which it differs in the stouter apical segment of the clasper and the shouldered





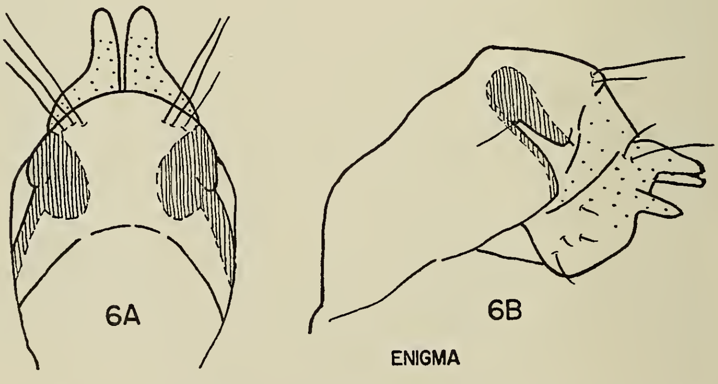


FIG. 4. Male genitalia of *Cheumatopsyche petersi*. *A*, posterior aspect of clasper and apical lobes of tenth tergite; *B*, lateral aspect of entire genitalia.

apical lobes of the tenth tergite which in lateral view do not project dorsally to the level of the mesal part of the tergite. The female differs in the shape of the clasper receptacle, which is more perpendicular than in *analis* and has a broad angular ventral lip not present in that species.

Male: Length 7 mm. Head, body, and legs dark brown, antennae and mouthparts also brown but paler at the base. Wings teneral, apparently chiefly dark brown with only a few small light areas. General structure typical for genus. Genitalia as in figure 4. Ninth segment annular, dorsally with a pair of lateral lobes bearing several setae. Tenth tergite moderately short, sloping down evenly from its juncture with the ninth tergite, with a pair of small, lateral, cushion-like lobes near the apex of the segment, the apex divided into a pair of dorsally-projecting lobes. In lateral view these lobes are relatively small and rounded dorsally, their apex below the level of the tergite; in posterior view they are almost truncate dorsally, giving the dorso-lateral portion a shouldered or angulate appearance. Clasper with apical segment elongate, ⅓ length of the basal segment, its lateral aspect slightly recurved, its posterio-ventral aspect broad at base, tapering to a narrow apex; posterio-ventral aspect of basal segment unusually narrow. Aedeagus with bulbous base relatively small and with a pair of movable plate-like processes at apex.

Female: Length, color, and general structure as in male. Ninth segment as in figure 5. Clasper receptacle only moderately large, in lateral view extending ventrally to about the mid point of the tenth segment, the ventral lip forming almost a right angle; the inner opening is minute and just below the apex. In dorsal view the clasper receptacle appears as a small ovate projection with the inner opening near the middle.

Holotype: FLORIDA, Okaloosa County, Blackwater River, 4.5 mi. NW Cannon Town, 7 April 1968, W. L. Peters et al.

Paratypes: FLORIDA: Okaloosa County, same data as holotype, 13♂, ♀; same but Bryant Bridge, 2½ mi. W Holt, 26 April to 29 May 1970, 231♂, ♀; same but Lily Bluff, 3 mi. NW Holt, 1 June 1970, 28♂, ♀; same but Peadton Bridge, 4½ mi NW Cannon Town, 25 April 1970, 7♀; same but Kennedy Bridge, 6 mi. W Blackman, 1 May 1970, 90♂, ♀. Santa Rosa County, field station 3½ mi. NW Holt, 24–25 April 1970, Peters et al., 1♀; same but 9 May 231♂, ♀.

←

FIGS. 5, 6. Female genitalia of *Cheumatopsyche* species. *A*, dorsal aspect; *B*, lateral aspect.

Vol. 84, No. 38, pp. 307–312 29 February 1972

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

A NEW SPECIES OF *SCELOPORUS* (UNDULATUS GROUP; SAURIA, IGUANIDAE) FROM MEXICO

By James R. Dixon, Chesley A. Ketchersid and
Carl S. Lieb
Department of Wildlife Science
Texas A&M University
College Station, Texas 77843

During the field investigations of an ecological transect across the Sierra Madre Oriental of Mexico from Huichihuayan, San Luis Potosi, to Cadereyta, Queretaro, a new and distinctive member of the *Sceloporus undulatus* group was discovered near Peña Blanca, Queretaro, along the Río Extoras, a small, permanent stream that flows into the Río Moctezuma.

Only two specimens of this population of *Sceloporus* were taken in June 1970, by Ketchersid. Dixon returned to the same area during September 1970, and secured four juveniles of the new species. The new *Sceloporus* appears to be restricted to an almost perfect relict of the Chihuahuan desert where ocotillo, prickly pear, peyote, catclaw, mesquite, leather plant, cresote bush, and desert Tillansia are the common plants.

The new species of *Sceloporus* is isolated from other members of the group geographically and ecologically, therefore we wish it to be known as:

Sceloporus exsul new species

Figures 1–2

Holotype: Adult male, Texas Cooperative Wildlife Collection 32376, taken at Peña Blanca, 1420 m, Queretaro, Mexico, by Chesley A. Ketchersid, 14 June 1970 (Figure 1).

Paratypes: TCWC 32377, 33075–78, subadult female, young female,

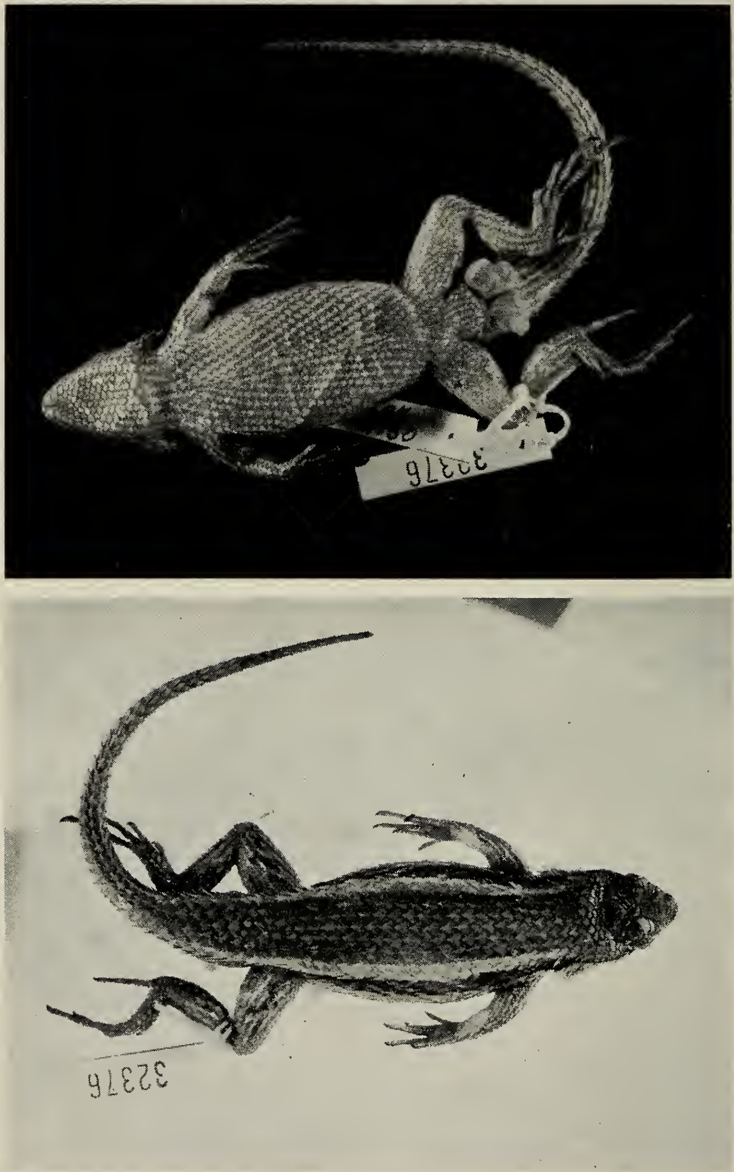


FIG. 1. A dorsal and ventral view of the holotype of *Sceloporus exsul,* Texas Cooperative Wildlife Collection 32376, adult male, from Peña Blanca, Queretaro, Mexico.

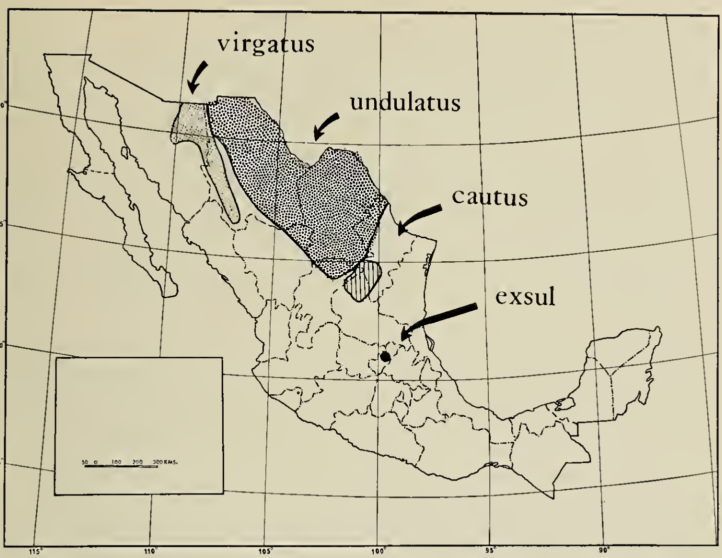


Fig. 2. Distribution of the *Sceloporus undulatus* group in Mexico.

3 young males, all taken from the immediate vicinity of Peña Blanca, Queretaro, 14 June and 14 September 1970.

Diagnosis: An average-sized member of the *Sceloporus undulatus* group (maximum snout-vent length 63 mm), differing from S. *undulatus*, S. *cautus*, and S. *virgatus* in lacking definitive dorsal dark spots between the dorsolateral dark bands and also blue patches in the gular region and venter, and in having the following combination of scale characters (counts are averages): scales around the body 35.5; dorsals 33.0; ventrals from level of arm to vent 39.0; fourth toe lamellae 23.5; femoral pore series separated medially by 9.2 scales.

Description of holotype: Frontal divided transversely, anterior section twice the size of posterior part; posterior part of frontal in narrow contact with interparietal; interparietal bordered laterally by 2 parietals and 2 frontoparietals; supraoculars 4–4, completely enclosed by single row of supraorbital scales; superciliaries 5–5; prefrontals in contact medially; 3 frontonasals, middle one wider than long, each lateral frontonasal twice as long as wide; 12 internasals (scales between postrostrals and frontonasals); 4 postrostrals; 2 canthals on each side; 2 large subnasals lying within canthal ridge; loreals 1–1; preoculars 1–1, with 2 tiny scales lying immediately above preocular and within anterior edge of orbit; suboculars 1–1, extremely long and narrow; postsuboculars 2–2; auricular spines 5–5, with 4 extremely long and pointed; recognizable supralabials 5–5, infralabials 7–7; postmentals 3–4, second pair separated by 2 gular scale rows; lorilabials in almost 2 complete rows; lamellar formula for hand 9-13-16-17-12, foot 10-15-19-24-14; dorsals strongly keeled, extremely large and mucronate; 31 dorsals from occiput to above vent; 37 scales around body; 37 ventrals from level of arm to vent; ventral scales about ½ the size of dorsals and deeply notched; 19 rows of gulars from ear to ear; antehumeral fold with granular center, covered by large mucronate scales along anterior margin; arms and legs covered with relatively large spinose scales; femoral pores 13–14, separated by 9 rows of ventrals; femoral pore scales not deeply notched posteriorly.

Measurements in mm: Snout-vent length 63.0; tail length 85.0; axilla-groin length 27.1; length of head 14.0; width of head 13.0; length of hind limb 42.0; length of arm 27.0.

Color in life: Dorsal surface of head uniform tan; dorsum of body with uniform brownish-tan vertebral band 5 and 2 half scale rows wide, slightly darker along dorsolateral margins; a pair of dorsolateral cream bands generally 1¾ scale rows wide, extending from above ear to proximal ⅕ of tail; dorsolateral cream band bordered below by dark brown band, flecked with black, 1 and 2 half scale rows wide, extending from eye to proximal ⅕ of tail; lateral black band bordered below by cream band 2 scale rows wide, extending from ear to hind limb insertion, bordered below by thin, dashed brown line on part of 1 scale row; venter grayish white with obscure dusky areas scattered throughout; limbs marked with dark brown spots having ill-defined borders; tail colored like dorsum; ventral surface of chin, throat, and upper chest dirty white with diffuse spots of brown on each scale; throat and venter completely devoid of blue color.

Variation: Of the six specimens, only the type is an adult; therefore, little variation in adult sizes is available.

Number of scales around middle of body varies from 32 to 38 (35.5); number of dorsals varies from 31 to 35 (33.0); number of ventrals from level of arm to vent varies from 37 to 41 (39.0); number of fourth toe lamellae varies from 23 to 24 (23.5); total number of femoral pores varies from 27 to 30 (27.6); scales separating femoral pore series vary from 8 to 10 (9.2); supraoculars number 4–4 in all; superciliaries are 4–4 in three, 5–5 in three; prefrontals in medial contact in all.

The dorsal color pattern is similar in both sexes and very little ontogenetic change in pattern is evident from young to adult. The four young specimens are slightly darker in ground color, with more differentiation between the light and dark longitudinal banding of the body. There is some indication that the inner, narrow dark band bordering the upper cream band consists of a series of ill-defined dark marks loosely connected to each other. This band becomes a very narrow, inner border to the upper dorsolateral cream band in adults.

Comparisons: Geographically, S. *cautus* is the nearest member of the *undulatus* group to the type locality of S. *exsul*. Some 275 airline kilometers separate the two nearest localities of each species, but adult male

Table 1. A comparison of the number of scales around middle of body, scales from occiput to above vent, femoral pores, scales separating femoral pore series, and ventrals from level of arm to vent. Numbers in parentheses are averages for each sample examined. Data for S. *undulatus* and S. *virgatus* taken from Cole (1963) and Smith (1938).

	Sceloporus virgatus	*Sceloporus undulatus*	*Sceloporus cautus*	*Sceloporus exsul*
Scales around body	36–48(43.8)	35–47(41.3)	38–42(39.7)	32–38(35.5)
Number of dorsals	34–43(38.7)	36–46(40.5)	31–39(35.2)	31–35(33.0)
Scales sep. F.P. series	4–7 (4.8)	2–8 (4.9)	9–12(10.6)	8–10(9.2)
Number of femoral pores	22–34(27.9)	25–37(31.9)	20–28(24.2)	27–30(27.6)
Ventrals, arm to vent	no data	no data	44–50(46.0)	37–41(39.0)

cautus have distinctive black-edged, dark blue throat patches and lateral venter patches, while *exsul* has none. Male and female *cautus* have distinct, dark spots or blotches along the inner border of the dorsolateral light line; *exsul* has none. The dorsal surface of the tail is banded with 8 to 12 dark bands in *cautus*, it is uniform in *exsul*. Both species have similar averages in number of dorsals and scales separating the femoral pore series, but differ in average number of scales around middle of body and number of ventrals from arm to vent, and number of femoral pores (Table 1).

The nearest locality of *Sceloporus virgatus* to that of *exsul* is some 1,170 airline kilometers to the northwest. The dorsal and ventral color and pattern of *virgatus* is similar to that of *exsul*, except for absence of blue on the throat and blotches on the dorsum in *exsul*. The number of scales around the body and number of dorsals are higher in *virgatus*, combined with a lower number of scales separating the femoral pore series. In addition, *virgatus* is found at relatively high elevations and generally in oak or pine-oak forests. *Sceloporus exsul* is an inhabitant of desert pavement, with mesquite, leather plant, acacia, prickly pear, ocotillo, and peyote as the common desert plants.

Sceloporus undulatus differs from *exsul* in essentially the same characters as *virgatus*, but there are more color differences (blue belly patches) between *undulatus* and *exsul*. The nearest known locality of *undulatus* to an *exsul* locality is approximately 480 kilometers to the north.

ACKNOWLEDGMENTS

We wish to thank John W. Wright, Los Angeles Museum of Natural History, and William E. Duellman, Museum of Natural History, University of Kansas, for the privilege of examining specimens in their care.

LITERATURE CITED

COLE, C. J. 1963. Variation, distribution, and taxonomic status of the lizard, *Sceloporus undulatus virgatus* Smith. Copeia, 1963 (2): 413–425.

SMITH, H. M. 1938. Remarks on the status of the subspecies of *Sceloporus undulatus*, with descriptions of new species and subspecies of the *undulatus* group. Occ. Paps. Mus. Zool., Univ. Michigan (387):1–17.

Vol. 84, No. 39, pp. 313–326 29 February 1972

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

STENASELLID ISOPOD CRUSTACEANS IN THE WESTERN HEMISPHERE—A NEW GENUS AND SPECIES FROM MÉXICO—WITH A REVIEW OF OTHER NORTH AMERICAN FRESHWATER ISOPOD GENERA

By Gerald A. Cole and W. L. Minckley
Department of Zoology, Arizona State University,
Tempe 85281

Until recently, the freshwater isopod family Asellidae was divided into two subfamilies, the Asellinae and the more primitive Stenasellinae. The former included the North American genus *Lirceus* Rafinesque 1820, the Old World genus *Synasellus* Braga 1944, and the abundant, Holarctic *Asellus* G. St.-Hilaire 1764. Stenasellinae, proposed by Vandel (1964) and later diagnosed by Magniez (1966b), included the North African genus *Johanella* Monod 1924, and isopods that originally were assigned to the genus *Stenasellus* Dollfus 1897. Henry and Magniez (1968, 1970) elevated each of the subfamilies to family rank, a reasonable taxonomic shift, and separated *Asellus* into a number of different genera, as will be discussed later in this report.

Species of *Stenasellus* (in the broad sense) are widely distributed in subterranean waters of Europe, especially in the peri-Mediterranean area (Birstein, 1964; Magniez, 1966b, 1968). Twelve forms were recently listed from Europe (Straškraba, 1967), not including *S. hazeltoni* Collinge (1946), which Chappuis (in Racovitza, 1950) believed to be an oniscoidean, a judgment later confirmed (Husson, 1957). One form lives in Turkemenia, east-central Asia (Birstein and Starostin, 1949), and at least six species have been described from tropical Africa-Portuguese Guinea, the Belgian Congo, and Somalia (Remy, 1938; Monod, 1945; Braga, 1950; Chappuis, 1951, 1952; Lanza, 1966). When Magniez (1966b) diagnosed the subfamily Stenasellinae, he included the Algerian *Johanella purpurea* Monod, and split the old genus *Stenasellus* into *Stenasellus* (sensu stricto), *Parastenasellus*, and *Metastenasellus*. *Parastenasellus* includes Remy's *S. leleupi*, *S. congolensis*, and *S. dartevellei* from the Congo basin in west-central Africa. Lanza (1966) described a new species of *Stenasellus* (s.s.) from East Africa, and in the same paper erected a new genus, *Magniezia*, to include *S. africanus* Monod and possibly *S. guineensis* Braga. The present contribution describes yet another new genus and species of this family, the first from the Western Hemisphere, from thermal waters of the Mexican state of Coahuila. Studies upon which this report are based were supported by Grants GB-2461 and GB-6477X from the National Science Foundation. We thank the personnel who aided us in the field and in the laboratory, and the Mexican Government for granting permits and providing encouragement for continuation of our work within the northern Mexican Plateau.

The principal taxonomic literature on the stenasellids, in addition to that cited above, includes papers by Racovitza (1924a, b), Karaman (1954), Braga (1962), Buresch and Guéorguiev (1962), and Magniez (1966a). Husson (1957) and Vandel (1964) provide ecological data for the group.

Mexistenasellus new genus

Diagnosis: Bright red in life; eyeless. Pleonites 1 and 2 well developed. Exopod of antenna 2 absent, or represented (perhaps) by a stout seta. Maxilla 1, inner plate with four setae. Dactyls of pereopods 2–4 with one spine, those of pereopods 5–7 with two spines. Male pleopod 1, protopodite lacking coupling spines. Male pleopod 2, protopodite with distolateral corner produced and armed with setae; exopod narrow and sub-cylindrical, bearing a single seta on distal segment; endopod two segmented, enclosing a sharp spike that protrudes terminally. Pleopods 3–5, endopods non-bifid, respiratory; exopods non-bifid, non-respiratory. Plumose setation absent from all pleopods. Uropods slightly shorter than pleotelson.

Type-species: *Mexistenasellus coahuila* Cole and Minckley, by monotypy.

Mexistenasellus coahuila new species
Figures 1–31

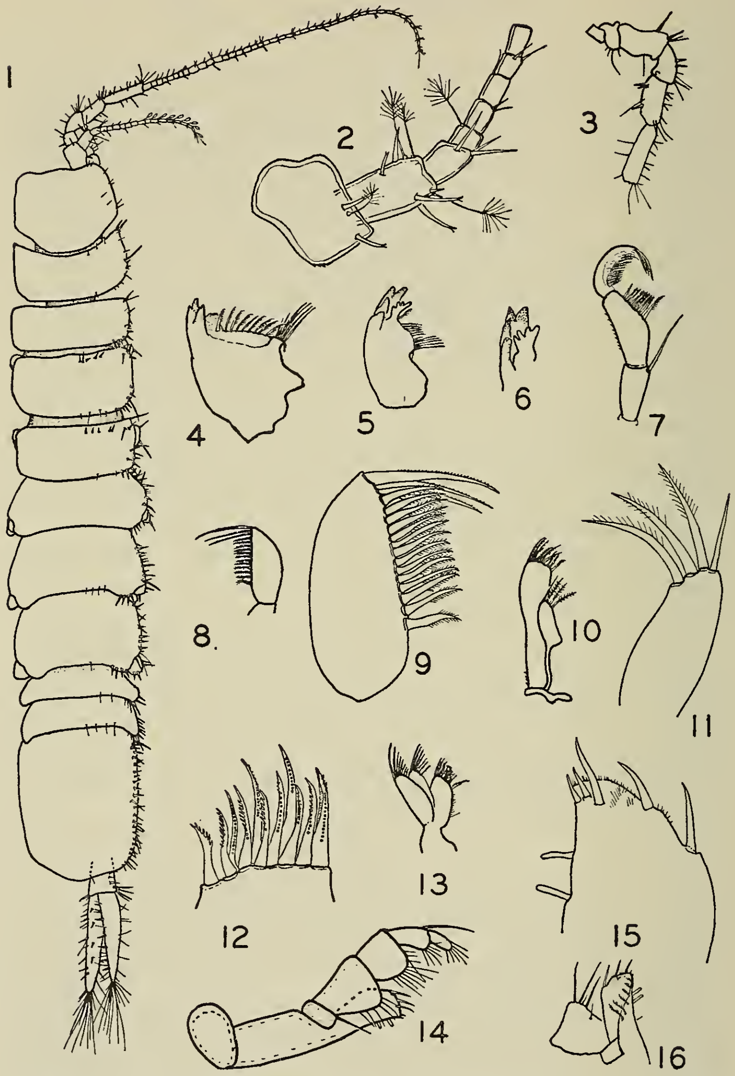
Material: Ten specimens are known, all from thermal springs of the Cuatro Ciénegas basin, central Coahuila, northern México. The holotype (8.2 mm ♂), the allotype (7.4 mm, non-ovigerous), and three paratopotypes (7.2 mm ♂, 5.7 mm ♂, 5.3 mm ♂) are from the eastern end of Laguna Juan Santos, 8.5 km south and 8.0 km west of Cuatro Ciénegas de Carranza, 16 August 1967; collectors, G. A. Cole, W. L. and Robert L. Minckley. Five additional specimens, designated as paratypes, are from the following localities: Laguna Escobeda, 9.8 km south, 2.3 km west Cuatro Ciénegas, 6 August 1968 (6.9 mm ♂); small (unnamed) spring, 8.2 km south, 8.4 km west Cuatro Ciénegas, 15 August 1968 (5.5 mm ♂); small (unnamed) spring, 8.8 km south, 4.0 km west Cuatro Ciénegas, 19 August 1968 (4.8 mm ♂); "Pozo Barbado," 9.4 km south, 7.9 km west Cuatro Ciénegas, 20 August 1968 (4.4 mm ♀, non-ovigerous); and small (unnamed) seep near "Pozo Barbado," 2 September 1970 (4.2 mm ♀, non-ovigerous). All collections from 1968 were made by G. A. Cole, R. L., W. L., and R. K. Minckley; the specimen from 1970 was caught by J. Jerry Landye. Two specimens (5.3 mm ♂, 16 August 1967 and 4.4 mm ♀, 20 August 1968) are in the Nacional Coleccion de México, México, D. F., the specimen from 1970 was deposited with Professor Guy Magniez, and the remainder is in the National Museum of Natural History, Washington, D. C.

Description: Male (based on the holotype and the three largest paratypes). Body slender, elongate, length about 5 × width (Fig. 1). Cephalon length about 0.85 × width, anterior margin slightly convex medially; anterolateral rostral angles rounded, salient. Pereonites 1 and 2 shortest; pereonites 6 and 7 longest. Pleonites 1 and 2 free, subequal, with produced posterolateral corners. Pleotelson 1.3 × longer than broad, median process not conspicuous.

First antenna (Figs. 1, 2), when reflected, extending slightly posteriad to anterior margin of pereonite 1; peduncle of four segments, the last scarcely wider than articles of flagellum; plumose setae on segments 1, 2, and 4. Flagellum of 10–14 articles, distal 6–9 articles with slender lammae olfactoriae, each about 1.5 × length of article bearing it.

Second antenna (Figs. 1, 3), about 0.6 × body length; peduncle of six articles, flagellum of 33–44 articles.

Mandible (Figs. 4–9), with four-toothed incisor. Right mandible with spine row of eight or nine pectinate setae, molar lobe with six–nine closely-set, smooth setae. Left mandible with four-toothed lacinia, spine row of seven faintly-plumose setae, distal one inserted at base of lacinia, molar lobe indistinct, with six–nine smooth setae. Palp with proximal article 0.55 × length of penultimate; penultimate segment of palp 1.4 to 2.0 × ultimate, and with 10 stout, toothed setae on distal half anterior margin; ultimate segment of palp with three long, distal setae, and 14 shorter, stout setae along nearly-straight margin.



FIGS. 1–16. *Mexistenasellus coahuila* new genus and species. 1. Male holotype, 8.2 mm. 2. Antenna 1, paratype, 7.2 mm; peduncle and first four flagellar segments. 3. Antenna 2, holotype; peduncle. 4. Right mandible, holotype. 5. Left mandible, allotype, 7.4 mm. 6. Left mandible, holotype; lacinia and incisor. 7. Mandibular palp, paratype, 7.2 mm. 8. Mandibular palp, paratype, 7.2 mm; distal segment. 9. Mandib-

Maxilla 1 (Figs. 10–12), outer ramus with 12 pectinate, apical teeth; inner ramus with three plumose and one smooth outer setae.

Maxilla 2 (Fig. 13), inner plate with distal setae in two ranks, one of five, grossly-plumose setae, inclined slightly laterad, the other of nine slender, smooth setae; largest, robust, sub-apical seta thick, with faint, transverse suture, curving inward and bearing plumosities on outer, proximal surface. Other plates with 7–10 medially-curving setae, each faintly pectinate on inner surface.

Maxilliped (Figs. 14–16), masticatory lobe with two coupling spines, two stout, marginal setae on distal surface, and one slightly-submarginal seta near mediodistal corner, two smaller spines at mediodistal corner; curved inner surface with seven faintly-plumose setae, decreasing in size distally, fine apical hairs present. Palp, second segment largest, outer margins of three proximal segments unarmed, with long, distal seta on fourth segment.

Pereopods (Figs. 17–23), increasing in length posteriad; extended pereopod 7 about 1.6 × length of pereopod 1. Pereopod 1 prehensile, straight palmar margin of propodus armed with many short setae and two robust spines at posterior corner. Pereopods 2–7 ambulatory. Dactyls of pereopods 2–4 armed with one spine in addition to terminal claw; pereopods 5–7 with two spines on dactyl. Pereopods 2–7, basis with two to six plumose, sensory setae on posterior surfaces; carpus with one such seta at posterodistal corner; propodus of pereopods 5 (rarely), 6, and 7, with subterminal, sensory seta.

Pleopod 1 (Fig. 24), peduncle with concave medial margin and no coupling spines. Exopod oval, bearing 25 or more smooth setae, medial six setae much longer than others.

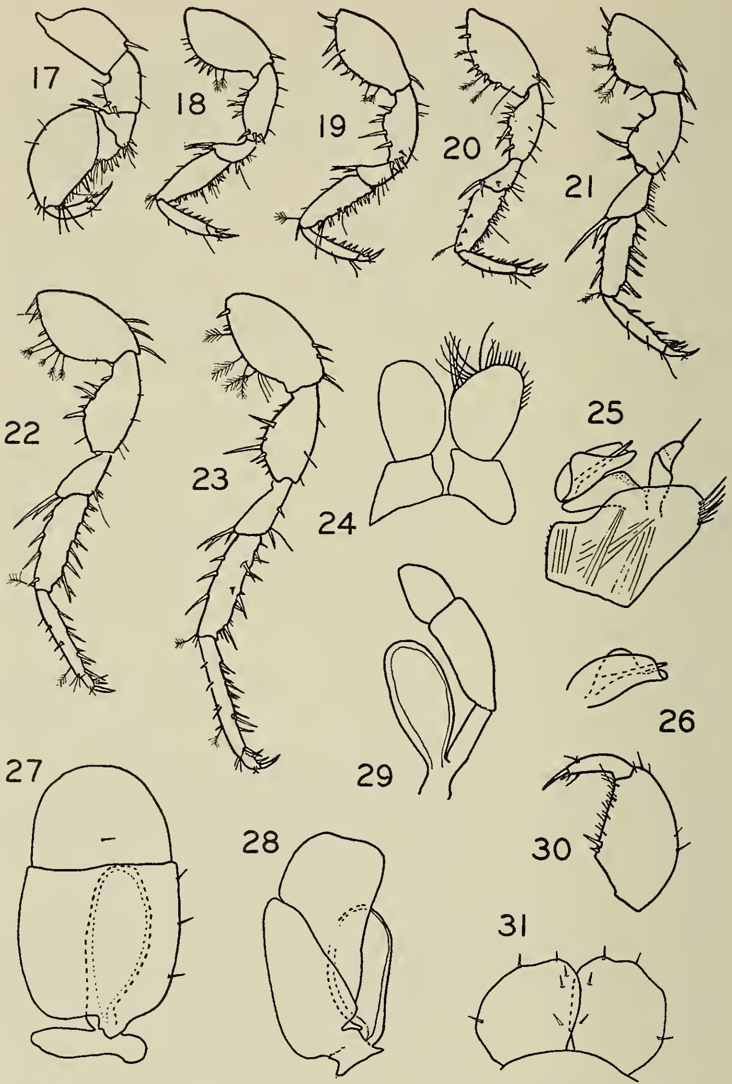
Pleopod 2 (Figs. 25, 26), peduncle sub-pentagonal, base about 0.7 × widest part, length about equal greatest width; outer, distal corner with five or six smooth setae. Exopod narrow, two jointed, 0.5 × length of peduncle, curving laterad, with one stout, terminal seta on distal segment. Endopod two jointed, stouter than exopod, sigmoid, curving laterad, enclosing a sharp, styliform process which protrudes terminally.

Pleopod 3 (Fig. 27), exopod with transverse suture in distal half, sparsely armed with spinules, especially on outer margin of basal half.

Pleopod 4 (Fig. 28), exopod with diagonal suture from near inner, proximal side, to slightly midway on outer margin; both rami lacking setation.

←

ular palp, holotype; distal segment. 10. Maxilla 1, paratype, 5.7 mm. 11. Maxilla 1, holotype; inner plate. 12. Maxilla 1, holotype; outer plate, distal surface. 13. Maxilla 2, paratype, 5.7 mm. 14. Maxilliped, holotype. 15. Maxilliped, holotype; masticatory lobe apex. 16. Maxilliped, allotype; masticatory lobe and basal segments of palp.



FIGS. 17–31. *Mexistenasellus coahuila* new genus and species. 17. Pereopod 1, holotype. 18. Pereopod 2, holotype. 19. Pereopod 3, holotype. 20. Pereopod 4, holotype. 21. Pereopod 5, holotype. 22. Pereopod 6, holotype. 23. Pereopod 7, holotype. 24. Pleopod 1, holotype. 25. Pleopod 2, holotype. 26. Pleopod 2, holotype; endopodite, distal segment. 27. Pleopod 3, holotype. 28. Pleopod 4, paratype, 5.7 mm. 29.

Pleopod 5 (Fig. 29), exopod elongate, narrow, with transverse suture in distal half, extending well beyond endopod; both rami without setation.

Uropod (Fig. 1), rami subequal, much longer than peduncle; exopod somewhat dorsal to endopod. Lateral and dorsal surfaces of exopod and lateral surface of endopod setose, all other surfaces spinose; each ramus with a tuft of long, terminal setae.

Female (allotype only). Similar to male in most details, including prehensile pereopod 1 (Fig. 30). Fewer setae on mandible and maxilla 2 (perhaps a function of smaller size). Pleopod 2 (Fig. 31), scarcely longer than broad, sub-circular, with broadly crenulate margins armed with few spinules.

Remarks on relationships of Mexistenasellus: Most morphological features of *Mexistenasellus coahuila* differ little from those of Old World forms, although the lack of ovigerous females makes some interpretations tentative at best. The New World organism differs from other stenasellids by: lacking an exopodite on the third peduncular segment of the second antenna; the male pleopod 2 having a distolateral process armed with setae and with the rami inserted sub-terminally (recalling *Parastenasellus*, but quite different from *Stenasellus*, s.s.); the presence of a different number of spines on the dactyls of pereopods 2–4 from those of 5–7; and of course the unique terminal segment of the endopodite of male pleopod 2. In addition, the lack of plumose setae on all pleopods of *Mexistenasellus*, the single distal seta on the exopod of male pleopod 2, and the oval shape of pleopod 1 recall species of *Synasellus*. The significance of such similarities cannot yet be interpreted.

The occurrence of stenasellids from more than one presumed phyletic line in Equatorial Africa was considered by Chappuis (in Racovitza, 1950) as evidence for a very ancient dispersal of the group, and perhaps for its origin in Africa. Birstein (1964) disagreed, but offered no firm alternative in the statement that "*Stenasellus* is a remnant from an ancient warmwater tropical fauna occupying a vast range in the Tertiary, from Equatorial Africa to Central Asia." In light of the presence of *Mexistenasellus* in North America, an origin prior to the Tertiary must now be considered.

Habitat and ecology: In 1967, our five specimens were taken from a single block of travertine pulled from the bank of Laguna Juan Santos, about 25 cm below the water surface. Another individual was in the same block, but escaped. The animals were in tiny crevices and tube-like channels in the soft, porous stone, and retreated rapidly toward the interior when disturbed. Many hours were spent that summer seeking additional material of the isopod in travertines and other habitats of Juan Santos, and elsewhere, but to no avail.

←

Pleopod 5, paratype, 5.7 mm. 30. Pereopod 1, allotype, 7.4 mm; propodus and dactylus. 31. Pleopod 2, allotype.

Juan Santos waters originate from thermal springs along the margins and from two or more deep (5 m) depressions near its center. Water temperatures were an uniform 31° C where we were collecting. The filtrable residue of the water, determined by evaporating samples at 103° C, was 2.1 gm/liter. The laguna is more than 100 m wide and supports a large and diversified fish fauna (Minckley, 1969). The only other crustaceans we have found there are the amphipod *Hyalella azteca* (Saussure) and the decapod *Paleomonetes suttkusi* Smalley.

During summer 1968, the four specimens were found singly in widely different habitats. The male from Laguna Escobeda was taken from soft, copropelic sediment about 3 m below the water surface. Water temperature was 34.2° C. The male collected 15 August was in a small, spongy fragment of travertine taken from the bottom of a detritus-choked spring inlet, 50 cm below the surface; water temperature was 33° C. On 19 August, a male *Mexistenasellus* was found in soft detritus beneath a floating mat of vegetation at the outlet of a small limnocrene. The temperature at that point was 31° C. The female specimen, taken 20 August from "Pozo Barbado," was inadvertently secured along with amphipods; its habitat relations are unknown. Water of that pozo was 30.5° C. Landye's specimen was sieved from detrital materials in a small, almost-filled spring, where water temperatures also exceeded 30° C. Definition of the ecology of this form must obviously await accumulation of additional specimens.

More detailed information on the ecology of the waters of the Cuatro Ciénegas basin is available in papers by Taylor (1966), Minckley and Cole (1968a), and Minckley (1969); Holsinger and Minckley (1970) describe smaller seeps and springs of that area in considerable detail.

Distributional relations of North and Middle American freshwater Isopods: A review of the occurrences of freshwater isopods in the inland waters of North America seems appropriate, although perhaps 50 years "behind the times" when compared to literature of the Eastern Hemisphere.[1]

At least three genera of sphaeromatid isopods live in freshwaters of western Europe and the Southern Alps (Vandel, 1964). Most isopods of this family recorded from North American freshwaters are secondarily derived from nearby estuarine or oceanic habitats (Menzies, 1954); however, "*Exosphaeroma*" *thermophilum* (Richardson) is known from warm springs in the Río Grande basin at Socorro, New Mexico, and "*E.*" *dugesi* (Dollfus) from the state of Aguas Calientes, México. Rioja (1950) considered the two species to be closely related, on the basis of his comparisons of the Mexican form with descriptions and figures provided by Richardson (1897, 1905) for the northern species.

Cirolanid isopods are widely distributed in subterranean waters of

---

[1] Since this was written an admirable revision of the North American epigean species of *Asellus* appeared (Williams, 1970). We regret that we were not able to consult this work.

western Europe (Racovitza, 1912), and also in similar habitats of North and Middle America (Bowman, 1964, 1966). Eight genera are known in freshwaters of the Western Hemisphere, including a marine genus *Conilera* Leach 1818, with a referred species that is presently unidentifiable (*"Conilera" stygia* Packard, from Monterrey, Nuevo Leon, México). The genus *Antrolana* Bowman 1964 has one species in the Appalachian Mountains, Virginia. *Cirolanides* Benedict 1896 is represented by *C. texensis* Benedict, widespread and abundant in caves of the Edward's Plateau of Texas (Reddell, 1965). *Speocirolana* Bolivar 1950, represented by at least three species, lives in northeastern México (Rioja, 1953; Bowman, 1964; Cole and Minckley, 1966). One species, *S. thermydronis* Cole and Minckley, may occur only within the Cuatro Ciénegas basin (Minckley and Cole, 1968b), as perhaps does *Mexistenasellus.* The cirolanid genus *Sphaerolana* Cole and Minckley 1970, also presently known only from the Cuatro Ciénegas basin, includes two described species (Cole and Minckley, 1970). Other genera, *Creaseriella* Rioja 1953, from the Yucatan Peninsula, and *Troglocirolana* Rioja 1956 and *Haptolana* Bowman 1966, both from Cuba, complete an arc of cirolanids about the Gulf of Mexico (Bowman, 1964, 1966).

Asellid isopods are the most widespread and abundant freshwater group in North America, including both epigean and subterranean forms. Two genera were formerly recognized, *Lirceus* (= *Mancasellus* Harger 1876), which seems taxonomically stable, and *Asellus* (including *Caecidotea* Packard 1888), long in need of revision (Chappuis, 1955; Bowman, 1967), and which has been re-evaluated by Henry and Magniez (1970). *Lirceus* is an endemic North American genus, generally distributed in eastern United States (Hubricht and Mackin, 1949), and with relationships thought to be transatlantic with *Synasellus* and *Johanella.*

Henry and Magniez (1968, 1970) have elevated some subgenera of *Asellus* to generic rank and proposed a number of new genera. According to them, *Asellus* (sensu stricto) is represented in North America only by *A. aquaticus* (Linnaeus) in Greenland, where it may have been introduced by man. The Western American forms in the United States, *Asellus californicus* Miller and *A. tomalensis* Harford, were considered by Birstein (1964) to belong to the subgenus *Mesoasellus* Birstein 1939, and to have invaded North America via the Bering Straits (see also van Name, 1936). Henry and Magniez (1970) agreed with derivation of the two species from Asia, but suggested that *Mesoasellus* and *Phreatoasellus* Matsumoto 1962 were poorly differentiated subgenera and should be combined under *Asellus* (s.s.). They tentatively referred *Asellus californicus* and *A. tomalensis* to the genus *Nipponasellus* Matsumoto 1962, a group otherwise distributed in the Japanese Archipelago (Matsumoto, 1962).

Eastern American species all were referred to *Conasellus* Collinge 1945, a former subgenus of *Asellus.* This group is endemic to North America, insofar as known at present, and was thought by Racovitza

(1920) to be closely related to *Proasellus* Dudich 1925, of peri-Mediterranean distribution (Henry and Magniez, 1970). The range of *Conasellus* in the Western Hemisphere is now known to include the southern Mexican Plateau, in the Pacific drainage, with the discovery and description of *Asellus puebla* Cole and Minckley (1968). An additional locality for *Asellus puebla* is the mainstream of the Río Lerma, ca. 28 km north of Toluca at Hwy 55 Crossing, state of México, México, 23 May 1969; collectors, C. D. Barbour and R. J. Douglass. This stream, a major tributary of the Río Grande de Santiago system, is part of one of the more complex drainage systems in México (Meek, 1904). Occurrence of asellids in both the Santiago and Balsas hydrographic basins (the latter drainage from which *A. puebla* was described) indicates a much wider dispersion on the Mexican Plateau that we anticipated, and may predict discovery of a substantial aquatic isopod fauna in that area when collecting is accomplished.

Pseudobaicalasellus Henry and Magniez 1970 is the fourth asellid genus of North America, erected to include Bresson's (1955) three eyeless species from Virginia (*Asellus henroti*, *A. simonini*, and *A. vandeli*). Their superficial resemblance to *Baicalasellus* Stammer 1932, a group limited to the Lake Baïkal hydrographic basin, prompted the name, but no interpretations of their relationships have appeared.

Discussion: Direct relationships between certain faunal elements of North and Middle America and the Mediterranean—African region seems apparent. This is especially obvious in Crustacea, and was recently emphasized by discovery of *Monodella texana* Maguire, a representative of the Old World crustacean order Thermosbaenacea in waters of the Edward's Plateau of Texas (Maguire, 1964, 1965). The present record of a stenasellid in México also is significant. Similar relations are mapped by Taylor (1966) for the principally-subterranean hydrobiid snail tribe Horatiini, from the peri-Mediterranean area to the Cuatro Ciénegas basin. These ranges, transgressing the Atlantic, substantiate direct biogeographic affinities of the continental masses, at least for some of the more ancient, subterranean faunal elements. Myers (in Greenwood et al., 1966) implies a similar possibility for some South American and African, obligate freshwater fishes.

Origins of some of the invertebrate groups are known to date well into mid-Mesozoic (Racovitza, 1912; Chilton, 1918; van Straelen, 1928; Birstein, 1964), and their present distributions, when better understood, may serve to support geophysical findings in the area of continental drift (reviewed by Dietz and Holden, 1970; and others).

LITERATURE CITED

BIRSTEIN, J. A. 1964. Freshwater isopods (Asellota). Fauna of U. S. S. R., Crustacea, 7: 1–148 (original published, 1951, Zool. Inst. Acad. Sci. S. S. S. R. 47: 1–140; Israel Program Sci. Transl., 1964).

———, and I. V. Starostin. 1949. Novyi dlya SSR rod vodyanykh oslikov (*Stenasellus*) iz Turkmenii i ego znachenie dlya zoogeografii Srednei Azii. Doklady Akad. Nauk SSSR 69: 691–694.

Bowman, T. E. 1964. *Antrolana lira,* a new genus and species of troglobitic cirolanid isopod from Madison Cave, Virginia. Internat. J. Speleol. 1: 229–236, 8 pls.

———. 1966. *Haptolana trichostoma,* a new genus and species of troglobitic cirolanid isopod from Cuba. *Ibid.* 2: 105–108, 4 pls.

———. 1967. *Asellus kenki,* a new isopod crustacean from springs in the eastern United States. Proc. Biol. Soc. Wash. 80(1): 131–140.

Braga, J. M. 1950. Sur deux *Stenasellus* (Crust. Isopoda) de la Guinée Portugaise. Anals Faculdade Ciências Porto. 35: 50–56.

———. 1962. Sur la distribution géographique des *Stenasellus* de la Péninsule Ibérique et description d'une espèce nouvelle de ce genre. *Ibid.* 44: 9–28.

Bresson, J. 1955. Aselles de sources et de grottes d'Eurasie et d'Amérique du Nord. Arch. Zool. Exp. Gén. Paris 92: 45–77.

Buresch, I., and V. Guéorguiev. 1962. Contribution à la connaissance des espèces du genre *Stenasellus* (Crustacea, Asellota) en Bulgarie avec description d'une nouvelle espèce. Bull. Inst. Zool. et Mus. 11: 189–206.

Chappuis, P. A. 1951. Isopodes et copépodes cavernicoles. Rev. Zool. Bot. Africa 44: 342–359.

———. 1952. Un noveau *Stenasellus* du Congo Belge. *Ibid.* 45: 353–357.

———. 1953. Sur la systématique du genre *Asellus.* Notes Biospéol. 8: 67–79.

———. 1955. Remarques générales sur le genre *Asellus* et description de quatro espèces nouvelles. *Ibid.* 10: 163–182.

Chilton, C. 1918. A fossil isopod belonging to the freshwater genus *Phreatoicus.* J. Proc. Roy. Soc. N. S. Wales 51: 365–388.

Cole, G. A., and W. L. Minckley. 1966. *Speocirolana thermydronis,* a new species of cirolanid isopod crustacean from central Coahuila, México. Tulane Stud. Zool. 13: 17–22.

——— and ———. 1968. A new species of aquatic isopod crustacean (genus *Asellus*) from the Puebla Plateau, central México. Proc. Biol. Soc. Wash. 81: 755–760.

——— and ———. 1970. *Sphaerolana,* a new genus of cirolanid isopod from northern México, with description of two new species. Southwest. Nat. 15: 71–81.

Collinge, W. E. 1946. Preliminary description of *Stenasellus hazeltoni,* a cavernicolous isopod new to Great Britain. Ann. Mag. Nat. Hist. (Ser. 11) 13: 140–142.

Dietz, R. S., and J. C. Holden. 1970. The breakup of Pangaea. Sci. Amer. 223: 30–41, 144.

Greenwood, P. H., D. E. Rosen, S. H. Weitzman, and G. S. Myers. 1966. Phyletic studies of teleostean fishes, with a provisional classification of living forms. Bull. Amer. Mus. Nat. Hist. 131: 339–456, 4 pls.

Henry, J. P., and G. Magniez. 1968. Sur la systématique et la biogéographie des Asellides. C. R. Acad. Sci. Paris 267: 87–89.

——— and ———. 1970. Contribution à la systématique des Asellides (Crustacea Isopoda). Ann. Spéléol. 25: 335–367.

Holsinger, J. R., and W. L. Minckley. 1970. A new genus and two new species of subterranean amphipod crustaceans (Gammaridae) from northern México. Proc. Biol. Soc. Wash. 83: 875–894.

Hubricht, L., and J. C. Mackin. 1949. The freshwater isopods of the genus *Lirceus* (Asellota, Asellidae). Amer. Midl. Nat. 42: 334–349.

Husson, R. 1957. A propos de la biologie du crustacé troglobie *Stenasellus virei* Dollfus. Ann. Univ. Saraviensis Naturwissenschaft Sci. 6: 259–269.

Karaman, S. L. 1954. Über die Jugoslavischen *Stenasellus*-arten. Fragmenta Balcanica Mus. Macedon. 1: 7–20.

Lanza, B. 1966. *Stenasellus pardii* sp. n. della Somalia e note sistematiche su gli Stenasellinae (Crustacea, Isopoda). Monit. Zool. Ital. Firenze 74: 221–256.

Magniez, G. 1966a. Contribution à la systématique des Stenasellinae d'Afrique (Crustacés, Asellotes). Internat. J. Speleol. 2: 173–190.

———. 1966b. Les Stenaselles (Crustacés, Isopodes, troglobies) de la Province de Santander (Espagne). Ann. Spéléol. 21: 827–837.

———. 1968. L'espèce polytypique, *Stenasellus virei* Dollfus, 1897 (Crustacé, Isopode, hypogé). *Ibid.* 23: 363–407.

Maguire, B., Jr. 1964. Crustacea: a primitive Mediterranean group also occurs in North America. Science 146: 931–932.

———. 1965. *Monodella texana* n. sp., an extension of the range of the crustacean order Thermosbaenacea to the Western Hemisphere. Crustaceana 9: 149–154, 1 pl.

Matsumoto, K. 1962. Two new genera and a new subgenus of the family Asellidae of Japan. Annot. Zool. Jap. 35: 162–169.

Meek, S. E. 1904. The fresh-water fishes of México north of the Isthmus of Tehuantepec. Publ. Field. Col. Mus., Zool. Ser. 5: i–ixiii, 1–252, 17 pls.

Menzies, R. J. 1954. A review of the systematics and ecology of the genus "*Exosphaeroma*," with the description of a new genus, a new species, and a new subspecies (Crustacea, Isopoda, Sphaeromidae). Amer. Mus. Novitates 1683: 1–24.

Minckley, W. L. 1969. Environments of the Bolsón of Cuatro Ciénegas, Coahuila, México, with special reference to the aquatic biota. Univ. Texas, El Paso, Sci. Ser. 2: 1–65.

——— AND G. A. COLE. 1968a. Preliminary limnologic information on waters of the Cuatro Cienegas basin, Coahuila, Mexico. Southwest. Nat. 13: 421–431.

——— AND ———. 1968b. *Speocirolana thermydronis* (Crustacea: Isopoda) from north-east México, re-discovery, habitat, and supplemental description. Tulane Stud. Zool. Bot. 15: 2–4.

MONOD, T. 1945. Un noveau *Stenasellus* Ouest-Africain. Bull. Inst. Franç. Afr. Noire 7: 101–114.

RACOVITZA, E. G. 1912. Cirolanides (Première Série). Biospéologica 27, Archiv. Zool. Exp. Gén. (5th Sér.) 10: 203–329, 14 pls.

———. 1920. Notes sur les Isopodes. 6. *Asellus communis* Say. 7. Les pléopodes I et II des Asellides; morphologie et développement. *Ibid.* (Notes et Revue No. 4) 58: 79–115.

———. 1924a. Diagnoses des genres *Asellus* et *Stenasellus* et description de deux *Stenasellus* noveaux (note préliminaire). Bull. Soc. Sci. Cluj. 2: 81–92.

———. 1924b. Notes sur les Isopodes. 12. Morphologie et morphogénie des pléopodes I et II des femelles des Asellides. Arch. Zool. Exp. Gén. (Notes et Revue No. 2) 62: 35–48.

———. 1950. Asellides. Première série: *Stenasellus.* Biospéologica 70, *Ibid.* 87: 1–94.

REDDELL, J. R. 1965. A checklist of the cave fauna of Texas, I: the invertebrates (exclusive of Insecta). Texas J. Sci. 17: 143–187.

REMY, P. 1938. Un *Stenasellus* en Afrique Occidentale Française: S. *chappuisi* n. sp. de Côte d'Ivoire. Arch. Zool. Exp. Gén. (Notes et Revue No. 2) 79: 69–74.

RICHARDSON, H. E. 1897. Description of a new crustacean of the genus *Sphaeroma* from a warm spring in New Mexico. Proc. U.S. Nat. Mus. 20: 465–466.

———. 1905. A monograph on the isopods of North America. Bull. U.S. Nat. Mus. 54: 1–727.

RIOJA, E. 1950. Estudios carcinologicos. XXIII. Estudio morfologico del *Exosphaeroma dugesi* (Dollfus), isopodo termofilo de la fauna Mexicana. Ann. Inst. Biol. México 21: 351–365.

———. 1953. Estudios carcinologicos. XXX. Observaciones sobre los cirolanidos cavernicolos de México (crustacous, Isopodos). *Ibid.* 24: 141–170.

STRAŠKRABA, M. 1967. Isopoda. *In,* Limnofauna Europaea (J. Illies, Ed.), Gustav Fischer Verlag, Stuttgart, pp. 198–201.

TAYLOR, D. W. 1966. A remarkable snail fauna from Coahuila, México. Veliger 9: 152–228, 12 pls.

VANDEL, A. 1964. (translated by B. E. Freeman, 1965). Biospeleology—the Biology of Cavernicolous Animals. Pergamon Press, xxxiv + 254 pp.

van Name, W. G. 1936. The American land and fresh-water isopod Crustacea. Bull. Amer. Mus. Nat. Hist. 71: 1–533.

van Straelen, V. 1928. Contribution à l'étude de isopodes Meso- et Cenozoiques. Mem. Acad. Roy. Belg. Cl. Sci. (9) 5: 1–66.

Williams, W. D. 1970. A revision of North American epigean species of *Asellus* (Crustacea: Isopoda). Smithsonian Contr. Zool. No. 49. Washington. 80 pp.

Vol. 84, No. 40, pp. 327–334 29 February 1972

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

A SUBSPECIES OF *AGKISTRODON BILINEATUS* (SERPENTES: CROTALIDAE) ON THE YUCATÁN PENINSULA, MÉXICO

By Howard K. Gloyd
Department of Biological Sciences,
University of Arizona, Tucson, Arizona 85721

Study of the snake species *Agkistrodon bilineatus* has proved to be unexpectedly difficult because of the nature of available material. Although I have examined some 130 specimens, 39 percent of them are without definite localities or are young born in zoos with no indication of provenance. Many to which localities are attached are mangled or injured in such ways as to make accurate scale counts or measurements impossible. No single locality is represented by a series sufficiently large for an indication of local variation, except possibly Colima, and some specimens listed from there are questionable.

First described by Günther (1863) from the Pacific Coast of Guatemala, *Agkistrodon bilineatus* was recorded from Yucatán by this same author (1895), and subsequently from there by Gaige (1936), Schmidt and Andrews (1936), and Duellman (1965a). Through the courtesy of Dr. William E. Duellman and of Dr. T. Paul Maslin I have had the privilege of studying some well-preserved specimens recently obtained in Yucatán and Campeche, and have been led to the conclusion that this peninsular population represents a subspecies that should be recognized by name. I therefore propose that it be known as:

Agkistrodon bilineatus russeolus new subspecies
Yucatecan Cantil

Ancistrodon bilineatus, Günther, 1895, p. 186 (part).—Velasco, 1895, p. 37.—Boulenger, 1896, p. 521–522 (part).

Agkistrodon bilineatus, Gaige, 1936, p. 303.—Schmidt and Andrews, 1936, p. 181.—Gloyd and Conant, 1943, p. 163 (part).—Smith and Taylor, 1945, p. 177 (part).

Agkistrodon bilineatus bilineatus, Duellman, 1965a, p. 611.

Holotype: University of Kansas, Museum of Natural History (KU) No. 70905, male, collected 20 July 1962 by Jerome B. Tulecke, 11.7 km. north of Pisté, Yucatán, México.

Paratypes: KU 70904, male, Pisté, Yucatán, 21 July 1962, Erwin E. Klaas; KU 70903, female, 5 km. south of Champotón, Campeche, William C. Stanley; University of Colorado Museum (UCM) 40640 and 40641, females, UCM 41792, male, Pisté, Yucatán, Eduardo Welling; University of Michigan, Museum of Zoology (UMMZ) 73056, female, Motul, Yucatán; UMMZ 83934, female, Chichén Itzá, Yucatán; Field Museum of Natural History (FMNH) 19425, female, Mérida, Yucatán; FMNH 36253, female, Libre Unión, Yucatán.

Diagnosis: From *A. b. bilineatus* this subspecies is distinguished by the following attributes: the presence of conspicuous light areas of ground color between crossbands; cheek stripe, bases of crossbands and ventrolateral spots dark chestnut brown, broadly edged with white, the white extending onto ventral scutes; belly light along midline and with numerous white markings irregularly distributed; light lines on sides of head relatively narrow, the upper especially so, the lower extending across the centers of the supralabials anteriorly then descending to their lower margins posteriorly. The white does not extend over the greater part of the supralabials as in *A. b. taylori*. From *A. b. taylori* this form is distinguished by the narrow light line on the supralabials bordered by dark below, and by the higher number of subcaudals.

Description of holotype: Crown with the nine symmetrical plates characteristic of the genus, unmodified in shape. Rostral slightly higher than wide, apex not rising above canthus. Nasals 2, the anterior at upper edge about 1½ times the width of the posterior one. Preoculars 2, the upper separated from the postnasal by a quadrangular loreal, wider at the base; the lower preocular forming the upper posterior border of the pit; a small postfoveal below. Post- and suboculars 3 on the left side, 5 on the right. Orbit surrounded by 7 scales on left, 8 on right (including postfoveals). Supralabials 8, the upper portion of the second forming the anterior border of the pit, which is bordered below by a rectangular subfoveal. Infralabials 12 on left, 11 on right. Temporals in irregular rows, the anteriormost of the lowest row conspicuously larger than all the others; first and second rows of temporals without keels. First pair of infralabials extending backward in long, narrow points that are in contact with each other posterior to tip of mental. One pair of enlarged chin shields, each about twice as long as wide. Median gulars in 3 pairs; lateral gulars in 3 to 5 oblique rows.

Dorsal scales with paired apical pits; all with keels except those of lowermost row anteriorly. Scale rows 25-23-21-19, order of reduction irregular (Dowling recount system, 1951):

$$25\ \frac{-4\ (44)}{4+5\ (31)}\ 23\ \frac{-5\ (93)}{4+5\ (85)}\ 21\ \frac{-5\ (118)}{-5\ (117)}\ 19\quad (137)$$

Ventrals 137; anal not divided; hemipenes everted. Subcaudals 62, the 28th to 30th and the distal 31 divided; terminal spine sharp, decurved. No conspicuous injuries or anomalies.

Total length 850 mm; length of tail 155 mm, 18.2 percent of total length.

General coloration, in alcohol, varying tones and shades of brown. Crown and sides of head deep reddish brown. A broad, dark reddish-brown cheek stripe bordered by narrow light lines above and below; the upper line shows traces of yellow, begins on the tip of the internasal, extends along the edges of the internasal, supraocular, uppermost postocular, and diagonally backward on the second row of temporals and downward to the neck; the lower light line extends obliquely downward on the anterior nasal and first supralabial, and backward on the middle of supralabials 2 and 3 and then across supralabials 4 to 8 to the commissure, and downward as a series of spots on the lateral gulars. The rostral and mental are each marked medially with a conspicuous vertical light bar.

The dorsal ground color, which appears in the pale areas between the crossbands dorsally and down the sides, is light brown. The 15–16 reddish-brown crossbands are darker at their edges and incompletely bordered by white spots which are larger and more conspicuous on the sides. The chestnut brown ventrolateral blotches are broadly connected with the crossbands on the sides and merge below with the dark grayish brown on the venter; they also are broadly but incompletely edged with white. The ventral ground color is grayish brown, lighter along the middle of the belly. On the tail there are 10 or 12 dark crossbands that become pale where the distal half of the tail is light yellowish gray.

Paratypes: In these nine specimens, five adults and four juveniles, the diagnostic characters of pattern and coloration are consistently present. The three KU specimens (including the holotype) and the three UCM specimens were collected more recently than the others and have color tones much better preserved. KU 70903 and 70904 resemble the type specimen in general but are somewhat darker. The cheek stripes, crossbands, and ventrolateral spots are dark chestnut brown or grayish brown, with a suggestion of red. The light areas dorsally between the bands are pale tan with a slight tinge of pink. The ventral ground color is dark chocolate brown, conspicuously lighter medially. The white markings at the edges of the crossbands are narrow and interrupted dorsally, broad and conspicuous ventrolaterally. UCM 40641 resembles KU 70904 in general coloration; UCM 40640 and 41792 are notably darker than other subadults examined; 41792 has a strikingly ornate pattern, the crossbands in strong contrast with the pale brown ground color and the white markings notably conspicuous.

Three slight aberrations occur in KU 70903: there is a small azygous scale at the anterior midpoint of the frontal; the loreals are apparently absent (the postnasals are in contact with the upper preoculars); and the parietals are separated posteriorly by a triangular scale. FMNH 36253 also has a median azygous scale just anterior to the frontal.

Other characters of the two males and seven females of the paratype series may be summarized as follows. Scale rows 25–23–19 (17 in one); ventrals, males, 131, 137, females 135–138 (136.8); subcaudals, males, 61, 53+ (tip missing), females, 49–61 (54.4); divided subcaudals, males, 30, 30+, females, 21–38 (31.8); supralabials 8–8; infralabials 10–12 (10.8), 8 in one case, an aberration; post- and suboculars 4–4 (4–3 in one); loreals 1–1; crossbands of body 13–17 (indistinct in some specimens); crossbands of tail, when visible, about 10. Total length of males 450, 1050+ mm (tail incomplete); of adult females 945, 985, 995, 1010 mm; of juvenile females 282, 300, 315 mm. Tail length in percent of total, one male 19.5; adult females 15.0–16.2 (15.7), juveniles 19.0–20.0 (19.5).

The Mayan name for this snake is *wolpoch* (Gaige, 1936) or *Uol-poch* (Schmidt and Andrews, 1936).

The subspecific name *russeolus* refers to the somewhat reddish tinge in the coloration of the more recent specimens. Although the vernacular name cantil appears to be most commonly applied to *A. bilineatus* on the west coast of Mexico, it has been generally accepted as an English name for the species. It therefore seems logical to suggest Yucatecan Cantil for the peninsular subspecies.

Geographical distribution: Yucatán Peninsula of Mexico: States of Campeche and Yucatán.

KEY TO THE SUBSPECIES OF *AGKISTRODON BILINEATUS*

1a. Subcaudals 50–56 in males, 47 in (2) females; lower light line on side of head covering lower halves of supralabials, not bordered by dark below; crossbands of body more or less distinct in adults as well as juveniles .... *taylori* Burger and Robertson, 1951.
Eastern Mexico: Semi-arid areas in southern Nuevo León and Tamaulipas (Martin, 1958).

1b. Subcaudals 58–68 in males, 49–62 in females; lower light line on side of head crossing supralabials above commissure, bordered by dark below 2

2a. Conspicuous light areas separating crossbands dorsally; main pattern dark chestnut brown; white markings at edges of crossbands and ventrolateral spots notably broad and ornate; venter lighter along midline and with numerous white markings .... *russeolus* new subspecies.
Mexico: Yucatán Peninsula—Campeche and Yucatán. The species was reported from Campeche by Velasco (1895).

2b. Dorsal ground color between crossbands dark, little if any different from that of bands; main pattern dark gray or brownish black; white markings mostly narrow, less conspicuous; venter generally dark, white markings few .... *bilineatus* Günther, 1893.

Pacific side of Central America and Mexico, from Costa Rica (Bolaños and Montero, 1970), Nicaragua (Villa, 1962) and El Salvador (Mertens, 1952a, b) to southern Sonora (Bogert and Oliver, 1945). I have examined specimens from Guatemala and from the States of Chiapas, Oaxaca, Guerrero, Morelos, Michoacán, Colima, Jalisco, Nayarit, Sinaloa, and Sonora, Mexico.

The Tres Marías Islands, off Nayarit, are represented by two specimens of *A. bilineatus* in the British Museum, collected [probably on María Madre] by A. Forrer in 1881 (Boulenger, 1896, p. 522), and one from María Madre in the National Museum of Natural History collected by Nelson and Goldman in 1897. Possible differences in coloration of these specimens from those of the mainland population are obscured by ageing. One of the two males (USNM 24685) has a deceptively low number of subcaudals (21 + 25, Stejneger, 1899, p. 71). Although the tip is pointed and bears what may be mistaken for a terminal spine, the tail is probably incomplete. If the species still exists on María Madre, fresh material would be of considerable interest.

A specimen in the British Museum (Boulenger, 1896, p. 522, "b") and another in the Field Museum (FMNH 4196) are listed as from "Belize." According to Allen and Neill (1959, p. 227), Belize was a 19th Century name for a vaguely defined area before it became officially known as British Honduras. Various other authors have assumed, perhaps erroneously, that the present capital city of that name was indicated. On the basis of uncertainty of the provenance of these two specimens, and on topographical and ecological considerations, these authors have properly questioned the natural occurrence of the species in that region.

Ecological data for *Agkistrodon bilineatus* are scanty throughout its range, but from what is now known of its occurrence in both eastern and western Mexico it appears not to be confined to riparian habitats. Although frequently mentioned in the literature as found along streams and in other moist places, it is now known to occur in less humid areas. The KU specimens of *A. b. russeolus* from Yucatán were collected at night in deciduous scrub forest (Duellman, 1965a); the known specimens of *A. b. taylori* are reported from semi-arid areas in Tamaulipas (Burger and Robertson, 1951; Martin, 1958). As to *A. b. bilineatus*, the example from Sonsonate, El Salvador (Mertens, 1952b) appears to have been taken in lowland dry forest; specimens reported from Michoacán (Duellman, 1961, 1965b) and from Sinaloa (Hardy and McDiarmid, 1969) are from semi-arid regions; the individual recently reported from Costa Rica, 25 km northwest of Liberia, Guanacaste Province (Bolaños and Montero, 1970), was taken during the dry season on rocky terrain in "Tropical Dry Forest, Moist Province Transition."

In a personal communication, Roger Conant has remarked that during the enormous amount of time he has spent in exploring riparian habitats at night in many parts of Mexico, primarily in quest of water snakes of the genus *Natrix*, he never once encountered *Agkistrodon bilineatus* in the field. A more detailed treatment of the distribution and ecology of this species is reserved for a later contribution on the genus as a whole.

Acknowledgments

For the loan of specimens and for other assistance directly involved in this paper, I am indebted to William E. Duellman, University of Kansas, Museum of Natural History; T. Paul Maslin, University of Colorado Museum; Donald W. Tinkle, University of Michigan, Museum of Zoology; Robert F. Inger and Hymen Marx, Field Museum of Natural History; Alice G. C. Grandison, British Museum (Natural History); James A. Peters and George R. Zug, National Museum of Natural History; Hobart M. Smith, University of Colorado; and Roger Conant, Philadelphia Zoological Garden. I am deeply appreciative. This contribution includes results of part of a study supported by the National Science Foundation (G2896, G8702, and G19400).

Literature Cited

Allen, Ross and Wilfred T. Neill. 1959. Doubtful locality records in British Honduras. Herpetologica 15: 227–233.

Bogert, Charles M. and James A. Oliver. 1945. A preliminary analysis of the herpetofauna of Sonora. Bull. Amer. Mus. Nat. Hist. 83: 297–425.

Bolaños, Roger and José R. Montero. 1970. *Agkistrodon bilineatus* Günther from Costa Rica. Rev. Biol. Trop. 16: 277–279, 2 fig.

Boulenger, George A. 1896. Catalogue of the snakes in the British Museum (Natural History). London, vol. 3, xiv + 721 pages.

Burger, W. Leslie and William B. Robertson. 1951. A new subspecies of the Mexican moccasin, *Agkistrodon bilineatus*. Univ. Kans. Sci. Bull. 34: 213–218, pl. 25.

Duellman, William E. 1961. The amphibians and reptiles of Michoacán, México. Univ. Kans. Publ. Mus. Nat. Hist. 15: 1–148, 6 pl., 11 fig.

———. 1965a. Amphibians and reptiles from the Yucatán Peninsula, Mexico. Ibid. 15: 577–614.

———. 1965b. A biogeographic account of the herpetofauna of Michoacán, México. Ibid. 15: 627–709, 8 pl., 5 fig.

Gaige, Helen T. 1936. Some reptiles and amphibians from Yucatán and Campeche, México. Carnegie Inst. Washington, Publ. 457: 289–304.

Gloyd, Howard K. and Roger Conant. 1943. A synopsis of the American forms of *Agkistrodon* (copperheads and moccasins). Bull. Chicago Acad. Sci. 7: 147–170, 16 fig.

Günther, Albert. 1863. Third account of new species of snakes in the collection of the British Museum. Ann. Mag. Nat. Hist. ser. 3. 12: 348–365.

———. 1895. Reptilia and Batrachia, Biologia Centrali-Americana, 1895–1902, xx + 326 p., 76 pl.

Hardy, Laurence M. and Roy W. McDiarmid. 1969. The amphibians and reptiles of Sinaloa, México. Univ. Kans. Publ. Mus. Nat. Hist. 18: 39–252, 8 pl., 91 fig.

Martin, Paul S. 1958. A biogeography of reptiles and amphibians in the Gomez Farias region, Tamaulipas, Mexico. Misc. Publ. Mus. Zool. Univ. Mich. 101: 1–102.

Mertens, Robert. 1952a. Neues über die Reptilienfauna von El Salvador. Zool. Anz. 148: 87–93.

———. 1952b. Die Amphibien und Reptilien von El Salvador, auf Grund der Reisen von R. Mertens und A. Zilch. Abh. Senckenb. Naturf. Ges. 487: 1–120, 16 pl.

Schmidt, Karl P. and E. Wyllys Andrews. 1936. Notes on snakes from Yucatan. Zool. Ser. Field Mus. Nat. Hist. 20: 167–187.

Smith, Hobart M. and Edward H. Taylor. 1945. An annotated checklist and key to the snakes of México. U.S. Nat. Mus. Bull. 187: 1–239.

Stejneger, Leonhard. 1899. Reptiles of the Tres Marías and Isabel Islands. N. Amer. Fauna 14: 63–71.

Velasco, Alfonso Luis. 1895. Geografia y estadistica de la República Mexicana. Campeche, Reptiles. 16: 37–39. Secr. Fomento, Mexico.

Villa, Jaime. 1962. Las serpientes venenosas de Nicaragua. Managua, D. N. 90 p., 18 pl.

Vol. 84, No. 41, pp. 335–344 29 February 1972

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

THREE NEW SPECIES AND ONE NEW GENUS OF HETEROTHRIPIDAE (THYSANOPTERA) FROM SOUTH AMERICA

By Lewis J. Stannard, Jr.
Illinois Natural History Survey, Urbana 61801

The three new species of Heterothripidae from the Andean region of South America described herein bring the total of the New World members of the family to approximately 54 species. Only a few Old World and fossil species are also known.

A new genus, *Scutothrips*, is proposed for those species, formerly in *Heterothrips* Hood, which bear a triangular metascutum. This type of scutum occurs in the advanced heterothripine genus *Aulacothrips* Hood, and appears in some of the species in Heliothripinae (Thripidae), demonstrating their possible evolutionary alliance.

Alternatively, *Scutothrips* could have been made a subgenus of *Heterothrips*, as was done in the case of *Protemnothrips* Hood and *Lenkothrips* de Santis, but it seems more forthright to designate the category as a full one in view of the distinctive head and notable triangular metascutum. The subgenus *Protemnothrips* is based on a rather minor characteristic, that is the shortening of the last three antennal segments (not fused as stated by Bailey and Cott 1954), whereas the subgenus *Lenkothrips* is based on a more distinctive feature, the radically different form of the sensoria on antennal segments III and IV (inverted U shaped rather than circumapical), an extraordinary characteristic that also could reasonably allow *Lenkothrips* to be made a full genus.

Holotypes of the new species are deposited in the collections of the Illinois Natural History Survey (INHS).

FIG. 1. *Scutothrips incaensis,* female. Head and prothorax, dorsal aspect.

Scutothrips new genus

Head wider than long, deeply indented between the eyes, cheeks abruptly extended laterally beyond eyes tapering inward basally. Ocelli placed between eyes, fore ocellus not extended up to anterior eye margin. Antennae each 9 segmented, segments III and IV each with a circumpolar band of numerous small circular sensoria, segments VII to IX together longer than VI. Mouth cone bluntly rounded, maxillary palps 3 segmented.

Pronotum longer than head, anterior and posterior margins each with 2 pairs of stout, short setae. Mesoscutum transversely striate to nearly hexagonally reticulate. Metanotum with a marked, differentiated, triangular scutum, which is seemingly elevated above the rest of the sclerite; border of triangle thickened and fringed with microtrichia. All tarsi 2 segmented, fore tarsi each with cocoon-breaking hooks. Fore wings swollen basally, narrowed and nearly parallel sided in apical ⅔, fringe cilia straight.

Abdomen with segment I well separated by membrane from segment II. Most tergites with median pair of setae spaced fairly closely together. Lateral regions of tergites I to VII with posterior microtrichia fused at base forming numerous platelets. Abdominal segment X long and pointed.

Males, where known, with abdominal sternites III to VIII each with a transverse elliptical, glandular area.

Type-species: Scutothrips incaensis new species.

This genus is similar in most respects to *Heterothrips* Hood, differing from it mainly by having the cheeks strongly angulate behind the eyes and in having a triangular metascutum. In the latter respect, *Scutothrips* shows similarity to *Aulacothrips* Hood which also has a differentiated triangular metascutum. Furthermore, this type of scutum is found in some genera in the Heliothripinae (Thripidae), as for example *Heliothrips* and *Retithrips.*

To the genus *Scutothrips* are transferred, herewith: *moreirai* Moulton, *nudus* Moulton, and *peruvianus* Hood, all of which are also from South America.

Scutothrips incaensis new species

Female (macropterous): Length, not distended, 1.6 mm. Color dark brown, darkest in head, thorax and portions of legs. Fore femora at apex, fore tibiae except at the middle along the sides, the mid tibiae at the apex, the hind tibiae at the base and extreme apex, and all tarsi bright yellow. Antennal segment I brown, segment II yellowish brown to yellow at apex, segment III yellow, segments IV to IX dark brown. Fore wings brown except for a wide clear subbasal area. Hind wings pale except for median brown streak. Body setae brown. Subintegumental pigment orange red.

Head, Figure 1, dorsally with about 6 transverse lines of sculpture posteriorly. Ocellar triangle strongly inset posteriorly from anterior margin. Antennae with segments III and IV bearing 2 circumapical rows of small sensoria, segments VII to IX together longer than segment VI.

Pronotum smooth, with only faint indications of hexagonal sculpture, and with many minute setae. Postero- and anterolateral setae small. Mesoscutum transversely striate laterally and with scale-like sculpture (modified hexagonal sculpture) medially. Metanotum with a median triangular scutum, Figure 2, containing nearly 24 scalelike markings. Fore wings with costa bearing 38 setae, anterior vein bearing 33 setae, posterior vein bearing 27 setae, scale with 6 inner marginal setae.

FIG. 2. *Scutothrips incaensis*, female. Photograph of the metascutum showing scalelike sculpture.

Abdominal tergites I to VII with lateral posterior microtrichia coalesced into platelets. Tergite I lacking median setae, tergites II to V each with a separate group of median microtrichia, tergites VI and VII with median microtrichia extending to lateral plates, tergite VIII with entire posterior margin composed of simple, closely-spaced trichia. Tergites II to VIII with a pair of closely-spaced median setae, becoming wider apart in VII and VIII. Lateral regions of abdominal tergites, except posterior margin, lacking microtrichia. Abdominal sternites II to VI posteriorly with complete row of microtrichia which are fused at base. Abdominal tergite IX with numerous small setae, tergite X with a median posterior slit that is slightly shorter than unsplit basal portion.

Male: Unknown.

Holotype: Female, Machu Picchu, Peru, July 4, 1964, M. and L. Stannard, from blue flower.

This species resembles *peruvianus* but differs in having more setae on the anterior and posterior veins of the fore wing, in having scallops rather

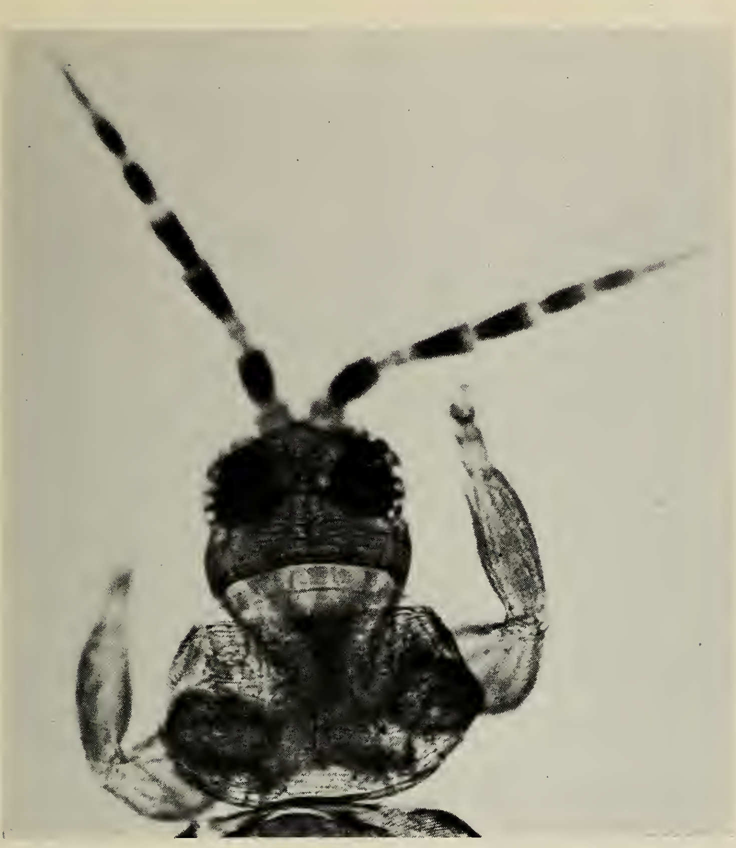


FIG. 3. *Heterothrips bolivianus*, female. Photograph of head and prothorax.

than transverse sculpture in the triangular metascutum, and in having antennal segment IV entirely brown, not yellowish brown basally.

Heterothrips bolivianus new species

Female (macropterous): Length, distended, 1.5 mm. General color light yellowish brown, appearing bright because of intense orange-red subintegumental pigment. Fore margin of head and legs bright yellow. Antennae entirely brown with antennal segment I slightly lighter brown. Fore wings brown except small spot near base, much as in *sericatus* Hood. Hind wing colorless with brown median streak or line. Body setae brown on brown surfaces, yellow to colorless at margins or on yellow surfaces. Wing cilia brown.

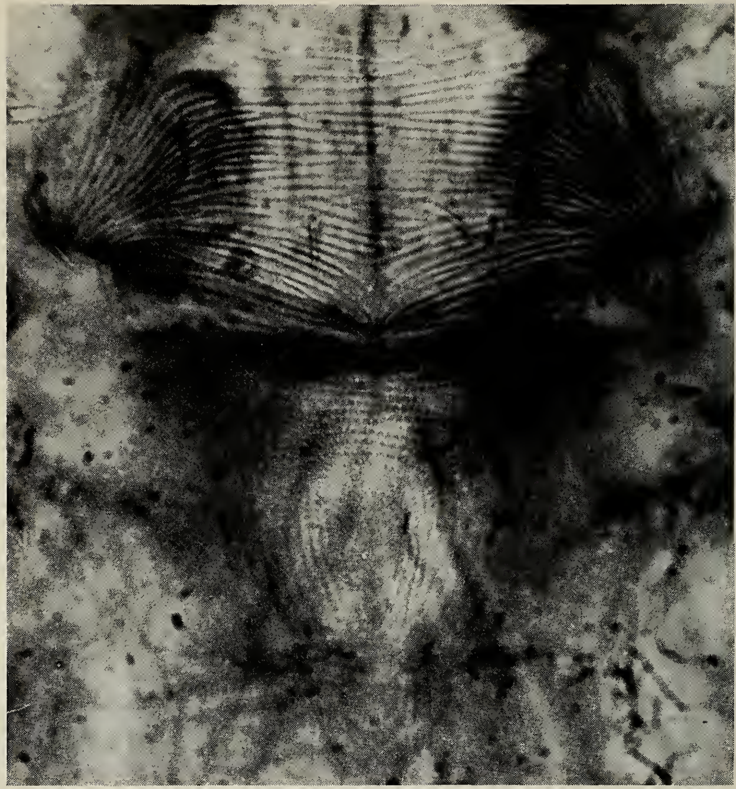


FIG. 4. *Heterothrips bolivianus*, female. Photograph of meso- and metascuta.

Head, Figure 3, with cheeks roundly curved, with about 5 to 6 lines of sculpture posteriorly. Maxillary palps 3 segmented. Antennal segments III and IV each with a circumapical band of small circular sensoria more or less arranged in a single row. Antennal segments VII to IX together longer than VI.

Pronotum subequal in length to head length, closely transversely striate with about 38 lines which occasionally anastomose, and with numerous small setae. Mesoscutum with close transverse striae, metascutum, Figure 4, with concentric closely-spaced sculpture typical of genus. Fore tarsi each with cocoon-breaking hooks. Fore wings with costa bearing 36 setae, anterior vein bearing 32 setae, hind vein bearing 26 setae, and inner margin of scale bearing 6 setae.

Abdominal tergites I to VIII with all posterior microtrichia separate, not coalesced at base. Tergite I lacking median posterior microtrichia, tergites II to V with median portions bearing about 10 or so microtrichia and tergites IV to VIII with trichial fringe extended completely across segments. Lateral margins of tergites I to IX with microtrichia. Tergite X with microsetae on the median portion, apical slit shorter than basal unsplit portion. Most abdominal sternites with posterior fringe of microtrichia complete.

Male (*macropterous*): Length, distended slightly, over 1.0 mm. General color and structure similar to female, except for terminalia. Testes orange in color. Sternites lacking glandular areas.

Holotype: Female, Coroico, Bolivia, June 28, 1964, M. &. L. Stannard, from flowers of tree at edge of town. *Allotype*: Male, same data as for holotype. *Paratypes*: 2 females, same data as for holotype.

This yellowish-brown species differs from the other yellow-colored, South American species in having the antennae wholly brown. In the color of the wings, almost entirely brown except for a minute subbasal spot, ***bolivianus*** resembles *sericatus*. The latter species has much more closely spaced striae, about 62 lines, on the pronotum as compared to 38 or so lines in ***bolivianus*** and in having 8 inner setae on the fore wing scale as compared to 6 inner setae in ***bolivianus***.

Heterothrips julius new species

Female (*macropterous*): Length, distended, 1.3 mm. General color dark brown. Apex of fore femora, base and apex of all tibiae and all tarsi yellow, rest of legs brown. Antennal segments I, II, and all of III except apex yellow, segments IV to IX brown. Subintegumental pigment red. Fore wings brown except for moderately sized subbasal white area, hind wings pale with median brown streak. Body setae brown to yellow.

Head, Figure 5, with cheeks slightly curved, dorsally with about 7 posterior, transverse striae. Antennal segments III and IV each with a circumapical band of small circular sensoria arranged in 2 rows. Antennal segments VII to IX together longer than VI.

Pronotum longer than head, nearly smooth, with relatively moderately sized setae. Mesoscutum with close transverse striae, metascutum with concentric closely spaced sculpture typical of genus. Fore tarsi each with cocoon-breaking hooks. Fore wings with costa bearing 36 setae, fore vein with 36 setae, hind vein with 26 setae, and inner margin of scale with 8 setae.

Abdominal tergites I to VIII with all posterior marginal microtrichia separate, not coalesced at base. Tergites I to V with posterior medium portion bare or with only a few trichia. Tergites VI to VIII with posterior marginal trichia complete. Lateral margins of all tergites and median portions of tergite VIII to X with microtrichia. Abdominal segment X elongate, pointed, dorsum with apical split less than ⅓ the length of the segment.

Male: Unknown.

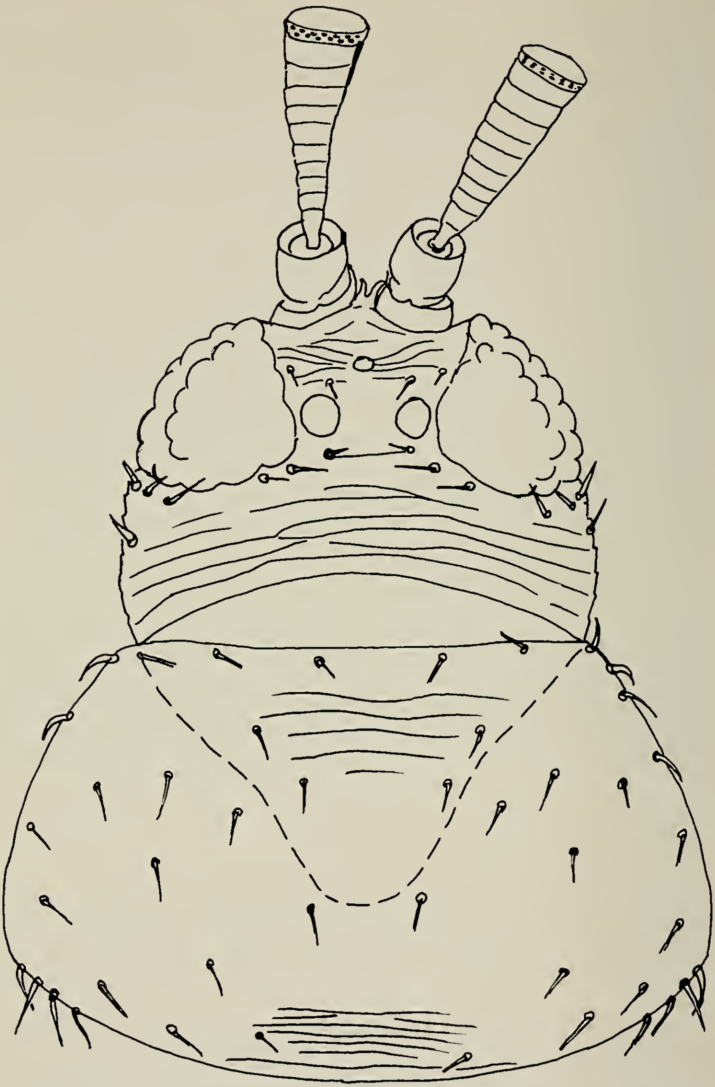


FIG. 5. *Heterothrips julius*, female. Head and prothorax, dorsal aspect.

Holotype: Female, Machu Picchu, Peru, July 5, 1964, M. & L. Stannard, beaten from vegetation along Rio Urubamba.

This species is distinguishable from the known brown South American species by the pale coloration of both antennal segments I and II. It is apparently closest in structure to *H. minor* Hood from Panama, differing from that species by having more setae on the wing veins and in having antennal segment II yellow, not brown as in *minor*.

ACKNOWLEDGMENTS

My appreciation is expressed to Miss Kellie O'Neill, ARS, Ent., USDA, for the opportunity to see the type of *Aulacothrips dictyotus* Hood and other authentic specimens of *Heterothrips* deposited in the National Museum of Natural History and to Dr. Thomas H. Wilson, INHS, for taking the photographs and Mr. Wilmer Zehr, INHS, for preparing them for publication.

LITERATURE CITED

BAILEY, S. F. AND H. E. COTT. 1954. A review of the genus Heterothrips Hood (Thysanoptera:Heterothripidae) in North America, with descriptions of two new species. Annals of the Entomological Society of America 47(4): 614–635.

Vol. 84, No. 42, pp. 345–358 29 February 1972

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

CYCLOPOID COPEPODS ASSOCIATED WITH TRIDACNIDAE (MOLLUSCA, BIVALVIA) AT ENIWETOK ATOLL[1]

By Arthur G. Humes
Boston University Marine Program and Systematics-
Ecology Program, Marine Biological Laboratory,
Woods Hole, Massachusetts 02543

Four species of cyclopoid copepods have been reported from large sea clams of the genus *Tridacna*. Kossmann (1877) described a new genus and species, *Paclabius tumidus*, from the pericardium (Herzbeutel) of a *Tridacna* at Bohol in the Philippine Islands, but this copepod has not been found again. Three new species of the myicolid genus *Anthessius* were described by Humes and Stock (1965) from the Red Sea and Madagascar: *Anthessius solidus* from *Tridacna squamosa* Lamarck, *Anthessius amicalis* from *Tridacna squamosa* and *Tridacna elongata* Lamarck, and *Anthessius alatus* from *Tridacna noae* (Röding) and *Tridacna squamosa*.

At Eniwetok the same three species of *Anthessius* and a new species of *Lichomolgus* occurred in the mantle cavity of various Tridacnidae.

The specimens reported here were collected by the author and Mr. Charles T. Krebs during field work made possible by the support and facilities of the Eniwetok Marine Biological Laboratory at Eniwetok. The study of the copepods has been aided by a grant (GB-8381X) from the National Science Foundation.

All figures have been drawn with the aid of a camera lucida. The letter after the explanation of each figure refers to the

---

[1] SEP Contr. No. 241.

scale at which it was drawn. The abbreviations used are: A_1 = first antenna, A_2 = second antenna, MXPD = maxilliped, and P_1 = leg 1.

FAMILY MYICOLIDAE YAMAGUTI, 1936

The collections of *Anthessius* made at Eniwetok Atoll, Marshall Islands, in 1969, are listed below. Specimens of the three species have been deposited in the National Museum of Natural History, Washington, and in the Zoölogisch Museum, Amsterdam, as indicated.

Anthessius solidus Humes and Stock, 1965

From *Tridacna squamosa* Lamarck: 3♀♀, 5♂♂, and 2 copepodids from 1 host, length of shell 30 cm, in a depth of 17 m, in lagoon west of beach between Parry (Elmer) I. and Eniwetok I., 10 July (USNM); 1♀, 6♂♂, and 2 copepodids from 1 host, length 30 cm, in 6 m, west of Eniwetok I., 17 July; 2♂♂ from 1 host, length 28 cm, west of Eniwetok I., 17 July; 1♀, 3♂♂, and 1 copepodid from 4 hosts, 12.5, 16, 20, and 29 cm long, in 3 m, south of Parry (Elmer) I., 9 July; 1♀ from 1 host, length 34 cm, in 6 m, west of Eniwetok I., 17 July; 2♀♀ from 1 host, length 32 cm, in 6 m, west of Eniwetok I., 16 July; 1♂ and 2 copepodids from 1 host, length 34 cm, in 6 m, west of Eniwetok I., 17 July.

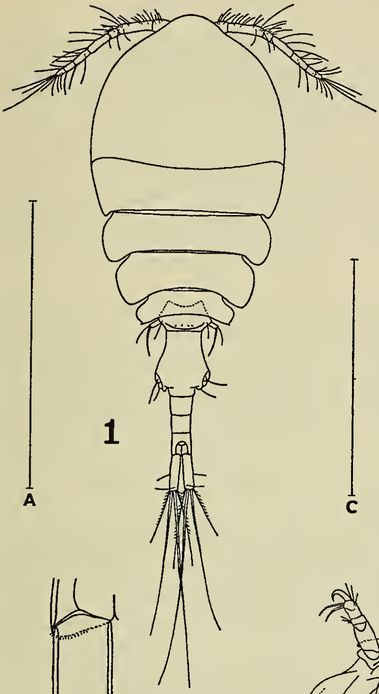
Anthessius amicalis Humes and Stock, 1965

From *Tridacna squamosa*: 21♀♀, 29♂♂, and 2 copepodids from 1 host, length 30 cm, in 17 m, in lagoon west of beach between Parry (Elmer) I. and Eniwetok I., 10 July (USNM); 14♀♀, 33♂♂, and 5 copepodids from 1 host, length 30 cm, in 6 m, west of Eniwetok I., 17 July (ZMA); 3♀♀, 13♂♂, and 4 copepodids from 1 host, length 28 cm, in 6 m, west of Eniwetok I., 17 July; 3♀♀, 20♂♂, and 3 copepodids from 4 hosts, 12.5, 16, 20, and 29 cm long, in 3 m, south of Parry (Elmer) I., 9 July; 8♀♀, 11♂♂, and 1 copepodid from 1 host, length 34 cm, in 6 m, west of Eniwetok I., 17 July; 1♀ and 2♂♂ from 1 host, length 32 cm, in 6 m, west of Eniwetok I., 16 July; 4♀♀, 5♂♂, and 1 copepodid from 1 host, in 3 m, western end of Bogen (Rex) I., 23 June; 4♀♀, 1♂, and 3 copepodids from 1 host, length 34 cm, in 6 m, west of Eniwetok I., 17 July.

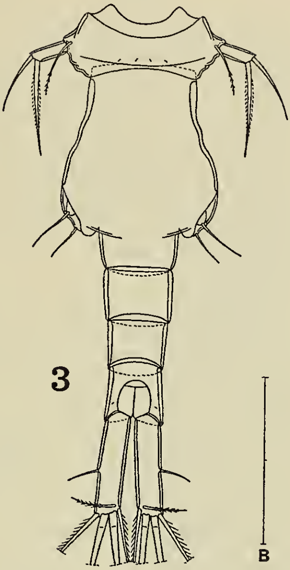
From *Hippopus hippopus* (Linnaeus): 1♀ from 1 host, length 27.5 cm, in 1 m, Runit (Yvonne) I., 19 July.

→

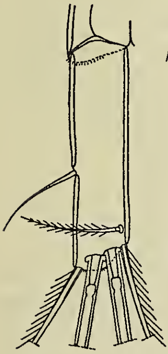
FIGS. 1–6. *Lichomolgus tridacnae* new species, female: 1, dorsal (A); 2, lateral (A); 3, urosome, dorsal (B); 4, area of attachment of egg sac, lateral (C); 5, caudal ramus, dorsal (D); 6, egg sac, dorsal (A). Scale A = 1.0 mm, B = 0.2 mm, C = 0.1 mm, and D = 0.1 mm.



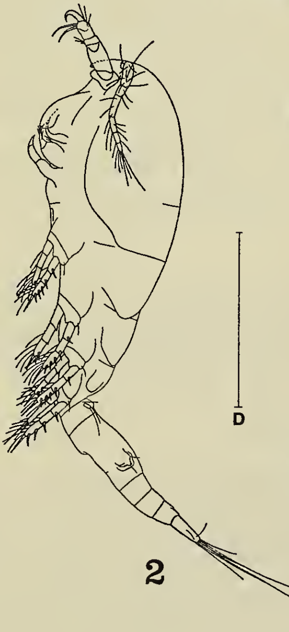
1



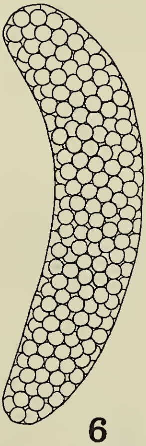
3



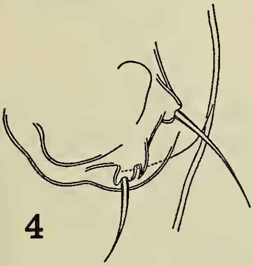
5



2



6



4

Anthessius alatus Humes and Stock, 1965

From *Tridacna squamosa*: 1♀, 2♂♂, and 3 copepodids from 4 hosts, 12.5, 16, 20, and 29 cm long, in 3 m, south of Parry (Elmer) I., 9 July (ZMA); 2♂♂ from 1 host, length 30 cm, in 6 m, west of Eniwetok I., 17 July; 2♀♀ and 4♂♂ from 1 host, length 28 cm, in 6 m, west of Eniwetok I., 17 July (USNM); 2♂♂ from 1 host, length 34 cm, in 6 m, west of Eniwetok I., 17 July; 1♂ from 1 host, length 32 cm, in 6 m, west of Eniwetok I., 16 July; 2♀♀, 1♂, and 2 copepodids from 1 host, in 3 m, western end of Bogen (Rex) I., 23 June; 1♀ and 1 copepodid from 3 hosts, each 10 cm long, in 3 m, north of Sand I., near Eniwetok I., 8 July.

From *Tridacna maxima* (Röding): 1♂ from 1 host, length 20 cm, in 2 m, western side of reef on northern end of Muti (David) I., 29 June; 1♂ from 2 hosts, both 10 cm long, in 3 m, southern end of Parry (Elmer) I., 5 July; 1♀ and 1♂ from 2 hosts, 11.5 and 13.5 long, in 3 m, Runit (Yvonne) I., 12 July; 1♀ and 1♂ from 1 host, length 18.5 cm, in 5 m, west of Eniwetok I., 16 July.

From *Tridacna gigas* (Linnaeus): 14♂♂ from 1 host, length 41 cm, in 3 m, west of Eniwetok I., 11 July.

New hosts are: *Hippopus hippopus* for *Anthessius amicalis* and *Tridacna maxima* and *Tridacna gigas* for *Anthessius alatus*. [A single male *Anthessius amicalis* was recovered from a spondylid bivalve, *Spondylus varius* Sowerby, in 18 m, in the lagoon west of the beach between Parry (Elmer) I. and Eniwetok I., 10 July. This record is regarded as accidental, since all other *A. amicalis* have been found in Tridacnidae.]

FAMILY LICHOMOLGIDAE KOSSMANN, 1877

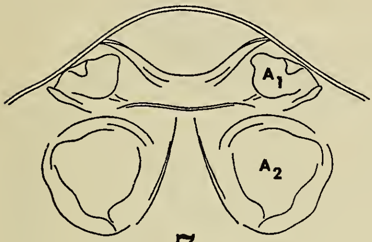
Lichomolgus tridacnae new species

Figures 1–32

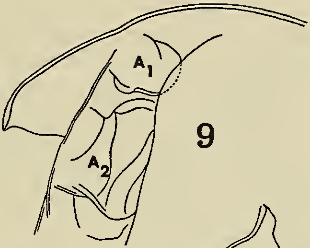
Type material: 10♀♀, 11♂♂, and 2 copepodids from 1 *Tridacna gigas* (Linnaeus), length 41 cm, in 3 m, west of Eniwetok I., Eniwetok Atoll, Marshall Islands, 11 July 1969. Holotype ♀, allotype, and 14 paratypes (6♀♀, 8♂♂) deposited in the National Museum of Natural His-

→

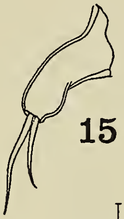
FIG. 7–15. *Lichomolgus tridacnae* new species, female: 7, rostrum, ventral (as seen in entire animal) (E); 8, rostrum, anteroventral (as seen in a dissection) (E); 9, rostrum, lateral (E); 10, first antenna (with the arrow indicating the position of an aesthete added in the male), dorsal (B); 11, second antenna, anterior (inner) (E); 12, tip of geniculate seta on last segment of second antenna, anterior (F); 13, labrum and paragnaths, ventral (C); 14, mandible, anterior (C); 15, first maxilla, anterior (C). Scale E = 0.2 mm and F = 0.02 mm.



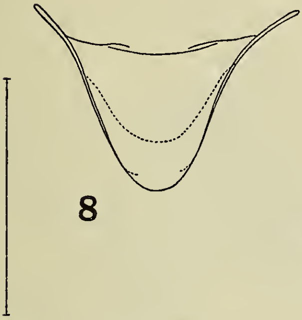
7



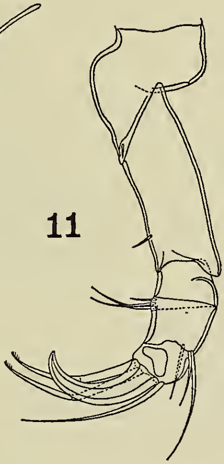
9



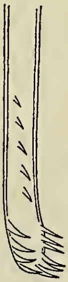
15



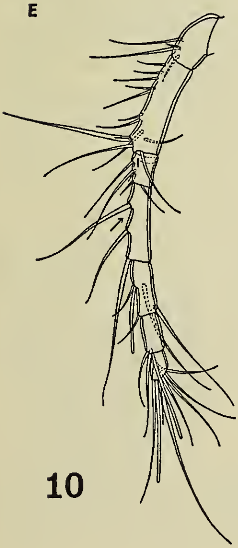
8



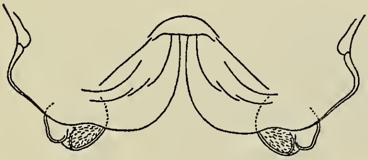
11



12



10



13

14

tory, Washington; the remaining paratypes (dissected) and the copepodids in the collection of the author.

Other specimens: All from Eniwetok Atoll in 1969.

From *Tridacna gigas*: 4♀♀, 4♂♂, and 1 copepodid from 1 host, length 30 cm, in 3 m, west of Eniwetok I., 20 July.

From *Tridacna squamosa* Lamarck: 1 copepodid from 1 host, in 3 m, western end of Bogen (Rex) I., 23 June; 12♀♀ and 8♂♂ from 4 hosts, 12.5, 16, 20, and 29 cm long, in 3 m, south of Parry (Elmer) I., 9 July (USNM); 11♀♀ and 2♂♂ from 1 host, length 30 cm, in 17 m, in lagoon west of beach between Parry (Elmer) I. and Eniwetok I., 10 July (ZMA); 1♀ from 1 host, length 32 cm, in 6 m, west of Eniwetok I., 16 July; 4♀♀ and 1♂ from 1 host, length 34 cm, in 6 m, west of Eniwetok I., 17 July; 1♀ from 1 host, length 34 cm, in 6 m, west of Eniwetok I., 17 July; 6♀♀ and 4 copepodids from 1 host, length 30 cm, in 6 m, west of Eniwetok I., 17 July; 3♀♀ and 2♂♂ from 1 host, length 28 cm, in 6 m, west of Eniwetok I., 17 July.

Female: The body (Figs. 1 and 2) is moderately slender. The length, not including the setae on the caudal rami, is 1.79 mm (1.62–1.86 mm) and the greatest width 0.70 mm (0.67–0.74 mm), based on 10 specimens in lactic acid. The segment of leg 1 is separated from the head dorsally by a transverse furrow. The epimeral areas of the segments of legs 1–4 are as indicated in Figure 1. The ratio of the length to the width of the prosome is 1.56:1. The ratio of the length of the prosome to that of the urosome is 1.72:1.

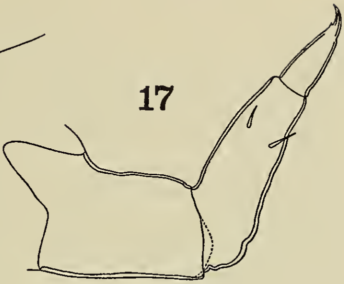
The segment of leg 5 (Fig. 3) is 81 × 205 μ. Between this segment and the genital segment there is no ventral intersegmental sclerite. The genital segment is a little longer than wide, 234 × 216 μ, broadest in its posterior half, with its posterior sixth abruptly constricted. The genital areas are located laterally on the expanded part of the segment. Each area (Fig. 4) bears two naked setae 29 μ and 44 μ with a small spiniform process between them. The three postgenital segments are 73 × 96 μ, 70 × 78 μ, and 73 × 75 μ from anterior to posterior. The anal segment bears on each side a posteroventral row of very small spinules.

The caudal ramus (Fig. 5) is elongated, 140 × 35 μ in greatest dimensions, the ratio being 4:1. The outer lateral seta is 57 μ and naked, the dorsal seta 65 μ and haired, the outermost terminal seta 195 μ with outer spinules, the innermost terminal seta 239 μ with inner spinules, and the two long median terminal setae 560 μ (outer) and 770 μ (inner), both

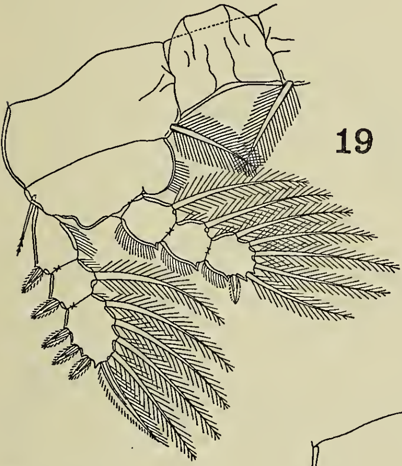
→

Figs. 16–21. *Lichomolgus tridacnae* new species, female: 16, second maxilla, posterior (C); 17, maxilliped, inner (C); 18, area between maxillipeds and first pair of legs, ventral (B); 19, leg 1 and intercoxal plate, anterior (E); 20, leg 2 and intercoxal plate, anterior (E); 21, endopod of leg 3, anterior (E).

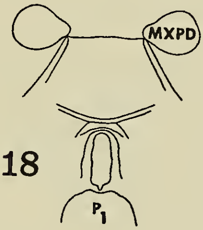
16



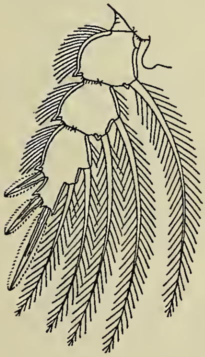
17



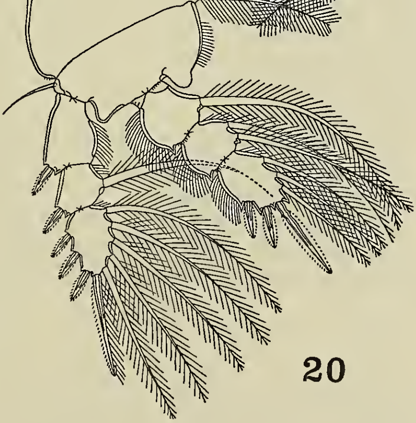
19



18



21



20

naked and both inserted dorsally to a small ventral flap with minute spinules.

The dorsal surface of the prosome and the dorsal and ventral surfaces of the urosome have very few hairs (sensilla).

The large egg sac (Fig. 6) is elongated, 500 × 100 μ, reaches well beyond the tips of the ramal setae, and contains many small eggs about 62 μ in diameter.

The rostrum in a ventral view of the whole animal appears as a broad lobe (Fig. 7), but in a dissected specimen it is subtriangular and linguiform (Fig. 8). In lateral view it projects noticeably (Fig. 9).

The first antenna (Fig. 10) is seven segmented and 455 μ long. The lengths of the segments (measured along their posterior nonsetiferous margins) are: 22 (72 μ along its anterior margin), 112, 35, 91, 68, 44, and 33 μ respectively. The formula for the armature is 4, 13, 6, 3, 4 + 1 aesthete, 2 + 1 aesthete, and 7 + 1 aesthete. All the setae are naked.

The second antenna (Fig. 11) is four segmented, with the fourth segment 85 μ along its outer edge, 48 μ along its inner edge, and 52 μ wide, bearing distally a recurved claw 99 μ along its axis and five setae, two of them geniculate and provided apically with spinules as in Figure 12. The first and second segments bear a small seta. The third segment carries three setae.

The labrum (Fig. 13) has two broad posteroventral lobes. The mandible (Fig. 14) has a long slender blade armed with spines along one side and with slender spinules along the other. The paragnath (Fig. 13) is a small lobe with fine spinules. The first maxilla (Fig. 15) has two setae. The second maxilla (Fig. 16) has an unarmed first segment. Its second segment carries a minute setule on its proximal postero-outer surface, a surficial posterior naked seta, and an inner distal spine with unilateral spinules, and terminates in a long slender lash borne nearly at a right angle to the two segments and having graduated spinules along the outer edge. The maxilliped (Fig. 17) is three segmented, the first segment unarmed, the second with two small naked setae, and the third terminating in a recurved clawlike process near the base of which there is a minute thorn.

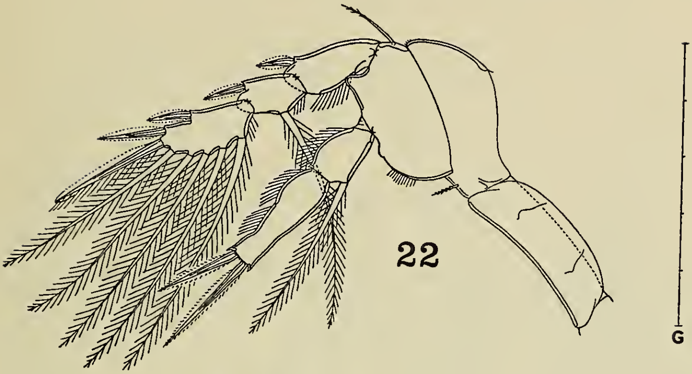
The area between the maxillipeds and the first pair of legs (Fig. 18) is only slightly protuberant (Fig. 2); a weakly sclerotized line connects the bases of the maxillipeds.

Legs 1–4 (Figs. 19, 20, 21, 22) have trimerous rami except for the endopod of leg 4 which is two segmented. The armature is as follows (the Roman numerals indicating spines, the Arabic numerals setae):

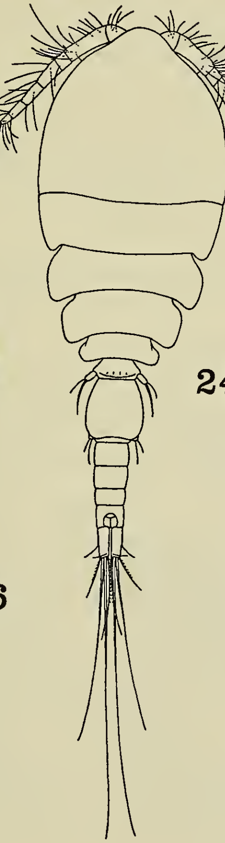
→

Figs. 22–23. *Lichomolgus tridacnae* new species, female: 22, leg 4 and intercoxal plate, anterior (E); 23, leg 5, dorsal (D).

Figs. 24–26. *Lichomologus tridacnae* new species, male: 24, dorsal (G); 25, lateral (G); 26, urosome, dorsal (E). Scale G = 0.5 mm.

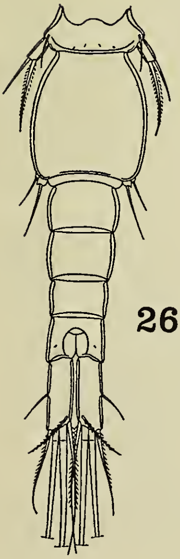


22

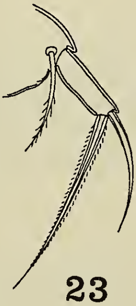


24

25



26



23

P_1	coxa	0–1	basis	1–0	exp	I–0;	I–1;	III,I,4
					enp	0–1;	0–1;	I,5
P_2	coxa	0–1	basis	1–0	exp	I–0;	I–1;	III,I,5
					enp	0–1;	0–2;	I,II,3
P_3	coxa	0–1	basis	1–0	exp	I–0;	I–1;	III,I,5
					enp	0–1;	0–2;	I,II,2
P_4	coxa	0–1	basis	1–0	exp	I–0;	I–1;	II,I,5
					enp	0–1;	II	

The inner coxal seta on legs 1–3 is long and plumose, but on leg 4 is short (22 μ) and finely barbed. The inner margin of the basis in all four legs bears a row of hairs. The outer spines on the exopod of leg 1 are fringed with stronger lateral spinules than in the succeeding legs. The exopod of leg 4 is 205 μ long. The first segment of the endopod is 52 × 41 μ, with its inner distal plumose seta 122 μ. The second segment is 105 μ long including the terminal processes, 32 μ in greatest width, and 18 μ in least width, with its outer margin irregular. The two terminal fringed spines are 72 μ (outer) and 100 μ (inner). Both segments have hairs along the outer margin, those on the second segment in two groups.

Leg 5 (Fig. 23) has a small unornamented free segment 41 × 15 μ bearing two terminal elements, one a slender naked seta 72 μ, the other a stouter fringed seta 112 μ. The seta on the body near the insertion of the free segment is 50 μ and haired.

Leg 6 is represented by the two setae on the genital area (Fig. 4).

Living specimens in transmitted light are translucid, the eye red, the egg sacs opaque gray.

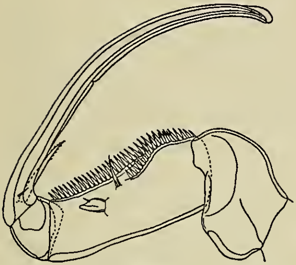
Male: The body (Figs. 24 and 25) resembles in general form that of the female. The length, without the ramal setae, is 0.89 mm (0.84–0.94 mm) and the greatest width 0.31 mm (0.28–0.33 mm), based on 10 specimens in lactic acid. The ratio of the length to the width of the prosome is 1.77:1. The ratio of the length of the prosome to that of the urosome is 1.66:1.

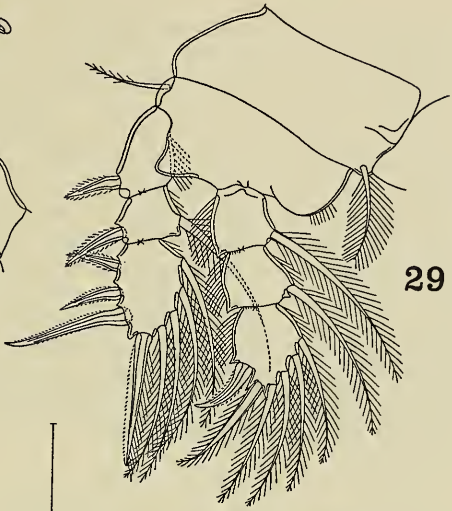
The segment of leg 5 (Fig. 26) is 31 × 81 μ. There is no ventral intersegmental sclerite. The genital segment is 104 × 94 μ, only slightly expanded laterally. The four postgenital segments are 39 × 56 μ, 39 × 52 μ, 31 × 45 μ, and 36 × 47 μ from anterior to posterior.

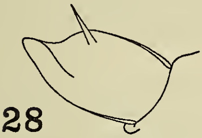
The caudal ramus resembles that of the female but is shorter, 60 × 21 μ, with the ratio being about 3:1.

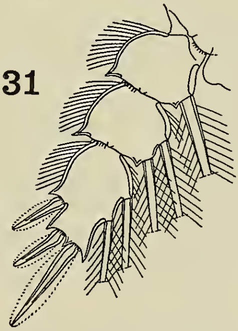
→

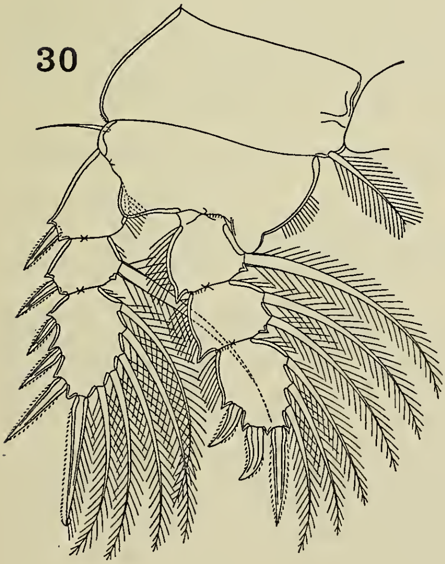
FIGS. 27–32. *Lichomolgus tridacnae* new species, male: 27, maxilliped, antero-inner (D); 28, modified seta on second segment of maxilliped, antero-inner (F); 29, leg 1, anterior (C); 30, leg 2, anterior (C); 31, endopod of leg 3, anterior (C); 32, leg 6, ventral (H). Scale H = 0.05 mm.

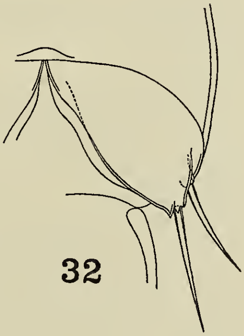

27


29


28


31


30


32

The body surface is very lightly ornamented as in the female.

The rostrum is like that of the female.

The first antenna resembles that of the female, but an aesthete is added on the fourth segment (at a point indicated by the arrow in Figure 10), so that the formula is 4, 13, 6, 3 + 1 aesthete, 4 + 1 aesthete, 2 + 1 aesthete, and 7 + 1 aesthete. The second antenna is similar to that of the female, but the third segment has four setae (three long and one short) instead of three as in that sex.

The labrum, mandible, paragnath, first maxilla, and second maxilla are like those of the female. The maxilliped (Fig. 27) is four segmented (assuming that the proximal part of the claw represents a fourth segment). The first and third segments are unarmed; the second segment bears two setae, one of them highly modified (hyaline and flattened) as in Figure 28, and two rows of spines. The claw is 195 μ along its axis including the small terminal lamella, shows on the concave edge a weak interruption in the narrow lamella, and bears proximally two very unequal elements.

The area between the maxillipeds and the first pair of legs is like that of the female.

Legs 1–4 are segmented as in the female, with the same spine and setal formula as in that sex. In leg 1 (Fig. 29) the outer exopod spines are longer than in the female, the distal one much longer than the proximal four; the last endopod segment shows slight sexual dimorphism in that the spine is stouter and more heavily sclerotized and the seta adjacent to it is stout and almost spinelike. In leg 2 (Fig. 30) the distalmost outer exopod spine is longer than the preceding spines and on the last endopod segment the outer spine and the outer terminal spine are recurved and more strongly sclerotized. Leg 3 is much like that of the female, but the proportions of the last endopod segment are different (Fig. 31). Leg 4 is similar to that of the female.

Leg 5 resembles that of the female, but the free segment is smaller, 21 × 9 μ.

Leg 6 (Fig. 32) consists of a posteroventral flap on the ventral surface of the genital segment bearing two naked setae 32 μ and 24 μ.

Etymology: The specific name is the genitive form of the generic name of the host.

Useful diagnostic features of *Lichomolgus tridacnae* in the female are the shape of the genital segment and in the male the modified seta on the second segment of the maxilliped. In both sexes the peculiar spinulose tips of the two geniculate setae on the last second antennal segment are distinctive.

Comparison with related species: There are seven species of *Lichomolgus* which live in the mantle cavity of bivalve mollusks and which, like the new species, have a mandible with a slender base merging gradually into a long slender attenuated pectinate lash. Two of these, *L. leptodermatus* Gooding, 1957, and *L. elegantulus* Stock, 1960, have more than one claw on the second antenna. The remaining five, *L. arcanus* Humes and Cressey, 1958, *L. asaphidis* Humes, 1959, *L. chamarum*

Humes, 1968, *L. inflatus* Tanaka, 1961, and *L. spondyli* Yamaguti, 1936, have a single claw on the second antenna as in the new species, but in these the genital segment in the female is widest anterior to the middle and the genital openings are located at the middle of the segment rather than posterior to it.

Three species of *Lichomolgus* have a similar mandible, but their true hosts are uncertain. They differ from *L. tridacnae* as follows: both *L. ieversi* Thompson and A. Scott, 1903, and *L. indicus* Ummerkutty, 1962, have two second antennal claws, and *L. minor* A. Scott, 1902, has no claws but instead five setae on the second antenna. The remaining species of *Lichomolgus* which have a slender attenuated mandible inhabit ascidians or cephalopods and all have more than one claw on the second antenna.

Note on occurrence in hosts: In each of four *Tridacna squamosa* all four species of copepods occurred together (*A. solidus*, *A. amicalis*, *A. alatus*, and *L. tridacnae*). Since these copepods were recovered in washings of the entire mantle cavity, their exact microhabitats (if such exist) are unknown.

LITERATURE CITED

GOODING, R. U. 1957. On some Copepoda from Plymouth, mainly associated with invertebrates, including three new species. J. Mar. Biol. Ass. U. K. 36: 195–221.

HUMES, A. G. 1959. Copépodes parasites de mollusques à Madagascar. Mem. Inst. Sci. Madgascar ser. F, 2: 285–342.

———. 1968. Two new copepods (Cyclopoida, Lichomolgidae) from marine pelecypods in Madagascar. Crustaceana, suppl. 1, Studies on Copepoda, pp. 65–81.

——— AND R. F. CRESSEY. 1958. Copepod parasites of mollusks in West Africa. Bull. Inst. Français Afrique Noire 20, ser. A, pp. 921–942.

——— AND J. H. STOCK. 1965. Three new species of *Anthessius* (Copepoda, Cyclopoida, Myicolidae) associated with *Tridacna* from the Red Sea and Madagascar. Bull. Sea Fish. Res. Sta. Haifa 40: 49–74.

KOSSMANN, R. 1877. Entomostraca (1. Theil: Lichomolgidae). *In*: Zool. Ergeb. Reise Küstengeb. Rothen Meeres, erste Hälfte, IV, pp. 1–24.

SCOTT, A. 1902. On some Red Sea and Indian Ocean Copepoda. Proc. Trans. Liverpool Biol. Soc. 16: 397–428.

STOCK, J. H. 1960. Sur quelques copépodes associés aux invertébrés des côtes du Roussillon. Crustaceana 1(3): 218–257.

TANAKA, O. 1961. On copepods associated with marine pelecypods in Kyushu. J. Fac. Agric., Kyushu Univ. 11(3): 249–273.

THOMPSON, I. C. AND A. SCOTT. 1903. Report on the Copepoda collected by Professor Herdman, at Ceylon, in 1902. Rept. Govt.

Ceylon Pearl Oyster Fish. Gulf of Manaar, Suppl. Repts. 7: 227–307.

Ummerkutty, A. N. P. 1962. Studies on Indian copepods 5. On eleven new species of marine cyclopoid copepods from the south-east coast of India. J. Mar. Biol. Ass. India, 1961, 3(1 & 2): 19–69.

Yamaguti, S. 1936. Parasitic copepods from mollusks of Japan, I. Jap. J. Zool. 7(1): 113–127.

Vol. 84, No. 43, pp. 359–370 29 February 1972

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

A NEW SPECIES OF TEMOROPIA (COPEPODA: CALANOIDA) FROM THE SARGASSO SEA[1]

By Georgiana B. Deevey[2]
Institute of Oceanography
Dalhousie University, Halifax, Nova Scotia

Since Thomas Scott (1894) described *Temoropia mayumbaensis* from the Gulf of Guinea a few female specimens whose fifth legs differed from those of typical female *T. mayumbaensis* have been reported from the Atlantic and Pacific Oceans. From 630 and 680 fathoms depth off Ireland and also from a 120 to 0 m vertical haul off New Zealand, Farran (1908, 1929) obtained several such specimens. Andrew Scott (1909), who found only typical *T. mayumbaensis* in his samples collected in the Pacific on the Siboga Expedition, recognized that Farran's North Atlantic specimens represented "a nearly related species." Farran (1936) finally obtained typical female and male *T. mayumbaensis* in the Great Barrier Reef collections, and then noted that "There seem to be distinct differences, probably of specific value, between the fifth feet of the various forms which have been recorded under this name." In many instances, references in the literature to *T. mayumbaensis* have not been accompanied by figures or descriptions, but typical *T. mayumbaensis* has been documented from the Pacific by A. Scott (1909), Wilson (1942) and Grice (1962), from the Gulf of Guinea (Vervoort, 1965), from the Cariaco Trench in the Caribbean Sea (Legaré, 1964), and from the North Atlantic by Wheeler (1970, Figs. 67–70), who figured females not only of *T. mayumbaensis* but also of *T. minor* new species (Figs. 71–75), the species here described, and noted that exam-

---

[1] Contribution No. 527 from the Bermuda Biological Station. This work was supported by Grant GB-15575 from the National Science Foundation.

[2] Present address: Florida State Museum, Gainesville, Fla.

ination of more specimens might lead to the separation of the two types.

Undocumented *T. mayumbaensis* has been reported from the Atlantic and Indian Oceans from samples collected over a wide depth range between the surface and 4,000 m. It was first recorded from the northwestern Atlantic by Grice and Hart (1962). In the South Atlantic off Brazil, Björnberg (1965) noted that it was most numerous from 100–300 m, but present in samples from 300–500 m and from 500–1,000 m depths. Cervigon and Marcano (1965) recorded its numbers year-round at several depths down to 500 m, and considered it typical of the intermediate levels of the Cariaco Trench. Grice and Hulsemann (1965, 1967) list *T. mayumbaensis* as a contaminant below 500 m, and in their 1965 paper do not give the hauls in which it was present, but Wheeler (1970) states that they "found eight individuals above 1,000 m compared to 46 specimens in tows closing below 1,000 m in the North Atlantic"; they recorded *T. mayumbaensis* in samples from 14 stations in the western Indian Ocean, which were collected over a total depth range of 3,000 to 750 m. Park (1970) listed this species as present in samples from two stations in the Caribbean Sea over depth ranges of 0–500 m and 487–1,900 m. It has also been recorded from the Florida Current (Owre and Foyo, 1967). Hure and di Carlo (1968) found *T. mayumbaensis* rare in the Gulf of Naples, but it was one of the most important bathypelagic forms in their 900–0 m samples at a station in the southern Adriatic near Dubrovnik. Wheeler's (1970) samples, which contained females of both species of *Temoropia*, were collected with closing nets between 2,000 and 4,000 m in the North Atlantic.

Judging from the published collection data, the overall possible depth range of verified specimens of *T. mayumbaensis* is from the surface to 4,000 m. It has been reported from samples collected 0–100 m (Wilson, 1942; Vervoort, 1965), 0–150 m (Grice, 1962), 0–500 m (Legaré, 1964), 0–600 m (Farran, 1936), 0–1536 m (A. Scott, 1909), and 2,000–4,000 m (Wheeler, 1970). *T. minor* new species as evidenced by published figures of the female fifth legs, has also been collected from the upper 120 m in the South Pacific off New Zealand (Farran, 1929), from 630 and 680 fathoms depth in the North Atlantic off Ireland (Farran, 1908), and from between 2,000 and 4,000 m in the Atlantic (Wheeler, 1970). Both species appear to have a wide depth range.

In a study of monthly plankton samples collected over four depth intervals between the surface and 2,000 m at Station "S", 32°10′N, 64°30′W, in the Sargasso Sea off Bermuda, specimens of *Temoropia* have been found year-round in small numbers throughout the 2,000 m water column. Since Grice and Hulsemann consider *T. mayumbaensis* a contaminant below 500 m, and since specimens of *Temoropia* were present in almost all the quantitative counts over the entire water column, special attention has first been centered on *Temoropia*, although many other taxonomic problems have also been encountered. The first most noticeable fact was a difference in size, the specimens from the upper waters being much larger. The larger specimens proved to be typical *T. mayumbaensis* Scott. The smaller form, *T. minor* new species, is easily distinguished from *T. mayumbaensis* on the basis of size, the shape of the rostrum, the fifth legs of both sexes, and the symmetry or asymmetry of the female genital segment and fifth legs.

Temoropia minor new species

Figures 1b, d-f; 2b-d, g, h; 3 and 4; 5b-f, l, k; 6B-D

Temoropia mayumbaensis—G. P. Farran, 1908, p. 59, Pl. VI, Figs. 9–15; 1929, p. 257, Fig. 22.—E. H. Wheeler, Jr., 1970, p. 12, Figs. 71–75 [part].

Types: Male and female paratypes will be deposited in the Smithsonian Institution.

Locality: 32°10′N, 64°30′W in the Sargasso Sea.

Occurrence: Year-round, depth range 500–2,000 m.

Diagnosis: Female: Head rounded, double rostrum wide and short, projecting ventrad (Figs. 1b, f; 2b). Head separated from first thoracic segment, fourth and fifth thoracic segments separate, urosome 4-segmented. Genital segment symmetrical in dorsal or ventral view, much swollen ventrally, lacking spines (Fig. 2c, d). Exopodite of second antenna slightly longer than endopodite and of approximately 8 segments (Fig. 3a). Cutting edge of mandible with 8 points (Fig. 3c). Proximal lobe of first maxilla strongly spined (Fig. 3e). Second maxilla with 7 lobes bearing 1, 3, 3, 3, 3, 3, 2 setae respectively (Fig. 3b). Maxilliped

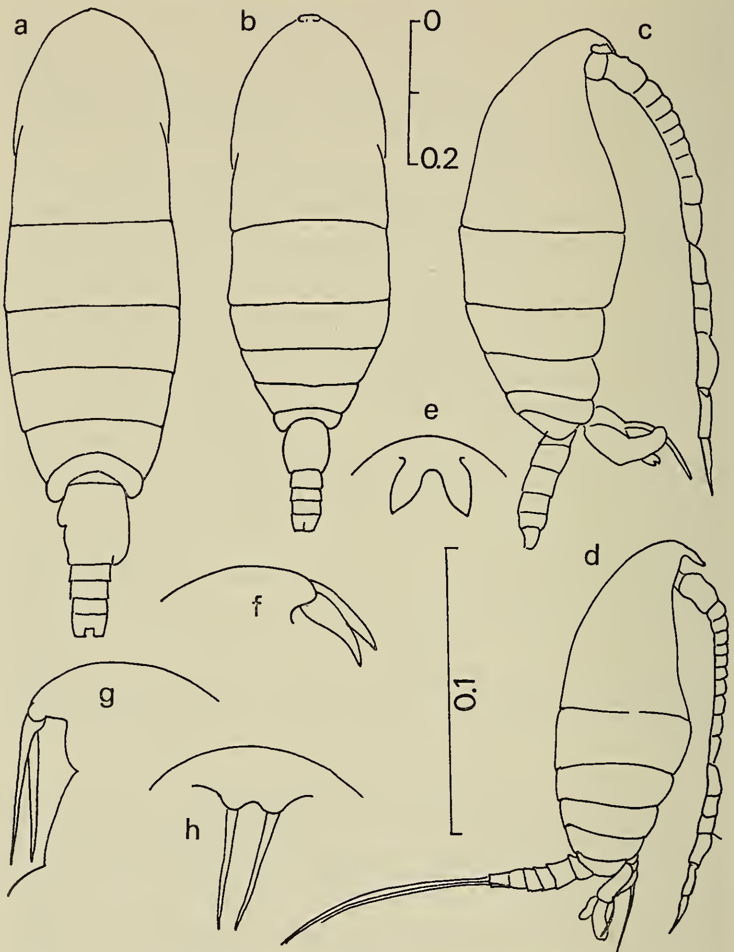


FIG. 1. a, *Temoropia mayumbaensis* female, dorsal view; b, *T. minor* female, dorsal view; c, *T. mayumbaensis* male, lateral view; d, *T. minor* male, lateral view; e, Anterior view of *T. minor* male rostrum; f, *T. minor* female rostrum, lateral view; g, *T. mayumbaensis* female rostrum, lateral view; h, *T. mayumbaensis* male rostrum, anterior view. Scale at top for Figs. a-d, at bottom for Figs. e-h. Scales in mm.

with 2 long terminal spines and characteristically shaped basal segment (Fig. 4i). First leg with 2 endopodal, 3 exopodal segments, with several tiny spines on second and third exopodite segments (Fig. 4c). Second to fourth legs with 3 endopodal and 3 exopodal segments, the second and

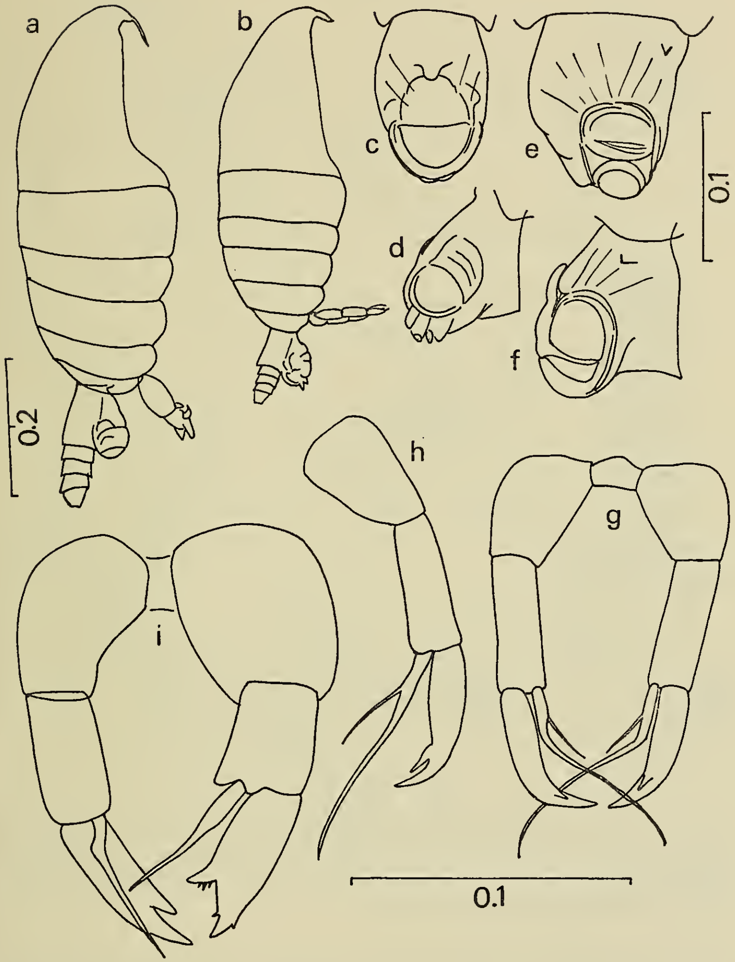


FIG. 2. a, *T. mayumbaensis* female, lateral view; b, *T. minor* female, lateral view; c, Ventral view of *T. minor* female genital segment; d, *T. minor* female genital segment, lateral view; e, *T. mayumbaensis* female genital segment, ventral view; f, *T. mayumbaensis* female genital segment, lateral view; g, Fifth legs of female *T. minor*; h, Another view of female *T. minor* fifth leg; i, Fifth legs of female *T. mayumbaensis*. Scale at left center for Figs. a and b, at top right for Figs. c-f, at bottom for Figs. g-i. Scales in mm.

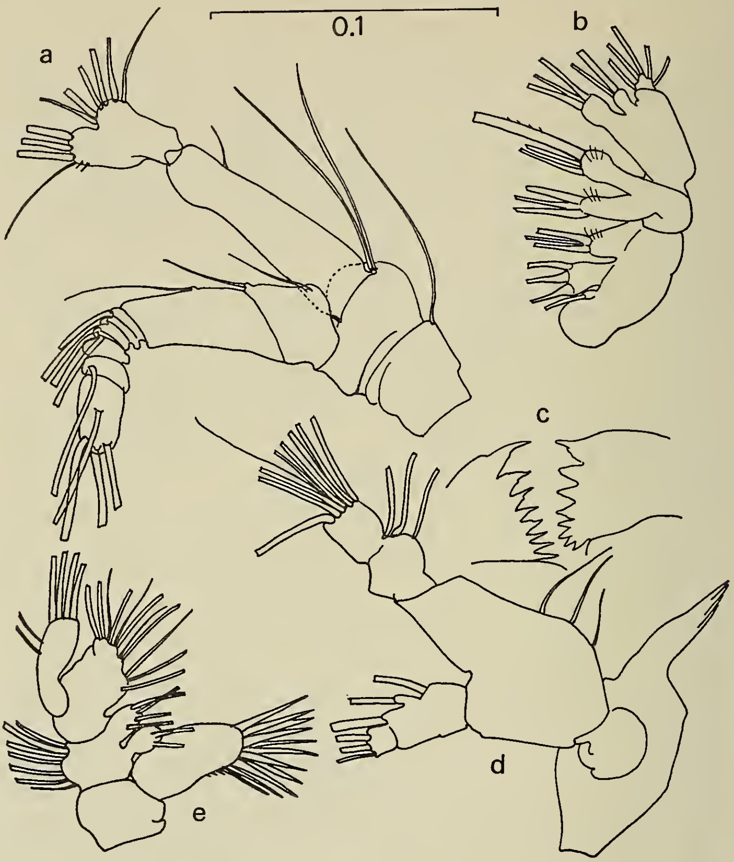


FIG. 3. *T. minor* female. a, Second antenna (most setae cut off); b, Second maxilla (setae cut off); c, Cutting edges of two mandibles; d, Mandible (most setae cut off); e, First maxilla (most setae cut off). Scale at top for Figs. a-e. Scale in mm.

third segments of the endopodite of the second leg not always clearly separated (Figs. 4b, g, h). Spines present on the second endopodal segments, posterior surface, of second to fourth legs, and at least on the second exopodite segment of the first to fourth legs. The strong terminal toothed spine of the third leg curved at tip (Fig. 4h), that of the fourth leg nearly straight (Fig. 4f). Fifth legs symmetrical, of "slender" type (Wheeler, 1970), with 3 segments, last segment forked at tip, longest point external, shorter inner point possibly toothed, long thin rudimentary endopodite (?) present, projecting beyond tip of third segment, forked near its base with a shorter internal seta (Figs. 2g, h).

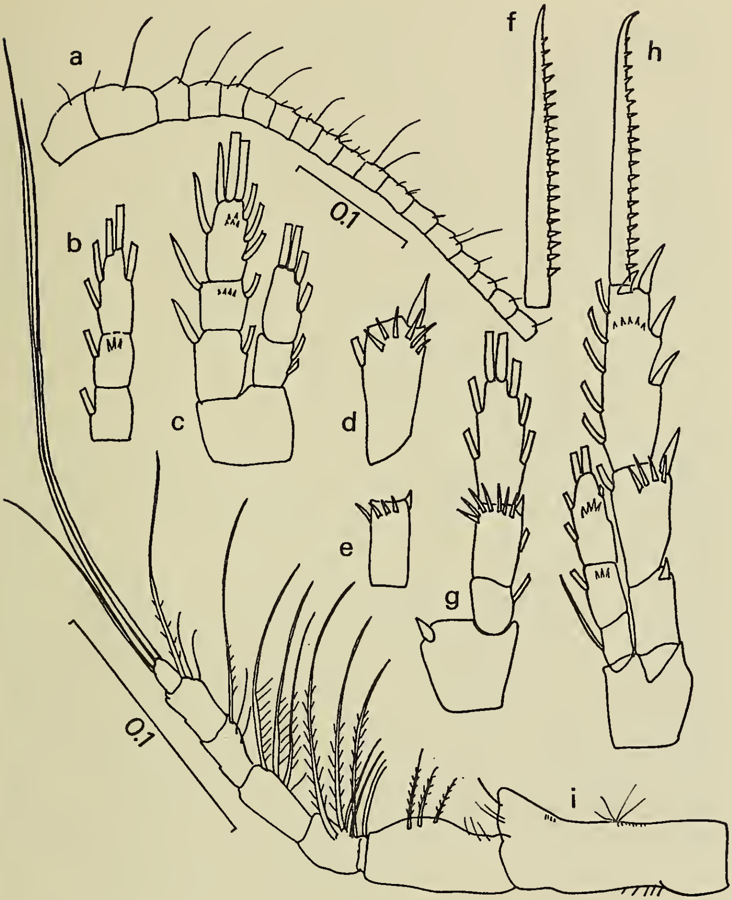


FIG. 4. *T. minor.* a, Male left first antenna, lacking last segments; b, Endopodite of female second leg (setae cut off); c, Female first leg (some spines and setae cut off); d, Second exopodite segment of female fourth leg, posterior surface; e, Second endopodite segment of female fourth leg, anterior surface; f, Terminal spine of third exopodite segment of female fourth leg; g, Endopodite of female fourth leg, posterior surface (setae cut off); h, Female third leg, posterior surface; i, Female maxilliped. Scale below a for Fig. a, at bottom left for Figs. b-i. Scales in mm.

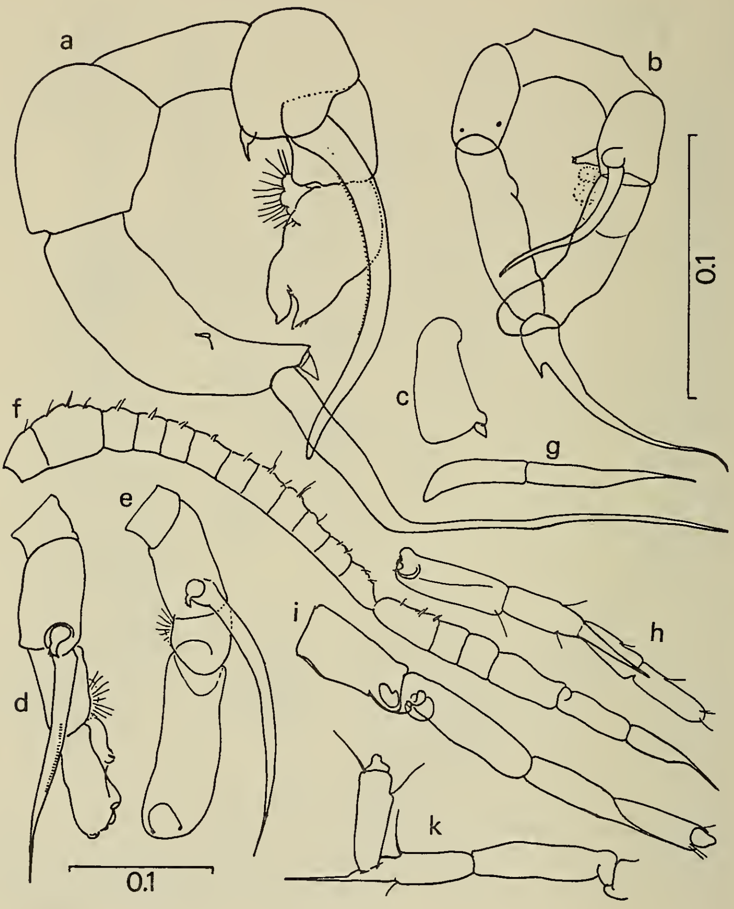


Fig. 5. a, *T. mayumbaensis* male fifth legs; b, *T. minor* male fifth legs; c, First segment of *T. minor* male right fifth leg, showing spine visible in lateral view; d, lateral view of male *T. minor* left fifth leg; e, Inner view of male *T. minor* left fifth leg; f, *T. minor* male right first antenna, lacking last segment; g, Pointed segment near tip of male *T. mayumbaensis* right first antenna; h, Last segments of *T. mayumbaensis* male right first antenna; i, Last segments of *T. minor* male right first antenna; k, Last segments of *T. minor* male right first antenna, last segment partially broken off. Scale at top right for Figs. a-e, g-k, at bottom left for Fig. f. Scales in mm.

Size: 0.67–0.73 mm total length.

Male: Segmentation of body and legs as in female, except that the urosome is 5 segmented (Fig. 1d). Short double rostrum as in female (Fig. 1e). As in the *T. mayumbaensis* male, the right antenna is geniculate, and is constricted between the twelfth and thirteenth and hinged between the sixteenth and seventeenth segments. As figured by Grice (1962, Pl. 20, Figs. 10, 11) for male *T. mayumbaensis*, and as shown in Figures 1c, 1d, and 5f, the right first antenna of most male specimens ends in a sharp point. However, several specimens had another segment beyond this point (Figs. 5i, k) and one male *T. mayumbaensis* had two segments beyond this point (Fig. 5h). Apparently the last one or two segments are easily broken off. Scott (1894, Pl. 8, Fig. 48) figured two segments beyond the sharply pointed segment for male *T. mayumbaensis*, as did Legaré (1964, Pl. 3, Fig. 12a). The total number of segments noted for the *T. minor* male right first antenna is thus 19, for the *T. mayumbaensis* male 20. The male left first antenna has been broken on all specimens examined. Figure 4a shows a male left first antenna with 18 segments, the last one or more segments broken off.

The male fifth legs (Figs. 5b-e) as well as the female's, are slimmer than those of the *T. mayumbaensis* male (Fig. 5a). The right fifth leg consists of a short first segment with a fat inner distal spine visible in lateral view (Fig. 5c), a long second segment, and a long curved distal spine, notched near the base with a small secondary spine (Fig. 5b). The left fifth leg consists of three segments, the second and third indistinctly separated in some views. The first segment has on its inner distal side a fat curved spine, and on its anterior distal side bears a long curved spine, which in some views is seen to have a clear break near the tip (Figs. 5d, e) and to be finely toothed over the center third of its length. The third segment is relatively long and slim in most views, ending bluntly distally, quite unlike this segment in the *T. mayumbaensis* male, which is wide and notched at the tip (Fig. 5a). In some views a transparent swelling protrudes from the third segment (Fig. 5d).

The short caudal rami each have two stout setae, the longer of which is 0.3 mm long (Fig. 1d).

Size: 0.60–0.62 mm total length.

Remarks: Both sexes of *T. minor* may be distinguished from *T. mayumbaensis* by the shape of the rostrum (compare Figs. 1e and f with 1g and h). In the female the symmetrical genital segment and the fifth legs with the long endopodite (?) filament, longer than the third segment, are easily observed. As noted and/or figured by Farran (1936), Grice (1962) and Wheeler (1970), the female *T. mayumbaensis* genital segment has a spine on the left side (Figs. 2e, f), which is lacking on the *T. minor* female genital segment. Also the *T. mayumbaensis* female genital segment is asymmetrical, more swollen on the right side (Figs. 1a, 2e), and the female fifth legs are asymmetrical, the right leg being larger and wider, and the rudimentary endopodite (?) filament is not forked and not longer than the notched third segment.

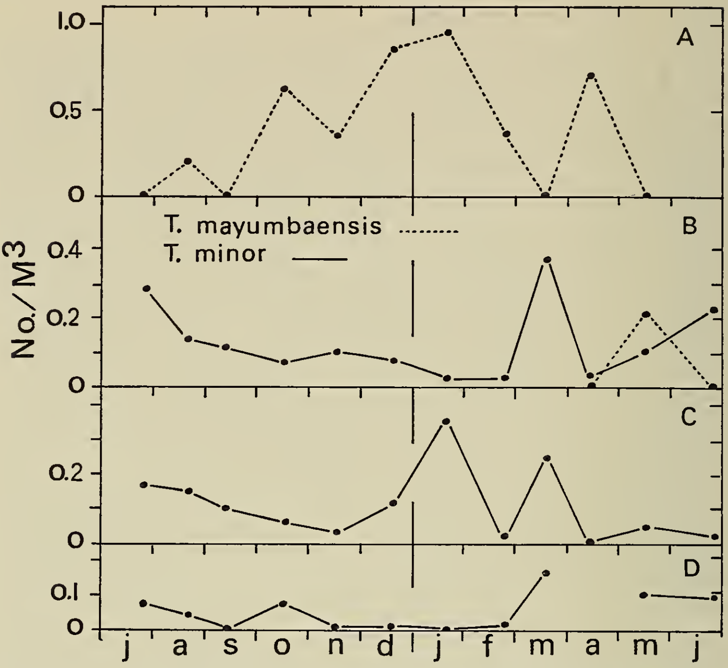


FIG. 6. Numbers per cubic meter from July 1968 to June 1969 of *T. mayumbaensis*, dotted line, and *T. minor*, solid line, for A, 0–500 m; B, 500–1,000 m; C, 1,000–1,500 m; D, 1,500–2,000 m.

It appears to be characteristic of *Temoropia* that the antennae, leg segments and caudal setae are broken off from specimens that otherwise are in good condition. The fifth legs are invariably present, the first legs usually intact, but the exopodite segments in particular of the other legs are usually missing. The female first antenna has apparently never been found intact on either species, although Scott (1894) assumed that in *T. mayumbaensis* females there were probably 22 or 23 segments. Farran (1908) also noted that the antennae and leg segments were missing from his specimens. Fortunately the diagnostic characters that most easily separate the two species, the shape of the rostrum and female genital segment and the fifth legs, are always intact.

At Station "S" female *T. mayumbaensis* are 0.85–0.95 mm long, males 0.78–0.80 mm long. Other reported lengths for females are 0.93 (T. Scott, 1894), 0.94–0.99 mm (Grice, 1962), 0.94 (A. Scott, 1909), 0.70–0.92 mm (Farran, 1936), and 0.990–1.045 mm (Vervoort, 1965), and for males 0.93 mm (Scott, 1894), 0.88–0.92 mm (Grice, 1962), 0.90 mm (Scott, 1909), and 0.84 mm (Farran, 1936). At Station "S", all *T. minor* females are around 0.7 mm long, males around 0.6 mm in length. Farran's (1908, 1929) females were 0.72–0.80 mm long.

VERTICAL DISTRIBUTION OF THE TWO SPECIES

At Station "S" *T. mayumbaensis* has been the only species observed in samples collected in the upper 500 m, and some specimens have been found in samples from the 500–1,000 m depth interval. *T. minor* has been present in almost all of the samples collected between 500 and 2,000 m. Figure 6 shows the total numbers/m^3 of the two species over the four depth intervals, 0–500 m, 500–1,000 m, 1,000–1,500 m, and 1,500–2,000 m, for the year from July 1968 to June 1969. *T. mayumbaensis* had a winter maximum and summer minimum in the upper 500 m (Fig. 6A). *T. minor* was most numerous between 500 and 1,500 m depths, with highest numbers in March between 500 and 1,000 m (Fig. 6B), and in January and March between 1,000 and 1,500 m depths (Fig. 6C). Although the numbers/m^3 are quite small, ranging up to 0.36/m^3 for T. minor, up to 71 specimens/sample were counted; 702 specimens of *Temoropia* were counted in obtaining the numbers/m^3 illustrated in Figure 6.

Since both species have been obtained in deep-water plankton samples on a number of occasions, it is obvious that *Temoropia* is not confined to the upper 500 m. At Station "S" *T. mayumbaensis*, which occurs only in small numbers, is a much less likely contaminant of deep-water samples than the smaller and much more numerous species of *Calocalanus* or *Farranula*, for example. *T. mayumbaensis* is most numerous in the upper waters, but may occur in small numbers below 500 m. *T. minor* has thus far been found only below 500 m at Station "S", and some undocumented reports of *T. mayumbaensis* in deep-water samples may refer to this species. However, this is not the case with Wheeler's samples, since he found both species in closing-net samples from 2,000–4,000 m. Possibly contamination of the deepest plankton tows may occur when the nets pass through the sparsely populated intermediate depths.

GEOGRAPHICAL DISTRIBUTION

The genus *Temoropia* has been recorded from the Atlantic, Pacific, and Indian Oceans, the Mediterranean and Adriatic Seas. *T. minor* is now known from the North Atlantic and the South Pacific off New Zealand, documented *T. mayumbaensis* from the Atlantic and Pacific Oceans.

LITERATURE CITED

BJÖRNBERG, T. K. S. 1965. The study of planktonic copepods in the south west Atlantic. An. da Acad. Brasileira de Ciencias, Vol. 37, supl., p. 219–230.

CERVIGON, F. AND P. J. MARCANO. 1965. Zooplancton. Mem. de la Soc. de Ciencias Nat. La Salle, Vol. 25, No. 70–72, p. 263–287, 32 figs., 17 tables.

Farran, G. P. 1908. Second report on the Copepoda of the Irish Atlantic Slope. Fisheries, Ireland, Sci. Invest., 1906, II. (1908), 104 p., 10 Pl.

———. 1929. Copepoda. Natural History Report. British Antarctic Terra Nova Expedition (Zoology), Vol. 8, No. 3, p. 203–306.

———. 1936. Copepoda. Scientific reports of the Great Barrier Reef Expedition, Vol. 5, No. 3, p. 73–142.

Grice, George D. 1962. Calanoid copepods from equatorial waters of the Pacific Ocean. U.S. Fish and Wildlife Service. Fishery Bulletin 186, Vol. 61, p. 167–246.

——— and A. D. Hart. 1962. The abundance, seasonal occurrence and distribution of the epizooplankton between New York and Bermuda. Ecol. Monogr., Vol. 32, No. 4, p. 287–309.

——— and Kuni Hulsemann. 1965. Abundance, vertical distribution and taxonomy of calanoid copepods at selected stations in the northeast Atlantic. J. Zool., Vol. 146, No. 2, p. 213–262.

——— and ———. 1967. Bathypelagic calanoid copepods of the western Indian Ocean. Proc. U.S. Nat. Mus., Vol. 122, No. 3583, p. 1–67.

Hure, Jure and B. S. di Carlo. 1968. Comparazione tra lo zooplancton del Golfo di Napoli e dell'Adriatico meridionale presso Dubrovnik. Pubbl. Staz. Zool. Napoli, Vol. 36, p. 21–102.

Legaré, J. E. Henri. 1964. The pelagic Copepoda of Eastern Venezuela 1. The Cariaco Trench. Biol. Inst. Oceanogr., Univ. Oriente, Vol. 3, Nos. 1–2, p. 15–81.

Owre, H. B. and Maria Foyo. 1967. Copepods of the Florida Current. Fauna Caribaea No. 1, Crustacea, Part 1: Copepoda. Institute of Marine Science, University of Miami, p. 1–137.

Park, Tai Soo. 1970. Calanoid copepods from the Caribbean Sea and Gulf of Mexico. 2. New Species and new records from plankton samples. Bull. Mar. Sci., Vol. 20, No. 2, p. 472–546.

Scott, Andrew. 1909. The Copepoda of the Siboga Expedition. Part I. Free-swimming, littoral and semi-parasitic Copepoda. Siboga Exped., Monogr. No. 29a, p. 1–323.

Scott, Thomas. 1894. Report on Entomostraca from the Gulf of Guinea, collected by John Rattray, B. Sc. Trans. Linn. Soc. London, Ser. 2, Vol. VI, Zool., p. 1–161, Pls. 1–15.

Vervoort, W. 1965. Pelagic Copepoda. Part II Copepoda Calanoida of the families Phaennidae up to and including Acartiidae, containing the description of a new species of Aetideidae. Atlantide Report No. 8, p. 9–216.

Wheeler, Ellsworth H., Jr. 1970. Atlantic Deep-Sea Calanoid Copepoda. Smithsonian Contrib. Zool., No. 55, p. 1–31.

Wilson, Charles B. 1942. The copepods of the plankton gathered during the last cruise of the Carnegie. Carnegie Inst. Wash. Publ. 536, Sci. Res. Cruise 7 of the Carnegie during 1928–1929 under the command of Capt. J. P. Ault. Biology-I. p. 1–237.

Vol. 84, No. 44, pp. 371–384 29 February 1972

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

A REDESCRIPTION OF *LOPHOGOBIUS CRISTULATUS* GINSBURG (PISCES: GOBIIDAE) WITH NOTES ON *L. CYPRINOIDES* (PALLAS)

By C. E. Dawson
Gulf Coast Research Laboratory
Ocean Springs, Mississippi 39564

The neotropical goby genus *Lophogobius* is represented by *L. cyprinoides* (Pallas) in the western Atlantic and portions of the Panama Canal and by *L. cristulatus* Ginsburg in eastern Pacific waters. Ginsburg (1939) provided an unfigured preliminary diagnosis of the latter species but the intended complete description was never published. With the sole exception of a discussion of its use in breeding experiments (Rubinoff and Rubinoff, 1968), *L. cristulatus* has not been treated in subsequent literature. I here describe and illustrate *L. cristulatus* and provide comparative material on *L. cyprinoides*, its only known congener.

Study material includes specimens deposited in collections of the following institutions: Academy of Natural Sciences of Philadelphia (ANSP), American Museum of Natural History (AMNH), Florida Department of Natural Resources (FSBC), Gulf Coast Research Laboratory Museum (GCRL), Universidad de Costa Rica (UCR), Universidad Nacional Autónoma de México (UNAM) and the Smithsonian Institution (USNM).

Measurements were taken with dial calipers and recorded to the nearest 0.1 mm; except as noted, standard length (SL) is used throughout. Second dorsal and anal fin-ray counts include the anterior spine and the last two segmented rays which are separate to their common base and are counted as one ray; all pectoral rays are counted; vertebral counts are from

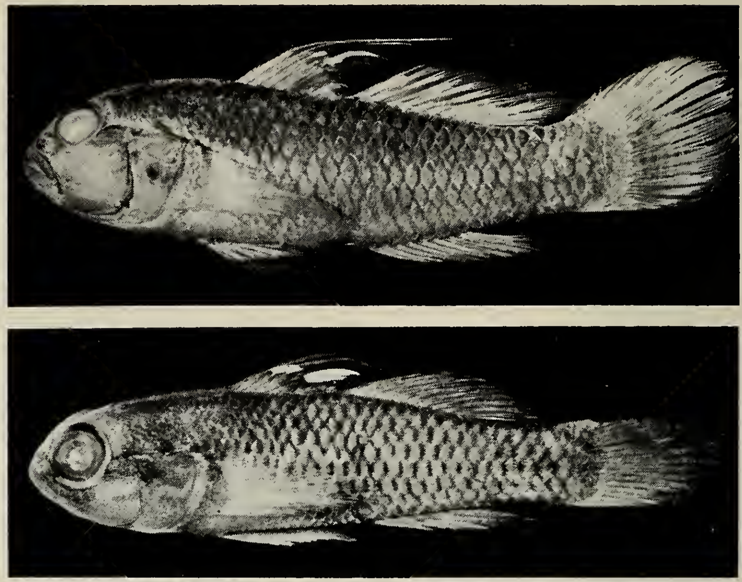


Fig. 1. *Lophogobius cristulatus* Ginsburg. Top: 61.8 mm SL, male (GCRL 3514). Bottom: 25.3 mm SL, female (GCRL 5921).

radiographs. Color descriptions are from recently preserved alcoholic specimens.

Lophogobius cristulatus Ginsburg

Figure 1

Lophogobius cristulatus Ginsburg, 1939: 52–53 (Type-locality: Pacific coast of Panamá, probably on Farfan Beach near Balboa).

Description: Dorsal rays VI–10, anal rays 9 in all specimens examined; selected proportional measurements are given in Table 1.

First dorsal fin with prolonged spines and incised membranes; 2nd spine the longest in both sexes, filamentous in adults, reaches (when depressed) to between the 4th and 5th rays of second dorsal fin in 23–25 mm fish and may extend beyond base of 2nd dorsal fin in 55 mm and larger specimens; the four anterior spines equally spaced, 5th slightly more distant from 4th and the interval between 5th and 6th spines is about 2.4 times that between 3rd and 4th; tips of depressed 2nd dorsal and anal fins reach to or slightly beyond caudal fin base in most specimens over 55 mm SL, usually fall well short of caudal base in small fish. Caudal fin with 17 segmented rays, with 10 procurrent spiniform rays

Table 1. Ranges and means ($\bar{x}$) of selected proportional measurements of *Lophogobius cristulatus* and Caribbean *L. cyprinoides* in percent of standard length or head length (*).

	L. cristulatus					*L. cyprinoides*			
Character	Holotype	Range	$\bar{x}$	Range	$\bar{x}$	Range	$\bar{x}$	Range	$\bar{x}$
Sex	Male	Male		Female		Male		Female	
Number of specimens		12		13		13		14	
Standard length (mm)	55.7	22.9–68.2	50.9	24.4–50.9	33.9	21.6–81.5	43.9	24.6–54.2	35.9
Caudal fin length	–	28.0–31.4	29.6	26.4–31.2	29.6	26.8–35.2	31.0	27.4–33.2	30.5
Caudal peduncle depth	16.5	14.6–16.5	15.7	13.8–16.9	15.4	13.0–18.9	14.7	12.3–15.2	14.1
Depth at anal fin origin	25.1	23.2–26.7	25.1	22.3–25.6	24.4	23.0–32.4	25.9	24.2–27.9	25.8
Predorsal length	36.8	37.1–40.2	38.2	36.8–40.0	38.5	31.9–36.1	34.4	33.2–35.9	34.5
Preanal length	61.9	57.4–61.3	59.5	57.6–60.7	58.9	56.5–62.1	58.5	56.5–59.9	58.3
Pectoral fin length	25.0	25.2–28.8	27.1	25.4–30.0	28.2	28.8–35.4	31.6	29.6–34.5	31.9
Pelvic fin length	21.2	21.0–26.2	23.0	22.6–27.2	24.6	24.0–27.4	25.7	24.8–26.8	25.8
Head length	32.0	31.2–34.1	32.0	31.2–34.7	32.3	30.5–34.4	32.6	31.2–33.8	32.6
Head breadth*	57.9	57.3–67.3	63.2	57.3–68.6	61.2	58.3–83.2	71.1	62.8–76.3	68.2
Eye diameter*	22.5	23.2–29.9	25.7	25.7–31.2	29.0	17.8–30.7	25.0	22.5–29.1	25.8
Snout length*	25.3	19.2–26.2	23.8	16.4–23.2	20.8	18.7–27.1	24.3	20.2–26.0	22.9
Postorbital length*	52.2	49.4–52.5	50.5	44.1–51.9	49.6	49.0–52.3	50.7	49.6–52.8	51.1
Length of gape*	35.4	30.8–38.7	35.6	31.6–35.2	32.6	33.3–41.8	38.2	32.9–39.3	35.8
Length of predorsal crest*	–	65.5–74.1	69.1	63.2–75.9	69.7	57.1–74.8	69.9	65.3–75.5	69.9
Height of predorsal crest*	5.1	3.8– 5.6	4.8	2.0– 5.2	4.0	7.1–17.9	12.0	8.8–14.4	11.6

Table 2. Ontogenetic development of branching in segmented caudal fin-rays of *Lophogobius.* Fin-ray formulae indicate number of simple upper (dorsad) rays + branched rays + simple lower (ventrad) rays; holotype marked.*

Segmented caudal rays	*L. cyprinoides*			*L. cristulatus*		
	N	SL range (mm)	x̄	N	SL range (mm)	x̄
All simple	3	8.3– 9.4	8.8			
5 + 9 + 3	1		9.6			
3 + 11 + 3	1		10.2			
3 + 12 + 2	14	10.0–16.0	13.1			
3 + 13 + 1	1		15.5			
2 + 13 + 2	28	11.6–40.9	18.0			
2 + 14 + 1	105	13.9–66.2	33.3	21	22.9–61.8	38.6
1 + 14 + 2	1		71.4			
1 + 15 + 1	6	43.5–81.5	55.8	3*	50.9–68.2	58.3
2 + 15 + 0	1		48.4			

above and 7 below in one cleared and stained specimen; there are 14 or 15 branched rays in study material (Table 2), usually with two simple, segmented rays above, 14 branched rays and a simple segmented ray below; caudal fin somewhat truncate in small fish, broadly and obliquely rounded with the upper portion slightly the longer in specimens above 30 mm SL. Pelvic fins I,5, united to form an adhesive disc; frenum well developed, disc usually reaches anal fin origin in specimens under 35 mm SL but falls short of anus in larger fish. Pectoral fins narrowly rounded; with 17–20 segmented rays (Table 3), dorsalmost ray usually simple, remainder branched; pectoral fins may reach vertical from 3rd anal fin-ray in the smallest fish but usually fall short of anal fin origin at lengths over 45 mm SL.

Body moderately robust, somewhat compressed, its greatest depth (about 28 percent SL) at pelvic fin insertion; snout and predorsum rounded; interorbital transversely flat, its width averages 12 percent of head length in

Table 3. Frequency distribution of pectoral fin-rays in *Lophogobius cristulatus* and in Atlantic and Pacific populations of *L. cyprinoides.*

Species and locale	Number of rays					x̄
	16	17	18	19	20	
L. cristulatus (*holotype)		2	19	44*	1	18.7
L. cyprinoides						
Atlantic	1	36	260	109	5	18.2
Pacific (Third Lock)		1	28	70	25	19.0

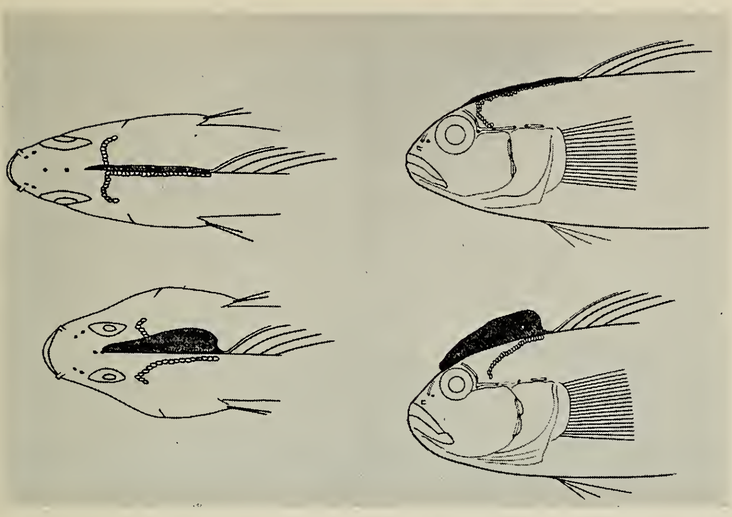


FIG. 2. Delineation of dorsal crest development of adults, lateralis system and extent of predorsal squamation in *Lophogobius.* Top: *L. cristulatus.* Bottom: *L. cyprinoides.*

males and 8 percent of HL in females; body gradually narrows posteriad to caudal peduncle where its depth averages about 57 percent of maximum depth. Gape moderately inclined, its outer posterior angle reaches vertical from anterior margin of pupil in small specimens, reaches middle of pupil in largest specimens; no upper lip frenum; premaxillae slightly protractile; anterior naris with a short tube, posterior naris a simple pore; upper limb of preopercle generally entire, without deep emarginations; gill opening continues forward leaving the posteroventral opercular membrane as a free flap; gill membranes broadly united to isthmus but forming a distinct V-shaped isthmial fold. Jaw teeth in several close-set series, similar in both sexes; each jaw with an outer row of large conical teeth, an inner row of smaller but similar and slightly recurved teeth, with several irregular intermediate rows of small pointed teeth; small intermediate teeth most numerous near symphyses, reduced to one or two rows posteriad; palatines and vomer edentate; tongue truncate to broadly rounded. Lateralis system of head (Fig. 2) well developed, pore complement complete in all study material; three pores in preopercular canal; a pore at each end of supraopercular segment of lateral canal; supraorbital canal with four pores including a pore slightly before and mesial to posterior naris, two shared median pores on interorbital and a posterior pore slightly above midline of eye; single infraorbital pore at terminus of a short anteroventral branch of lateral canal; two pores in lateral canal; one slightly posteriad of upper opercular angle, one about equidistant from infraorbital and posterior suprarobital pores. Predorsum with a low ridgelike median crest beginning near vertical from posterior margin of orbit, well removed from posterior interorbital pore, continuing posteriad to unite with 1st dorsal fin at anterior basal angle of fin; crest without prominent vertical expansion, its height generally subequal throughout. Branchiostegals five; gill arches four, a restricted slit behind 4th; pseudobranchiae present; gill rakers short, poorly developed, $12(3+9)$ in one specimen examined; basihyal narrowly triangular, slightly emarginate in front in cleared and stained 55 mm male; vertebrae 26 (10 abdominal, 16 caudal) in 21 specimens. Scales cycloid on breast and in front of line from 4th or 5th dorsal spine to upper pectoral angle, ctenoid elsewhere; except for naked distal margin of dorsal crest, predorsum and sides of head above opercle are completely covered with small scales to near vertical from just behind posterior supraorbital pore (Fig. 2), usually with one or two irregular rows of small scales continuing upward onto basal half of crest; opercle, preopercle and remainder of head naked; chest scaled forward to fold of gill membranes, scales small in front, larger behind; outer surface of pectoral peduncle scaled, pectoral axil naked; four or five irregular series of small scales on caudal fin base; 26 or 27 lateral scale rows between upper pectoral angle and caudal fin base, nine or 10 (usually nine) rows between anal fin origin and 2nd dorsal fin base.

Coloration brownish in all study material, generally darker in large fish; body without distinctive markings, darkest above, somewhat lighter below; lateral scale pockets posteriorly margined with darker brown. Young fish with an indistinct dark brown mark on posteroventral margin of orbit and about five small dark brown saddles equally spaced along the predorsal crest, but these markings are masked by general darkening in fish larger than 50 mm SL. Three (26–35 mm) specimens (GCRL 6595) had four short, narrow, indistinct brown lines on sides of head; two above the lateral canal and two crossing cheek and preopercle. Basal portion of 1st dorsal fin evenly shaded with brown in large fish but at lengths up to about 50 mm it is light proximad and distinctly darker above (Fig. 3); distal portion of fin with two (occasionally three) pale blotches surrounded by dark brown. The small anterior blotch is usually narrow, extends horizontally from 1st through most of 3rd interradial membrane; the posterior blotch, isolated from its companion by a dark brown streak, extends through 4th and 5th membranes, vertically expanded to near distal margin of 4th; prolonged tips of anterior fin-rays usually light brown.

Second dorsal, anal and paired fins without distinctive markings, generally pale and lightly shaded with tan micromelanophores; caudal fin similar but often marked with faint indications of eight or nine narrow brownish bands.

Distribution and habitat: Lophogobius cristulatus is known only from Pacific Panamá and Costa Rica. The original label was lost and Ginsburg (1939) stated that the holotype "was probably collected on Farfan Beach

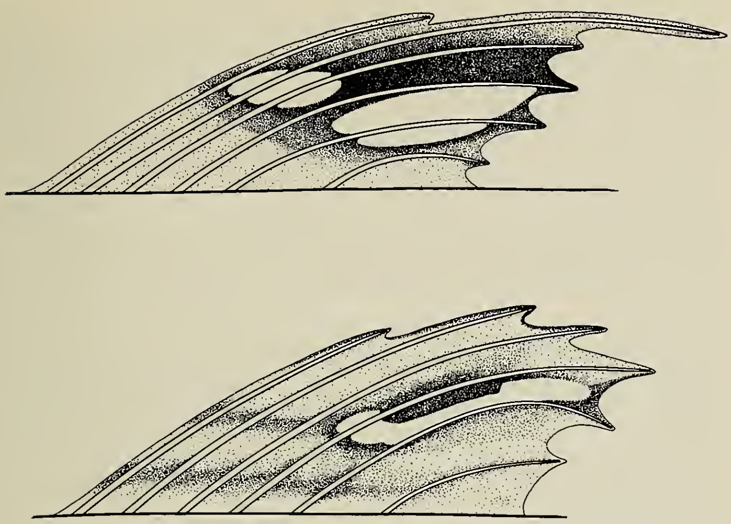


FIG. 3. Delineation of 1st dorsal fin in young (28 mm SL) *Lophogobius*. Top: *L. cristulatus*. Bottom: *L. cyprinoides*.

near Balboa." John E. McCosker and Ira Rubinoff (pers. comm.) have recently collected this species from small tidepools near mangrove clumps at Fort Kobbe Beach, some 4 or 5 miles from the probable type-locality.

In contrast to the relatively open beach habitats reported for Panamanian collections, all Costa Rican specimens have been taken in tidal creeks and pools within a mangrove swamp. Water depths ranged from a few centimeters to a meter or more during a tidal cycle; substrates varied from soft mud to sand. A salinity of 30.5 ‰ was recorded on 25 June 1971, and an abundance of such fishes as *Poeciliopsis*, *Eleotris*, *Evorthodus*, etc. in several collections (1968–71) indicates an estuarine salinity regimen at this locality.

Comparisons: Within studied length ranges, *Lophogobius cristulatus* is separable from *L. cyprinoides* by a number of characters and the most useful of these are given in Table 4. Proportional measurements (Table 1) show predorsal length to be about four percent longer in *L. cristulatus*, the pectoral fin is shorter and the head much narrower than in *L. cyprinoides*. Gape length is somewhat greater in the latter species and the dorsal crest height is from 2 to 3 times that of *L. cristulatus*. Ginsburg (1939), noting 15 branched caudal rays in the holotype of *L. cristulatus*, found 14 branched rays to be most common in *L. cyprinoides* and that 15 branched rays occurred in only two of 55 specimens examined. Counts of segmented caudal rays (Table 2) show the number of branched rays to increase with standard length in *L. cyprinoides* and that 14 branched

Table 4. Principal characters distinguishing species of the goby genus *Lophogobius*.

Character	*L. cristulatus* (23–68 mm SL)	*L. cryprinoides* (10–82 mm SL)
Longest 1st dorsal spine	2nd, prolonged at all sizes, may reach beyond 2nd dorsal fin base in adults.	4th, seldom reaches beyond interspace between 3rd and 4th rays of 2nd dorsal fin.
1st dorsal coloration	With two, sometimes three, pale blotches at all sizes (Figs. 1 and 3).	With one pale blotch in juveniles and young, uniformly shaded in mature fish (Figs. 3, 4 and 5).
Median predorsal crest	Falls well short of posterior interorbital pore; very low throughout.	Usually falls short of posterior interorbital pore and little developed at lengths under 15 mm; impinges on posterior pore, broadly expanded and fleshy at lengths over 20 mm SL.
Predorsal squamation	Reaches vertical from just behind eye, complete, continued on sides of crest.	A subtriangular naked area on either side of crest (Fig. 2); crest naked.
Pectoral fin	Reaches past anal fin origin in smallest fish, usually falls short of anal fin at lengths over 45 mm SL.	Reaches past anal fin origin at all sizes.
General body coloration	Brownish, without distinctive markings at all sizes.	Juveniles and young with variable but distinctive brown stripes and blotches; adults plain, dark grey to near black (Figs. 4 and 5).
Margin of preopercle	Straight.	Emarginate at each preopercular pore at lengths over 25 mm SL.
Angle of gape	Usually reaches past vertical from anterior margin of eye in adults.	Usually falls short of eye in adults.

FIG. 4. *Lophogobius cyprinoides* (Pallas). Top: 34.8 mm, female (GCRL 4455). Bottom: 32.8 mm SL, female (GCRL 4432).

rays is the most frequent number in 14–66 mm *Lophogobius.* Omitting a few aberrant individuals, head pore complement and counts of vertical fin-rays and vertebrae are the same in both species. Pectoral fin-rays are modally 19 in *L. cristulatus*, whereas they are modally 18 in most Atlantic samples of *L. cyprinoides* (Table 3).

Discussion: Although material is limited, it appears that *L. cristulatus* is less variable in coloration and occupies a more restricted geographic range than its congener.

Young *L. cyprinoides*, up to 30–35 mm SL, are typically well marked with brown blotches on the posterior body and with pale stripes anteriad (Fig. 4). These markings become indistinct at lengths of 35–45 mm, and large fish lack the pale blotch on the 1st dorsal fin and all distinctive body markings (Fig. 5). Ground color is usually pale in juveniles but most frequently dark brown in both males and females at lengths greater than 50 mm. Within a single collection there is wide variation of both markings and ground color among specimens of the same size and sex. The ground color tends to be darker in specimens from some localities and the few Campeche specimens, collected over white marl bottom, are pale rather than blotched or dark brown. Breder's (1932) description of *Lophogobius androsensis* from the Bahamas was based on sup-

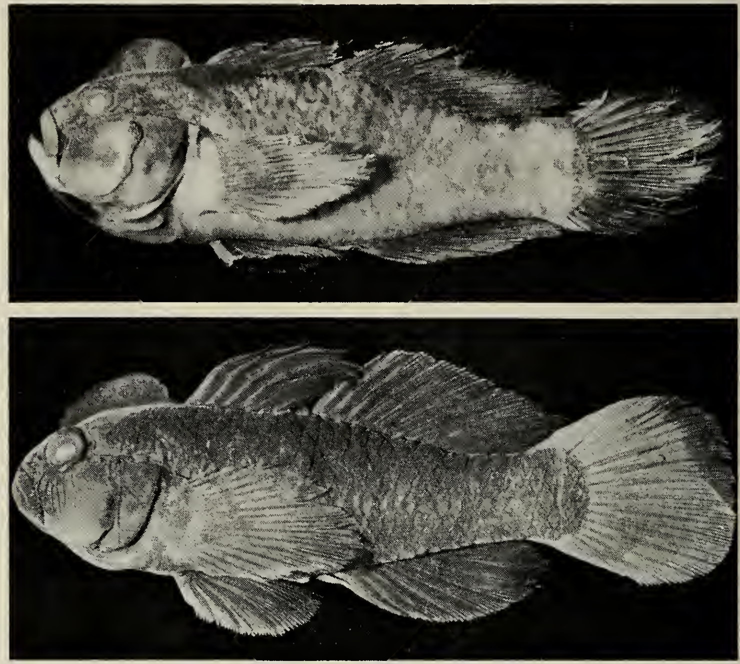


Fig. 5. *Lophogobius cyprinoides* (Pallas). Top: 81.5 mm SL, male (GCRL 2989). Bottom: 59.6 mm SL, male (GCRL 4440).

posed differences in coloration and proportional measurements. The figured holotype clearly represents the striped color phase of *L. cyprinoides* and reported proportional differences are all within its range of variation. The holotype of *L. androsensis* (AMNH 10109) is now largely faded and the 1st dorsal fin is badly frayed. Traces of blotches persist on the posterior body and the remaining distal portion of the 1st dorsal fin is distinctly brown rather than pale as indicated in Breder's figure. Böhlke and Chaplin (1968) were doubtlessly correct in suggesting that *androsensis* is a junior synonym of *cyprinoides*.

Breder (1932) and others state that the dorsal crest fails to reach the 1st dorsal fin in *L. cyprinoides* and the crest has been omitted in some illustrations (Jordan and Evermann, 1900, pl. 326, fig. 786; Cervigón, 1966, fig. 317). Crest development increases with growth of individuals in *L. cyprinoides* and, although variable in ultimate size and shape (Fig. 5), it is continued (posteriad of its greatest expansion) as a low ridge to the dorsal fin in 50 mm and larger fish. At lengths of 10–15 mm the crest is a minute ridge that falls well short of both the posterior interobital pore and the dorsal fin; in most 35 mm and larger fish it originates at or very close to the posterior pore (Fig. 2); the pore was absent in four of 22 large (over 40 mm) specimens and in some fish the crest is laterally deflected and originates slightly in advance of the pore.

Rubinoff and Rubinoff (1968) noted no morphological differences between Atlantic and Pacific populations in their report on the occurrence of *L. cyprinoides* in the Miraflores Third Lock. My data (Table 3) show a distinct modal shift from 18 to 19 in pectoral ray counts between Atlantic and Pacific (Miraflores) populations. The isolated Third Lock habitat did not exist prior to 1941 (Rubinoff and Rubinoff, 1968; Bozniak et al., 1969) and it now supports the only known Pacific population of *L. cyprinoides*. The apparent shift in pectoral ray counts suggests a need for further comparisons between the Panamanian Atlantic form and the recently established Pacific population of this species. It is of interest to note here that *L. cyprinoides* had traversed the Panama Canal several years prior to the construction of the Third Lock. A 35 mm female (USNM 185542) was taken by Dr. A. O. Foster in the east lower chamber of Miraflores Locks on 29 April 1937. This fish was inadvertently included with *Dormitator maculatus* (USNM 109181) from the same sample and was not treated in Hildebrand's (1939) report on these collections.

Lophogobius cyprinoides is widely distributed and locally abundant in estuarine and brackish habitats from Bermuda and south Florida to Venezuela (Cervigón, 1966), but it is unreported in the Gulf of Mexico between Punta Gorda, Florida (Fowler, 1945) and northern México. This hiatus presumably reflects the influence of low winter temperatures frequently experienced throughout most of this portion of the Gulf of Mexico. The species is usually found in protected waters but it also frequents the shores of open bays subject to moderate wave action. In view of its absence from numerous collections by myself and others in a variety of habitats on the Pacific coast of Central America, present information suggests that *L. cristulatus* occupies a restricted niche. More extensive collecting, especially in southern Panamá and northern South America, may result in significant range extensions.

Material examined: Lophogobius cristulatus—PANAMA: USNM 107294 (holotype, 55.7), Pacific coast, probably Farfan beach (label lost), 23 Feb. 1937, S. F. Hildebrand. COSTA RICA: Puntarenas Prov., Mata de Limón, among mangroves, 0.5 km NW of train station: UCR 32–3 (11, 22.9–57.0), 8 May 1966, W. A. Bussing and R. Suarez G. GCRL 3514 (7, 31.4–68.2), GCRL 6011 (1, 50.9, cleared and stained), 16 July 1968, C. E. Dawson. GCRL 6296 (1, 28.2), USNM 205772 (2, 47.0–51.2), 11 June 1969, C. E. Dawson. GCRL 5921 (2, 25.3–41.8), GCRL 6012 (1, 53.6, cleared and stained), 28 May 1970, C. E. Dawson. GCRL 6595 (7, 26.1–53.6), 25 June 1971, C. E. and E. Dawson.

L. cyprinoides—BERMUDA: USNM 74087 (1, 33.2), 1906, L. L. Mowbray. USNM 178165 (2, 43.5–49.6), Castle Harbor, Great Shoals, 20 Oct. 1931, W. Beebe. USNM 178821 (4, 34.9–48.4), Tuckerstown, mangrove lake, 18 Oct. 1931, W. Beebe. USNM 178890 (1, 43.1), Tuckerstown, mangrove lake, 25 July 1934, Adams and Hartley. USNM 197736 (1, 25.4), lakes and ponds, entered USNM catalog 13 Jan. 1963, Haskings. BAHAMAS: AMNH 24938 (1, 29.5), Long Island, Clarence Town, 8 Mar. 1966, C. L. Smith and J. J. Sohn. AMNH 10107 (35.2, holotype of *L. androsensis*), Andros Island, Lake Forsyth, Feb. 1932, Bacon-Andros Expdn. FLORIDA: FSBC 1181 (6, 20.5–45.6), Port Sewall, W shore of St. Lucie estuary opposite Sewall Point, Martin Co., 11 Mar. 1959, V. G. Springer and J. B. Pearce. AMNH 17244 (1, 21.0), Lake Worth, Palm Beach Co., 1946, A. H. Verrill. USNM 48793 (7, 21.7–33.1), USNM 126750 (6, 20.6–43.6), Little River, Dade Co., 28 Oct. 1896, B. W. Evermann and W. C. Kendall. FSBC 1701 (1, 46.0), SW corner of Key Largo Sound, Monroe Co., 5 Mar. 1960, V. G. Springer and A. J. McErlean. CUBA: USNM 4767 (1, 66.2), received from P. Poey in 1863. USNM 35166 (7, 33.3–51.8), Havana, received from D. S. Jordan in 1884. USNM 37485 (1, 62.4), USNM 37509 (1, 71.4), received from P. Poey in 1885. AMNH 3384 (2, 41.8–51.2), Havana harbor, 26 Feb. 1912, J. T. Nichols. USNM 192079 (23, 17.7–41.2), Havana Biltmore Yacht and Country Club, 24 Dec. 1957, B. B. Collette. JAMAICA: USNM 78132 (12, 22.9–36.5), probably Montego Bay, June 1910, C. B. Wilson. HAITI: USNM 120355 (2, 29.4–33.9), Miragoane, 27 Feb. 1943, A. Curtiss. USNM 122650 (4, 29.7–41.9), Miragoane, 17 June 1943, A. Curtiss. USNM 122649 (1, 39.9), Miragoane, 13 Apr. 1944, A. Curtiss. USNM 133744 (1, 45.3), Port-au-Prince, 5 Oct. 1946, A. Curtiss. AMNH 18986 (5, 55.2-64.6), Port-au-Prince, Feb. 1958, A. Curtiss. PUERTO RICO: USNM 123648 (1, 40.5), Rio Piedras, 24 Feb. 1934, S. F. Hildebrand. USNM 144048 (2, 26.5–60.5), Luquillo, creek between Punta Embarcaderos and Punta Monserrate, 11 Feb. and 15 Sept. 1945, D. S. Erdman. USNM 147632 (4, 24.6–58.7), Luquillo, mangrove creek E of Punta Monserrate, 15 Sept. 1948, D. S. Erdman. MEXICO: Tamaulipas—UNAM IB/CML-P239 (1, 47.2), Esterillo Chijoles, Laguna de Tamiahua, 19 Dec. 1966, A. Reséndez. Veracruz—GCRL 2441 (1, 19.6), S side of Laguna Zontecomapan about 1 km from mouth, 1 Sept. 1967, C. E. Dawson and W. A. Abbott. Campeche—GCRL 2989 (3, 31.4–81.5), mangrove creek crossing highway 180 about 21 km E of Champoton, 13 June 1968, C. E. Dawson. Yucatán—USNM 192256 (108, 19.0–72.4), mangrove lagoon, Ascension Bay, 14 Apr. 1960, Smithsonian-Bredin Expdn. Quintana Roo—GCRL 4625 (4, 27.6–44.8), S side of harbor at Cd. Chetumal, 11 May 1970, C. E. Dawson and A. Reséndez. ANSP 109811 (3, 29.3–42.0), Xehla, 25 July 1970, Zumwalt and Braker. GUATEMALA: GCRL 4432 (86, 9.0–51.6), GCRL 4437 (1, 33.8), GCRL 4413 (1, 31.3), Bahia de Matias de Galvez, 28 May 1969, C. E. Dawson. USNM 134679 (8, 25.2–38.2), Rio Dulce just S of Zacapa, 25 Apr. 1946, R. R. Miller and A. D. Holloway. HONDURAS: GCRL 4440 (28, 13.1–59.6), GCRL 6010 (4, 41.9–53.0, cleared and stained), Boca del Rio Cienquita, about 5 km W of Porto

Cortes, approx. 15°48′16″N, 87°56′45″W, 4 June 1969, C. E. Dawson. GCRL 4455 (14, 14.9–36.9), Boca del Rio Tulian, approx. 15°47′30″N, 87°57′50″W, 4 June 1969. GCRL 4466 (1, 51.3), Boca del Rio Omoa, approx. 15°45′55″N, 88°02′40″W, 4 June 1969, C. E. Dawson. PANAMA, Atlantic: USNM 81925 (1, 36.1), Portobello, 16 Mar. 1912, S. E. Meek and S. F. Hildebrand. USNM 123647 (23, 22.8–60.4), lowest chamber Gatun Locks, 24 Feb. 1935, S. F. Hildebrand. GCRL 4735 (1, 53.3), about 20 km E of Maria Chiquita, at mouth of creek crossing Portobello highway, 27 June 1970, C. E. Dawson. PANAMA, Pacific: USNM 185542 (1, 34.6), E side of lower chamber of Miraflores Locks, 29 April 1937, A. O. Foster. GCRL 3364 (328, 6.0–48.7), E of Cocoli, Miraflores Third Lock, 6 Aug. 1968, C. E. Dawson. GCRL 5960 (97, 10.3–59.3), E of Cocoli, Miraflores Third Lock, 3 June 1970, C. E. Dawson. COLOMBIA, Magdalena: GCRL 4789 (5, 44.7–49.6), Ciénaga Grande de Santa Marta, approx. 10°59′35″N, 74°17′20″W, 11 June 1970, C. E. Dawson. GCRL 4824 (1, 42.3), brackish lagoon behind W beach of Ancon de Concha, 7 June 1970, C. E. Dawson. TRINIDAD: USNM 178728 (1, 49.6), Cocorite, 13 Sept. 1936, W. Beebe.

ACKNOWLEDGMENTS

I thank W. A. Bussing (UCR), A. Reséndez M. (UNAM) and R. W. Topp (FSBC) for the loan of specimens. Appreciation is expressed to J. W. Atz and C. L. Smith (AMNH) and to E. A. Lachner and colleagues (USNM) for permitting me to examine specimens in their care. Special thanks are due R. S. Birdsong (Old Dominion College) for his comments on L. *cyprinoides*, and to James E. Böhlke and V. G. Springer for critically reading the manuscript. The author's field work was supported in part by National Science Foundation Grants GB-6823 and GB-15295.

LITERATURE CITED

BÖHLKE, J. E. AND C. C. G. CHAPLIN. 1968. Fishes of the Bahamas and adjacent tropical waters. Livingston Publ. Co., Wynnewood, Pa. 771 pp.

BOZNIAK, E. G., N. S. SCHANEN, B. C. PARKER AND C. M. KEENAN. 1969. Limnological features of a tropical meromictic lake. Hydrobiologia 34(3–4): 524–532.

BREDER, C. M., JR. 1932. An annotated list of fishes from Lake Forsyth, Andros Island, Bahamas, with the descriptions of three new forms. Amer. Mus. Novit. 551: 1–7.

CERVIGÓN, F. 1966. Los peces marinos de Venezuela. Tomo II. Fundacion La Salle de Ciencias Naturales, Caracas. Monogr. 12: 439–952.

FOWLER, H. W. 1945. A study of the fishes of the southern Piedmont and coastal plain. Acad. Nat. Sci. Phila. Monogr. 7: 1–408.

GINSBURG, I. 1939. Twenty one new American gobies. J. Wash. Acad. Sci. 29(2): 51–63.

HILDEBRAND, S. F. 1939. The Panama Canal as a passageway for fishes, with lists and remarks on the fishes and invertebrates observed. Zoologica 24(1): 15–45.

JORDAN, D. S. AND B. W. EVERMANN. 1900. The fishes of North and Middle America: a descriptive catalogue of the species of fish-like vertebrates found in the waters of North America, north of the Isthmus of Panama. Bull. U.S. Nat. Mus. 47(4): i–ci + 3137–3313, 392 pls.

RUBINOFF, R. W. AND I. RUBINOFF. 1968. Interoceanic colonization of a marine goby through the Panama Canal. Nature 217(5127): 476–478.

Vol. 84, No. 45, pp. 385–392 29 February 1972

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

A NEW SPECIES OF SHORT-TAILED GERBIL (*DIPODILLUS*) FROM MOROCCO (MAMMALIA: CRICETIDAE: GERBILLINAE)

By Duane A. Schlitter and Henry W. Setzer
African Mammal Project, Division of Mammals
Smithsonian Institution, Washington, D.C. 20560

Since the description of *Dipodillus simoni* (Lataste, 1881), specimens of short-tailed gerbils have been reported rarely among collections of African rodents. Recently, however, reports of the capture of these rodents have begun to appear (Wassif, 1956:179, 1960:31; Setzer, 1958:214; Harrison, 1967: 381; Ranck, 1968:149). As more specimens of gerbilline rodents have become available, interest in the generic classification of this subfamily has increased. Petter (1959) commented on generic classification of the genus *Gerbillus.* He raised the subgenus *Dipodillus,* previously including all the species of *Gerbillus* with naked plantar soles, to generic rank with *Dipodillus simoni* as the only species based on its alternating molar tubercles and shortened tail. The remaining species with bare plantar soles were retained in the subgenus *Hendecapleura* in the genus *Gerbillus.* An examination of literature plus comparison of specimens in the United States National Museum of Natural History collection shows that the genus *Dipodillus* can be distinguished from other gerbilline genera by the following combination of characters: length of tail generally averages less than length of head and body; tail lacks penicillated tip; plantar soles naked; molar tubercles alternate in position, especially M^1 (Fig. 1); tympanic bullae relatively small for the subfamily Gerbillinae; and M^3 lacks cusps.

From September 1969 through July 1970, personnel of the

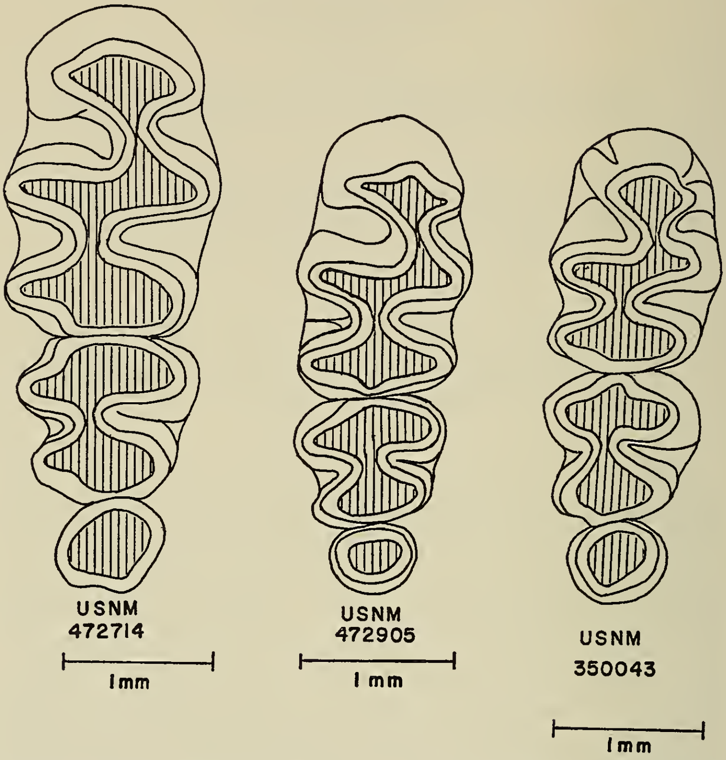


Fig. 1. Right maxillary toothrows of three species of *Dipodillus*. From left to right: 472714, holotype of *Dipodillus maghrebi* from Morocco; 472905, *Dipodillus simoni* from Morocco and 350043, *Dipodillus kaiseri* from Egypt.

Division of Mammals, Smithsonian Institution, undertook a mammal survey of Morocco in collaboration with Mohammed V University, Rabat, Morocco. Preliminary study of the resulting collection revealed a remarkable new species of *Dipodillus.*

All measurements were taken with dial calipers and are in millimeters, weights are in grams and capitalized color terms are from Ridgway "Color Standards and Color Nomenclature" 1912.

This new species may be known as:

Dipodillus maghrebi new species

Holotype: Adult male, skin and skull, United States National Museum of Natural History no. 472714, from 15 km. WSW Taounate, Fes Province, Morocco [34°29′N, 40°48′W]. Obtained 8 May 1970 by R. E. Vaden, original no. 6019.

Specimens examined: Seven, from 15 km. WSW Taounate, Fes Province, Morocco (USNM 472713–719).

Diagnosis: Upper parts near Avellaneous, purest on sides and flanks, strongly mixed with black becoming darkest on forehead; all hairs plumbeous at base. Lips, entire underparts, and dorsal surfaces of hands and feet, between Pale Ochraceous Salmon and Pale Pinkish Buff; all hairs uniformly colored to base. Purest color, at point of demarcation between dorsal and ventral color, near Light Pinkish Cinnamon. Tail obscurely bicolored, dorsal color same as color of back. Tail lacking penicillate tip but with increasing admixture of black-tipped hairs toward the distal end. Circumorbital ring of black hairs. Color of back extending to hairs on external surface of pinna; internal face of pinna grayish. Skull large for genus; zygomatic arches rugged; upper toothrow relatively long; audital portion of auditory bulla relatively small and relatively well inflated ventrally; mastoidal portion of auditory bulla not projecting beyond occiput; external auditory meatus projecting strongly anteriorly and lacking foramen of Huschke; anterior palatine foramina relatively short and wide; posterior palatine foramina short.

Measurements: External and cranial measurements of the holotype are: Total length, 224; length of tail, 110; length of hind foot, 27; length of ear from notch, 18; occipitonasal length of skull, 31.4; greatest breadth across zygomatic arches, 16.9; greatest breadth of braincase, 13.2; least interorbital breadth, 5.0; greatest length of nasals, 12.2; greatest breadth of rostrum at level of antorbital foramina, 4.7; oblique length of audital portion of auditory bulla, 8.6; greatest length of anterior palatal foramina, 5.6; greatest length of posterior palatal foramina, 1.5; greatest crown length of upper toothrow, 4.3; greatest crown breadth across M^3–M^3, 5.4.

Additional specimens measured: Dipodillus simoni: MOROCCO, Oujda Prov.: 10 km. S Ain-Benimathar (33°55′N, 2°2′W), 2. *Dipodillus kaiseri*: EGYPT, Western Desert Governorate: Burq El Arab, 2. LIBYA, Cyrenaica Prov.: 20 km. E Tobruch, 1, 3 km. E Derna, 1; Tripolitania Prov.: 12 km. S Chicla, 2, 20 km. E Rumia, 1. *Gerbillus* (*H.*) *hilda*: MOROCCO, Rabat Prov.: 17 km. SW Rabat (33°55′N, 6°59′W), 8. *Gerbillus* (*H.*) *campestris*: MOROCCO, Safi Prov.: 13 km. E Essaouira (35° 30′N, 9°40′W), 10.

Comparisons: From the two species of *Dipodillus* already known from North Africa, *D. simoni* (Lataste, 1881) and *D. kaiseri* (Setzer, 1958), this new species differs by its remarkably larger size, both externally and cranially (Tables 1 and 2).

From *Dipodillus simoni*, *Dipodillus maghrebi* differs cranially by hav-

Table 1. Selected comparative external measurements of specimens of north African *Dipodillus* and *Gerbillus* subgenus *Hendecapleura* in the United States National Museum of Natural History.[1]

	N	TL	HB	Tail	HF	Ear	Weight
Dipodillus maghrebi	4 ♂♂	221 (210–224)^{3}	113.3(107–119)^{3}	107.7(103–110)^{3}	26.8(26–27)	18.5(18–19)	46 (41–58)
	3 ♀♀	216.7(208–225)	110.3(106–119)	106.3(102–111)	27 (27)	17.7(17–18)	38.7(34–44)
Dipodillus simoni	2 ♂♂	152, 154	81, 83	71, 71	19, 20	13, 13	18, 16
Dipodillus kaiseri							
Egypt	2 ♂♂	177, 172	85, 85	92, 87	22, 22	13, 12.5	–
Libya	5 ♂♂	160.4(153–169)	82.2 (81–85)	78.2 (71–84)	21 (21)	12.2(12–13)	–
Gerbillus (*H.*) *hilda*	8 ♀♀	207.9(200–216)	95.0 (89–101)	112.9(105–119)	24.6(23–25)	14.9(14–16)	22.5(20–26)
Gerbillus (*H.*) *campestris*	10 ♂♂	232.8(223–245)	101.9 (97–106)	130.9(126–139)	27.0(26–28)	16.4(13–17)	31.1(30–33)

[1] Measurements are given as means followed by extremes enclosed in parentheses. Size of sample (indicated in column under N) is followed by designation of sex of specimen. Sample sizes are as given unless indicated otherwise by a number in superscript following extremes. The abbreviations used are as follows: N = number in sample; TL = total length; HB = head and body length (TL minus Tail); Tail = length of tail; HF = hind foot; Ear = length of ear from notch; Weight = weight in grams.

Table 2. Selected comparative cranial measurements of the same specimens as listed in Table 1.[1]

	N	OCN	ZB	Nasal	Ob. L. Bulla	Ant. P. For.	Cr. L. Up. Tr.	Br. M^3–M^3
Dipodillus maghrebi	4 ♂♂	31.7(31.3–32.1)	16.9(16.4–17.8)	12.4(12.2–12.7)	8.5(8.4–8.6)	5.6(5.5–5.6)	4.3(4.2–4.3)	5.4(5.2–5.5)
	3 ♀♀	30.8(30.5–31.1)	15.9(15.1–16.7)	12.0(11.7–12.4)	8.0(7.9–8.1)	5.4(5.2–5.5)	4.2(4.1–4.3)	5.3(5.2–5.4)
Dipodillus simoni	2 ♂♂	24.4, 24.4	13.1, 13.0	9.6, 9.4	6.6, 6.5	4.8, 4.7	3.4, 3.4	4.2, 3.8
Dipodillus kaiseri								
Egypt	2 ♂♂	25.8, 26.0	14.0, 13.8	9.5, 9.6	7.2, 7.1	4.8, 4.9	3.5, 3.4	4.0, 4.2
Libya	5 ♂♂	25.6(24.6–26.5)	13.7(13.4–14.0)[4]	9.6 (9.1–10.3)	7.2(6.9–7.5)	4.9(4.5–5.2)	3.4(3.2–3.4)	4.1(3.9–4.4)
Gerbillus (H.) hilda	8 ♀♀	27.6(27.2–28.2)	14.6(14.1–15.1)	10.4(10.1–10.8)	7.6(7.1–8.0)	4.6(4.2–5.0)	3.6(3.4–3.7)	4.5(4.3–4.8)
Gerbillus (H.) campestris	10 ♂♂	29.8(28.8–30.8)	15.7(14.9–16.5)	11.5(10.7–12.5)	8.0(7.4–8.1)	5.1(4.7–5.4)	4.0(3.8–4.4)	4.7(4.3–5.2)

---

[1] Abbreviations used are: OCN = occipitonasal length; ZB = zygomatic breadth; Nasal = length of nasal; Ob. L. Bulla = oblique length of audital portion of auditory bulla; Ant. P. For. = length of anterior palatine foramina; Cr. L. Up. Tr. = crown length of upper toothrow; and Br. M^3–M^3 = breadth across M^3–M^3.

ing rounded rather than truncated zygomatic plates; anterior palatine foramina "tear-drop" shaped with widest point toward posterior end; well-developed supraorbital ridges; and narrow pterygoid fossae with flaring hamuli. Between the orbits, the supraorbital ridges of *D. maghrebi* diverge more strongly posteriorly when viewed from above rather than being more nearly parallel as in *D. simoni*. Externally, *D. maghrebi* has shorter pelage with more brown color and less suffusion of black hairs than does *D. kaiseri*.

Skulls of *D. maghrebi* can be distinguished from *D. kaiseri* by the presence of more rounded rather than truncated zygomatic plates; by having the anterior palatine foramina "tear-drop" shaped with widest portion toward the posterior end; and with markedly better developed supraorbital ridges. The paler pelage of *D. simoni* serves to distinguish this species from the darker, more brownish *D. maghrebi*.

In comparison with the species of *Gerbillus* (*Gerbillus*) available to us, *Dipodillus maghrebi* can be distinguished by having the tail shorter than the head and body and lacking a terminal tuft; and by having naked rather than hairy plantar soles of the hind feet.

Of the species of the subgenus *Hendecapleura* currently known from northwest Africa, only two species, *Gerbillus campestris* and *G. hilda* approach the dimensions of *D. maghrebi*. All the other species of this subgenus from northwest Africa are smaller both externally and cranially than is *D. maghrebi*.

Gerbillus hilda, as known from specimens taken 17 km. SW Rabat, is darker in color and smaller in size than *D. maghrebi* (Table 1). In addition, as pointed out by Thomas (1918: 62) in the original description, specimens of *G. hilda* have a small band of hairs on the plantar surface of the hind foot reminiscent of the hairs found on the hind foot of *Taterillus*. Cranially, *D. maghrebi* differs from *G. hilda* by having more rugged zygomatic arches, more ventrally inflated auditory bullae and a more dorsally flattened braincase; and is generally larger in most measurements taken (Table 2).

Although nearly as long in head and body as *D. maghrebi* (Table 1), *Gerbillus campestris* has a tail which is longer than head and body and possesses a terminal pencil of black hairs. *D. maghrebi* has a longer ear and longer head and body but shorter tail than *G. campestris*. *D. maghrebi* differs cranially from *G. campestris* in the same manner as given above for *G. hilda* except for some measurements which show a small amount of overlap.

Remarks: Specimens of *Dipodillus maghrebi* were snap trapped from 8 to 12 May 1970 in old, harvested grain fields with herbaceous shrubs and grasses remaining after the harvest. The predominant soil type was clay. The only other rodent trapped in these fallow fields was *Mus musculus*.

Individuals of the genus *Dipodillus* are generally more robust of body than are those of the genus *Gerbillus*. The general robustness of this new species is evident from the weights given in Table 1. Although the four males weighed more than the three females, the weights of the latter are still heavier than those given in the table for *Gerbillus campestris.*

A single female, weighing 44 grams, showed reproductive activity when taken on 12 May. This individual contained eight embryos (three in the right horn of the uterus) which averaged 10 millimeters in crown-rump length.

Two features of this new species warrant discussion. Firstly, *Dipodillus maghrebi* has fur shorter in length than is characteristic of specimens of *D. simoni* and *D. kaiseri.* Whether this difference is due to a seasonal change in pelage cannot be ascertained. Seasonal changes such as this are not obvious in other north African *Dipodillus* or *Gerbillus.* Secondly, whereas other species of *Dipodillus* and *Gerbillus* have pure white ventral hairs, *D. maghrebi* lacks this striking feature. It is possible that the color of the ventral fur in *D. maghrebi* is due to staining from soil or plant juices. However, various solvents normally used to test for staining proved unsuccessful.

The name *maghrebi* refers to the Arabic term for northwestern Africa.

The efforts and cooperation of Prof. Ben Ab-Jelil, Dean, Faculty of Sciences, Mohammed V University, and Prof. M. el Hilali, Chairman, Department of Animal Biology, Mohammed V University, were instrumental in enabling us to obtain this new species from Morocco. Special gratitude is extended to them for their help. Appreciation is extended to Dr. Clyde Jones for critically reading the manuscript.

The field and laboratory work upon which this paper is based were financed under PL 480 Grant SFG-0-1684 and U.S. Army Medical Research and Development Command Contract No. DA-49-193-MD-2738.

LITERATURE CITED

HARRISON, D. L. 1967. Observations on some rodents from Tunisia, with the description of a new gerbil (Gerbillinae: Rodentia). Mammalia 31(3): 381–389. September.

PETTER, F. 1959. Evolution du dessin de la surface d'usure des Molaires des gerbillidés. Mammalia 23(3): 304–315. September.

RANCK, G. L. 1968. The Rodents of Libya. Taxonomy, Ecology and Zoogeographical Relationships. U.S. Nat. Mus. Bull. 275: vii + 264 pp., 9 plts., 54 figs. 2 October.

SETZER, H. W. 1958. The Gerbils of Egypt. J. Egyptian Pub. Health Assoc. 33(6): 205–227.

THOMAS, O. 1918. New Forms of *Dendromus, Dipodillus,* and *Gerbillus.* Ann. Mag. Nat. Hist. (9), vol. 2(7): 59–64. July.

WASSIF, K. 1956. Studies on gerbils of the subgenus *Dipodillus* recorded from Egypt. Ain Shams Sci. Bull. 1: 173–194.

———. 1960. Further observations on *Gerbillus simoni* Lataste from the Egyptian Province (U.A.R.). Bull. Zool. Soc. Egypt 15: 29–31.

Vol. 84, No. 46, pp. 393–410 29 February 1972

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

TWO NEW TROGLOBITIC CRAYFISHES (DECAPODA, ASTACIDAE) FROM FLORIDA

By Horton H. Hobbs, Jr., and D. Bruce Means
Smithsonian Institution, Washington, D.C. 20560 and
Tall Timbers Research Station, Tallahassee, Florida 32301

The two species described here from Jefferson, Leon, and Wakulla Counties, Florida, bring the total number of troglobitic crayfishes recorded from the State to nine, all except one (*Cambarus cryptodytes* Hobbs, 1941: 110) of which are endemic. A key for the identification of the previously known species, together with brief summaries of their ranges, is presented by Hobbs (in press).

Juvenile specimens of one of the new species, *Procambarus orcinus*, were collected in 1956 by Horst R. H. Heinemann and were tentatively assigned by Hobbs (1958: 81) to *Procambarus pallidus* (Hobbs, 1940: 394). Some 3 years later, Warren (1961: 8) recorded the occurrence of *P. pallidus* in Clay Sink (almost certainly the same locality herein referred to as Gopher Sink), indicating that "The Leon Co. locality, though far removed from other known populations of *pallidus*, is not too surprising. Various limestone formations are at the surface along the coast from Leon Co. southward." Warren's record is based on the specimens collected by Heinemann.

More recently, Lawrence A. Abele donated three specimens of this species from Osgood Sink, Leon County to the Smithsonian Institution. Unfortunately, we have no record of the donor of the specimen collected from Wakulla Springs by L. B. Trott; however, the remaining material of *P. orcinus* was collected by Joseph Halusky and the junior author.

If the tentatively identified juvenile male of *Procambarus horsti*, the other species described herein, proves to be a valid determination, it is the first known specimen of this species. It was collected from a well in Leon County and was sent to the Smithsonian by Stephen P. Cobb of the Florida Department of Natural Resources. Michael N. Horst presented us with the specimens comprising the type-series obtained from Big Blue Springs in Jefferson County.

We should like to thank all of those individuals who have donated or assisted in collecting the specimens on which this report is based. We are also grateful to Fenner A. Chace, Jr., Martha R. Cooper, and Marian H. Pettibone for their criticisms of the manuscript.

Procambarus orcinus new species

Figure 1

Procambarus pallidus (Hobbs, 1958: 81) [part].—Hobbs and Hart, 1959: 149.—Warren, 1961: 8 [part].—Hobbs, in press [part].

Diagnosis: Integument translucent, underlying tissues usually pinkish orange; eyes moderately large for troglobitic species, usually with small red pigment spot, but always lacking facets. Rostrum with marginal spines. Areola 31.2 to 35.6 percent of entire length of carapace and 8.9 to 11.8 times longer than wide. Two to 12 cervical spines present. Suborbital angle rudimentary. Postorbital ridge with apical spine and with 2 to 5 caudally situated ones. Hepatic area of carapace with few to many spines in adults, reduced in juveniles. Antennal scale approximately 2.2 times longer than wide, broadest slightly proximal to midlength. Ischia of third and fourth pereiopods of male with simple hooks, their tips over-reaching basioischial articulation. First pleopods slightly asymmetrical, with distinct rounded hump on cephalic surface, provided with subterminal setae, and reaching cephalad to coxae of third pereiopods; distal extremity bearing (1) subspiculiform mesial process directed caudodistally, (2) prominent, laterally flattened, corneous cephalic process lying lateral to base of central projection and directed caudodistally, (3) corneous, beaklike central projection directed caudolaterally at right angle to principal shaft of appendage, and (4) caudal element consisting of two parts: small caudal knob lying at caudolateral base of central projection, and prominent, mesially inflated adventitious process located mesial to central projection, latter process with narrow, low, corneous, crestlike caudal margin. Annulus ventralis sculptured by only two conspicuous grooves: submedian, broadly sigmoid sinus, and subparallel shallow sulcus dextral to sinus. Sternum immediately cephalic to annulus with prominent, weakly bilobed, paired tubercles extending caudally from caudal margin.

Holotypic Male, Form I: Body (Fig. 1a, h) subcylindrical. Abdomen narrower than thorax (7.5 and 8.5 mm). Greatest width of carapace

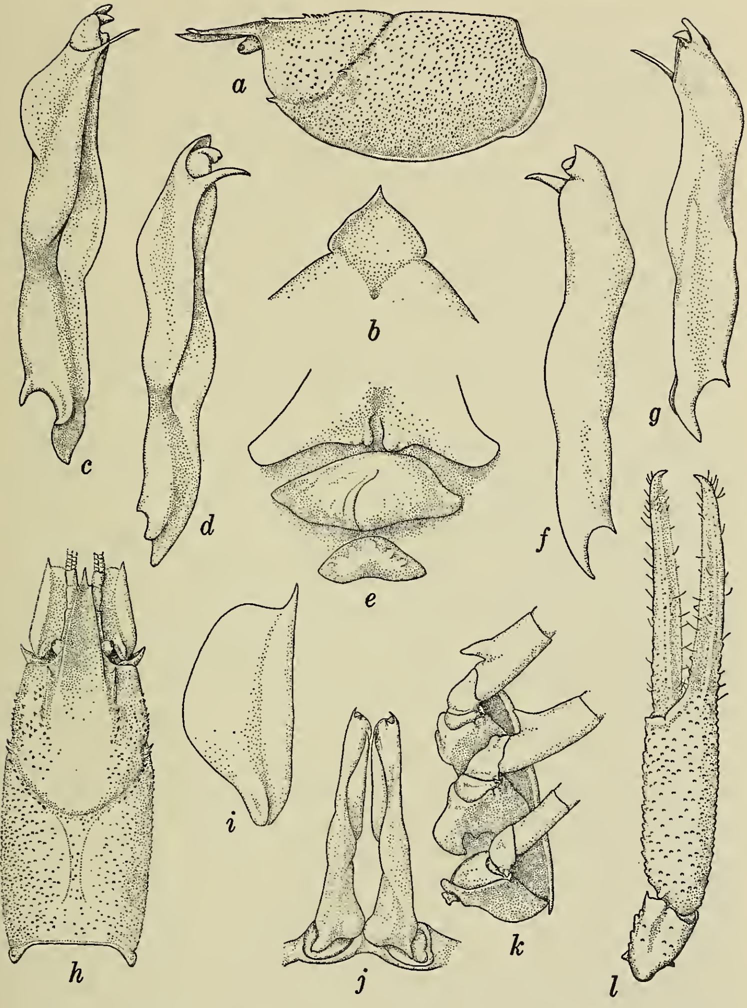


FIG. 1. *Procambarus orcinus* new species. a, Lateral view of carapace of holotype; b, Epistome of paratypic male, form I; c, Mesial view of first pleopod of holotype; d, Mesial view of first pleopod of morphotype; e, Annulus ventralis of allotype; f, Lateral view of first pleopod of morphotype; g, Lateral view of first pleopod of holotype; h, Dorsal view of carapace of holotype; i, Antennal scale of holotype; j, Caudal view of first pleopods of holotype; k, Basal podomeres of third, fourth, and fifth pereiopods of holotype; l, Dorsal view of distal podomeres of cheliped of holotype.

subequal to height at caudodorsal margin of cervical groove (8.5 and 8.6 mm). Areola 10.2 times longer than wide with 2 punctations across narrowest part. Cephalic section of carapace almost twice as long as areola (length 34.8 percent of entire length of carapace). Rostrum excavate dorsally with unthickened, strongly convergent margins; marginal spines long and acute, distinctly delimiting, although asymmetrically, base of acumen, latter reaching level of distal end of peduncle of antennule; dorsal surface with deepest concavity at level slightly anterior to caudal margin of orbit, with submarginal row of setiferous punctations and scattered ones between. Subrostral ridges weak and evident in dorsal aspect only in caudal orbital region. Postorbital ridges very prominent, strongly elevated cephalically, and bearing 3 cephalically inclined spines basally and slender acute spine at apex; dorsolateral groove scarcely evident. Suborbital angle obsolete. Branchiostegal spine prominent. Dorsomedian and extreme cephalolateral portions of carapace punctate; hepatic region with group of prominent spines laterally and dorsolaterally; branchiostegites tuberculate, with row of 11 spines on left side and 9 on right immediately caudal to cervical groove, all in series with usual cervical spines; row continuing cephaloventrally as tubercles to base of branchiostegal spine.

Abdomen longer than carapace (22.4 and 20.7 mm). Cephalic section of telson with 2 spines in each caudolateral corner. Cephalic portion of epistome subtriangular, more rounded than in Figure 1b, with prominent cephalomedian projection; lateral margins only slightly elevated (ventrally) above surface; fovea well developed. Antennules of usual form with very prominent, anterolaterally directed spine on ventral surface of basal article of peduncle near midlength. Antennae extending considerably beyond caudal margin of telson. Antennal scale (Fig. 1i) 2.2 times longer than wide, greatest width slightly proximal to midlength, with lamellar area distinctly broader than thickened lateral part; latter terminating in moderately long spine.

Third maxilliped extending anteriorly to level of tip of rostrum; opposable margin of ischium with teeth, its ventrolateral surface devoid of setae.

Right chela (Fig. 1l) slender and elongate, subovate in cross section, not strongly depressed. Mesial surface of palm with several rows of 9 or 10 tubercles; lateral margin of palm with serrations extending along proximal third of fixed finger; dorsal and ventral surfaces entirely tuberculate. Both fingers provided with submedian longitudinal ridges dorsally and ventrally; dorsal ridges flanked proximally by tubercles and setiferous punctations along distal four-fifths. Opposable margin of fixed finger with 3 small corneous tubercles along proximal fourth, and similar large acute tubercle present at lower level slightly proximal to midlength; minute denticles present along entire length of finger. Opposable margin of dactyl studded with minute denticles, lacking teeth; mesial margin of dactyl tuberculate along proximal half, tubercles decreasing in size distally, and punctate along distal half.

Carpus of right cheliped longer than broad (3.9 and 2.5 mm) with all surfaces sparsely tuberculate; dorsal surface with only slight depression representing usual oblique longitudinal groove; dorsomesial margin with row of 4 tubercles and prominent spine on dorsomesial distal angle; ventrodistal margin with 2 spines, 1 at base of ventrolateral condyle, other more mesial in position.

Merus of right cheliped tuberculate except proximomesially, there sparsely punctate; upper surface with 4 spiniform tubercles, 3 of these forming subdistal group; ventral surface with lateral row of 14 tubercles of which eighth, tenth, twelfth and fourteenth from base large and spikelike, and mesial row of 20 of which only distalmost spikelike; other tubercles flanking 2 rows and crowded between them; ventral laterodistal angle also with strong spiniform tubercle. Ischium with 3 small tubercles dorsally, punctate laterally and mesially, and with row of 6 tubercles ventrally. Basis with 2 small tubercles ventrally, otherwise punctate.

Hooks on ischia of third and fourth pereiopods (Fig. 1k) simple and over-reaching basioischial articulation; basis of fourth pereiopod with prominent tubercle opposing hook. Coxa of fourth pereiopod with massive boss; that of fifth pereiopod with smaller cephalocaudally flattened prominence extending ventrally from caudomesial ventral angle.

Sternum between second, third, and fourth pereiopods only moderately deep, bearing fringe of setae on ventrolateral margins.

First pleopods (Fig. 1c, g, j) as described in diagnosis. Subterminal setae projecting caudodistally from immediately caudolateral to caudal knob around lateral base of cephalic process, and almost to base of mesial process.

Uropod with 2 distally projecting spines on basal podomere; median spine on mesial ramus not reaching distal margin of ramus.

Allotypic Female: Differs from holotype in following respects: acumen reaching slightly beyond level of distal end of antennular peduncle; cervical groove flanked caudally by row of 10 spines on each side; third maxillipeds extending anteriorly to level of penultimate article of peduncle of antennule; lateral margin of chela weakly serrate; opposable margin of fixed finger with row of 6 small, corneous tubercles along proximal two-fifths with larger one at lower level slightly proximal to midlength; opposable margin of dactyl with row of 12 minute corneous tubercles along proximal half; upper surface of merus with 7 spiniform tubercles, 4 grouped subdistally, ventral surface with mesial row of 17 tubercles (most along distal half spiniform) and lateral row of 16; tubercles on ischium and basis of cheliped much reduced. See Table 1.

First pleopods uniramus and small but extending cephalad to cephalic margin of annulus. Sternum cephalic to annulus (Fig. 1e) very shallow with conspicuous caudomedian longitudinal groove flanked by paired tuberculiform prominences extending caudoventrally from caudal margin. Annulus ventralis subovate, broader than long, with median portion

Table 1. Measurements (mm) of *Procambarus orcinus.*

	Holotype	Allotype	Morphotype
Carapace:			
Height	8.6	9.3	8.5
Width	8.5	9.5	8.7
Length	20.7	22.4	21.0
Areola:			
Width	0.7	0.7	0.6
Length	7.2	7.5	7.1
Rostrum:			
Width	2.5	2.8	2.5
Length	6.0	6.9	6.1
Chela:			
Length of inner margin of palm	6.8	5.2	4.5
Width of palm	3.0	2.5	1.9
Length of outer margin of chela	17.6	14.1	10.9
Length of dactyl	10.1	8.6	5.8

gently elevated and bearing submedian longitudinal sinus, latter originating slightly cephalic to midlength, forming broad dextral arc and cutting caudal margin slightly dextral to median line. Sternal plate between fifth pereiopods concave caudally, somewhat depressed in caudomedian area and with cephalic arc of 6 tubercles.

Morphotypic Male, Form II: Differing from holotype in following respects: acumen extending distinctly beyond level of distal end of antennular peduncle; cervical groove flanked caudally by row of 9 spines on left and 11 on right; 4 posterior spines on posterior part of left postorbital ridge and 2 on right; third maxillipeds reaching distal end of antennular peduncle; lateral margin of chela very weakly serrate; opposable margin of fixed finger with moderately large corneous tubercle at end of proximal tenth of finger and very large one at lower level near end of basal third; opposable margin of dactyl with 5 very small corneous teeth along basal third; dorsomesial surface of carpus with only 2 tubercles; dorsal surface of merus with row of 16, mostly spiniform, tubercles, ventral surface with lateral row of 13 tubercles and mesial one of 12, only distalmost as prominent as largest 3 in lateral row; ischium with dorsal tubercles almost obsolete and with 7 small ones ventrally; tubercles on basis almost atrophied; hooks on ischia of third and fourth pereiopods reduced to tubercles; boss on coxa of fourth pereiopod reduced, and prominence on fifth represented by small tubercle. See Table 1.

First pleopod (Fig. 1d, f) differing chiefly from that of holotype in lacking corneous elements, mesial process comparatively more robust, cephalic process forming broad subacute hood extending over cephalolateral portion of rounded central projection, and caudal element exceedingly reduced.

Type-locality: Gopher Sink, 3.1 miles southwest of Florida Road 61 and 0.2 miles east of Florida Road 369 (SW ¼, NW ¼, NE ¼ Sec. 16, T. 2S, R. 1W), Leon County, Florida. The type-locality is a limestone sinkhole in the Woodville Karst Plain (Hendry and Sproul, 1966: 29). It is steep-sided, nearly vertical in some parts, with walls about 35 feet from ground level to the water line. The underwater portion of the sinkhole has a greater diameter (about 100 feet) near the floor than at the surface (about 75 feet). Beginning at about 55 feet below the surface, an underwater cavern opens to the east and extends for about 300 feet, sloping downward to a water-pressure depth of about 100 feet (L. Briel, personal communication). The cavern is approximately 20 feet high by 40 feet wide at its mouth and does not taper appreciably until about 120 feet from the entrance. In the colder months, from November through April, the water is clear with nearly unlimited visibility. Measured water temperature at 65 feet depth was constant at 22°C between 3 February and 11 March 1971. The surface temperature varied slightly, depending upon the air temperature. The floor of the cavern was covered by deep silt which billowed up in a dense cloud with the slightest disturbance.

Types: The holotypic male, form I, allotypic female, and morphotypic male, form II, (Nos. 132031, 132032, 132033, respectively) are deposited together with the paratypes (2♂I, 3♂II, 10♀, 3j♂, 3j♀, all from the type-locality) in the National Museum of Natural History, Smithsonian Institution. Two of these specimens were collected by Heinemann and the others by Halusky and the junior author.

Size: The largest first form male has a carapace length of 21.4 mm, the smallest 19.3 mm. The largest female has a comparable length of 23.9 mm, and the largest specimen, a second form male, 25.3 mm.

Range and Specimens Examined: *Procambarus orcinus* is known from only four localities in Leon and Wakulla counties, Florida: (1) type-locality; (2) Osgood Sink (NE ¼ Sec. 11, T. 2S, R. 1E), Leon County, 1♀, 1 juv. ♂, 1 juv. ♀, 2 Sept. 1968, James Bishop, coll.; (3) Culley's Cave, 0.2 miles east of Florida Road 369 and 0.4 mile north of Leon-Wakulla County line (SE ¼ Sec. 17, T. 2S, R. 1W), Leon County, 1 juv. ♂, 1 juv. ♀, 25 March 1971, Joseph Halusky, coll.; 1 juv. ♂, 1 juv. ♀, 29 April 1971, D. B. Means and J. Halusky, coll.; and (4) Wakulla Springs, Sec. 11, T. 3S, R. 1W, Wakulla County, 1 juv. ♂, 4 May 1957, L. B. Trott, coll.

Variations: There seems to be an almost direct correlation between the size of the individual and the relative development of spines and tubercles on the carapace: the larger the individual the more tubercles and spines. There is also a suggestion that allometric growth occurs between the length of the areola and that of the cephalic region of the carapace: with increase in carapace length there seems to be a proportionately greater increase in the length of the areola.

Except as indicated above, the range of variation among our specimens from the type-locality is, for the most part, no greater than that described for the primary types. The juvenile female obtained by Heinemann is somewhat exceptional in having an areola that comprises 36.2 percent of the carapace length.

The three specimens from Osgood Sink are typical in every respect, and possess areolae ranging from 31.4 to 35.2 percent of the entire length of the carapace.

The single juvenile male from Wakulla Springs, having a carapace length of 11 mm, has a smooth carapace, lacking hepatic spines; only a single large cervical tubercle is present on each side, and the postorbital ridges lack the caudal spines. It does not differ markedly, however, from juvenile specimens from the type-locality.

The four specimens from Culley's Cave (two with complete rostra have carapace lengths of 12.1 and 16.2 mm) are without pigment, lack the red eye-spot typical of individuals from Gopher Sink, and have spines on the carapace distinctly less well-developed than in the adult specimens from the latter mentioned locality. Except for the lack of pigment, however, they are not conspicuously different from the smaller members of the type-series.

It should be pointed out that pigmentation, which disappears soon after preservation, of specimens from Osgood Sink, Wakulla Springs, and those collected from "Clay Sink" by Heinemann, was not recorded on the labels accompanying them.

Life History and Ecological Notes: First form males were collected on February 26 and April 3. No ovigerous females have been observed, although a copulating pair was seen at the type-locality on 3 April 1971.

Specimens were obtained by the junior author in November, February, and March. They were found clinging upside-down to the ceiling and head down on the vertical sidewalls. The first individuals seen were about 25 feet from the mouth of the cavern, and sightings became more frequent with increasing penetration to about 150 feet, beyond which no collections were made, although crayfish were observed deeper in the cavern. Light was just perceivable 150 feet from the mouth, indicating that these animals are abundant in the twilight zone. Individuals were most numerous along the walls, especially where there were cracks and fissures near the floor. When disturbed, they swam toward the bottom. If pursued, the majority came to rest partially buried in the bottom sediments. The pinkish-orange color of many individuals was obvious at the time of collection; however, some were white. All specimens were observed to have pigmented eyes while alive, but the color disappeared a short time after preservation. The pigmented crayfish emitted an orange-colored fluid from their mouths when placed in formalin. A few unidentified troglobitic isopods were observed on the limestone in the cavern. These also had a pinkish-orange color. On one occasion, an isopod was apparently eaten by a crayfish within 10 minutes after being brought to the surface. Dead and injured crayfish were usually cannibalized if not removed from containers shortly after arrival at the surface. Animal life found in the lighted water of the sinkhole included *Palaemonetes paludosus* (shrimp), *Anguilla rostrata* (American Eel), *Hybopsis harperi* (Florida Chub), and *Gambusia affinis* (Mosquitofish). All of these except the Mosquitofish were seen at least once in the twilight zone of the cavern.

Relationships: See discussion of relationships for *P. horsti* below.

Etymology: Orcinus (L., of the nether world), referring to the spelean habitat of this crayfish.

Procambarus horsti new species

Figure 2

Diagnosis: Body white or colorless, eyes small, lacking pigment and facets. Rostrum with marginal spines. Areola 40.2 to 41.8 percent of entire length of carapace, and 13 to 19 times longer than wide. Ten to 12 cervical spines present. Suborbital angle rudimentary. Postorbital ridges with paired apical spines and 2 or 3 caudally-situated spiniform tubercles. Hepatic area of carapace with many spines. Antennal scale approximately 2.1 times longer than wide, broadest short distance proximal to midlength. Ischia of third and fourth pereiopods with simple hooks, tips extending proximally over corresponding bases. First pleopods asymmetrical, reaching cephalad to coxae of third pereiopods, lacking distinct shoulder on cephalic surface, but provided with subterminal setae; distal extremity bearing (1) subspiculiform mesial process directed caudodistally, (2) prominent, laterally flattened, corneous cephalic process lying lateral to base of central projection and inclined caudodistad but with tip directed caudad, (3) corneous, beaklike central projection directed caudomesially at right angle to principal shaft of appendage, and (4) caudal element consisting of 2 parts: vestigial caudal knob lying at caudolateral base of central projection and prominent, mesially inflated adventitious process situated mesial to central projection, latter process with narrow, low, corneous, crestlike caudal margin. Annulus ventralis sculptured by 2 moderately conspicuous grooves: submedian, slightly undulating sinus, and subparallel shallow sulcus sinistral to sinus. Sternum immediately cephalic to annulus multituberculate, with 1 or 2 tubercles on each side of median line slightly overhanging (ventrally) cephalic margin of annulus when latter pressed forward.

Holotypic Male, Form I: Body (Fig. 2a, h) subcylindrical. Abdomen narrower than thorax (12.3 and 17.6 mm). Greatest width of carapace greater than height at caudodorsal margin of cervical groove (17.6 and 14.1 mm). Areola 15.9 times longer than wide with 2 or 3 punctations across narrowest part. Cephalic section of carapace about 1.4 times

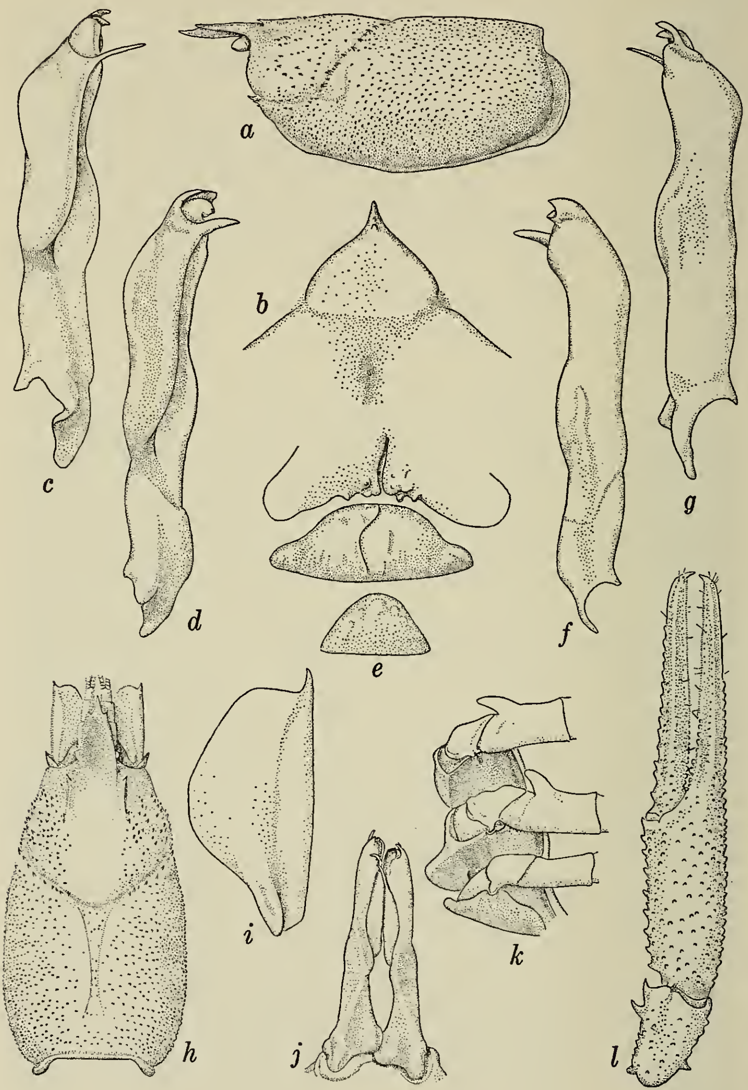


FIG. 2. *Procambarus horsti* new species. a, Lateral view of carapace of holotype; b, Epistome of holotype; c, Mesial view of first pleopod of holotype; d, Mesial view of first pleopod of morphotype; e, Annulus ventralis of allotype; f, Lateral view of first pleopod of morphotype; g, Lateral view of first pleopod of holotype; h, Dorsal view of carapace

as long as areola (length 41.8 percent of entire length of carapace). Rostrum excavate dorsally, with unthickened, moderately convergent margins; marginal spines acute, distinctly delimiting base of acumen, latter extending to midlength of ultimate segment of peduncle of antennule; upper surface with deepest concavity at level of caudal margin of orbit, with submarginal row of setiferous punctations and widely scattered ones between. Subrostral ridges weak and evident in dorsal aspect only in caudalmost orbital region. Postorbital ridges very prominent, distinctly grooved dorsolaterally, and bearing large, acute apical spines and 2 or 3 spiniform tubercles situated at caudal base of ridges. Suborbital angle very weak, and rounded. Branchiostegal spine strong, curved cephalodorsally, and 2 smaller spines situated immediately caudoventrally. Carapace with few punctations dorsally and in cephalic hepatic region, otherwise studded with crowded tubercles, most of those in hepatic region spiniform or subspiniform; cervical spine forming one of irregular series (approximately 18 on each side) extending along posterior margin of cervical groove from anterior extremity of branchiocardiac grooves anteroventrally to branchiostegal spine, 2 in usual position of cervical spine bi- or trispinose.

Abdomen and carapace subequal in length (34.5 and 34.2 mm). Cephalic section of telson with 4 spines in dextral and 3 in sinistral caudolateral corners. Cephalic portion of epistome subcordiform, with prominent cephalomedian projection bearing prominent tubercle ventrally near base; lateral margins not elevated; surface subplane; fovea represented by moderately deep longitudinal groove. Antennules of usual form, with longest (mesial) flagellum 1.6 times length of areola and with anterolaterally directed spine on ventral surface of basal article of peduncle near midlength. Antenna extending some distance caudal to margin of telson. Antennal scale (Fig. 2i) approximately 2.1 times longer than broad, its greatest width distinctly proximal to midlength, with lamellar area broader than thickened lateral portion; latter terminating in moderately long spine.

Third maxilliped surpassing apex of rostrum by length of dactyl and one-half that of propodus; opposable margin of ischium with teeth and with ventrolateral surface devoid of setae.

Right chela (Fig. 2l) slender and elongate, subovate in cross section, not strongly depressed. Mesial surface of palm with row of 9 tubercles subtended by other sublinear series above and below; lateral margin of palm with serrations extending slightly beyond midlength of fixed

---

←

of holotype; i, Antennal scale of holotype; j, Caudal view of first pleopods of paratypic male, form I; k, Basal podomeres of third, fourth, and fifth pereiopods of holotype; l, Dorsal view of distal podomeres of cheliped of holotype.

finger; dorsal and ventral surfaces entirely tuberculate. Fixed finger with submedian longitudinal ridges dorsally and ventrally, both ridges flanked by tubercles along basal two-fifths to one-half, and by setiferous punctations distally; opposable margin with row of 11 tubercles along proximal half, third and fourth from base largest, and more massive tubercle at lower level between ninth and tenth tubercles of upper row; crowded minute denticles present from base to corneous tip of finger. Dactyl with dorsal and ventral surfaces similar to those of fixed finger; mesial surface serrate to base of distal fourth; opposable margin with row of 12 small tubercles, second and fourth from base slightly larger than other members of row; crowded minute denticles distributed as on fixed finger.

Carpus of right cheliped longer than broad (7.5 and 4.0 mm) with all surfaces tuberculate; dorsal surface with only faint depression representing usual oblique longitudinal groove; dorsomesial margin with 2 prominent spines, 1 at distal angle and other slightly proximal to it; ventrodistal margin with 2 spines, 1 at base of ventrolateral condyle, other more mesial in position.

Merus of right cheliped tuberculate except proximomesially where sparsely punctate; upper surface with 5 spiniform tubercles, 4 of which grouped subdistally; ventral surface with 2 rows of 16 tubercles converging to strong spiniform tubercle at mesiodistal angle; other, generally smaller, tubercles between rows, and serially arranged ones mesially and laterally; ventral laterodistal angle also with strong spiniform tubercle. Ischium serrate dorsally, punctate laterally and mesially, and tuberculate ventrally; ventral surface with row of 5 tubercles flanked by additional smaller ones. Basis with single prominent tubercle ventrally, otherwise punctate.

Hooks on ischia of third and fourth pereiopods (Fig. 2k) simple and overhanging corresponding basis; basis of fourth pereiopod with small tubercle opposing hook. Coxa of fourth pereiopod with prominent swollen boss; that of fifth pereiopod with smaller cephalocaudally flattened prominence extending ventrally from ventral caudomesial angle.

Sternum between second, third, and fourth pereiopods moderately deep and bearing heavy fringe of setae on ventrolateral margins.

First pleopods (Fig. 2c, g, j) as described in diagnosis. In addition, subterminal setae projecting caudodistally from cephalic base of vestigial caudal knob around cephalic side to level of midlength of mesial base of adventitious process.

Uropod with 2 distally projecting spines on basal podomere; median spine on mesial ramus not reaching distal margin of ramus.

Allotypic Female: Differing from holotype in following respects: rostrum with more convergent margins and tip of acumen reaching distal end of antennular peduncle; series of cervical spines resembling rather closely that of morphotype with single simple spine in location of usual cervical spine; cephalic section of telson with 2 spines in each caudolateral corner; mesial margin of palm of chela with 10 or 11 tubercles;

Table 2. Measurements (mm) of *Procambarus horsti.*

	Holotype	Allotype	Morphotype
Carapace:			
Height	14.1	15.0	15.2
Width	17.6	20.2	20.5
Length	34.2	39.0	38.7
Areola:			
Width	0.9	1.1	1.2
Length	14.3	15.7	16.2
Rostrum:			
Width	3.7	4.7	4.3
Length	8.0	9.1	9.0
Chela:			
Length of inner margin of palm	10.4	9.9	10.0
Width of palm	5.7	5.6	5.5
Length of outer margin of chela	27.8	29.0	32.6
Length of dactyl	16.5	17.2	20.4

serrations on lateral margin of chela and mesial margin of dactyl extending no farther than midlength of fingers; opposable margins of fixed finger and dactyl with 7 and 9 small tubercles, respectively; ventral surface of merus with 2 rows of 15 spines each; basis of dextral cheliped with very small tubercle, that of sinistral member lacking tubercle. See Table 2.

First pleopods uniramous and small but extending cephalad to cephalic margin of annulus. Sternum cephalic to annulus ventralis (Fig. 2e) with deep median fissure flanked caudally by pair of tubercles subtended laterally by 1 or 2 additional ones. Annulus broader than long, rounded cephalically, and with almost straight caudal margin; surface weakly sculptured but strongly convex ventrally, bearing shallow, slightly curved, longitudinal fissure sinistral to more prominent submedian sinus; sinus originating near median line on cephalic slope, curving gently caudodextrally and finally caudosinistrally, terminating before reaching midcaudal margin. Postannular plate subtrapezoidal in outline, elevated in cephalic half with 6 tuberculiform prominences, medianmost largest.

Morphotypic Male, Form II: Differing from holotype in following respects: apex of acumen almost reaching distal end of ultimate article of antennule; cervical spines and other spines in same series not so strongly developed, only 1 large, simple spine present in usual position of cervical spine; cephalic section of telson with 2 spines in each caudolateral corner; mesial margin of palm of chela with tubercles more irregularly arranged, but spaced similarly to those in holotype; serrations on lateral surface of chela not quite reaching midlength of fixed finger; opposable margin of fixed finger with row of 13 small tubercles, that of dactyl with 18; caudalmost tubercle on dorsomesial distal portion of merus of cheliped much reduced in size; approximately 20 tubercles in lateral and 23 in mesial row on ventral surface of merus of cheliped, and 7 on ischium; basis of cheliped lacking ventral tubercle; hooks of ischia of third and fourth pereiopods greatly reduced in size; sternum between posterior 3 pairs of pereiopods with much shorter setae. See Table 2.

First pleopods (Fig. 2d, f) symmetrical and with oblique suture near base. Terminal elements noncorneous, proportionately more massive, except for caudal element; latter much reduced in size. Cephalic process considerably larger and hooding smaller central projection.

Type-locality: Big Blue Springs (tributary to the Wacissa River), 2.2 miles south of the crossroads in the town of Wacissa, Jefferson County, Florida (SE ¼, NW ¼, Sec. 12, T. 2S, R. 3E). In describing the type-locality, Mr. Horst wrote the following: "Our next stop was Big Blue Springs, which is much like a huge bowl filled with crystal clear water: 25 yards across and about 50 feet deep at the center. The boil . . . is at the very bottom and is about four feet in diameter. With underwater lights and safety lines, we entered the cave source going straight down, pulling ourselves in, as the water exiting the spring source has a great deal of force. The hard limestone bottleneck which we had entered was about ten feet in length and opened into a small room which contained several branches. . . . The floor of this room was white with crayfish: a huge population. . . . . In spite of the direct beams of our diving lights, the crayfish exhibited no variation in behavior. They extend throughout the entire spring, at least as far as we have been able to go with our diving gear, maximum depth being 70–80 feet. I saw little in the way of food, aside from many intact gastropod shells. . . . . In collecting the specimens, we encountered two individuals with some brown hue to their carapace. . . . Also, we noted in collecting the crayfish in the cave that they seem quite weak. . . . . In general, they are inactive during the day and extremely active at night. . . . . I found two or three specimens in protected areas of the 'bowl', completely out of the cave itself, but near auxiliary entrances." In investigating other springs of the Wacissa, Mr. Horst found no other crayfish populations.

Types: The holotypic male, form I, allotypic female, and morphotypic male, form II, (Nos. 132043, 132044, 132045, respectively) are deposited together with the paratypes (2♂I, 2♀) in the National Museum of Natural History, Smithsonian Institution. All specimens were collected by Michael N. Horst in October 1970.

Size: The largest first form male has a carapace length of 41.1 mm, the smallest, 32.5 mm. The allotype has a comparable length of 39.0 mm and a paratypic female, approximately 40.6 mm (the rostrum is injured).

Range: Although positively known only from the type-locality, a single male collected from a "well-digging rig" on the farm of Mr. Pichard, 4.5 miles east of Tallahassee on the Old St. Augustine Road, is tentatively assigned to this species.

Variations: While variations in minor features are rampant in this species, rather slight differences occur in most of the characters singled out in the above descriptions. Among these are the following: the apex of the rostrum reaches at least to midlength of the ultimate article of the antennular peduncle, and never extends beyond it for a distance of more than a fraction of a millimeter; the posterior spiniform tubercles at the posterior extremity of the postorbital ridges vary in number from 2 to 5, occasionally long and slender but more often only slightly more conspicuous than the adjacent tubercles on the hepatic region; small tubercles are sometimes present both in the posterior gastric and posterior cardiac regions of the carapace; the epistome is occasionally subtrapezoidal in shape with faintly elevated (ventrally) cephalolateral margins; the number of spines in the cervical series varies from 10 to 18, and they may range in size from scarcely larger than the adjacent branchiostegal tubercles to 3 or 4 times as large, most of them with strongly acute tips; the number of tubercles in the row along the mesial margin of the palm of the chela varies from 8 to 10; the upper surface of the merus of the cheliped exhibits considerable variation in development of tubercles and spines: in some chelipeds they increase in size progressively distally; in others such a gradation is hardly evident, with the largest members in the distal group and 1 or 2 others projecting well above their immediate neighbors; the ventral surface of the merus may have as many as 20 tubercles comprising the 2 rows. In the largest first form male, the basial tubercle opposing the hook on the ischium of the fourth pereiopod is much more massive than that in the holotype. In one of the paratypic females, the sinus of the annulus ventralis is C-shaped, the sinistral fissure is much broader and deeper than in the allotype, and there are 1 or 2 small tubercles situated near the lateral margins; the postannular plate bears 8 conspicuous tubercles. Other differences have been pointed out in the comments on the allotype and morphotype.

The single male collected on the Pichard Farm has a carapace length of 17.7 mm, is comparatively less spiny than are the members of the type-series. The marginal spines of the rostrum and the apical spine on the postorbital ridges are very short. Cervical spines are lacking but are represented by 1 or 2 minute tubercles; otherwise the carapace is smooth. The areola constitutes only 37.8 percent of the total length of the carapace; however, inasmuch as we have no specimens of comparable size from the population in the type-locality, it is possible that smaller specimens have a proportionately shorter areola, suggestive of the variations noted in *Procambarus orcinus.*

Etymology: This species is named in honor of Michael N. Horst who kindly donated to us the series of specimens on which this description is based.

Relationships: Procambarus horsti and *P. orcinus* are distinctly more closely related than either is to *Procambarus pallidus*, their closest previously described ally. The obvious similarities between the three lie in the conspicuous major morphological features and in details of the secondary sexual characteristics. All three are exceedingly tuberculate; the cephalothorax is inflated; the chelipeds are long and slender; the rostral margins are convergent; simple hooks are present on the ischia of the third and fourth pairs of pereiopods; and the humped form of the first pleopod and the comparative sizes of the terminal elements are noteworthy. In the female, the sternum immediately cephalic to the annulus ventralis is cleft and tuberculate, and the similar conformation of the annulus is striking. The features which set *P. pallidus* apart from the two described here, while seemingly minor in character, are constant. Most conspicuous among them is the absence of posterior spines on the postorbital ridges, the absence of spiniform development of the tubercles in the hepatic and cervical regions, and usually the reduction of the marginal spines, often represented by tubercles, on the rostrum. In the pleopod of the first form male, the cephalic process is situated cephalolateral to the central projection and partially hoods it, whereas in the other two species it is distinctly lateral in position, compressed laterally, and in no way overhangs the central projection.

Procambarus horsti differs from *P. orcinus* in lacking pigmentation of any kind either in the eye or body musculature, although in living individuals, the yellow hepatopancreas and brown ovary may be seen through the integument; the areola is narrower (13.5 to 19.2 times longer than broad as opposed to 8.9 to 11.8 in *P. orcinus*) and longer, constituting 40.2 to 41.8 percent of the total length of the carapace (31.2 to 35.6 percent in *P. orcinus*). It is much more strongly tuberculate, but the spiniform tubercles and spines are not nearly so well developed as in *P. orcinus.* The pleopods, although markedly similar to those of the latter, have a much less well-developed caudal knob.

LITERATURE CITED

HENDRY, CHARLES W., JR., AND CHARLES R. SPROUL. 1966. Geology and groundwater resources of Leon County, Florida. Bull. Fla. Geol. Surv. 47: i–xii, 1–178.

HOBBS, HORTON H., JR. 1940. Seven new crayfishes of the genus *Cambarus* from Florida, with notes on other species. Proc. U.S. Nat. Mus. 89 (3097): 387–423, 8 figs.

———. 1941. Three new Florida crayfishes of the subgenus *Cam-*

barus (Decapoda, Astacidae). Amer. Midl. Nat. 26 (1): 110–121, 32 figs.

———. 1958. The evolutionary history of the Pictus Group of the crayfish genus *Procambarus* (Decapoda, Astacidae). Quart. Journ. Fla. Acad. Sci. 21 (1): 71–91, 20 figs.

———. (in press). A new troglobitic crayfish from Florida. Quart. Journ. Fla. Acad. Sci.

——— AND C. W. HART, JR. 1959. The freshwater decapod crustaceans of the Apalachicola drainage system in Florida, southern Alabama, and Georgia. Bull. Fla. State Mus. 4 (5): 145–191, 39 figs.

WARREN, RICHARD DEAN. 1961. The obligative cavernicoles of Florida. Special Papers, Fla. Speleol. Soc., no. 1, pp. 1–10, 2 figs.

Vol. 84, No. 47, pp. 411–420 29 February 1972

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

A NEW CRAYFISH OF THE SUBGENUS *PUNCTICAMBARUS* FROM THE SAVANNAH RIVER DRAINAGE WITH NOTES ON *CAMBARUS* (*P.*) *REBURRUS* PRINS (*DECAPODA, ASTACIDAE*)

Rudolph Prins[1] and Horton H. Hobbs, Jr.
Western Kentucky University, Bowling Green,
Kentucky 42101 and Smithsonian Institution,
Washington, D.C. 20560

The new crayfish described below represents the second member of the subgenus *Puncticambarus* known to inhabit headwater streams of the Savannah River. Prins (1968) described *Cambarus reburrus* from a single tributary in Jackson County, North Carolina, and although he searched in other streams in the area, he was unable to find it elsewhere. Unknown to Prins, but about the same time, Gregory L. Dougherty collected specimens of *C. reburrus* from several tributaries of the French Broad River in the vicinity of Black Mountain, Buncombe County, North Carolina. Furthermore, juvenile specimens that the junior author had tentatively assigned to *C. acuminatus* Faxon, 1884, had been obtained from three additional localities in the French Broad drainage system.

In view of the facts that *C. reburrus* seems to be widely dispersed in the French Broad drainage and that the type-locality is the only one situated outside of it, it seems possible, if not probable, that the population described by Prins in the headwaters of the Savannah River is an introduced one. That the type-locality is on "a short tributary leading from an impoundment (Sapphire Lake) . . ." (Prins, loc. cit., p. 458) provides

---

[1] Supported in part by the U.S. Department of the Interior, Office of Water Resources Research, Project No. A-001-SC, Clemson University, Clemson, South Carolina.

all the more reason to suspect that this population was derived from the "left-overs" of a fisherman's bait bucket. Because the range of *C. reburrus* is so poorly known, the unpublished localities are cited below.

We wish to thank all of those who have assisted in obtaining specimens of *C. reburrus* and the new species for us, particularly Mr. Dougherty who donated the fine series from the Black Mountain area. We are grateful to Fenner A. Chace, Jr. and Martha R. Cooper for their criticisms of the manuscript and to Carolyn B. Gast for the illustrations.

Cambarus (*Puncticambarus*) *reburrus* Prins

Cambarus acuminatus.—Faxon, 1884: 114, 144 [part]; 1885: 68, 178 [part].—Underwood, 1886: 365 [part].—Faxon, 1890: 624 [part].—Hay, 1899: 959 [part].—Harris, 1903: 59, 68, 137, 147, 154, 156 [part].—Ortmann, 1913: 336, 366 [part].—Newcombe, 1929: 279, 280 [part].—Brimley, 1938: 503 [part].

Cambarus montanus acuminatus.—Ortmann, 1931: 110, 118 [part].—Crocker, 1957: 42 [part].

Cambarus reburrus Prins, 1968: 458–461, 11 figs.

"advanced relative . . . of *C.* (*V.*) *pristinus*" Hobbs, 1969: 167.

Type-locality: "Small tributary to the Horsepasture River from Sapphire (= Fairfield) Lake off U.S. 64, 5.5 miles east of Cashiers, Jackson County, North Carolina." [Savannah River Drainage].

All except the latter two references included in the synonymy are based on misidentifications made by Faxon (1884: 114) and/or Ortmann (1931: 110) on specimens obtained from the Swannanoa River at Asheville and Black Mountain, Buncombe County, North Carolina.

Additional Localities: NORTH CAROLINA [French Broad River Drainage], Buncombe County—Several localities in the immediate vicinity of Black Mountain, 9♂I, 3♂II, 6♀, 17 juv. ♂, 25 juv. ♀, collected in 1967 and 1970, G. L. Dougherty, coll.; 2.1 miles east of Swannanoa, 2j♂, 3j♀, 5 Sept. 1949, W. R. West and H. H. Hobbs, Jr., coll. Madison County—3.5 mi. west of Old Fort in Pisgah National Forest on U.S. Hwy. 70., 1j♂, 17 June 1940, J. C. Moore, coll. These specimens are somewhat atypical and are thus tentatively assigned to this species. Transylvania County—Davidson River at the junction of U.S. Hwys. 64 and 276, 1j♂, 25 June 1957, E. A. Crawford, Jr., coll. All of these specimens are deposited in the Smithsonian Institution.

Doughtery found first form males in the Buncombe County localities in February, March, and July, and Prins (loc. cit., p. 461) collected those in the type-series in April, May, and November.

Cambarus (Puncticambarus) chaugaensis new species

Cambarus (*Puncticambarus*) sp. E Hobbs, 1969: 102, 134, 135.

Diagnosis: Body pigmented, eyes moderately large and well developed. Rostrum with gently convergent margins, lacking marginal spines or tubercles. Areola 2.2 to 3.2 times longer than wide and comprising 29.3 to 35.5 (only one individual more than 34.8) percent of entire length of carapace with 5 to 8 punctations across narrowest part. Cervical spines comparatively small, only slightly larger than adjacent tubercles. Suborbital angle moderately strong, frequently acute. Postorbital ridges terminating cephalically bluntly in small subspiniform tubercles. Antennal scale approximately 2.5 times longer than broad, broadest slightly distal to midlength. Chela with width of palm greater than 1.3 times length of mesial margin, with 2 rows of tubercles along mesial surface of palm, mesial row consisting of 5 to 7 tubercles; distolateral margin of palm and fixed finger costate, and both fingers with well-defined longitudinal ridges on upper surface. First pleopod of first form male with moderately long, corneous central projection recurved caudally at angle of approximately 90 degrees, slightly tapering, and with subapical notch; mesial process noncorneous, somewhat inflated, with slenderer apical portion directed caudolaterally. Annulus ventralis slightly movable, shallowly embedded in sternum, subsymmetrical, and comparatively weakly sculptured.

Holotypic Male, Form I: Body subovate, depressed (Fig. 1a, j). Abdomen narrower than thorax (13.3 and 15.3 mm); greatest width of carapace greater than depth at caudodorsal margin of cervical groove (15.3 and 11.0 mm). Areola broad, 2.7 times longer than wide, with 7 punctations across narrowest part; length of areola 32.3 percent of entire length of carapace. Rostrum with slightly elevated, weakly swollen margins converging to base of acumen, then more abruptly tapering to slightly upturned, acute, corneous tip; latter reaching anteriorly to base of ultimate segment of antennular peduncle. Upper surface of rostrum weakly concave. Subrostral ridges very weak and evident in dorsal aspect to level of caudalmost margin of cornea of eye. Postorbital ridges well developed with small corneous, spiniform tubercles cephalically and deeply grooved dorsolaterally. Suborbital angle obtuse but clearly defined. Branchiostegal spines well developed. Small cervical spine on each side of carapace situated cephaloventral to small group of tuberosities. Carapace punctate dorsally, granulate laterally.

Abdomen longer than carapace (32.1 and 28.7 mm); pleura moderately long: first comparatively large; second subovate, rounded caudoventrally; and third through sixth truncate ventrally, rounded cephalo- and caudoventrally. Cephalic section of telson with 3 spines in each caudolateral corner, mesial 2 on each side articulated at base. Proximal podomere of uropod with strong spine on inner lobe; mesial ramus with well-developed dorsomedian keel terminating in small distal spine not

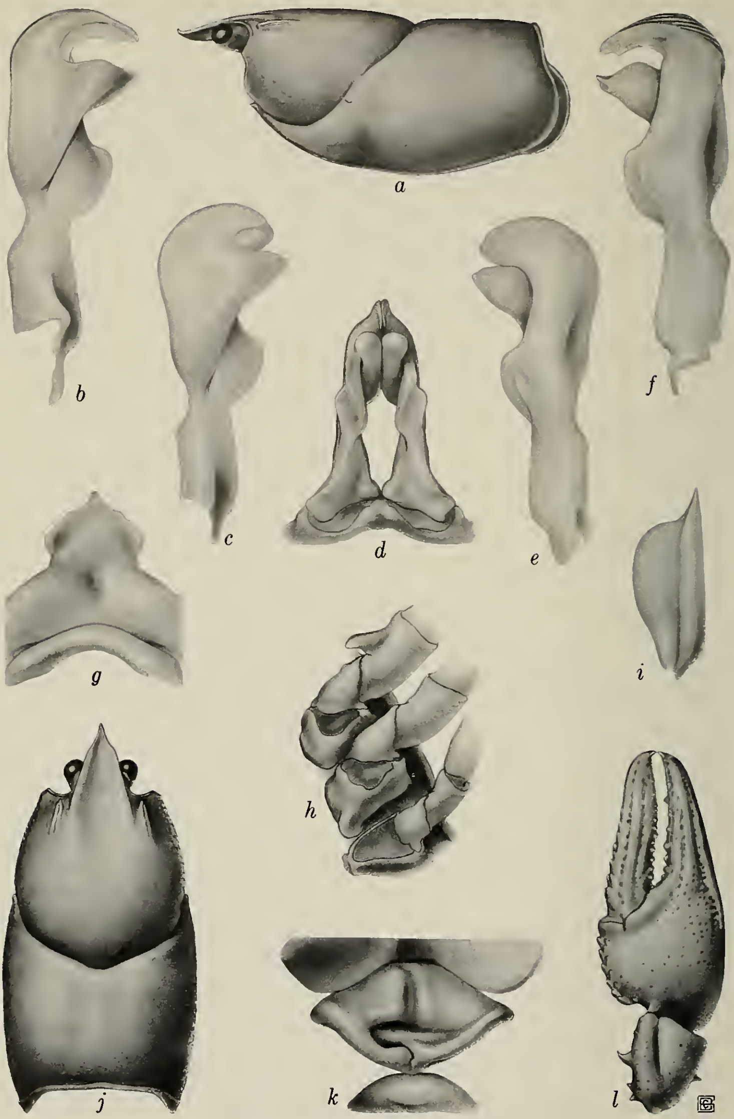


FIG. 1. *Cambarus chaugaensis* new species (pubescence removed from all structures illustrated). a, Lateral view of carapace of holotype. b, Mesial view of first pleopod of paratypic male, form I. c, Mesial view of first pleopod of morphotypic male. d, Caudal view of first

reaching distal margin of ramus; outer ramus with usual transverse row of small spines across distal margin of proximal section.

Projecting portion of epistome (Fig. 1g) subtriangular, broader than long with crenulated cephalolateral margins. Antennules of usual form with small median spine on ventral surface distal to midlength. Antennae reaching caudal margin of fourth abdominal tergite. Antennal scale (Fig. 1i) 2.5 times longer than broad, broadest slightly distal to midlength; mesial margin of lamellar area evenly rounded; thickened lateral portion terminating in prominent spine extending beyond tip of rostrum.

Right chela (Fig. 1l) about twice as long as wide, somewhat depressed with inflated palm; inner margin of palm with row of 6 prominent tubercles, row of 6 weaker ones immediately dorsolateral to it, and single tubercle below and between fourth and fifth tubercles of mesial row; ventral surface of palm with small tubercle proximal to articulation with dactyl; remainder of palm punctate. Fingers only slightly gaping. Opposable margin of immovable finger with row of 9 tubercles (fourth from base largest) along proximal four-fifths, and with single acute one on lower level between seventh and eighth tubercle from base; row of minute denticles situated distal to fourth tubercle interrupted only by fifth and sixth; dorsal and ventral surfaces of finger with median longitudinal ridges flanked on both sides by punctate grooves, grooves deeper on dorsal surface; lateral margin costate; base of finger slightly impressed dorsally and ventrally. Opposable margin of dactyl with row of 12 tubercles along proximal four-fifths and minute denticles between, and distal to, third through twelfth tubercles; dorsal and ventral surfaces similar to those of immovable finger; mesial surface with prominent, rounded tubercles, diminishing in size distally, along proximal half of finger.

Carpus longer than broad (8.7 and 6.0 mm) with deep, slightly oblique longitudinal furrow on upper surface; dorsal and lateral surfaces punctate; mesial surface with centrally located prominent spiniform tubercle and smaller, stout, acute one proximal to it; ventral surface with 1 prominent submedian distal tubercle and knoblike one proximomesial to it.

Dorsal surface of merus tuberculate along distal half with cluster of

---

←

pleopods of paratypic male. e, Lateral view of first pleopod of morphotypic male. f, Lateral view of first pleopod of paratypic male, form I. g, Epistome of holotype. h, Bases of third, fourth, and fifth pereiopods of holotype. i, Antennal scale of paratypic male, form I. j, Dorsal view of carapace of holotype. k, Annulus ventralis and adjacent sternal elements of allotype. l, Dorsal view of distal podomeres of cheliped of holotype.

4 rounded tubercles near distal end; ventral surface of merus with single row of 11 tubercles corresponding to ventromesial row of other species; lateral row represented by only 2 large tubercles; laterodistal margin armed with slight tuberculate swelling. Ventromesial margin of ischium with row of 4 tubercles.

Hooks on ischia of third pereiopods only (Fig. 1h); hooks strong and simple, extending proximally much beyond basioischial articulation and opposed by low tubercle on basis. Coxae of fourth pereiopods with prominent caudomesial, obliquely vertically disposed, rounded boss; coxae of fifth pereiopods without prominences. See Table I.

First pleopods (Fig. 1b, d, f) reaching coxae of third pereiopods when abdomen flexed. See Diagnosis for description.

Allotypic Female: Differs from holotype in secondary sexual characters and the following: Base of acumen imperceptibly continuous with remainder of rostrum, rostral surface almost flat; suborbital angle spiniform; cephalic section of telson with only 2 spines in caudosinistral corner; cephalolateral margins of epistome less undulating; inner margin of palm of left chela with mesial row of 7 tubercles and adjacent dorsolateral row of 5; opposable margin of immovable finger with row of 6 tubercles and tubercle below row situated at base of distal fourth of finger; dactyl with only 10 tubercles on opposable margin; tubercle on ventral distolateral condyle of carpus more spiniform; dorsodistal cluster of tubercles on merus represented by 2 acute strong spines; mesioventral surface of merus with row of 8 tubercles on right cheliped, 10 on left, and with 1 and 2, respectively, lateral to row; ischia with row of 5 tubercles. First pleopods uniramous and reaching midlength of annulus when abdomen flexed. See Measurements (Table 1).

Annulus ventralis (Fig. 1k) subquadrangular, slightly movable, concave ventrally, with long low longitudinal ridges flanking cephalomedian trough in cephalic half; sinus originating at caudal end of trough, extending dextrally from median line, making hairpin turn and returning to median line, bending caudally and reaching caudal wall of annulus; tongue directed dextrad between horizontal arms of sinus. Sternal plate caudal to annulus subovate, approximately 3 times broader than long. See Table I.

Morphotypic Male, Form II. Differs from holotype in following respects: subrostral ridges evident in dorsal aspect to base of acumen; suborbital angle strongly acute; cephalic section of telson with 2 spines in each caudolateral corner; lateral lobe of proximal podomere of uropod with small spine but much more weakly developed than that on mesial lobe; epistome with cephalolateral margins more convex and less irregular; left chela (right regenerated) with only 5 tubercles in more lateral row on inner margin of palm; opposable margin of immovable finger with row of 10 tubercles, that of dactyl with 11; proximomesial surface of dactyl with greater number of tubercles; merus with ventromesial row of 8 tubercles; ischium with ventral row of 3; hooks on ischia of third pereiopods much reduced, not over-reaching basio-

Table 1. Measurements (in mm) of *Cambarus chaugaensis* new species.

	Holotype	Allotype	Morphotype
Carapace			
Height	11.0	11.0	11.6
Width	15.3	14.6	16.6
Length	28.7	27.7	30.4
Rostrum			
Width	4.2	4.0	4.8
Length	6.0	6.2	4.8
Areola			
Width	3.4	3.4	3.8
Length	9.2	8.6	10.0
Chela			
Length, dactyl	14.7	11.5	16.8*
Length, palm	7.8	5.7	9.5
Length, outer margin of hand	24.8	18.6	29.0
Width, palm	11.2	8.5	13.7

* Left chela.

ischial articulation; boss on coxa of fourth pereiopod also reduced. See Table 1.

First pleopod (Fig. 1c, e) with neither terminal element corneous and both with apices more rounded. Proximal opening of sperm groove not nearly so distinctly delimited as in holotype.

Type-locality: Chauga River at Cassidy Bridge (off County Road 290), Oconee County, South Carolina. This locality is in the upper southwestern corner of the State in the headwaters of the Savannah River. The Chauga River now empties into a relatively new impoundment, Lake Hartwell. At the type-locality, it is about of 40 feet wide and 3 feet deep in mid-channel during modal flows; substrates consist primarily of boulders and rocks.

Disposition of Types: All known specimens are deposited in the Smithsonian Institution: holotypic male, allotypic female, and morphotypic male (nos. 131926, 131927, and 131928, respectively). The paratypic series consists of 25 males, Form I; 56 males, Form II; 45 females; 75 juvenile males; 62 juvenile females, and 11 ovigerous females.

Specimens Examined: All from tributaries of the Savannah River in Oconee County, SOUTH CAROLINA: (1) Type-locality, 11♂I, 4♂II, 7♀, 7 Nov. 1967, R. P. et al, coll.; 1♂I, 1♂II, 7♀, 28 July 1966, R. P. et al, coll.; 12♂II, 1♀, 5j♂, 2j♀, 4 ovig. ♀, 17 May 1967, V. H. McCaskill and J. R. Cunningham, coll. (2) Ramsey Creek at U.S. Hwy. 76, 5 miles west of Westminster, 2♂I, 3♀, 2j♂, 3j♀, 9 March 1967, R. P. and G. E. Dillard, coll.; 16j♂, 10j♀, 3 ovig. ♀, 23 April 1967, R. P., H. H. H., Jr., et al, coll.; 1♂I, 1♀, 1j♂, 1j♀, 26 Nov. 1966, R. P. and G. E. D., coll. (3) Ramsey Creek, 0.6 miles west of S. C. Rte. 36, 1♂II, 28 July 1966, R. P. et al, coll. (4) Tributary to Ramsey Creek (near headwaters), 4.5 miles northwest of Westminster, 1j♂, 2j♀, 13 Jan. 1967, R. P. et al, coll. (5) Village Creek at S. C. Rte. 258, 1♂I, 9♂II, 14j♂, 10j♀, 2 ovig. ♀, 17 May 1967, V. H. M. and J. R. C., coll. (6) West Village Creek at S. C. Rte. 258, 1♂I, 3♂II, 6♀, 28 July 1966, R. P. et al, coll. (7) Cane Creek at S. C. Rte. 183, near Walhalla, 7j♂, 13j♀, 23 April 1967, R. P., H. H. H., Jr., et al, coll.; 1♂I, 6j♂, 1j♀, 26 Nov. 1966, R. P. and G. E. D., coll. (8) Cane Creek, 3 miles southwest of Walhalla on S. C. Rte. 28, 1♂I, 1♂II, 1♀, 1j♂, 25 March 1951, E. C. Raney, et al, coll. (9) Cedar Creek, 5 miles west and 2 miles north of Walhalla, 2♂I, 14♂II, 14♀, 6j♂, 14j♀, 28 July 1966, R. P. et al, coll. (10) Seneca Creek, 0.1 mile south of U.S. Hwy. 76, 3♂II, 3♀, 1j♂, 1j♀, 28 July 1966, R. P. et al, coll. (11) Rocky Fork Creek at Ramey's Mill, west of Westminster on U.S. Hwy. 76, 1♂I, 1♀, 14 Oct. 1967, R. P. and G. E. D., coll. (12) Headwaters of Chauga River, 1.8 miles southeast of Mountain Rest on S. C. Rte. 28, 6♂I, 2♂II, 2j♀, 25 March 1951, E. C. R. et al, coll. (13) Little Cane Creek, Walhalla, 23j♂, 23j♀, 28 March 19??, collector unknown. (14) 15 miles south of N. C.–S. C. state line on S. C. Rte. 28, 1♂II, 1♀, 4 June 1962, W. S. Woolcott and J. S. Ramsey, coll. (15) Small stream west of Jocassee, 3♀, 15 May 1954, B. Martof, coll. (16) Whitewater River near Jocassee, 1♂II, 1j♀, 18 July 1952, coll. unknown. (17) Colonels Fork at S. C. Rte. 183, 2j♀, 23 April 1967, R. P., H. H. H., Jr., et al, coll. (18) Stream between Long Creek and Chatooga on U.S. Hwy. 76, 3♂II, 1♀, 13j♂, 5j♀, 2 ovig. ♀, 23 April 1967, R. P., H. H. H., Jr. et al., coll.

Size: The largest specimen available is a first form male having a carapace length of 38.9 mm, the smallest first form male, 25.1 mm. The largest female has a corresponding length of 38.0 mm, the largest ovigerous female, 34.7 mm, and the smallest ovigerous female, 25.2 mm.

Color Notes: Carapace olive green dorsally fading to light green lateroventrally, and mottled (conspicuously so dorsally) with dark olive brown to black markings; lower half of hepatic area and branchiostegites with large irregular splotches, those on caudodorsal surface of branchiostegites forming base of irregular and broken dorsolateral longitudinal stripes on abdomen; lateral surfaces of branchiostegites with splotches loosely united to form second band continuous with that extending along bases of pleura of abdomen. Dorsal surfaces of podomeres distal to ischia on chelipeds and other pereiopods bearing coloration similar to that on body proper; carpus of cheliped with prominent proximo- and distolateral splotches as well as one at base of major mesial spine and another on mesiodistal angle; tips of fingers of chelae yellowish to red; ventral surfaces of pereiopods and sternum cream-colored, and antennae reddish brown.

Relationships: *Cambarus chaugaensis*, although more closely allied to the members of the subgenus *Puncticambarus* than to *Cambarus*, has fewer than 8 tubercles on the mesial margin of the chela; consequently, utilizing Hobbs' key (1969: 95–96) to the subgenera, it would be identified as a member of the subgenus *Cambarus*. The broad, punctate areola in combination with the tapering rostrum, however, will serve to separate it from species belonging to the subgenus *Cambarus*.

Cambarus chaugaensis resembles most closely those members of the subgenus lacking marginal spines on the rostrum: *C. acuminatus*, *C. reburrus*, *C. robustus* Girard, 1852, and *C. veteranus* Faxon, 1914 (see Hobbs, 1969: 101–102). It may be distinguished from *C. acuminatus* by possessing a distinct suborbital angle and more weakly developed cervical spine. It differs from *C. reburrus* in having a shorter, more tapering rostrum, weaker cervical spines, and a chela that is more depressed, less setiferous, and having a shorter, broader palm (length of chela greater than 3 times length of inner margin of palm, less than 3 in *C. reburrus*; width of palm greater than 1.3 times length of inner margin, less than 1.3 in *C. reburrus*). The areola of *C. chaugaensis* is less than 3.5 times longer than broad whereas that of *C. robustus* and *C. veteranus* is greater than 3.5.

Life History Notes: First form males were collected in March, May, July, October, and November. The 11 ovigerous females were found in April and May. On the basis of the size ranges in the specimens examined, it seems probable that *C. chaugaensis* has a life cycle virtually identical to that outlined by Smart (1962) for *Cambarus longulus* Girard.

LITERATURE CITED

BRIMLEY, C. S. 1938. The insects of North Carolina, being a list of the insects of North Carolina and their close relatives. North Carolina Dept. Agri., Raleigh, pp. 1–560.

CROCKER, DENTON W. 1957. The crayfishes of New York State (Decapoda, Astacidae). Bull. N.Y. St. Mus. Sci. Serv., no. 355: 1–97, 5 pls, 7 figs.

FAXON, WALTER. 1884. Descriptions of new species of *Cambarus*, to which is added a synonymical list of the known species of *Cambarus* and *Astacus*. Proc. Amer. Acad. Arts and Sci. 20: 107–158.

———. 1885. A revision of the Astacidae, Part I. The genera *Cambarus* and *Astacus*. Mem. Mus. Comp. Zool., Harvard College 10(4): i–vi, 1–186, 10 pls.

———. 1890. Notes on North American crayfishes, Family Astacidae. Proc. U.S. Nat. Mus. 12 (785): 619–634.

———. 1914. Notes on the crayfishes in the United States National

Museum and the Museum of Comparative Zoology with descriptions of new species and subspecies to which is appended a catalogue of the known species and subspecies. Mem. Mus. Comp. Zool., Harvard College, 40(8): 351–427, 13 pls.

GIRARD, CHARLES. 1852. A revision of the North American Astaci, with observations on their habits and geographical distribution. Proc. Acad. Nat. Sci., Philad., 6: 87–91.

HARRIS, J. ARTHUR. 1903. An ecological catalogue of the crayfishes belonging to the genus Cambarus. Kan. Univ. Sci. Bull. 2 (3): 51–187, 4 pls.

HAY, WILLIAM PERRY. 1899. Synopsis of North American Invertebrates—The Astacidae of North America. Amer. Nat. 33 (396): 957–966.

HOBBS, HORTON H., JR. 1969. On the distribution and phylogeny of the crayfish genus *Cambarus*. *In* Holt, Perry C., Richard L. Hoffman, and C. Willard Hart, Jr., The distributional history of the biota of the Southern Appalachians, Part I: Invertebrates. Va. Polytechnic Institute, Research Division Monograph 1: 93–178, 20 figs.

NEWCOMBE, CURTISS L. 1929. The crayfishes of West Virginia. Ohio. Journ. Sci. 29 (6): 267–288, 2 figs.

ORTMANN, ARNOLD E. 1913. The Alleghenian Divide, and its influence upon the freshwater fauna. Proc. Amer. Philso. Soc. 52(210): 287–390, 3 pls.

———. 1931. Crawfishes of the Southern Appalachians and the Cumberland Plateau. An. Carnegie Mus. 20(2): 61–160.

PRINS, RUDOLPH. 1968. A new crayfish of the genus *Cambarus* from North Carolina (Decapoda, Astacidae). Journ. Elisha Mitchell Sci. Soc. 84(4): 458–461, 11 figs.

SMART, GROVER C., JR. 1962. The life history of the crayfish *Cambarus longulus longulus*. Amer. Midl. Nat. 68(1): 83–94, 4 figs.

UNDERWOOD, LUCIEN M. 1886. List of the described species of freshwater Crustacea from America, north of Mexico. Bull. Ill. St. Lab. Nat. Hist. 2(5): 323–386.

Vol. 84, No. 48, pp. 421–426 29 February 1972

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

MIDGARDIA XANDAROS NEW GENUS, NEW SPECIES, A LARGE BRISINGID STARFISH FROM THE GULF OF MEXICO

By Maureen E. Downey
Smithsonian Institution, Washington, D. C. 20560

In the late summer of 1968 the Texas A&M University R/V "*Alaminos*" collected in the southern Gulf of Mexico what is probably the largest starfish on record. It proved to represent a new genus and species, and I thank Dr. Willis Pequegnat of Texas A&M University, chief scientist on the cruise, for allowing me to examine and describe the specimen. I am also grateful to the scientific staff and the crew of the "*Alaminos*" for their care in handling the dredge and removing the starfish from it so that the specimen could be photographed intact. Thanks are also due to Mr. Bela James for photographing the animal before it broke up, and to Dr. David L. Pawson for reading and advising me on the manuscript.

Starfishes of the family Brisingidae are notably fragile, having many long thin rays, sharply distinct from the small, round disc. Because of their general form and very brittle skeleton, as well as their remarkable ability to cast off rays at the slightest disturbance, brisingids bear a strong superficial resemblance to the Ophiuroidea. They occur only in deep water, and it is therefore most unusual to collect a whole fully grown specimen. Only the fortunate circumstances of using a dredge with a 3-meter-wide opening, and of its apparently picking up the specimen just before it left the bottom, so that the starfish caught in the front of the dredge and did not slide back into the box end, brought this animal to the surface intact. A second specimen in the same dredge haul was found in the box end, but it was, of course, in fragments.

ORDER EUCLASTERIDA TORTONESE, 1958

With the characters of the family Brisingidae.

BRISINGIDAE SARS, 1875

Rays many, deciduous, sharply distinct from small circular disc. Ambulacral and adambulacral plates vertebralike, not compressed. Tube feet biserial. Dorsal skeleton weak, never reticulate, confined to proximal third of ray. Pedicellariae abundant, crossed, never straight. Mouth plates expanded; mouth large, with broad peristomial membrane. Papulae lacking or confined to disc and/or genital region of rays. Marginal and adambulacral spines long, delicate, acicular, ensacculate.

Midgardia new genus

With the characters of the type-species, *M. xandaros* new species.

Etymology: N., from the Midgard (middle earth) serpent, of Norse mythology, which lies at the bottom of the sea and encircles the earth.

Midgardia xandaros new species

Etymology: Gr., xandaros—a fabulous sea monster.

Material examined: Holotype (USNM E 11420), and one paratype, "*Alaminos*" Station 69–A–11, 19°02.6′N, 95°27.5′W, 250 fms, 18 August 1969. R—680 mm, r—13 mm, Rr—1:60.

The disc is small (approx. 29 mm diameter), and plane (height 7 mm), covered by a thin abactinal tegument containing numerous small round plates, most of them bearing a single small pricklelike acicular spinelet. There is a central anal pore surrounded by a dense cluster of these plates, the spinelets here being more numerous and slightly longer. Around the upper periphery of the disc, there is a single row of small papulae, two over each arm. The tumid, almost conical madreporite is at the edge of the disc, interradial, irregular, and wartlike.

There are 11–12 long (approx. 600 mm), attenuate arms, covered abactinally with a thin tegument. Starting at about the 4th adambulacral, there are 25–28 costal arches, some incomplete (strongest and most complete over the genital region). From about the 10th adambulacral to about the 22nd, the arm is inflated (genital region). Beyond the gonadal swelling, the arches become thinner and eventually disappear altogether, being replaced by dense bands of small pedicellariae. The costae, of elongate, imbricate plates, arise from the center of each adambulacral and meet (or, frequently, pass) each other in the carinal region of the arm. Most of the costal plates bear a small, pricklelike acicular spinelet. Numerous flat, thin, irregularly rounded plates are scattered in the tegument between the costae in the genital region; elsewhere, these plates are absent, and the ambulacrals are plainly visible thru the thin tegument.

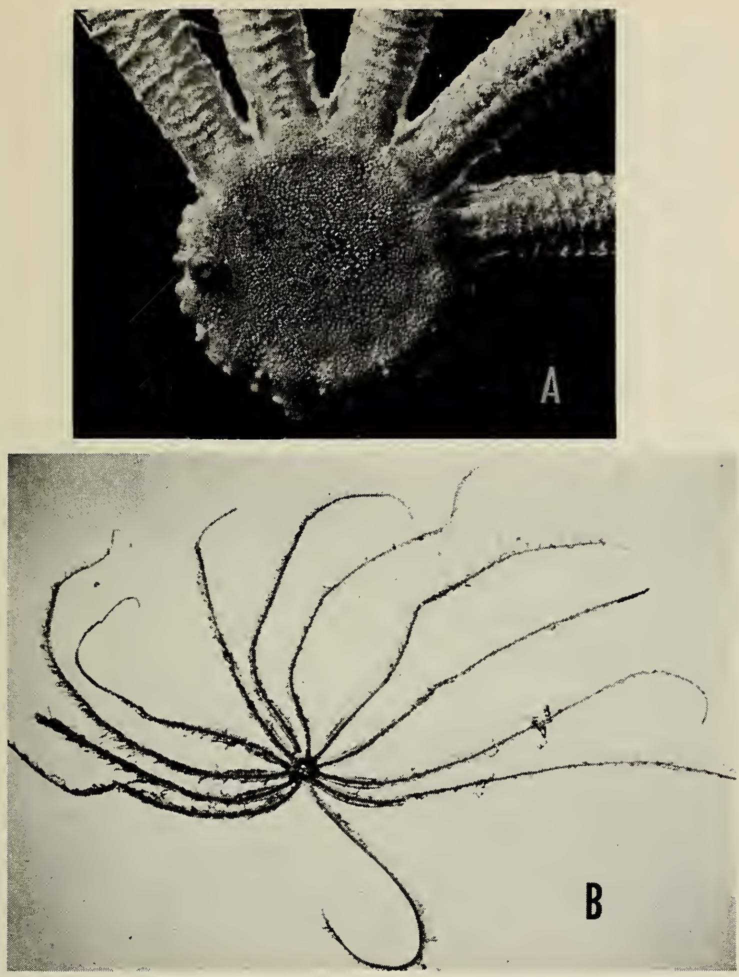


FIG. 1. *Midgardia xandaros* new genus, new species, holotype (USNM E 11420), A, Abactinal surface of the disc; actual size, disc diameter = 26 mm. B, Overall view of actinal surface, taken aboard ship immediately after removal from dredge; actinal size, arm tip to arm tip = 1380 mm.

There is a continuous heavy calcareous ring around the disc inside the mouth, and the mouth plates rest on and are partially fused to it. The mouth plates are smaller than the first adambulacrals and bear, on the oral edge, 2–4 slender delicate spines; there is a single similar spine at the distal outer corner of the plate. On the actinal face is a much larger, long acicular spine. The second ambulacrals are compressed between the massive, tumid, fused first ambulacrals which form the calcareous ring, and the normal, vertebralike third ambulacrals. The second ambulacrals and adambulacrals, together with the first pair of marginals, form the outer wall of the disc when the arms are removed. One of the paired marginals separates the adjacent adambulacrals, as in the genus *Brisinga.*

The ambulacral groove is broad and shallow. There is a deep channel for the radial water vessel, bridged over between each pair of ambulacrals by a narrow band of calcite. The long, biserial tubefeet terminate in small suckers and are stiffened at the base by a thin calcareous collar. They rest in very large cuplike basins between the ambulacrals. In dorsal aspect, the ambulacral pores are covered with a thin membrane which appears to be only slightly expandable; indeed, it can hardly be called an ampulla. The tubefeet, which were very long and agile in the living specimen, therefore probably had a limited ability to contract. Sars (1875), in his study of the structure of the related genus *Brisinga,* noted that the tubefeet were not so highly contractile as in other starfishes.

The vertebra-shaped adambulacrals each bear 3–4 fine sharp furrow spines, 1–2 mm long, 2 on the distal edge of the plate and 1–2 on the proximal edge. There is a single, larger, acicular subambulacral spine, up to 10 mm long.

Between the disc and the genital region of the arm, there are 11–13 marginal plates in single series, not bearing spines. The second marginal is modified to form an attachment on the oral face with the distal face of the first marginal (which forms part of the disc wall), and on the lateral face with the second marginal of the adjoining arm. From the beginning of the genital region on, there is one tumid marginal to about every other adambulacral, each bearing a very long acicular spine, up to 25 mm long beyond the genital region. There is only one series of marginals.

Distally, the arms become extremely attenuate, terminating in a tiny, broader-than-long, down-curved plate (less than .4 mm wide), armed on the actinal edge with small spines, so that it looks like a tiny cat's-paw with claws extended.

The subambulacral spines and marginal spines bear a flap of tissue at the tip, and all spines bear numerous pedicellariae.

The pedicellariae are very numerous, and frequently, in the ambulacral groove, a few are enlarged. They are hyaline, crossed, with two long, curved, almost C-shaped valves, finely denticulate at the upper end, and arising from a flat, oval, sieved base plate.

One or two inconspicuous paired gonopores appear on either side of 1–2 of the central costae of the genital region, on either side of the arm between the marginals and the top of the arm. It was not possible to determine the exact arrangement of the gonads, but probably there were 4 to each arm (inferred from the disposition of the gonopores).

Discussion: This genus closely resembles *Brisingenes* Fisher in having a single circle of small papulae around the margin of the disc, 2 corresponding to each ray. The numerous pedicellariae strongly resemble those of *Brisingenes*, but unlike *Brisingenes*, this genus does not have any pedicellariae on the abactinal surface of the disc. It differs from *Brisingenes* mainly, however, in having the 1st pair of adambulacrals in each interbrachium separated by the intrusion of one of the paired marginals above. In this feature, it most closely resembles the genus *Brisinga* Asbjørnsen, the arrangement of the plates around the edge of the disc (with arms removed) being almost exactly as in Figs. I and 2 of Fisher's 1917 paper. However, this genus differs from *Brisinga* in having numerous intracostal plates in the tegument of the genital region. The genus to which this bears the closest resemblance is *Stegnobrisinga* Fisher; like *Stegnobrisinga*, there are numerous immersed plates in the intracostal tegument, the proximal adambulacrals are higher than long, and the proximal subambulacral spines acicular rather than truncate or flared-tipped. However, *Stegnobrisinga* has no papulae, according to Fisher, and the costae are much more numerous.

The holotype, a female, arrived at the surface whole, caught on the front of the dredge. It was bright red, and measured over 130 cm from arm tip to arm tip ($R = 68$ cm). This is probably the largest brisingid on record, and may be the largest starfish known, although it is certainly not the bulkiest. The largest previously recorded starfish was a specimen of *Pycnopodia helianthoides*, from Puget Sound, reported by Dr. C. McLean Fraser to W. K. Fisher (1928); this specimen had a major radius of 40 cm. Prof. F. J. Bell (1889) recorded a specimen of *Luidia savignyi*, from Mauritius, as being the largest starfish, with a major radius of 37 cm. A specimen of *Luidia magnifica* from Hawaii, in the collection of the National Museum of Natural History, measures 40 cm (R). Of course, *Pycnopodia* may weigh as much as 5 kilograms, while the dry weight of this specimen of *Midgardia* is only about 70 grams.

The gonads were ripe, and strands of large yolky orange eggs were present. As soon as the dredge was raised from the water and the specimen exposed to the air, it started to autotomize its arms, most of them breaking at the juncture with the disc. The second specimen was at the bottom of the dredge, and pretty well broken up. It was a male, and a quantity of bright red sperm oozed, apparently, from base of the arms, around the periphery of the disc. In both animals, the peristome was wide open, and no trace of food could be found. It is quite likely that this species, and possibly most of the Brisingidae, do not feed directly but absorb nutrients through the general body tissue.

LITERATURE CITED

BELL, F. J. 1889. Note on a remarkably large specimen of *Luidia* from the island of Mauritus. Ann. N. H. iii, p. 422.

FISHER, WALTER K. 1916. New East Indian Starfishes. Proc. Biol. Soc. Washington, vol. 29, pp. 27–36.

———. 1917. New genera and species of Brisingidae. Ann. and Mag. Nat. Hist., ser. 8, vol. 20, pp. 418–431.

———. 1928. Asteroidea of the North Pacific and adjacent waters. II. Forcipulata (part). U.S. Nat. Mus. Bull. 76, pp. 1–245, 81 pls.

SARS, GEORGE O. 1875. On some remarkable forms of animal life from the great deeps off the Norwegian Coast. II. Researches on the structure and affinity of the genus *Brisinga*, based on the study of a new species: *Brisinga coronata*. Christiania, 112 p., 7 pls.

TORTONESE, ENRICO. 1958. Euclasteroidea: A new order of Asteroidea (Enchinodermata). Dorina, Supplemento agli Annali del Museo Civico di Storia Naturale "G. Doria", Genova, II (88): 1–3.

Vol. 84, No. 49, pp. 427–434 29 February 1972

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

A NEW GENUS AND NEW SPECIES OF WATER BEETLE FROM BOLIVIA WITH A KEY TO THE GENERA OF THE WESTERN HEMISPHERE COLYMBETINI (COLEOPTERA: DYTISCIDAE)[1]

By Paul J. Spangler
Smithsonian Institution, Washington, D. C. 20560

The interesting new genus and species of dytiscid beetle described below was collected in 1969 during an extended field trip in South America.

The new genus keys to the tribe Colymbetini and to the genus *Meladema* in Zimmerman's (1919) review of the subfamily Colymbetinae. In Brinck's (1948) review of the tribes of the subfamily Colymbetinae, this new genus does not key clearly to the Colymbetini because the metatarsal segments are not distinctly lobed on the outer, lower part but are feebly lobed only on the basal two segments. However, in comparing the other genera in the Colymbetinae with the new Bolivian form, I found that some other species in the tribe Colymbetini, e.g., *Rhantus vianus* Aubé and *R. validus* Sharp, possess feebly lobed metatarsal segments similar to the new genus. Because this new genus keys satisfactorily in Zimmerman's key and agrees with Brinck's analysis of the Colymbetini in all characters except the variable lobing of the hind tarsal segments, I assign this new genus to the Colymbetini.

Bunites new genus

Head large, broadest across eyes. Eyes emarginate above bases of antennae. Labrum broadly emarginate medially, with dense fringe of golden setae in emargination. Clypeus arcuate anteriorly. Maxillary palpus 4 segmented; basal segment short, about one-third length of

---

[1] This study was made possible by Smithsonian Institution Grant No. Sg063310.

second segment; second segment slightly shorter than third segment; third segment slightly shorter than fourth segment; fourth segment swollen, with a glabrous dorsal sensory region at basal third, a glabrous and depigmented lateral sensory region at apical fourth and a ventral seta-bearing area at apical third. Ligula subquadrate. Anterior margin of mentum bisinuate. Labial palpus 3 segmented; basal segment short, about one-third as long as second segment; second and third segments subequal; third segment swollen just beyond midlength (in lateral view), with 2 fine seta-bearing sensory areas ventrally at apical third.

Pronotum more than twice as wide as long; margined laterally; anterolateral angles acute, prolonged anteriorly; posterolateral angles obtuse; base narrower than base of elytra. Prosternum convex medially. Prosternal process distinctly convex; margined; apex acute, extending between mesocoxae and fitting in a deep notch in metasternum.

Elytra convex; slightly wider at apical third; base wider than base of pronotum; narrowly margined laterally. Metasternal wings broadly wedge-shaped. Metasternum with a weak longitudinal sulcus becoming deeper between metacoxal processes. Metacoxal plates broad, slightly incised along posterior margin. Metacoxal lines well separated and diverging anteriorly. Pleurite of second abdominal segment (first visible segment) with strong, transverse rugae.

Male with basal protarsal segment (Fig. 2) longer than next 3 segments combined (in lateral view). Basal mesotarsal segment shorter than segments 2, 3, and 4 combined. Pro- and mesotarsal claws long, stout, and equal in length. Metatibia with several discontinuous, medial, longitudinal rows of large aciculate seta-bearing punctures on anterior (ventral) surface. Basal metatarsal segment longest, twice as long as second segment; metatarsal segments, at most, very slightly lobed in outer lower part; outer metatarsal claw curved and shorter than straighter inner claw. Profemur stout; anterior surface swollen medially and covered with coarse, seta-bearing punctures; with a densely setose sulcus along lower, outer half near hind margin. Mesofemur similar to profemur but lacks the densely setose sulcus. Metafemur gradually widening from base to apex; anterolateral angle strongly rounded; posterolateral angle feebly rounded, almost forming a right-angle.

Parameres (Figs. 3, 6) of male genitalia broadest and curved near base, tapering to slender apices; underside densely pubescent in apical three-fourths. Median lobe curved (side view) and tip recurved (Fig. 5); slightly sinuous and cleft (Fig. 4) from midlength to apex in dorsal view.

Type of the genus: *Bunites phyllisae* new species.

Etymology: *Bunites* from bounites, G.—dweller in the hills. Gender: masculine.

The new genus *Bunites* may be distinguished from the Old World genus *Meladema* by the presence of slightly unequal metatarsal claws and several discontinuous, medial, longitudinal rows of large aciculate seta-bearing punctures on anterior (ventral) surface of the metatibia. *Meladema* has distinctly unequal metatarsal claws and the metatibia has a medial, continuous, longitudinal stria on the anterior (ventral) surface.

The new genus may be separated from the genera of the Colymbetini occurring in the Western Hemisphere by the following key.

KEY TO THE GENERA OF THE TRIBE COLYMBETINI OF THE WESTERN HEMISPHERE

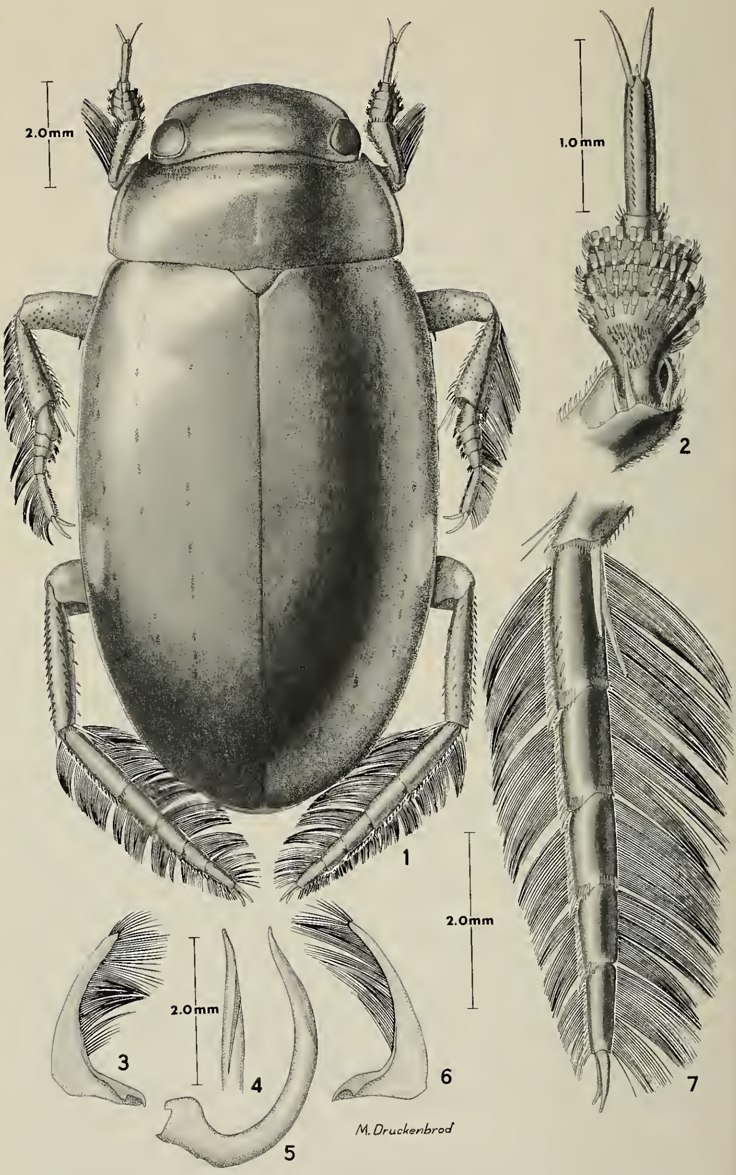
1. Prosternal process flat; dorsal surface of beetle unusually flat; pronotum widely margined laterally; elytra lightly reticulate throughout, meshes rather coarse, unequal, and irregular in shape; North America .... *Hoperius* Fall

   Prosternal process convex or carinate, not flat; pronotum margined or not; elytra coarsely or finely reticulate or with transverse grooves 2
2. Elytral sculpture consisting of many parallel transverse grooves; apex of metasternum strongly depressed and indistinctly notched for apex of prosternal process; North America .... *Colymbetes* Clairville

   Elytra without transverse grooves, reticulate; apex of metasternum slightly or not depressed but distinctly notched for apex of poststernal process 3
3. Body form ovate; sides evenly arcuate, uninterrupted; sides of pronotum continuous with elytra; base of pronotum same width as base of elytra; pronotum usually margined; color usually not black; North, Central, and South America .... *Rhantus* Dejean

   Body form oblong; sides not evenly arcuate, interrupted; sides of pronotum not forming a continuous arc with elytra; base of pronotum narrower than base of elytra; pronotum margined or not; color black 4
4. Pronotum without lateral margin, posterolateral angles acute; elytral reticulation coarse; apex of prosternal spine fits into a shallow notch on apex of metasternum; front tibia incised on inner side at base, strongly so in male; metatarsal segments distinctly lobed on outer, lower part; North America .... *Neoscutopterus* J. Balfour-Browne

   Pronotum with lateral margin, posterolateral angles obtuse; elytral reticulation fine; apex of prosternal spine fits into a deep notch on apex of metasternum; front tibia not incised on inner side at base; only basal 2 metatarsal segments moderately lobed on outer, lower part; South America .... *Bunites* Spangler



Figs. 1–7. *Bunites phyllisae* new genus, new species, ♂ holotype: 1. habitus, dorsal view; 2. left protarsus, ventral view; 3. right paramere, medial view; 4. apex, median lobe, dorsal view; 5. median lobe, lateral view; 6. left paramere, medial view; 7. right metatarsus, ventral view.

Bunites phyllisae new species

Figures 1–7

Holotype male: Length 14.00 mm, greatest width 6.50 mm at apical third. Color of head, pronotum, and elytra piceous except transverse, reddish-yellow macula on middle of head between eyes and short longitudinal, reddish-yellow macula near lateral margin slightly behind midlength on elytron. Epipleuron dark reddish brown. Ventral side of body piceous except metacoxae, posterolateral margins of third, fourth, and fifth abdominal sterna, middle two-fourths of sixth sternum, and last 3 or 4 antennal segments dark reddish brown.

Head finely alutaceous; with numerous, fine punctures scattered over surface, punctures separated by a distance of 1 to 4 times their diameter; with a deep, short, setose, transverse sulcus at anterolateral angle adjacent to labrum; with a few coarse punctures along margin of clypeus between sulci; also a row of coalesced punctures along inner margin of eye, another shorter group of punctures along frontoclypeal suture and a few coalesced punctures between eye and frontoclypeal suture. Clypeus arcuate anteriorly. Labrum finely alutaceous and finely, sparsely punctate; broadly emarginate medially, with dense fringe of golden setae in emargination. Ventral surface of head microreticulate laterally behind eyes; ligula subquadrate and smooth except for a few fine punctures on surface; mentum bisinuate along anterior margin, surface weakly rugose medially, finely alutaceous laterally, with few coarse shallow punctures. Antenna 11 segmented, basal segment longest, second segment shortest, remainder subequal. Maxillary palpus 4 segmented; basal segment short, about one-third length of second segment; second segment slightly shorter than third segment; third segment slightly shorter than fourth segment; fourth segment swollen, with a glabrous dorsal sensory region at basal third, a glabrous and depigmented lateral sensory region at apical fourth and a ventral seta-bearing area at apical third. Labial palpus 3 segmented; first segment short, about one-third as long as second segment; second and third segments subequal; third segment swollen just beyond midlength (in lateral view), with 2 fine, seta-bearing, ventral sensory areas at apical third.

Pronotum more than twice as wide as long; surface sculpture similar to that of head but with numerous very coarse punctures adjacent to anterior and lateral margins and a few near posterior margin; margined laterally; anterolateral angles acute, prolonged anteriorly; posterolateral angles obtuse; base narrower than base of elytra; underside of anterolateral angles with a tuft of long golden setae. Prosternum convex medially. Prosternal process distinctly convex, margined, apex acute, fitting in a deep notch in metasternum between mesocoxae.

Elytra convex; slightly wider at apical third; base wider than base of pronotum; finely margined laterally; surface finely alutaceous, with numerous fine punctures scattered over surface, punctures separated by a distance of 4 to 10 times their diameter; with 3 well-defined serial rows of coarse, seta-bearing punctures on discal area and lateral margin with a row of smaller, poorly defined punctures. Scutellum broadly triangular, twice as wide as long, finely alutaceous. Ventral surface of meso- and metathorax finely alutaceous and rugose. Metasternal wings broadly wedge-shaped with an arcuate series of coarse punctures just behind mesocoxal cavity. Metacoxal plate broad, with fine, widely spaced punctures in addition to alutaceous sculpture. Metacoxal processes separated by deep sulcus, margined laterally, each with a posterior incision; surface smooth except for few, fine punctures. Metacoxal lines distinct posteriorly, diverging and disappearing anteriorly. Abdominal sterna 3, 4, and 5 each with a coarse, medial puncture bearing a tuft of long golden setae; each with a weak, transverse row of fine seta-bearing punctures laterad of medial puncture; posterior three-fourths of last sternum strongly strigose. Second abdominal pleurite with strong, transverse rugae.

Legs finely alutaceous. Profemur stout, anterior surface swollen medially and covered with coarse, seta-bearing punctures; with a densely setose sulcus along lower, outer half adjacent to hind margin of tibia in repose; lower edge with fringe of short, stout, golden setae on proximal half. Protibia gradually widening distally; anterior surface with many coarse, seta-bearing punctures and a dense serial row of similar punctures close to lateral edge of tibia. Protarsus (Fig. 2) with first segment broadened, with basal tuft of golden hairs and 2 apical rows of 10 or 11 golden setae each with a rectangular sucker at apex; second and third segments broadened, each with a row of 8 to 11 golden, sucker-bearing setae; first segment longer than next 3 segments combined (in lateral view); second, third, and fourth segments subequal; fifth segment elongate, longer than segments 2, 3, and 4 combined; claws long, stout, and equal in length.

Mesofemur similar to profemur but lacks the densely setose sulcus. Mesotibia similar to protibia but lacks the serial row of seta-bearing punctures and is more densely covered with coarse, seta-bearing punctures on anterior surface. Mesotarsus with first segment broadened, with sucker-bearing setae; first segment shorter than segments 2, 3, and 4 combined; second and third segments subequal; fourth segment about a fourth longer than third segment; fifth segment about a fourth shorter than combined length of segments 1 through 4; claws long, stout, and equal in length.

Metafemur gradually widening from base to apex; anterolateral angle strongly rounded; posterolateral angle feebly rounded, almost a right-angle; anterior (ventral) surface finely alutaceous along anterior edge, also finely, sparsely punctate except a cluster of 10 to 12 large, coarse, seta-bearing punctures in posterolateral angle. Metatibia finely alutaceous; anterior (ventral) surface with a regular row of coarse seta-bearing punctures along lateral and medial edges; with several medial, discontinuous rows of large aciculate seta-bearing punctures on anterior (ventral) surface. Metatarsus (Fig. 7) with segments, at most, very feebly lobed in outer lower part; basal segment longest, twice as long as second; segments 2, 3, and 4 subequal; fifth segment slightly more than half as long as first; outer claw curved and shorter than straighter inner claw.

Female: Similar to male except pro- and mesotarsus not broadened, lacking sucker-bearing setae, basal segments only as long as second and third segments combined. Tarsal claws and comparative lengths of metatarsal segments similar to male. Setose sulcus along lower, outer half of profemur reduced to a single row of golden setae. Last abdominal sternum weakly strigose posterolaterally.

Variations: Specimens vary in length from 13.00 to 14.00 mm and in width from 6.00 to 7.00 mm. The reddish-yellow elytral maculae are lacking on one paratype and are extremely reduced on two others.

Type-data: Holotype, ♂, Bolivia, Department of Cochabamba, Cochabamba (48 km. N.), 10 May 1969, Paul and Phyllis Spangler. USNM Type No. 70837, deposited in the National Museum of Natural History. Allotype: Same data as holotype. Paratypes: 12 ♂ ♂, 2 ♀ ♀, same data as holotype and 1 ♂ from Bolivia, Pongo de Quime, July, W. M. Mann, Mulford Biol. Expd., 1921–22.

Habitat: The specimens from 48 km. north of Cochabamba were collected from a pool about 6 feet long, 3 feet wide, and 1 foot deep in a springgutter that drained into Corani Dam. The vegetation at this elevation (about 9,000′) was typical puna grassland. No larvae were found.

Etymology: I take great pleasure in naming this new species for my wife in appreciation for her years of generous assistance with all aspects of my entomological endeavors.

LITERATURE CITED

BRINCK, P. 1948. Coleoptera of Tristan da Cunha. Results of the Norwegian Scientific Expedition to Tristan da Cunha 1937–1938, No. 17, pp. 1–121, figs. 1–26, 1 pl.

ZIMMERMAN, A. 1919. Die Schwimmkäfer des Deutschen Entomologischen Museums zu Berlin-Dahlem. Archiv. für Naturg. (1917), 83 (A12): 68–249, Taf. 1–3. Berlin.

Vol. 84, No. 50, pp. 435–438 29 February 1972

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

A NEW WASP FROM TRINIDAD, PREDACEOUS ON CURCULIONIDAE AND BRUCHIDAE (HYMENOPTERA: SPHECIDAE)

By Karl V. Krombein
Smithsonian Institution, Washington, D. C. 20560

Some years ago Dr. E. McC. Callan made biological observations on a number of solitary wasps in Trinidad, British West Indies. Dr. H. A. Scullen, to whom the *Cerceris* were submitted for identification, recognized one of them as representing a new species allied to *C. azteca* Saussure. Because of his other commitments, Dr. Scullen asked me to provide a description of this taxon, so that Dr. Callan could publish his biological notes. I take pleasure in naming the species for its prospective biographer.

Cerceris callani new species

Holotype: ♀, Talparo, Trinidad, British West Indies, 15 June 1949, E. McC. Callan. USNM Type No. 71961.

Length 10 mm, forewing 8 mm. Black with rather pale yellow markings as follows: Base of mandible, transverse bar near apex of clypeal process, small spot on front along lower inner eye margin, scape and flagellum beneath, tiny spot behind upper outer margin of eye, narrow band on pronotal disk interrupted in middle, outer margin of tegula, broad band on scutellum, narrow band across middle of postscutellum, elongate streak along margin between lateral propodeal surface and dorsal and posterior surfaces, three transverse spots across apex of first tergum, that in center twice as long as lateral mark, band across apical half of second tergum narrowing laterally, narrow apical bands on third to fifth terga broadening slightly toward sides, large spot on side of sixth tergum adjacent to pygidium, very narrow apical streak on second sternum interrupted in middle, tiny posterolateral spots on third through fifth sterna, and anterior surfaces of fore and mid tibiae. The following reddish to brown: Apical third of mandible, tegula except outer margin, pygidium, lower surfaces of fore and mid femora, fore and mid tibiae

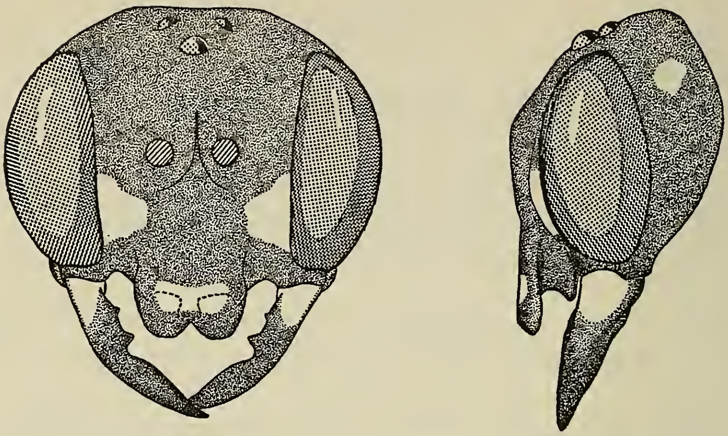


FIG. 1. *Cerceris callani* new species, holotype: Frontal view of head at left, apical margin of clypeus indicated by dotted lines beneath clypeal process; lateral view of head at right.

except anterior surfaces, apex of hind femur, and fore and mid tarsi. Wings subhyaline except anterior half of forewing infuscated, stigma dark amber.

Head in frontal view as figured, very similar to *azteca* in conformation of apical margin of clypeus and clypeal process, and in punctation. Thoracic punctation coarse and dense as in *azteca* except propodeal enclosure with a deeper median groove and most of surface with coarse, contiguous punctures, propodeum outside of enclosure somewhat more coarsely punctate. Abdominal terga coarsely and closely punctate as in *azteca*; pygidium also as in *azteca*, very narrow at base, the sides rounding toward the broader, truncate apex; posterolateral tubercle of fifth sternum prominent, but a bit smaller than in *azteca*.

Allotype: ♂, same locality, date and collector as holotype (USNM). Length 6.5 mm, forewing 6 mm. Color pattern as in female except clypeus entirely yellow, lateral face mark extending upward slightly above level of antennal insertion, postscutellum black, propodeal mark smaller, lateral mark on first tergum evanescent, sixth tergum with a narrow apical band and seventh tergum dark.

Apical margin of clypeus with a complete fimbria of curled hairs meeting on midline as in *azteca*. Thoracic punctation coarse and dense as in *azteca*, that on propodeum denser. Abdominal terga with coarse, contiguous punctures, larger and denser than in *azteca*; fourth to sixth sterna clothed with dense, soft reclinate hair as in *azteca*; posterolateral angles of fifth and sixth sterna swollen but not tuberculate as in *azteca*.

Paratypes: 12♀, same locality and collector as holotype, collected 26

July 1945 (2 ♀), 15 June 1949 (2 ♀), 15 July 1949 (2 ♀) and 29 December 1950 (6 ♀). The paratypes are quite similar to the holotype in all details; about half the series lacks the small yellow bar on the clypeal process and the small spot on the postscutellum, a few have a small yellow spot on the side of the clypeus which may extend beneath the process, and the length range is 8.5–10 mm. Paratypes are in the collections of the National Museum of Natural History and the British Museum (Natural History).

Prey: Dr. Callan collected the following species of prey at Talparo, weevils being stored more commonly than bruchids: Curculionidae—*Centrinaspis* or genus near, *Geraeus* or genus near, *Anacentrinus* or genus near, *Limnobaris* or genus near, and two species belonging to two unknown genera; Bruchidae—*Sennius* sp., *Caryedes* sp. near *plagicornis* (Jekel), and *Acanthoscelides zeteki* Kingsolver.

Both sexes of *callani* run to *azteca* in Scullen's keys to the species of Mexico and Central America (Scullen, in press). The two species are separated as follows:

Paler yellow markings present on propodeum and second tergum, third to fifth (♀) or sixth (♂) terga with narrow apical bands. ♀: Propodeal enclosure with deeper median groove, rest of surface punctate; propodeal punctation elsewhere coarser; posterolateral tubercle of fifth sternum smaller. ♂: Posterolateral angles of fifth and sixth sterna swollen but not tuberculate; punctation of propodeum and abdominal terga coarser. Trinidad ---------------- *callani* new species

Brighter yellow markings lacking on propodeum and second tergum, covering most of third to fifth (♀) or sixth (♂) terga. ♀: Propodeal enclosure impunctate and with a shallower median groove; propodeal punctation elsewhere not so coarse; posterolateral tubercle of fifth sternum larger. ♂: Posterolateral angles of fith and sixth sterna tuberculate as well as swollen; punctation of propodeum and abdominal terga not so coarse. Southwestern Texas, and southern New Mexico and Arizona to Nicaragua ------------------ *azteca* Saussure

LITERATURE CITED

SCULLEN, H. A. In press. Review of the genus *Cerceris* Latreille in Mexico and Central America (Hymenoptera: Sphecidae). Smithsonian Contrib. Zool.

Vol. 84, No. 51, pp. 439–444 29 February 1972

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

NEW SPECIES OF NORTH AMERICAN DELTOCEPHALINE LEAFHOPPERS (HOMOPTERA, CICADELLIDAE)[1]

By H. H. Ross and K. G. A. Hamilton
Department of Entomology, University of Georgia,
Athens, 30601

During the course of ecological studies concerning the relationships between leafhopper species and North American grasslands, several species new to science have been encountered. Five of these are described herein in order that the names may be used in subsequent papers. Except as noted, types of the new species are deposited in the collection of the Illinois Natural History Survey, Urbana, Illinois.

Latalus intermedius new species

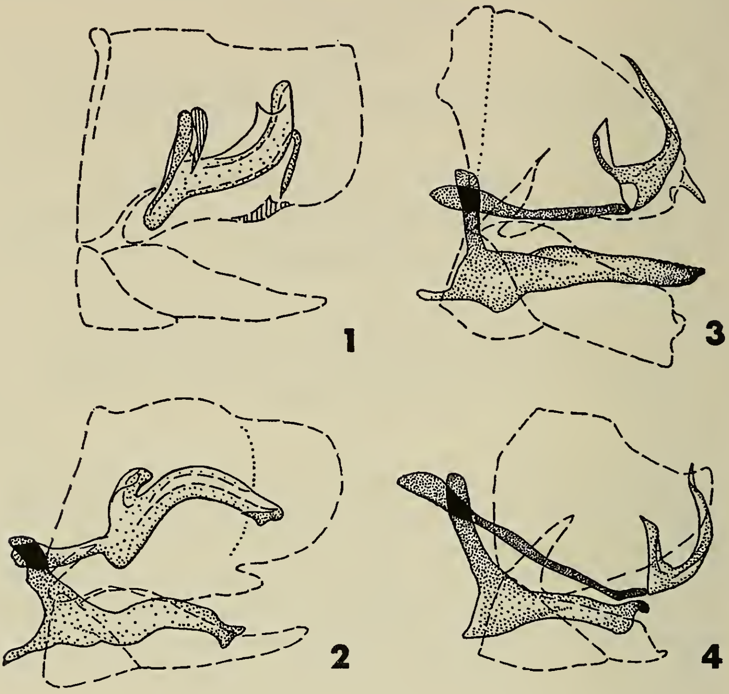
Figure 11

In genitalic characters, this species is intermediate between *L. personatus* Beirne (Fig. 10) and *L. histrionicus* Beirne (Fig. 12). The breadth of the shaft below the gonopore resembles that of *personatus*, as do the parallel apical processes of the shaft; the width of the shaft and virtual lack of the second pair of spines ally it to *histrionicus*. The northern part of the range of this species is sympatric with the western part of the range of *personatus*, and the eastern part of the range of the western species *histrionicus*. The southern part of the range of *intermedius* extends into Colorado, far south of the known range of either of the other two species.

Male: Length 2.6–2.8 mm. Color stramineous, mottled with brown; tegmina stramineous, the veins heavily and evenly bordered with fuscous, half filling the apical cells. Aedeagus (Fig. 11) evenly curved dorsad and cephalad, subparallel margined, strongly tapered to base, bearing paired spines one on each side of preapical ventral gonopore,

---

[1] This investigation was supported by a research grant from the National Science Foundation.

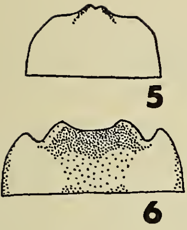


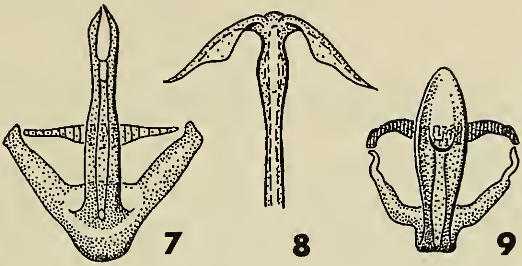
Figs. 1–4. Male genitalia of leafhoppers, lateral aspect. 1, *Latalus draculus* new species; 2, *Orocastus* (*Cabrulus*) *pinnipenis* new species; 3, *Diplocolenus nigrior* new species; 4, *Psammotettix viridinervis* new species.

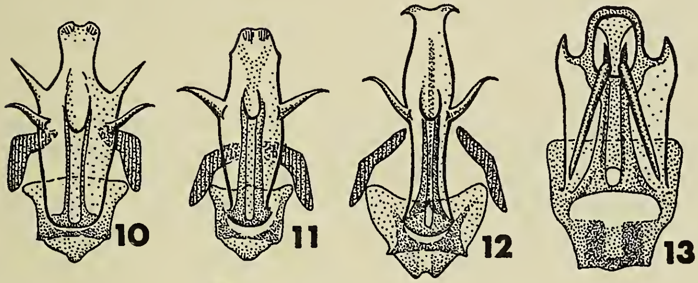
tiny lateral teeth near apex, and parallel apical processes. Style apex short and strongly hooked, as in *histrionicus*. Plates and pygofer typical for species group.

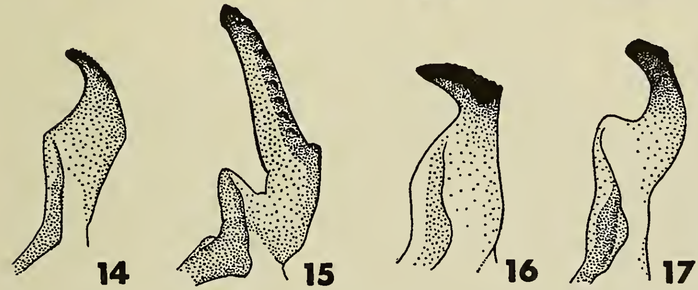
Female: Length 2.8–3.0 mm. Color as in male. Seventh sternum without projecting lateral angles, caudal margin slightly produced across almost entire width of sternum, shorter and more nearly truncate than that of *personatus*.

Types: Holotype ♂, 10♂, 15♀, 4 nymphs paratypes, Mt. Flagstaff, near Boulder, Colorado, 27 July 1956, Ross & Ross, GL 312. Additional material from the following localities has been examined: Colorado: Boulder (GL 313), Cascade (GL 240), Climax (GL 43 & 44), Divide (GL 230), Frisco (GL 34), Green Mountain Falls (GL 241 & 299), Tarryall (GL 222 & 223), Woodland Park (GL 291); Alberta: Valley View (GL 1046); British Columbia: Toad River (GL 1062).









FIGS. 5–6. Female seventh sternum of leafhoppers. 5, *Orocastus* (*Cabrulus*) *pinnipenis* new species; 6, *Latalus draculus* new species.

FIGS. 7–13. Male aedeagi of leafhoppers, ventral aspect. 7, *Diplocolenus nigrior* new species; 8, *Orocastus* (*Cabrulus*) *pinnipenis* new species, (apex only); 9, *Psammotettix viridinervis* new species; 10, *Latalus personatus* Beirne; 11, *Latalus intermedius* new species; 12, *Latalus histrionicus* Beirne; 13, *Latalus draculus* new species.

FIGS. 14–17. Male styles of leafhoppers, ventral aspect. 14, *Latalus draculus* new species; 15, *Diplocolenus nigrior* new species; 16, *Orocastus* (*Cabrulus*) *pinnipenis* new species; 17, *Psammotettix viridinervis* new species.

Latalus draculus new species

Figures 1, 6, 13, 14

This species is related to *uncinatus* Beamer & Tuthill, from which it can be distinguished by the broad pygofer and wide lateral membranes of the shaft.

Male: Length 2.8 mm. Color as in *intermedius.* Genitalia as in Figures 1, 13, 14. Aedeagus curved dorsad on apical half, shaft slender with broad parallel-margined lateral membranes extending to sharp tips beside large round apical gonopore, from which arise two long, divergent spines directed ventrad. Style apex rapidly tapered, small, slightly curved, extreme apex minutely serrate. Plates slightly shorter than pygofer, strongly tapered, as in *sayi* (Fitch). Pygofer broad, not tapered, apex truncate, bearing a tiny in-turned triangular tooth on ventral margin.

Female: Length 3.4–3.6 mm. Color as in male; abdomen greatly exceeding tegmina. Seventh sternum (Fig. 6) with weak lateral angles, broadly and prominently produced across two-thirds of caudal margin, shallowly, broadly and roundedly excavated at center.

Types: Holotype ♂, 1♂ and 2♀ paratypes, Yavapai Co., Oak Creek Canyon overlooking Coconino National Forest, Arizona, 24 August 1970, Harris & Harris, GL 2041.

Diplocolenus nigrior new species

Figures 3, 7, 15

In several morphological features this species resembles the Alaskan *D. aquilonius* Ross and Hamilton and the Palearctic *D. frauenfeldi* Fieber, from which it can be distinguished by the truncate plate apices. The plates of *nigrior* are intermediate between the primitive elongate type found in *aquilonius* and *frauenfeldi* and the short, divergent plates found in *configuratus* (Uhler) and *brevior* Ross and Hamilton, the three types forming a phenocline. From this evidence it would seem that *nigrior* represents a primitive branch of the line leading to *configuratus* and *brevior.*

Male: Length, 3.7 mm. Color: heavily marked with brown, obscuring the stramineous ground color, which appears as five pronotal stripes, a coronal cross and marginal bands, and pale tegminal veins; scutellum stramineous, unmarked. Genitalia as in Figures 3, 7, 15. Aedeagus angled dorsad at basal third of shaft length, parallel-margined, narrower on apical third, terminating in short convergent paired spines above gonopore. Style apex elongate, tapered beyond mesal projection, with a prominent lateral thumblike projection. Plates long, truncate, bearing a strongly sclerotized tooth on caudal margin. Pygofer elongate, tapered, terminating in a short spine directed caudoventrad.

Female: Unknown.

Type: Holotype ♂, Soda Springs, Idaho, 22 July 1951, D. J. & J. N.

Knull. Type deposited in the D. M. DeLong collection, Ohio State University, Columbus, Ohio.

Orocastus (Cabrulus) pinnipenis new species

Figures 2, 5, 8, 16

This species can be distinguished readily by the finlike apical processes of the male aedeagus.

Male: Length 2.7–2.8 mm. Color cream, unmarked except for two broad, parallel light brown coronal stripes that continue backwards as narrower bands across the pronotum. Elytra milky white, semihyaline, unmarked. Genitalia as in Figures 2, 8, 16. Plates each with a fuscous spot on apical third. Aedeagus stout, widest in lateral aspect, parallel sided, strongly arched in lateral aspect, bearing paired long apical processes directed laterad, widened beyond base to triangular flaps; gonopore dorsal, ovoid; atrial arm very short. Style apex angled laterad, strongly tapered, armed with minute teeth on caudal margin. Plates elongate-triangular, as long as pygofer. Pygofer with caudal margin produced as a broad round lobe, incised on caudoventral margin.

Female: Length 2.7–2.9 mm. Color similar to male, but paler, ivory white on head and pronotum. Tegmina sub-brachypterous. Seventh sternum (Fig. 5) lacking lateral angles; caudal margin produced as two small appressed, darkened teeth, as in *Orocastus perpusillus* Ball and DeLong.

Types: Holotype ♂, 2♂, 3♀ paratypes, Vernon, British Columbia, 12 August 1953, Ross & Ross, GL 66; 5♂, 7♀ paratypes, base of hill, McDonald Pass, Montana, 26 August 1953, H. H. Ross.

Remarks: In comparing this species with related ones in *Orocastus* and related genera, it became apparent that *Orocastus* Oman and *Cabrulus* Oman are remarkably similar in many respects, most conspicuous of which are aedeagal form, shape of the style, and both shape and color pattern of the male plates and female seventh sternum. Chief differences between the two are the absence of coronal bands in *Orocastus* and the fusion of the connective and aedeagus in *Cabrulus*. Both differences occur within various genera (e.g., *Flexamia* DeLong) and seem to be derived characters having little weight for generic recognition. We are, therefore, considering *Cabrulus* as a subgenus of *Orocastus*.

Psammotettix viridinervis new species

Figures 4, 9, 17

In Greene's key (1971) to the genus, this species will run to *beirnei* Greene, from which it differs in having the posterior aspect of the aedeagal shaft broadly elliptic rather than flared laterally at the apex as in *beirnei*. It is most closely related to *asper* Ribaut, from which *viridinervis* differs in lacking the row of dorsal serrations on the aedeagal shaft, in having a much shorter gonopore, with the shaft twice as wide at the middle as its width of the base, and in lacking a two-toned color pattern.

Male: Length, 3.2–3.3 mm. Color pale ochre, unmarked or with weak indefinite blotches of light brown on crown; tegmina stramineous, the veins paler, yellow to light green, giving the wing a greenish cast. Genitalia as in Figures 4, 9, 17. Aedeagus evenly curved dorsad, shaft evenly spatulate, blunt-tipped, gonopore distinctly narrower than shaft. Style apex elongate, terminating in short, curved, blunt mesal process. Plates very short, produced on inner margin to small pointed tips. Pygofer short, tapered to pointed end turned dorsad.

Female: Length, 3.3–3.6 mm. Color as in male. Seventh sternum quadrate, with shallow rounded mesal emargination.

Types: Holotype ♂, 1♂, 4♀ and 1 nymph paratypes, East of Laramie, Wyoming, 5 August 1967, D. W. Ribble, GL 700.

LITERATURE CITED

GREENE, J. F. 1971. A revision of the Nearctic species of the genus *Psammotettix* (Homoptera: Cicadellidae). Smithsonian Contr. Zool. 74: 1–40.

Vol. 84, No. 52, pp. 445–448 29 February 1972

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

STUDIES IN *DIOSCOREA*, II: AN UNUSUAL NEW SPECIES FROM MEXICO[1]

BY BERNICE G. SCHUBERT AND C. V. MORTON
Harvard University, Cambridge, Massachusetts 02138
and Smithsonian Institution, Washington, D. C. 20560

Among the vast collections made by the late George B. Hinton in the Mexican states of México, Guerrero, and Michoacán during the decade 1930–1940 there are still undescribed species in many genera. Hinton's collections of *Dioscorea* include one of the most unusual members of the genus, here described by us as *Dioscorea insignis*.[2] These striking plants have the largest flowers of any species in the New World and, so far as we know, in the Old World as well. The largest flowers noted by Knuth[3] were those of *D. macrantha* Uline ex Knuth, of Brazil, with a diameter of 2.75 centimeters, and Burkill[4] has stated that "the largest flower of the Old World among the Dioscoreeae is that of *D. buchanani*—7 mm. across the mouth." The densely flowered inflorescences and flowers with slender, white tepals 2 to 3 centimeters long must give a striking aspect to *Dioscorea insignis* and are surely the basis for its vernacular name "cola de borrego" or lamb's tail.

---

[1] The preceding paper in this series, Studies in *Dioscorea*, I: A collection from British Honduras, was published in the Journal of the Arnold Arboretum 47: 147–159. 1966.

[2] Mr. Morton long ago annotated a specimen of this material as *Dioscorea insignis*. However, lacking carpellate material he delayed publishing a description. After finding a carpellate collection in the Gray Herbarium set of Hinton material and having an illustration prepared, I discussed the species with Mr. Morton who cordially offered to publish it jointly with me. Matuda, in his monograph, listed the name as a nomen nudum and cited Hinton 6713 from Hinton's own herbarium as representative. There seems no reason now, however, not to use Morton's epithet. B. G. S.

[3] Knuth, R., 1924. Das Pflanzenreich IV. 43(Heft 87): 27, 118.

[4] Burkill, I. H., 1960. Jour. Linn. Soc. (Bot.) 56: 392.

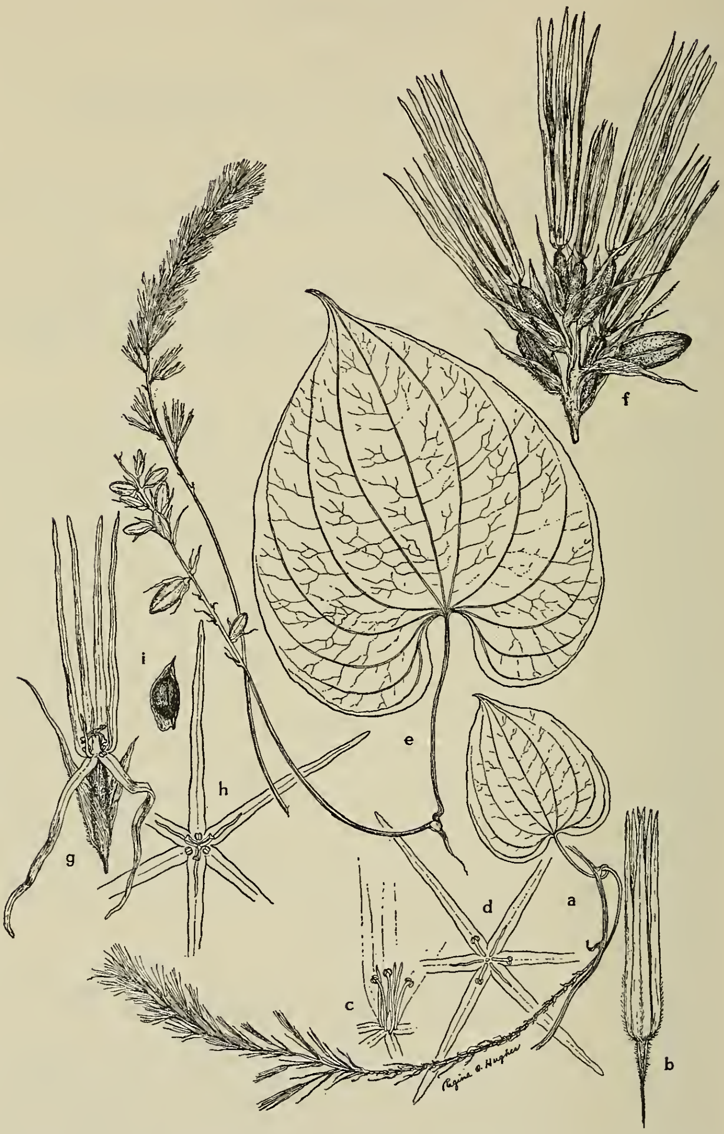


Fig. 1. a-i, *Dioscorea insignis* Morton & Schubert (a-d from Hinton 6713 (NA 170242), e-i from Hinton 6716 (GH)). a, portion of stem with leaf and staminate inflorescence, × ⅓; b, unopened staminate flower to show pubescence on pedicel and outer surface of tepals, × 3;

Dioscorea insignis Morton & Schubert, new species

D. insignis Morton ex Matuda, Anal. Inst. Biol. México 24(2): 386. 1954, NOMEN NUDUM.

Volubilis, ca. 1 m., sinistrorsum torta, caule gracili canaliculato, 3 mm. diametro supra, sparse piloso vel glabrescente; foliis ovato-acuminatis ad apicem longo-attenuatis, 9–11–nervatis, nervis extremis bifurcatis. Inflorescentiae ♂ axillares, racemis 15–30 cm. longis dense floriferis, rachibus racemorum canaliculatis abundanter pilosis; bracteis albis oblongo-lanceolatis, glanduloso-pilosis, cum costa prominente, pedicellos pilosos excedentibus. Perianthium 6-partitum album, segmentis lanceo-attenuatis. Stamina fertilia 3, centralia, tepalibus exterioribus opposita, antheris extrorsis; staminodia 3 in tepalis interioribus affixa in dimidio inferiore; rudimentum stylinum filamentis duplo brevius. Inflorescentiae ♀ 23–33 cm. longae, pedunculatae ad dimidium longitudinis; tepala eis florum stamineorum simillima; staminodia 6, 3 brevia tepalis exterioribus opposita, 3 elongata tepalis interioribus opposita et adnata; columna stylina apice 3-partita, stigmatibus 3 bifidis; capsula breviter pedicellata plus minusve ubique pilosa; semina undique alata.

Holotype: Cutzamalato Rancho, District Coyuca, Guerrero, MÉXICO, 4 Oct. 1934, Hinton et al. 6713 (US ♂, no. 1,792,463; isotypes GH ♂, LL ♂).

Climbing or scrambling plant with a slender, canaliculate stem, ca 3 mm thick above, sinistrorsely twining; leaves ovate-acuminate to a long-attenuate tip, rather deeply cordate and with a broad sinus, 9–11-veined, the 2 outermost veins forked from the base, glabrous, 8–21 cm long, 6–17 cm wide; petioles canaliculate, pilose with small, 1-to-several-celled, light to very dark, scattered trichomes, 3.5–10 cm long. Staminate plant with leaves smaller than those of carpellate plant; racemes axillary, 15–30 cm long, densely flowered more or less from the base, the rachis canaliculate, rather abundantly pilose throughout, the bracts white, oblong-lanceolate with prominent midrib, with scattered glandular tri-

---

←

c, opened staminate flower with most of tepals removed, showing 3 stamens, 3 staminodia, and elongate stylar rudiment, × 3; d, flattened staminate flower to show position of the 3 stamens opposite the outer tepals and the 3 staminodia opposite the inner tepals, × 3; e, portion of stem with leaf and carpellate inflorescence, × ⅓; f, portion of carpellate inflorescence with almost mature capsules, × 3; g, carpellate flower with 2 tepals turned down to show 3 short staminodia opposite the outer tepals, 3 long staminodia opposite the inner tepals, and the stylar column tripartite at apex and with 3 bifid stigmas, × 3; h, carpellate flower flattened and showing relative positions of staminodia and stigmas, × 3; i, winged seed, × 5. The illustration was prepared by Regina O. Hughes formerly of the U.S. Department of Agriculture.

chomes on the outer surface, ca 8 mm long, 1.5 mm wide at base, longer than the pilose pedicels; perianth white, 6-parted almost to base, the segments lance-attenuate, 2.5–3 cm long, 1.5 mm wide with a single prominent nerve, somewhat pilose below on the outer surface or throughout; stamens 3, centrally attached and opposite the outer tepals, the anthers extrorse; staminodia 3, attached for about half their length to the inner tepals, twice as long as the stamens; stylar rudiment about half the length of the staminal filaments. Carpellate inflorescence 23–33 cm long, pedunculate about half its length, the rachis similar to the staminate, the bracts about 1 cm long; perianth segments similar to those of the staminate flowers, 2 cm long; 3 long staminodia opposite inner tepals and attached to them, 3 short staminodia opposite outer tepals; style 3-parted above and with 3 bifid stigmas; capsule short pedicellate, elliptic, somewhat pilose throughout, 2.3 cm long, 1.2 cm wide; only immature seeds seen, winged all around, 2.5 mm long.

MEXICO. MEXICO: Dist. Temascaltepec, Palmar, in barranca, 5 Oct. 1934, Hinton et al 6716 (GH ♀♂, US ♀). GUERRERO: Dist. Coyuca, Cutzamalato Rancho, barranca, 14 Oct. 1934, Hinton et al. 6713 (MO ♂ [as 7613], NA ♂); Dist. Montes de Oca, San Antonio, 30 Oct. 1937, Hinton et al. 11555 (GH ♂, US ♂); Dist. Galeana, Carrizo to Santo Domingo (alt. 850 m, by river in mixed forest, 25 Oct. 1939, Hinton et al. 14716 (GH ♂, NA ♂, US ♂).

This extraordinary species, *Dioscorea insignis*, seems to be most closely related to *D. densiflora* Hemsley of section *Oxypetalum* Uline, in subgenus *Dioscorea*. The section is characterized by plants with sinistrorsely twining stems, flowers borne singly and subtended by bracts, staminate flowers with 3 stamens and 3 staminodia, and carpellate flowers with 6 staminodia and the styles connate in a column. From all other members of the section the species is distinguished by the extremely elongate perianth segments of the flowers of both sexes, the elongate pedicels of the staminate flowers, and the narrowly alate capsules. In addition, its leaves are 9–11-veined rather than 7–9-veined as are those of other members of the section.

Although Hinton collected *Dioscorea insignis* in three localities in Guerrero and one in the state of Mexico, other collectors seem not to have found it at all. Since its range and that of *D. densiflora* (which is found in Honduras, Guatemala, British Honduras, and north into Veracruz, Tamaulipas, Chiapas and Oaxaca) do not overlap, it would be interesting to hunt for related elements which may bridge the gap.

Vol. 84, No. 53, pp. 449–458 29 February 1972

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

THREE NEW CRAWFISHES RELATED TO *ORCONECTES DIFFICILIS* (FAXON) (DECAPODA: ASTACIDAE)[1]

By Jerry G. Walls[2]
Department of Biological Sciences, McNeese State
University, Lake Charles, Louisiana 70601

During an investigation of the taxonomy of *Orconectes difficilis* (Faxon, 1898) and *Orconectes palmeri* (Faxon, 1884), two new subspecies of *Orconectes difficilis* were discovered, and the evolutionary significance of a related new species was realized. As it appears that the complete study will not be published immediately, I take this opportunity to describe the new taxa mentioned above. Complete lists of specimens examined, natural history and distributional notes, and a discussion of the evolution of these taxa are available in Walls (1970), and will be presented at a later date.

Measurements follow Penn (1957) except for width of central projection, which is measured as a straight line from the cephalic edge of the central projection to the base of the mesial process, in mesial view. Abbreviations: CL, carapace length; G, gonopod length; DMS + CP, length of distal mesial shaft plus central projection; WCP, width of central projection; CP, central projection length; MP, mesial process length. Ratios are presented as percentages; mean and range (in parentheses) are given in most descriptions. Illustrations are semi-diagrammatic and may be based on more than one specimen.

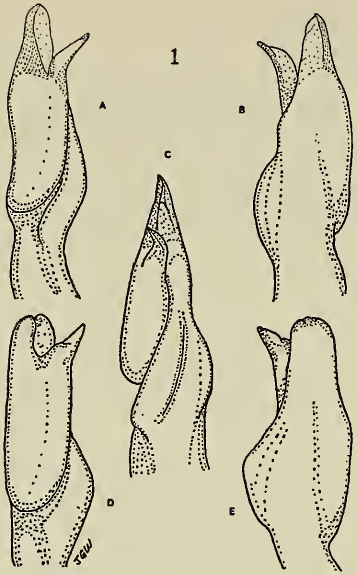
Paratypic series of the two new subspecies of *Orconectes difficilis* will be deposited in the Smithsonian Institution,

---

[1] Part of a thesis submitted in partial fulfillment for the degree Master of Science, McNeese State Univ., May 1970.

[2] Present address: P. O. Box 49, Hightstown, New Jersey 08520.

1



2

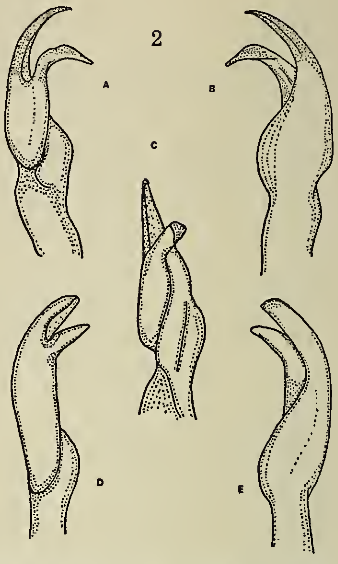
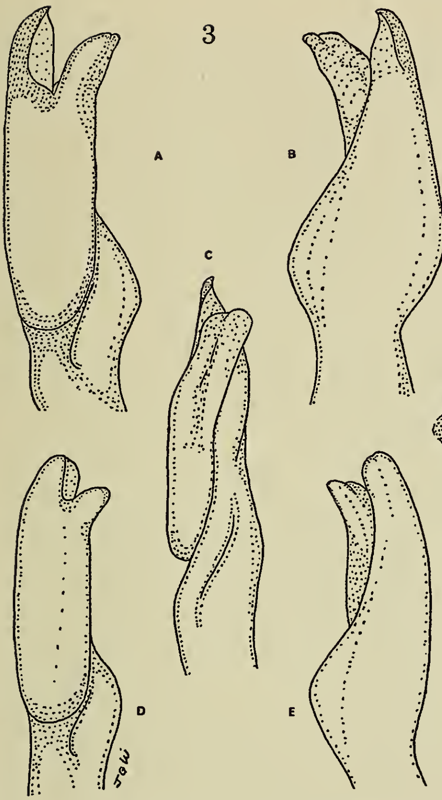


FIG. 1: Left gonopods of *Orconectes perfectus.* A. Male I, mesial view; B. Male I, lateral view; C. Male I, caudal view; D. Male II, mesial view; E. Male II, lateral view.

FIG. 2: Left gonopods of *Orconectes difficilis maletae.* A. Male I, mesial view; B. Male I, lateral view; C. Male I, caudal view; D. Male II, mesial view; E. Male II, lateral view.

Museum of Comparative Zoology (MCZ), Tulane University, and the collections of Dr. J. F. Fitzpatrick, Jr., Dr. Joe B. Black, and the author. Allotypes and morphotypes are purposefully not designated.

Thanks are due to Dr. Horton H. Hobbs, Jr., and Fenner A. Chace, Jr., Smithsonian Institution, Alfred E. Smalley, Tulane University, J. F. Fitzpatrick, Jr., Randolph-Macon Woman's College, Herbert W. Levi, Harvard University, and Rollin D. Reimer, Jr., Texas A. & M. University, for loans of important specimens. Leroy Abel, Frank Amsden, Norman Arnold, Harry Nash, Jr., Robert Shelton, Tom Williams, and Sherry Manuel aided in the field. Dr. Joe B. Black provided specimens, directed the study, read the manuscript, and provided numerous useful hints; his assistance is especially appreciated.



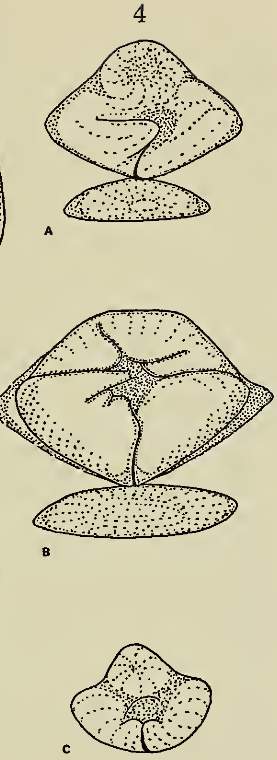


Fig. 3: Left gonopods of *Orconectes difficilis blacki*. A. Male I, mesial view; B. Male I, lateral view; C. Male I, caudal view; D. Male II, mesial view; E. Male II, lateral view.

Fig. 4: Annuli ventrales. A. *Orconectes difficilis blacki*; B. *Orconectes difficilis maletae*; C. *Orconectes perfectus*.

Orconectes perfectus new species

Figures 1A–E, 4C

Diagnosis: Rostral margins not markedly thickened, parallel to slightly convergent; areola closed, slightly open and impunctate, or open and with one row of punctations; chela indistinctly costate, fingers not or only slightly gaping; immovable finger tapering from palm to tip, not distinctly flattened; fingers not ridged dorsally, with one row of large punctations near cutting edges of fingers. Gonopod of Form I male short, 25.6% length of carapace, reaching to third coxa when in situ, centrocaudal and centrocephalic processes about equal in length and width; in lateral view, caudal margin of centrocaudal process straight, slanting proximocaudally from apex; central projection 33.2% length of DMS + CP, blunt; mesial process thin, twisted, with sharp edges, and not troughed. Annulus wide-oval to subrhomboid; cephalic margin appearing scalloped, weakly inflated; caudal margin strongly inflated.

Description: Rostral margins not greatly thickened, parallel to slightly convergent; antennal scale evenly rounded; rostral, postorbital, branchiostegal, and cervical spines all well developed. Areola closed, narrowly open and impunctate, or open and with one row of punctations. Chela weakly costate; immovable finger gradually diminishing in thickness from palm to tip, not flattened. Fingers of chela not ridged dorsally, with only one row of large punctations adjacent to cutting edge of each finger. Gape of fingers small or absent; tubercles of cutting edges of fingers weak. Palm with two distinct rows of tubercles mesially. Carpal furrow shallow.

Form I male: (Figs. 1A–C). Gonopod 25.6% (26.3–24.5%) length of carapace, short, reaching to third coxa when in situ. Central projection 33.2% (37.5–28.5%) length of DMS + CP, thick basally; centrocephalic and centrocaudal processes about equal in length and width; centrocaudal process slanting sharply proximocaudally from apex of central projection, its caudal edge straight in lateral view. Central projection 17.6% (19.6–14.2%) length of gonopod, its width 48.1% (50.0–40.0%) of its length. Mesial process 77.7% (100.0–57.1%) length of central projection, and 25.7% (31.0–17.8%) length of DMS + CP; mesial process directed caudolaterally at about 45° angle to gonopod shaft, thin, and twisted, appearing wider in lateral view than in mesial view; mesial edge sharp, tip without trough. Gonopods symmetrical; distinct shoulder absent, though cephalic margin of central projection slanting slightly caudad. Copulatory hook on third pereiopod only, large, blunt; mesial edge indented; ischiopodite with ciliated depression on caudoventral surface near junction with meropodite. Second pleopod with basal half straight, distal half very slightly bowed. Sternum densely setose, both from coxae and sternal plates.

Form II male: (Figs. 1D–E). Gonopod 25.1% (27.7–21.6%) length of carapace, thick, with rounded distal margin; central projection appearing to tilt slightly mesially. Central projection 17.6% (19.6–14.2%) length of gonopod, and 18.1% (23.5–15.7%) length of DMS + CP. Mesial process small, directed caudolaterally at about 70° angle to gonopod shaft. Copulatory hook in form of low tubercle; sternum sparsely setose or bare.

Female: (Fig. 4C). Annulus ventralis wide-oval to almost subrhomboidal. Caudal margin strongly inflated, evenly rounded posteriorly, sometimes with slight caudal eminence. Median cephalic area depressed; cephalic margin appearing scalloped. Fossa very shallow; sinus distinct, long; tongue formed by sinus and fossa short and broad, often indistinct; dextral or sinistral.

Holotype: Form I male, USNM 131256.

Type-locality: Alabama, Clarke Co., Satilpa Creek, 8.7 mi. E Grove Hill; coll. E. T. Hall, Jr., 28 March 1957.

Specimens examined: 42 (13♂ I, 10♂ II, 17♀, 2 juv.), from five localities in Clarke and Choctaw Counties, Alabama, and Clay and Lowndes Counties, Mississippi. Only the 14 specimens from the type-locality are considered paratypes (USNM 129533).

Variation: The annulus appears to be variable with age and breeding condition. The cephalic margin is most elevated in breeding condition, seeming almost subrhomboidal in some breeding females. Annular length varies from 53 to 74% of its width, with most measurements in the 60–70% range. Figure 4C is of a small topotypic specimen.

The areola appears to vary individually and perhaps geographically. Specimens from the lower Tombigbee River drainage in Alabama vary from closed to barely open to distinctly open; all appear to be impunctate, however. Specimens from the upper Tombigbee drainage in Mississippi generally have the areola distinctly open and with one row of punctations; a few specimens have closed areolas.

Mississippi specimens also differ from the Alabama collections in having a longer mesial process (MP/CP = 100–88.8%, as opposed to 78–57% in Alabama Form I males) in proportion to central projection in males. This is possibly due to the large size of the Mississippi specimens (CL, ♂ I = 26.0–28.7 mm) as compared to the very small Alabama specimens (CL, ♂ I = 15.0–21.5 mm).

Relationships and comparison: Orconectes perfectus is closely related to *O. shoupi* Hobbs, 1948a, *O. wrighti* Hobbs, 1948b, and *O. difficilis hathawayi* Penn, 1952. From *O. shoupi* and *O. wrighti*, it is easily distinguished by the blunt central projection, closed or very narrow areola, and (*O. shoupi* only) chela shape. In general appearance *O. perfectus* is very similar to *O. difficilis hathawayi*; meristically the two are inseparable. *O. perfectus* may be distinguished from *O. d. hathawayi* by the non-flattened immovable finger with only one indistinct row of deep punctations on each finger, resulting in a ridgeless finger; *O. d. hathawayi* possesses a distinctly flattened immovable finger in adults, with two rows of punctations and resulting distinct ridges. No specimens of *O. d. hathawayi* with punctations in the areola are known, although juveniles with narrowly open areolas have been seen. Several differences exist in the gonopod, the most obvious being the sharp-edged, twisted mesial process (thick and of different configuration in *O. d. hathawayi*), straight-edged centrocaudal process (often concave in *O. d. hathawayi*), and the generally thicker, shorter appearance of the *O. perfectus* central projection. The gonopod of *O. d. hathawayi* is well illustrated in the original description. The exact shape of the *O. perfectus* annulus is not found in *O. d. hathawayi*, though very large female

O. perfectus approach the subrhomboidal condition found in *O. d. hathawayi.*

There is little doubt in my mind that *O. perfectus* represents a stock similar to, or perhaps even identical with, the ancestor of *O. d. hathawayi.* The great similarity of gonopod morphology and meristics indicate that *O. perfectus* may be a subspecies of *O. difficilis*, but it is retained as a full species because of its retention of a probably primitive chela and annulus ventralis. The large gap between the ranges of *O. perfectus* and *O. difficilis* also indicates that interbreeding is physically impossible under natural conditions.

Etymology: L., *perfectus*, complete. In reference to the seemingly complete sequence of species showing the evolution of *O. difficilis* and *O. palmeri* from the Limosus Group.

Orconectes difficilis blacki new subspecies

Figures 3A–E, 4A

Diagnosis: Gonopod of Form I male short, 25.9% length of carapace, reaching third coxa when in situ; centrocaudal process wider in lateral view than centrocephalic, convex or straight proximally and concave distally; central projection 29.3% length of DMS + CP; mesial process thick, fleshy, greatly enlarged; in mesial view, mesial process appearing as wide as or wider than base of central projection. Central projection of Form II males 14.7% DMS + CP, slanting mesially. Annulus ventralis subrhomboid.

Description: Rostral margins slightly convergent, base of rostrum depressed; carina weak or absent. Postorbital, rostral, cervical, and branchiostegal spines strong; suborbital angle weak. Areola closed except in some juveniles. Lateral edge of chela strongly keeled; immovable finger flattened in adults; distinct mesial and lateral rows of punctations dorsally, and accompanying ridges, present on immovable finger; carpal furrow deep. Antennal scale evenly rounded distally.

Form I male: (Figs. 3A–C). Gonopod 25.9% (29.0–21.9%) length of carapace, appearing very stout. Central projection 29.3% (34.6–22.6%) length of DMS + CP, and much as in *O. d. hathawayi*, except caudal edge of centrocaudal process deeply concave just proximal to apex; central projection erect, not slanting laterally. Central projection 17.9% (20.0–13.7%) length of gonopod, its width 49.5% (60.0–37.5%) of its length. Mesial process 100.6% (114.3–77.6%) length of central projection, 30.0% (37.0–22.0%) length of DMS + CP. Mesial process twisted, with keel situated on mesial edge, and directed caudolaterally at about 45° angle to gonopod shaft; usually ending in acute tip and extremely thick, in mesial view appearing as wide as or wider than base of central projection.

Form II male: (Figs. 3D–E). Similar to *O. d. hathawayi* except mesial process as wide as or wider than base of central projection; central projection slanting mesially. Gonopod 25.7% (27.5–22.8%) length of carapace; central projection 9.5% (12.0–7.7%) length of gonopod, 14.7% (21.4–13.0%) length of DMS + CP.

Female: (Fig. 4A). Annulus length 54.5–94.5% of width, averaging 70.5%; subrhomboid, all margins inflated in breeding condition. Fossa shallow, sinus and tongue usually distinct; sinistral or dextral. Chela coloration, breeding: lateral keel dark blue; fingers brown basally, followed by dark blue, especially on movable finger; blue area succeeded by bright yellow ring at base of distal fourth of both fingers; tips of fingers red. Nonbreeding: similar, except yellow completely or partially replaced by narrow cream area.

Holotype: Form I male, USNM 131255.

Type-locality: Louisiana, Beauregard Parish, Bearhead Creek on La. St. Hwy. 109, 4 mi. SW Juanita; coll. Joe B. Black and class, 30 Sept. 1969.

Specimens examined: 297 (51 ♂ I, 101 ♂ II, 120 ♀, 25 juv.), from six localities in Beauregard and Calcasieu Parishes, Louisiana. Only specimens from Bearhead and Beckwith Creeks, Beauregard Par., are considered paratypes. In addition, 55 specimens (9 ♂ I, 23 ♂ II, 23 ♀) from seven localities in the Calcasieu River drainage of Allen, Beauregard, Calcasieu, and Vernon Parishes, Louisiana, represent intergradation between *O. d. blacki* and *O. d. hathawayi*.

Variation: Little obvious variation occurs in this subspecies. The mesial process is always greatly expanded, but sometimes ends bluntly; in some specimens, especially from Bearhead Creek, a distinct trough is present. The caudal edge of the centrocaudal process may be either straight or convex basally, but there is always a distinct notch distally. The proportions and appearance of the annulus are especially variable, as they are in all the subspecies of *O. difficilis* and in *O. palmeri*.

Relationships and comparison: Orconectes difficilis blacki is closely related to *O. d. hathawayi*, but is easily distinguished by the enormously developed mesial process of Form I males and the mesial slant of the Form II male central projection (lateral in *O. d. hathawayi*). From all other subspecies of *O. difficilis*, it also differs in the short central projection of both Form I and Form II males. Important meristic characters of the subspecies of *O. difficilis* are given in Table 1.

O. d. blacki seems to represent a population which became isolated from the parental *O. d. hathawayi* stock relatively recently. *O. d. hathawayi* is typically found in streams which flow through Pliocene or early Pleistocene sediments in central Louisiana, while the range of *O. d. blacki* is apparently restricted to streams in late Pleistocene deposits. The rather large area of intergradation also seems to indicate a recent origin for this subspecies.

Etymology: It is a pleasure to name this subspecies in honor of Dr. Joe B. Black, who has contributed greatly to our knowledge of the crawfishes of Louisiana and Mississippi.

Orconectes difficilis maletae new subspecies

Figures 2A–E, 4B

Diagnosis: Gonopod of Form I male short, 27.9% length of carapace, reaching to third coxa when in situ; central projection narrow in lateral view, gently curved caudad; central projection 48.2% length of DMS + CP; mesial process thin, directed caudolaterally, troughed. Central projection of Form II males 24.9% length of DMS + Cp; terminal elements somewhat resembling an open beak. Annulus ventralis subrhomboid.

Description: Body and chela characters as described for *O. d. blacki.*

Form I male: (Figs. 2A–C). Gonopod 27.9% (30.2–26.1%) length of carapace, less stout than in *O. d. difficilis* or *O. d. hathawayi,* but not as slender as in *O. palmeri,* reaching about to third coxa when in situ, occasionally longer. Central projection 48.2% (52.7–44.0%) length of DMS + CP, gently curved caudally, pointed; centrocephalic and centrocaudal processes subequal in width, but centrocephalic process distinctly longer; caudal border of centrocaudal process straight or slightly concave in lateral view; central projection slanting mesially, its tip not twisted. Central projection 29.9% (32.7–27.5%) length of gonopod, its width 25.7% (31.8–21.4%) of length. Mesial process 77.6% (90.9–66.6%) length of central projection, and 37.3% (44.4–30.3%) length of DMS + CP; mesial process directed caudolaterally at about 80–90° angle to shaft, keeled, with tip expanded or shallowly troughed. Cephalic shoulder absent, but distinct shallow notch sometimes present in its position; central projection strongly slanting caudally, but its base not distinctly delimited from cephalic margin of gonopod.

Form II male: (Figs. 2D–E). Gonopod 27.5% (29.6–25.2%) length of carapace; more elongated than in other subspecies, and with central projection and mesial process both curved caudally. Central projection 16.9% (18.9–15.3%) length of gonopod and 24.9% (26.6–23.0%) length of DMS + CP. Terminal elements of gonopod somewhat resembling open beak; tip of central projection truncate, especially so in larger specimens. Mesial process much as in *O. palmeri.*

Female: (Fig. 4B). Indistinguishable morphologically from females of *O. palmeri* and other *O. difficilis* subspecies. Chela coloration, breeding: lateral keel light tan, not marked with blue or distinct from background color of palm; fingers with pale blue band present over proximal two-thirds of immovable finger and on mesial edge of palm, but faint or absent on movable finger; distal third of fingers butter-yellow, very conspicuous; red tips absent or reduced. Nonbreeding: similar, but blue darker and yellow often replaced with cream.

Holotype: Form I male, USNM 131254.

Type-locality: Louisiana, Natchitoches Parish, Bayou Santabarb on La. St. Hwy. 117 (third branch north of Kisatchie), coll. Walls, M. Milsom, S. Manuel, 7 Oct. 1967.

Specimens examined: 113 (13 ♂ I, 41 ♂ II, 44 ♀, 15 juv.), from

Table 1. Mean and corrected mean (± two standard errors of the mean) for selected characters of *Orconectes difficilis* subspecies. Abbreviations as in text. MCZ 4359 is a specimen of *O. d. difficilis* designated by Faxon as "type."

	G/CL (%)		CP/DMS + CP (%)		CP/G (%)		MP/DMS + CP (%)	
	$\bar{x}$	$\bar{x} \pm 2s_{\bar{x}}$	$\bar{x}$	$\bar{x} \pm 2s_{\bar{x}}$	$\bar{x}$	$\bar{x} \pm 2s_{\bar{x}}$	$\bar{x}$	$\bar{x} \pm 2s_{\bar{x}}$
O. d. hathawayi								
I	27.0	27.5–26.5	33.4	34.5–32.3	18.9	19.5–18.3	26.1	27.5–24.7
II	26.6	27.4–25.8	18.9	19.8–18.0	11.4	11.8–11.0	—	—
O. d. blacki								
I	25.9	26.5–25.3	29.3	30.2–28.4	17.9	18.4–17.4	30.0	31.2–28.8
II	25.7	26.3–25.1	14.7	15.8–13.6	9.5	9.9– 9.1	—	—
O. d. difficilis								
I	26.2	—	41.5	—	23.5	—	31.7	—
II	27.4	—	21.2	—	12.5	—	—	—
MCZ 4359, I	23.6	—	36.3	—	19.7	—	29.5	—
O. d. maletae								
I	27.9	28.6–27.2	48.2	49.6–46.8	29.9	30.8–29.0	37.3	39.5–35.1
II	27.5	28.1–26.9	24.9	25.5–24.3	16.9	17.4–16.4	—	—

seven localities in Natchitoches and Sabine Parishes, Louisiana, and Upshur Co., Texas. All are considered paratypes except for Sabine Par. specimens. In addition, three specimens (2 ♂ I, 1 ♀) from Coal Co., Oklahoma, seem to be integrades with *O. d. difficilis.*

Variation: Large Form II males possess more truncate and curved gonopods than small specimens. Some Form I males have the gonopods extending to the second coxa when in situ.

Relationships and comparison: This subspecies is a derivative of *O. d. difficilis,* differing from it in the longer, more curved central projection and the expanded mesial process which is more smoothly curved than in *O. d. difficilis.* Although the ratios are narrowly separated, *O. d. maletae* differs from *O. palmeri* by its shorter gonopods (usually reaching to third coxa instead of second as in *O. palmeri*), shorter central projection (male I, 52.7–44.0% DMS + CP in *O. d. maletae,* and 68.3–53.3% in *O. palmeri,* based on data from Penn, 1957), and the stouter appearance of the central projection as compared to that of *O. palmeri.*

Etymology: This subspecies is christened after my wife, Maleta, who helped collect many of the original specimens and who has been of great aid during many difficult periods.

LITERATURE CITED

FAXON, WALTER. 1884. Descriptions of new species of *Cambarus* to which is added a synonymical list of the known species of *Cambarus* and *Astacus.* Proc. Amer. Acad. Arts and Sci. 20: 107–158.

———. 1898. Observations on the Astacidae in the United States National Museum and in the Museum of Comparative Zoology, with descriptions of new species. Proc. U.S. Nat. Mus. 20 (1136): 643–694.

HOBBS, HORTON H., JR. 1948a. On the crayfishes of the Limosus section of the genus *Orconectes.* J. Washington Acad. Sci. 38(1): 14–21.

———. 1948b. A new crawfish of the genus *Orconectes* from southern Tennessee. Proc. Biol. Soc. Washintgon 61: 85–91.

PENN, GEORGE H. 1952. A new crawfish of the Virilis Section of the genus *Orconectes.* Nat. Hist. Misc., Chicago Acad. Sci. 109: 1–7.

———. 1957. Variation and subspecies of the crawfish *Orconectes palmeri* (Faxon). Tulane Stud. Zool. 5(10): 231–262.

WALLS, JERRY G. 1970. A review of the *Orconectes difficilis* Complex, with comments on the phylogeny of the Palmeri Group. Unpublished masters thesis, McNeese State Univ., Lake Charles, La. i–vii, 1–98.

Vol. 84, No. 54, pp. 459–466 29 February 1972

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

NOTES ON ANTHRIBID WEEVILS. I. SOME INDO-AUSTRALIAN GENERA RELATED TO *EUCORYNUS*

By Barry D. Valentine
Faculty of Zoology, Ohio State University,
Columbus, Ohio 43210

The examination of a variety of anthribid types in European museums reveals a need for so many taxonomic changes that a meaningful analysis of the world fauna based on existing literature is not possible. I expect to summarize the necessary changes from time to time, and when feasible to review in broad terms our knowledge of the taxa involved. This is the first of these summaries, it involves new generic and specific synonymy, locates omitted names and misplaced species, verifies synonymies mentioned in but not supported by the literature, and reviews biological data. Most of the taxonomic observations were incidental to other studies and thus vary considerably in detail; it is my intent to provide useful summaries of little-known or misunderstood taxa.

In the discussions which follow, type-localities are quoted from the original description; pin label data, when given, are identified as such, if omitted it is to be understood that they confirm the original description. When citing pin label data, each label is set apart by quotation marks, and a diagonal stroke / indicates lines within one label.

It is my great pleasure to acknowledge the financial support of The Ohio State University, College of Biological Sciences and of the OSU Development Fund which made the trip possible. I also particularly thank the curators of the European museums at which I studied, they are: Mr. R. T. Thompson of the British Museum (Natural History) in London; Dr. S. L.

P. Tuxen and Dr. Borge Petersen of the Universitets Zoologiske Museum in Copenhagen; Dr. Tord Nyhlom and Dr. Per Inge Persson of the Naturhistoriska Riksmuseet in Stockholm; and Dr. A. Villiers and Mme. A. Bons of the Museum National d'Histoire Naturelle in Paris.

Three often confused, partly sympatric, Indo-Australian genera are discussed: *Eucorynus* Schoenherr, *Ecelonerus* Schoenherr, and *Dendrotrogus* Jekel; two related genera, *Rawasia* Roelofs and *Basitropis* Jekel are mentioned more briefly. All have elongate parallel form; rostrum short, thick, without a deep epistomal excavation; eye rounded, finely faceted, lateral, notched or flattened on margin nearest the scrobe; transverse pronotal carina appearing antebasal (except *Basitropis*); and intercoxal process of mesosternum widened and angulate near the apex.

Immature stages of these genera are partly known, and it may be significant that larvae of *Eucorynus* (Gardner, 1936, 1937a, 1937b), *Dendrotrogus* (Gardner, 1936), *Rawasia* (Mathur, 1950), *Basitropis* (Gardner, 1937a, 1937b), and *Sintor* (Gardner, 1937b) have spiracles with multiple (3 or more) peripheral air tubes. In all other known anthribid larvae (about 35 genera) the spiracles are bicameral (2 peripheral air tubes), unicameral, or simple. The multiple air tubes suggest that the adult insects be checked for additional signs of relationship. I think that adults of *Eucorynus*, *Dendrotrogus*, *Rawasia*, and *Ecelonerus* (larvae of the last not known to me) are closely similar morphologically, and probably related. *Basitropis* is also a close relative, differing primarily in the more posterior position of the transverse pronotal carina. The last genus, *Sintor* Schoenherr, 1839, (type-species *Sintor quadrilineatus* Fahraeus, in Schoenherr, 1839, by original designation and monotypy), is more of a problem. I am not familiar with *Sintor floridus* (the species for which larvae are known), however the type of the genus is an elegant species with a long, slender beak, elongate-oval eyes, broad humeri, inflated metathorax, apically narrowed elytra and abdomen, evenly narrowed intercoxal process of the mesosternum, and is far removed from the prosaic, parallel-sided members of the present complex. Apparently, multiperforate spiracles have evolved more than once in anthribid larvae.

A surprising amount of biological information has accumulated; most of the references are cited by Mathur (1957) who also lists 22 species of food plants for *Eucorynus*, 14 for *Dendrotrogus*, 12 for *Basitropis*, and 2 (both bamboo) for *Rawasia*. A reference not in Mathur's catalogue is Bhatia (1950) who mentions that larvae of *Dendrotrogus colligens* bore in the sapwood of sal (*Shorea robusta*). General information about habits and economic importance can be found in Beeson (1919, *Eucorynus*), Beeson (1941, *Eucorynus*, *Dendrotrogus*, *Basitropis*, and *Rawasia*), and Lefroy (1909, *Eucorynus*). The last author states only (p. 380) ". . . a dark colored insect found not uncommonly in tree bark in the plains." The only other biological information known to me are the twin reports by Blair (1924) and Dover (1924) of larvae thought to be *Eucorynus crassicornis* in the burrows of a carpenter bee *Xylocopa aestuans* L. in India. The observations were made by Dover in April 1922, on Barkuda Island in the Chilka Lake, Orissa. The bees tunnel into the branches of fig trees. Dover believes the anthribid larvae "were probably only stray intruders," but Blair says "larvae of the family Anthribidae were found in some numbers in the *Xylocopa* burrows, and since *E. crassicornis* was the only species found in any numbers the identity of the larva is presumed." Arrow (1923) lists the adult anthribids collected on Barkuda Island (identified by Karl Jordan); they are 6 *Eucorynus crassicornis* and 1 each of *Basitropis nitidicutis* (misspelled *nitidiscutis*), *Phloeobius gigas* var. *nigroungulatus*, and *Araecerus suturalis*.

Genus Eucorynus Schoenherr

Eucorynus Schoenherr, 1823, Isis von Oken, 1823(10): 1135.
Type-species: *Anthribus crassicornis* Fabricius, 1801, Syst. Eleuth. 2: 407, by original designation and monotypy.

The two Fabrician collections in Copenhagen each contain one specimen. The Kiel Collection (Fabricius' personal collection) contains a female labeled "crassicornis" written by Fabricius on a long rectangle of browned paper, and a second, more recent pencilled label with the number "154112." The Sehstedt and Toder Lund collection (studied by Fabricius) contains a female with a small green square on the pin and a handwritten label reading "Sumatra. / Daldorff. / Mus. S. & T. L. / Crassicor: / nis. Fabr." In his original description, Fabricius states "Habitat in Sumatra. D. Daldorff."

This type-species has the antennal clubs four segmented, the lateral prothoracic carina extends only about halfway to the thoracic apex, the dorsal pubescence is setose, not flattened or scaly, the tibiae are rounded in cross-section, in frontal view the scrobes are partly open, there is no carina from scrobe to eye, and the sides of the rostrum at its base are rounded.

All of these features are shared with the genus *Rawasia* Roelofs, 1880, but *Rawasia* is immediately recognized among all Oriental anthribids by the laterally expanded second tarsal segment and the huge connate lobes of the third tarsal segment (the paired lobes of the third segment being fused together into a continuous large adhesive surface). In view of this, the species, *Eucorynus flavescens* Nakane, 1963, from Nakanoshima Island in the Tokara Islands (between Japan and the Ryukyu Islands) requires comment. The original description mentions four-segmented antennal clubs, incomplete lateral prothoracic carinae, enlarged second tarsal segments, and medially carinate rostrum. The first two features suggest *Eucorynus* or *Rawasia*, however the last two occur in *Rawasia* but not *Eucorynus*. Nakane et al. (1963, pl. 175, fig. 21) illustrate the species in color; the greatly enlarged second and especially third tarsal segments and the rostral carina are discernible. These features plus the overall facies require the transfer of the species *flavescens* from *Eucorynus* to *Rawasia flavescens* (Nakane), NEW COMBINATION.

A total of seven described taxa have the characteristics of *Eucorynus* and are congeneric, however most appear to be synonyms. A revised checklist follows.

Eucorynus crassicornis (Fabricius), 1801, Syst. Eleuth. 2: 407, (*Anthribus*), type-locality "Sumatra."
  = *Eucorynus colligendus* Walker, 1859, Ann. & Mag. Nat. Hist. (3)3: 261, type-locality "Ceylon." NEW SYNONYMY.
  = *Eucorynus setulosus* Pascoe, 1859, Ann. & Mag. Nat. Hist. (3)4: 434, type-locality "Philippine Islands. (Manilla?)." Synonymy by Jordan, 1913, Records Indian Mus., 9: 211.
  = *Eucorynus stevensi* Pascoe, 1859, Ann. & Mag. Nat. Hist. (3)4: 433, type-locality "Dorey," New Guinea. NEW SYNONYMY.
  = *Eucorynus mastersi* Blackburn, 1900, Trans. Royal Soc. S. Australia 24: 144, type-locality "Queensland." NEW SYNONYMY.
  = *Eucorynus clavator* Fairmaire, 1903, Rev. d'Ent., 22: 43, type-locality "Ile Maurice." Synonymy by Jordan, 1913, Records Indian Mus., 9: 211.
Eucorynus unicolor Jordan, 1904, Ann. Mus. Genova (3)1: 85, type-locality "Ternate (Laglaize, Bruijn)." The two names in parentheses are apparently the collectors; Ternate is a small island off the west coast of Halmahera in the Moluccas.

The type of *Eucorynus colligendus* is in the British Museum. There is confusion surrounding this name, because Walker described two distinct but similarly sounding species both from Ceylon, on the same page of the same article, *Eucorynus colligendus* and *Eucorynus colligens*. The latter is a species of *Dendrotrogus*, and is discussed under that name. A number of workers (for example Wolfrum, 1929: 75) apparently thought that the spelling *colligendus* was an error for *colligens*, and that the two names apply to the same species; this is not so. Types of *Eucorynus mastersi*, *setulosus*, and *stevensi* are all in the British Museum. They appear to represent geographic trends which have not been carefully analyzed. The type specimen of *Eucorynus clavator* is, according to Fairmaire's original description, in the R. Oberthur collection now in Paris. If true, the specimen is not recognizable, for there is no *Eucorynus* labeled from Mauritius, nor is there any indication of types among those present. The synonymy appears reasonable because *Eucorynus crassicornis* (F.) is the only species in the complex known from Mauritius (Jordan, 1936: 276; 1937; and my own unpublished studies).

Genus Ecelonerus Schoenherr

Ecelonerus Schoenherr, 1839, Gen. et Sp. Curcul. 5(1): 163. Type-species: *Ecelonerus subfasciatus* Fahraeus, loc. cit. p. 164, by original designation.

= *Icelonirus* Gemminger and von Harold, 1872, Catal. Coleop. 9: 2742. (Emendation.)

The Schoenherr collection in Stockholm contains two males of the type-species. One is now labeled "Typus" printed on red, and "*Ptychoderes sub- / fasciatus*. Hope. / Melville, Novae / Holland: Hope." handwritten; the other "Swan Riv. / N: Holl. / Hope." handwritten. The red type label was originally on the Swan River specimen, but since Fahraeus states in the original description "Melville Novae Hollandiae, D. Hope." I switched it to its present position. The type labels were, of course, not placed by Schoenherr, but by a subsequent curator at the Naturhistoriska Riksmuseet.

The type-species has the following features. The antennal club is three segmented, the lateral prothoracic carina extends almost to the thoracic apex, the pubescence is short-scaly, not setose, the tibiae are slender and rounded in cross-section, in frontal view the scrobes are not open dorsally, there is no carina from scrobe to eye, and the sides of the rostrum at its base are rounded.

The seven species of this genus (see Wolfrum, 1929: 76 for a checklist) are confined to the Australian Region, occurring in Australia, New Guinea, Solomons, and Aru. The closely related genus *Dendrotrogus* Jekel is Oriental except for one species, *Dendrotrogus marmoratus* Montrouzier which duplicates the range of *Ecelonerus*.

One species, *Ecelonerus arciferus* (Blanchard), 1853, (as determined by Karl Jordan; I have not seen the type) starts a trend toward *Eucory-*

nus in that the scrobes are partly open in frontal view, but in most other features, it matches *Ecelonerus*; this species has the male antennae longer than the body, an anomalous feature, out of place in this complex.

Genus DENDROTROGUS Jekel

Dendrotrogus Jekel, 1855, Ins. Saunders. 1: 80. Type-species: *Dendrotrogus hypocrita* Jekel, loc. cit. p. 82, by original designation and monotypy.

Xenotropis Fairmaire, 1895, Bull. Soc. Ent. France, 1895 (12–13): CCLXXXI. Type-species *Xenotropis rugicollis* Fairmaire, loc. cit. p. CCLXXXII, by original designation and monotypy. NEW SYNONYMY.

Jekel's male type is in the British Museum. It bears four labels which read "Hypocrit. / Jek." written by Jekel on a tiny rectangle; "Coll Jekel"; "Bowring. / 63.47*"; and a British Museum "Holotype" label printed within a red ring. The British Museum also has a specimen from the W. W. Saunders collection from "Ceylon" but it is too big to be Jekel's type, and has different locality data. Fairmaire's unique type is in the Charles Alluaud collection in the Museum National d'Histoire Naturelle, in Paris. It is a male labeled "Iles Seychelles / La Digue / Ch. Alluaud 1892." printed on white; "MUSEUM PARIS / Coll. Ch. ALLUAUD" printed on blue; and "Xenotropis / rugicollis / Fairm. n g / n sp" handwritten, probably by Fairmaire. The types of the two genera represent different species, but are congeneric.

Dendrotrogus hypocrita has the antennal club three segmented, the lateral prothoracic carina extends almost to the thoracic apex, the pubescence is scaly, not setose, the tibiae (especially the anterior pair) are robust and rectangular in cross-section, in frontal view the scrobes are lateral and covered, not partly open, there is a carina from scrobe to eye, so the side of the beak at the base appears somewhat flattened and angulate, not rounded. The genus contains eight Oriental species and one from the Australian Region.

Dendrotrogus angustipennis Jordan, 1895, Stettin Ent. Zeit. 56(1–6): 191, type-locality "Carin Cheba, 400m, und Teinzo, Birma (L. Fea leg); Cochinchina. 18 Exemplare."

Dendrotrogus colligens (Walker), 1859, Ann. & Mag. Nat. Hist. (3)3: 261, (*Eucorynus*), type-locality "Ceylon."

= *Xenotropis rugicollis* Fairmaire, 1895, Bull. Soc. Ent. France, 1895 (12–13): CCLXXXII, type-locality "Iles Seychelles, La Digue." NEW SYNONYMY.

Dendrotrogus conspectus Jordan, 1923, Opusc. Inst. Scient. Indochine, 1: 93, type-locality "Laos:Pak-Neum, I (R. Vitalis de Salvaza)."

Dendrotrogus feae Jordan, 1895, Stettin Ent. Zeit. 56(1–6): 192, type-locality "Teinzo, Birma (L. Fea leg; 2♂, 1♀)."

Dendrotrogus hypocrita Jekel, 1855, Ins. Saunders., 1: 82, pl. 2, fig. 1, type-locality ". . . . . (India probabiliter?)."

= *Dendrotrogus fallax* Jekel, 1855, loc. cit. (lapsus for *hypocrita*, see addenda et corrigenda in Jekel, 1860, Ins. Saunders., 2: 237).

Dendrotrogus hypocrita enganensis Jordan, 1897, Ann. Mus. Genova (3) 18: 642, type-locality "Engano, Bua Bua, May and June 1891 (Modigliani)." Engano is a small island off the south west coast of Sumatra.

Dendrotrogus hypocritia levis Jordan, 1929, Treubia, Fauna Buruana 7 (4): 337, type-locality "Station 9 . . . and 10" Buru Island.

Dendrotrogus marmoratus (Montrouzier), 1855, Ann. Soc. Imper. Agric. Lyon 7:45, (*Eucorhinus* sic), type-locality not given, but by inference Woodlark Island.

= *Dendrotrogus colligens papuanus* Jordan, 1904, Ann. Mus. Genova (3)1: 84, type-locality "Andai, Dutch N. Guinea (W. Doherty)." NEW SYNONYMY.

Dendrotrogus perfolicornis (Fabricius), 1801, Syst. Eleuth 2: 407, (*Anthribus*), type-locality "Sumatra."

Dendrotrogus reticulatus Jordan, 1923, Opusc. Inst. Scient. Indochine 1: 94, type-locality "Laos:Xieng-Khouango, V (R. Vitalis de Salvaza)."

Dendrotrogus variolosus (Motschoulsky), 1874, Bull. Soc. Nat. Moscou 48: 231, (*Eucorynus*) type-locality "Du continent indien, Siam."

Dendrotrogus colligens (Walker), described from Ceylon, occurs also in southern India and the Seychelles. Males have a hemispherical patch of bristles on the center of the fifth abdominal sternum, as contrasted with *hypocrita* males which have a weak transverse line of bristles at the same site. Walker's species differs from all of the others in the genus in having the scrobes dorsolateral and weakly open in frontal view suggesting *Eucorynus* Sch., however the scaly vestiture, squared tibiae, and laterally carinate rostral base clearly align the species with *Dendrotrogus*. Fairmaire's monotypic genus *Xenotropis rugicollis* is a normal *Dendrotrogus colligens*; the male holotype has a hemispherical patch of bristles on the center of the fifth abdominal sternum, the scrobes are weakly open, the tibiae are squared, the vestiture is scaly, etc.

The synonymy of *Dendrotrogus marmoratus* Montrouzier and *D. colligens papuanus* Jordan is by Jordan (in litt.). I have not seen type material of *marmoratus*, but long series of *Dendrotrogus* from northern Australia, New Guinea, and adjacent islands in the British Museum appear to represent only one species. Regardless of the synonymy, *papuanus* is not a subspecies of *colligens*, having closed rather than weakly open scrobes.

LITERATURE CITED

ARROW, G. J. 1923. The fauna of an island in the Chilka Lake. Certain Coleoptera of Barkuda. Rec. Indian Mus. 25(2): 259–263.

BEESON, C. F. C. 1919. Indian Forester 45(2): 50. (Not seen.)

———. 1941. The Ecology and Control of the Forest Insects of India and the Neighboring Countries. Vasant Press, Dehra Dun, 1007 pp.

BHATIA, B. M. 1950. Borers of sal poles and their control. Indian Forest Rec. (N. S.) Ent. 8(4): 17–34, tab. 1–8.

BLAIR, K. G. 1924. Coleopterous larvae from the burrows of *Xylocopa aestuans*. Trans. Ent. Soc. London, 1924: 149–150.

DOVER, C. 1924. Some observations on the bionomics of *Xylocopa aestuans* Linn. (Apidae). Trans. Ent. Soc. London, 1924: 144–149, fig. a-d.

GARDNER, J. C. M. 1936. Immature stages of Indian Coleoptera (19) Anthribidae. Indian Forest Rec. (N. S.) 2(2): 99–113, pl. 1–2.

———. 1937a. Immature stages of Indian Coleoptera (22). Indian Forest Rec. (N. S.) 3(6): 127–140, pl. 1–2.

———. 1937b. The larva of *Sintor floridus* Jordan (Coleopt. Anthribidae). Proc. Royal Ent. Soc. London (B) 6(11): 214–216, fig. 1–8.

JORDAN, H. E. K. 1936. The Anthribidae of Mauritius. Nov. Zool. 39: 275–291, fig. 37–49.

———. 1937. Report on a second collection of Mauritian Anthribidae sent by Mr. J. Vinson. Nov. Zool. 40: 336–343, fig. 109–113.

LEFROY, H. M. 1909. Indian Insect Life, A Manual of the Insects of the Plains (Tropical India). Agri. Res. Inst. Pusa, i–xii, 1–786, pl. I–LXXXIV, fig. 1–536.

MATHUR, R. N. 1950. Larvae of two species of Anthribidae. Indian Forest Rec. (N. S.) Ent. 8(3): 13–16, pl. I.

———. 1957. Anthribidae (Coleoptera). Catalogue of Indian Insects 28: i–ii, 1–65. (Published by the Indian Council of Agricultural Research, New Delhi.)

NAKANE, T. 1963. New or little known Coleoptera from Japan and its adjacent regions. XX. Frag. Coleopt. 8: 31–34.

NAKANE, T. et al. 1963. Iconographia Insectorum Japanicorum Colore Naturali Edita. Vol. II (Coleoptera). Hokuryukan, Tokoyo, Japan, 384 pp, 192 col. pls.

WOLFRUM, P. 1929. Anthribidae. Coleop. Catal. 102: 1–145.

Vol. 84, No. 55, pp. 467–476 29 February 1972

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

A NEW SPECIES OF *COROPHIUM* LATREILLE, 1806 (CRUSTACEA: AMPHIPODA) FROM GEORGIA BRACKISH WATERS WITH SOME ECOLOGICAL NOTES[1]

By Richard W. Heard III and Walter B. Sikora
University of Georgia Marine Institute
Sapelo Island, Georgia 31327

While surveying the invertebrate fauna of Georgia estuaries during 1968, a new species of tube-dwelling amphipod was discovered in low salinity marsh areas near the upper reaches of the North Newport River (Liberty County). This species is here designated as *Corophium aquafuscum.*

Corophium aquafuscum new species

Diagnosis: A moderately large, very setose species with urosome completely segmented. Distinct rostrum lacking in male, but present in female. Antenna 2 alike in male and female with two strong teeth present on distoventral margin of segment 4. Inner margin of uropod 1 peduncle bare except for a blunt distal spine. A single blunt distoventral spine on segment 1 antenna 1 of female, lacking in male. Compound spines present on rami of uropods 1 and 2 in both sexes. Bifid compound spinules on distal margin of palm of gnathopod 1 of both sexes.

Description: (Based on adult specimens.) Male. Length (excluding antennae) 4 to 7 mm. Head frontal margin nearly straight, rostrum absent or reduced to small nub in large specimens. Eyes well developed on anterior head margin, oval and often notched posteriorly. Antenna 1 with three peduncular and 13–16 flagellar segments, reaching to about middle of segment 5 of antenna 2; peduncular segment 1 in shape of inverted triangle in cross section; row of 18 to 20 long setae on inner dorsal margin, 13 to 16 moderately long setae on ventral margin; single, stout, "brushlike" compound setae on distoventral margin; stout ventral spines absent; outer dorsal margin with two or three small stout setae

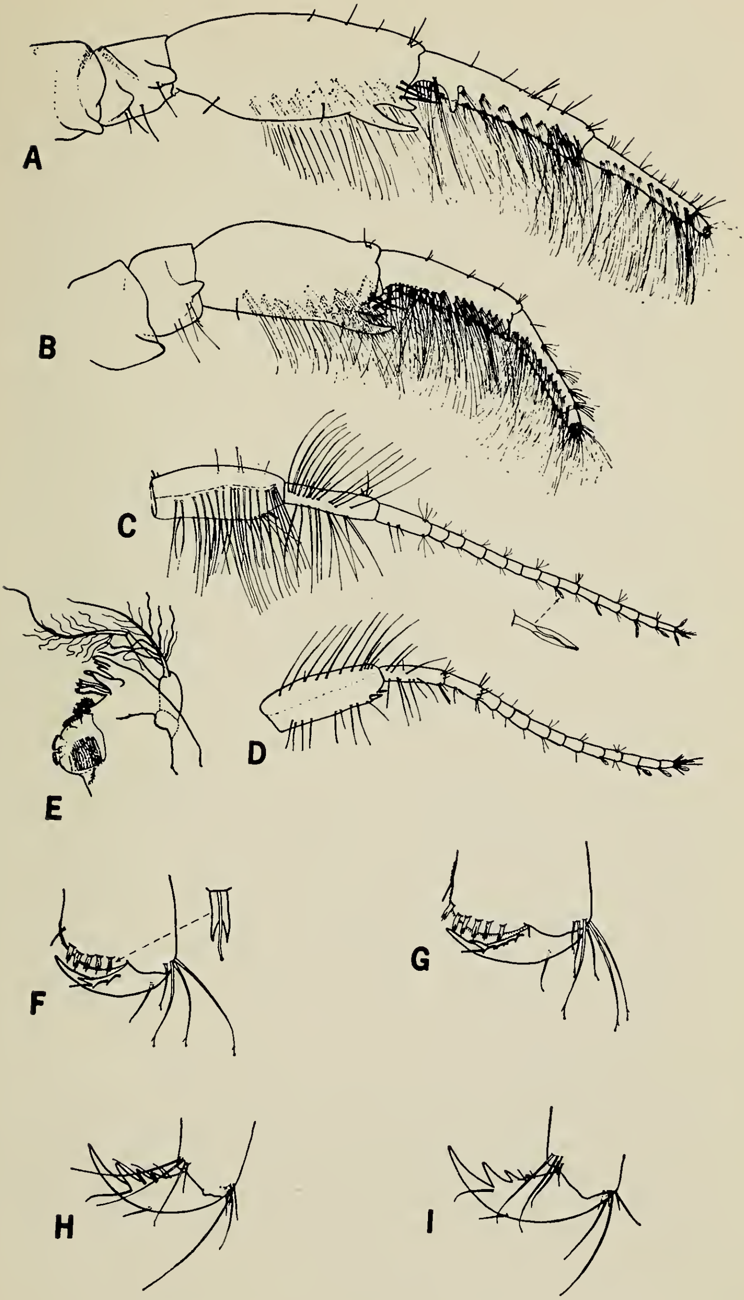
---

[1] Contribution No. 218 from the University of Georgia Marine Institute.

(sometimes compound) proximally and three to five small slender setae on distal half of segment; segment 2 with row of 11–13 long setae on ventral and 12–16 on inner margins, dorsal margin with three or four small proximal setae and a small cluster of three distal setae; segment 3 with three or four mid-ventral setae and a ventral and dorsal cluster of three or four setae distally; most flagellar segments bearing setae distally, some segments without setae, spatulate (sensory?) setae on more distal segments (Fig. 1C). Antenna 2 from ½ to ¾ length of body; five peduncular segments present, second segment with strong forward-projecting gland cone; third segment with distomesal and proximoventral protuberances on strongly developed ridge (Fig. 2D); segment 4 with two well-developed teeth on distoventral margin, ventral-most tooth larger, projecting past shorter second tooth (Fig. 1A), three prominent stout setae on upper mesial base of second tooth, 9–12 clusters of three to six long setae on ventrolateral margin, one small proximal and one small distal seta on inner ventral margin, five to seven small setae on dorsodistal half of segment; segment 5 with prominent ventral-projecting tooth on proximal fourth of segment, 16–19 clusters of long setae on ventral margin, 11–16 small setae on dorsal margin, inner ventrodistal margin produced to form a stout tooth; flagellum with four articles, first article over ¾ length of peduncular segment 5 with 22–26 ventral clusters of long setae and 18–20 small dorsal setae; article 2 short (less than ⅕ length of first article) with cluster of distal setae, articles 3 and 4 greatly reduced, with pair of very small blunt uncinate ventral spines at distal end of article 3. Mandible incisor strongly developed, tridentate; lacinia mobilis bidentate, well developed (but not quite so large as incisor in some specimens), three to four strong compound spine-teeth occupying position of spine-row; cluster of small soft plumose setae immediately before molar on distal margin; molar very strong and prominent, with 16–20 rows of microdenticles on trituarative surface, three pedestalate accessory pads present on proximal margin; one plumose seta on proximal margin; mandibular palp appearing to be three segmented, "second" segment slightly produced distally, bearing one long plumose seta; "third" segment bearing long plumose setae distally. Gnathopod 1 (Fig. 1F) subchelate; segment 6 (palm) with six to seven transverse rows of long comblike setae on the inner surface; row of three to four transverse submarginate compound setae on lateroproximal third of segment, several compound and simple setae along posterior margin, 9–11 (four to five lateral and five to six mesal) submarginate compound,

→

FIG. 1. *Corophium aquafuscum* new species A, male antenna 2; B, female antenna 2; C, male antenna 1; D, female antenna 1; E, female right mandible; F, male gnathopod 1; G, female gnathopod 1; H, male gnathopod 2; I, female gnathopod 2.

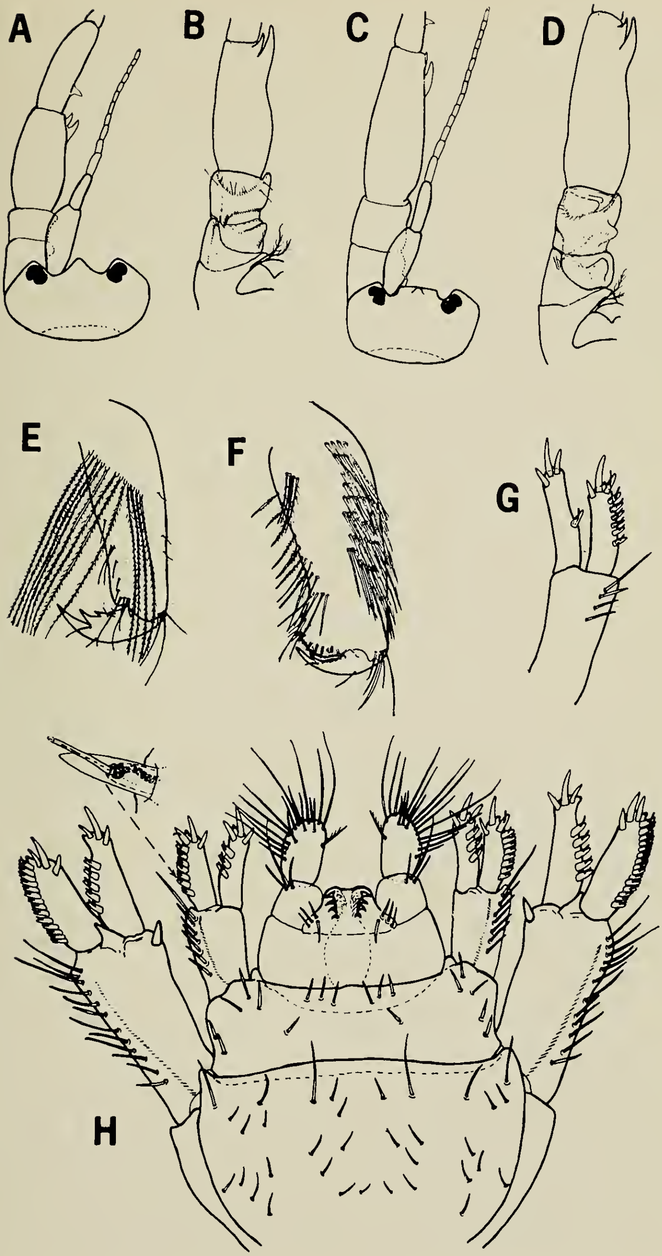

A
B
C
E
D
F
G
H
I

bifid spinules along distal grasping surface on palm; four to five slender setae weakly bifid near their rounded tips, all on disto-anterior margin. Dactyl (segment 7) with one seta on outer proximal margin; single tooth on inner margin; one distal, straight thick seta and two more proximomesal curved setae present. Gnathopod 2 simple, (Fig. 1H); segment 6 with straight row of 10–12 very long transverse compound setae, two groups of distal setae, posterior group with four setae on inner surface, anterior group with five or six setae, three on inner surface and two or three on outer surface. Dactyl with six setae as illustrated, armed with three teeth on inner margin. Pereon, coxae, and pereopods as other described males of genus. Urosome completely segmented, setation varies somewhat with individual specimens. Uropod 1 peduncle with 10 or 11 setae on the outer margin, only a single stout spine on distal-inner margin; outer ramus with 12–15 compound spines along outer margin, three distal spines; inner ramus with four to six compound spines on outer margin, two or three distal spines. Uropod 2 peduncle with three or four setae on outer margin; outer ramus with six or seven compound spines on outer margin, two distal spines; inner ramus with zero to two compound spines on outer margin, two or three distal spines. Uropod 3 uniramous, peduncle with two distolateral setae, ramus rounded with 12–14 setae. Telson with four proximal setae on each side, two rows of four short recurved thorn-shaped spines medially.

Female. Body (excluding antennae) 4 to 6 mm. Head well developed, rostrum present, sinuses of antennae 1 distinct and widely concave. Eyes as in male. Antenna 1 with three peduncular and 11–13 flagellar segments, reaching nearly to the distal end of segment 5 of antenna 2. Segment 1 with a short thick spine and a small compound seta distally, six or seven stout setae (several compound brushlike) on dorsolateral margin, rows of long setae on inner dorsal and inner ventral margins as in male but much sparser, flagellar segments bearing setae as in male. Antenna 2 about ½ length of body, second peduncular segment with a distal protuberance and proximal ridge. Segment 4 similar to male, with two well-developed distal teeth and three stout setae at the origin of the inferior tooth, 13–15 dense clusers of long setae on outer ventral margin with very dense cluster on the outer surface at the origin of the inferior tooth. Segment 5, as in male, with a prominent ventral-projecting tooth on proximal third of segment, 19–23

→

FIG. 2. *Corophium aquafuscum* new species A, female dorsal view head and left antennae; B, female ventral view right antenna 2; C, male dorsal view head and antennae; D, male ventral view right antenna 2; E, female gnathopod 2 mesial view; F, male gnathopod 1 mesial view; G, male left uropod 2 dorsal view; H, female urosome dorsal view.


A
B
C
D
E
F
G
H

dense clusters of long setae on the ventromesal and ventrolateral margins, inner ventrodistal margin produced to form stout tooth. Mandible and palp (Fig. 1E) as in male. Flagellum with four articles: first article with 18–22 long ventral and four or five dorsal clusters of three to six short setae, one or two short setae on dorsoproximal margin. Gnathopod 1 very similar to male except with more setae present (Fig. 1G); segment 6 with six or seven stout, compound bifid spinules and six to eight slender, weakly bifid setae on the distal margin; dactyl with one seta proximally on the outer margin armed with a single tooth slightly more developed than in the male, one distal straight, thick seta and three or four definitely curved setae on inner margin. Gnathopod 2 (Figs. 1I; 2E) segment 6 with single row of 10–12 very long compound setae; two groups of distal setae, the posterior group with five or six setae on inner surface, anterior group with five or six setae, two or three on inner margin and two or three on outer distal margin; dactyl with three teeth on inner margin, proximal-most tooth very small in comparison to that of male. Urosome completely segmented, setation with individual variation but generally with more setae and spines than in the male. Uropod 1 peduncle with 12–15 setae on outer margin, only a single stout spine on inner distal margin; outer ramus with 15–18 compound spines on outer margin and three distal spines. Uropod 2 peduncle with three to seven setae on the outer margin, inner margin bare; outer ramus with five to eight compound spines on outer margin, three distal spines; inner ramus with two to four compound spines on outer margin, two or three distal spines. Uropod 3 peduncle with two to four setae, ramus subovate with 13–18 setae; telson as in male, pereon, coxae, pereopods and associated brood plates typical of other described females of genus.

Holotype: Adult female, and paratype adult male, deposited in the collection of the Division of Crustacea, Smithsonian Institution, Washington, D.C., Numbers USNM 128291 and USNM 128292 respectively.

Type-locality: Georgia, Liberty County, Riceboro Creek (headwaters of the North Newport River) at U.S. Highway 17.

Distribution: Corophium aquafuscum is presently known from the Nanticoke River, Maryland, Pamunkey and York Rivers, Virginia (Boesch, personal communication), and the type-locality. This species probably extends into extreme northern Florida, however it appears to be absent from suitable habitats in the St. Johns River estuary, Florida (Bousfield, personal communication).

Etymology: The specific name refers to the dark brown, humic waters of the type-locality.

Comparisons: By having a completely segmented urosome and segment 4 of antenna 2 alike in both sexes, *C. aquafuscum* new species belongs to Section A(1) of the subgeneric scheme proposed by Crawford (1937) as modified by Shoemaker (1947). This grouping, (Section A(1)) as used here includes those species of *Corophium* in which the urosome is completely segmented and segment 4 of antenna 2 is alike in both sexes. This group thus includes: *C. volutator* (Pallas, 1766); *C.*

chelicorne Sars, 1895; *C. curvispinum* Sars, 1895; *C. homoceratum* Yu, 1938; *C. maeoticum* Sowinsky, 1898; *C. monodon* Sars, 1895; *C. mucronatum* Sars, 1895; *C. multisetosum* Stock, 1952; *C. nobile* Sars, 1895; *C. robustum* Sars, 1895; *C. spinicorne* Stimpson, 1857; and *C. spinulosum* Sars, 1896. Two forms, *C. arenarium* Crawford, 1937 and *C. salmonis* Stimpson, 1857, in which segment 4 of antenna 2 is not alike in both sexes were erroneously included in this subsection by Nayar (1950). The presence of two well-developed distoventral teeth on segment 4 of antenna 2 distinguish *C. aquafuscum* new species from all but four species (*C. homoceratum*, *C. maeoticum*, *C. mucronatum* and *C. nobile*) in Section A (1). The lack of setae or spines on the inner margin of uropod 1 peduncular segment and the absence of a distinct rostrum in the male separate *C. aquafuscum* new species from *C. homoceratum*, *C. mucronatum* and *C. nobile* which have three or more setae on the inner margin of uropod 1 peduncular segment and a distinct rostrum in both sexes. The presence of a row of setae (three to seven) on the outer margin of uropod 2 peduncular segment and rows of compound spines on the outer margins of the outer rami of uropod 1 (12–15) and uropod 2 (six to eight) will differentiate *C. aquafuscum* new species from *C. maeoticum*. *Corophium chelicorne* and *C. spinicorne* are the only previously described species in Section A(1) having males without a distinct rostrum. *Corophium chelicorne* along with *C. spinulosum* have a greatly enlarged ventrodistal tooth on segment 4 antenna 2 which with the stout flagellum superficially presents a chelate appearance. *Corophium spinicorne* (with *C. monodon*, *C. multisetosum* and *C. volutator*) is distinct from *C. aquafuscum* new species by having only a single distoventral tooth on segment 4 antenna 2. Two species, *C. curvispinum* and *C. robustum*, are unique in possessing three distoventral teeth on segment 4 of antenna 2. There are two forms *C. rotundirostre* Stephensen, 1915, and *C. kitamorii* Nagata, 1965, whose descriptions were based on specimens which had antenna 2 missing on one or both sexes, however they are readily distinguished from *C. aquafuscum* new species by both having a narrow elongate ramus on uropod 3.

In summary, the combination of the following three characteristics separate *C. aquafuscum* new species from all other described species in Section A(1): (1) two strong distoventral teeth on segment 4 antenna 2, (2) distinct rostrum lacking in male, and (3) inner margin of uropod 1 peduncular segment bare except for a single distal spine.

Ecological Notes: At present little information is available on the bionomics of *C. aquafuscum*. In Georgia this species appears to be confined to freshwater-oligohaline creeks influenced by tidal action. It was most abundant in the mid intertidal zone where the muddy substrate is shaded by marsh vegetation and debris. At the type-locality large concentrations of specimens occurred under fill rocks adjacent to the bridge abutment (Fig. 3). Our observations indicate that *C. aquafuscum* normally constructs U-shaped burrows in mud-fine-sand substrates which are usually permeated with roots of *Spartina alterniflora*

FIG. 3. View of the type locality of *Corophium aquafuscum* new species from across Riceboro creek.

L., *Lileopsis chinensis* (L.), and other marsh vegetation. However, on several occasions at "Crossroads," near the headwaters of Riceboro Creek (about 2 miles west of the type-locality), specimens were found in sand-covered tubes attached to submerged logs and vegetation.

Ovigerous females were collected during the warmer months (June–September). During late August and September populations appeared to be at their peak. Specimens were comparatively rare in winter collections (February).

Corophium aquafuscum was found in the stomachs of white catfish *Ictalurus catus* (L.) and the mummichog *Fundulus heteroclitus* (L.) collected in Riceboro Creek near the type-locality during the winter and early spring of 1970. In addition, this species is probably preyed upon by clapper rails, spotted sandpipers, seaside sparrows and other birds which were observed in the collecting area.

Other oligohaline or euryhaline invertebrates occurring in the type-locality were the crabs, *Callinectes sapidus* Rathbun, *Rhithropanopeus harrisii* (Gould) and *Uca minax* (LeConte); the shrimps, *Penaeus setiferus* (L.), (juveniles during late summer and fall) and *Palaemonetes pugio* Holthuis; the isopods, *Cyathura polita* (Stimpson) *and Cassidinidea lunifrons* (Richardson); the amphipods, *Orchestia grillus* Bosc, *Orchestia uhleri* Shoemaker, *Gammarus tigrinus* Sexton, and *Corophium lacustre* Vanhoffen; the barnacle, *Balanus improvisus* Darwin; the polychaete, *Namalycastis abiuma* (Muller); and molluscs, *Litterodinops te-*

nuipes (Couper), *Hydrobia* sp., *Melampus bidentatus* Say, *Detracia floridana* (Pfieffer), *Polymesoda carolina* Bosc, and *Cyrenoidea floridana* Dall.

ACKNOWLEDGMENTS

The authors wish to thank Dr. E. L. Bousfield and Mr. Donald F. Boesch for kindly making distributional information available to us. We also thank Dr. Olga Hartman for identifying *Namalycastis abiuma* and Drs. Joseph P. Morrison and Fred G. Thompson for identifying some of the molluscs. This study was made possible through a grant administered by the Georgia State Water Quality Control Board to the University of Georgia Marine Institute, #D2422–122.

LITERATURE CITED

CRAWFORD, G. I. 1937. A review of the genus *Corophium* with notes on the British species. J. Mar. Biol. Ass. U. K. 21: 589–630.

LATREILLE, P. A. 1806. Genera crustaceorum et insectum secundum ordinem naturalem in familias deposita, iconibus exemplisque plurimis explicata, vol. 1, pp. i–xviii, 1–302 + emendanda, Amand Koenig, Parisus et Argentorata.

NAGATA, K. 1965. Studies on marine gammaridean Amphipods of the Seto Island Sea III. Publ. Seto Mar. Biol. Lab. 13(4): 291–326.

NAYAR, K. N. 1950. Description of a new species of amphipod of the genus *Corophium* from Adyar, Madras, India Jour. Wash. Acad. Sci. (40)7: 225–228.

PALLAS, P. S. 1766. Miscellana zoologica. Quibus novae imprimis atque obscurae animalium species describuntur et observationibus iconibusque illustrantur. Hagae Comitum, pp. i–xii, 1–224, pls. 1–14.

SARS, G. O. 1895. Crustacea Caspia. III Amphipoda. Bull. Acad. Imper. Sci. St. Petersb. Tome III, 3: 375–314, pls. 17–24.

———. 1896. Crustacea Caspia. Amphipoda Supplement. Bull. Acad. Imper. Sci. St. Petersb. Tome IV, 5: 420–485, pls. 1–12.

SHOEMAKER, C. R. 1947. Further notes on the amphipod genus *Corophium* from the east coast of America. Jour. Wash. Acad. Sci. 37(2): 47–63.

SOWINSKY, V. 1898. Scientific results of the "*Atmanaya*" expedition. Crustacea Malacostraca of the Sea of Azov. Bull. Acad. Imper. Sci. St. Petersb. Tome VIII, 5: 359–398, pls. 1–4.

STEPHENSEN, K. 1915. Isopoda, cumacea, amphipoda (excl. Hyperidea). Rep. Danish Oceanog. Expeds. 1908–10 to the Mediterranean and Adjacent Seas 2, Biol., D, vol. 1, ppl. 1–53, figs. 1–33.

STIMPSON, W. 1857. Some California Crustacea. Proc. Calif. Acad. Sci. vol. 1, pp. 87–90.

STOCK, J. H. 1952. Some notes on the taxonomy, the distribution and the ecology of four species of the amphipod genus *Corophium*. Beaufortia 21: 1–10.

YU, S. C. 1938. Descriptions of two new amphipod crustacea from Tangku. Bull. Fan. Mem. Inst. Biol., Zool. Ser. 8: 83–103.

Vol. 84, No. 56, pp. 477–488 29 February 1972

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

A REVIEW OF SPECIES OF THE FAMILY SCYPHACIDAE IN THE NEW WORLD (CRUSTACEA, ISOPODA, ONISCOIDEA)

By George A. Schultz
15 Smith St., Hampton, N. J. 08827

Species of the family Scyphacidae (= Scyphacinae of the family Oniscidae of Vandel, 1962, p. 465) occupy beach niches on the sea coasts of the world. Eight species representing four genera are recorded from the New World. The genus *Deto* Guérin is represented by two species in southern South America. The genus *Armadilloniscus* Uljanin contains four species in North America. One species is present on the east coast and in Bermuda, and three are present on the west coast. The two other genera are represented by a single species each in the New World. *Scyphacella arenicola* Smith (1873), a monotypic genus, has been recorded from Woods Hole, Massachusetts, south to Miami, Florida. *Detonella papillicornis* (Richardson, 1904) inhabits the coast from the western Aleutians south to Friday Harbor, Washington (Hatch, 1947). *Detonella* Lohmander contains a second species from a latitude in Asia comparable to that of southern Alaska (Sakhalin Island—Verhoeff, 1942). For the most part species of Scyphacidae are recorded from the Southern Hemisphere. The two genera at present not represented in the New World are *Scyphax* and *Scyphoniscus*. Specimens of the members of the family in both the National Museum of Natural History, Smithsonian Institution and the American Museum of Natural History were examined. More New World species probably will be discovered when the beach niches of the West Indies and of South America are more thoroughly explored.

Species of the family have four flagellar articles on the flagellum of antenna 2. Verhoeff (1942) stated that there are seven articles in *Detonella sachalina*, but this seems unlikely since Richardson (1904) made a similar error when she observed the flagellum of *D. papillicornis* (she observed "about seven articles"). On the basis of her observation she placed the species in Trichoniscidae. Lohmander (1927—through C. R. Shoemaker, footnote p. 17) determined that there were four or five articles, and placed the species in a new genus, *Detonella*, in the Scyphacidae. The author examined the type-specimen (USNM 28772) and saw only four articles. After about 64 years clearing in alcohol and with an improved microscope, the articulations were distinct and four articles unquestionably are present.

Vandel (1962, p. 466) records the principal characters of members of the family. He considers it to be a subfamily of the Oniscidae. Vandel (1968, p. 54 and elsewhere) places the genus *Alloniscus* Dana (1856) in the subfamily Scyphacinae. The members of *Alloniscus* including the type-species have three distinct flagellar articles on antenna 2 and are closer related to species of Oniscinae or perhaps Philosciinae of the Oniscidae rather than to the Scyphacidae. The author has examined the type-species *Alloniscus perconvexus* Dana (1856) in light of the widely misused genus name *Alloniscus*, and his study will be the subject of another paper. The author considers the Scyphacidae to be a distinct family defined in part on the presence of four flagellar articles on the flagellum of antenna 2 as did Chilton (1901), Van Name (1936), Arcangeli (1957) and Green (1961) among others.

The species of the family Scyphacidae are defined as follows (modified from Vandel, 1962, p. 466): 1. Four flagellar articles on the flagellum of antenna 2. 2. Cephalon primitive in structure with (almost always) a supra-antennal line. 3. Maxilliped with four palp articles and endite, or with five defined articles. 4. Dactyl organ present on peraeopods (except in *Scyphax*). 5. Male genital apophysis and endopod of pleopod 1 primitive.

Citations and synonyms later than those included by Van Name (1936) are recorded for all New World species of the family. The geographic distribution of each species is recorded. Menzies (1950) reviewed and illustrated three species of *Armadilloniscus* from the west coast of North America. Arcangeli (1957) reviewed the *Armadilloniscus* species including those from Europe, North America and the islands in between. Vandel (1962) described in detail the species from France. Schultz (1972) briefly described and illustrated the common species of *Armadilloniscus* from Bermuda and the east coast—*A. ellipticus* (Harger).

Scyphacella arenicola Smith (1873)
Figures 1–28

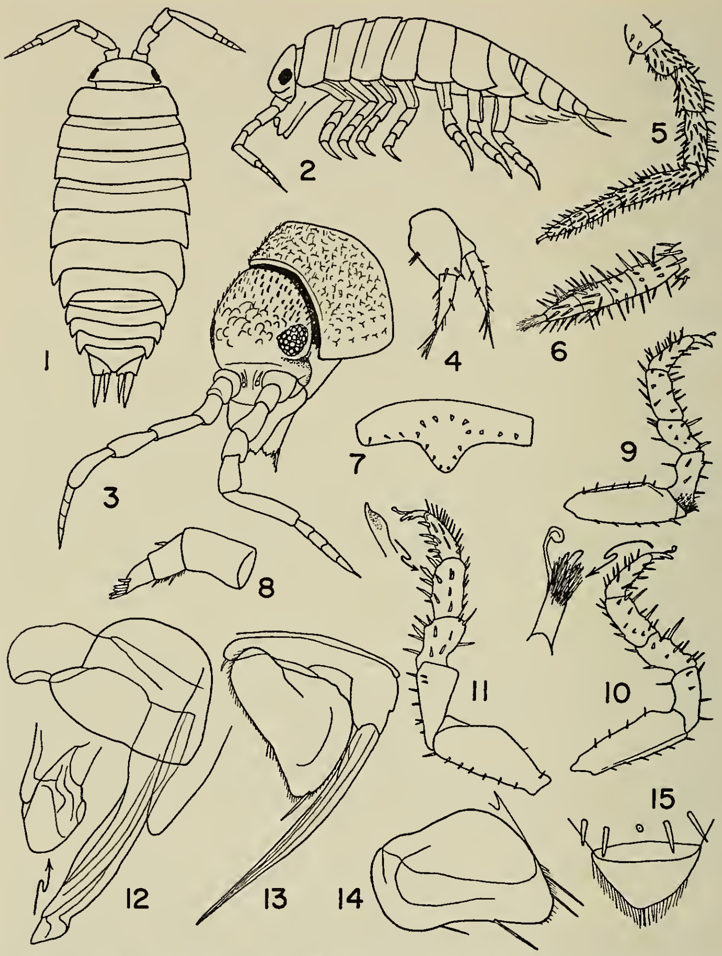
Scyphacella arenicola Smith, 1873.—Van Name, 1936, p. 96, fig. 41.

In spite of the number of records of the species from the east coast of the United States, the species has never been properly illustrated. The range is recorded as from Woods Hole, Massachusetts (USNM 25088; AMNH 1892, 1893) south to Miami, Florida (USNM 42585—E. B. Thomas coll.). The specimens from Miami were collected before 1918 (as inferred by the accession number). They perhaps represent the former distribution of the species since it has never been recorded from Miami or other Florida locations since. The author (1964) spent much time studying the terrestrial isopods of the coast of North Carolina and never encountered the species on the extensive beaches and marshy places near Beaufort in that state. The National Museum of Natural History has many specimens from Cleoptauk River, Maryland (USNM 33059) and nearby Norfolk, Virginia (USNM 35934). The specimen dissected and drawn here is a male 3.4 mm long from Norfolk. It was the longest male in the collection. The largest female was 4.4 mm long from Cleoptauk River. No females were gravid.

Detonella papillicornis (Richardson, 1904)
Figure 29

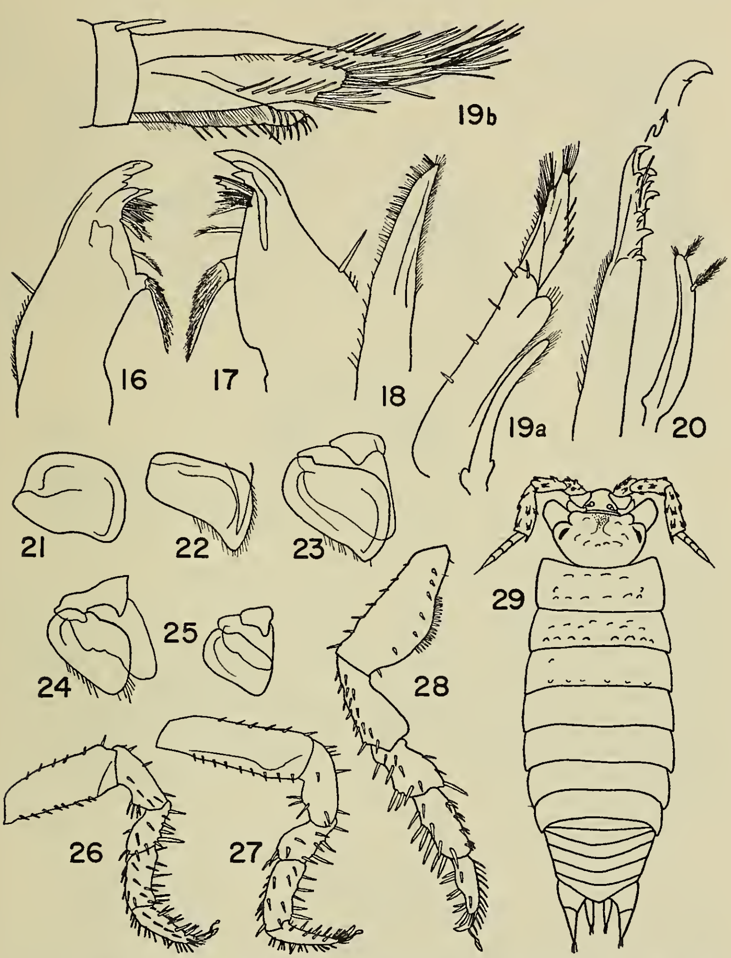
Detonella papillicornis (Richardson, 1904).—Van Name, 1936, p. 100, fig. 44.—Verhoeff, 1942, p. 171.—Hatch, 1947, p. 191, figs. 41, 144–148, 172.
Detonella lohmanderi Verhoeff, 1942, p. 171.

The appendages including mouth parts of the species are described in detail by Lohmander (1927) who removed the species from *Trichoniscus* and put it in a new genus. Lohmander did not, however, illustrate the whole animal. The type-specimen, a male 3.8 mm long (USNM 28772), is illustrated here. There are small, but conspicuous tubercles on the cephalon and on the anteriormost peraeonal segments. The anterolateral lobes are larger than those illustrated by Richardson (1904) and the eyes are on conspicuous bumps arising from the cephalon



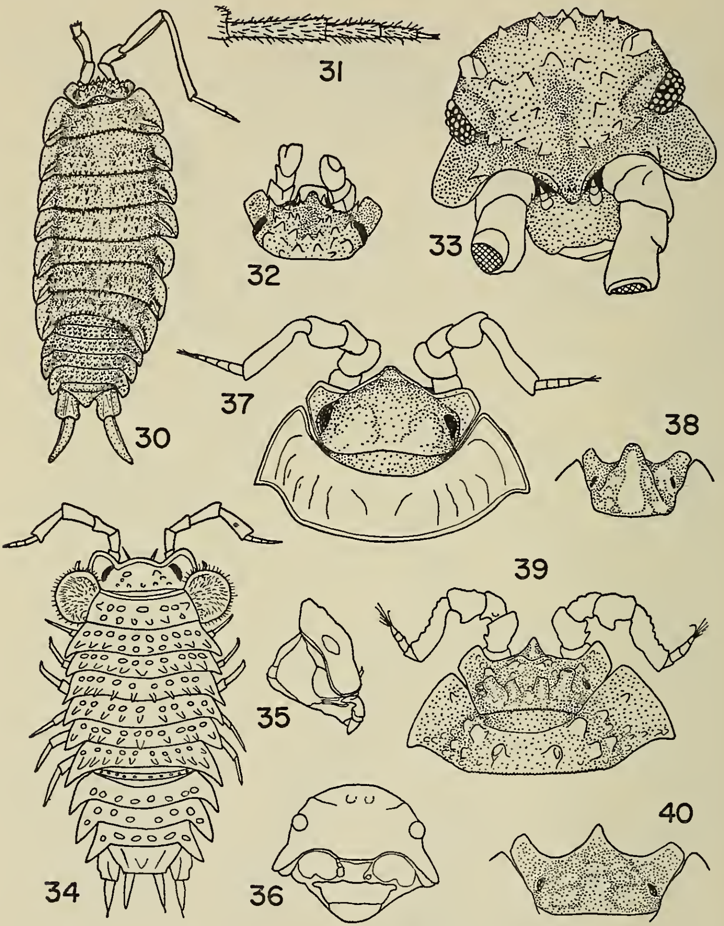
FIGS. 1–15. *Scyphacella arenicola* Smith, male 3.4 mm long. 1. dorsal view. 2. lateral view. 3. oblique view cephalon. 4. uropod. 5. antenna 2. 6. flagellum antenna 2. 7. pleotelson. 8. antenna 1. 9–11. peraeopods I, II and VII respectively. 12–14. pleopods 1–3 respectively. 15. clypeus.

proper. Richardson shows the anterior margin notched, but close inspection by the author showed that the notch was not quite in the center. It appears to be damage, not a natural notch. Lohmander recorded the cephalon "with triangularly produced, broadly rounded medial lobe" on the frontal margin. The buccal mass extends a considerable



Figs. 16–28. *Scyphacella arenicola*, male and female. 16. left mandible. 17. right mandible. 18. maxilla 1. 19a. maxilliped (whole). 19b. maxilliped (detail apex). 20. maxilla 2. 21–25. pleopods female 1–5 respectively. 26–28. peraeopods female I, II and VII respectively. Fig. 29. *Detonella papillicornis*, male 3.8 mm long (type-specimen).

distance beyond the frontal margin of the cephalon as in *Scyphacella arenicola* (cf. figs. 3 and 29). As noted before there are four articles on the flagellum of antenna 2. The species has been recorded as an inhabitant of beaches from Bering Island (Ostrov Bering), Russia, along the Aleutian Islands to Cook Inlet south to Puget Sound, Washington



Figs. 30–33. *Deto marina* female 14 mm (from S. Australia). 30. dorsal view. 31. flagellum antenna 2. 32. dorsal view cephalon. 33. facial view cephalon. Figs. 34–36. *Deto bucculenta.* 34. dorsal view (after Nicolet). 35. lateral view cephalon (after Jackson). 36. facial view cephalon (after Jackson). Figs. 37–40. *Armadilloniscus* species. 37. *A. ellipticus* cephalon. 38. *A. lindahli* cephalon. 39. *A. coronacapitalis* cephalon. 40. *A. holmesi* cephalon.

(Hatch, 1947, p. 191). When enough specimens are collected of Verhoeff's species *Detonella sachalina* from Sakahlin Island, they should be compared to bring out the differences of the two species or prove the synonymy of the species (Unfortunately specimens in the National

Museum of Natural History labeled *Detonella sachalina* Verhoeff, 1942, are of a *Trichorhina*—two distinct flagellar articles, subtropical tropical distribution—and are probably the result of someone's mistake.)

Deto bucculenta (Nicolet, 1849)
Figures 34–36

Deto bucculenta (Nicolet, 1849).—Van Name, 1936, p. 98, fig. 42.

Van Name (1936) included a discussion of the species. It was collected in Chile at the Bay of Valparaiso, and has not been cited since 1936 from the New World. Hurley (1950, p. 121, pl. 1, fig. 2) illustrates what he calls *Deto bucculenta* from New Zealand.

Deto marina (Chilton, 1884)
Figures 30–33

Deto marina (Chilton, 1884).—Ringuelet, 1955, p. 438.—Vandel, 1952, p. 18.

Trichoniscus magellanicus Dana.—Stebbing, 1900, p. 566.—Van Name, 1936, p. 82.—Vandel, 1952, p. 18.

The species is most abundant in New Zealand and southern Australia. Ringuelet (1955) noted its presence on Islas Malvinas (Falkland Islands) as cited by Stebbing (1900). Vandel (1952, p. 18) stated that Stebbings record was really a record of *Deto marina.* No specimens of *D. marina* from South America were seen, but Green (1961, p. 294, figs. 73 and 74) illustrated and described key characters of the species. The specimens illustrated here are from the upper beach at Willunga, South Australia. They were collected from under rocks in seaweed, and perhaps specimens of *D. marina* will be found in similar habitats in southern South America.

Armadilloniscus ellipticus (Harger, 1878)
Figure 37

Armadilloniscus ellipticus (Harger, 1878).—Van Name, 1936, p. 102, fig. 45.—Menzies, 1950, p. 467.—Arcangeli, 1957, p. 423.—Vandel, 1962, p. 471.—Schultz, 1963, p. 26; 1966, p. 457; 1972, p. —, fig. 4I-P.

The species recently has been illustrated by Schultz (1971) using specimens from Bermuda. The specimens from Bermuda have more noticeable tubercles on the cephalon than those from North Carolina illustrated here. Unfortunately a series of specimens for comparison are not available so that subspecies if present can be revealed. The species is common on well-drained sand beaches in the maritime drift or under any flat cover such as a board, flat rock or box which has been on the beach for a long time. Frequently the habitat is covered with water at high tide. The species has been recorded from Woods Hole, Massachusetts, south to Miami, Florida (Schultz, 1966). The National Museum of Natural History has many specimens from Virginia.

Armadilloniscus lindahli (Richardson, 1905)
Figure 38

Actoniscus lindahli Richardson, 1905.—Miller, 1938, p. 114.

Armadilloniscus lindahli (Richardson).—Van Name, 1936, p. 104, fig. 47.—Menzies, 1950, p. 469, pl. 26, figs. 17–26.—Arcangeli, 1957, p. 424.—Schultz, 1970, p. 130.

Scleropactes cedrosensis Mulaik, 1960, p. 181, pl. 17, figs. 342–346.—Schultz, 1970, p. 130.

The species has been found on the beach from Tomales Bay, central California, to Isla Cedros, Baja California. The species is unique among west coast species because it is capable of rolling into a ball like a pill-bug.

Armadilloniscus holmesi Arcangeli (1933)
Figure 40

Actoniscus tuberculatus Holmes and Gay, 1909.—Miller, 1938, p. 114.

Armadilloniscus tuberculatus (Holmes and Gay).—Van Name, 1936, p. 103, fig. 46; 1940, p. 132.—Hatch, 1947, p. 192, fig. 153.—Vandel, 1962, p. 471.

Armadilloniscus holmesi Arcangeli, 1933, p. 59; 1957, p. 424.—Van Name, 1940, p. 132.—Menzies, 1950, p. 470, pl. 27, figs. 27–36.—Mulaik, 1960, p. 135, pl. 6, figs. 93–105.

The species was described originally as *tuberculatus* (Holmes and Gay, 1909), but the name was found to be preoccupied by Arcangeli (1933). The species lives on the seashore from Friday Harbor to Bahía Magdalena, Baja California.

Armadilloniscus coronacapitalis Menzies (1950)
Figure 39

Armadilloniscus coronacapitalis Menzies, 1950, p. 468, pls. 23–25, figs. 1–16.—Arcangeli, 1957, p. 425.

The species was collected from under rocks at the high tide line on the beach at Tomales Bay, central California. Menzies (1950) described and illustrated the large tubercles on the cephalon which serve to distinguish the species from other California species of the genus.

A KEY TO THE SPECIES OF NEW WORLD SCYPHACIDAE

1a. Uropodal bases flattened and expanded with rami extending to or slightly beyond body margin 2

1b. Uropodal bases not expanded; rami extending well beyond body margin 5

2a. Eyes moderately large (10 or more ocelli); dorsal ornamentation of peraeon consists of elongate tubercles arranged in longitudinal rows .... *Armadilloniscus ellipticus*
2b. Eyes small (7 or less ocelli); dorsal ornamentation various 3
3a. Rostrum broad or truncate; capable of rolling into ball .... *Armadilloniscus lindahli*
3b. Rostrum pointed; not capable of rolling into ball 4
4a. Dorsum of cephalon with large tubercles; dorsum of peraeon with at least two conspicuous longitudinally arranged rows of tubercles .... *Armadilloniscus coronacapitalis*
4b. Dorsum of cephalon with only small rounded tubercles; dorsum of peraeon relatively smooth .... *Armadilloniscus holmesi*
5a. Anterolateral processes of cephalon large and angular (very conspicuous in dorsal view) 6
5b. Anterolateral processes of cephalon small and inconspicuous in dorsal view .... *Scyphacella arenicola*
6a. Peraeonal segment I expanded laterally .... *Deto bucculenta*
6b. Peraeonal segment I not expanded laterally 7
7a. Dorsum of cephalon and peraeon covered with short spines .... *Deto marina*
7b. Dorsum of cephalon and peraeon relatively smooth, never covered with spines .... *Detonella papillicornis*

The author wishes to thank the personnel of the Department of Crustacea, National Museum of Natural History, Smithsonian Institution and the personnel of the Department of Living Invertebrates of the American Museum of Natural History for their help in making this study possible.

LITERATURE CITED

ARCANGELI, A. 1933. Per una migliore conoscenza di alcune specie di isopodi terrestri in rapporto alla loro distribuzione geografica. Boll. Mus. Zool. Anat. Comp. Univ. Torino (3) 43(31): 47–62.

———. 1957. Il genere *Armadilloniscus* Ulj. egli Scyphacidae (Crustacei Isopodi terrestri). Atti Accad. Sci. Torino (I) Cl. Sci. Fiz. Mat. Nat. 91(2): 399–428.

CHILTON, C. 1884. Additions to the sessil-eyed Crustacea of New Zealand. Trans. Proc. New Zealand Inst. 16(14): 249–265.

———. 1901. The terrestrial isopods of New Zealand. Trans. Linn. Soc. London, Zool. (2)8: 99–152.

DANA, J. D. 1856. Catalogue and descriptions of Crustacea collected in California by Dr. John L. LeConte. Proc. Philadelphia Acad. Nat. Sci. 7: 175–177.

GREEN, A. J. A. 1961. A study of Tasmanian Oniscoidea (Crustacea: Isopoda). Australian Jour. Zool. 9(2): 258–364.

Harger, O. 1878. Descriptions of new genera and species of Isopoda from New England and adjacent regions. Amer. Jour. Sci. (3) 15: 373–379.

Hatch, M. H. 1947. The Chelifera and Isopoda of Washington and adjacent regions. Univ. Washington Pub. Biol. 10(5): 155–274.

Holmes, S. J. and M. E. Gay. 1909. Four new species of isopods from the coast of California. Proc. U.S. Nat. Mus. 36(1670): 375–379.

Hurley, D. E. 1950. New Zealand terrestrial isopods. Tuatara 3: 115–127.

Lohmander, H. 1927. On some terrestrial isopods in the United States National Museum. Proc. U.S. Nat. Mus. 72(2713): 1–18.

Menzies, R. J. 1950. Notes on California isopods of the genus *Armadilloniscus*, with the description of *Armadilloniscus coronacapitalis* n. sp. Proc. California Acad. Sci. 26(13): 467–481.

Miller, M. A. 1938. Comparative ecological studies on the terrestrial isopod Crustacea of the San Francisco Bay Region. Univ. California Pub. Zool. 43(7): 113–142.

Mulaik, S. B. 1960. Contribucion al conocimiento de los isopodos terrestres de Mexico (Isopoda, Oniscoidea). Rev. Soc. Mex. Hist. Nat. 21(1): 79–220.

Nicolet, H. 1849. Isopodos. *In*: Gay, C., Historia fisica y politica, Chile. Zool. 3: 256–287. Atlas Zoologico (1854), II, Pls. Crustaceos III and IV.

Richardson, H. 1904. Isopod crustaceans of the northwest coast of North America. Harriman Alaska Exped. 10: 213–230.

Ringuelet, R. A. 1955. Ubicacion zoogeografica de las Islas Malvinas. Rev. Mus. La Plata (Zool.) 6: 419–464.

Schultz, G. A. 1963. *Philoscia robusta*, a new species of terrestrial isopod crustacean from southeastern United States. Jour. Elisha Mitchell Sci. Soc. 79(1): 26–29.

———. 1964. Taxonomy and ecology of some American terrestrial isopods (Oniscoidea). Unpublished Doctoral Dissertation, Duke Univ., Durham, North Carolina, pp. xi–362.

———. 1966. *Philoscia miamiensis* sp. nov. an isopod crustacean from Florida with ecological notes on the new species. Trans. Amer. Micro. Soc. 85(3): 457–462.

———. 1970. Disposition of species of terrestrial isopod crustaceans of the genera *Synuropus*, *Spherarmadillo*, *Sphaeroniscus* and *Scleropactes* (Oniscoidea, Sphaeroniscidae). Proc. Biol. Soc. Washington 83(10): 123–132.

———. 1972. Ecology and systematics of terrestrial isopod crustaceans from Bermuda (Oniscoidea). Crustaceana, suppl. 3 (In press).

SMITH, S. I. 1873. Professor Cope's crustaceans. Amer. Nat. 7: 244–245.

STEBBING, T. R. R. 1900. On some crustaceans from the Falkland Islands collected by Mr. Robert Vallentin. Proc. Zool Soc. London, pp. 517–568.

VANDEL, A. 1952. Les trichoniscides (Crustacés-Isopodes) de l'hémisphère austral. Mém. Mus. Nat. Hist. Nat. (N. S.) Ser. A. Zool. 6(1): 1–116.

———. 1962. Isopodes terrestres (Deuxième partie). Faune de France 66: 417–931.

———. 1968. I. Isopodes terrestres. Mission Zool. Belge Galapagos et en Ecquador 1: 37–168.

VAN NAME, W. G. 1936. The American land and fresh-water isopod Crustacea. Bull. Amer. Mus. Nat. Hist. 71: 1–535.

———. 1940. A supplement to the American land and fresh-water isopod Crustacea. Bull. Amer. Mus. Nat. Hist. 77(2): 109–142.

Vol. 84, No. 57, pp. 489–500 29 February 1972

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

FOUR NEW SPECIES OF TROGLOBITIC ASELLIDS (CRUSTACEA: ISOPODA) FROM THE UNITED STATES

By Laurence E. Fleming
Department of Biology
Virginia Polytechnic Institute and State University
Blacksburg, Va. 24061

The increase in the number of previously unknown species of North American troglobitic asellids that have been described in recent years furnishes the systematist with a more nearly adequate amount of material for the consideration of the evolution of both the epigean and the troglobitic nearctic asellid faunas. Such will be the objective of a subsequent paper; herein, are described four new species in partial preparation for that task. I am grateful to the following individuals for collecting this material and making it available to me: J. R. Holsinger, R. Norton, A. L. Metcalf, and T. D. Thornhill. I would like to thank Dr. Perry C. Holt for reviewing the manuscript.

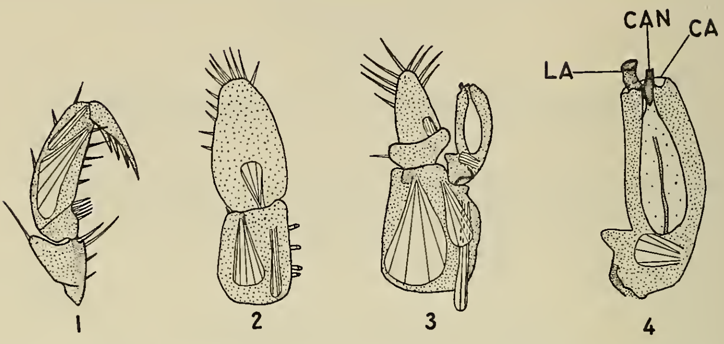
Asellus ancylus new species
Figures 1–4

Type-specimens: Holotype, USNM 135254; allotype, USNM 135255; 1 paratype, LEF 18–Y; taken from Brewer Cave, in mud bottom of stream, Boone County, Arkansas, by J. R. Holsinger, 26 June 1964.

Diagnosis: Small, albinistic, eyeless; holotype 4.6 mm in length, 1.0 mm in width; allotype (ovigerous) 4.1 mm in length, 1.2 mm in width (at brood pouch). Body slender, length approximately 4.6 times the width in holotype and 3.4 times the width in allotype.

Palmar margin of propodus of male gnathopod (peraeopod 1) without processes, but with 5 or 6 short, stout spines (Fig. 1). Opposable margin of dactyl without processes but armed with 3 or 4 long, stout spines.

Peduncle of first pleopod with 4 or 5 coupling hooks (Fig. 2). Exopod



Figs. 1–4. *Asellus ancylus.* 1. Mesial view of distal podomeres of left gnathopod. 2. Cephalic view of left first pleopod. 3. Cephalic view of left second pleopod. 4. Cephalic view of tip of endopodite of left second pleopod; LA = lateral process. CAN = cannula, CA = caudal process.

1.3 times longer than peduncle, 1.8 times longer than wide. Exopod narrows to obtuse apex. Slender setae distributed over lateral one-half to mesial one-fifth of exopod. Single small seta on laterodistal margin of peduncle.

Peduncle of male second pleopod 1.3 times longer than wide (Fig. 3). Exopod 0.75 times as long as peduncle; proximal segment bearing a single slender seta on lateral margin. Distal segment of exopod narrows apically to obtuse apex with long, slender setae on lateral one-half to mesial one-third of margin. Proximal part of endopod shorter than exopod with well-developed, triangular, lateral apophysis; reduced mesial apophysis. Distal part of endopod terminating in 3 processes (Fig. 4): (1) lateral process (LA) long, slender, projecting above other processes with apex cephalically recurvate forming a triangular structure with an acute tip proximally, (2) endopodial groove extended in the form of an apically projecting cannula (CAN) extending rectilinearly beyond caudal process to distal one-third of lateral process, and (3) caudal process (CA) forming a large, broadly rounded process lying behind cannula and lateral process.

Uropods absent in specimens collected.

Etymology: ancyl, Greek = crooked, bent, referring to the crooked, or recurvate shape of the lateral process of the male endopodial tip.

Variation: Only two variations were noted in the specimens studied: (1) in some specimens the mesial apophysis of the proximal part of the endopod is well-developed, and (2) in other specimens the proximal apex of the cephalically directed tip of the lateral process is not acute but rounded.

Affinities: *A. ancylus* is believed to have its closest affinities with

A. metcalfi (a new species described in this paper) and *A. spatulatus* (Mackin and Hubricht), 1940. All of the above species reveal affinities to each other through similarity in the anatomy of the endopodial tip of the male second pleopod. *A. ancylus* resembles the other two species in the shape of the cannula and the caudal process: the cannula in *A. ancylus* is straight, directed anteriad and extended beyond the tip of the endopod; the caudal process in *A. ancylus* is a large, broadly rounded process lying behind the cannula and lateral process. The cannula and the caudal process in the other two species are quite similar. The male gnathopod in *A. ancylus* resembles that of *A. metcalfi* in that it lacks processes, while the male gnathopod of *A. spatulatus* has at least two processes. The first pleopod in *A. ancylus* closely resembles the first pleopod in *A. metcalfi* and *A. spatulatus*. *A. ancylus* can be distinguished from *A. spatulatus* and *A. metcalfi* by use of the lateral process of the endopodial tip of the male second pleopod. The lateral process in *A. ancylus* is a long, slender structure projecting beyond the other processes with a cephalically recurvate apex. In the two other species the lateral process is about equal to or slightly shorter than the cannula and does not extend far beyond the endopodial tip.

Distribution: This species is known from a cave in Arkansas and a cave in Oklahoma and may be restricted to the central part of the United States.

Material Examined: Other than the type-locality, specimens of this species have been studied from: OKLAHOMA: Three Forks Cave on Gittin Down Mountain, Adair County, by Jeffery H. Black, 1 August 1970, 2♂♂.

Asellus steevesi new species

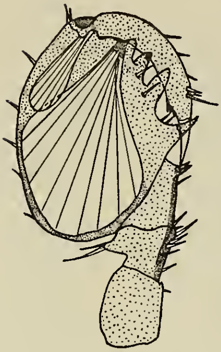
Figures 5–9

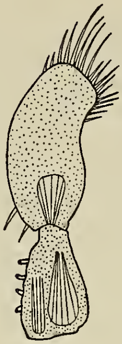
Type-specimens: Holotype, USNM 135727; allotype, USNM 135728; 10 paratypes, LEF 28–G; taken from Carrico Cave, Dade County, Missouri, by J. Holsinger and R. Norton, 20 August 1968.

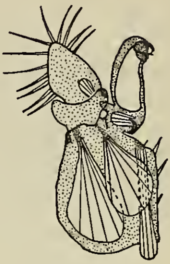
Diagnosis: Moderate sized, albinistic, eyeless; holotype 8.3 mm in length, 1.5 mm in width; largest male 10.5 mm in length; allotype 8.3 mm in length, 1.3 mm in width; largest female 10.1 mm in length. Body slender, length (excluding uropods) approximately 5.5 times the width in holotype and 6.3 times the width in allotype.

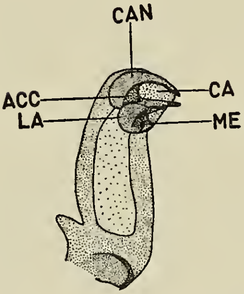
Palmar margin of propodus of male gnathopod (peraeopod 1) with 4 processes (Fig. 5): (1) proximal process, large with subacute apex, (2) two median processes short, subacute, conjointly located, and (3) distal process, small with obtuse apex. Proximal end of palmar margin with single robust spine on elevated, heavily sclerotized ridge. Opposable margin of dactyl without processes but armed with 3 or 4 small spines.

Peduncle of first pleopod with 4 to 6 coupling hooks (Fig. 6); peduncle triangular shaped, narrowing distally. Exopod 1.3 times longer

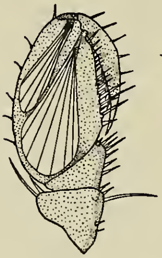

5


6


7

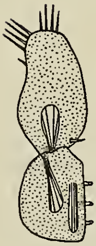


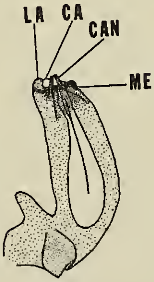
8


10

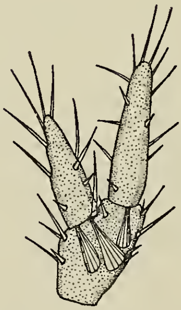

12

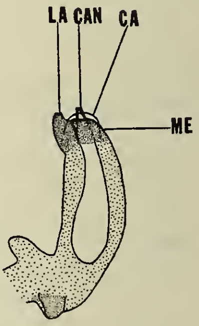

9


11



13


14



15

FIGS. 5–9. *Asellus steevesi.* 5. Mesial view of distal podomeres of left gnathopod. 6. Caudal view of left first pleopod. 7. Cephalic view of left second pleopod. 8. Cephalic view of tip of endopodite of left second pleopod; LA = lateral process, ACC = accessory process, CAN = cannula, CA = caudal process, ME = mesial process. 9. Ventral view of left uropod.

than peduncle, approximately 2.0 times longer than wide. Exopod with lateroproximal margin convex, laterodistal margin concave; mesial margin convex; apex strongly directed laterad. Mesioproximal border of exopod bearing 2 setae directed obliquely posteriad. Apex of exopod covered with long, slender setae from mesial one-sixth to lateral one-fourth.

Peduncle of male second pleopod 1.3 times longer than wide with 3 stout setae and one small seta on mesiodistal border (Fig. 7). Exopod 0.63 times as long as peduncle. Distal segment of exopod ovate with long slender setae on entire lateral margin to distal one-third of mesial margin. Endopod equal to or slightly longer than exopod with well-developed, slender, lateral apophysis, much reduced mesial apophysis in proximal part; distal part of endopod with apex directed strongly mesiad perpendicular to mesial margin, terminating in 5 processes (Fig. 8): (1) mesial process (ME), small protuberance lying over lateral process, apex narrowing to obtuse tip, (2) lateral process (LA) large, rounded with 2 projections: proximal bluntly rounded projection and distal distinctly acute projection, (3) endopodial groove extended in form of large, rounded cannula (CAN) with 2 projections: proximal lanceolate projection extending beyond other processes and distal crescentic projection directed proximad, (4) caudal process (CA) broad, lying behind extended portions of other projections, and (5) accessory process (ACC) triangular, lying over rounded base of cannula.

Uropods (Fig. 9) of male with peduncle approximately 2.7 times longer than exopod. Endopod approximately 1.8 times longer than exopod. Both rami and peduncle sparsely covered with short setae. Apices of rami with many long, slender setae.

Etymology: This species is named in honor of Dr. Harrison R. Steeves III who has contributed so greatly to our knowledge of the troglobitic asellids of the United States.

Variation: The only variations worthy of mention are: (1) the two setae on the mesioproximal border of exopod of male first pleopod sometimes absent, and (2) the palmar margin of the propodus of the male gnathopod often without the two conjointed mesial processes.

Affinities: As presently understood, *A. steevesi* has no known close affinities with any of the previously described troglobitic asellids and must be regarded as a unique species.

←

FIGS. 10–15. *Asellus metcalfi*. 10. Mesial view of distal podomeres of left gnathopod. 11. Cephalic view of left first pleopod. 12. Cephalic view of left second pleopod. 13. Cephalic view of tip of endopodite of left second pleopod; LA = lateral process, CA = caudal process, CAN = cannula, ME = mesial process. 14. Ventral view of left uropod. 15. Cephalic view of tip of endopodite of left second pleopod of a paratype revealing a common form of variation.

Distribution: This species is known from a seep in Kansas, a cave in Missouri, and a cave in Oklahoma and is probably restricted to the central part of the United States.

Material Examined: Other than the type-locality, specimens of this species have been studied from: KANSAS: Seeps off of 7th Street in Baxter Springs, Cherokee County, by J. R. Holsinger, 12 June 1964. 9♂♂; 12♀♀. OKLAHOMA: Three Forks Cave on Gittin Down Mountain, Adair County, by Jeffrey H. Black, 1 August 1970. 7♂♂; 5♀♀.

Asellus metcalfi new species

Figures 10–15

Type-specimens: Holotype, USNM 135263; allotype, USNM 135264; 36 paratypes, LEF 33–W; taken from well about 30 feet west of A. C. Metcalf farmhouse about 8 miles southeast of Dexter, ¼ mile south, center, section 4T., 34S., R. 7E., Cowley County, Kansas, by Artie L. Metcalf.

Diagnosis: Small to moderate sized, albinistic and eyeless; holotype (largest male) 5.8 mm in length, 1.0 mm in width; allotype (largest female) 7.7 mm in length, 1.5 mm in width. Body slender, length (excluding uropods) approximately 5.8 times the width in holotype; approximately 5.1 times the length in allotype.

Palmar margin of propodus of male gnathopod (peraeopod 1) without processes but armed with many slender spines (Fig. 10). Opposable margin of dactyl without processes but armed with 2 or 3 short setae.

Peduncle of first pleopod with 3 coupling hooks (Fig. 11); mesial border rectilinear; lateral border convex. Exopod 1.4 times longer than peduncle, 1.8 times longer than wide. Exopod with single, short seta at proximal mesial border conjointed to peduncle; exopod convex proximally on lateral margin, concave distally on lateral margin, slightly narrowing to rounded apex, possessing long slender apical setae.

Peduncle of male second pleopod 1.3 times longer than wide with 2 short setae on mesiodistal margin (Fig. 12). Exopod approximately 0.58 times as long as peduncle; proximal segment with 3 or 4 slender setae on lateral border. Distal segment of exopod broadly rounded apically with long, slender setae on lateral margin to distal one-third of mesial margin. Endopod longer than exopod with well-developed slender, lateral apophysis, moderately-developed mesial apophysis in proximal part; distal part of endopod terminating in 4 distinct parts (Fig. 13): (1) lateral process (LA) short with broad heavily sclerotized base narrowing to fingerlike projection with rounded apex extending slightly beyond caudal process, (2) endopodial groove extended in form of stiff cannula (CAN) projecting slightly beyond the tip of the lateral process, (3) mesial process (ME) forming broad projection with slightly emarginate, heavily sclerotized apex reaching to base of lateral process and cannula, and (4) caudal process (CA) forming a wide, broadly rounded process lying behind other processes.

Uropods (Fig. 14) of male with peduncle approximately same length as or slightly shorter than exopod. Endopod approximately 1.3 times longer than exopod. Both rami and peduncle armed with long, slender setae on margins and apices of rami.

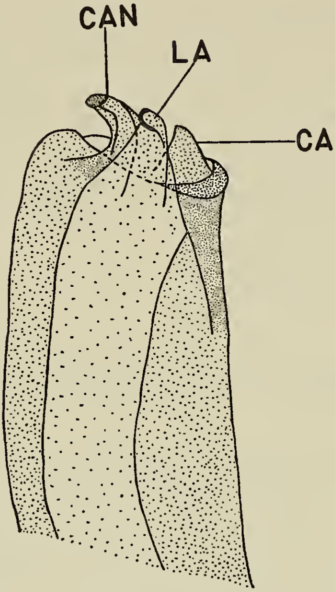
Etymology: This species is named in honor of Mr. A. C. Metcalf on whose property the well containing the isopods is located.

Variation: The endopodial tip of the male second pleopod reveals some variation from that of the holotype (Fig. 15). This form is very common among various specimens. It differs from that of the holotype primarily in the shape of the lateral process which is widely separated laterally from the other processes with the apex ending in a slightly rugose lobe. In some specimens the mesial process lies over and partially conceals the cannula.

Affinities: A. metcalfi exhibits a very close relationship to *A. spatulatus*. This relationship is indicated by the marked similarity between the endopods and endopodial tips of the second pleopod of the two species, as well as the close resemblance between the first pleopods of the two species. In *A. metcalfi* and *A. spatulatus* the first pleopod has a convex lateral border in the exopod and a single, slender seta on the proximal mesial border at the point of junction of exopod and peduncle. The general appearance of the male second pleopod in both species is quite similar in shape. The endopodial tip possesses 4 processes in both species which are similar: (1) a broad, platelike mesial process, (2) a stiff cannula projecting slightly beyond the tip of the lateral process, (3) a short fingerlike lateral process, and (4) a caudal process forming a wide, broadly rounded projection lying behind the other processes. *A. metcalfi* may be distinguished from *A. spatulatus* by the male gnathopod, male uropod, and lateral and mesial processes of the endopodial tip of the male second pleopod. The male gnathopod in *A. metcalfi* lacks processes on the palmar margin of the propodus, while *A. spatulatus* possesses at least two processes. The male uropod in *A. metcalfi* has the endopod and the exopod of approximately equal length, while the male uropod of *A. spatulatus* possesses an exopod much shorter than the endopod. The lateral process of the endopodial tip in *A. metcalfi* is fingerlike with a rounded apex and directed anteriad, while the lateral process in *A. spatulatus* is slender with an acute apex and is recurved mesially. The mesial process in *A. metcalfi* is a broad projection with a slightly emarginate, heavily sclerotized apex lying over the basal part of the cannula, while the mesial process in *A. spatulatus* is not quite as broad as that of *A. metcalfi* and lacks the heavily sclerotized apex. *A. metcalfi* also has close affinities with *A. ancylus*. It resembles *A. ancylus* in the shape of the endopod and endopodial tip of the male second pleopod. For details of the relationships of these two species see the affinities section in the description of *A. ancylus*.

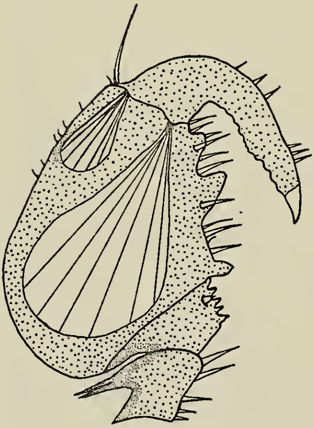
Distribution: Known only from the type-locality.

Material Examined: Known only from the type-material.



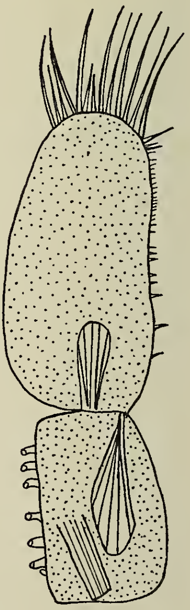
19

18



16

20



17

Asellus paurotrigonus new species

Figures 16–20

Type-specimens: Holotype, USNM 135726; taken from ditch under Homochitto River bridge on U.S. 61 at Wilkinson–Adams County line, Adams County, Mississippi, by T. D. Thornhill, 1 March 1969.

Diagnosis: Large, albinistic, eyeless; holotype 16.7 mm in length, 2.8 mm in width. Body length (excluding uropods) 5.9 times the width.

Palmar margin of propodus of male gnathopod (peraeopod 1) with 3 processes (Fig. 16): (1) proximal process, small, short, narrowing to acuminate apex, obliquely directed posteriad, (2) mesial process, large with rounded apex, acutely directed anteriorly, and (3) distal process, small, short, with rounded apex. Opposable margin of dactyl without processes or spines, but with an undulating border.

Peduncle of first pleopod with 7 or 8 coupling hooks (Fig. 17). Exopod 1.5 times longer than peduncle, 2.0 times longer than wide. Exopod with mesial margin slightly convex, lateral margin slightly concave, bearing numerous setules along entire margin; apex rounded, bearing long setae confined to tip.

Peduncle of male second pleopod (Fig. 18) 1.6 times longer than wide with 4 long, stiff setae on mesiodistal margin. Exopod approximately 0.90 times as long as peduncle; proximal segment bearing 6 short setae on lateral margin. Distal segment of exopod slender, narrowing to subacute apex, bearing long, slender setae on entire lateral margin from mesiodistal one-fifth. Endopod shorter than exopod with well-developed mesial and lateral apophyses in proximal part; distal part of endopod terminating in 3 processes (Fig. 19): (1) caudal process (CA) extended from endopod tip, broad, roughly triangular in shape with flattened apex, (2) lateral process (LA) extended slightly beyond caudal process, broad, roughly triangular in shape, apex folded back upon itself with heavily sclerotized mesial margin, and (3) endopodial groove extended in the form of a broad, tubular cannula (CAN) slightly narrowing apically, extending beyond other processes and directed mesiad. Lateral margin of endopod apex with heavily sclerotized semicircular ridge enclosing caudal process.

Uropods (Fig. 20) of male with peduncle approximately 3.4 times longer than exopod. Endopod approximately 3.2 times longer than exopod. Both rami and peduncle covered with short setae. Apices of rami with many long, slender setae.

Etymology: pauro, Greek = small, trigon, Greek = triangle, referring

---

←

Figs. 16–20. *Asellus paurotrigonus*. 16. Mesial view of distal podomeres of left gnathopod. 17. Caudal view of left first pleopod. 18. Caudal view of left second pleopod. 19. Caudal view of tip of endopodite of left second pleopod; CAN = cannula, LA = lateral process, CA = caudal process. 20. Dorsal view of left uropod.

to the shape of the caudal process of the male endopodial tip which resembles a small triangle.

Affinities: A. paurotrigonus has its closest affinities with two members of the Stygius Group, *A. stygius* (Packard), 1871, and *A. alabamensis* (Stafford), 1911. It resembles these two species in the shape of the uropods, armament of the male gnathopod and details of the endopodial tip of the male second pleopod. All three species have an enlarged, elongated endopod and a greatly shortened exopod of the male uropod. The three species have at least two large, prominent processes on the palmar margin of the male gnathopod. The endopodial tip of the male second pleopod reveals similarities among the three species in the cannula and caudal process: the caudal process of all three species is a prominent projection extended beyond the endopodial apex; the cannula in the three species is an elongated recurvate process. *A. paurotrigonus* differs from the other two species primarily in features of the endopodial tip of the male second pleopod. The lateral process in *A. paurotrigonus* is an enlarged, elongated process extending beyond the endopodial apex to approximately the same length as the other processes. The lateral process in *A. stygius* and *A. alabamensis* is a small, rounded projection not extended beyond the endopodial tip. Because of the above anatomical similarities of *A. paurotrigonus, A. stygius,* and *A. alabamensis* it is my opinion that *A. paurotrigonus* should be placed in the Stgyius Group of troglobitic asellids.

Distribution: Known only from the type-locality.

Material Examined: Known only from the holotype.

Remarks: This species exhibits most of the recognized characteristics of troglobitic isopods, such as: absence of body pigmentation and eyes, attenuation and elongation of appendages. Yet it was collected in a ditch in a locality without caves or a substrate in which caves might be formed.

There have been previous reports of troglobitic asellids from epigean habitats (Leonard and Ponder, 1949; Dexter, 1954, Minckley, 1961), but in all cases the animals were collected in the resurgents of cave streams, in springs, or in streams flowing over limestone in cavernous areas. The most probable explanation for the epigean occurrence of troglobitic animals is that put forth by Barr (1960) attributing their presence to accidental displacement. The feasibility of applying this explanation to the presence of *A. paurotrigonus* in an epigean habitat seems less likely due to the lack of nearby cavernous areas. Yet Holsinger (Personal Communication, April 1971) stated that the possibility for the occurrence of an "interstitial" species in the coastal plains area is very likely. He noted that for the amphipods this is a common place of habitation for certain species and specimens are often "washed" out by elevations in the water table such as occur during spring rains.

Nonetheless, the presence of this troglobitic animal in this epigean environment will remain an enigma until further collections of it are taken and their locations noted.

LITERATURE CITED

BARR, T. C. JR. 1960. Introduction. P. 1–9. In Symposium: speciation and raciation in cavernicoles. Am. Midl. Nat. 64(1): 1–160.

DEXTER, R. W. 1954. A record of the blind isopod, *Asellus tridentatus* from an open stream habitat. Am. Midl. Nat. 52(1): 256.

LEONARD, A. B. AND L. H. PONDER. 1949. Crustacea of eastern Kansas. Trans. Kansas Acad. Sci. 52(2): 168–204.

MACKIN, J. G. AND L. HUBRICHT. 1940. Descriptions of seven new species of *Caecidotea* (Isopoda, Asellidae) from central United States. Trans. Amer. Micros. Soc. 59: 383–397.

MINCKLEY, W. L. 1961. Occurrence of subterranean isopods in epigean waters. Am. Midl. Nat. 66(2): 452–455.

PACKARD, A. S., JR. 1871. On the crustaceans and insects. *In* Packard and Putnam: The Mammoth Cave and its inhabitants. Am. Nat. 5: 744–761.

STAFFORD, B. E. 1911. A new subterranean freshwater isopod. Pomona J. Ent. 3(3): 572–575.

Vol. 84, No. 58, pp. 501–506 29 February 1972

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

A NEW SPECIES OF *LEPIDOPA*, *L. DEXTERAE*, (ANOMURA, ALBUNEIDAE), FROM THE CARIBBEAN COAST OF PANAMA[1]

By Lawrence G. Abele and Ian E. Efford
Rosenstiel School of Marine and Atmospheric Science,
University of Miami, Miami, Florida 33149, U. S. A. and
Institute of Resource Ecology,
University of British Columbia, Vancouver 8, Canada

Until recently, our knowledge of the taxonomy and distribution of the American sand crab genus *Lepidopa* has been poor. Efford (in press) revised the description of the eight known species and described six new species. One obvious gap in our knowledge results from the great paucity of collections taken along the Caribbean coast of Central America. Thus, we welcomed the opportunity, offered by Dr. Deborah Dexter, to examine material of a species of *Lepidopa* collected from the Caribbean coast of Panama. The species is unknown and, therefore, we have prepared the following description.

The abbreviation cl refers to carapace length measured from the apex of the rostrum to the truncate posterior margin of the carapace; cb refers to carapace breadth measured at the anterior margin; AHF refers to the Allan Hancock Foundation, Los Angeles, California; LM refers to the Rijksmuseum van Natuurlijke Historie, Leiden, The Netherlands; UPRC refers to the University of Panama Reference Collection; USNM refers to the National Museum of Natural History, Washington, D. C.

---

[1] Contribution No. 1456 from the University of Miami, Rosenstiel School of Marine and Atmospheric Science. Support for this work was provided by Research Grants GB-7075X and GB-19384 from the National Science Foundation.

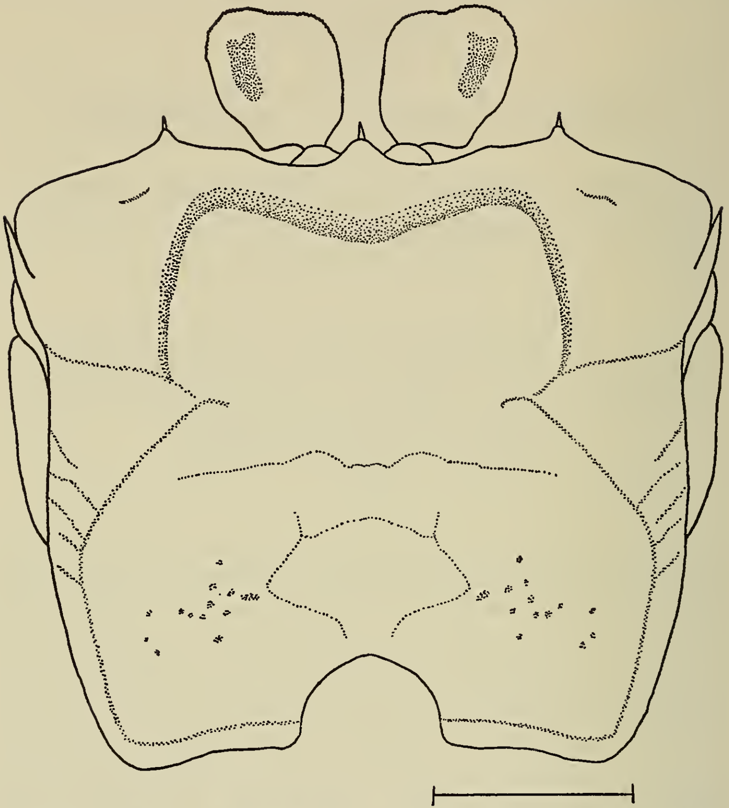


FIG. 1. *Lepidopa dexterae* new species. Female paratype (setae omitted). Scale = 1 mm.

Lepidopa dexterae new species

Figures 1 and 2

Material: Holotype: female, cl 4.3 mm, cb 5.6 mm; Shimmey Beach, Ft. Sherman, Caribbean coast of the Panama Canal Zone; intertidal sandy beach with coarse sand; 10 August 1969; coll. Deborah Dexter; USNM 135401.—Paratypes: 5 females, cl 3.8 to 4.8 mm; data as for holotype; USNM 135402.—2 females; data as for holotype; UPRC 89.—1 female; data as for holotype; AHF.—2 females; locality data as for holotype but collected 21 January 1971; coll. L. G. Abele, T. A. Biffar; coll. LGA 71–2; LM.

Diagnosis: Eye plate with small indentations along anterior edge. Posterior groove of carapace ending at posterior angle of concavity.

Description: All of the specimens are non-ovigerous females ranging in size from cl 3.8 to cl 4.8 mm.

The carapace (Fig. 1) is wider than long, laterally convex and highly setose. Its greatest width is at the level of the lateral teeth and it narrows sharply slightly posterior to these teeth. The rostrum (Fig. 2B) is short, blunt and is armed with a distinct subrostral spine. The ocular sinus (Fig. 2B) is smoothly rounded merging laterally into the small lobe of the anterior margin. These small lobes (Fig. 2B) (one on each side of the rostrum) are each armed with an acute spine which extends beyond the level of the subrostral tooth. The lateral spines of the carapace (Fig. 2A) are small and do not extend to the anterior margin of the carapace. The anterior margin of the carapace is lined with long plumose setae. The median concavity of the posterior margin of the carapace (Fig. 2D) is semicircular in shape. The sculpture of the dorsal surface of the carapace (Fig. 1) is typical of the genus. A distinct groove begins at about the middle of the carapace and extends along the lateral margins to the posterior margin of the concavity (Fig. 2D).

The first abdominal somite (Fig. 2E) is wider than long and narrows a little towards the anterior margin. The pleura of the second abdominal somite (Fig. 2E) are greatly expanded with the anterior corners more sharply angled than the posterior corners. The depth of the anterior emargination of the second somite is about one-quarter of its length. The posterior emargination is slight. The overall shape of the somite is somewhat rectangular. The third and fourth somites (Fig. 2C) are similar to each other in shape with the third being larger. The anterior margins of the somites are slightly concave medially. The anterior margins of the pleura are concave to the subacute distal tips. The posterior margins are convex, widening medially from the subacute tips. The general outline of an individual pleuron is saber-shaped. The fifth somite (Fig. 2C) narrows posteriorly so that the anterior margin is almost twice as wide as the posterior margin. The pleura are very narrow and concave anteriorly. They reach to about the distal quarter of the fourth pleuron. The length and width of the sixth somite are subequal. The telson (Fig. 2C) is pear-shaped and distinctly longer than wide.

The eye plate (Fig. 2H) is longer than wide with the anterior edge armed with indentations. The median angle is evenly rounded. The anterior margin is slightly concave medially. The lateral angle is on a distinctly higher level than the medial angle and is more rounded than the medial angle. The medial margin is almost straight. The dorsal surface of the eye plate is smooth and shiny and carries no setae. The margins of the eye plate are lined with setae, some of which are nearly half as long as the plate. A few additional setae extend out from the smooth, ventral surface of the eye plate. The eye spot is somewhat diffuse but of a general rectangular shape. It is located in the distal half of the plate lateral to the center.

The length of the third segment of the antennule (Fig. 2F) is slightly less than three times its width. The dorsal ramus of the flagellum is long and slender, and lined with two rows of long setae arranged as a wide V. The arrangement of these setae is such that when the two antennular

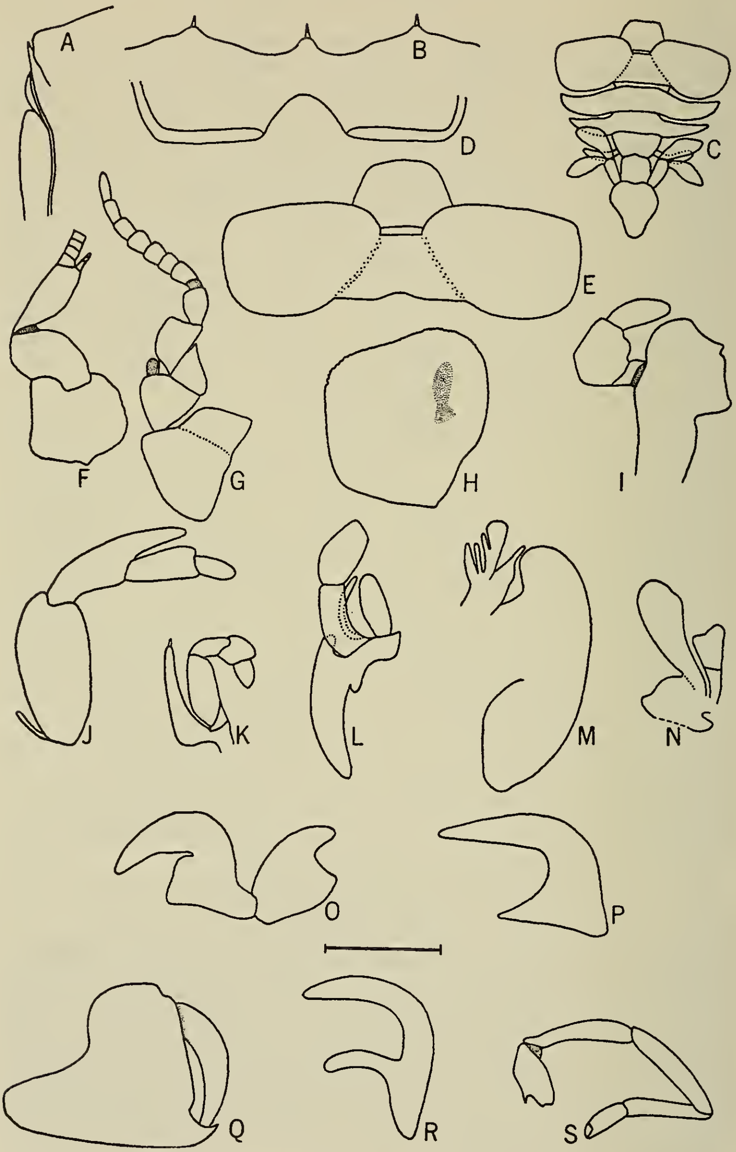


FIG. 2. *Lepidopa dexterae* new species. Holotype (setae omitted): A, left anterolateral portion of carapace. B, anterior margin of carapace. C, abdomen. D, posterior border of carapace. E, first and second abdominal somites. F, antennule. G, antenna. H, right eye plate. I,

flagella come together, the setae would form a distinct square tube—presumably a respiratory tube. The ventral ramus of the flagellum is short, consisting of three articles. It reaches to the third article of the dorsal ramus.

The basal antennal segment (Fig. 2G) is broad with a distinct lateral expansion. The second segment is very narrow proximally but widens rapidly distally. The scaphocerite is slightly longer than wide. The flagellum has eight articles. The most distal article is about four times as long as wide.

The mandible (Fig. 2I) has a three-jointed palp and a sharp cutting edge armed with two teeth, a blunt tooth adjacent to a stronger subacute tooth. The maxillula (Fig. 2N) has the coxal endite shorter and narrower than the basial endite. The palp is very broad. The maxilla (Fig. 2M) is typical. The first maxilliped (Fig. 2L) has the coxal and basial endites distinctly separated. The palp is distinct and narrow extending to the ultimate segment of the exopod. The exopod is broad, consisting of two segments; the ultimate segment being broader and slightly shorter than the penultimate. The epipod is well developed. The exopod of the second maxilliped (Fig. 2K) consists of two segments; the ultimate being very narrow and much reduced. The penultimate segment of the second maxilliped is expanded. The expansion of the antepenultimate segment of the third maxilliped (Fig. 2J) extends almost to the distal margin of the penultimate segment. The exopod is short and narrow. The two arthrobranchs are reduced. The branchial formula is:

	Maxillipeds			Pereiopods				
	1	2	3	1	2	3	4	5
Pleurobranch	–	–	1	–	–	–	–	1
Arthrobranch	–	–	2	2	2	2	2	–
Podobranch	–	–	1	–	–	–	–	–
Exopod	1	1	1	–	–	–	–	–
Epipod	1	–	1	–	–	–	–	–

The first pereiopods are subchelate. The dactyl (Fig. 2Q) is strongly curved and is acute. The fixed finger is curved upwards and is acute. The upper margin of the palm slopes down sharply slightly proximal to

←

mandible. J, third maxilliped. K, second maxilliped. L, first maxilliped. M, maxilla. N, maxillula. O, dactyl and propodus of second pereiopod. P, dactyl of fourth pereiopod. Q, right chela. R, dactyl of third pereiopod. S, fifth pereiopod.

Scale—4 mm for C; 2 mm for A, B, D, E, F, G, J, K, L, O, P, Q, R, S; 1 mm for H, I, M, N.

the distal margin. The dactyl of the second pereiopod (Fig. 2O) has a deep proximal emargination formed by an acute, curved distal process and a truncate proximal process. The dactyl of the third pereiopod (Fig. 2R) has both processes long and slender; the distal one is curved and acute, the proximal one is blunt and shorter than the distal. The dactyl of the fourth pereiopod (Fig. 2P) has the distal process long and straight with the proximal process shorter and acute. The dactyl of the fifth pereiopod (Fig. 2S) is much reduced and is equal to about one-fourth of the length of the palm.

The color of this species is highly irridescent.

Etymology: The specific name is for the collector Dr. Deborah Dexter of San Diego State University who was kind enough to allow us to study this material.

Remarks: The species is known only from the type locality. The specimens were collected from a sandy beach having a coarse grain size and moderate wave action. On the same beach a few specimens of *Lepidopa richmondi* Benedict and *Emerita portoricensis* Schmitt were collected. A search for additional specimens in the areas of Piña, the San Blas Islands and Ft. San Lorenzo was unsuccessful. These beaches all had fine-grained sand and slight wave action, and *Hippa testudinaria* (Herbst) (= *H. cubensis*) was very common, with up to 30 specimens per square meter on many beaches. In addition, at Piña a few specimens of *Lepidopa richmondi* Benedict, *Emerita portoricensis* Schmitt and *Arenaeus cribrarius* (Lamarck) were collected.

Discussion: Efford (in press) showed that the species in the genus *Lepidopa* could be divided into three groups—the *myops-californica* group, the *benedicti* group and the *venusta* group. *Lepidopa dexterae* fits fairly well into the *benedicti* group as the distal edge of the eyeplate has small indentations and is lined with long setae. In addition, the undersurface of the plate is smooth, except for a few setae near the edges. Other characteristics putting it in the *benedicti* group are the antepenultimate segment of the third maxilliped which extends almost to the distal end of the penultimate segment, the antennal flagellum which has eight articles and a rostrum which has a subrostral spine.

The species differs from the *benedicti* group, and resemble the *venusta* group, in having an eyeplate which is rounded, rather than square, and in having the posterior groove on the carapace straight rather than following the edge of the posterior concavity.

Within the *benedicti* group it resembles *richmondi*, *mearnsi*, and *haigae* in having a subrostral spine but, as the groove along the posterior edge is interrupted, it is closer to the latter two species.

LITERATURE CITED

EFFORD, IAN E. (in press). The species of sand crabs in the genus *Lepidopa* (Decapoda: Albuneidae). Zoologischen Anzeiger.

Vol. 84, No. 59, pp. 507–518 29 February 1972

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

EFFECTS OF STRIP MINING ON SMALL-STREAM FISHES IN EAST-CENTRAL KENTUCKY[1]

By Branley A. Branson and Donald L. Batch
Department of Biology, Eastern Kentucky University, Richmond, Kentucky 40475

Prior to World War II, most of the coal mined in Kentucky was secured from shaft mines which could be (although many were not) sealed following the cessation of operations. Following 1940, with the advent of higher wages for miners and increases in severance taxes, shaft mining became much reduced and strip mining increased. In Kentucky, nearly 70 percent of the mine operators conduct stripping exposure of very poor-grade bituminous coal deposits (grades 4 to 9). In exposing the coal deposits, the mining machines cut an L-shaped notch in a mountain, thus producing a highwall 50 to 60 feet tall and massive spoil banks below it. Often, the miners auger into the veins which cannot be mined otherwise.

In 1964, there were over 580 square miles of U. S. lands that were deleteriously affected by acid mine pollution (Kinney, 1964), and from most of this devastated area little data on physical and biological effects are available. One of the main problems resulting from this type of mining operation is the exposure of substances responsible for the formation of acid-mine water, mainly three forms of iron sulfide: pyrites, marcasites, and black amorphous pyrite (Parsons, 1957). These substances react with water and air to produce ferrous sulfate ($FeSO_4$) and hydrosulfuric acid (H_2SO_4) which, during rains, flush into streams, sometimes reducing the pH to readings as low as 2.3 (Harrison, 1958). When an acid produces a pH of

---

[1] This study is being conducted in cooperation with the Northeastern Forest Experiment Station, Forest Service, U. S. Department of Agriculture, Berea, Kentucky.

4.0 or less, it is toxic to fishes, regardless of the acid or acid-salt combination (Ellis, 1937).

Although some workers (Jewell, 1922; Jewell and Brown, 1924; and others) have reported prolonged survival of various fishes at pH values below 5, a host of others (Frost and Streeter, 1924; Carpenter and Herndon, 1933; Trax, 1933; Lackey, 1939; Tarzwell and Gaufin, 1953; Turner, 1958; Musser, 1963; Collier et al., 1964; Sheridan, 1966; and many others) have reported the extermination of fishes when the pH remained below 4.0 for any length of time.

Some studies (Riley, 1960; Ruhr, 1952; Maupin, Wells, and Leist, 1954) have demonstrated the feasibility of reclaiming strip-mined areas, but of course this does nothing for local endemics and endangered species which might have been exterminated during the mining operation. Moreover, Harrison (op. cit.) reported acid drainage to drastically affect the benthos. A few highly resistant forms persist and there develops a specialized biota.

While acid drainage from stripped areas has received considerable attention, the importance of stream siltation has been neglected. Bell (1956) indicated that erosion of spoil banks carried calcium, magnesium, sodium phosphate, and other ions into surrounding waters, but he did not measure siltation. It has been demonstrated (Shaw and Magna, 1943) that silt originating from mine tailings smothers incubating salmon and trout eggs and eliminates benthic food organisms (Henderson, 1949). Our data (cited by Stevens, 1969) indicates that such siltation may be increased by 15 to 30 times that present in non-affected streams in east-central Kentucky, and that such siltation decreases benthic organisms, particularly Ephemeroptera and decapod crustaceans, by 90 percent in 1 year.

Extensive areas of eastern and western Kentucky are afflicted with strip-mining operations. In general, the unaffected streams of Kentucky are of excellent quality but are extremely susceptible to the effects of acid-water pollution because of the low bicarbonate content of the water. This is particularly true in the Lee formation, which is very low in bicarbonates (Shoup, 1943). For example, Branson and Batch (1970) reported bicarbonate values of 9.7 to 25.0 ppm for order I, II, and III

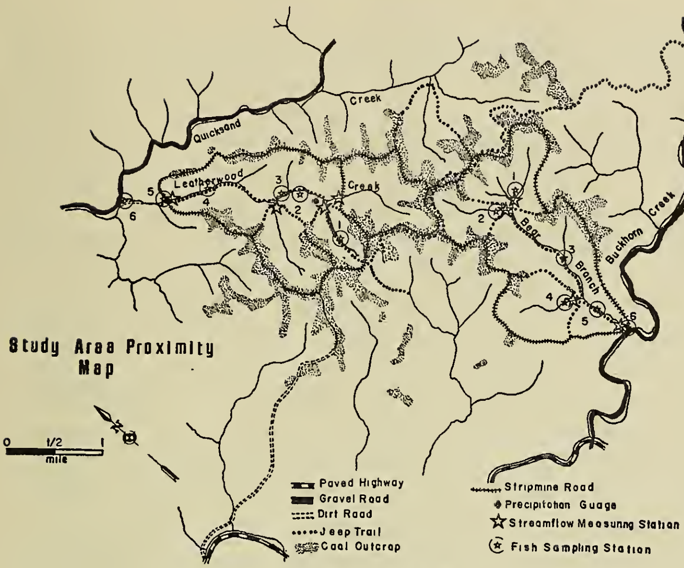


FIG. 1. Proximity map of the Study Area.

streams in east-central Kentucky. In streams tributary to the Big Sandy Drainage, Biesecker and George (op. cit.) reported an absence of bicarbonates, but indicated that in northern Kentucky free acidity from mining operations is not as severe as in other parts of the state. They suggest that among the various solutes in these streams sulfates are the best index to acid drainage from mines.

The purpose of the study was to observe the effects of siltation from strip mining on the fish populations of two streams. Such observations were feasible since acid drainage from the mines was very limited. The present report covers the first 17 months, May 1967 to September 1969, of a 5 year project.

The authors are greatly indebted to Mr. Willie Curtis and his assistants of the U. S. Forest Service for their assistance in conducting weekly chemical analyses and stream-flow determinations. Mr. Steve Stacy, graduate student, Eastern Kentucky University, conducted the food study on *Semotilus atromaculatus*.

Materials and Methods: The study area (Fig. 1) is located in Breathitt County, east-central Kentucky, a site in the Lee formation of the Appalachian Plateau. Two streams, separated one from the other by a relatively narrow ridge, are involved. Leatherwood Creek, tributary of Quicksand Creek, is 3.5 miles long, draining approximately 4 square miles. Bear Branch drains about 2.5 square miles, is 2 miles long, and flows into Buckhorn Creek. These streams are segments of the North Fork of Kentucky River. Leatherwood Creek and Bear Branch comprise order I and II tributaries. Mining operations commenced in the headwaters of Leatherwood Creek on August 15, 1967, and ceased on December 17, 1968. Prior to 1967, considerable stripping was done in the headwaters of Quicksand Creek. This earlier mining operation is meaningful in that the fish fauna at the mouth of one of our study streams was modified before the investigation started (see below). Mining commenced in the headwaters of Bear Branch in mid-August 1969, and it is still proceeding. Prior (May 1969) to commencing mining, some silt-trapping dams and roads were constructed on the latter stream, and the influence of this activity was reflected in an increased turbidity (Fig. 3).

For the purpose of determining silt loads and water-level fluctuations, concrete wiers with spillways, and recording devices (housed in permanent, locked chambers) were installed at critical points in each stream (Fig. 1). Weekly water samples for chemical analyses were also taken at these sites. Each water sample was analyzed for: specific conductivity, suspended sediment, turbidity, Fe^{++}, total Fe, SO_4, Al, Mg, Mn, Ca, Zn, total alkalinity, bicarbonates, and pH. For the reasons given by Wang and Brabec (1969), turbidity was measured in and is presented here as Jackson units.

Six fish-sampling stations, selected to include as many habitats as possible, were established in each creek (Fig. 1). These were periodically visited in order to determine how the process of strip mining affected the benthos (subject of another paper) and fishes (Fig. 4). Fishes were primarily collected by intensive seining for 30 minutes at each site.

Finally, a food study was conducted on *Semotilus atromaculatus*, in order to determine if its diet was correlated with an observed resistance to mine pollution.

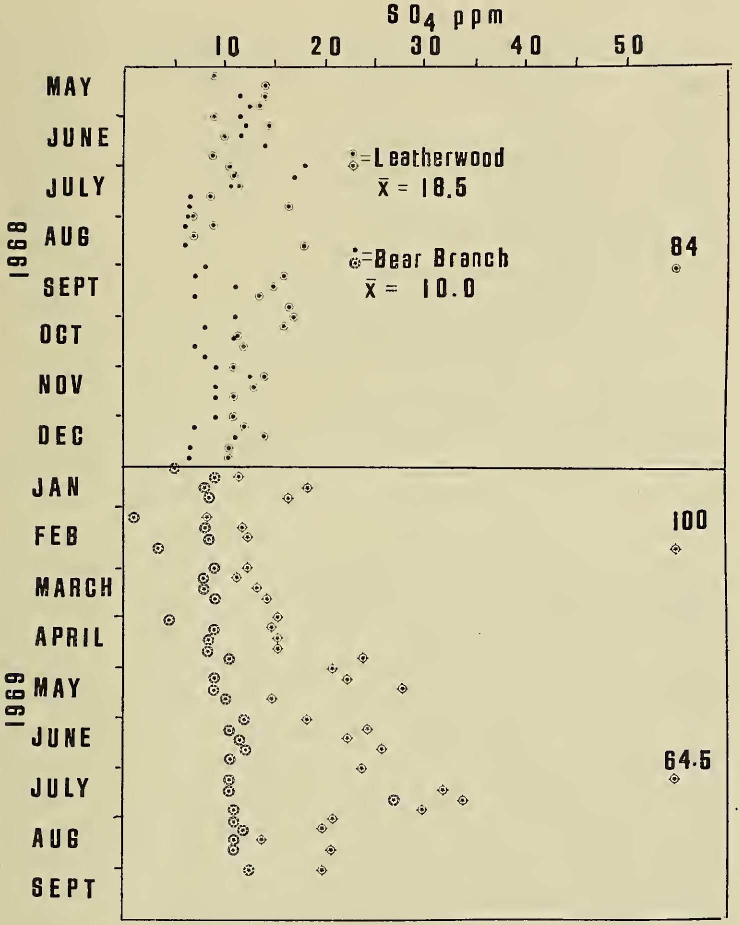


FIG. 2. Sulfate concentration in Leatherwood and Bear Branch Creeks, Breathitt County, Kentucky during 1968–1969.

The main objectives of the study were: (1) to determine the fishes present in a polluted versus an unpolluted stream (Leatherwood versus Bear Branch up to the time of mining in the latter); (2) to monitor the effects of strip mining on the fishes and bottom fauna; (3) to monitor recovery, if any.

Results: In general, our survey work demonstrated that the fishes of Leatherwood and Bear Branch creeks exhibited the kind of longitudinal succession of species characteristic of the area, similar to that observed by Kuehne (1962) in Buckhorn Creek, i.e., becoming progressively more abundant from headwaters to the mouth. This is, of course, also reflected in Figure 4. The faunas of the two creeks were doubtless identical prior to the onset of mining, but since Quicksand Creek had already been affected before we started monitoring Leatherwood Creek, the number of taxa of fishes occurring in the downstream area of this stream was less than that of nearby Bear Branch. Thus, we observed nine genera and 17 species of fishes in Bear Branch, but only seven genera and 12 species in Leatherwood Creek (Fig. 4), the difference being that some forms normally living in the lower reaches of the stream had been apparently extirpated from Quicksand Creek. Moreover, it was calculated that about 15.4 pounds of fish per acre occupied the lower portion of Bear Branch during October of 1968, whereas Leatherwood Creek possessed only approximately 5.8 pounds per acre. By September of 1969, the fauna of Bear Branch had dropped to 8.6 pounds per acre, following the onset of mining in that drainage. Although marked, these figures are not as striking as those reported from Goose Creek (Upper Kentucky River Drainage) (Turner, 1958) where nonpolluted segments of the stream produced 61.3 pounds per acre as compared with 5.38 pounds per acre in the polluted, or Beaver Creek (Sheridan, 1966) and Cane Creek (Smith, 1964) where fishes were completely eliminated by acid-mine water. However, these creeks were considerably larger than the ones here being investigated, and the latter have not been thus far subjected to much acid effluence, doubtless because minerals having a sulfur content are limited in the overburden.

A comparison (Fig. 2) of the sulfate profiles for the two streams shows the evidence of strip-mine pollution in Leatherwood Creek and the normal levels which were characteristic of Bear Branch prior to the onset of mining. The normal level of sulfates in waters of the region never rise above 100 ppm even during heavy rain washdown while contaminated waters may have concentrations of up to 832 ppm (Biesecker and George, 1966). During our period of study, pH values in the two streams varied between 5.6 and 7.8, with only an occa-

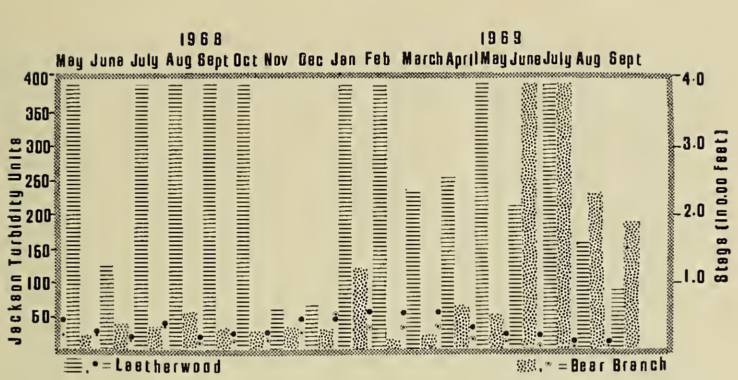


FIG. 3. Turbidity (Jackson units) in Leatherwood and Bear Branch Creeks, Breathitt County, Kentucky, during 1968–1969. Black spots and circled stars are stream stage distribution. Both measurements represent monthly averages for 4 or 5 samples, according to the number of weeks per month. (See text for additional discussion.)

sional reading dropping to as low as 4.0. No observable fish kills occurred during the advent of low pH. Nonetheless, fishes were being affected (see below), and in order to understand why we had to look at some aspects of the habitat.

During the early stages of the investigation, the two creeks were crystal clear and the gravel to sandstone bottoms were free of silt. However, after mining commenced the turbidity suddenly increased from around 30 Jackson units to nearly 400 in Leatherwood Creek (Fig. 3). The highest readings, of course, were always correlated with highwater stages, but turbidity never fell to the low levels observed in the then unaffected Bear Branch until June 1969 when some silt-catching dams and roads were constructed across the stream in an attempt to prevent down-stream siltation. During the highest turbidity in Leatherwood Creek, silt loads were measured at over 3,000 ppm. The bottom of the stream in some places was covered to a depth of 2 to 6 inches with clay, and nowhere was unaffected. The gravel and rocks were cemented to the bottom. The authors found salamanders (*Eurycea bislineata* and *Desmognathus*) entombed beneath rocks, and the bottom fauna and flora was virtually eliminated (mayflies and crayfish, for example, were reduced by 90%).

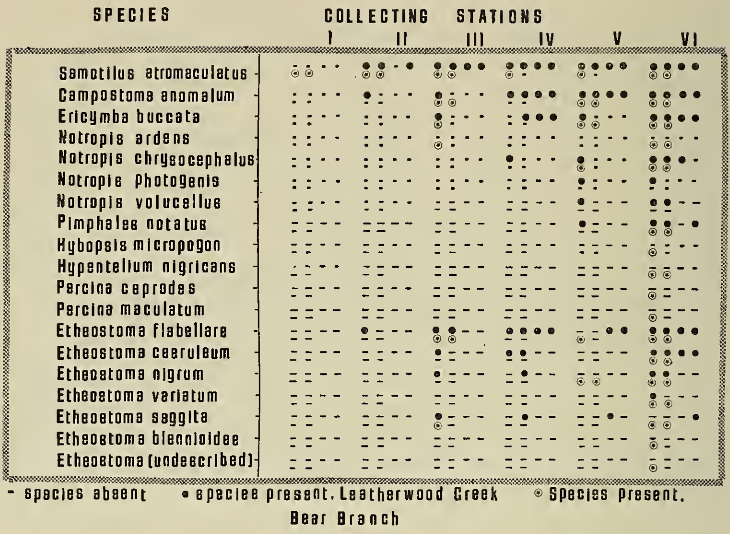


FIG. 4. Comparison of fish faunas at six stations in Leatherwood and Bear Branch Creeks, Breathitt County, Kentucky, affected by strip mining. Upper row of symbols, for each species, Leatherwood samples; lower row, Bear Branch. Visitation dates for Leatherwood Creek: 1 June 1968, 26 October 1968, 7 May 1969 and 1 October 1969; dates for Bear Branch: 21 March 1969 and 12 December 1969. (See text for additional discussion.)

Analyzing the results presented in Figure 4, two things become obvious. Declination of the ichthyofauna started upstream and progressed downstream in a kind of reverse succession; forms were either pushed downstream, or eliminated from the fauna altogether. We are of the opinion that this phenomenon resulted either directly or indirectly from siltation of the habitat. Since most of the fishes involved, i.e., *Campostoma* and *Etheostoma* and *Percina*, feed from the bottom, much of the adverse effects probably result from elimination of food supplies by siltation. Also, during later visits, although we secured numerous gravid females and ripe males, we did not observe young fishes from Leatherwood Creek. Either reproduction (mating?) had been curtailed, or the eggs and/or fry were smothered by the silt.

The second point made obvious by Figure 4 is that *Semotilus* *atromaculatus* appears to be considerably resistant to the influence of mine wastes. Smith (1964) also demonstrated that the fish was the last to be eliminated (but eliminated!) by acid-mine water. A study of the gut contents of 243 Leatherwood creek chubs gave at least partial explanation. Many of the guts (30 to 70%) proved empty. The others contained primarily terrestrial dipterans, coleopterans, adult trichopterans, and a few mayfly larvae. The creek chub, then, is primarily a surface-feeding fish, and is thus able to remain over ensilted bottoms long after other species have been eliminated.

Summary and conclusions: 1. A 17-month study of the effects of strip mining on the fish faunas of two small creeks in east-central Kentucky demonstrated a low-level of acid-mine water effluence but a high level of siltation and turbidity originating from intensive erosion of the spoil banks.

2. Fishes are progressively eliminated from headwaters downstream, or, are forced to emigrate downgrade.

3. Benthic food organisms were reduced in numbers and kinds by at least 90 per cent.

4. Reproduction in darters and minnows was curtailed by siltation, either by the prevention of mating or by kill-off of fry and eggs.

5. *Semotilus atromaculatus* is resistant to silt and turbidity pollution. This seems to be correlated with the fish's feeding habits, i.e., since the diet consists largely of terrestrial-type insects or aquatic ones taken from the surface, the fish is able to subsist following silting of the bottom.

Although silt-correlated removal of fish life, by smothering the benthos, by interfering with reproduction, or by direct effects, may not be as dramatic as that associated with acid-mine water kills, it is, nevertheless, an important disruptive force which is occuring on a large scale in Appalachia and elsewhere. Fishes are eliminated. When rare or endangered species are involved, as *Etheostoma saggita* is here, the results could and probably will be extirpation.

The authors intend to continue monitoring Leatherwood and Bear Branch Creeks in order to determine continued effects and whether or not recovery occurs. However, the situation in the entire upper Kentucky River appears bleak, since mining operations are being intensified.

LITERATURE CITED

BELL, R. 1956. Aquatic and marginal vegetation of strip-mine waters in southern Illinois. Illinois Acad. Sci. 48: 85–91.

BIESECKER, J. E. AND J. R. GEORGE. 1966. Stream quality in Appalachia as related to coal-mine drainage, 1965. U.S. Geol. Surv. Circ. 526: 1–27.

BRANSON, B. A. AND D. L. BATCH. 1970. An ecological study of valley-forest gastropods in a mixed mesophytic situation in northern Kentucky. Veliger 12: 333–350.

CARPENTER, L. V. AND L. K. HERNDON. 1933. Acid mine drainage from bituminous coal mines. West Virginia. Univ. Coll. Eng. Res. Bul. 10: 1–38.

COLLIER, C. R. et al. 1964. Influences of strip-mining on the hydrologic environment of parts of Beaver Creek Basin, Kentucky 1955–1959. U.S. Geol. Surv. Prof. Pap. 427: 1–83.

ELLIS, M. M. 1937. Detection and measurement of stream pollution. Bull. U.S. Bur. Fish. 48: 365–437.

FROST, W. H. AND H. W. STREETER. 1924. A study of the pollution and natural purification of the Ohio River. V. Chemical anlysis. Publ. Health Bul. 143: 110–183.

HARRISON, A. D. 1958. The effects of sulphuric acid pollution on the biology of streams in the Transvaal, Africa. Verh. Internat. ver. Limnal. 13: 603–610.

HENDERSON, C. R. 1949. Value of the bottom sampler in demonstrating the effects of pollution on fish food organisms and fish in the Shenandoah River. Prog. Fish-Cult. 11(4): 217–230.

JEWELL, M. E. 1922. The fauna of an acid stream. Ecology 3: 22–26.

——— AND H. BROWN. 1924. Fishes of an acid lake. Trans. Amer. Micros. Soc. 43: 77–84.

KINNEY, E. C. 1964. Extent of acid-mine pollution in the United States affecting fish and wildlife. Bur. Sport Fish. Wildl. Circ. 191: i–iv; 1–27.

KUEHNE, R. A. 1962. A Classification of streams, illustrated by fish distribution in an eastern Kentucky creek. Ecology 43: 608–614.

LACKEY, J. B. 1939. Aquatic life in water polluted by acid mine waste. U.S. Publ. Health Repts. 54: 740–746.

MAUPIN, J. R., J. R. WELLS AND C. LEIST. 1954. A preliminary survey of food habits of the fish and physico-chemical conditions of the water of three strip-mine lakes. Trans. Kansas Acad. Sci. 57: 164–171.

MUSSER, J. J. 1963. Description of physical environment and of strip-mining operations in parts of Beaver Creek Basin, Kentucky. U.S. Geol. Surv. Prof. Pap. 427 A: 1–25.

Parsons, J. D. 1957. Literature pertaining to formation of acid-mine wastes and their effects on the chemistry and fauna of streams. Trans. Ill. Acad. Sci. 50: 49–59.

Riley, C. V. 1960. The ecology of water areas associated with strip-mined lands in Ohio. Ohio J. Sci. 60: 106–121.

Ruhr, E. 1952. Fish populations of a mining pit lake. Unpublished ms thesis, Iowa State College, Ames, 78p.

Shaw, P. A. and J. A. Magna. 1943. The effect of mining silt on fry from salmon spawning beds. California Fish Game 29: 29–41.

Sheridan, J. R. 1966. *In*, Collier, C. R. and R. J. Pickering. Influences of strip-mining on the hydrologic environment of parts of Beaver Creek Basin, Kentucky 1959–1964. Unpub. draft, U.S. Geol. Surv., 1966: i–x; 1–149.

Shoup, C. S. 1943. Distribution of freshwater gastropods in relation to total alkalinity of streams. Nautilus 56: 130–134.

Smith, M. A. 1964. *In*, Collier, C. R. et al., loc. cit. pp. 80–83.

Stevens, D. R. 1969. Reclamation is still an infant. Mountain Life and Work 45: 3–5; 21–22.

Tarzwell, C. M. and A. R. Gaufin. 1953. Some important biological effects of pollution often disregarded in stream surveys. U.S. Dept. Health, Educ. Welfare EHC20: 1–38.

Trax, E. C. 1933. A quarter century of progress in the purification of acid waters. West Virginia Univ. Coll. Eng. Tech. Bull. 6: 5–19.

Turner, W. R. 1958. The effects of acid-mine pollution on the fish population of Goose Creek, Clay County, Kentucky. Prog. Fish-Cult. 1958: 45–46.

Wang, W. and D. J. Brabec. 1969. Nature of turbidity in the Illinois River. J. Amer. Waterworks Assn. 61: 460–464.

Vol. 84, No. 60, pp. 519–524 29 February 1972

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

DESCRIPTIONS OF NEW BATS OF THE GENUS *VAMPYROPS*

By Charles O. Handley, Jr. and Kay C. Ferris
Smithsonian Institution, Washington, D.C. 20560

Neotropical fruit juice and fruit-eating bats of the genus *Vampyrops* Peters were last reviewed by Sanborn (1955). Study of the extensive collections of the Smithsonian Venezuelan Project has revealed that some of Sanborn's species (i.e., *V. dorsalis*) are actually groups of species and that a considerable number of taxa remain to be described. Four are described in this paper.

We are grateful to Gordon B. Corbet and John E. Hill, British Museum (Natural History) (BM), for the privilege of studying the collections in their care. Specimens in the U.S. National Museum of Natural History are designated by the abbreviation (US). All measurements are in millimeters. For definition of cranial measurements, see Handley (1959: 98–99). This paper is a contribution of the Smithsonian Venezuelan Project, supported by a contract (DA-49-193-MD-2788) of the Medical Research and Development Command, Office of the Surgeon General, United States Army.

Vampyrops latus new species

Holotype: USNM no. 364408, adult male, skin and skull, collected 12 August 1964, by Arden L. Tuttle, at San Juan, 900 ft., Province of Oxapampa, Department of Pasco, Perú, original number 1789.

Etymology: Latin, latus, broad, referring to the unusual breadth of skull.

Distribution: Basin of the Amazon, downstream at least to Obidos, Amazonas, Brazil, and upstream to elevations of at least 1,000 feet in the drainages of the Río Marañón and Río Ucayali in Perú. Probably occurs also in the Amazonian portions of Bolivia, Ecuador, Colombia, and Venezuela.

Description: Body size small for a *Vampyrops* (forearm 37.2; greatest length of skull 20.6). Dorsal coloration dull brown; hairs grayish toward base, rather buffy subterminally; white median dorsal stripe and white facial stripes above and below eye prominent; underparts paler, grayish brown. Proximal portion of forearms and to a lesser extent dorsal portions of tibiae and feet hairy; interfemoral membrane sparsely covered with short hairs and sparsely fringed with longer hairs. In dried skin wing membranes blackish; interfemoral membrane, tibiae, feet, forearms, and fingers brownish; noseleaf and lips dusky; ears blackish, but lower margins and tragus cream-colored.

Rostrum short, broad, and relatively shallow; facial profile dished; zygomata flared out from rostrum; postpalatal extension short and its outer margins merge with hind edge of palate without a sharp angle; tooth rows bowed out so as to form a nearly circular pattern; P^4, M^1, and M^2 relatively large; P_4 with two anterior and one posterior cusp.

Measurements: Total length 55, hind foot (dry) 11, ear from notch 16, forearm 37.2, tibia 13.6, calcar 3.3.

Greatest length of skull 20.6, zygomatic breadth 12.4, postorbital breadth 5.3, braincase breadth 9.4, braincase depth 8.4, maxillary tooth row length 7.4, postpalatal length 7.0, palatal breadth at M^1 8.9, palatal breadth at canines 5.0.

Comparisons: *V. latus* is a small bat of the *V. helleri* group. It most closely resembles *V. l. saccharus* of northeastern South America, described below, but is smaller (e.g., forearm 36.9–39.0 vs. 39.7–40.6; greatest length of skull 20.6–21.4 vs. 21.8–22.5; maxillary tooth row 7.1–7.5 vs. 7.8–8.3) and has on the average a lower and less arched braincase. It differs more markedly from *V. recifinus* Thomas of eastern Brazil in size (in *V. recifinus* forearm is 40.5–42.6, greatest length of skull 23.5–24.2, maxillary tooth row 8.8–9.2); relatively shorter, higher braincase; shorter postpalatal extension; smaller auditory bullae; and bicuspid vs. cuspless anterior margin of P_4. Resemblances among these three taxa are many, and additional specimens from the Orinocan and Guianan lowlands may show them all to be geographic representatives of a single widespread species.

On the other hand, *V. l. latus* is sympatric with *V. helleri incarum* Thomas and can be easily distinguished from it by its shorter, broader, relatively shallower rostrum; more dished facial profile; flared rather than subparallel zygomata; nearly circular rather than roundly V-shaped palate; shorter postpalatal extension; two vs. one cusp on anterior margin of P_4; larger P^4, M^1, and M^2; and less copious fringe on hind edge of interfemoral membrane.

Specimens examined: BRAZIL: AMAZONAS: Obidos, 1 (BM). PERU: LORETO: Iquitos (Quistococha), 1 (US); Masisea (Tushemo, 1,000 ft., Río Ucayali), 2 (BM); Pebas (south bank, 300 ft.), 1 (BM); San Lorenzo (Río Marañón, 500 ft.), 1 (BM). PASCO: San Juan, 900 ft., 8 (US). NO EXACT LOCALITY: "Amazon," 1 (BM).

Vampyrops latus saccharus new subspecies

Holotype: USNM no. 408411, adult male, skin and skull, collected 20 July 1967, by Norman E. Peterson, at Manacal, 300 m, 5 km S and 25 km E Carúpano, Sucre, Venezuela, original number 14362.

Etymology: Greek, sakcharon, sugar, referring to the type region, Sucre.

Distribution: Northeastern South America, from the state of Sucre in Venezuela to Demerara, Guyana.

Description: Similar to *V. latus latus* described above, but larger and with a relatively higher and more arched braincase.

Measurements: Total length 66, hind foot (dry) 11, ear from notch 18, forearm 39.7, tibia 14.7, calcar 4.0.

Greatest length of skull 21.8, zygomatic breadth 13.5, postorbital breadth 5.8, braincase breadth 10.1, braincase depth 8.7, maxillary tooth row length 8.0, postpalatal length 7.2, palatal breadth at M^1 9.2, palatal breadth at canines 5.0.

Comparisons: See account of *V. latus latus* above for comparisons with *V. helleri* and *V. recifinus.*

Specimens examined: Guyana: Demerara, 1 (BM). Venezuela: delta amacuro: Delta of Orinoco, 1 (BM). sucre: Manacal, 300 m, 5 km S and 25 km E Carúpano, 3 (US); near Manacal, 176 m, 4 km S and 25 km E Carúpano, 1 (US).

Vampyrops aquilus new species

Holotype: USNM no. 338025, lactating adult female, skin and skull, collected 19 February 1964, by Charles O. Handley, Jr., on the head of the Río Pucro, 4,100 ft., Cerro Malí, Darién, Panamá, original number 12655.

Etymology: Latin, aquilus, swarthy, referring to pelage coloration.

Distribution: In and near cloud forest, between 4,100 and 4,700 ft., on the Río Pucro and Cerro Malí, Darién, Panamá.

Description: Body size medium for a *Vampyrops* (forearm 45.0; greatest length of skull 27.4). Dorsal coloration bright blackish brown; hair bases dark brown, poorly differentiated from hair tips; median dorsal stripe very sharply defined, pure white; facial stripes well defined, buffy; throat dusky and remainder of underparts grayish. Proximal portion of forearms and to a lesser extent dorsal portions of tibiae and feet hairy; interfemoral membrane narrow, hairy on both surfaces, and conspicuously fringed with long hairs. In dried skin wing membranes, lips, noseleaf, ears, and tragi blackish (with yellowish cast in life); fingers, forearm, legs, feet, and interfemoral membrane dusky brown.

Zygomata subparallel, not flaring; rostrum relatively broad anteriorly; I^1 short and with outer edge straight; I^2 narrow; canine small; P^2 low; P^4 with accessory cusp on hind edge of blade and with large posterocingular cusp; P^4 and M^1 narrow; M^1 with well-developed posterolabial cingulum, and bases of paracone and metacone connected so that basin between them opens to lingual side; M^2 wide and with ridge connecting paracone and metacone and with continuous labial and lingual ridges enveloping bases of cusps.

Measurements: Total length 78, hind foot (dry) 13, ear from notch 20, forearm 45.0, tibia 13.8, calcar 4.1, wingspread 373.

Greatest length of skull 27.4, zygomatic breadth 15.4, postorbital breadth 6.0, braincase breadth 11.3, braincase depth 9.3, maxillary tooth row length 10.6, postpalatal length 8.3, palatal breadth at M^1 13.3, palatal breadth at canines 6.7.

Comparisons: Vampyrops aquilus is a highland species most closely related to *V. oratus* Thomas (possibly including *V. umbrinus* Lyon) of northern Venezuela and northeastern Colombia. Collection of additional specimens in the northern reaches of the Andes in Colombia may show *V. aquilus* to be only a very well-marked race of *V. oratus.* It can be distinguished easily from *V. oratus* by its larger skull (e.g., greatest length 27.0–27.5 vs. 24.9–26.6; maxillary tooth row 10.5–10.7 vs. 9.6–10.5); brighter, richer, darker coloration with more prominent markings; subparallel (rather than flaring) zygomata; and longer rostrum with relatively broader tip.

V. aquilus is less like *V. dorsalis* Thomas of eastern Panamá, western Colombia, and western Ecuador. *V. aquilus* has smaller size (e.g., forearm 45.0–46.5 vs. 48.2–51.3); much brighter coloration and more prominent markings; has throat coloration differentiated from that of the belly; the interfemoral membrane more distinctly fringed; rostrum narrower and less inflated; zygomata subparallel rather than flaring; I^1 with straighter edges; smaller canines; and P^4, M^1, and M^2 narrower and with more suppressed hypocone.

Specimens examined: PANAMÁ: DARIÉN: Head of Río Pucro on Cerro Malí, 4,100–4,700 ft., 3 (US).

Vampyrops aurarius new species

Holotype: USNM no. 387163, adult male, skin and skull, collected 18 May 1966, by Merlin D. Tuttle and Arden L. Tuttle, at Km 125, 1,000 m, 85 km SSE El Dorado, Bolivar, Venezuela, original number 8329.

Etymology: Latin, aurarius, golden, referring to the type region, El Dorado.

Distribution: Guiana Highlands of Venezuela.

Description: Body size large for a *Vampyrops* (forearm 52.3; greatest length of skull 28.6). Dorsal coloration bright blackish brown; hair bases paler brown; white median dorsal stripe and buffy facial stripes prominent; underparts dull, dark brown. Interfemoral membrane conspicuously fringed. In dried skin wing membranes, noseleaf, and ears blackish; tragus yellowish; lips, fingers, forearms, legs, feet, and interfemoral membrane fuscous.

Rostrum relatively arched and narrowed anteriorly; facial profile dished; zygomata flaring; I^1 averaging relatively long and narrow; P^4, M^1, and M^2 relatively wide; hypoconal area bulging in M^1.

Measurements: Total length 71, hind foot (dry) 14, ear from notch 22, forearm 52.3, tibia 19.8, calcar 5.0.

Greatest length of skull 28.6, zygomatic breadth 17.1, postorbital breadth 6.6, braincase breadth 11.5, braincase depth 10.2, maxillary tooth row length 10.9, postpalatal length 9.0, palatal breadth at M^1 12.3, palatal breadth at canines 6.9.

Comparisons: V. aurarius is larger than any member of the *V. dorsalis* group and needs comparison only with *V. vittatus* Peters and its allies, with which it agrees in cranial details. It is considerably smaller than *V. vittatus* of northern Venezuela (forearm 49.8–53.9 vs. 54.5–60.7; greatest length of skull 28.3–29.0 vs. 30.5–32.6) but resembles it in coloration. Compared with eastern Ecuadorean *V. infuscus* Peters, and judging by the original description of *V. intermedius* Marinkelle (1970), it is smaller; darker, brighter, and better marked; and has I^1 longer, narrower, and usually more vertically oriented than either of those nominal species. In addition, *V. aurarius* lacks the white tipping of the wings that characterizes *V. intermedius.*

Specimens examined: VENEZUELA: BOLIVAR: Km 125, 1,000 m, 85 km SSE El Dorado, 41 (US). T. F. AMAZONAS: Caño Culebra, 800 m, Cerro Duida, 50 km NNW Esmeralda, 3 (US).

LITERATURE CITED

HANDLEY, C. O., JR. 1959. A revision of American bats of the genera *Euderma* and *Plecotus.* Proc. U.S. Nat. Mus. 110:95–246, 27 figs.

MARINKELLE, C. J. 1970. *Vampyrops intermedius* sp. n. from Colombia (Chiroptera, Phyllostomatidae). Rev. Brasil. Biol. 30(1): 49–53, 8 figs.

SANBORN, C. C. 1955. Remarks on the bats of the genus *Vampyrops.* Fieldiana: Zool. 37:403–413.

INDEX TO NEW TAXA

VOLUME 84

(New taxa indicated in **boldface**; n.c. = new combination)

MONOCOTYLEDON

LILIALES

ANNELIDA

OLIGOCHAETA

ARTHROPODA

CRUSTACEA

DIPLOPODA

INSECTA

ECHINODERMATA

ASTEROIDEA

HOLOTHURIOIDEA

CHORDATA

PISCES

AMPHIBIA

REPTILIA

MAMMALIA

FOSSIL PRIMATES