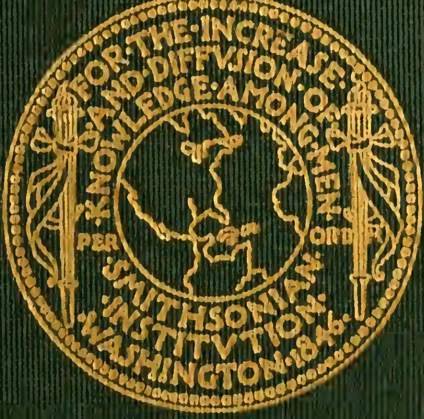

FOR THE INCREASE AND DIFFUSION OF KNOWLEDGE AMONG MEN
PER
ORBEM
SMITHSONIAN INSTITUTION
WASHINGTON 1846

SMITHSONIAN INSTITUTION
UNITED STATES NATIONAL MUSEUM

PROCEEDINGS

OF THE

UNITED STATES NATIONAL MUSEUM

VOLUME 112

NUMBERS 3431–3449

UNITED STATES
GOVERNMENT PRINTING OFFICE
WASHINGTON : 1962

Publications of the United States National Museum

The scientific publications of the United States National Museum include two series, *Proceedings of the United States National Museum* and *United States National Museum Bulletin.*

In these series are published original articles and monographs dealing with the collections and work of the Museum and setting forth newly acquired facts in the fields of anthropology, biology, geology, history, and technology. Copies of each publication are distributed to libraries and scientific organizations and to specialists and others interested in the various subjects.

The *Proceedings,* begun in 1878, are intended for the publication, in separate form, of shorter papers. These are gathered in volumes, octavo in size, with the publication date of each paper recorded in the table of contents of the volume.

In the *Bulletin* series, the first of which was issued in 1875, appear longer, separate publications consisting of monographs (occasionally in several parts) and volumes in which are collected works on related subjects. *Bulletins* are either octavo or quarto in size, depending on the needs of the presentation. Since 1902 papers relating to the botanical collections of the Museum have been published in the *Bulletin* series under the heading *Contributions from the United States National Herbarium.*

REMINGTON KELLOGG,
Director, United States National Museum.

CONTENTS

ERRATA

Page 16, line 37: change *Hysipyrgias* to read *Hypsipyrgias.*
Page 18, fourth name in list: change *Pseudodacysta* to read *Pseudacysta.*
Page 24, line 26: change *lelcupi* to read *lepeupi.*
Page 25, line 36: change *vanderstyi* to read *vanderysti.*
Page 32, line 6: change *amigera* to read *armigera.*
Page 32, line 18: change *apicicornis* to read *apicornis.*
Page 40, line 15: change *wucrontausi* to read *wuorentausi.*
Page 57, line 38: change *Frucilliger* to read *Furcilliger.*
Page 63, line 23: change *hedenborgi* to read *hedenborgii.*
Page 87, line 8: change *Phylloncheila* to read *Phyllontocheila.*
Page 117, line 28: change *Sinoconops* to read *Siniconops.*
Page 309, figure 1,*a*: change *Trochilocoetes* to read *Trochiloecetes.*
Page 309, figure 1,*f*: change *Trociliphagus* to read *Trochiliphagus.*
Page 312, figure 2, line 1: change *Trochilophagus* to read *Trochiliphagus.*
Page 312, figure 2,*c*: change *irazuensisus* to read *irazuensis.*
Page 312, figure 2,*h*, p: change *T.* to read *Trochiloecetes.*
Page 323, figure 6: *T.* = *Trochiloecetes.*
Page 401, line 42: change *monenes* to read *monense.*

Proceedings of
the United States
National Museum

SMITHSONIAN INSTITUTION • WASHINGTON, D.C.

Volume 112 1960 Number 3431

LACE-BUG GENERA OF THE WORLD (HEMIPTERA: TINGIDAE) [1]

By Carl J. Drake and Florence A. Ruhoff

Introduction

A treatise of the generic names of the family Tingidae from a global standpoint embodies problems similar to those frequently encountered in corresponding studies in other animal groups. The more important criteria, including such basic desiderata as fixation of type species, synonyms, priority, and dates of technical publications implicate questions concomitant with recent trends toward the clarification and stabilization of zoological nomenclature.

Zoogeography, predicated and authenticated on the generic level by the distribution of genera and species, is portrayed here by means of tables, charts, and maps of the tingifauna of the world. This visual pattern of distribution helps one to form a more vivid concept of the family and its hierarchic levels of subfamilies and genera. To a limited extent the data indicate distributional concentrations and probable centers of evolution and dispersal paths of genera. The phylogenetic relationship of genera is not discussed.

The present treatise recognizes 216 genera (plus 79 synonyms, homonyms, and emendations) of the Tingidae of the world and gives

---

[1] Research for this paper was supported in part by the National Science Foundation, grant No. 4095.

the figure of 1,767 as the approximate number of species now recognized. These figures, collated with similar categories in Lethierry and Severin (1896), show that there has been an increase of many genera and hundreds of species of Tingidae during the past three-quarters of a century. And as attested by the number of new forms being described each year in technical publications, there are still many unknown genera and many more new species yet to be discovered.

The three subfamilies of the Tingidae are listed in alphabetic sequence. The genera and subgenera (including synonyms, homonyms, emendations, misapplied names, misspellings, nomina nuda (sine species), lapsus calami, and errata) are also alphabetized under their respective subfamilies. Although absolute completeness and perfection are unattainable, every effort has been taken to formulate a complete registery of all generic and subgeneric names, both valid and invalid, heretofore proposed in the literature for both existing and fossil tingids. Each reference has been checked against the original publication. Thus, a number of errors that have crept into the literature have been rectified.

The authors hope that the users of this work will make known typographical, technical, and other errors so that corrections may be made in the catalog of the Tingidae of the world, now in preparation.

Often it has been difficult to accredit with any degree of certainty the first authority accountable for synonymy, subsequent type designation of a genus, and other taxonomic changes. When such information was not so expressed in the literature, the oldest ascertainable record of the action has been cited as the authoritative citation.

Accepted or valid generic and subgeneric names are printed in boldface type; the invalid or inacceptable names are in lightface type. Cross-references are provided to link every synonym, homonym, emendation, unaccepted name, and error of any type to the proper taxon.

The name of each genus, subgenus, and type species is followed by the name of author with date and page reference, thus providing identification in the list of literature cited. "Later citation" as used herein refers to authors who have correctly cited the type species after its fixation; a "previous selection" is a citation made prior to the official list of the International Commission on Zoological Nomenclature but is in agreement with that list; "erroneous or invalid citations" are explained under the respective genera.

In searching for new generic records and other taxonomic changes, the reader should begin with volume 93 of the Zoological Record (1956).

Smithsonian Institution
United States National Museum
Washington, D. C.

Proceedings of the United States National Museum
Volume 112, Number 3431

Lace-Bug Genera of the World (Hemiptera : Tingidae)

ERRATA

Page 18, fourth name in list: change *Pseudodacysta* to read *Pseudacysta.*

Page 24, line 26: change *leleupi* to read *lepeupi*.

Page 25, line 36: change *vanderstyi* to read *vanderysti*.

Page 32, line 6: change *amigera* to read *armigera.*

Page 32, line 18: change *apicicornis* to read *apicornis.*

Page 40, line 15: change *wuerontausi* to read *wuorentausi*.

Page 57, line 38: change *Frucilliger* to read *Furcilliger*.

Page 63, line 23: change *hedenborgi* to read *hedenborgii*.

Acknowledgments

The authors express sincere thanks to the following: Dr. J. F. Gates Clarke, U.S. National Museum, for reading the manuscript and making numerous helpful suggestions; Mr. Curtis W. Sabrosky, U.S. Department of Agriculture, for many helpful suggestions and advice on nomenclature; Dr. Reece I. Sailer, U.S. Department of Agriculture, for help and encouragement; Dr. W. E. China for information on rare species in the British Museum (Natural History) and especially for notes on tingid types in the Linnaean Collection (Linnaean Society London, Burlington House, Piccadilly); Mr. R. J. Izzard for supplying notes on types and checking drawings made from types and other specimens in the British Museum; Dr. S. L. Tuxen for lending the type of *Acanthia costata* Fabricius in the Universitetets Zoologiske Museum, Copenhagen; Mr. Arthur Smith of the British Museum, Mrs. Richard Froeschner of Bozeman, Mont., and Mrs. Patricia Hogue of Alexandria, Va., for the drawings of insects; Mr. Theodore B. Ruhoff, U.S. National Museum, for preparation of maps and circular graphs; and Miss Emily F. Bennett of the U.S. National Museum library staff for her tireless efforts in locating and putting at our disposal many of the technical papers required for reference.

Family Tingidae Laporte [2]

Membranaceae Latreille, 1825, pp. 415, 422.
Tingidites Laporte, 1833, p. 47.
Membranacei Burmeister, 1835, p. 249
Tingini Costa, 1838, p. 20.
Tingidae Westwood, 1840, p. 120.—Costa, 1855, p. 293.—Lethierry and Severin, 1896, p. 1.—Hurd, 1946, p. 437.—Monte, 1947, p. 2.—China, 1955, p. 261.
Tingides Amyot and Serville, 1843, pp. 285, 295.
Tingideae Fieber, 1844, pp. 20, 27.
Ductirostri Sahlberg, 1848, pp. 125, 127.
Tingiditae Spinola, 1850, p. 27.
Tingididea Fieber, 1851, p. 9.—Flor, 1860, p. 317.—Vollenhoven, 1878, p. 265.
Tingitidea Costa, 1860, p. 6.
Tingididae Fieber, 1861, p. 26.—Oshanin, 1908, p. 395.—Van Duzee, 1916, p. 25; 1917, p. 209.
Tingidida Stål, 1865, p. 25.
Tingina Stål, 1870, p. 671.
Tingitidae Stål, 1873, p. 115.—Uhler, 1886, p. 21.—Horváth, 1906c, p. 1; 1911, p. 14.—Oshanin, 1912, p. 42.—Drake and Poor, 1936a, p. 382.—China, 1943, p. 245.

---

[2] The 15th International Congress of Zoology (London, 1958) made provisos for the acceptance of family names originally founded in the vernacular—such as Tingidites Laporte (1833) in French—providing such usage has been generally accepted. Since Tingidae (for "Tingidites") meets the new code of Zoological Nomenclature, we are accrediting "Tingidae" to Laporte, who was the first to use a family name for the lace-bugs. It should be noted that all technical and vernacular names for the family always have been based upon the generic name of *Tingis* Fabricius.

TINGITIDES Puton, 1875, p. 28; 1899, p. 38.
TINGIDIDES Vollenhoven, 1878, p. 9.

TYPE GENUS: *Tingis* Fabricius (1803, p. 224).

The family Tingidae comprises a moderately large assemblage of insects ranging rarely more than 2–5 mm. in length. The species are entirely plant-feeders, and both adults and nymphs obtain food by sucking out the juices from the cells of the tissues within the living plants. At times they occur in sufficient numbers to constitute an important plant-pest.

Adults and offspring live on the underside of the leaves of the host plants. Their presence soon betrays itself by the appearance of whitish and discolored spots on the upperside of the leaves just above the place of feeding. Many species are gregarious and both adults and nymphs cluster near the spot where the eggs were laid. The life-cycle is relatively short, two or more generations usually being passed during the growing season. Metamorphosis, called hemimetabola, is gradual.

Many different kinds of wild and cultivated plants serve as feeding and breeding hosts. Among the common economic hosts might be mentioned such plants as cotton, sugarcane, eggplant, cassava, rubber, pear, apple, cherry, avocado, almond, tea, coffee, banana, cacao, coconut, camphor, black pepper, and olive. Shade and forest trees, shrubs, herbs, grasses, and decorative plants also serve as primary hosts. Mosses, too, are inhabited. Members of three genera found in Africa, Australia, Asia, and southern Europe are typical gall-forming insects. Distribution, except for the lands of the Arctic and Antarctic Zones, is practically worldwide.

As a familial group, tingids are separated from almost all other families[3] of the order Hemiptera by the intricate pattern of delicate lacework occurring all over the processes of the pronotum and of the fore pair of wings. On account of their lacy appearance, tingids are known globally by the same colloquial name, "lace-bugs," and once seen they are thus easily recognized. The immature stages are often adorned with long, plain or modified spines, only the adults being clothed with lacework in different specific patterns.

The question is frequently asked, "What is the use or function, if any, of the lacy dorsal covering of tingids?" Perhaps it is for protective concealment. For similar reasons man himself makes use of "nets" or "screens" of various kinds to conceal or camouflage strategic objects from the eyes of enemies, especially from the air. Color and markings also enter into the picture.

---

[3] Members of the hemipterous families Piesmatidae and Peloridiidae also have the dorsal surface of their bodies composed of lacework, but phylogenetically neither is very closely allied to Tingidae or to each other.

In the subfamily Tinginae, members of many genera at times are said to "run wild" structurally in the development of unique and fanciful forms of specific designs in lacework. The pepper tingid (fig. 1) of the South Pacific is only one of hundreds of such creations. Many species in other genera are at least just as ornately clothed and befittingly decorated in singular lacy structures. There are no replicas nor facsimiles among species, because each species possesses its own form, pattern, and style of lacework. Both generic and specific characters used in the identification of lace-bugs are based largely upon lacy structures. Only with the aid of illustrations can such unequaled oddities of intricate lacework be described adequately for taxonomic studies.

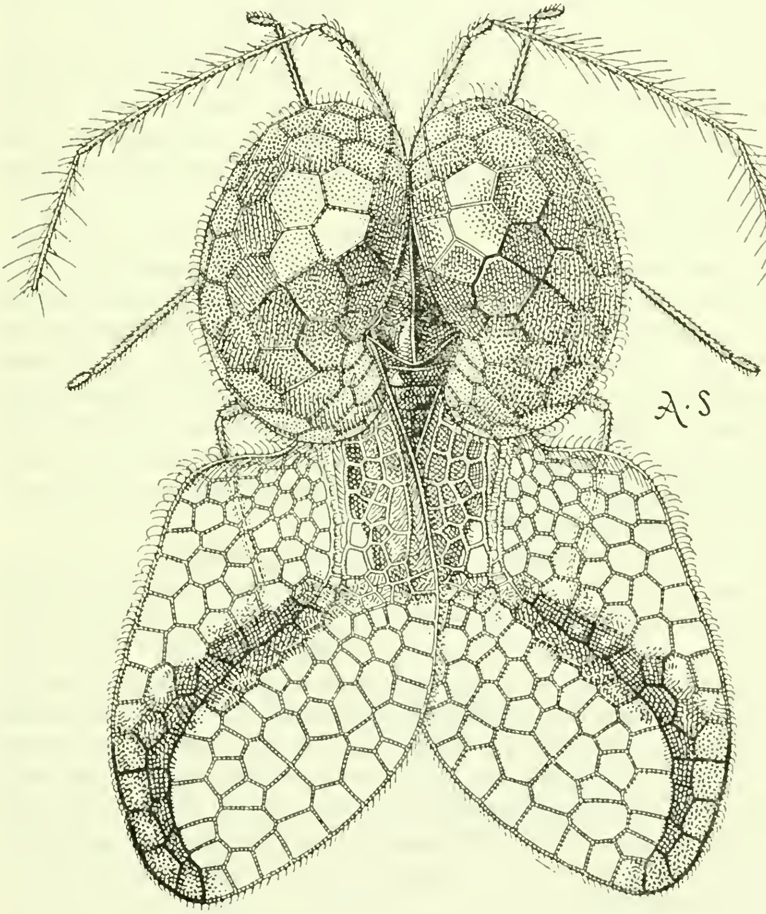


FIGURE 1.—*Nesocypselas piperica* Drake, the black pepper lace bug.

Hemipterists are almost entirely of the opinion that the families Tingidae and Piesmatidae are not very closely related and thus together did not form a natural higher taxon. According to a recent paper by Drake and Davis (1958, p. 572), evidences from external morphology and reproductive organs of males and females of the two families do not substantiate the retention of the superfamily Tingoidea for these families. Consequently, those authors suppressed the superfamily as then constituted.

The myrmecophile family Vianaididae was erected by Kormilev (1955, p. 465–477) to hold a new genus and new species, *Vianaida coleopterata* Kormilev, and another monobasic genus, *Anommotocoris minutissimus* China (1945, pp. 126–128) described from Trinidad, British West Indies. As the families Tingidae and Vianaididae are without ventral trichobothria and both belong to the group Cimicomorpha of Leston, Pendergrast, and Southwood (1954, pp. 91–94), Kormilev suggested that these two families may be consociates so as to form a superfamily Tingidoidea (sensu novum). The relationship of these families and the status of the proposed superfamily "Tingidoidea" (proper spelling should be Tingoidea) are now being critically studied and will be discussed in a subsequent paper dealing with the morphology and higher classification of Tingidae.

Except for the characterization of many new genera and several hundred species, tingids have received scant attention for many decades in the taxonomic hierarchy of higher categories ascending from the generic to ordinal rank. Obviously the subfamilies and particularly some of the larger polytypic genera (*Tingis*, *Leptopharsa*, and *Cysteochila*, for examples) need more thorough analyses, both objectively and subjectively, from a worldwide aspect so that such heterogenous taxa can be better understood and especially delimited. Their constituents can then be more concretely tied into the generic concept of their respective type species.

The progenitors and other pioneer genera at times have served as temporary repositories ("catch-alls") for many new species of doubtful or even unknown generic affinities ever since the days of Linnaeus and Fabricius. For example, the genera *Phyllontocheila* and *Monanthia*, both recently buried in synonymy, formed generic anchors for the erection of a number of subgenera which have been withdrawn for elevation to the generic level. An examination of the specific names also reveals that more than 100 species of tingids originally described as *Monanthia* have been transferred to other, sometimes newly created, genera. Several genera now recognized as valid, such as *Tingis*, *Cysteochila*, and *Leptopharsa*, still hold some species of doubtful generic affinities.

In the only catalog so far published on the Hemiptera (Heteroptera;

Miridae not included) of the world, Lethierry and Severin (1896, pp. 4–26) recorded a total of only 50 genera and 317 species of Tingidae for all five continents and the islands of the seas. Forty years later, Drake and Poor (1936a, p. 381) enumerated 52 genera from the Western Hemisphere alone. The latter authors also stated that 424 species had been described from the Americas and estimated that approximately 1,100 species were then characterized in the world. Monte (1947) published a list (incomplete) of 99 tingid genera (including synonyms) and their respective type species for the world.

Two basic and monumental treatises have been written on the family Tingidae. Horváth (1906c) published a very comprehensive study of the Tingidae of the Palearctic subregion, with original keys to genera and species. He recognized 19 valid genera and 201 valid species for the Palearctic subregion. Hurd (1946) published descriptions and original keys to the 44 genera known to occur in North America. This author gave the figure 424 as the number of known species at that time inhabiting the Americas north of the Panama Canal.

Inasmuch as the foregoing papers dealt with land areas of various extents, involving diverse biotic conditions and even overlapping faunal regions, the data are too disparate to trace growth and to compare generic and specific populations in different faunal areas.

In a lengthy paper dealing with the Rhynchota, Amyot (1845, pp. 369–492; 1846, pp. 73–192) proposed a monomial system to replace the binomial nomenclature as originally organized by Linnaeus (1758). This new system, mononymy, would classify animals by means of a one-word taxon representing both genus and species in lieu of the binary system of two words, one for genus and the other for species. This monomial system of Amyot was never seriously considered by entomologists, nor recognized in the Zoological Code.

Under Division III, Membranientes, Amyot (1846, pp. 175–192) mononymized technical names for a number of species of tingids and piesmatids. In the transition from the binomial to the monomial system, he employed several well-known generic names and created a number of new monomial names. Only one of the mononymic taxa was created for a new tingid species, the others being erected for well-known species of that time. This mononymic species, "*Dictyesthes*," described by Amyot (1846, p. 181), has been cited by Garbiglietti (1869, p. 275) as *Dictyonota dictyesthes* Amyot. The publication of Garbiglietti (1869) validated *D. dictyesthes* as a specific name and thus credit of authorship must be given to Garbiglietti rather than to Amyot.

In his "Nomenclator Zoologicus," Neave (1939–1950) wrongly included the monomial names of species named or renamed by

Amyot as generic names and credited them to Amyot as such. This is a serious error. Since Amyot's names are not true generic names and have no nomenclatorial standing, they are not included herein in the present treatise of the generic names of Tingidae of the world. The authors hope that the above comments will prevent further confusion and use of these monomial names.

In his catalog of the Hemiptera, Walker (1873, pp. 175–179) included only two families, Tingididae and Piesmidae, in the Membranacea, and divided a number of tingid genera into "Divisions" and "Subdivisions." For the new taxa below the generic level, Walker used a jumble of scientific names of other workers. These names were wrongly employed, wrongly synonymized, and wrongly classified by him. Since no new generic or subgeneric names are involved, the present authors are following previous catalogers and omitting Walker's names of generic and subgeneric divisions.

The proper form of the family name of the lace-bugs was an item of contention for more than a century. The moot point of the controversy rested almost entirely upon finding the correct "root" and "stem" of the type generic term *Tingis* of Fabricius. These items have been amiably and consummately investigated by Holland (1922a; 1922b; 1924), Baker (1922; 1923), Parshley (1922a; 1922b), and Schmitz (1935). Their findings showed much diversity of opinions and little unanimity as to the origin and status of "*Tingis*."

In January 1923, Baker submitted to the International Commission of Zoological Nomenclature a concise summary of the findings and conclusions on the controversy of Holland, Parshley, and himself, including a request for a ruling on the origin and formation of the word "*Tingis*." To quote from Opinion 143 of the International Commission of Zoological Nomenclature (1943, pp. 83–85):

> *Tingis* étant un nom latin dont le genitif est *Tingis* et l'accusatif *Tingim*, TINGIDAE est la forme correcte du nom de la famille.

The ruling was:

> The family name for *Tingis* Fabricius, 1803 (*Syst. Rhyng.*: 124) in the Hemiptera is TINGIDAE.

Beginning with volume 59 (1922), the Zoological Record has continually used the family name Tingidae for the lace-bugs. That spelling under the Régles has been universally accepted as the proper family name for the lace-bug family.

Stål (1873, p. 116) and Distant (1903c, pp. 122–145) both used the higher categories as divisions for the family Tingidae, although Distant placed a few genera in the wrong division. These categories were Cantacaderaria, Serenthiaria, and Tingidaria. Later, Distant

(1909, pp. 121–122) created two new divisions: Axiokersosaria, for the reception of *Axiokersos ovalis* Distant, from India; and Aidoneusaria to hold *Aidoneus dissimilis* Distant. As the characters of these two new divisions will not always separate them from genera of the division Tingidaria, they are both synonymized here with Tinginae (olim Tingidaria).

Since Distant's (1903c) work titled "The Fauna of British India" is used so extensively in systematic studies, the present equivalent taxa for the above divisions are listed here:

Cantacaderaria, synonymized with subfamily Cantacaderinae.
Serenthiaria, synonymized with subfamily Agrammatinae.
Tingidaria, synonymized with subfamily Tinginae.
Axiokersosaria, synonymized with subfamily Tinginae.
Aidoneusaria, synonymized with subfamily Tinginae.

Blatchley (1926) subdivided the subfamily Tinginae into three new tribes for the reception of the genera occurring in eastern North America. The status of these tribes is discussed below in the order of their erection.

Tribe Galeatini Blatchley (1926, p. 451) comprises the genera *Galeatus*, *Corythuca* (error for *Corythucha*), *Stephanitis*, *Leptobyrsa* (not Stål), *Corythaica*, *Dictyonota*, *Gargaphia*, *Gelchossa*, *Leptodictya*, and *Acanthocheila*. *Gelchossa* is a synonym of *Leptopharsa* (p. 58). *Leptobyrsa* is a South American genus not represented in the United States. As used by Blatchely (not Stål), *Leptobyrsa* is synonymous with *Stephanitis*, and thus *Stephanitis blatchleyi* Drake (1925b, p. 37) and *S. rhododendri* Horváth (1905, p. 567) were wrongly transferred by him from their original generic position to this genus. Galeatini is not applicable for the inclusion of some of the American genera as well as many related genera in the Old World, and it is here suppressed as a synonym of the subfamily Tinginae (p. 31).

The tribal name Acalyptini Blatchley (1926, p. 479) was established to hold the genera *Acalypta* and *Drakella*. As the latter is a synonym of the former, only *Acalypta* is left in the tribe. Acalyptini is not a valid tribe and thus is treated here as a synonym of Tinginae (p. 31).

The tribal name Physatocheilini Blatchley (1926, p. 483) was established to include the genera *Physatocheila*, *Dichocysta*, *Tingis*, *Teleonemia*, and *Leptoypha*. The characters employed by Blatchley in his tribal descriptions and key couplets do not correspond to those of the genus *Physatocheila* itself, those of all the species of *Teleonemia* of South America; nor those of some genera found in insular America, South America, and the Old World. Thus, it becomes necessary here to synonymize the tribe Physatocheilini with Tinginae (p. 31).

Fossil Forms

Fossil records are too few to tell much about tingids in geologic time. The molds of the species that became entangled and engulfed in amber, both Baltic and Prussian, belong to existing genera, though specifically representing quite different species. Most of the petrified forms also belong to existing genera. Table 1 summarizes the distribution of fossil species. There are 6 genera and 9 species, plus 4 species determined only as "*Tingis* sp." The genera not represented by present-day species are mentioned below.

TABLE 1.—*Distribution of fossil genera of Tingidae*

Subfamilies and genera	Nearctic species (5)		Palearctic species (9)	
	In amber	In stone	In amber	In stone
Cantacaderinae	---	---	---	---
Cantacader	---	---	2	---
Phatnoma	---	---	1	---
Tinginae	---	---	---	---
Celantia	---	1	---	---
Dictyla	---	1	---	2
Eotingis	---	1	---	---
Tingis	---	2	1	3

Eotingis Scudder (1890, p. 359) was erected to hold *antennata* Scudder (p. 360, fig.) from the United States (Florissant, Colorado. Horizon, Oligocene) and *Tingis quinquecarinata* Germar and Berendt (1856, p. 23, figs.), found in Prussian amber. Since *T. quinquecarinata* is being transferred to the genus *Cantacader* of the subfamily Cantacaderinae, this now leaves *Eotingis* with the genotype as its only member.

Cantacader quinquecarinatus (Germar & Berendt), new combination

Tingis quinquecarinata Germar and Berendt, 1856, p. 23, fig.—Scudder, 1891, p. 449.
Eotingis quinquecarinata Scudder, 1890, p. 359; 1891, p. 406.

Scudder (1890, p. 359) wrongly transferred *Tingis quinquecarinata* Germar and Berendt to the genus *Eotingis* Scudder. The original description and the two fine illustrations of *T. quinquecarinata* show that species to be a typical member of the genus *Cantacader* Amyot and Serville, and it is herein transferred.

For an unusual fossil found in southern Russia, Bekker-Migdisova (1953) created for its reception the name *Tingiopsis reticulata* in the family Tingidae. A study of the venation of the hemelytron of this fossil species shows that it does not fall into the classification of the family Tingidae of the Hemiptera. To the present authors, the wing appears to be that of a homopteron, perhaps the family Psyllidae.

In a recent paper Evans (1957, p. 289) placed *Tingiopsis reticulata* in the family Cercopidae of the Homoptera. Until more specimens are found that will provide better structural characters on the familial level, the species should be left in family Cercopidae.

FOSSILIZED GENERA AND SPECIES

Name	Discovery
Subfamily Cantacaderinae Stål:	
Cantacader avitus Drake, 1950	Baltic amber
Cantacader quinquecarinatus (Germar and Berendt), 1856	Baltic amber
Phatnoma baltica Drake, 1950	Baltic amber
Subfamily Tinginae Stål:	
Celantia seposita Cockerell, 1921	Oligocene, Isle of Wright
Dictyla veterana (Scudder), 1890	Florissant, Colorado
Dictyla flexousa (Novak), 1877	Bohemia (Krottensee)
Dictyla wollastoni (Heer), 1865	Baden (Oeningen)
Eotingis antennata Scudder, 1890	Florissant, Colorado
Tingis florissantensis Cockrell, 1914	Florissant, Colorado
Tingis obscura Heer, 1853	Croatia (Radoboj)
Tingis sp., Berendt, 1865	Prussian amber
Tingis sp., Hope, 1847	France (Aix)
Tingis sp., Scudder, 1881	Florissant, Colorado
Tingis sp., Serres, 1829	France (Aix)

Chorology

FAUNAL DIVISIONS

The partitioning of the world into faunal realms, regions, subregions, and provinces has been a concern of zoogeographers for more than a century. The basic concepts and features of faunal divisions were formulated by such eminent scholars as Swainson (1835), Sclater (1858; 1874), Darwin (1859), Huxley (1868), and Wallace (1876). The recent book by Darlington (1957) on zoogeography and the one by Lindroth (1957) on faunal connections between Europe and America are classics in their respective fields. All of the above publications also have been most helpful in charting the chorology of the existing tingifauna by regions.

Schmidt's (1954) schemes of faunal division and maps of the world (figs. 2, 3) based on grid North Pole with continents radiating in their relative positions have been followed rather closely. As our data failed to lend themselves fully into the lower subdivisions of provinces, the faunal tabulations of genera and of species were not carried further than the subregions. For the same reasons the Caribbean Transition subregion and the Celebesian Transition province were not included in the tables.

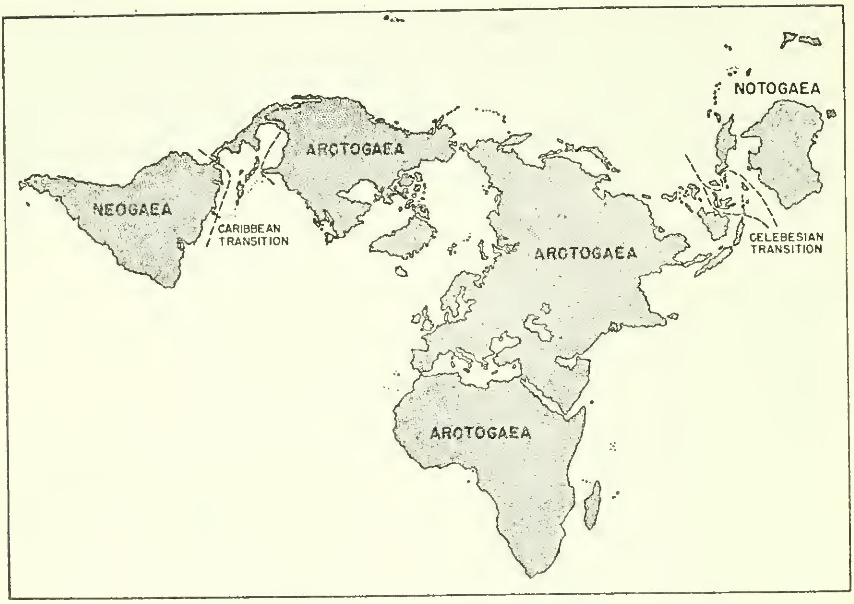


FIGURE 2.—Faunal realms of the world.

The genera and species of living tingids as they are known today are treated chorologically in table 2. There appear to be no truly relict species. Morphologically, the Cantacaderinae represent the oldest and most primitive subfamily, and two of its genera are well represented by both living and fossil forms. The genus *Dictyla* of the subfamily Tinginae contains more species and is more widely distributed than any other genus of this subfamily comprising both extinct and living species.

The literature shows that certain regions such as Europe, North America, Brazil, Belgian Congo, and Japan have received more attention taxonomically than many other areas. Tingids are poorly known from many islands of the South Pacific and Indian Oceans. Many parts of the Orient, Africa, and South America have also received scant consideration.

The circular graphs (figs. 4, 5) depict the genera and species by faunal subregions. The Ethiopian subregion is represented by 296 species divided among 65 genera, the Oriental by 256 species among 67 genera, and the Neotropical by 594 species among 60 genera. The larger genera in the Neotropical indicate that many genera of this subregion are less primitive than those found in the Ethiopian and Oriental regions.

Figure 3.—Faunal regions and subregions of the world.

TABLE 2.—*Distribution of Tingidae by faunal zones*

Subfamilies, genera, and No. species	Arctogaean					Neogaean	Notogaean			
	Holarctic		Paleotropical			Neotropical	Australian		Oceanian	
	Nearctic	Palearctic	Oriental	Ethiopian	Malagasy	Neotropical	Australian	Papuan	New Zealandian	Oceanic
AGRAMMATINAE										
Genera (5)		*1*	*1*	*1*	*1*	*1*	*1*			
Agramma (49)		17	10	22	1		1			
Ceratinoderma (2)				2						
Coleopterodes (2)						2				
Lullius (2)				2						
Sabestena (1)				1						
Species (56)		*17*	*10*	*27*	*1*	*2*	*1*			
CANTACADERINAE										
Genera (21)		*1*	*8*	*8*	*2*	*5*	*5*	*3*	*1*	*2*
Allocader (2)							2			
Angiocader (1)				1						
Astolphos (1)				1						
Cantacader (27)		4	9	8	3		2	1		1
Ceratocader (2)							2			
Cnemiandrus (1)				1						
Cyclotynaspis (1)			1							
Cyperobia (1)									1	
Eocader (2)						2				
Gonycentrum (9)			1	7			1			
Malala (1)			1							
Nectocader (1)						1				
Oranoma (1)								1		
Phatnoma (25)			6	2	1	11	1	1		2
Plesionoma (3)				3						
Pseudophatnoma (1)			1							
Recaredus (1)			1							
Stenocader (1)						1				
Teratocader (1)			1							
Ulmus (1)				1						
Zetekella (3)						3				
Species (86)		*4*	*21*	*24*	*4*	*18*	*8*	*3*	*1*	*3*
TINGINAE										
Genera (188)	*22*	*26*	*58*	*53*	*26*	*54*	*46*	*5*	*5*	*14*
Abdastartus (3)			3							
Acalypta (37)	10	25	1			1				
Acanthocheila (15)	2					15				
Acanthotingis (1)						1				
Aconchus (2)			1	2						
Acysta (9)						8	1			
Aepycysta (3)						3				
Aframixia (1)					1					
Agachila (1)				1						
Agaotingis (1)									1	
Aglotingis (3)				3						
Aidoneus (1)			1							
Alloiothucha (3)			3							

TABLE 2.—*Distribution of Tingidae by faunal zones*—Continued

Subfamilies, genera, and No. species	Arctogaean					Neogaean	Notogaean			
	Holarctic		Paleotropical			Neotropical	Australian		Oceanian	
	Nearctic	Palearctic	Oriental	Ethiopian	Malagasy	Neotropical	Australian	Papuan	New Zealandian	Oceanic
Allotingis (2)						2				
Alveotingis (3)	3									
Amblystira (18)						18				
Ambycysta (4)						4				
Ammianus (29)		2	6	20	1					
Angolotingis (1)				1						
Angolusa (1)				1						
Aphelotingis (3)			1		2					
Aristobyrsa (1)						1				
Arushia (2)				2						
Atheas (14)	6					9				
Aulotingis (1)										1
Australotingis (2)							2			
Axiokersos (1)			1							
Bacochila (5)			4		1					
Baeotingis (3)						3				
Baichila (3)				3						
Bako (5)			4	1						
Belenus (6)			3	3						
Berotingis (3)										3
Birabena (4)						4				
Biskria (5)		5								
Bunia (1)				1						
Bunotingis (1)							1			
Callithrincus (2)							2			
Caloloma (1)						1	1			
Calotingis (2)	1						1			
Campylosteira (18)		15	1	2						
Campylotingis (14)						14				
Cantinona (1)					1					
Catoplatus (16)		15	2							
Celantia (2)			2							
Cochlochila (13)		4	3	8						
Codotingis (1)							1			
Collinutius (1)			1							
Compseuta (18)		1	1	16			1			
Conchotingis (3)					3					
Congochila (1)				1						
Copium (9)		8	1							
Corinthus (1)									1	
Corycera (17)						17				
Corythaica (13)	4					11				
Corythauma (1)			1	1						
Corythotingis (1)										1
Corythucha (72)	51					27				
Cottothucha (1)			1							
Cromerus (8)			6				1	1		1
Cysteochila (83)			33	34	11		4			2
Dasytingis (2)			2							

TABLE 2.—*Distribution of Tingidae by faunal zones*—Continued

Subfamilies, genera, and No. species	Arctogaean					Neogaean	Notogaean			
	Holarctic		Paleotropical			Neotropical	Australian		Oceanian	
	Nearctic	Palearctic	Oriental	Ethiopian	Malagasy	Neotropical	Australian	Papuan	New Zealandian	Oceanic
Derephysia (8)		7	1							
Dichocysta (1)	1					1				
Diconocoris (7)			7							
Dictyla (63)	3	14	12	19		14	1			
Dictyonota (26)	1	24	2	1						
Dictyotingis (2)			2							
Dicysta (12)						10	2			
Diplocysta (3)							3			
Dulinius (8)			1	6	1					
Dyspharsa (1)						1				
Elasmognathus (2)			1	1						
Elasmotropis (3)		3								
Engynoma (6)							6			
Epimixia (7)							6		1	
Esocampylia (2)							2			
Eteoneus (14)			9	4						2
Euahanes (1)				1						
Euaulana (2)							2			
Eurypharsa (5)						5				
Froggattia (3)				1			2			
Furcilliger (2)							1	1		
Gabirobius (1)				1						
Galeatus (16)	2	11	3							
Gargaphia (64)	13					53				
Gitava (8)				4	4					
Gymnotingis (1)							1			
Habrochila (11)			3	7	1					
Haedus (14)			4	9	1					
Hegesidemus (4)			3		1					
Henrikus (1)				1						
Hesperotingis (7)	7									
Holophygdon (1)										1
Hovatlas (1)					1					
Hurdchila (2)			2							
Hyalochiton (6)		6								
Hybopharsa (1)						1				
Hysipyrgias (1)							1			
Idiocysta (5)										5
Idiostyla (2)						2				
Ildefonsus (1)			1							
Inoma (2)							2			
Inonemia (1)							1			
Ischnotingis (4)							4			
Kapiriella (10)				10						
Lasiacantha (21)		4	2	10	2		3			
Leptobyrsa (8)						8				
Leptocysta (4)						4				

TABLE 2.—*Distribution of Tingidae by faunal zones*—Continued

Subfamilies, genera, and No. species	Arctogaean					Neogaean	Notogaean			
	Holarctic		Paleotropical			Neotropical	Australian		Oceanian	
	Nearctic	Palearctic	Oriental	Ethiopian	Malagasy	Neotropical	Australian	Papuan	New Zealandian	Oceanic
Leptodictya (52)	5					49				
Leptopharsa (103)	5			2	1	93	2			
Leptoypha (16)	8	1	3			4	1			
Lepturga (4)			1				3			
Liotingis (4)						4				
Litadea (1)					1					
Macrocorytha (1)			1							
Macrotingis (3)						3				
Mafa (1)				1						
Malandiola (3)							3			
Mecopharsa (1)							1			
Megalocysta (1)						1				
Melanorhopala (3)	3									
Monosteira (5)		5		1						
Mummius (2)				2						
Naochila (6)				5	2					
Neotingis (1)						1				
Nesocypselas (6)										6
Nesocysta (1)										1
Nesotingis (2)					2					
Nethersia (7)							7			
Nobarnus (3)							1		2	
Nyctotingis (2)						2				
Octacysta (1)		1								
Oedotingis (2)						2				
Ogygotingis (1)					1					
Olastrida (1)				1						
Oncochila (2)		2								
Oncophysa (3)							3			
Onymochila (1)				1						
Orotingis (1)			1							
Pachycysta (4)						4				
Palauella (1)										1
Paracopium (37)		1	5	18	8		4		1	1
Parada (6)							6			
Pascala (1)				1						
Penottus (6)			6							
Perbrinckea (1)				1						
Perissonemia (14)			9	4			1			
Phacochila (1)						1				
Phaenotropis (2)		2		1						
Phymacysta (7)						7				
Physatochella (39)	5	10	12	8			5			
Planibyrsa (4)						4				
Platytingis (1)				1	1					
Plerochila (4)				4	1					
Pleseobyrsa (10)						10				

Table 2.—*Distribution of Tingidae by faunal zones*—Continued

Subfamilies, genera, and No. species	Arctogaean					Neogaean	Notogaean			
	Holarctic		Paleotropical			Neotropical	Australian		Oceanian	
	Nearctic	Palearctic	Oriental	Ethiopian	Malagasy	Neotropical	Australian	Papuan	New Zealandian	Oceanic
Pliobyrsa (6)						6				
Pogonostyla (6)				4	2					
Pontanus (4)			1	1			2			
Pseudodacysta (1)	1									
Psilobyrsa (2)						2				
Radinacantha (3)					1		2			
Renandea (1)					1					
Sanazarius (3)				3						
Sinuessa (4)				4						
Sphaerista (1)		1								
Sphaerocysta (13)						13				
Stenocysta (1)						1				
Stephanitis (59)	3	6	42	1		8	2	4		
Stymnonotus (1)					1					
Tanybyrsa (2)							2			
Tanytingis (2)			2							
Teleonemia (83)	13		1			75	1			1
Tigava (15)						15				
Tigavaria (1)							1			
Tingis (102)	1	51	14	4		13	13			
Trachypeplus (5)			4					1		
Uhlerites (2)			2							
Ulocysta (1)						1				
Ulonemia (9)			4				5			1
Ulotingis (5)						5				
Urentius (13)		5	6	2			1			
Vatiga (10)						10				
Xenotingis (5)			3					2		
Xynotingis (1)			1							
Ypsotingis (3)			3							
Zatingis (1)						1				
Zelotingis (1)						1				
Species (1,625)	*148*	*229*	*256*	*245*	*53*	*574*	*118*	*9*	*6*	*27*
Total genera (214)	*22*	*28*	*67*	*65*	*29*	*60*	*52*	*8*	*6*	*16*
Total species (1,767)	*148*	*250*	*287*	*296*	*58*	*594*	*127*	*12*	*7*	*30*

Of all the tingids found in the Eastern Hemisphere, there is only one—*Stephanitis pyrioides*, in Argentina—that is recorded in South America. Several species occur in both the Nearctic and Neotropical subregions, but there are more species shared by faunal subregions in the Old World than in the Americas.

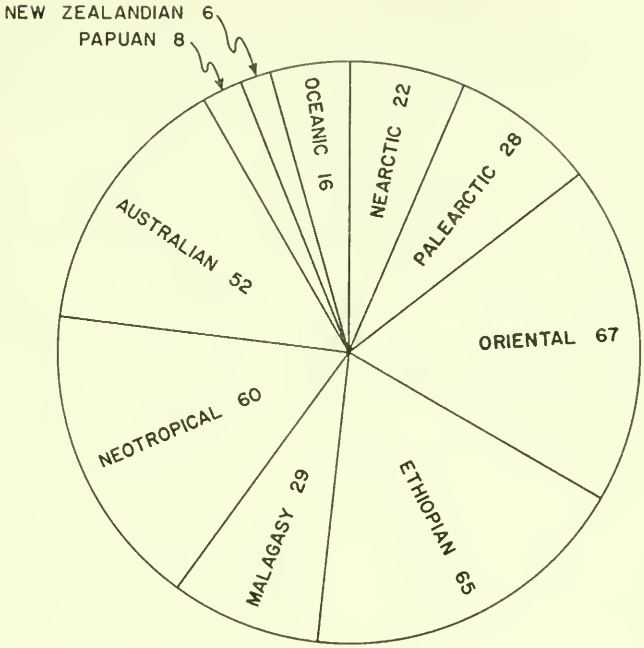


FIGURE 4.—Distribution of tingid genera by faunal subregions.

FAUNAL EXCHANGE

NATURAL: Numerous genera are shared by two or more faunal subregions (table 2). Distribution of existing species is shown in figure 5 and in table 2. The fossil species are treated in table 1.

Natural emigration of tingids is a more or less continuous phenomenon and varies greatly with the biotic potential and vagility of the species. The faunal subregions (figs. 3–5) with land-connections such as the Nearctic and Neotropical, and the Palearctic, Oriental, and Ethiopian subregions share more genera and species than subregions without such connections, such as South America and Australia, and South America and Africa. Some tingid species have disseminated over large areas, although most species are not very active or strong fliers and are rather sedentary in habit. Macroptery and brachyptery are present in a considerable number of species. The brachypterous form has metathoracic or flight wings atrophied or entirely absent. Apterous forms are unknown.

IMPORTED: Only a few species of Tingidae from the Old World have been introduced across the seas into the Americas through the agency of man, all unintentionally. However, only one transport has occurred in the opposite direction, and that purposely. The latter case concerns the purposeful introduction of *Teleonemia scrupulosa*

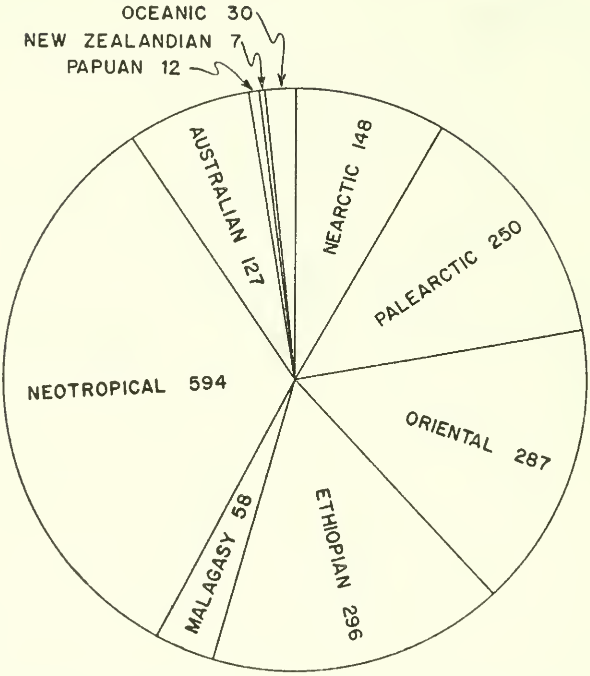


Figure 5.—Distribution of tingid species by faunal subregions.

Stål from the neotropics into the Hawaiian Islands for the "biological control" of the noxious lantana plant, previously imported there as a decorative flowering shrub from Mexico. Since then, this tingid has been released in numbers for the same purpose in India, Australia, Fiji, the Philippines, and islands of the South Pacific and Indian Oceans. *Teleonemia* is an indigenous American genus and records of its occurrence in Oceanic, Oriental, Australian, Papuan, Malagasy, and Ethiopian subregions are now all referable to *T. scrupulosa.* The species, formerly described from Asia and Africa as members of the genus *Teleonemia,* have all been transferred to other genera during the past two decades.

Caloloma uhleri Drake and Bruner, originally described from the West Indies, seems to be an accidentally introduced species from Australia. During the past decade, three small lots of *C. uhleri* have been identified from Queensland. As no specimen of this species has been seen from insular America since its characterization, it appears doubtful that it has been able to establish itself in the Lesser Antilles.

The genus *Dictyonota* of the Old World is represented solely in the Nearctic by the unintentionally imported species *D. tricornis* (Schrank) (described as variety *americana* Parshley) from Europe. This species has become a permanent resident and is now found in several New England States and eastern Canada.

Corythucha morrilli Osborn and Drake, new immigrant in Hawaii, is a native of the southwestern United States, Mexico, and the West Indies.

Through international commerce (dormant nursery plants), three Palearctic species of the genus *Stephanitis* accidentally have been shipped into and became established in eastern United States: *S. globulifera* (Matsumura) and *S. pyrioides* (Scott) from Japan, and *S. rhododendri* Horváth from Europe. *Stephanitis rhododendri* was originally described by Horváth (1905, p. 567) from Holland. Distant (1910c, p. 396) theorized that the species had been introduced into Europe from India, "the headquarters of the genus *Rhododendron* in the Himalayan region." Johnson (1936, pp. 345–346) presents a different hypothesis relative to the dissemination of the rhododendron lace-bug. Contrary to other authors, he believes that *S. rhododendri* is indigenous to America (eastern United States) and that its occurrence in Europe originated from the shipments of dormant nursery plants of *Rhododendron* and *Azalea* from eastern United States.

Lounsbury (1923, p. 548) states that *S. rhododendri* gained entrance into South Africa through large shipments of rhododendron plants. In this connection, it is interesting to record that we have received several specimens of *S. pyrioides* from Australia (Lone Cove, New South Wales), taken there on azalea.

In the subfamily Agrammatinae (olim Serenthiinae) there are 56 species distributed among five genera. Fossil forms are unknown. The subfamily is represented in six of the faunal subregions of the world (table 2). It is not known to inhabit the Nearctic, Papuan, New Zealandian, and Oceanic subregions. An indigenous genus, *Coleopterodes*, with two species, is the only genus found in the Neotropical subregion, and the only one inhabiting the New World.

Agramma is by far the largest and most widely distributed genus. It comprises 17 species in the Palearctic subregion, 22 in the Ethiopian, 10 in the Oriental, 1 in the Malagasy, and 1 in the Australian. Of the 49 described species, two occupy two subregions.

The subfamily Cantacaderinae, apparently the most primitive of the Tingidae, comprises an aggregate of 86 species separated among 21 genera. Unlike the other subfamilies, there are no discordant genera in the cantacaderines. In fact, considering all genera and their components together, the entire subfamily forms a readily recognizable, homogeneous unit with combinations of characters that distinctly set them apart from both Tinginae and Agrammatinae.

Cantacaderines are represented in the Neotropical, Oriental, Malagasy, Oceanic, Papuan, Ethiopian, New Zealandian, and Australian subregions (table 2). *Phatnoma* is by far the most widespread of all of the genera, and the only genus so far shared by both the Old and New Worlds. *Cantacader*, with 27 components, is the largest genus, and it is best represented in the Ethiopian and Oriental subregions. Of all the cantacaderines, only one species of *Cantacader* and one of *Phatnoma* are shared by two faunal subregions. The members of the remaining 19 genera are much more localized, only *Gonycentrum* (in three subregions) being known to occur in more than one subregion.

Paradoxically, an anomalous element enters into the distribution of the cantacaderines in the Holarctic region. There is a complete absence of species, both living and extinct, in the entire Nearctic subregion. In the Palearctic subregion, fossils of two genera (three species) have been found entombed in Baltic and Prussian ambers, and, singularly, only one living species is now known to exist in southern Europe.

The subfamily Tinginae constitutes by far the largest (in both number of genera and of species) and the most generally distributed subfamily of the lace-bugs. It is represented in all the world's faunal subregions except the Arctic and Antarctic. Some of the muscicoline species, such as members of the genus *Acalypta*, have been collected far north in Eurasia and North America. The northernmost species so far found in the Americas is the muscivorus *Acalypta nyctalis* Drake, which has been found breeding in mosses in Alaska (Fairbanks and Fort Richardson) and northern Canada (near Alaska and in Newfoundland). *Acalypta* tends to be northern in distribution and is not represented south of Mexico. Its members fall among the older forms of the subfamily.

This subfamily is represented by 1,625 existing species divided among 188 genera (table 2). Both genera and species are most abundant in tropical and subtropical regions, although the temperate zones are also well represented. Approximately one-third of all the members of the subfamily are recorded from the Neotropical subregion (table 2). The average number of species in a genus is greater in this faunal area than in any of the other subregions.

There are 125 genera in one faunal subregion; 36 in two subregions; 10 in three subregions; 6 in four subregions; 6 in five subregions; 2 (*Dictyla* and *Tingis*) in six subregions; and 2 (*Paracopium* and *Stephanitis*) in seven subregions.

Only a few species of the subfamily Tinginae have been found fossilized. The fossil genera *Celantia*, *Dictyla*, and *Tingis* are represented by existing species.

Systematic Treatment

Subfamily AGRAMMATINAE Douglas and Scott

AGRAMMIDAE Douglas and Scott, 1865, p. 24 (as "family').

SERENTHIARIA Stål, 1873, pp. 116, 117; 1874, p. 46.—Puton, 1879, p. 89.—Distant, 1903c, p. 126.—Horváth, 1906c, p. 107.—Oshanin, 1908, p. 457; 1912, p. 46. (As "division.")

AGRAMMINAE Drake and Maa, 1955, p. 10.—China and Miller, 1955, p. 261.

Type genus: *Agramma* Stephens (1829a).

Remarks: Because the name of the type genus, *Agramma*, is neuter (from the Greek, stem "Agrammatos"), the correct spelling of the subfamily name is "Agrammatinae," not "Agramminae."

Van Duzee (1917, p. 223) wrongly included a genus and species of piesmatid as a Nearctic representative of this subfamily.

GENERA OF SUBFAMILY AGRAMMATINAE

Agramma **Stephens** (1829a, p. 64; 1829b, p. 336).

Type species: *Tingis laeta* Fallén (1807, p. 40). See plate 1, herein.

Fixation: Stephens (1829a, p. 64), by monotypy.

Later citations: China (1943, p. 248); Monte (1947, p. 4); Drake (1955c, p. 1).

Synonyms: *Drakea, Serenthia, Wombalia, Serenthiella, Paraserenthia.*

Note: China (1943, p. 248) resurrected *Agramma* Stephens—until then wrongly accredited in the literature to Westwood (1840, p. 120)—as a valid genus based upon a well-known included species (*Tingis laeta* Fallén, 1807). *Agramma* is not a nomen nudum, as theretofore cited, and has priority by 12 years over *Serenthia*. The type species of the latter is congeneric with *laeta* Fallén. Wagner (1941, pp. 1–27, figs.) divided the genus *Serenthia* Spinola into four subgenera: *Agramma* Westwood, *Serenthia* Spinola, *Serenthiella*, and *Paraserenthia*. Drake (1956d, p. 7) pointed out that Wagner's new subgenera (*Serenthiella* and *Paraserenthia*) were not applicable for the inclusion of many of the Old World species and relegated all into synonymy as inseparable from typical *Serenthia*. *Wombalia* Schouteden was suppressed by Drake (1954a, p. 13) as a synonym of *Serenthia*.

Distribution of species: Ethiopian (22), Palearctic (17), Oriental (10), Australian (1), Malagasy (1).

Number of species: 49.

Ceratinoderma **Stål** (1873, p. 117).

Type species: *Ceratinoderma fornicata* Stål (1873, p. 117).

Fixation: Stål (1873, p. 117), by monotypy.

Later citation: Monte (1947, p. 4).

Note: Type species figured by Distant (1902a, p. 240, pl. 15, fig. 4).

Distribution of species: Ethiopian.

Number of species: 2.

***Coleopterodes* Philippi** (1864, p. 306).

Type species: *Coleopterodes fuscescens* Philippi (1864, p. 306)=*Solenostoma liliputiana* Signoret (1863, p. 575).

Fixation: Philippi (1864, p. 306), by monotypy (as *Coleopterodes fuscescens* Philippi (1864, p. 306)=*Solenostoma liliputiana* Signoret (1863, p. 575).

Later citations: Drake (1922a, p. 353; 1922b, p. 50); Drake and Poor (1936a, p. 383); Monte (1947, p. 5).

Homonym: *Solenostoma.*

Note: As both generic and specific names of *Coleopterodes fuscescens* Philippi (1864) and of *Solenostoma liliputiana* Signoret (1863) were created to hold identical species, they are consequently synonyms. The preoccupation of *Solenostoma* (1863) (homonym) by a genus of fishes gives antecedence to *Coleopterodes* Philippi (junior synonym) as the valid generic name and *liliputiana* (Signoret) survives as the valid specific name by priority. See Kirkaldy (1900, p. 241) and Drake (1922a, p. 353, fig.).

Distribution of species: Neotropical.

Number of species: 2.

Drakea Schouteden (1953, p. 166). Synonym of *Agramma.*

Type species: *Drakea leleupi* Schouteden, 1953, p. 166.

Fixation: Schouteden (1953, p. 166), by monotypy.

Synonymy: See *Agramma.* Synonymized by Drake (1958a, p. 107).

***Lullius* Distant** (1904, p. 429).

Type species: *Lullius major* Distant (1904, p. 430, fig.).

Fixation: Distant (1904, p. 430), by monotypy.

Later citation: Monte (1947, p. 5).

Note: This genus originally included two species but as the generic name of *Lullius minor* Distant was followed by a question mark, *Lullius* is effectively monobasic. [*L. minor* is here transferred to the genus *Agramma* (new combination).]

Distribution of species. Ethiopian.

Number of species: 2.

Paraserenthia Wagner (1941, pp. 6, 8, 26, as subgenus of *Serenthia*). Synonym of *Agramma*.

Type species: *Tingis ruficornis* Germar (1835, fasc. 15, fig.).
Fixation: Wagner (1941, pp. 8, 26), by original designation.
Synonymy: See *Agramma*. Synonymized by Drake (1956d, p. 7).

***Sabestena* Drake** (1944b, p. 67).

Type species: *Sabestena africana* Drake (1944b, p. 67, fig.).
Fixation: Drake (1944b, p. 67), by monotypy and original designation.
Later citations: Monte (1947, p. 5).
Distribution of species: Ethiopian.
Number of species: 1.

Serenthia Spinola (1837, p. 168). Synonym of *Agramma*.

Type species: *Serenthia atricapilla* Spinola (1837, p. 168).
Fixation: Spinola (1837, p. 168), by monotypy.
Later citations: Distant (1911b, p. 269); Monte (1947, p. 5).
Synonymy: See *Agramma*. Synonymized by China (1943, p. 328); see Drake (1956d, p. 7).

Serenthiella Wagner (1941, pp. 6, 8, 26, as subgenus of *Serenthia*). Synonym of *Agramma*.

Type species: *Serenthia minuta* Horváth (1874, p. 333).
Fixation: Wagner (1941, p. 26), by monotypy and original designation.
Synonymy: See *Agramma*. Synonymized by Drake (1956d, p. 7).

Solenostoma Signoret (1863, p. 575). Preoccupied; see *Coleopterodes*.

Type species: *Solenostoma liliputiana* Signoret (1863, p. 575, fig.)
Fixation: Signoret (1863, p. 575), by monotypy.
Later citations: Drake (1922a, p. 353); Drake and Poor (1936a, p. 383); Monte (1947, p. 5).
Synonymy: See *Coleopterodes*. Synonymized by Kirkaldy (1900, p. 241).
Note: *Solenostoma* preoccupied. The transfer of *S. liliputiana* Signoret to the genus *Coleopterodes* made it the genotype of *Coleopterodes* by priority. See Drake (1922b, p. 50).

Wombalia Schouteden (1919, p. 139). Synonym of *Agramma*.

Type species: *Wombalia vanderstyi* Schouteden (1919, p. 139).
Fixation: Schouteden (1919, p. 139), by monotypy and original designation.

Later citation: Monte (1947, p. 22).
Synonymy: See *Agramma*. Synonymized by Drake (1954a, p. 13).
Note: Monte (1947, p. 22) wrongly included *Wombalia* in the subfamily Tinginae.

Subfamily CANTACADERINAE Stål

CANTACADERARIA Stål, 1873, p. 116; 1874, p. 46; Puton, 1879, p. 88; Distant, 1903c, p. 122; Horváth, 1906c, p. 10; Oshanin, 1908, p. 400; 1912, p. 42. (As "division.")

CANTACADERINI Champion, 1897, p. 2. (As "group.")

TYPE GENUS: *Cantacader* Amyot and Serville.

GENERA OF SUBFAMILY CANTACADERINAE

***Allocader* Drake** (1950, p. 156).

Type species: *Cantacader leai* Hacker (1928, p. 176, fig.)
Fixation: Drake (1950, p. 156), by original designation.
Distribution of species: Australian.
Number of species: 2.

***Angiocader* Drake,** 1950, p. 159.

Type species: *Phatnoma obesus* Distant (1902a, p. 239, fig.)
Fixation: Drake (1950, p. 159), by monotypy and original designation.
Distribution of species: Ethiopian.
Number of species: 1.

***Astolphos* Distant** (1904, p. 428).

Type species: *Astolphos capitatus* Distant (1904, p. 429, fig.).
Fixation: Distant (1904, p. 428), by monotypy.
Later citations: Monte (1947, p. 3); Drake (1950, p. 163).
Distribution of species: Ethiopian.
Number of species: 1.

***Cantacader* Amyot and Serville** (1843, p. 299).

Type species: *Piesma quadricornis* Le Peletier and Serville (1828, p. 653). See plate 2, herein.
Fixation: Amyot and Serville (1843, p. 299), by monotypy.
Later citations: Oshanin (1912, p. 42); Monte (1947, p. 3); Drake (1950, p. 163).
Synonym: *Taphrostethus*.
Variant spelling: *Canthacader*. (Amyot and Serville, 1843, p. 652 (index); Schouteden, 1916, p. 290; 1923, p. 83; 1955, pp. 162, 163.)

Distribution of species: Oriental (9), Ethiopian (8), Malagasy (3), Palearctic (4), Australian (2), Papuan (1), Oceanic (1), Fossil (2, Baltic and Prussian ambers).
Number of species: 27.

Canthacader. Error for *Cantacader.*

***Ceratocader* Drake** (1950, p. 157).

Type species: *Cantacader armatus* Hacker (1928, p. 174, fig.).
Fixation: Drake (1950, p. 158), by monotypy and original designation.
Distribution of species: Australian.
Number of species: 2.

***Cnemiandrus* Distant** (1902a, p. 239).

Type species: *Cnemiandrus typicus* Distant (1902a, p. 240, fig.).
Fixation: Distant (1902a, p. 240), by monotypy.
Later citations: Monte (1947, p. 3); Drake (1950, p. 164).
Distribution of species: Ethiopian.
Number of species: 1.

***Cyclotynaspis* Montandon** (1892, p. 265).

Type species: *Cyclotynaspis acalyptoides* Montandon (1892, p. 265)·
Fixation: Montandon (1892, p. 256), by monotypy.
Later citation: Monte (1947, p. 3).
Note: Drake (1955e, p. 78, fig.) redescribed and figured type species.
Distribution of species: Oriental.
Number of species: 1.

***Cyperobia* Bergroth** (1927, p. 673).

Type species: *Cyperobia carectorum* Bergroth (1927, p. 674).
Fixation: Bergroth (1927, p. 674), by monotypy.
Later citations: Monte (1927, p. 3); Drake (1950, p. 164).
Distribution of species: New Zealandian.
Number of species: 1.

***Eocader* Drake and Hambleton** (1934, p. 436).

Type species: *Eocader vegrandis* Drake and Hambleton (1934, p. 436, fig.).
Fixation: Drake and Hambleton (1934, p. 436), by monotypy and original designation.
Later citations: Drake and Poor (1936a, p. 382); Monte (1939, p. 63; 1941, p. 71; 1947, p. 3); Drake and Hambleton (1944, p. 121); Drake (1944a, p. 141; 1950, p. 164); Hurd (1946, p. 439).
Synonym: *Montea.*

Distribution of species: Neotropical.
Number of species: 2.

***Gonycentrum* Bergroth** (1898, p. 9).

Type species: *Teleia coronata* Fieber (1844, p. 56, fig.).
Fixation: Fieber (1844, p. 56), by monotypy.
Later citations: Monte (1947, p. 3); Drake (1950, p. 165).
Synonyms: *Teleia*, *Sinalda*.
Note: Bergroth (1898, p. 9) proposed *Gonycentrum* as a new generic name to replace *Teleia* (preoccupied), and thus *Teleia coronata* became the type species of *Gonycentrum* by autotypy.
Distribution of species: Ethiopian (7), Oriental (1), Australian (1).
Number of species: 9.

***Malala* Distant** (1910a, p. 101).

Type species: *Malala bulliens* Distant (1910a, p. 101, fig.).
Fixation: Distant (1910a, p. 101), by monotypy.
Later citations: Monte (1947, p. 3); Drake (1950, p. 165).
Distribution of species: Oriental.
Number of species: 1.

Minitingis Barber (1954, p. 7). Synonym of *Zetekella*. (New synonymy.)

Type species: *Minitingis minusculus* Barber (1954, p. 7, fig.).
Fixation: Barber (1954, p. 7), by monotypy.
Synonymy: See *Zetekella*.
Note: An examination of the type species of *Minitingis* and of *Zetekella* Drake (1944) shows that they are congeneric. *Minitingis* is thus a junior synonym of *Zetekella*, to which *M. minusculus* Barber is here transferred. (New combination.)

Montea Bruner (1940, p. 246). Synonym of *Eocader*.

Type species: *Montea bouclei* Bruner (1940, p. 246, fig.).
Fixation: Bruner (1940, p. 246), by monotypy and original designation.
Later citation: Monte (1947, p. 3).
Synonymy: See *Eocader*. Synonymized by Monte (1942, p. 104); Drake and Hambleton (1944, p. 121).

***Nectocader* Drake** (1928a, p. 41).

Type species: *Cantacader gounellei* Drake (1923b, p. 81, fig.).
Fixation: Drake (1928a, p. 41), by original designation.
Later citations: Drake and Poor (1936a, p. 283); Monte (1939, p. 63; 1941, p. 71; 1947, p. 3); Drake (1944a, p. 141; 1950, p. 165).

Distribution of species: Neotropical.
Number of species: 1.

***Oranoma* Drake** (1951, p. 165).

Type species: *Oranoma biroi* Drake (1951, p. 165).
Fixation: Drake (1951, p. 166), by monotypy and original designation.
Distribution of species: Papuan.
Number of species: 1.

***Phatnoma* Fieber** (1844, p. 57).

Type species: *Phatnoma laciniata* Fieber (1844, p. 57, fig.).
Fixation: Fieber (1844, p. 57), by monotypy.
Later citations: Drake and Poor (1936a, p. 383), Monte (1941, p. 72; 1946, p. 253; 1947, p. 4), Drake (1944a, p. 141; 1950, p. 165); Hurd (1946, p. 438).
Distribution of species: Neotropical (11), Oriental (6), Ethiopian (2), Oceanic (2), Australian (1), Papuan (1), Fossil (1, Baltic amber), Malagasy (1).
Number of species: 25.

***Plesionoma* Drake** (1950, p. 157).

Type species: *Phatnoma humeralis* Distant (1902a, p. 239, fig.).
Fixation: Drake (1950, p. 157), by monotypy and original designation.
Distribution of species: Ethiopian.
Number of species: 3.

***Pseudophatnoma* Blöte** (1945, p. 78).

Type species: *Pseudophatnoma corniculata* Blöte (1945, p. 78, fig.).
Fixation: Blöte (1945, p. 78), by monotypy and original designation.
Later citation: Drake (1950, p. 166).
Distribution of species: Oriental.
Number of species: 1.

***Recaredus* Distant** (1909b, p. 361).

Type species: *Recaredus rex* Distant (1909b, p. 361).
Fixation: Distant (1909b, p. 361), by monotypy.
Later citations: Distant (1910a, p. 104, fig., redescription and figure of type species); Monte (1947, p. 19); Drake (1950, p. 166).
Note: Monte (1947, p. 19) wrongly placed *Recaredus* in subfamily *Tinginae*.
Distribution of species: Oriental.
Number of species: 1.

Sinalda Distant (1904, p. 426). Synonym of *Gonycentrum.*

Type species: *Sinalda elegans* Distant (1904, p. 427, fig.).
Fixation: Monte (1947, p. 4), by subsequent designation.
Synonymy: See *Gonycentrum.* Synonymized by Drake (1950, p. 165).

***Stenocader* Drake and Hambleton** (1944, p. 120).

Type species: *Piesma tingidoides* Spinola (1852, p. 200).
Fixation: Drake and Hambleton (1944, p. 120), by monotypy and original designation.
Later citations: Drake (1944a, p. 142; 1950, p. 166); Monte (1947, p. 4).
Distribution of species: Neotropical.
Number of species: 1.

Taphrostethus Fieber (1844, p. 40). Synonym of *Cantacader.*

Type species: *Taphrostethus quinquecostatus* Fieber (1844, p. 41, fig.).
Fixation: Fieber (1844, p. 41), by monotypy.
Later citation: Monte (1947, p. 4).
Synonymy: See *Cantacader.* Synonymized by Stål (1873, p. 116).

Teleia Fieber (1844, p. 55). Preoccupied, see *Gonycentrum.*

Type species: *Teleia coronata* Fieber (1844, p. 56, fig.).
Fixation: Fieber (1844, p. 56), by monotypy.
Later citation: Monte (1947, p. 4).
Synonymy: See *Gonycentrum.*
Note: As *Teleia* Fieber (1844) was preoccupied in Lepidoptera, Bergroth (1898, p. 9) proposed *Gonycentrum* as its replacement.

***Teratocader* Drake** (1950, p. 158).

Type species: *Cantacader magnificus* Drake (1923b, p. 83).
Fixation: Drake (1950, p. 158), by monotypy and original designation.
Distribution of species: Oriental.
Number of species: 1.

***Ulmus* Distant** (1904, p. 425).

Type species: *Ulmus testudineatus* Distant (1904, p. 425, fig.).
Fixation: Distant (1904, p. 426), by monotypy.
Later citations: Monte (1947, p. 4); Drake (1950, p. 166).
Distribution of species: Ethiopian.
Number of species: 1.

Zetekella **Drake** (1944a; p. 139).

Type species: *Zetekella zeteki* Drake (1944a; p. 140, fig.).
Fixation: Drake (1944a, p. 139), by monotypy and original designation.
Later citations: Hurd (1946, p. 439); Monte (1947, p. 4); Drake (1950, p. 166).
Synonym: *Minitingis.* (New synonymy.)
Distribution of species: Neotropical.
Number of species: 3.

Subfamily TINGINAE Laporte

TINGIDITES Laporte, 1833, p. 47.
TINGITARIA Stål, 1873, p. 118; 1874, p. 47; Puton, 1879, p. 91; Distant, 1903c, p. 130; Horváth, 1906c, p. 13; Oshanin, 1908, p. 401; 1912, p. 42 (as "division").
TINGITINA Uhler, 1886, p. 22; Banks, 1910, p. 55 (as "subfamily").
TINGIDINI Van Duzee, 1916, p. 25 (as "tribe").
AIDONEUSARIA Distant, 1909, p. 125 (as "division"). (New synonymy.)
AXIOKERSOSARIA Distant, 1909, p. 124 (as "division"). (New synonymy.)
ACALYPTINI Blatchley, 1926, p. 479 (as "tribe"). (New synonymy.)
GALEATINI Blatchley, 1926, p. 451 (as "tribe"). (New synonymy.)
MONANTHIINI Costa, 1855, p. 293 (as "subfamily" [?]). (New synonymy.)
PHYSATOCHEILINI Blatchley, 1926, p. 483 (as "tribe"). (New synonymy.)

Type genus: *Tingis* Fabricius.

GENERA AND SUBGENERA OF SUBFAMILY TINGINAE

Abdastartus **Distant** (1910a, p. 103).

Type species: *Abdastartus tyrianus* Distant (1910a, p. 103)= *Monanthia atra* Motschulsky (1863, p. 91).
Fixation: Distant (1910a, p. 103), by monotypy and original designation (as *Abdastartus tyrianus* Distant (1910a, p. 103)=*Monanthia atrus* Motschulsky (1863, p. 91)).
Later citation: Monte (1947, p. 5) (as *A. tyrianus* Distant).
Note: *Abdastartus tyrianus* Distant was synonymized with *Teleonemia atra* (Motschulsky) (as *Monanthia*) based upon study of type species. (See Drake, 1956c, p. 110.)
Distribution of species: Oriental.
Number of species: 3.

Acalypta **Westwood** (1840, p. 121).

Type species: *Tingis carinata* Panzer (1806, Heft 99, Tab. 20).
Fixation: Westwood (1840, p. 121, fig.), by monotypy.
Later citations: Oshanin (1912, p. 43); Van Duzee (1916, p. 25; 1917, p. 211); Drake (1928d, p. 2); Drake and Poor (1936a, p. 383); Monte (1941, p. 151; 1947, p. 5); China (1943, p. 245); Hurd (1946, p. 462).

Synonyms: *Drakella, Fenestrella, Orthosteira, Orthostira.*
Distribution of species: Palearctic (25), Nearctic (10), Oriental (1), Neotropical (1).
Number of species: 37.

Acanthocheila **Stål** (1858, p. 61).

Type species: *Monanthia (Acanthocheila) amigera* Stål (1858, p. 61).
Fixation: Van Duzee (1916, p. 26), by subsequent designation.
Later citations: Van Duzee (1917, p. 219); Drake and Poor (1936a, p. 384); Monte (1939, p. 64; 1941, p. 73; 1947, p. 5); Hurd (1946, p. 469).
Variant spelling: *Acanthochila* Stål (1873, p. 127).
Note: Founded as a subgenus of *Monanthia*, raised to generic level by Stål (1873, p. 127).
Distribution of species: Neotropical (15), Nearctic (2).
Number of species: 15.

Acanthochila. Variant spelling for *Acanthocheila.*

Acanthotingis **Monte** (1940a, p. 13).

Type species: *Acanthotingis apicicornis* Monte (1940a, p. 15, fig.).
Fixation: Monte (1940a, p. 14), by monotypy and original designation.
Later citation: Monte (1947, p. 6).
Distribution of species: Neotropical.
Number of species: 1.

Aconchus **Horváth** (1905, p. 566).

Type species: *Galeatus (Aconchus) urbanus* Horváth (1905, p. 565).
Fixation: Horváth (1905, p. 565), by monotypy.
Later citations: Oshanin (1912, p. 43); Monte (1947, p. 6).
Note: Founded as a subgenus of *Galeatus,* raised to generic level by Horváth (1906c, p. 54).
Distribution of species: Ethiopian (2), Oriental (1).
Number of species: 2.

Acysta **Champion** (1898a, p. 46).

Type species: *Acysta integra* Champion (1898a, p. 46, fig.).
Fixation: Van Duzee (1916, p. 26), by subsequent designation.
Later citations: Van Duzee (1917, p. 223); Drake and Poor (1936a, p. 384); Monte (1939, p. 64; 1941, p. 76; 1947, p. 6); Hurd (1946, p. 458).
Distribution of species: Neotropical (8), Australian (1).
Number of species: 9.

Aepycysta **Drake and Bondar** (1932, p. 93).

Type species: *Aepycysta undosa* Drake and Bondar (1932, p. 94, fig.).

Fixation: Drake and Bondar (1932, p. 94), by monotypy and original designation.

Later citations: Drake and Poor (1936a, p. 384); Monte (1939, p. 65; 1941, p. 77; 1947, p. 6); Hurd (1946, p. 478).

Distribution of species: Neotropical.

Number of species: 3.

Aframixia, new genus

Type species: *Epimixia roboris* Drake (1942b, p. 12).

Fixation: Present designation.

Note: This genus is erected here to hold *Epimixia roboris* from Madagascar.

Description: Moderately large, oblong. Head short, very little extended in front of eyes, inserted into prothorax up to hind margins of eyes, armed with not more than five spines, antenniferous tubercles short, blunt, rounded in front; bucculae rather short, areolate, with ends meeting in front. Labium rather short, stout, reaching very little beyond prosternum; laminae not very high, uniseriate, widely separated on both mesosternum and metasternum, open behind. Scent gland ostiole and channel plainly visible, with sulcus extending nearly upright. Hypocostal laminae long, uniseriate. Legs rather short, with femora slightly incrassate, tarsi considerably swollen.

Pronotum with lateral sides slowly converging anteriorly in front of humeri, very little swollen across humeral angles, coarsely reticulately punctate, unicarinate, lateral carinae completely wanting; collar distinct, with two encircling rows of small pits; paranota very narrow, cariniform, without areolae, slightly wider opposite calli and there with indistinct cells; posterior process triangular, areolate.

Elytra a little longer and slightly wider than abdomen, also slightly wider than pronotum at humeri (scarcely more than width of costal areas), divided into the usual areas; costal area horizontal, uniseriate; subcostal area wider, subvertical; discoidal area large, extending slightly beyond middle of elytra; sutural area on same level as discoidal, both areas flat and on same horizontal level.

Distinguishing characteristics: Allied to the genus *Epimixia* Kirkaldy of the Australian subregion, but easily distinguishable by the somewhat more depressed and unicarinate pronotum, depressed and almost flat underside of the abdomen, swollen tarsi, and the less foliaceous and much more widely separated rostral laminae on mesosternum. The laminae on metasternum are also widely separated from each other and open behind.

Distrbution of species: Malagasy.

Number of species: 1.

***Agachila* Drake and Gomez-Menor** (1954, p. 89).

Type species: *Agachila biafrana* Drake and Gomez-Menor (1954, p. 90, fig.).

Fixation: Drake and Gomez-Menor (1954, p. 90), by monotypy and original designation.

Distribution of species: Ethiopian.

Number of species: 1.

***Agaotingis* Drake** (1954a, p. 13).

Type species: *Tingis australis* Montrouzier (1864, p. 235).

Fixation: Drake (1954a, p. 13), by monotypy and original designation.

Distribution of species: New Zealandian.

Number of species: 1.

***Aglotingis* Drake** (1954c, p. 232).

Type species: *Aglotingis nimbana* Drake (1954c, p. 233).

Fixation: Drake (1954c, p. 233), by monotypy and original designation.

Distribution of species: Ethiopian.

Number of species: 3.

***Aidoneus* Distant** (1909a, p. 122).

Type species: *Aidoneus dissimilis* Distant (1909a, p. 123).

Fixation: Distant (1909a, p. 123), by monotypy.

Later citations: Distant (1910a, p. 126, fig., type species); Monte (1947, p. 3).

Note: Distant (1909a, p. 122) erected Division *Aidoneusaria* for the reception of this genus. Monte (1947, p. 3) wrongly placed *Aidoneus* in the subfamily Cantacaderinae.

Distribution of species: Oriental.

Number of species: 1.

***Alcletha* Kirkaldy** (1900, p. 241). See ***Dictyonota* (*Alcletha*).**

***Alloiothucha* Drake** (1927a, p. 58).

Type species: *Alloiothucha philippinensis* Drake (1927a, p. 58).

Fixation: Drake (1927a, p. 58), by original designation.

Later citations: Drake and Poor (1939b, p. 207, fig., type species); Monte (1947, p. 6).

Note: Drake and Poor (1937b, p. 18) erroneously suppressed *Alloiothucha* as a synonym of *Holophygdon.* Two years later they (1939b, p. 207) resurrected *Alloiothucha* as a valid genus.

Distribution of species: Oriental.

Number of species: 3.

***Allotingis* Drake** (1930, p. 269).

Type species: *Leptobyrsa binotata* Drake and Bruner (1924b, p. 155).

Fixation: Drake (1930, p. 270), by monotypy and original designation.

Later citations: Drake and Poor (1936a, p. 384); Monte (1941, p. 151; 1947, p. 6).

Distribution of species: Neotropical.

Number of species: 2.

***Alveotingis* Osborn and Drake** (1916, p. 245).

Type species: *Alveotingis grossocerata* Osborn and Drake (1916, p. 245, fig.).

Fixation: Osborn and Drake (1916, p. 245), by monotypy and original designation.

Later citations: Van Duzee (1917, p. 221); Drake and Poor (1936a, p. 384); Monte (1941, p. 152; 1947, p. 4); Hurd (1946, p. 446).

Note: Monte (1947, p. 4) wrongly transferred *Alveotingis* to subfamily Agrammatinae.

Distribution of species: Nearctic.

Number of species: 3.

Amaurosterphus Stål (1868, p. 92). Synonym of *Teleonemia.*

Type species: *Tropidocheila morio* Stål (1855b, p. 187).

Fixation: Van Duzee (1917, p. 221), by subsequent designation.

Later citation: Monte (1947, p. 6).

Synonymy: See *Teleonemia.* Synonymized by Champion (1897, p. 34).

Note: *Amaurosterphus* was erected as a subgenus for the inclusion of six species of tingids. Although erected in a note under genus *Tingis*, its generic relationship was not indicated. Stål (1873, p. 131) included *Amaurosterphus* as a subgenus of *Teleonemia.*

***Amblystira* Stål** (1873, pp. 120, 129).

Type species: *Monanthia pallipes* Stål (1858, p. 62).

Fixation: Stål (1873, p. 129), by monotypy.

Later citations: Drake and Poor (1936a, p. 384); Monte (1939, p. 65; 1941, p. 77; 1947, p. 6); Hurd (1946, p. 455).
Distribution of species: Neotropical.
Number of species: 18.

***Ambycysta* Drake and Hurd** (1945, p. 129).

Type species: *Megalocysta championi* Drake (1922b, p. 38).
Fixation: Drake and Hurd (1945, p. 130), by original designation.
Later citation: Monte (1947, p. 6); Hurd (1946, p. 475).
Distribution of species: Neotropical.
Number of species: 4.

Americia Stål (1873, p. 131). Synonym of *Teleonemia.*

Type species: *Tingis* (*Americia*) *albilatera* Stål (1873, p. 131).
Fixation: Van Duzee (1917, p. 221), by subsequent designation.
Later citation: Monte (1947, p. 6).
Synonymy: See *Teleonemia.*
Note: Established as a subgenus of *Tingis;* synonymized with genus *Teleonemia* by Champion (1898a, p. 34). Lethierry and Severin (1896, p. 18) wrongly treated *Americia* Stål as a synonym of the genus *Lasiacantha* Stål.

***Ammianus* Distant** (1903c, p. 136).

Type species: *Monanthia erosa* Fieber (1844, p. 71, fig.).
Fixation: Distant (1903c, p. 136, fig.), by monotypy and original designation.
Later citations: Distant (1910a, p. 115); Van Duzee (1916, p. 26); Monte (1947, p. 6); Drake (1955c, p. 5).
Synonyms: *Kitoko, Phyllontocheila* (in part), *Phyllontochila, Sakuntala.*
Note: Van Duzee (1916, p. 26) wrongly treated *Ammianus* Distant as a synonym of genus *Physatocheila.* For a discussion of nomenclatorial changes and history of the genera *Ammianus, Belenus, Sakuntala,* and *Physatocheila* see Drake (1955c, p. 5; 1957b, pp. 31–32). This genus and its components are much confused in the literature and the species have been described largely as members of genus *Phyllontocheila* (or *Phyllontochila*).
Distribution of species: Ethiopian (20), Oriental (6), Palearctic (2), Malagasy (1).
Number of species: 29.

***Angolotingis* Drake** (1955a, p. 88).

Type species: *Angolotingis vilhenai* Drake (1955a, p. 88, fig.).
Fixation: Drake (1955a, p. 88), by monotypy and original designation.
Distribution of species: Ethiopian.
Number of species: 1.

***Angolusa* Drake** (1958, p. 104).

Type species: *Angolusa machadoi* Drake (1958, p. 104).
Fixation: Drake (1958, p. 104), by monotypy and original designation.
Distribution of species: Ethiopian.
Number of species: 1.

[*Anomaloptera* Perris (1843, p. 302), *in* Amyot and Serville. Family *Lygaeidae.*

Note: Monte (1947, p. 22) wrongly appended *Anomaloptera* under the caption "Posicao duvidosa" at the end of his paper on genera and genotypes of Tingidae. This genus is not a tingid and belongs to the family Lygaeidae. Monte also cited incorrectly the year, page, and publication.]

***Aphelotingis* Drake** (1948b, p. 176).

Type species: *Abdastartus muiri* Drake (1927b, p. 307).
Fixation: Drake (1948b, p. 176), by monotypy and original designation.
Distribution of species: Malagasy (2), Oriental (1).
Number of species: 3.

***Aristobyrsa* Drake and Poor** (1937a, p. 164).

Type species: *Leptobyrsa latipennis* Champion (1897, p. 25).
Fixation: Drake and Poor (1937a, p. 164), by monotypy and original designation.
Later citations: Monte (1941, p. 79; 1947, p. 7); Hurd (1946, p. 472).
Distribution of species: Neotropical.
Number of species: 1.

***Arushia* Drake** (1951, p. 170).

Type species: *Arushia horvathi* Drake (1951, p. 170).
Fixation: Drake (1951, p. 170), by original designation.
Distribution of species: Ethiopian.
Number of species: 2.

***Atheas* Champion** (1898a, p. 44).

Type species: *Atheas nigricornis* Champion (1898a, p. 45, fig.).
Fixation: Van Duzee (1916, p. 26), by subsequent designation.
Later citations: Van Duzee (1917, p. 222); Drake and Poor (1936a, p. 384); Monte (1939, p. 65; 1941, p. 80; 1947, p. 7); Hurd (1946, p. 460).
Distribution of species: Neotropical (9), Nearctic (6).
Number of species: 14.

***Aulotingis* Drake and Poor** (1943, p. 194).

Type species: *Aulotingis moalae* Drake and Poor (1943, p. 195, fig.).
Fixation: Drake and Poor (1943, p. 195), by monotypy and original designation.
Later citation: Monte (1947, p. 7).
Distribution of species: Oceanic.
Number of species: 1.

***Australotingis* Hacker** (1927, p. 29).

Type species: *Australotingis franzeni* Hacker (1927, p. 29, fig.).
Fixation: Hacker (1927, p. 29), by monotypy and original designation.
Later citations: Drake and Poor (1936a, p. 384); Monte (1941, p. 152; 1947, p. 7).
Distribution of species: Australian.
Number of species: 2.

***Axiokersos* Distant** (1909a, p. 121).

Type species: *Axiokersos ovalis* Distant (1909a, p. 122).
Fixation: Distant (1909a, p. 122), by monotypy.
Later citations: Distant (1910a, p. 125, figure of type species); Monte (1947, p. 7).
Note: Distant (1909a, p. 121) erected division *Axiokersosaria* for the reception of this genus.
Distribution of species: Oriental.
Number of species: 1.

Ayrerus Distant (1903c, p. 140). Synonym of *Urentius*. (New synonymy.)

Type species: *Tingis hystricellus* Richter (1869, p. 84, fig.).
Fixation: Distant (1903c, p. 140, figure of type species), by monotypy and original designation.
Later citation: Monte (1947, p. 7).

Synonymy: See *Urentius.*

Note: *Tingis hystricellus* (Richter) is here transferred to *Urentius.* (New combination.)

***Baeochila* Drake and Poor** (1937c, p. 400).

Type species: *Cysteochila elongata* Distant (1903a, p. 49).

Fixation: Drake and Poor (1937c, p. 400), by monotypy and original designation.

Note: Founded as a subgenus for *Cysteochila;* raised to generic level by Drake (1948d, p. 151).

Distribution of species: Oriental (4), Malagasy (1).

Number of species: 5.

***Baeotingis* Drake and Poor** (1939a, p. 96).

Type species: *Baeotingis ogloblini* Drake and Poor (1939a, p. 96, fig.).

Fixation: Drake and Poor (1939a, p. 96) by monotypy and original designation.

Later citations: Monte (1941, p. 152; 1947, p. 7).

Distribution of species: Neotropical.

Number of species: 3.

***Baichila* Drake and Slater** (1955, p. 50).

Type species: *Baichila capeneri* Drake and Slater (1955, p. 51).

Fixation: Drake and Slater (1955, p. 51), by original designation.

Distribution of species: Ethiopian.

Number of species: 3.

***Bako* Schouteden** (1923, p. 91).

Type species: *Bako lebruni* Schouteden (1923, p. 91).

Fixation: Schouteden (1923, p. 91), by monotypy.

Later citations: Monte (1947, p. 7); Drake (1956c, p. 63).

Synonym: *Galeotingis.*

Distribution of species: Ethiopian (4), Oriental (1).

Number of species: 5.

***Belenus* Distant** (1909a, p. 116).

Type of species: *Monanthia dentatus* Fieber (1844, p. 71, fig.).

Fixation: Distant (1909a, p. 116), by original designation.

Later citations: Distant (1910a, p. 115, fig. (type species)); Monte (1947, p. 7 (*dentata* credited to Distant instead of Fieber)); Drake (1957b, p. 31).

Note: For a discussion of nomenclatorial changes and history of the genera *Belenus, Sakuntala, Ammianus,* and *Phyllontocheila,* see Drake (1957b, pp. 31–32).

Distribution of species: Ethiopian (3), Oriental (3).
Number of species: 6.

Berotingis **Drake** (1956b, p. 113).

Type species: *Berotingis rugiana* Drake (1956b, p. 113, fig.).
Fixation: Drake (1956b, p. 113), by original designation.
Distribution of species: Oceanic.
Number of species: 3.

Birabena **Drake and Hurd** (1945, p. 127).

Type species: *Birabena birabeni* Drake and Hurd (1945; p. 128, fig.).
Fixation: Drake and Hurd (1945, p. 128), by original designation.
Later citation: Monte (1947, p. 7).
Distribution of species: Neotropical.
Number of species: 4.

Birgitta Lindberg (1927, p. 18). Synonym of *Leptoypha.*

Type species: *Tingis* (*Birgitta*) *wuerontausi* Lindberg (1927, p. 18, fig.).
Fixation: Lindberg (1927, p. 18), by original designation.
Later citation: Monte (1947, p. 7).
Synonymy: See *Leptoypha.* Synonymized by Drake and Maa (1953, p. 94).
Note: Founded as a subgenus of *Tingis;* synonymized with genus *Leptoypha* by Drake and Maa (1953, p. 94).

Biskria **Puton** (1874b, p. 440).

Type species: *Dictyonota* (*Biskria*) *gracilicornis* Puton (1874b, p. 440).
Fixation: Puton (1874, p. 440), by monotypy.
Later citations: Oshanin (1912, p. 43); Monte (1947, p. 7).
Note: Founded as subgenus of *Dictyonota,* raised to generic level by Lethierry and Severin (1896, p. 10).
Distribution of species: Palearctic.
Number of species: 5.

Bredenbachius Distant (1903a, p. 50). Synonym of *Cysteochila.*

Type species: *Bredenbachius pictus* Distant (1903a, p. 50).
Fixation: Distant (1903a, p. 50), by monotypy.
Later citations: Distant (1903c, p. 139), fig. (type species); Drake and Poor (1937b, p. 6, discussion); Monte (1947, p. 8).
Synonymy: See *Cysteochila.* Synonymized by Bergroth (1921, p. 104).

Buna. Error for *Bunia.*

Bunia **Schouteden** (1955, p. 167).

Type species: *Bunia ituriensis* Schouteden, 1955, p. 167.
Fixation: Schouteden (1955, p. 167), by monotypy.
Variant spelling: *Buna* (Zool. Record, 1955, p. 483).
Distribution of species: Ethiopian.
Number of species: 1.

Bunotingis **Drake** (1948d, p. 152).

Type species: *Cysteochila camelina* Hacker (1927, p. 24, fig.).
Fixation: Drake (1948d, p. 153), by monotypy and original designation.
Distribution of species: Australian.
Number of species: 1.

Cadamustus Distant (1903a, p. 47). Synonym of *Stephanitis.*

Type species: *Cadamustus typicus* Distant (1903a, p. 47).
Fixation: Distant (1903c, p. 132), by subsequent designation, fig. 95 (type species).
Later citations: Van Duzee (1917, p. 216); Drake and Poor (1936a, p. 384); China (1943, p. 246); Monte (1947, p. 8).
Synonymy: See *Stephanitis.* Synonymized by Horváth (1906a, p. 34).

Cadmilos Distant (1909a, p. 113). Synonym of *Galeatus.*

Type species: *Cadmilos retiarius* Distant (1909a, p. 114).
Fixation: Distant (1909a, p. 114), by monotypy.
Later citations: Distant (1910a, p. 107, fig., type species); Van Duzee (1917, p. 216); Drake and Poor (1936a, p. 384); Monte (1947, p. 8).
Synonymy: See *Galeatus.* Synonymized by Horváth (1911b, p. 337).
Note: Distant (1911b, p. 271) questioned the synonymy of *Cadmilos* with *Galeatus* Curtis (1833), but made no counterchanges and thus did not restore the genus to its original status.

Caenotingis **Drake** (1928b, p. 283). See ***Tingis*** **(*Caenotingis*).**

Calliphanes Horváth (1906a, p. 34). Synonym of *Stephanitis.*

Type species: *Tingis mitratus* Stål (1858, p. 64).
Fixation: Horváth (1906a, p. 34), by original designation.
Later citations: Monte (1947, p. 8).

Synonymy: See *Stephanitis*. Synonymized by Drake and Maa (1953, p. 99).

Note: Erected as new name for *Stephanitis* Champion (not Stål) (1898b, p. 58).

***Callithrincus* Horváth** (1925, p. 10).

Type species: *Callithrincus serratus* Horváth (1925, p. 10, fig.).

Fixation: Horváth (1925, p. 10), by monotypy.

Later citation: Monte (1947, p. 8).

Distribution of species: Australian.

Number of species: 2.

***Caloloma* Drake and Bruner** (1924a, p. 152).

Type species: *Caloloma uhleri* Drake and Bruner (1924a, p. 152).

Fixation: Drake and Bruner (1924a, p. 152), by monotypy and original designation.

Later citations: Drake and Poor (1936a, p. 385); Monte (1941, p. 152; 1947, p. 8); Hurd (1946, p. 472).

Note: Originally described by Drake and Bruner (1924a, p. 152) from 10 specimens, Antigua (San Juan), Lesser Antilles. During the past decade, three small lots of typical specimens of this species have been received from Queensland, Australia. The latter records prove that *C. uhleri* is an Australian indigene. And since no specimens of *C. uhleri* have subsequently been netted in the West Indies, there is some doubt relative to the provenance of the type specimens. The specimens from insular America probably represent either an incidental introduction or an accidental mislabeling. The type series is in the U.S. National Museum.

Distribution of species: Australian (1), Neotropical (1, introduced)

Number of species: 1.

***Calotingis* Drake** (1918, p. 86).

Type species: *Calotingis knighti* Drake (1918, p. 87).

Fixation: Drake (1918, p. 86), by monotypy and original designation.

Later citations: Drake and Poor (1936a p. 385); Monte (1941, p. 152; 1947, p. 8); Hurd (1946, p. 454).

Synonym: *Neopachycysta*.

Distribution of species: Australian (1), Nearctic (1).

Number of species: 2.

***Campylosteira* Fieber** (1844, p. 42).

Type species: *Campylosteira falleni* Fieber (1844, p. 43, fig.).
Fixation: Oshanin (1912, p. 42), by subsequent designation.
Later citations: China (1943, p. 245); Monte (1947, p. 8).
Variant spelling: *Campylostira,* Fieber (1861, p. 131).
Note: Monte (1947, p. 8) erroneously cited *falleni* as originally described in genus *Tingis.*
Distribution of species: Palearctic (15), Ethiopian (2), Oriental (1).
Number of species: 18.

Campylostira. Variant spelling for *Campylosteira.*

***Campylotingis* Drake and Bondar** (1932, p. 89).

Type species: *Tigava mollicula* Drake (1922a, p. 365).
Fixation: Drake and Bondar (1932, p. 89), by original designation.
Later citations: Drake and Poor (1936a, p. 385); Monte (1939, p. 66; 1941, p. 81; 1947, p. 8).
Distribution of species: Neotropical.
Number of species: 14.

***Cantinona* Distant** (1913, p. 158).

Type species: *Cantinona praecellens* Distant (1913, p. 159, fig.).
Fixation: Distant (1913, p. 159), by monotypy.
Later citation: Monte (1947, p. 8).
Distribution of species: Malagasy.
Number of species: 1.

***Catoplatus* Spinola** (1837, p. 167).

Type species: *Tingis fabricii* Stål (1868, p. 93).
Fixation: International Commission of Zoological Nomenclature, Opinion 250, 1954.
Previous selections: Oshanin (1912, p. 45); China (1943, p. 247); Monte (1947, p. 8).
Synonym: *Coscinopoea.*
Note: Opinion 250 set aside all prior selections of type species for the genus *Catoplatus* Spinola.
Distribution of species: Palearctic (15), Oriental (2).
Number of species: 16.

***Celantia* Distant** (1903c, p. 137).

Type species: *Leptodictya vagans* Distant (1903a, p. 48).
Fixation: Distant (1903c, p. 137). by monotypy and original designation.
Later citation: Monte (1947, p. 8).

Distribution of species: Oriental (2), Fossil (1, Oligocene, Isle of Wight).
Number of species: 3.

Cetiocysta Drake and Poor (1939b, p. 205). Synonym of *Penottus*. (New synonymy.)

Type species: *Diplocysta nimia* Drake (1927a, p. 54).
Fixation: Drake and Poor (1939b, p. 205), by original designation.
Later citation: Monte (1947, p. 9).
Synonymy: See *Penottus*.
Note: Drake and Maa (1953, p. 88; 1954, p. 115) described two new species in genus *Penottus* but failed to place *Cetiocysta* in synonymy.

***Cochlochila* Stål** (1873, p. 133).

Type species: *Monanthia* (*Cochlochila*) *bullita* Stål (1873, p. 133).
Fixation: Stål (1873, p. 133), by monotypy.
Later citations: Monte (1947, p. 9); Drake (1948c, p. 181).
Synonym: *Physodictyon*.
Note: Founded as a subgenus of *Monanthia*, raised to generic level by Horváth (1910, p. 67).
Distribution of species: Ethiopian (8), Oriental (3), Palearctic (4).
Number of species: 13.

***Codotingis* Drake** (1942a, p. 360).

Type species: *Codotingis recurva* Drake (1942a, p. 361).
Fixation: Drake (1942a, p. 361), by monotypy and original designation.
Later citation: Monte (1947, p. 9).
Distribution of species: Australian.
Number of species: 1.

***Collinutius* Distant** (1903c, p. 134).

Type species: *Tingis alicollis* Walker (1873, p. 182).
Fixation: Distant (1903c, p. 134, fig. 98), by monotypy and original designation.
Later citations: Monte (1947, p. 9).
Distribution of species: Oriental.
Number of species: 1.

***Compseuta* Stål** (1873, p. 133).

Type species: *Tropidocheila ornatella* Stål (1855a, p. 37).
Fixation: Distant (1904, p. 433), by subsequent designation.
Later citations: Distant (1910a, p. 105); Monte (1947, p. 9).

Note: Founded as a subgenus of *Monanthia,* raised to generic level by Distant (1904, p. 433).
Distribution of species: Ethiopian (16), Australian (1), Oriental (1), Palearctic (1).
Number of species: 18.

Conchochila Drake (1958b, p. 329). Lapsus for *Conchotingis.* (New synonymy.)

Synonymy: See *Conchotingis.*
Note: Through oversight, Drake (1958b, pp. 329–331) failed to change the generic name of two tingids from Madagascar (described by him as "*Conchochila sundra,* new species," and "*C. insulana,* new species,") to *Conchotingis* Drake (1954, p. 71), although the generic description of *Conchochila* was deleted. The latter generic name is here suppressed as a synonym of *Conchotingis,* and *sundra* and *insulana* are transferred to *Conchotingis.*

***Conchotingis* Drake** (1954b, p. 71).

Type species: *Xenotingis trepidantis* Drake (1927b, p. 310).
Fixation: Drake (1954b, p. 72), by monotypy and original designation.
Synonym: *Conchochila.* (New synonymy.)
Distribution of species: Malagasy.
Number of species: 3.

***Congochila* Drake** (1954d, p. 8).

Type species: *Congochila congoana* Drake (1954d, p. 9).
Fixation: Drake (1954d, p. 9), by monotypy and original designation.
Distribution of species: Ethiopian.
Number of species: 1.

***Copium* Thunberg** (1822, p. 8).

Type species: *Copium cornutum* Thunberg (1822, p. 8)=*Cimex clavicornis* Linnaeus (1758, p. 442). See plate 4, herein.
Fixation: Thunberg (1822, p. 8), by monotypy.
Later citations: Oshanin (1912, p. 45); Monte (1947, p. 9). (Both as *cornutum.*)
Synonyms: *Eurycera, Laccometopus, Monanthia* (new synonymy).
Note: *Copium cornutum* Thunberg (1822, p. 8) is here suppressed as a synonym of *C. clavicornis* (Linnaeus) (1758, p. 442), the latter name having priority by 64 years. This new synonymy makes *Monanthia* a synonym of *Copium.* Of the many species formerly placed in *Monanthia,* the type species, *M. clavicornis*

(Linnaeus), belongs to *Copium; M. rotundata* (Herrich-Schaeffer) belongs to *Octacysta,* new genus; and the rest are all transferred herein to *Dictyla* Stål.

Validity of *Copium clavicornis* (Linnaeus): Two centuries ago Linnaeus (1758, p. 442) characterized *Cimex clavicornis* in these words:

> *clavicornis.* 12. C. elytris abdomen occultantibus reticulato punctatis, antennis clavatis. Fn. Svec. 687. Habitat in Europa.

The citation "Fn. Svec." refers to "Fauna Svecica" by Linnaeus (1746, p. 121) and "687" refers to the description of a new *Cimex* without a specific name, the habitat of which is given as "in Uplandia. in Scania." Scania is the former name of a province in extreme southern Sweden. In the 12th edition of "Systema Naturae" Linnaeus (1767, p. 717) wrote:

> *clavicornis.* 16. C. coleoptratus, elytris nervoso-carinatis reticulato punctatis, antennis clavatis. Fn. Svec. 911. Reaum. ins. 3. t. 34. f. 1–4. Geoffr. paris. 1.p. 461. n. 56. Habitat in Europa.

By citing the two references above, Linnaeus (1767, p. 717) himself provided the incontestable evidence needed to identify positively his species *Cimex clavicornis* of Europe. Réaumur (1737, p. 427, pl. 34, figs.) gave a good discussion of a gall-making insect and its galls on "fleurs du camedrys," including figures of both insect and galls. In the other reference Geoffroy (1762, p. 461) described the same insect and its galls on "chamedrys." The last sentence of Geoffroy's description reads:

> La larve de cette punaise habite l'intérieur des fleurs du chamaedrys, qui avant de s'ouvrir, paroissent plus grosses & plus gonflées qu'à l'ordinaire, lorsque cette larve y est renfermée.

As Fabricius was a contemporary of Linnaeus and at times visited him, it is only natural to assume that he saw and studied the "Linnaean Collection." It is evident, too, that they were in concurrence regarding the identity of *clavicornis* as can be perceived in the following excerpt from Fabricius (1794, p. 70):

> *clavicornis.* 10. A. elytris reticulato punctatis, antennis clavatis. *Cimex clavicornis.* Linn. Syst. nat. 2. 717.16. Fn. Svec. 911. Geoff. Ins. 1. 461. 56. Reaum. Ins. e. tab. 34. fig. 1–4. Fyesl. Helvet. 25. 480. Panz. Fn. Germ. 3. tab. 24. Habitat in Europae hortis."

Fieber (1844, p. 97, fig.) founded the genus *Laccometopus* to hold *C. clavicornis* Linnaeus and *L. kollari,* both gall-making species. Seventeen years later, this author (Fieber 1861, p. 119) again treated Linnaeus' *clavicornis* as in 1844. The host plant as cited by the above and other authors of those times is *Teucrio chamaedri* (fide Fieber).

The first and so far the only reviser of the Palearctic species of the genus *Copium,* Wagner (1954, pp. 200–209) correctly treated *Monanthia clavicornis* (Linnaeus) (1758) and *Copium cornutum* Thunberg (1822) as identical species but failed to relegate the latter to synonymy. As indicated under *Copium* and *Monanthia,* the type species of these two genera are conspecific, the latter being a junior synonym of the former. For information relative to this synonymy, suppressing of *Copium cornutum* with *C. clavicornis,* and resurrection of *Dictyla* Stål from synonymy to hold almost all of the species included in *Monanthia,* see discussions under *Copium, Dictyla, Monanthia,* and *Octacysta.* Dr. W. E. China, in personal correspondence, states that there are two specimens of tingids under the name "*Cimex clavicornis* L." in the Linnaean Collection at the Linnaean Society of London, Burlington House, Picadilly, and that one, in Linnaeus' handwriting, is labeled "*Tingis cardui* Linn." and the other (without label) is *Acalypta carinata* (Panzer). The specimen bearing the label with *C. clavicornis* L. is the thistle tingid that Linnaeus described as *C. cardui* and it agrees with the original description of *cardui.* These are plainly self-evident errors made by others in handling the Linnaean specimens during the past two centuries and need no further comments.

Distribution of species: Palearctic (8), Oriental (1).
Number of species: 9.

Corinthus **Distant** (1920, p. 155).

Type species: *Corinthus typicus* Distant (1920, p. 156).
Fixation: Distant (1920, p. 156), by monotypy.
Distribution of species: New Zealandian.
Number of species: 1.

Corycera **Drake** (1922a, p. 368).

Type species: *Corycera comptula* Drake (1922a, p. 369, fig.).
Fixation: Drake (1922a, p. 368), by original designation.
Later citations: Drake and Poor (1936a, p. 385); Monte (1939, p. 66; 1941, p. 84; 1947, p. 9); Hurd (1946, p. 457).
Distribution of species: Neotropical.
Number of species: 17.

Corythaica **Stål** (1873, pp. 120, 128).

Type species: *Tingis monacha* Stål (1858, p. 64).
Fixation: Stål (1873, p. 128), by monotypy.

Later citations: Van Duzee (1917, p. 817); Drake and Poor (1936a, p. 385); Monte (1939, p. 67; 1941, p. 86; 1947, p. 9); Hurd (1945, p. 80; 1946, p. 480).
Synonyms: *Dolichocysta, Leptotingis, Typonotus.*
Distribution of species: Neotropical (11), Nearctic (4).
Number of species: 13.

***Corythauma* Drake and Poor,** 1939b, p. 206.

Type species: *Leptopharsa ayyari* Drake (1933, p. 1016).
Fixation: Drake and Poor (1939b, p. 206), by monotypy and original designation.
Later citation: Monte (1947, p. 9).
Distribution of species: Oriental (1), Ethiopian (1).
Number of species: 1.

***Corythotingis* Drake and Poor** (1943, p. 195).

Type species: *Corythotingis zimmermani* Drake and Poor (1943, p. 196, fig.).
Fixation: Drake and Poor (1943, p. 196), by monotypy and original designation.
Later citation: Monte (1947, p. 9).
Distribution of species: Oceanic.
Number of species: 1.

Corythuca. Error for *Corythucha.*

***Corythucha* Stål** (1873, pp. 119, 122).

Type species: *Tingis fuscigera* Stål (1862, p. 323).
Fixation: Van Duzee (1916, p. 25), by subsequent designation.
Later citations: Van Duzee (1917, p. 212); Drake and Poor (1936a, p. 385); Monte (1939, p. 67; 1941, p. 88; 1947, p. 9); Hurd (1946, p. 482).
Variant spelling: *Corythuca,* many authors.
Distribution of species: Nearctic (51), Neotropical (27).
Number of species: 72.

Coscinopoea Stål (1873, p. 128). Synonym of *Catoplatus.*

Type species: *Cimex carthusianus* Goeze (1778, p. 268).
Fixation: Stål (1873, p. 128), by objective synonymy.
Erroneous citation: Monte (1947, p. 9). See note below.
Synonymy: See *Catoplatus.*
Note: Stål (1873, p. 128) erected *Coscinopoea* as a subgenus of *Catoplatus* Spinola (1837) with two included species. Synonymized by Lethierry and Severin (1896, p. 20) and so treated by

Horváth (1906c, p. 85), Oshanin (1912, p. 45), and Monte (1947, p. 9). This synonymization was overlooked by China (1943, p. 247). Horváth (1906c, p. 89) synonymized *Tingis eryngii* Latreille (1804, p. 253) with *Catoplatus carthusianus* (Goeze) and treated *albidus* (Herrich-Schaeffer) as a variety of *Catoplatus carthusianus.* Through oversight, Monte (1947, p. 9) also failed to note the above synonymy in designating "*Monanthia* (*Coscinopoea*) *eryngii* Latr." as type species.

***Cottothucha* Drake and Poor** (1941, p. 162).

Type species: *Cottothucha oceanae* Drake and Poor (1941, p. 163).
Fixation: Drake and Poor (1941, p. 162), by monotypy and original designation.
Later citation: Monte (1947, p. 10).
Distribution of species: Oriental.
Number of species: 1.

***Cromerus* Distant** (1902b, p. 355).

Type species: *Monanthia invaria* Walker (1873, p. 196).
Fixation: Distant (1902b, p. 356), by monotypy.
Later citation: Monte (1947, p. 10).
Distribution of species: Oriental (6), Papuan (1), Australian (1), Oceanic (1).
Number of species: 8.

***Cysteochila* Stål** (1873, pp. 121, 129).

Type species: *Monanthia ? tingoides* Motschulsky (1863, p. 92).
Fixation: Distant (1903c, p. 138), by subsequent designation.
Later citations: Drake and Poor (1937b, p. 6); Monte (1947, p. 10).
Erroneous citations: Bergroth (1921, p. 104); Horváth (1925, p. 3) (as *Cysteochila sordida* Stål).
Synonym: *Bredenbachius.*
Note: See Drake and Poor (1937b, pp. 6, 7) for discussion of synonymy.
Distribution of species: Ethiopian (33), Oriental (34), Malagasy (11), Australian (4), Oceanic (2).
Number of species: 83.

***Dasytingis* Drake and Poor** (1936b, p. 145).

Type species: *Dasytingis rudis* Drake and Poor (1936b, p. 145, fig.).
Fixation: Drake and Poor (1936b, p. 145), by monotypy and original designation.
Later citation: Monte (1947, p. 10).

Distribution of species: Oriental.
Number of species: 2.

Derephisia. Error for *Derephysia.*

***Derephysia* Spinola** (1837, p. 166).

Type species: *Tingis foliacea* Fallén (1807, p. 39).
Fixation: Oshanin (1912, p. 43), by subsequent designation.
Later citations: China (1943, p. 246); Monte (1947, p. 10).
Variant spelling: *Derephisia* (Monte, 1947, p. 10).
Distribution of species: Palaearctic (7), Oriental (1).
Number of species: 8.

***Dichocysta* Champion** (1898a, p. 33).

Type species: *Dichocysta pictipes* Champion (1898a, p. 34, fig.).
Fixation: Champion (1898a, p. 34), by monotypy.
Later citations: Van Duzee (1916, p. 26; 1917, p. 221); Drake and Poor (1936a, p. 385); Monte (1941, p. 153; 1947, p. 10); Hurd (1946, p. 453).
Variant spelling: *Dichrocysta* (Banks 1910, p. 56).
Distribution of species: Neotropical (1), Nearctic (1).
Number of species: 1.

***Diconocoris* Mayr** (1864, p. 442).

Type species: *Diconocoris javanus* Mayr (1864, p. 442).
Fixation: Mayr (1864, p. 442), by monotypy.
Later citations: Drake (1937, p. 386, fig., type species); Monte (1947, p. 10).
Synonym: *Diplogomphus.*
Distribution of species: Oriental.
Number of species: 7.

Dictiotingis. Error for *Dictyotingis.*

Dichrocysta. Error for *Dichocysta.*

***Dictyla* Stål** (1874, p. 57).

Type species: *Monanthia platyoma* Fieber (1861, p. 125). See plate 5, herein.
Fixation: Stål (1874, p. 57), by monotypy.
Later citations: Drake and Poor (1936a, p. 385); China (1943, p. 248); Monte (1947, p. 10).
Note: Stål (1874, p. 57) misspelled specific name as "*platyomia*"; others have perpetuated this error. Horváth (1906c, p. 97)

wrongly suppressed the genus *Dictyla* as a synonym of *Monanthia*. The present paper resurrects and restores *Dictyla* to the generic level. See *Copium* and *Monanthia* for a discussion of synonymy which led to this action. Species being transferred from *Monanthia* to *Dictyla* are listed below under "new combinations."

Distribution of species: Ethiopian (19), Neotropical (14), Oriental (12), Palearctic (14), Nearctic (3), Australian (1), Fossil (3).

Number of species: 63.

NEW COMBINATIONS: In suppressing the genus *Monanthia* Le Peletier and Serville as a synonym of *Copium*, it becomes necessary to transfer the following species to the genus *Dictyla* Stål: *abyssinica* Drake, *ainsliei* Drake and Poor, *amitina* Horváth, *aurigana* Drake, *aurigana* subsp. *discoris* Drake, *balli* Drake, *berryi* Drake, *cheriani* Drake, *c-nigrum* Champion, *collarti* Schouteden, *coloradensis* Drake, *comes* Drake, *echii* (Schrank), *echii* var. *nigricans* Hoberlandt, *echii* var. *rufina* Seidenstücker, *ehrethiae* Gibson, *femoralis* (Stål), *figurata* Drake, *flavipes* Signoret, *formosa* Drake, *fulvescens* Kirichenko, *gerardi* Schouteden, *haitiensis* Drake and Poor, *humuli* (Fabricius), *imparis* Drake, *indigena* (Wollaston), *indigena* var. *bugioensis* (China), *labeculata* Uhler, *leporis* Drake, *leroyi* Schouteden, *loricata* Distant, *lupuli* Herrich-Schaeffer, *lupata* Drake and Poor, *montandoni* Horváth, *montandoni* var. *rivalis* Horváth, *monotropidia* (Stål), *nassata* Puton, *nodipennis* Horváth, *parilis* Drake, *parmata* Distant, *patquiana* Drake, *picturata* Distant, *platyoma* Fieber, *pongana* Drake, *pucallpana* Drake and Hambleton, *putoni* Montandon, *putoni* var. *pulla* Horváth, *rasilis* Drake and Maa, *ruandae* Schouteden, *ruficeps* Horváth, *salicorum* (Baba), *sahlbergi* Horváth, *sauteri* Drake, *senta* Drake and Hambleton, *seorsa* Drake and Poor, *seorsa* var. *inflata* Drake and Poor, *sessoris* Drake and Poor, *sjostedti* Horváth, *subdola* Horváth, *sufflata* Drake and Poor, *symphyti* (Vallot), *triconula* Seidenstücker, *tuberosa* Horváth, *uichancoi* Drake and Poor, *vulcanorum* Schouteden, *uniseriata* (Horváth), *veterna* Scudder, *zavattarii* Mancini, and the fossils *wollastoni* (Heer) and *flexuosa* (Novak).

***Dictyonota* Curtis** (1827, p. 154).

Type species: *Dictyonota strichnocera* Fieber (1844, p. 95, fig.).

Fixation: International Commission on Zoological Nomenclature, Opinion 251, 1954.

Previous selections: Oshanin (1912, p. 43); China (1943, p. 246) (as *strichnocera*).

Invalid citations: Hurd (1946, p. 461); Monte (1947, p. 10).

Valid subgenera: *Dictyonota, Alcletha, Elina, Kalama.* (Horváth (1906c, p. 39) divided the genus *Dictyonota* into these four subgenera.)

Synonym: *Scraulia.* Synonymized with genus by Kirkaldy (1900, p. 241) and later delimited to subgenus *Dictyonota* (*Dictyonota*) by Horváth (1906c, p. 39).

Note: Opinion 251 set aside all prior designations of type species for the nominal genus *Dictyonota* Curtis (1827). Hurd (1946, p. 461) and Monte (1947, p. 10) both wrongly cited the type species as *Dictyonota eryngii* (Latreille) (described as *Tingis*), the same species incorrectly cited and designated by Curtis at the time he erected the genus *Dictyonota*. (Misidentified genotype.)

Distribution of species: Palearctic (24), Oriental (2), Ethiopian (1), Nearctic (1, introduced).

Number of species: 26.

Dictyonota (_Dictyonota_) Curtis (1827, p. 154).

Type species: Cited under the genus.

Later citation: China (1943, p. 246).

Synonym: *Scraulia.* Synonymized with subgenus by Horváth (1906c, p. 39).

Note: Oshanin (1912, p. 43) erroneously credited the subgenus *Dictyonota* (*Dictyonota*) to Kirkaldy (1900, p. 241).

Distribution of species: Palearctic (7), Oriental (1), Ethiopian (1).

Number of species: 9.

Dictyonota (_Alcletha_) Kirkaldy (1900, p. 241).

Type species: *Acanthia tricornis* Schrank (1801, p. 67).

Fixation: Kirkaldy (1900, p. 241), by original designation.

Later citations: Oshanin (1912, p. 43); China (1943, p. 246).

Synonyms: *Dictyonota* of Stål (1874 p. 49) (not Curtis), synonymized by Horváth (1906c, p. 40); *Dictyonota* of Lethierry and Severin (1896, p. 7) (not Curtis).

Note: Kirkaldy (1900, p. 241) proposed *Alcletha* as a new generic name for *Dictyonota* of Lethierry and Severin (1896, p 7) (not Curtis). Reduced to subgeneric level by Horváth (1906c, p. 40).

Distribution of species: Palearctic (5), Oriental (1), Nearctic (1, introduced).

Number of species: 5.

Dictyonota (_Elina_) Ferrari (1878, p. 84).

Type species: *Dictyonota beckeri* Jakovlev (1871, p. 25).

Fixation: Ferrari (1878, p. 84), by monotypy.

Later citation: Oshanin (1912, p. 43).

Distribution of species: Palearctic.
Number of species: 7.

***Dictyonota* (*Kalama*) Puton** (1876, p. 34).

Type species: *Dictyonota* (*Kalama*) *coquereli* Puton (1876, p. 34).
Fixation: Oshanin (1912, p. 43), by subsequent designation.
Distribution of species: Palearctic.
Number of species: 5.

Dictyonota of Lethierry and Severin (1896, p. 7) (not Curtis). See *Dictyonota (Alcletha).*

Dictyonota of Stål (1874, p. 49) (not Curtis). See *Dictyonota (Alcletha).*

***Dictyotingis* Drake** (1942b, p. 8).

Type species: *Dictyotingis gibberis* Drake (1942b, p. 8).
Fixation: Drake (1942b, p. 8), by monotypy and original designation.
Later citation: Monte (1947, p. 10).
Variant spelling: *Dictiotingis* (Monte, 1947, p. 10).
Distribution of species: Oriental.
Number of species: 2.

***Dicysta* Champion** (1897, p. 5).

Type species: *Dicysta vitrea* Champion (1897, p. 5, fig.).
Fixation: Champion (1897, p. 5), by monotypy.
Later citations: Drake and Poor (1936a, p. 385); Monte (1939, p. 68; 1941, p. 92; 1947, p. 10); Hurd (1946, p. 477).
Distribution of species: Neotropical (10), Australian (2).
Number of species: 12.

***Diplocysta* Horváth** (1925, p. 11).

Type species: *Diplocysta bilobata* Horváth (1925, p. 12, fig.).
Fixation: Horváth (1925, p. 12), by monotypy.
Later citation: Monte (1947, p. 10).
Distribution of species: Australian.
Number of species: 3.

Diplogomphus Horváth (1906b, p. 296). Synonym of *Diconocoris.*

Type species: *Diplogomphus capusi* Horváth (1906b, p. 296, fig.).
Fixation: Horváth (1906b, p. 296), by monotypy.
Later citation: Monte (1947, p. 11).
Synonymy: See *Diconocoris.* Synonymized by Drake (1937, p. 386).

Dolichocysta Champion (1898b, p. 56). Synonym of *Corythaica*.

Type species: *Dolichocysta venusta* Champion (1898b, p. 57, fig.).
Fixation: Champion (1898b, p. 57), by monotypy.
Later citations: Drake and Poor (1936a, p. 385); Monte (1947, p. 11).
Synonymy: See *Corythaica*. Synonymized by Hurd (1945, p. 80).

Drakella Bergroth (1922, p. 152). Synonym of *Acalypta*.

Type species: *Fenestrella ovata* Osborn and Drake (1916, p. 223, fig.).
Fixation: Bergroth (1922, p. 152), by monotypy.
Later citations: Drake and Poor (1936a, p. 385); Monte (1947, p. 11).
Synonymy: See *Acalypta*. Synonymized by Drake (1928d, p. 2).
Note: Bergroth (1922, p. 152) proposed *Drakella* as new name for *Fenestrella*.

***Dulinius* Distant** (1903a, p. 48).

Type species: *Dulinius conchatus* Distant (1903a, p. 48).
Fixation: Distant (1903a, p. 48), by monotypy.
Later citations: Distant (1903c, p. 133, fig., type species); Monte (1947, p. 11).
Synonym: *Sankisia*.
Distribution of species: Ethiopian (6), Malagasy (1), Oriental (1).
Number of species: 8.

***Dyspharsa* Drake and Hambleton** (1944, p. 127).

Type species: *Leptopharsa myersi* Drake (1926, p. 87).
Fixation: Drake and Hambleton (1944, p. 128), by monotypy and original designation.
Later citations: Monte (1947, p. 11); Hurd (1946, p. 467).
Distribution of species: Neotropical.
Number of species: 1.

***Elasmognathus* Fieber** (1844, p. 90).

Type species: *Elasmognathus helferi* Fieber (1844, p. 91, fig.).
Fixation: Fieber (1844, p. 90), by monotypy.
Later citations: Distant (1903c, p. 141); Monte (1947, p. 11).
Note: The three species (Ethiopian) described by Schouteden (1953, pp. 167–169) are not members of the genus *Elasmognathus* and will be treated elsewhere.
Distribution of species: Oriental (1), Ethiopian (1).
Number of species: 2.

Elasmotropis **Stål** (1874, p. 54).

Type species: *Monanthia echinopsidis* Fieber (1844, p. 62, fig.) = *Tingis testacea* Herrich-Schaeffer (1830, Heft 118, Tab. 23).
Fixation: Stål (1874, p. 54), by monotypy.
Later citations: Oshanin (1912, p. 44); Monte (1947, p. 11).
Note: Monte (1947, p. 11) wrongly treated *Elasmotropis* Stål as a synonym of *Phyllontochila* Fieber.
Distribution of species: Palearctic.
Number of species: 3.

Elina **Ferrari** (1878, p. 84). See ***Dictyonota*** **(*Elina*).**

Engynoma **Drake** (1942a, p. 362).

Type species: *Perissonemia tasmaniae* Drake and Poor (1937c, p. 402).
Fixation: Drake (1942a, p. 362), by original designation.
Later citation: Monte (1947, p. 11).
Distribution of species: Australian.
Number of species: 6.

Eotingis **Scudder** (1890, p. 359).

Type species: *Eotingis antennata* Scudder (1890, p. 360, fig.).
Fixation: Scudder (1890, p. 360), by monotypy.
Later citations: Drake and Poor (1936a, p. 386); Monte (1941, p. 153; 1947, p. 11); Hurd (1946, p. 455).
Distribution of species: Nearctic (fossil, Florissant, Colorado; Tertiary).
Number of species: 1.

Epimixia **Kirkaldy** (1908a, p. 779). (New status.)

Type species: *Epimixia alitophrosyne* Kirkaldy (1908a, p. 780).
Fixation: Kirkaldy (1908a, p. 780), by monotypy.
Later citations: Horváth (1925, p. 16); Monte (1947, p. 5).
Note: Transferred herein to subfamily Tinginae from subfamily Agrammatinae. [An examination of the type of *Agramma nigriceps* Signoret (1881, p. L) from New Caledonia, which is in the Naturhistorisches Museum (Wien), shows that this species belongs to the Australian genus *Epimixia* Stål, and it is here so transferred (new combination).]
Distribution of species: Australian (6), New Zealandian (1).
Number of species: 7.

***Esocampylia* Hacker** (1929, p. 326).

Type species: *Esocampylia incarinata* Hacker (1929, p. 326, fig.).
Fixation: Hacker (1929, p. 326), by monotypy and original designation.
Later citation: Monte (1947, p. 11).
Distribution of species: Australian.
Number of species: 2.

***Eteoneus* Distant** (1903c, p. 129).

Type species: *Serenthia dilata* Distant (1903a, p. 46).
Fixation: Distant (1903c, p. 129), by monotypy and original designation, fig. (type species).
Later citation: Monte (1947, p. 11).
Distribution of species: Oriental (9), Ethiopian (4), Oceanic (2).
Number of species: 14.

***Euahanes* Distant** (1911a, p. 42).

Type species: *Euahanes inflatus* Distant (1911a, p. 43, fig.).
Fixation: Distant (1911a, p. 43), by monotypy.
Later citation: Monte (1947, p. 12).
Distribution of species: Ethiopian.
Number of species: 1.

***Euaulana* Drake** (1945, p. 96).

Type species: *Euaulana ferritincta* Drake (1945, p. 96).
Fixation: Drake (1945, p. 96), by original designation.
Later citation: Monte (1947, p. 12).
Distribution of species: Australian.
Number of species: 2.

Eurycera Laporte (1833, p. 49). Synonym of *Copium*.

Type species: *Eurycera nigricornis* Laporte (1833, p. 49).
Fixation: Laporte (1833, p. 49), by monotypy.
Later citation: Monte (1947, p. 12).
Synonymy: See *Copium*. Synonymized by Lethierry and Severin (1896, p. 15).
Note: *E. nigricornis* Laporte is a synonym of *C. clavicornis* (Linnaeus), type species of *Copium*.

***Eurypharsa* Stål** (1873, pp. 122, 133).

Type species: *Tingis nobilis* Guérin (1838, p. 349).
Fixation: Stål (1873, p. 133), by monotypy.
Later citations: Drake and Poor (1936a, p. 386); Monte (1939, p. 69; 1941, p. 94; 1947, p. 12); Hurd (1946, p. 468).

Distribution of species: Neotropical.
Number of species: 5.

Fenestrella Osborn and Drake (1916, p. 222). Synonym of *Acalypta*.

Type species: *Fenestrella ovata* Osborn and Drake (1916, p. 223, fig.).
Fixation: Osborn and Drake (1916, p. 223), by monotypy and original designation.
Later citation: Monte (1947, p. 12).
Synonymy: See *Acalypta, Drakella.*
Note: As *Fenestrella* was preoccupied (Mollusca and Bryozoa), Bergroth (1922, p. 152) proposed *Drakella* as a new name for *Fenestrella.* Drake (1928d, p. 1) synonymized *Drakella* and *Fenestrella* with *Acalypta.*

***Froggattia* Froggatt** (1901, p. 1601).

Type species: *Froggattia olivinia* Froggatt (1901, p. 1601, fig.).
Fixation: Froggatt (1901, p. 1601), by monotypy.
Later citation: Monte (1947, p. 12) wrongly credited both genus and type species to Horváth (1902) as *Froggattia olivina.*
Homonym: *Froggattia* Horváth. (New homonymy.)
Note: The olive tingid has heretofore been wrongly accredited to Horváth (1902) as *Froggattia olivina*, though the description and figure by Froggatt (1901) as *Froggattia olivinia* (wrongly attributed by Froggatt himself to Horváth) has priority by almost one year. Under these circumstances the genus and species must be credited to Froggatt, and the spelling of the specific name should be *olivinia* and not *olivina* Horváth, which is a synonym. (New synonymy.)
Distribution of species: Ethiopian (1), Australian (2).
Number of species: 3.

Froggattia Horváth (1902, p. 604). Homonym of *Froggattia* Froggatt. (New homonymy.)

Type species: *Froggattia olivina* Horváth (1902, p. 605).
Fixation: Horváth (1902, p. 605), by monotypy.
Later citations: Monte (1947, p. 12).
Homonymy: See *Froggattia* Froggatt.
Note: *F. olivina* Horváth is a junior synonym of *F. olivinia* Froggatt.

***Furcilliger* Horváth** (1925, p. 3).

Type species: *Frucilliger asperulus* Horváth (1925, p. 4, fig.).
Fixation: Horváth (1925, p. 3), by monotypy.
Later citation: Monte (1947, p. 12).

Distribution of species: Papuan (1), Australian (1).
Number of species: 2.

***Gabirobius* Schouteden** (1955, p. 166).

Type species: *Gabirobius basilewskyi* Schouteden (1955, p. 167).
Fixation: Schouteden (1955, p. 167), by monotypy.
Distribution of species: Ethiopian.
Number of species: 1.

***Galeatus* Curtis** (1833, p. 196).

Type species: *Tingis spinifrons* Fallén (1807, p. 38).
Fixation: Curtis (1833, p. 196), by monotypy.
Later citations: Distant (1903c, p. 131; Oshanin (1912, p. 43); Van Duzee (1916, p. 25; 1917, p. 215); Drake and Poor (1936a, p. 386); Monte (1941, p. 153; 1947, p. 12); Hurd (1946, p. 478).
Synonym: *Cadmilos*.
Distribution of species: Palearctic (11), Oriental (3), Nearctic (2).
Number of species: 16.

Galeotingis Drake (1947a, p. 1). Synonym of *Bako*.

Type species: *Galeotingis malayana* Drake (1947a, p. 1).
Fixation: Drake (1947a, p. 1), by original designation.
Later citation: Drake (1956c, p. 63).
Synonymy: See *Bako*. Synonymized by Drake (1954e, p. 8).

***Gargaphia* Stål** (1862, p. 324).

Type species: *Monanthia* (*Phyllontochila*) *patricia* Stål (1862, p. 324).
Fixation: Van Duzee (1916, p. 25), by subsequent designation.
Later citations: Van Duzee (1917, p. 217); Hurd (1946, p. 479).
Erroneous citations: Drake and Poor (1936a, p. 386) and Monte (1939, p. 69; 1941, p. 95; 1947, p. 12) wrongly cited year as 1873 instead of 1862.
Note: Raised from a subgenus of *Monanthia* to generic level by Stål (1873, p. 124).
Distribution of species: Neotropical (53), Nearctic (13).
Number of species: 64.

Gelchossa Kirkaldy (1904, p. 280). Synonym of *Leptopharsa*.

Type species: *Tingis oblonga* Say (1825, p. 325).
Fixation: Drake (1922a, p. 372), by subsequent designation.
Later citations: Drake and Poor (1936a, p. 386); Monte (1947, p. 12).

Synonymy: See *Leptopharsa*. Synonymized by Drake (1928, p. 21).
Note: Kirkaldy (1904, p. 280) proposed *Gelchossa* to replace *Leptostyla* Stål (1873, p. 125), which was preoccupied.

***Gitava* Drake** (1948d, p. 149).

Type species: *Tigava uganda* Drake (1942b, p. 11).
Fixation: Drake (1948d, p. 149), by monotypy and original designation.
Distribution of species: Ethiopian (4), Malagasy (4).
Number of species: 8.

***Gymnotingis* Hacker** (1928, p. 181).

Type species: *Gymnotingis serrulata* Hacker (1928, p. 182, fig.).
Fixation: Hacker (1928, p. 181), by monotypy and original designation.
Later citation: Monte (1947, p. 12).
Distribution of species: Australian.
Number of species: 1.

***Habrochila* Horváth** (1912a, p. 353).

Type species: *Habrochila placida* Horváth (1912a, p. 354).
Fixation: Horváth (1912a, p. 354), by monotypy.
Later citation: Monte (1947, p. 12).
Distribution of species: Ethiopian (7), Oriental (3), Malagasy (1).
Number of species: 11.

***Haedus* Distant** (1904, p. 432).

Type species: *Haedus clypeatus* Distant (1904, p. 432, fig.).
Fixation: Distant (1904, p. 432), by monotypy.
Later citation: Monte (1947, p. 13).
Synonym: *Hormisdas*.
Distribution of species: Ethiopian (9), Oriental (4), Malagasy (1).
Number of species: 14.

***Hanuala* Kirkaldy** (1905, p. 217). See ***Leptodictya* (*Hanuala*).**

***Hegesidemus* Distant** (1911b, p. 270).

Type species: *Hegesidemus eliyanus* Distant (1911b, p. 270).
Fixation: Distant (1911b, p. 270), by monotypy.
Later citation: Monte (1947, p. 13).
Distribution of species: Oriental (3), Malagasy (1).
Number of species: 4.

***Henrikus* Drake** (1955b, p. 280).

Type species: *Henrikus schoutedeni* Drake (1955b, p. 282, fig.).
Fixation: Drake (1955b, p. 281), by monotypy and original designation.
Distribution of species: Ethiopian.
Number of species: 1.

***Hesperotingis* Parshley** (1917, p. 21).

Type species: *Hesperotingis antennata* Parshley (1917, p. 21, fig.).
Fixation: Parshley (1917, p. 21), by original designation.
Later citations: Van Duzee (1917, p. 818); Drake and Poor (1936a, p. 386); Monte (1941, p. 153; 1947, p. 13); Hurd (1946, p. 446).
Distribution of species: Nearctic.
Number of species: 7.

***Holophygdon* Kirkaldy** (1908b, p. 364).

Type species: *Holophygdon melanesica* Kirkaldy (1908b, p. 364, fig.).
Fixation: Kirkaldy (1908, p. 364), by monotypy.
Later citation: Monte (1947, p. 13).
Distribution of species: Oceanic.
Number of species: 1.

Hormisdas Distant (1910b, p. 59). Synonym of *Haedus*.

Type species: *Hormisdas pictus* Distant (1910b, p. 60, fig.).
Fixation: Distant (1910b, p. 59), by monotypy and original designation.
Later citation: Monte (1947, p. 13).
Synonymy: See *Haedus*. Synonymized by Drake (1953b, p. 93).

***Hovatlas* Schouteden** (1957, p. 85).

Type species: *Hovatlas elegantulus* Schouteden (1957, p. 85).
Fixation: Schouteden (1957, p. 85), by monotypy.
Distribution of species: Malagasy.
Number of species: 1.

***Hurdchila* Drake** (1953b, p. 92).

Type species: *Jannaeus togularis* Drake and Poor (1936c, p. 441).
Fixation: Drake (1953b, p. 93), by original designation.
Distribution of species: Oriental.
Number of species: 2.

***Hyalochiton* Horváth** (1905, p. 566).

Type species: *Galeatus komaroffi* Jakovlev (1880, pp. 130, 133).
Fixation: Horváth (1905, p. 566), by monotypy.

Later citations: Oshanin (1912, p. 43); Monte (1947, p. 13).

Note: Created as a subgenus of *Galeatus;* raised to generic rank by Horváth (1906c, p. 48). Type species is sometimes spelled *H. komarovi.*

Distribution of species: Palearctic.

Number of species: 6.

Hybopharsa **Hurd** (1946, p. 467).

Type species: *Leptostyla colubra* Van Duzee (1907, p. 19).

Fixation: Hurd (1946, p. 468), by monotypy and original designation.

Later citations: Monte (1947, p. 13); Hurd (1946, p. 467).

Distribution of species: Neotropical.

Number of species: 1.

Hypsipyrgias **Kirkaldy** (1908a, p. 779).

Type species: *Hypsipyrgias telamonides* Kirkaldy (1908a, p. 779, fig.).

Fixation: Kirkaldy (1908a, p. 779), by monotypy.

Later citation: Monte (1947, p. 13).

Distribution of species: Australian.

Number of species: 1.

Idiocysta **China** (1930, p. 141).

Type species: *Idiocysta hackeri* China (1930, p. 142, fig.).

Fixation: China (1930, p. 141), by monotypy and original designation.

Later citation: Monte (1947, p. 13).

Distribution of species: Oceanic.

Number of species: 5.

Idiostyla **Drake** (1945, p. 97).

Type species: *Tigava anonae* Drake and Hambleton (1938a, p. 45).

Fixation: Drake (1945, p. 98), by original designation.

Later citation: Monte (1947, p. 13).

Distribution of species: Neotropical.

Number of species: 2.

Ildefonsus **Distant** (1910a, p. 110)

Type species: *Ildefonsus provorsus* Distant (1910a, p. 110, fig.).

Fixation: Distant (1910a, p. 110), by monotypy and original designation.

Later citation: Monte (1947, p. 13).

Distribution of species: Oriental.
Number of species: 1.

***Inoma* Hacker** (1927, p. 25).

Type species: *Inoma multispinosa* Hacker (1927, p. 25, fig.).
Fixation: Hacker (1927, p. 25), by monotypy and original designation.
Later citation: Monte (1947, p. 14).
Distribution of species: Australian.
Number of species: 2.

***Inonemia* Drake** (1942a, p. 361).

Type species: *Inonemia mussiva* Drake (1942a, p. 362).
Fixation: Drake (1942a, p. 362), by original designation.
Later citation: Monte (1947, p. 14).
Distribution of species: Australian.
Number of species: 1.

***Ischnotingis* Horváth** (1925, p. 7).

Type species: *Ischnotingis prolixa* Horváth (1925, p. 8, fig.).
Fixation: Horváth (1925, p. 8), by original designation.
Later citation: Monte (1947, p. 14).
Distribution of species: Australian.
Number of species: 4.

Jannaeus Distant (1909a, p. 118). Synonym of *Lasiacantha*.

Type species: *Jannaeus cuneatus* Distant (1909a, p. 118).
Fixation: Distant (1909a, p. 118), by monotypy.
Later citations: Distant (1910a, p. 117, fig., type species); Monte (1947, p. 14).
Synonymy: See *Lasiacantha*. Synonymized by Drake (1953b, p. 92).

***Kalama* Puton** (1876, p. 34). See ***Dictyonota* (*Kalama*)**.

***Kapiriella* Schouteden** (1919, p. 138).

Type species: *Kapiriella leplaei* Schouteden (1919, p. 139).
Fixation: Schouteden (1919, p. 139), by monotypy and original designation.
Later citations: Monte (1947, p. 14); Drake (1957c, p. 206).
Synonym: *Lembella*.
Distribution of species: Ethiopian.
Number of species: 10.

Kitoko Schouteden (1923, p. 95). Synonym of *Ammianus.*

Type species: *Phyllontocheila* (*Kitoko*) *alberti* Schouteden (1923, p. 96).
Fixation: Schouteden (1923, p. 95), by monotypy.
Synonymy: See *Ammianus.* Synonymized by Drake (1955d, p. 105)
Variant spelling: *Kotoko* (Drake, 1955d, p. 105).

Kotoko. Error for *Kitoko.*

Laccometopus Fieber (1844, pp. 30, 96). Synonym of *Copium.*

Type species: *Cimex clavicornis* Linnaeus (1758, p. 442).
Fixation: Present designation.
Erroneus citation: Monte (1947, p. 14).
Synonymy: See *Copium.* Synonymized by Horváth (1906c, p. 91).
Note: Monte (1947, p. 14) designated *L. costatus* (Fabricius) as type species of *Laccometopus*, which is invalid since it was not included in the original generic description. *Laccometopus* was erected by Fieber to hold *L. clavicornis* (Linnaeus) and *L. kollari* Fieber. As no type species has heretofore been named, *L. clavicornis* (Linnaeus) is here so designated, thus fixing the synonymization by Horváth (1906c, p. 91), and others, with *Copium.*

Lambella. Error for *Lembella.*

***Lasiacantha* Stål** (1873, p. 130).

Type species: *Tingis* (*Lasiacantha*) *hedenborgi* Stål (1873, p. 130).
Fixation: Oshanin (1912, p. 44), by subsequent designation.
Later citations: China (1943, p. 246); Drake (1953b, p. 92).
Erroneous citation: Monte (1947, p. 14) cited type species as *L. odontostoma* (Stål).
Synonyms: *Jannaeus, Myrmecotingis.*
Note: Stål (1874, p. 56) elevated *Lasiacantha* to generic rank from subgenus of *Tingis.*
Distribution of species: Ethiopian (10), Palearctic (4), Australian (3), Oriental (2), Malagasy (2).
Number of species: 21.

***Lasiotropis* Stål** (1874, p. 55). See ***Tingis* (*Lasiotropis*).**

Lembella Schouteden (1919, p. 141). Synonym of *Kapiriella.*

Type species: *Lembella maynei* Schouteden (1919, p. 142).
Fixation: Schouteden (1919, p. 142), by monotypy and original designation.

Later citation: Monte (1947, p. 14).
Synonymy: See *Kapiriella*. Synonymized by Drake (1953b, p. 93).
Variant spelling: *Lambella* (Drake, 1948e, p. 76).

***Leptobyrsa* Stål** (1873, pp. 119, 123).

Type species: *Tingis steini* Stål (1858, p. 64).
Fixation: Stål (1873, p. 123), by monotypy.
Later citations: Van Duzee (1916, p. 25; 1917, p. 216); Drake and Poor (1936a, p. 386); Monte (1939, p. 71; 1941, p. 101; 1947, p. 14).
Note: Species of tingids included in *Leptobyrsa* by Banks (1910, p. 56), Van Duzee (1916, p. 25), and Osborn and Drake (1916, p. 240) belong to the genus *Stephanitis*. Van Duzee (1917, p. 216) wrongly treated *Leptobyrsa* Stål as a synonym of *Stephanitis* Stål.
Distribution of species: Neotropical.
Number of species: 8.

***Leptocysta* Stål** (1873: pp. 121, 127).

Type species: *Tingis sexnebulosa* Stål (1858, p. 64).
Fixation: Stål (1873, p. 127), by monotypy.
Later citations: Drake and Poor (1936a, p. 386); Monte (1939, p. 71; 1941, p. 103; 1947, p. 14).
Distribution of species: Neotropical.
Number of species: 4.

Leptodicta. Error for *Leptodictya*.

***Leptodictya* Stål** (1873, pp. 121, 127).

Type species: *Monanthia ochropa* Stål (1858, p. 62).
Fixation: Oshanin (1912, p. 45), by subsequent designation.
Later citations: Van Duzee (1916, p. 26; 1917, p. 218); Drake (1931, p. 120); Drake and Poor (1936a, p. 387); Monte (1939, p. 71; 1941, p. 103; 1947, p. 15); Hurd (1946, p. 452).
Valid subgenera: *Leptodictya, Hanuala*. Drake (1931, p. 119) divided the genus *Leptodictya* into these two subgenera, resurrecting the genus name *Hanuala* Kirkaldy as a subgenus.
Variant spelling: *Leptodicta*, Van Duzee (1916, p. 26; 1917, p. 850).
Distribution of species: Neotropical (49), Nearctic (5).
Number of species: 52.

***Leptodictya* (*Leptodictya*) Stål** (1873, pp. 121, 127).

Type species: Cited under genus.
Distribution of species: Neotropical.
Number of species: 1.

***Leptodictya* (*Hanuala*) Kirkaldy** (1905, p. 217).

Type species: *Hanuala leinahoni* Kirkaldy (1905, p. 217).
Fixation: Kirkaldy (1905, p. 217), by monotypy.
Later citations: Drake and Poor (1936a, p. 386); Monte (1947, p. 13).
Note: Drake (1931, p. 119) resurrected genus *Hanuala* Kirkaldy from synonymy and made it a subgenus of *Leptodictya* Stål.
Distribution of species: Neotropical (48), Nearctic (5).
Number of species: 51.

***Leptopharsa* Stål** (1873, pp. 122, 126).

Type species: *Leptopharsa elegantula* Stål (1873, p. 126).
Fixation: Drake (1922a, p. 370), by subsequent designation.
Later citations: Drake (1928c, p. 21); Drake and Poor (1936a, p. 387); Monte (1939, p. 72; 1941, p. 108; 1947, p. 15); Hurd (1946, p. 465).
Synonyms: *Leptostyla, Gelchossa.*
Distribution of species: Neotropical (93), Nearctic (5), Australian (2), Ethiopian (2), Malagasy (1).
Number of species: 103.

Leptostyla Stål (1873, pp. 120, 125). Synonym of *Leptopharsa.*

Type species: *Tingis oblonga* Say (1825, p. 325).
Fixation: Drake (1922a, p. 372), by subsequent designation.
Later citations: Drake and Poor (1936a, p. 387); Monte (1947, p. 15).
Synonymy: See *Leptopharsa.* Synonymized by Drake (1928c, p. 21).
Note: As *Leptostyla* was preoccupied (Diptera), Kirkaldy (1904, p. 280) proposed the name *Gelchossa* to replace the hemipterous genus *Leptostyla* Stål.

Leptotingis Monte (1938, p. 128). Synonym of *Corythaica.*

Type species: *Leptotingis umbrosa* Monte (1938, p. 129).
Fixation: Monte (1938, p. 129), by monotypy and original designation.
Later citations: Monte (1939, p. 75; 1941, p. 121; 1947, p. 15); Hurd (1945, p. 80).
Synonymy: See *Corythaica.* Synonymized by Monte (1942; p. 104).

***Leptoypha* Stål** (1873, pp. 121, 129).

Type species: *Tingis mutica* Say (1859, p. 349).
Fixation: Stål (1873, p. 129), by monotypy.
Later citations: Van Duzee (1916, p. 26; 1917, p. 220); Drake and Poor (1936a, p. 387); Monte (1941, p. 121; 1947, p. 15); Hurd (1946, p. 456).

Synonym: *Birgitta.*
Distribution of species: Nearctic (8), Neotropical (4), Oriental (3), Australian (1), Palearctic (1).
Number of species: 16.

***Lepturga* Stål** (1873, pp. 119, 124).

Type species: *Lepturga nigritarsis* Stål (1873, p. 124).
Fixation: Stål (1873, p. 124), by monotypy.
Later citation: Monte (1947, p. 15).
Distribution of species: Australian (3), Oriental (1).
Number of species: 4.

***Liotingis* Drake** (1930, p. 270).

Type species: *Liotingis evidens* Drake (1930, p. 271). (Emendation.)
Fixation: Drake (1930, p. 270), by monotypy and original designation.
Later citations: Drake and Poor (1936a, p. 387); Monte (1939, p. 76; 1941, p. 122; 1947, p. 15).
Distribution of species: Neotropical.
Number of species: 4.

***Litadea* China** (1924, p. 438).

Type species: *Litadea delicatula* China (1924, p. 439, fig.).
Fixation: China (1924, p. 438), by monotypy and original designation.
Later citation: Monte (1947, p. 15).
Distribution of species: Malagasy.
Number of species: 1.

***Macrocorytha* Stål** (1873, p. 123). (New status.)

Type species: *Tingis rhomboptera* Fieber (1844, p. 103, fig.).
Fixation: Stål (1873, p. 123), by monotypy.
Later citation: Monte (1947, p. 15).
Note: Founded as a subgenus of *Corythucha,* raised herein to generic level.
Distribution of species: Oriental.
Number of species: 1.

***Macrotingis* Champion** (1897, p. 22).

Type species: *Macrotingis biseriata* Champion (1897, p. 22, fig.).
Fixation: Drake and Poor (1936a, p. 387), by subsequent designation.
Later citations: Monte (1941, p. 154; 1947, p. 15); Hurd (1946, p. 469).

Distribution of species: Neotropical.
Number of species: 3.

Maecenas Kirkaldy (1904, p. 280). Synonym of *Stephanitis*.

Type species: *Acanthia pyri* Fabricius (1775, p. 696).
Fixation: Present designation.
Synonymy: See *Stephanitis*. Synonymized by Horváth (1906a, p. 34).
Note: Kirkaldy (1904, p. 280) proposed *Maecenas* as a new name for *Tingis* Lethierry and Severin (not Fabricius). Since the type species for this polytypic genus has not been named, *Acanthia pyri* Fabricius is here so designated.

***Mafa* Hesse** (1925, p. 88). (New status.)

Type species: *Mafa lanceolata* Hesse (1925, p. 89, fig.).
Fixation: Hesse (1925, p. 89), by monotypy and original designation.
Later citation: Monte (1947, p. 5).
Note: Transferred herein to subfamily Tinginae from subfamily Agrammatinae.
Distribution of species: Ethiopian.
Number of species: 1.

***Malandiola* Horváth** (1925, p. 13).

Type species: *Malandiola simplex* Horváth (1925, p. 14, fig.).
Fixation: Horváth (1925, p. 14), by monotypy.
Later citation: Monte (1947, p. 16).
Distribution of species: Australian.
Number of species: 3.

***Mecopharsa* Drake** (1953b, p. 96).

Type species: *Mecopharsa hackeri* Drake (1953b, p. 97).
Fixation: Drake (1953b, p. 97), by monotypy and original designation.
Distribution of species: Australian.
Number of species: 1.

***Megalocysta* Champion** (1897, p. 5).

Type species: *Megalocysta pellucida* Champion (1897, p. 6, fig.).
Fixation: Champion (1897, p. 6), by monotypy.
Later citations: Drake and Poor (1936a, p. 387); Monte (1941, p. 123; 1947, p. 16); Hurd (1946, p. 474).
Distribution of species: Neotropical.
Number of species: 1.

Melanorhopala **Stål** (1873, p. 130).

Type species: *Tingis* (*Melanorhopala*) *clavata* Stål (1873, p. 130).
Fixation: Van Duzee (1916, p. 26), by subsequent designation.
Later citations: Van Duzee (1917, p. 220); Drake and Poor (1936a, p. 387); Monte (1941, p. 154; 1947, p. 16); Hurd (1946, p. 446).
Note: Founded as a subgenus of *Tingis;* raised to generic level by Horváth (1908, p. 564). Lethierry and Severin (1896, p. 18) wrongly treated *Melanorhopala* as a synonym of *Lasiacantha* Stål (pro parte).
Distribution of species: Nearctic.
Number of species: 3.

Menodora Horváth (1912b, p. 324). See ***Stephanitis*** **(*Menodora*).**

[*Metatropis* Breddin (1907, p. 94). Family Berytidae

Note: Zoological Record (1907, p. 380) listed *Metatropis* as the family Tingitidae. Breddin correctly described it as a *Berytidae.*]

Mokanna Distant (1910a, p. 111). Synonym of *Stephanitis.*

Type species: *Mokanna princeps* Distant (1910a, p. 112, fig.).
Fixation: Distant (1910a, p. 111), by monotypy and original designation.
Later citations: China (1943, p. 246); Monte (1947, p. 16).
Synonymy: See *Stephanitis.* Synonymized by Horváth (1912b, p. 319).

Monanthia Le Peletier and Serville (1828, p. 653). Synonym of *Copium.* (New synonymy.)

Type species: *Cimex clavicornis* Linnaeus (1758, p. 442).
Fixation: Westwood (1840, p. 121, synopsis), by subsequent designation. (See note below).
Later citation: China (1943, p. 248).
Invalid fixations: (1) *Monanthia echii* (Schrank) (1782, p. 276): Distant (1903c, p. 144) and Monte (1947, p. 16) wrongly spelled the author's name "Schranck." (2) *Monanthia rotundata* (Herrich-Schaeffer) (1835, p. 59)=*Tingis echii* Fabricius (1803, p. 126): Kirkaldy (1904, p. 281); Oshanin (1912, p. 45); Van Duzee (1916, p. 26; 1917, p. 223); Monte (1939, p. 388; 1941, p. 123); Drake and Poor (1936a, p. 388); Hurd (1946; p. 450). (3) *Monanthia humuli* (Fabricius) (1794, p. 77): China (1943, p. 248), in a discussion of possible type fixation, suggested that "*Cimex clavicornis* Linnaeus 1758= ? *Acanthia humuli* Fabricius

1794"; Horváth (1906c, p. 102) treated *clavicornis* Linnaeus as a synonym of *humuli* but was in doubt to the extent that priority of Linnaeus's species was disregarded.

Synonymy: See *Copium.*

Note: Opinion 71 of the International Commission on Zoological Nomenclature (1922, pp. 16–18) ruled "The species cited by Westwood, 1840 (An Introduction to the Modern Classification of Insects, vol. 2, Synopsis, separate pagination, pages 1 to 158), as 'typical species' are to be accepted as definite designations of genotypes for the respective genera." The genus *Dictyla,* for decades a synonym of *Monanthia,* is herein resurrected to hold almost all of the species now included in *Monanthia.* See the history and discussion of *Copium clavicornis* (Linnaeus), which revealed this synonymy with genus *Copium* (p. 46); list of species transferred to *Dictyla* (p. 51); and present generic position of *M. rotundata* (p. 97).

Monosteira **Costa** (1860, p. 7).

Type species: *Monanthia unicostata* Mulsant and Rey (1852, p. 134).
Fixation: Costa (1860, p. 7, fig.), by monotypy.
Later citations: Oshanin (1912, p. 46); Monte (1947, p. 16).
Variant spelling: *Monostira* (various authors).
Distribution of species: Palearctic (5), Ethiopian (1).
Number of species: 5.

Monostira. Error for *Monosteira.*

Mummius **Horváth** (1910, p. 65).

Type species: *Mummius bicorniger* Horváth (1910, p. 65).
Fixation: Horváth (1910, p. 65), by monotypy.
Later citation: Monte (1947, p. 16).
Distribution of species: Ethiopian.
Number of species: 2.

Myrmecotingis Hacker (1928, p. 182). Synonym of *Lasiacantha.*

Type species: *Myrmecotingis leai* Hacker (1928, p. 182, fig.).
Fixation: Hacker (1928, p. 182), by monotypy and original designation.
Later citation: Monte (1947, p. 16).
Synonymy: See *Lasiacantha.* Synonymized by Hacker (1929, p. 334).

Naochila **Drake** (1957d, p. 127).

Type species: *Cochlochila boxiana* Drake (1953a, p. 214).
Fixation: Drake (1957d, p. 128), by original designation.
Distribution of species: Ethiopian (5), Malagasy (2).
Number of species: 6.

Neopachycysta Hacker (1928, p. 183). Synonym of *Calotingis*.

Type species: *Neopachycysta subopaca* Hacker, (1928, p. 184, fig.).
Fixation: Hacker (1928, p. 183), by monotypy and original designation.
Later citations: Drake and Poor (1936a, p. 388); Monte (1947, p. 16).
Synonymy: See *Calotingis*. Synonymized by Hacker (1929, p. 334).

Neotingis **Drake** (1922a, p. 366).

Type species: *Neotingis hollandi* Drake (1922a, p. 367, fig.).
Fixation: Drake (1922a, p. 367), by monotypy and original designation.
Later citations: Drake and Poor (1936a, p. 388); Monte (1941, p. 126; 1947, p. 16).
Distribution of species: Neotropical.
Number of species: 1.

Nesocypselas **Kirkaldy** (1908b, p. 364).

Type species: *Nesocypselas dicysta* Kirkaldy (1908b, p. 365, fig.).
Fixation: Kirkaldy (1908b, p. 365), by monotypy.
Later citation: Monte (1947, p. 16).
Distribution of species: Oceanic.
Number of species: 6.

Nesocysta **Kirkaldy** (1908b, p. 365).

Type species: *Nesocysta rugata* Kirkaldy (1908b, p. 366).
Fixation: Kirkaldy (1908b, p. 366), by monotypy.
Later citation: Monte (1947, p. 17).
Distribution of species: Oceanic.
Number of species: 1.

Nesotingis **Drake** (1957c, p. 402).

Type species: *Nesotingis pauliani* Drake (1957c, p. 403).
Fixation: Drake (1957c, p. 403), by original designation.
Distribution of species: Malagasy.
Number of species: 2.

***Nethersia* Horváth** (1925, p. 14). New status.

Type species: *Nethersia maculosa* Horváth (1925, p. 15, fig.).
Fixation: Horváth (1925, p. 15), by monotypy.
Later citation: Monte (1947, p. 5).
Note: Transferred herein from subfamily Agramminae.
Distribution of species: Australian.
Number of species: 7.

***Nobarnus* Distant** (1920, p. 156).

Type species: *Nobarnus typicus* Distant (1920, p. 157).
Fixation: Distant (1920, p. 157), by monotypy.
Later citation: Monte (1947, p. 17).
Note: Monte (1947, p. 17) listed genotype as "*N. tipycus.*"
Distribution of species: Australian (1), New Zealandian (2).
Number of species: 3.

***Norba* Horváth** (1912b, p. 334). See ***Stephanitis* (*Norba*).**

***Nyctotingis* Drake** (1922a, p. 362).

Type species: *Nyctotingis osborni* Drake (1922a, p. 363, fig.).
Fixation: Drake (1922a, p. 363), by monotypy and original designation.
Later citations: Drake and Poor (1936a, p. 388); Monte (1941, p. 126; 1947, p. 17).
Distribution of species: Neotropical.
Number of species: 2.

***Octacysta*, new genus** (Plates 6, 7).

Type species: *Tingis rotundata* Herrich-Schaeffer (1835, p. 59).
Fixation: Present designation.
Note: This genus is erected to hold *rotundata* (Herrich-Schaeffer), which for many years has been placed as a member of *Monanthia*. Suppressing *Monanthia* as a synonym of *Copium* and resurrecting *Dictyla* from synonymy (with *M. platyoma* as the type species) make it necessary to erect this new genus to hold *rotundata* (Herrich-Schaeffer). *Octacysta*, new genus, is separated from *Dictyla* by the eight inflated cysts (hood, each paranotum, hind process of pronontum, and two processes on discal part of each elytron).
Description: Head short, very little produced in front of eyes, unarmed or provided with two to five spines; bucculae broad, areolate, with ends meeting in front, not produced beyond apex of clypeus. Labium moderately long; laminae wide, areolate,

not meeting behind. Orifice of metathoracic scent glands indistinct. Antennae slender, moderately long, segments I and II short, III very long, IV moderately long. Pronotum tricarinate, lateral carinae short; hood rather small, inflated, not projecting anteriorly as far as eyes; paranota large, strongly reflexed, conchate, inflated; posterior process inflated. Elytra divided into usual areas, with two tumid elevations in each elytron, one at middle of and one at apex of boundary separating discoidal and sutural areas; discoidal area extending slightly beyond middle of elytra in macropterous form, much further beyond in brachyptery. Metathoracic wings well developed in macropterous form, much reduced or absent in brachyptery. Hypocostal laminae long, uniseriate. Legs slender, moderately long. Specimens illustrated are from Europe.)

Distribution of species: Palearctic.
Number of species: 1.

***Oedotingis* Drake** (1942b, p. 19).

Type species: *Australotingis williamsi* Drake (1928a, p. 51).
Fixation: Drake (1942b, p. 20), by monotypy and original designation.
Later citation: Monte (1947, p. 17).
Distribution of species: Neotropical.
Number of species: 2.

***Ogygotingis* Drake** (1948d, p. 149).

Type species: *Teleonemia insularis* China (1924, p. 436, fig.).
Fixation: Drake (1948d, p. 149), by monotypy and original designation.
Distribution of species: Malagasy.
Number of species: 1.

***Olastrida* Schouteden** (1956, p. 205).

Type species: *Olastrida oleae* Schouteden (1956, p. 205).
Fixation: Schouteden (1956, p. 205), by monotypy.
Distribution of species: Ethiopian.
Number of species: 1.

***Omoplax* Horváth** (1912b, p. 336), See ***Stephanitis* (*Omoplax*).**

***Oncochila* Stål** (1873, p. 121).

Type species: *Monanthia* (*Physatocheila*) *scapularis* Fieber (1844, p. 80, fig.).
Fixation: Stål (1873, p. 121), by monotypy.

Later citations: Oshanin (1912, p. 45); China (1943, p. 248); Monte 1947, p. 17).

Note: Monte (1947, p. 17) erroneously synonymized *Oncochila* with *Physatocheila,* and in the same paragraph also wrongly made *Oncochila* a subgenus of *Physatocheila.*

Distribution of species: Palearctic.

Number of species: 2.

***Oncophysa* Stål** (1873, pp. 121, 129).

Type species: *Monanthia vesiculata* Stål (1859, p. 259).

Fixation: Stål (1873, p. 129), by monotypy.

Distribution of species: Australian.

Number of species: 3.

***Onymochila* Drake** (1948d, p. 152).

Type species: *Cysteochila dichopetali* Horváth (1929, p. 324).

Fixation: Drake (1948d, p. 152), by monotypy and original designation.

Distribution of species: Ethiopian.

Number of species: 1.

[*Opisthochasis* Berg (1884, p. 83). Family *Miridae.*

Note: Berg wrongly founded *Opisthochasis* as a genus of Tingidae. Drake and Poor (1938, p. 103) properly referred it to the family Miridae.]

***Orotingis* Drake and Poor** (1941, p. 161).

Type species: *Orotingis muiri* Drake and Poor (1941, p. 161).

Fixation: Drake and Poor (1941, p. 161), by monotypy and original designation.

Later citation: Monte (1947, p. 17).

Distribution of species: Oriental.

Number of species: 1.

Orthosteira Fieber (1844, p. 46). Synonym of *Acalypta.*

Type species: *Tingis carinata* Panzer (1806, Heft 99, Tab. 20) = *Tingis cassidea* Fallén (1807, p. 37) = *Tingis cervina* Germar (1836, Fasc. 18, Tab. 22).

Fixation: China (1941, p. 130), by subsequent designation.

Later citation: China (1943, p. 245).

Erroneous citations: Drake and Poor (1936a, p. 388); Monte (1947, p. 17).

Synonymy: See *Acalypta.* Synonymized by Horváth (1906c, p. 24).

Variant spelling: *Orthostira* Fieber (1861, p. 130).
Note: Drake and Poor (1936a, p. 388) and also Monte (1947, p. 17) designated *O. cassida* (Fallén) as the type species and then erroneously treated *cassida* as a synonym of *O. musci* (Schrank).

Orthostira. Variant spelling for *Orthosteira.*

***Pachycysta* Champion** (1898b, p. 59).

Type species: *Pachycysta diaphana* Champion (1898b, p. 59, fig.).
Fixation: Champion (1898b, p. 59), by monotypy.
Later citations: Drake and Poor (1936a, p. 388); Monte (1941, p. 126; 1947, p. 17); Hurd (1946, p. 474).
Distribution of species: Neotropical.
Number of species: 4.

***Palauella* Drake** (1956b, p. 110).

Type species: *Palauella gressitti* Drake (1956b, p. 112, fig.).
Fixation: Drake (1956b, p. 111), by monotypy and original designation.
Distribution of species: Oceanic.
Number of species: 1.

***Paracopium* Distant** (1902b, p. 354).

Type species: *Dictyonota cingalensis* Walker (1873, p. 178).
Fixation: Distant (1902b, p. 354), by monotypy.
Later citation: Monte (1947, p. 17).
Distribution of species: Ethiopian (18), Malagasy (8), Oriental (5), Australian (4), Oceanic (1), Palearctic (1), New Zealandian (1).
Number of species: 37.

***Parada* Horváth** (1925, p. 3).

Type species: *Cysteochila* (*Parada*) *taeniophora* Horváth (1925, p. 2, fig.).
Fixation: Horváth (1925, p. 2), by original designation.
Later citations: Monte (1947, p. 18); Drake (1952, p. 143).
Note: Created as a subgenus of *Cysteochila;* raised to generic rank by Drake (1942b, p. 4).
Distribution of species: Australian.
Number of species: 6.

***Paseala* Schouteden** (1923, p. 93).

Type species: *Paseala arnoldi* Schouteden (1923, p. 94).
Fixation: Schouteden (1923, p. 94), by monotypy.
Later citation: Monte (1947, p. 18).

Distribution of species: Ethiopian.
Number of species: 1.

Penottus **Distant** (1903b, p. 254).

Type species: *Penottus jalorensis* Distant (1903b, p. 254, fig.) = *Monanthia monticollis* Walker (1873, p. 196).
Fixation: Distant (1903b, p. 254), by monotypy (as *jalorensis* Distant, 1903b, p. 254 = *Monanthia monticollis* Walker, 1873, p. 193).
Later citation: Monte (1947, p. 18) (as *jalorensis*).
Synonym: *Cetiocysta*. (New synonymy.)
Note: Distant (1902b, p. 356) stated that the single specimen of *Monanthia monticollis* Walker was in very bad condition and that it somewhat resembled a species of *Diconicoris*. A study of this specimen (pl. 8, herein) shows that the hemelytron is identical with *P. jalorensis* Distant (1903b, p. 254) and by priority *monticollis* must replace *jalorensis* as the correct name for the type species, *Penottus monticollis* (new combination).
Distribution of species: Oriental.
Number of species: 6.

Perbrinckea **Drake** (1956a, p. 427).

Type species: *Perbrinckea brincki* Drake (1956a, p. 427, fig.).
Fixation: Drake (1956a, p. 427), by monotypy and original designation.
Distribution of species: Ethiopian.
Number of species: 1.

Perissonemia **Drake and Poor** (1937b, p. 2).

Type species: *Perissonemia torquata* Drake and Poor (1937b, p. 2, fig.).
Fixation: Drake and Poor (1937b, p. 2), by original designation.
Later citation: Monte (1947, p. 18).
Distribution of species: Oriental (9), Ethiopian (4), Australian (1).
Number of species: 14.

Phaeochila **Drake and Hambleton** (1945, p. 358).

Type species: *Amblystira hirta* Monte (1940b, p. 284, fig.).
Fixation: Drake and Hambleton (1945, p. 358), by monotypy and original designation.
Later citation: Monte (1947, p. 18).
Distribution of species: Neotropical.
Number of species: 1.

***Phaenotropis* Horváth** (1906c, p. 106).

Type species: *Monanthia* (*Monosteira*) *parvula* Signoret (1865, p. 117).

Fixation: Oshanin (1912, p. 46), by subsequent designation.

Later citation: Monte (1947, p. 18).

Note: Erected as a subgenus of *Monosteira;* raised to generic level by Drake (1957a, 415).

Distribution of species: Palearctic (2), Ethiopian (1).

Number of species: 2.

Phyllochisme Kirkaldy (1904, p. 280). Synonym of *Physatocheila.*

Type species: *Acanthia costata* Fabricius (1794, p. 77).

Fixation: Present designation.

Synonymy: See *Physatocheila.* Synonymized by Horváth (1906c, p. 94).

Note: Kirkaldy proposed *Phyllochisme* as a new name for *Physatochila* of Lethierry and Severin (1896, p. 21) (not Fieber).

Phyllontocheila Fieber (1844, p. 59). Synonym of *Tingis* (in part).

Type species: *Monanthia ampliata* Herrich Schaeffer (1839, p. 62).

Fixation: Distant (1903c, p. 135), by subsequent designation. Distant wrongly credited *ampliata* to Fieber instead of Herrich-Schaeffer.

Later citations: China (1943, p. 247) correctly credited Herrich-Schaeffer; Monte (1947, p. 18) erroneously gave credit of authorship of *ampliata* to Fieber.

Synonymy: See *Tingis* (in part); *Ammianus* (in part).

Variant spellings: *Phyllontochila* (Stål, 1873, pp. 120, 128 and others); *Phyllotocheila* (Monte, 1947, p. 19).

Note: Fieber erected *Phyllontocheila* as a subgenus of *Monanthia*; Stål (1873, pp. 120, 128) raised it to generic status. Synonymized with *Tingis* by Oshanin (1912, p. 44) and by China (1943, p. 247), and with *Ammianus* "as delimited by Horváth and Bergroth" (not Distant, 1903c, p. 135) by Drake (1955c, p. 5). Many species have been described and wrongly placed in the genus *Phyllontocheila* (or *Phyllontochila*) and these species have been recently transferred to the genus *Ammianus.*

Phyllontochila. Variant spelling for *Phyllontocheila.*

[*Phyllotingis* Walker (1873, p. 3). Family Aradidae.

Note: Walker erroneously erected *Phyllotingis* as a genus of Tingidae. Champion (1898, p. 68) correctly transferred it to the family Aradidae.]

Phyllotocheila. Error for *Phyllontocheila.*

Phymacysta **Monte** (1942, p. 106).

Type species: *Leptostyla tumida* Champion (1897, p. 14, fig.).
Fixation: Monte (1942, p. 107, figure of type species), by monotypy and original designation.
Later citations: Monte (1947, p. 18); Hurd (1946, p. 476).
Distribution of species: Neotropical.
Number of species: 7.

Physatocheila **Fieber** (1844, p. 80).

Type species: *Acanthia quadrimaculata* Wolff (1804, p. 133) = *Acanthia costata* Fabricius (1794, p. 77).
Fixation: Oshanin (1912, p. 45), by subsequent designation (as *quadrimaculata* (Wolff) = *costata* (Fabricius)).
Later citations: Van Duzee (1916, p. 26; 1917, p. 219); Drake and Poor (1936a, p. 388); Monte (1941, p. 154; 1947, p. 18); China (1943, p. 247); Hurd (1946, p. 451). (All as *quadrimaculata.*)
Synonym: *Phyllochisme.*
Variant spellings: *Physatochila* (Fieber 1861, p. 433); *Physatochilae* (Fieber 1861, p. 120).
Note: An examination of the type of *Acanthia costata* Fabricius (1794, p. 77) from "Europa boreali" shows (pl. 9, herein) that it is inseparable from *Acanthia quadrimaculata* Wolff (1804, p. 132, fig.). As the former name has priority by 10 years, *costata* is the valid name of the species, and thus is the type species of *Physatocheila.* New synonymy and new combination.)
Distribution of species: Oriental (12), Palearctic (10), Ethiopian (8), Australian (5), Nearctic (5).
Number of species: 39.

Physatochila. Variant spelling for *Physatocheila.*

Physatochila of Lethierry and Severin (1896, p. 21). See *Phyllochisme.*

Physatochilae. Variant spelling for *Physatocheila.*

Physodictyon Lindberg (1927, p. 16). Synonym of *Cochlochila.*

Type species: *Physodictyon vesicarius* Lindberg (1927, p. 17, fig.).
Fixation: Lindberg (1927, p. 17), by monotypy and original designation.
Later citation: Monte (1947, p. 18).
Synonymy: See *Cochlochila.* Synonymized by Drake (1948c, p. 179).

***Planibyrsa* Drake and Poor** (1937a, p. 164).

Type species: *Leptobyrsa splendida* Drake (1922a, p. 374, fig.).
Fixation: Drake and Poor (1937a, p. 164), by original designation.
Later citations: Monte (1939, p. 77; 1941, p. 127; 1947, p. 18).
Note: Type species misspelled in original generic description as "*spendida*."
Distribution of species: Neotropical.
Number of species: 4.

Platychila Puton (1879, p. 107). Synonym of *Tingis*.

Type species: *Cimex cardui* Linnaeus (1758, p. 443).
Fixation: China (1943, p. 247), by subsequent designation.
Erroneous citation: Monte (1947, p. 19).
Synonymy: See *Tingis*. Synonymized by Horváth (1906c, p.71).
Note: Fieber (1861, p. 119) used *Platychilae* (plural form) apparently to replace the subgenus *Phyllontocheila* Fieber (1844, p. 59) (nomen nudum; sine species). Puton (1879, pp. 106–111) validated *Platychila* (singular, correct form) as a subgenus of *Monanthia* by use of key characters and the inclusion of 11 species, and thus became the author of the subgenus instead of Fieber. Horváth (1906c, p. 71) suppressed *Platychila* as a synonym of subgenus *Tingis* of genus *Tingis*. See China (1943, p. 247) for history and type designation. Lethierry and Severin (1896, p. 18) treated *Platychila* as a synonym of *Lasiacanthia* (pro parte). Monte (1947, p. 19) erroneously designated *Platychila ampliata* Fieber (=*Phyllotochila ampliata* Fieber) (sic) as the type species.

Platychilae Fieber (1861, p. 119, nomen nudum). See *Platychila*.

Note: Erected as nomen nudum, plural form, sine species. Discussed under *Platychila*.

***Platytingis* Drake** (1925a, p. 107).

Type species: *Platytingis pediades* Drake (1925a, p. 108, fig.).
Fixation: Drake (1925a, p. 108), by monotypy and original designation.
Later citation: Monte (1947, p. 19).
Distribution of species: Ethiopian (1), Malagasy (1).
Number of species: 1.

***Plerochila* Drake** (1954b, p. 69).

Type species: *Teleonemia australis* Distant (1904, p. 432, fig.).
Fixation: Drake (1954b, p. 69), by original designation.
Distribution of species: Ethiopian (4), Malagasy (1).
Number of species: 4.

***Pleseobyrsa* Drake and Poor** (1937a, p. 165).

Type species: *Pleseobyrsa boliviana* Drake and Poor (1937a, p. 165).
Fixation: Drake and Poor (1937a, p. 165), by original designation.
Later citations: Monte (1939, p. 77; 1941, p. 128; 1947, p. 19); Hurd (1946, p. 470).
Distribution of species: Neotropical.
Number of species: 10.

***Pliobyrsa* Drake and Hambleton** (1946a, p. 123).

Type species: *Leptopharsa inflexa* Drake and Hambleton (1938b, p. 54, fig.).
Fixation: Drake and Hambleton (1946a, p. 123), by original designation.
Later citation: Monte (1947, p. 19).
Note: Drake and Hambleton (1946a, p. 123) wrongly spelled the specific name as *inflata* instead of *inflexa*.
Distribution of species: Neotropical.
Number of species: 6.

***Pogonostyla* Drake** (1953a, p. 221).

Type species: *Pogonostyla intonsa* Drake (1953a, p. 222).
Fixation: Drake (1953a, p. 222), by original designation.
Distribution of species: Ethiopian (4), Malagasy (2).
Number of species: 6.

***Pontanus* Distant** (1902b, p. 354).

Type species: *Monanthia gibbiferus* Walker (1873, p. 197).
Fixation: Distant (1902b, p. 354), by monotypy.
Later citation: Monte (1947, p. 19).
Synonym: *Teratochila*.
Distribution of species: Australian (2), Oriental (1), Ethiopian (1).
Number of species: 4.

Prionostirina Schumacher (1913, p. 457). Synonym of *Urentius*.

Type species: *Prionostirina nana* Schumacher (1913, p. 458).
Fixation: Schumacher (1913, p. 458), by monotypy.
Later citation: Monte (1947, p. 19).
Synonymy: See *Urentius*. Synonymized by Bergroth (1914, p. 183).

***Pseudacysta* Blatchley** (1926, p. 497).

Type species: *Acysta perseae* Heidemann (1908, p. 103, fig.).
Fixation: Blatchley (1926, p. 497), by monotypy and original designation, refigured Heidemann's figure.

Later citations: Drake and Poor (1936a, p. 389); Monte (1941, p. 155; 1947, p. 19); Hurd (1946, p. 459).
Distribution of species: Nearctic.
Number of species: 1.

***Psilobyrsa* Drake and Hambleton** (1935, p. 148).

Type species: *Psilobyrsa aechemeae* Drake and Hambleton (1935, p. 149).
Fixation: Drake and Hambleton (1935, p. 149), by original designation.
Later citations: Monte (1941, p. 129; 1947, p. 19).
Variant spelling: *Psylobyrsa* Monte, 1941, p. 129.
Distribution of species: Neotropical.
Number of species: 2.

Psylobyrsa. Error for *Psilobyrsa.*

***Radinacantha* Hacker** (1929, p. 330).

Type species: *Radinacantha reticulata* Hacker (1929, p. 330, fig.).
Fixation: Hacker (1929, p. 330), by original designation.
Later citation: Monte (1947, p. 19).
Distribution of species: Australian (2), Malagasy (1).
Number of species: 3.

***Renaudea* Drake** (1958b, p. 332).

Type species: *Renaudea pauliani* Drake (1958b, p. 333, fig.).
Fixation: Drake (1958, p. 333), by monotypy and original designation.
Distribution of species: Malagasy.
Number of species: 1.

Sakuntala Kirkaldy (1902, p. 298). Synonym of *Ammianus.*

Type species: *Sakuntala ravana* Kirkaldy (1902, p. 299).
Fixation: Kirkaldy (1902, p. 298), by monotypy and original designation.
Later citation: Monte (1947, p. 19).
Synonymy. See *Ammianus.* Synonymized by Horváth (1910, p. 62).
Note: Bergroth (1911, p. 186 pointed out that *Sakuntala* was preoccupied by Coleoptera and that *Belenus* must be maintained. See Drake 1957b, pp. 31–32.

Sanazarius **Distant** (1904, p. 431).

Type species: *Sanazarius cuneatus* Distant (1904, p. 431, fig.).
Fixation: Distant (1904, p. 431), by monotypy.
Later citations: Distant (1911a, p. 43); Monte (1947, p. 20).
Distribution of species: Ethiopian.
Number of species: 3.

Sankisia Schouteden (1916, p. 263). Synonym of *Dulinius*.

Type species: *Sankisia pulchra* Schouteden (1916, p. 294).
Fixation: Schouteden (1916, p. 293), by monotypy and original designation.
Later citation: Monte (1947, p. 20).
Synonymy: See *Dulinius*. Synonymized by Drake (1953b, p. 95).

Scraulia Stål (1874, p. 50). Synonym of *Dictyonota*.

Type species: *Dictyonota strichnocera* Fieber (1844, p. 95, fig.).
Fixation: Kirkaldy (1900, p. 241), by susequent designation.
Synonymy: See *Dictyonota*. Synonymized with genus *Dictyonota* by Kirkaldy (1900, p. 241) (type species, *D. eryngii* Curtis (not Latreille)=*strichnocera* Fieber) and later delimited to subgenus *Dictyonota* by Horváth (1906c, p. 39).

Sinuessa **Horváth** (1910, p. 63).

Type species: *Phyllontocheila* (*Sinuessa*) *subinermis* Horváth (1910, p. 64).
Fixation: Horváth (1911b, p. 332), by subsequent designation.
Erroneous citations: Monte (1947, p. 20) cited "*Phyllontocheila* (*Sinuessa*) *alaticollis* (Stål) (=*Monanthia* (*Phyllonotocheila*) *alaticollis* Stål)" as genotype. [*P. alaticollis* (Stål) belongs to the genus *Ammianus*]. Drake (1957b, p. 32) wrongly stated that Horváth (1910, p. 63) designated *P. waelbroecki* Schouteden as the type species.
Note: Founded as a subgenus of *Phyllontocheila* and raised to generic level by Drake (1957b, p. 32).
Distribution of species: Ethiopian.
Number of species: 4.

Sphaerista **Kiritshenko** (1951, pp. 240, 245).

Type species: *Orthostira paradoxa* Jakovlev (1880, p. 128).
Fixation: Kiritschenko (1951, p. 245, fig.), by monotypy.
Distribution of species: Palearctic.
Number of species: 1.

Sphaerocysta **Stål** (1873, pp. 120, 128).

Type species: *Tingis ? globifera* Stål (1858, p. 65).
Fixation: Drake (1928a, p. 42), by subsequent designation.
Later citations: Drake and Poor (1936a, p. 389); Monte (1939, p. 78; 1941, p. 129; 1947, p. 20).
Distribution of species: Neotropical.
Number of species: 13.

Stenocysta **Champion** (1897, p. 28).

Type species: *Stenocysta pilosa* Champion (1897, p. 29, fig.).
Fixation: Champion (1897, p. 29), by monotypy.
Later citations: Drake and Poor (1936a, p. 389); Monte (1939, p. 78; 1941, p. 132; 1947, p. 20); Hurd (1946, p. 473).
Distribution of species: Neotropical.
Number of species: 1.

Stephanitis **Stål** (1873, pp. 119, 123).

Type species: *Acanthia pyri* Fabricius (1775, p. 696).
Fixation: Oshanin (1912, p. 130), by subsequent designation.
Later citations: Van Duzee (1916, p. 25; 1917, p. 216); Drake and Poor (1936a, p. 389); China (1943, p. 246); Monte (1939, p. 78; 1941, p. 132; 1947, p. 21); Hurd (1946, p. 481).
Valid subgenera: *Menodora*, *Norba*, *Omoplax* and *Stephanitis*. Horváth (1912b, pp. 219–312, figs.) divided the genus into these four subgenera.
Synonyms: *Cadamustus*, *Calliphanes*, *Maecenas*, *Mokanna*, *Tingis* of Laporte (not Fabricius), *Tingis* of Lethierry and Severin (not Fabricius).
Note: Fabricius (1803, p. 126) transferred *A. pyri* to genus *Tingis*. Some authors wrongly cite *Stephanitis pyri*=*Tingis pyri* instead of "=*Acanthia pyri*." See Horváth (1912b, pp. 218–312, figs.) for descriptions and keys to subgenera and species.
Distribution of species: Oriental (42), Neotropical (8), Palearctic (6), Ethiopian (1, introduced), Nearctic (4, three introduced), Papuan (4), Australian (2, one introduced).
Number of species: 59.

Stephanitis (Stephanitis) **Stål** (1873, pp. 119, 123).

Type species: Cited under genus.
Distribution of species: Oriental (28), Neotropical (8), Palearctic (6), Nearctic (4, three introduced), Papuan (2), Australian (1), Ethiopian (1).
Number of species: 43.

***Stephanitis* (*Menodora*) Horváth** (1912b, p. 324).

Type species: *Stephanitis* (*Menodora*) *formosa* Horváth (1912b, p. 324, fig.).
Fixation: Horváth (1912b, p. 324), by monotypy.
Distribution of species: Oriental.
Number of species: 2.

***Stephanitis* (*Norba*) Horváth** (1912b, p. 334).

Type species: *Stephanitis* (*Norba*) *mendica* Horváth (1912b, p. 334).
Fixation: Drake and Poor (1936a, p. 389), by subsequent designation.
Later citation: Monte (1947, p. 17).
Distribution of species: Oriental (11), Papuan (2).
Number of species: 13.

***Stephanitis* (*Omoplax*) Horváth** (1912b, p. 336).

Type species: *Stephanitis* (*Omoplax*) *desecta* Horváth (1912b, p. 337, fig.).
Fixation: Horváth (1912b, p. 336), by monotypy.
Distribution of species: Oriental.
Number of species: 1.

Stephanitis Champion (not Stål) (1898b, p. 58). See *Calliphanes*.

***Stymnonotus* Reuter** (1887, p. 103).

Type species: *Stymnonotus apicalis* Reuter (1887, p. 104).
Fixation: Reuter (1887, p. 104), by monotypy.
Later citation: Monte (1947, p. 20).
Distribution of species: Malagasy.
Number of species: 1.

***Tanybyrsa* Drake** (1942b, p. 21).

Type species: *Compseuta secunda* Hacker (1927, p. 27, fig.)
Fixation: Drake (1942b, p. 21), by original designation.
Later citation: Monte (1947, p. 20).
Distribution of species: Australian.
Number of species: 2.

***Tanytingis* Drake** (1939, p. 205).

Type species: *Tanytingis takahashii* Drake (1939, p. 206).
Fixation: Drake (1939, p. 205), by monotypy and original designation.
Later citation: Monte (1947, p. 20).

Distribution of species: Oriental.
Number of species: 2.

***Teleonemia* Costa** (1864, p. 144).

Type species: *Teleonemia funerea* Costa (1864, p. 145, fig.).
Fixation: Costa (1864, p. 144), by monotypy.
Later citations: Distant (1903c, p. 143); Van Duzee (1916, p. 26; 1917, p. 221); Drake and Poor (1936a, p. 389); Monte (1941, p. 133; 1947, p. 20); Hurd (1946, p. 447).
Synonyms: *Amaurosterphus*, *Americia*.
Distribution of species: Neotropical (75), Nearctic (13); introduced into Oriental (1), Oceanic (1), Australian (1).
Number of species: 83.

Teratochila Drake and Poor (1936b, p. 147). Synonym of *Pontanus*.

Type species: *Teratochila puerilis* Drake and Poor (1936b, p. 147).
Fixation: Drake and Poor (1936b, p. 147), by monotypy and original designation.
Later citation: Monte (1947, p. 20).
Synonymy: See *Pontanus*. Synonymized by Drake (1956a, p. 425).

***Tigava* Stål** (1858, p. 63).

Type species: *Tigava praecellens* Stål (1858, p. 63).
Fixation: Stål (1858, p. 63), by monotypy.
Later citations: Drake and Poor (1936a, p. 389); Monte (1939, p. 80; 1941, p. 143; 1947, p. 21); Hurd (1946, p. 449).
Distribution of species: Neotropical.
Number of species: 15.

***Tigavaria* Drake** (1945, p. 99).

Type species: *Tigava unicarinata* Hacker (1929, p. 325, fig.).
Fixation: Drake (1945, p. 99), by monotypy and original designation.
Later citation: Monte (1947, p. 21).
Distribution of species: Australian.
Number of species: 1.

[*Tingiopsis* Bekker-Migdisova (1953, p. 461, fig.). Family Cercopidae.

Note: Bekker-Migdisova wrongly founded *Tingiopsis* as a genus of Tingidae. The fossil species *Tingiopsis reticulata* is represented only by a forewing. Evans (1957, p. 289, fig. 6e) is of the opinion that the wing is probably that of a homopteron and quite possibly that of a cercopid.]

***Tingis* Fabricius** (1803, p. 124).

Type species: *Cimex cardui* Linnaeus (1758, p. 443). (See plate 3, herein.)

Fixation: Latrielle (1810, p. 433), substantiated by International Commission on Zoological Nomenclature, Direction 4, 1954.

Previous selections: Oshanin (1912, p. 44); Drake and Poor (1936a, p. 390); Monte (1939, p. 81; 1941, p. 146; 1947, p. 21); China (1943, p. 247); Hurd (1946, p. 463).

Valid subgenera: *Caenotingis, Lasiotropis, Tingis, Tropidocheila.* Stål (1873, p. 130) divided the genus *Tingis* into four subgenera—*Tingis, Lasiacantha, Melanorhopala* and *Americia*—but only the subgenus *Tingis* remains in this genus today.

Synonyms: *Phyllontocheila* (in part), *Platychila.*

Distribution of species: Palearctic (51), Oriental (14), Neotropical (13), Australian (13), Ethiopian (4), Nearctic (1), Fossil (6).

Number of species: 102.

***Tingis* (*Tingis*) Fabricius** (1803, p. 124).

Type species: Cited under genus.

Distribution of species: Palearctic (24), Oriental (11), Australian (9), Neotropical (7), Ethiopian (1), Nearctic (1).

Number of species: 53.

***Tingis* (*Caenotingis*) Drake** (1928b, p. 283).

Type species. *Tingis* (*Caenotingis*) *beesoni* Drake (1928b, p. 283).

Fixation: Drake (1928b, p. 283), by monotypy and original designation.

Distribution of species: Oriental.

Number of species: 1.

***Tingis* (*Lasiotropis*) Stål** (1874, p. 55).

Type species: *Monanthia* (*Platychila*) *trichonota* Puton (1874a, p. 216).

Fixation: Oshanin (1912, p. 44), by subsequent designation.

Later citation: China (1943, p. 247).

Erroneous citation: Monte (1947, p. 14).

Note: Horváth (1906c, pp. 61, 69) made *Lasiotropis* a subgenus of *Tingis.* Monte (1947, p. 14) wrongly treated *Lasiotropis* as a valid genus, not a subgenus of *Tingis,* and then also wrongly cited the type species as "*Tingis grisea* Germar."

Distribution of species: Palearctic (7), Neotropical (2), Oriental (1).

Number of species: 10.

***Tingis* (*Tropidocheila*) Fieber** (1844, p. 72).

Type species: *Monanthia stachydis* Fieber (1844, p. 73, fig.)= *Monanthia maculata* Herrich-Schaeffer (1839, p. 56, fig.).

Fixation: Oshanin (1912, p. 44), by subsequent designation.

Invalid fixation: Monte (1947, p. 21).

Variant spellings: *Tropidochila* (many authors); *Tropidochilae* (Fieber, 1861, p. 120).

Note: Founded as a subgenus of *Monanthia*. Horváth (1906c, pp. 79, 84) transferred subgenus *Tropidocheila* to genus *Tingis* and synonymized *Monanthia stachydis* Fieber with *Tingis maculata* (Herrich-Schaeffer). Fieber (1861, p. 130) transferred *M. maculata* to genus *Tingis*. Oshanin (1912, p. 44) designated *maculata* as the type species of subgenus *Tropidocheila*. As *M. stachydis* Fieber was one of the originally included species of *Tropidocheila* and a synonym of *maculata*, the fixation by Oshanin is valid. Monte (1947, p. 21) incorrectly designated "*Monanthia* (*Tropidocheila*) *costata* (Fabr.) (=*Acanthia costata* Fabr.)" as the type species. It should be noted that *costata* was wrongly determined by Fieber (1844, p. 74) and that the technical name is *Catoplatus fabricii* (Stål). Fieber included an excellent figure of this species.

Distribution of species: Palearctic (20), Neotropical (4), Australian (4), Ethiopian (3), Oriental (1).

Number of species: 32.

Tingis of Laporte (1833, p. 48) (not Fabricius). Synonym of *Stephanitis*.

Tingis of Lethierry and Severin (1896, p. 12) (not Fabricius). See *Maecenas*.

***Trachypeplus* Horváth** (1926, p. 329).

Type species: *Trachypeplus jacobsoni* Horváth (1926, p. 330, fig.).

Fixation: Horváth (1926, p. 330), by monotypy.

Later citation: Monte (1947, p. 21).

Distribution of species: Oriental (4), Papuan (1).

Number of species: 5.

***Tropidocheila* Fieber** (1844, p. 72). See ***Tingis* (*Tropidocheila*)**.

Tropidochila. Variant spelling for *Tropidocheila*.

Tropidochilae. Variant spelling for *Tropidocheila*.

Typonotus Uhler (1893, p. 716). Synonym of *Corythaica.*

Type species: *Typonotus planaris* Uhler (1893, p. 716).
Fixation: Uhler (1893, p. 716), by monotypy.
Later citations: Monte (1941, p. 86; 1947, p. 21); Hurd (1945, p. 80).
Synonymy: See *Corythaica.* Synonymized by Champion (1897, p. 9).

***Uhlerites* Drake** (1927a, p. 56).

Type species: *Phyllontocheila debile* Uhler (1896, p. 265).
Fixation: Drake (1927a, p. 56), by monotypy and original designation.
Later citation: Monte (1947, p. 21).
Distribution of species: Oriental.
Number of species: 2.

***Ulocysta* Drake and Hambleton** (1945, p. 364).

Type species: *Ulocysta praetabilis* Drake and Hambleton (1945, p. 365).
Fixation: Drake and Hambleton (1945, p. 364), by monotypy and original designation.
Later citation: Monte (1947, p. 21).
Distribution of species: Neotropical.
Number of species: 1.

***Ulonemia* Drake and Poor** (1937b, p. 3).

Type species: *Perissonemia (Ulonemia) dignata* Drake and Poor (1937b, p. 3).
Fixation: Drake and Poor (1937b, p. 3), by original designation.
Later citation: Monte (1947, p. 21).
Note: Created as a subgenus by Drake and Poor (1937b, p. 3); raised to generic level by Drake (1942, p. 359).
Distribution of species: Australian (5), Oriental (4), Oceanic (1).
Number of species: 9.

***Ulotingis* Drake and Hambleton** (1935, p. 144).

Type species: *Acysta brasiliensis* Drake (1922b, p. 42).
Fixation: Drake and Hambleton (1935, p. 145), by original designation.
Later citations: Monte (1939, p. 82; 1941, p. 148; 1947, p. 21).
Distribution of species: Neotropical.
Number of species: 5.

***Urentius* Distant** (1903c, p. 134).

Type species: *Urentius echinus* Distant (1903c, p. 134, fig.).
Fixation: Distant (1903c, p. 134), by monotypy and original designation.
Later citations: Oshanin (1912, p. 43); Monte (1947, p. 21).
Synonyms: *Ayrerus*, *Prionostirina.*
Distribution of species: Oriental (6), Palearctic (5), Ethiopian (2), Australian (1).
Number of species: 13.

***Vatiga* Drake and Hambleton** (1946b, p. 10).

Type species: *Vatiga vicosana* Drake and Hambleton (1946b, p. 10).
Fixation: Drake and Hambleton (1946b, p. 10), by original designation.
Later citations: Monte (1947, p. 21); Hurd (1946, p. 466).
Distribution of species: Neotropical.
Number of species: 10.

***Xenotingis* Drake** (1923a, p. 105).

Type species: *Xenotingis horni* Drake (1923a, p. 105, fig.).
Fixation: Drake (1923a, p. 105), by monotypy and original designation.
Later citation: Monte (1947, p. 22).
Distribution of species: Oriental (3), Papuan (2).
Number of species: 5.

***Xynotingis* Drake** (1948a, p. 8).

Type species: *Xynotingis hoytona* Drake (1948a, p. 8, fig.).
Fixation: Drake (1948a, p. 8), by monotypy and original designation.
Distribution of species: Oriental.
Number of species: 1.

***Ypsotingis* Drake** (1947b, p. 229).

Type species: *Ypsotingis sideris* Drake (1947b, p. 230, fig.).
Fixation: Drake (1947b, p. 230), by monotypy and original designation.
Distribution of species: Oriental.
Number of species: 3.

***Zatingis* Drake** (1928a, p. 44).

Type species: *Zatingis extraria* Drake, 1928a, p. 45.
Fixation: Drake (1928a, p. 45), by monotypy and original designation.

Later citations: Drake and Poor (1936a, p. 390); Monte (1941, p. 155; 1947, p. 22).
Distribution of species: Neotropical.
Number of species: 1.

***Zelotingis* Drake and Hambleton** (1946b, p. 9).

Type species: *Stenocysta aspidospermae* Drake and Hambleton (1934, p. 444, fig.).
Fixation: Drake and Hambleton (1946b, p. 10), by monotypy and original designation.
Later citation: Monte (1947, p. 22).
Distribution of species: Neotropical.
Number of species: 1.

SUMMARY OF NOMENCLATORIAL CHANGES

FAMILY GROUP

Agrammatinae, emendation, correct spelling for Agramminae.
Acalyptini Blatchley, synonymized with Tinginae.
Aidoneusaria Distant, synonymized with Tinginae.
Axiokersosaria Distant, synonymized with Tinginae.
Galeatini Blatchley, synonymized with Tinginae.
Monanthiini Costa, synonymized with Tinginae.
Physatocheilini Blatchley, synonymized with Tinginae.

GENUS GROUP

Aframixia, new genus.
Ayrerus Distant, synonymized with *Urentius* Distant.
Celiocysta Drake and Poor, synonymized with *Penottus* Distant.
Conchochila Drake, synonymized with *Conchotingis* Drake.
Dictyla Stål, resurrected as a valid generic name to hold most species formerly classified in *Monanthia*.
Epimixia Kirkaldy, transferred from subfamily Agrammatinae to subfamily Tinginae.
Froggattia Froggatt, given authorship priority over Horváth.
Froggattia Horváth, made a homonym of *Froggattia* Froggatt.
Macrocorytha Stål, raised from subgeneric to generic level.
Mafa Hesse, transferred from subfamily Agrammatinae to subfamily Tinginae.
Monanthia Le Peletier and Serville, synonymized with *Copium* Thunberg.
Minitingis Barber, synonymized with *Zetekella* Drake.
Nethersia Horvath, transferred from subfamily Agrammatinae to subfamily Tinginae.
Octacysta, new genus.

SPECIES GROUP

Agramma nigriceps Signoret, transferred to genus *Epimixia*.
Ayrerus hystricellus (Richter), transferred to genus *Urentius*.
Conchochila insulana Drake, transferred to genus *Conchotingis*.
Conchochila sundra Drake, transferred to genus *Conchotingis*.
Copium clavicornis (Linnaeus) becomes type species of genus *Copium*.
Copium cornutum Thunberg, synonymized with *Copium clavicornis* (Linnaeus).
Dictyla species, list of species transferred to this genus will be found on page 51.

SPECIES GROUP—Continued

Eotingis quinquecarinata (Germar and Berendt), transferred to genus *Cantacader.*

Epimixia roboris Drake, transferred to *Aframixia*, new genus, and designated type species.

Froggattia olivinia Froggatt, given priority over *Froggattia olivina* Horváth.

Laccometopus clavicornis (Linnaeus), designated type species of the genus.

Lullius ? minor Distant, transferred to genus *Agramma.*

Maecenas pyri (Fabricius), designated type species of the genus.

Minitingis minusculus Barber, transferred to genus *Zetekella.*

Monanthia clavicornis (Linnaeus), transferred to genus *Copium.*

Monanthia monticollis Walker, transferred to genus *Penottus.*

Monanthia rotundata (Herrich-Schaeffer), transferred to *Octacysta*, new genus, and designated type species.

Paracopium costata (Fabricius), transferred to genus *Physatocheila.*

Penottus monticollis (Walker), designated type species of the genus.

Penottus jalorensis Distant, synonymized with *Penottus monticollis* (Walker).

Phyllochisme costata (Fabricius), designated type species of the genus.

Physatocheila costata (Fabricius), through synonymy becomes type species of the genus.

Physatocheila quadrimaculata (Wolff), synonymized with *Physatocheila costata* (Fabricius).

References

AMYOT, CHARLES JEAN BAPTISTE

1845–1847. Entomologie Française. Rhynchotes. Méthode mononymique. Ann. Soc. Ent. France, ser. 2, vol. 3, pp. 369–492, 1845; vol. 4, pp. 73–192, 359–452, 1846; vol. 5, pp. 143–238, 453–524, 1847.

AMYOT, CHARLES J. B., and SERVILLE, AUDINET

1843. Histoire naturelle des insectes. Hémiptères. lxxvi + 675 pp.

BAKER, ARTHUR C.

1922. Tingitidae or Tingidae. Science, vol. 56, p. 603.

1923. Tingidae. Science, vol. 57, p. 272.

BANKS, NATHAN

1910. Catalogue of the Nearctic Hemiptera-Heteroptera. Amer. Ent. Soc. 103 pp.

BARBER, HARRY G.

1954. A report on the Hemiptera Heteroptera from the Bimini Islands, Bahamas, British West Indies. Amer. Mus. Nov., No. 1682, pp. 1–18, 3 figs.

BEKKER-MIGDISOVA, E. E.

1953. Two representatives of hemipterous insects from the district of Maduigen. Doklady Akademiia Nauk S. S. S. R. Moscow, new ser., vol. 90, pp. 461–464, 1 fig. [In Russian.]

BERG, CARLOS

1884. Addenda et emendanda ad Hemiptera Argentina. Anal. Soc. Cient. Argentina, 213 pp.

BERGROTH, ERNST E.

1898. Eine neue Tingidae. Wiener Ent. Zeit., vol. 17, No. 1, p. 9.

1911. On some recently described Hemiptera, chiefly from India. Ann. Soc. Ent. Belgique, vol. 55, pp. 184–189.

1913. On some North American Hemiptera. Ent. News, vol. 24, pp. 263–267.

1914. Zwei neue Paläarktische Hemipteren, nebst synonymischen Mitteilungen. Wiener Ent. Zeit., vol. 33, Nos. 5–6, pp. 177–184.

1921. On the types of the exotic Hemiptera Heteroptera described by V. Motschulsky. Rev. Russe d'Ent., vol. 17, pp. 96–109. [Not 1917 as shown on the paper.]

1922. On some Neotropical Tingidae (Hem.). Ann. Soc. Ent. Belgique, vol. 62, pp. 149–152.

1927. Hemiptera Heteroptera from New Zealand. Trans. New Zealand Inst., vol. 57, pp. 671–684.

Blackwelder, Richard E.

1957. Checklist of the coleopterous insects of Mexico, Central America, the West Indies and South America. U.S. Nat. Mus. Bull. 185, pt. 6, pp. 927–1492.

Blatchley, Willis Stanley

1926. Heteroptera or true bugs of eastern North America. 1116 pp., 215 figs., 12 pls.

Blöte, Hendrick C.

1945. Catalogue of the Berytidae, Piesmidae, and Tingidae in the Rijksmuseum van Natuurlijke Historie. Zool. Med., vol. 25, pp. 72–92, 1 fig.

Breddin, Gustav

1907. Rhynchotographische Beitrage. Wiener Ent. Zeit., vol. 26, pp. 93–97.

British Museum (Natural History)

1940– Catalogue of the books, manuscripts, maps and drawings in the British Museum (Natural History). 8 vols.

Bruner, Stephen C.

1940. A new tingid from Cuba (Hemiptera). Mem. Soc. Cubana Hist. Nat., vol. 14, No. 3, pp. 245–247, 1 fig.

Burmeister, Hermann

1835. Handbuch der Entomologie. Vol. 2, 400 pp.

Champion, George C.

1897. Rhynchota. *In* Godman and Salvin, Biologia Centrali-Americana, vol. 2, pp. 1–32.

1898a. Rhynchota. *In* Godman and Salvin, Biologia Centrali-Americana, vol. 2, pp. 33–193.

1898b. Notes on American and other Tingidae, with descriptions of two new genera and four species. Trans. Ent. Soc. London, vol. 1, pp. 55–64, 2 pls.

China, William E.

1924. The Hemiptera-Heteroptera of Rodriguez, together with the description of a new species of *Cicada* from that island. Ann. Mag. Nat. Hist., ser 9, vol. 14, pp. 427–453, fig.

1930. Heteroptera. *In* Insects of Samoa, pt. 2, Hemiptera, Fasc. 3, pp. 81–162, 28 figs.

1941. Genotype fixations in Hemiptera Heteroptera. Proc. Roy. Ent. Soc. London, vol. 10, No. 7, p. 130.

1943. The generic names of the British Hemiptera-Heteroptera, with a check list of the British species. *In* The generic names of British insects, pt. 8, pp. 211–342. Roy. Ent. Soc. London.

1945. A completely blind bug of the family Lygaeidae (Hemiptera Heteroptera). Proc. Roy. Ent. Soc. London, vol. 14, Nos. 9, 10, pp. 126–128, 1 fig.

China, William E., and Miller, N. C. E.

1955. Check-list of family and subfamily names in Hemiptera-Heteroptera. Ann. Mag. Nat. Hist., ser. 12, vol. 8, pp. 257–267.

Cockerell, Theodore D. A.

1914. New and little-known insects from the Miocene of Florissant, Colorado. Journ. Geol., vol. 22, No. 7, pp. 714–724, 11 figs.

1921. Fossil anthropods in the British Museum. Ann. Mag. Nat. Hist., vol. 8, No. 7, pp. 541–545.

Costa, Achille

1838. Cimicum regni Neapolitani centuriae. Vol. 1, 76 pp.

1855. Conspectus methodicus cimicum in regno Neapolitano. Atti Reale Ist. d'Incoraggiamento Napoli, vol. 8, pp. 291–299.

1860. Additamenta ad centurias cimicum regni Neapolitani. 41 pp., 3 col. pls.

1864. Annuario del Museo Zoologico della Universita di Napoli. Vol. 2, 176 pp., 4 col. pls.

Curtis, John

1823–1840. British entomology; being illustrations and descriptions of the genera of insects found in Great Britain and Ireland. 16 vols., 770 col. pls.

1833. Characters of some undescribed genera and species, indicated in the "Guide to an arrangement of British Insects." Ent. Mag., vol. 1, pp. 186–199.

Darlington, Philip P.

1957. Zoogeography. The geographical distribution of animals. 675 pp.

Darwin, Charles R.

1859. The origin of species by means of natural selection. 490 pp. (Ed. 6, 1872.)

Distant, William L.

1902a. Rhynchotal miscellanea. Ann. South African Mus., vol. 2, No. 9, pp. 237–254, 1 pl.

1902b. Rhynchotal notes. 13. Heteroptera: Families Tingididae, Phymatidae and Aradidae. Ann. Mag. Nat. Hist., ser. 7, vol. 9, pp. 353–362.

1903a. Contributions to a knowledge of the Rhynchota. Ann. Soc. Ent. Belgique, vol. 47, pp. 43–65.

1903b. Report on the Rhynchota. Part 1, Heteroptera. Fasc. Malayan Zool., vol. 1, No. 2, pp. 219–273, 2 pls.

1903c. The Fauna of British India, including Ceylon and Burma. Rhynchota. Vol. 2, pp. 1–242, figs. 1–167.

1904. On South African Tingididae and other heteropterous Rhynchota. Trans. South African Philos. Soc., vol. 14, No. 5, pp. 425–436, 1 pl.

1909a. New Oriental Tingididae. Ann. Soc. Ent. Belgique, vol. 53, pp. 113–123.

1909b. Rhynchota (Heteroptera) from British India. Ann. Soc. Ent. Belgique, vol. 53, pp. 360–376.

1910a. The fauna of British India, including Ceylon and Burma. Rhynchota. Vol. 5, pp. 1–362, 214 figs. (Tingididae pp. 100–126, figs. 48–66.)

1910b. Rhynchota Philippinensia, Part 1. Philippine Journ. Sci., vol. 5, No. 1, pp. 57–66, 1 pl.

1910c. An introduced pest to rhododendrons. Zoologist, ser. 4, vol. 14, No. 166, pp. 395–396.

1911a. On some South African Rhynchota in the South African Museum. Ann. South African Mus., vol. 10, No. 2, pp. 39-49, 9, figs.

1911b. Rhynchota indica (Heteroptera). Entomologist, vol. 44, pp. 269–271.

1913. The Percy Sladen Trust Expedition to the Indian Ocean in 1905. Vol. 5, No. 9, Rhynchota, Part 1. Suborder Heteroptera. Trans. Linnaean Soc. London, vol. 16, No. 2, pp. 139–191, 3 pls.

1920. Rhynchota from New Caledonia. Ann. Mag. Nat. Hist., ser. 9, vol. 6, pp. 143–164.

Douglas, John W., and Scott, John

1865. The British Hemiptera. Vol. 1, 627 pp., 21 pls.

Drake, Carl J.

1918. Notes on North American Tingidae (Hem.-Het.). Bull. Brooklyn Ent. Soc., vol. 13, pp. 86–88.

1922a. Neotropical Tingitidae with descriptions of three new genera and thirty-two new species and varieties (Hemiptera). Mem. Carnegie Mus., vol. 9, No. 2, pp. 351–378, 1 pl.

1922b. On some North and South American Tingidae (Hemiptera). Florida Ent., vol. 5, No. 3, pp. 37–43, 48–50.

1923a. Some Tingitidae from Japan (Hemip.). Ohio Journ. Sci., vol. 23, No. 2, pp. 102–106, 1 fig.

1923b. Two new species of Cantacaderia (Hemip.-Tingitidae). Bull. Brooklyn Ent. Soc., vol. 18, No. 3, pp. 81–84, 1 fig.

1925a. A new genus and new species of Tingitidae from Madagascar (Homopt.). Ent. Mitt., vol. 14, No. 2, pp. 107–109, 1 fig.

1925b. Concerning some Tingitidae from the Gulf States (Heteroptera). Florida Ent., autumn number, pp. 36–39.

1926. Notes on some Tingidae from Cuba (Hemiptera). Psyche, vol. 33, No. 3, pp. 86–88.

1927a. Tingitidae from the Far East (Hemiptera). Philippine Journ. Sci., vol. 32, No. 1, pp. 53–59.

1927b. Tingitidae from the Far East and Madagascar (Hemiptera). Philippine Journ. Sci., vol. 34, No. 3, pp. 307–312.

1928a. New and little known Neotropical Tingitidae. Iowa State Coll. Journ. Sci., vol. 3, No. 1, pp. 41–56.

1928b. A new subgenus and species of *Tingis* from Burma (Hemip.). Indian Forest Records, vol. 8, No. 4, pp. 283–284.

1928c. Synonymical notes on tingitid genera with the descriptions of two new species from Haiti (Hemip.). Proc. Biol. Soc. Washington, vol. 41, pp. 21–24.

1928d. A synopsis of the American species of *Acalypta* (Hemip.-Tingitidae). Bull. Brooklyn Ent. Soc., vol. 23, No. 1, pp. 1–9.

1930. Notes on American Tingitidae (Hemiptera). Bull. Brooklyn Ent. Soc., vol. 25, No. 5, pp. 268–272.

1931. Concerning the genus *Leptodictya* Stål (Hemiptera, Tingitidea). Bol. Mus. Nac. Rio de Janeiro, vol. 7, No. 2, pp. 119–122.

1933. On some Tingitidae from South India including two new species (Hemiptera). Journ. Bombay Nat. Hist. Soc., vol. 36, No. 4, pp. 1015–1016.

1937. Some Tingitidae from China, East Indies and India. Lingnan Sci. Journ., vol. 16, No. 3, pp. 385–388, 1 pl.

1939. A new genus and species of tingitid (Hemiptera) from Formosa. Trans. Nat. Hist. Soc. Formosa, vol. 29, No. 191, pp. 205–206.

1942a. New Australian Tingitidae (Hemiptera). Journ. Washington Acad. Sci., vol. 32, No. 12, pp. 359–364.

1942b. New Tingidae (Hemiptera). Iowa State Coll. Journ. Sci., vol. 17, No. 1, pp. 1–21.

1944a. Concerning the American cantacaderinids (Hemiptera: Tingitidae). Bol. Ent. Venezolana, vol. 3, No. 3, pp. 139–142, 1 fig.

1944b. A new genus and ten new species of serenthiines (Hemiptera: Tingitidae). Proc. Ent. Soc. Washington, vol. 46, No. 3, pp. 67–76, 2 figs.

1945. New Tingidae (Hemiptera). Bull. Southern California Acad. Sci., vol. 44, No. 3, pp. 96–100.

1947a. A new genus and two new species of Tingidae (Hemiptera). Bol Mus. Nac. Rio de Janeiro, vol. 81, pp. 1–4, 1 fig.

1947b. Tingidae (Hemiptera) from the Orient and South Pacific. Musée Heude, Notes d'Ent. Chinoise, vol. 11, No. 7, pp. 225–231, 4 figs.

1948a. Some Tingidae (Hemiptera) from China, Japan and India. Musée Heude, Notes d'Ent. Chinoise, vol. 12, No. 1, pp. 1–9, 3 figs.

1948b. New Tingidae from the Orient and other regions (Hemiptera: Heteroptera). Musée Heude, Notes d'Ent. Chinoise, vol. 12, No. 15, pp. 173–178.

1948c. The genus *Cochlochila* Stål (Hemiptera: Tingidae). Musée Heude Notes d'Ent. Chinoise, vol. 12, No. 16, pp. 179–181.

1948d. New genera and species of Tingidae (Hemiptera). Proc. Biol. Soc. Washington, vol. 61, pp. 149–156.

1948e. New and little known Piesmidae and Tingidae (Hemiptera). Zool. Med., vol. 30, No. 4, pp. 73–76, 1 fig.

1950. Concerning the Cantacaderinae of the world (Hemiptera: Tingidae). Arthropoda. Vol. 1, Nos. 2–4, pp. 153–166, 3 figs.

1951. New genera and species of Tingidae (Hemiptera) in the Hungarian National Museum. Ann. Hist.-Nat. Mus. Nat. Hungarici, vol. 1, No. 1, pp. 165–178.

1952. The genus *Parada* Horváth (Hemiptera: Tingidae). Psyche, vol. 59, No. 4, pp. 143–147.

1953a. A new genus and new species of Tingidae (Hemiptera). Proc. Biol. Soc. Washington, vol. 66, pp. 211–224.

1953b. Synonymic data and descriptions of new genera and species of Tingidae (Hemiptera). Great Basin Nat., vol. 13, Nos. 3–4, pp. 91–99.

1954a. A miscellany of new Tingidae (Hemiptera). Proc. Biol. Soc. Washington, vol. 67, pp. 1–16.

1954b. New genera and species of Tingidae from the Old World (Hemiptera). Philippine Journ. Sci., vol. 83, No. 1, pp. 69–73.

1954c. New Senegalese Tingidae (Hemiptera). Bull. Inst. Français d'Afrique Noire, vol. 16, No. 1, pp. 232–237.

1954d. Some tingids from the Belgian Congo (Hemiptera: Tingidae). Bull. Inst. Roy. Sci. Nat. Belgique, vol. 30, No. 17, pp. 1–10, 1 fig.

1954e. Tingidae: Descriptions and synonymic data (Hemiptera). Great Basin Nat., vol. 14, Nos. 1–2, pp. 1–10.

1955a. Angolan Tingidae (Hemiptera). Companhia de Diamante de Angola Publicacão Cultural, No. 27, pp. 83–90, 2 figs.

1955b. A new genus and species of African lacebug (Tingidae: Hemiptera). Rev. Zool. Bot. Africaine, vol. 52, Nos. 3–4, pp. 280–282, 1 fig.

1955c. New Tingidae (Hemiptera) from the Belgian Congo. Bull. Inst. Roy. Sci. Nat. Belgique, vol. 31, No. 85, pp. 1–5, 1 fig.

1955d. Some Tingidae from the French Cameroons (Hemiptera). Proc. Biol. Soc. Washington, vol. 68, pp. 105–108.

1955e. Three new Tingidae (Hemiptera). Bull. Southern California Acad. Sci., vol. 54, No. 2, pp. 78–81, fig.

1956a. Hemiptera Heteroptera, Tingidae and Saldidae. South African Animal Life, vol. 3, pp. 421–433, 2 figs.

1956b. Hemiptera: Tingidae. *In* Insects of Micronesia, Bernice P. Bishop Museum, vol. 7, No. 2, pp. 101–116, 8 figs., map.

1956c. The genus *Bako* Schouteden (Hemiptera: Tingidae). Rev. Zool. Bot. Africaine, vol. 54, Nos. 1–2, pp. 63–66.

1956d. Tingidae (Hemiptera Heteroptera). National Albert Park, vol. 86, No. 1, pp. 3–9, 1 fig.

1956e. New African Tingidae (Hemiptera). Rev. Zool. Bot. Africaine, vol. 53, Nos. 1–2, pp. 109–113.

1957a. Hemiptera: Tingidae. British Museum Expedition to South West Arabia, vol. 1, Nos. 27–33, pp. 415–420, 2 figs.

1957b. The genus *Belenus* Distant and its allies (Hemiptera: Tingidae). Quart. Journ. Taiwan Mus., vol. 10, No. 1, pp. 31–35.

1957c. The genus *Kapiriella* Schouteden (Hemiptera: Tingidae). Rev. Zool. Bot. Africaine, vol. 55, Nos. 1–2, pp. 205–218, 1 fig.

1957d. Tingidae de Madagascar (Hemiptera). Nat. Malgache, vol. 9, No. 1, pp. 125–131.

1957e. Quelques Tingidae de la Réunion (Hemiptera). Mem. Inst. Scient. Madagascar, ser. E, vol. 8, pp. 399–405, 1 fig.

1958a. Angolan Tingidae (Hemiptera). II. Companhia de Diamante de Angola Publicacão Cultural, No. 38, pp. 99–110, 3 figs.

1958b. Quelques Tingidae Malgaches (Hemiptera). Mem. Inst. Scient. Madagascar, ser. E, vol. 9, pp. 315–333, 2 figs.

Drake, Carl J., and Bondar, Gregorio

1932. Concerning Brazilian Tingitidae—Hemiptera. Bol. Mus. Nac. Rio de Janeiro, vol. 8, pp. 87–96, 1 fig.

Drake, Carl J., and Bruner, Stephen C.

1924a. Concerning some Tingitidae occurring in the West Indies (Hemip.). Mem. Soc. Cubana Hist. Nat. "Felipe Poey," vol. 6, Nos. 3–4, pp. 144–154, 2 figs.

1924b. Notes on some Tingitidae from Cuba (Hemiptera). Mem. Soc. Cubana Hist. Nat. "Felipe Poey," vol. 6, Nos. 3–4, pp. 155–156.

Drake, Carl J., and Davis, Norman T.

1958. The morphology and systematics of the Piesmatidae (Hemiptera) with keys to world genera and American species. Ann. Ent. Soc. Amer., vol. 51, No. 6, pp. 567–581, 34 figs.

Drake, Carl J., and Gomez-Menor, Juan

1954. Some Tingidae from Spanish Guinea (Hemiptera). "EOS," Rev. Espanola Ent., vol. 30, Nos. 1, 2, pp. 89–93, 1 fig.

DRAKE, CARL J., AND HAMBLETON, EDSON J.

1934. Brazilian Tingitidae (Hemiptera). Part 1. Rev. Ent., Rio de Janeiro, vol. 4, No. 4, pp. 435–451, 2 figs.

1935. New Brazilian Tingitidae (Hemiptera). Part 2. Arch. Inst. Biol., São Paulo, vol. 6, No. 16, pp. 141–154, 6 figs.

1938a. Concerning Brazilian Tingidae (Hemiptera). Part 3. Rev. Ent., Rio de Janeiro, vol. 8, Nos. 1, 2, pp. 44–68, 11 figs.

1938b. Brazilian Tingitoidea (Hemiptera). Part 4. Arch. Inst. Biol., São Paulo, vol. 9, No. 5, pp. 51–57, 2 figs., 2 pls.

1944. Concerning Neotropical Tingitidae (Hemiptera). Journ. Washington Acad. Sci., vol. 34, No. 4, pp. 120–129, 1 fig.

1945. Concerning Neotropical Tingitidae (Hemiptera). Journ. Washington Acad. Sci., vol. 35, No. 11, pp. 356–367.

1946a. Three new species and a new genus of American Tingidae (Hemiptera). Ent. News, vol. 57, No. 5, pp. 121–125.

1946b. New species and new genera of American Tingidae (Hemiptera). Proc. Biol. Soc. Washington, vol. 59, pp. 9–16.

DRAKE, CARL J., AND MAA T. (MAA TSING-CHAO)

1953. Chinese and other Oriental Tingoidea (Hemiptera). Quart. Journ. Taiwan Mus., vol. 6, No. 2, pp. 87–101.

1954. Chinese and other Oriental Tingoidea (Hemiptera). Part 2. Quart. Journ. Taiwan Mus., vol. 7, Nos. 1–2, pp. 111–118.

1955. Chinese and other Oriental Tingoidea (Hemiptera). III. Quart. Journ. Taiwan Mus., vol. 8, No. 1, pp. 1–11.

DRAKE, CARL J., AND POOR, MARGARET E.

1936a. The genera and genotypes of Tingitoidea of the Western Hemisphere. Iowa State Coll. Journ. Sci., vol. 10, No. 4, pp. 381–390.

1936b. New Indian Tingitidae (Hemiptera). Indian Forest Records, vol. 2, No. 5, pp. 141–149, 1 fig.

1936c. Tingitidae from Hainan Island (Hemiptera). Lingnan Sci. Journ., vol. 15, No. 3, pp. 439–443.

1937a. Concerning the genus *Leptobyrsa* Stål (Hemiptera). Proc. Biol. Soc. Washington, vol. 50, pp. 163–166.

1937b. Tingitidae from Malaysia and Madagascar (Hemiptera). Philippine Journ. Sci., vol. 62, No. 1, pp. 1–18, 1 pl.

1937c. Some Tingitidae (Hemiptera) from Oceania. Iowa State Coll. Journ. Sci., vol. 11, No. 4, pp. 397–404.

1938. Los "Tingitidae" (Hemiptera) de la colección Carlos Berg. Notas Mus. La Plata, vol. 3, No. 10, pp. 103–109, 1 pl.

1939a. Some Tingitidae from the Republic of Argentina (Hemiptera). Physis. (Rev. Soc. Argentina Cienc. Nat.), vol. 17, pp. 95–98, 1 fig.

1939b. Some Tingitidae (Hemiptera) from the Eastern Hemisphere. Proc. Hawaiian Ent. Soc., vol. 10, No. 2, pp. 203–207, 1 fig.

1941. Tingitidae from Amboina Island (Hemiptera). Pan-Pacific Ent., vol. 17, No. 4, pp. 160–166.

1943. Fijian Tingitidae (Hemiptera). Occ. Papers Bernice Bishop Mus., vol. 17, No. 15, pp. 191–205, 7 figs.

DRAKE, CARL J., AND HURD, MARGARET POOR

1945. New American Tingidae (Hemiptera). Bol. Ent. Venezolana, vol. 4, No. 2, pp. 127–132, 1 fig.

DRAKE, CARL J., AND SLATER, JAMES A.

1955. New genus and four new species of African Tingidae (Hemiptera). Acta Ent. Mus. Nat. Prague, vol. 30, No. 443, pp. 49–53.

EVANS, J. W.
1957. Some aspects of the morphology and interrelationships of extinct and recent Homoptera. Trans. Roy. Ent. Soc. London, vol. 109, pp. 275–294, 6 figs.
FABRICIUS, JOHANN C.
1775. Systema entomologiae. 832 pp.
1794. Entomologia systematica. Vol. 4, 472 pp.
1803. Systema rhyngotorum. 314 pp.
FALLÉN, CARL F.
1807. Menographia cimicum Sveciae. 121 pp.
FERRARI, PIETRO M.
1878. Hemiptera Ligustica. Ann. Mus. Civ. Storia Nat. Genova, vol. 12, pp. 60–96.
FIEBER, FRANZ X.
1844. Entomologische Monographien. 138 pp., 10 pls.
1851. Genera Hydrocoridum. Pp. 1–30, 4 pls.
1861. Die Europäischen Hemiptera . . . (Rhynchota Heteroptera). 444 pp., 2 pls.
FLOR, GUSTAV
1860. Die Rhynchoten Livlands in systematischer Folge beschrieben. Vol. 1, 826 pp.
FROGGATT, WALTER W.
1901. Notes on Australian Hemiptera (plant bugs). Agr. Gaz. New South Wales, vol. 12, pp. 1592–1601, 1 col. pl.
GARBIGLIETTI, ANTONIO
1869. Catalogus methodicus et synonymicus hemipterorum heteropterorum (Rhyngota Fabr.) Italiae indigenarum. Bull. Soc. Ent. Italiana, vol. 1, pp. 41–52, 105–124, 181–198, 271–281.
GEOFFROY, ETIENNE L.
1762. Histoire abregée des insectes qui se trouvent aux environs de Paris. Vol. 1, pp. 1–523.
GERMAR, ERNST F.
1835. Fauna insectorum Europae. Fasc. 13–15, figs.
1836. Fauna insectorum Europae. Fasc. 16–18, figs.
GERMAR, ERNST F., AND BERENDT, George C.
1856. Die im Bernstein befindlichen Hemipteren und Orthopteren der Verwelt. *In* Die im Bernstein befindlichen Organischen reste der Vorwelt, vol. 2, No. 1, pp. 3–40, 3 pls.
GERSTÄCKER, CARL E. A.
1862. Berecht uber die Wissenschaftlichen Leistungen im Gebiete der Entomologie Während der Jahr 1859–1860. 410 pp.
GOEZE, JOHN A. E.
1778. Entomologische Beyträge zu des Ritter Linné zwölften. Ausgabe des Natursystems. Vol. 2, 352 pp.
GUÉRIN-MÉNEVILLE, FELIX E.
1838. Iconographie du Règne Animal de G. Cuvier. Vol. 3, No. 2, 576 pp.
HACKER, HENRY
1927. New Tingitoidea (Hemiptera) in the Queensland Museum. Mem. Queensland Mus., vol. 9, No. 1, pp. 19–32, pls. 6–10.
1928. New species and records of Australian Tingitoidea (Hemiptera). Mem. Queensland Mus., vol. 9, No. 2, pp. 174–188, pls. 20–23.
1929. New species of Australian Tingitidae (Hemiptera). Mem. Queensland Mus., vol. 9, No. 3, pp. 324–334, pls. 32–35.

HAGEN, HERMAN A.

1862–1863. Bibliotheca entomologica. Vols. 1, 2.

HARRIS, HALBERT H.

1942. On the date of publication of Laporte's Essai. Pan-Pacific Ent., vol. 18, No. 4, pp. 161–162.

HEER, OSWALD

1853. Die Insectenfauna der Tertiargebilde von Oeningen u. Radoboj in Croatien. Vol. 3, pp. 4–138, pls.

1865. Die Urwelt der Schweiz. 622 pp., 11 pls.

HEIDEMANN, OTTO

1908. Two new species of North American Tingitidae (Hemiptera-Heteroptera). Proc. Ent. Soc. Washington, vol. 10, Nos. 1–2, pp. 103–108, 1 pl.

HERRICH-SCHAEFFER, GOTTLIEB A. W.

1830. Faunae Insectorum Germanicae Initia. Hefts 117–122, figs.

1835. Nomenclator Entomologicus. Verzeichniss der Europaischen Insecten. Vol. 1, pp. 1–116.

1839. Die Wanzenartigen Insekten. Vol. 4, pp. 1–16, 17–32, 33–64, 65–80; vol. 5, pp. 73–88.

HESSE, ALBERT J.

1925. Contributions to a knowledge of the fauna of South-West Africa. Part 4. A list of the heteropterous and homopterous Hemiptera of South-West Africa. Ann. South African Mus., vol. 23, 190 pp., 8 pls.

HOLLAND, WILLIAM J.

1922a. Tingitidae or Tingidae. Science, vol. 56, pp. 334–335.

1922b. Tingitidae or Tingidae again. Science, vol. 56, pp. 535–536.

1924. The family name of the lace-bugs (Tingitidae). Ann. Ent. Soc. Amer., vol. 17, pp. 95–96.

HOPE, FREDERIC W.

1847. Observations on the fossil insects of Aix in Provence, with descriptions and figures of three species. Trans. Ent. Soc. London, vol. 4, No. 4, pp. 250–255.

HORN, WALTHER, AND SCHENKLING, S.

1928–1929. Index litteraturae entomologicae. 1426 pp.

HORVÁTH, GÉZA

1874. Neue Heteroptera aus Ungarn. Berliner Ent. Zeitschr., vol. 18, pp. 332–336.

1902. Descriptions of new Hemiptera from New South Wales. Természetrajki Fuzetak, vol. 25, pp. 601–612.

1905. Tingitidae novae vel Minus Cognitae e Regione Palaearctica. Ann. Mus. Nat. Hungarici, vol. 3, pp. 556–572.

1906a. A new gall-inhabiting bug from Bengal. Ent. Monthly Mag., vol. 42, pp. 33–34.

1906b. Sur quelques hémiptères nuisibles de Cochinchine. Bull. Soc. Ent. France, 1906, pp. 295–297, 1 fig.

1906c. Synopsis Tingitidarum Regionis Palaearcticae. Ann. Mus. Nat. Hungarici, vol. 4, 118 pp., 1 col. pl.

1908. Remarques sur quelques hémiptères de l'Amerique du Nord. Ann. Mus. Nat. Hungarici, vol. 6, pp. 555–569.

1910. Hemiptera: Tingitidae und Aradidae. *In* Wissenschaftliche Ergebnisse der Schwedischen Zoologischen Expedition dem Kilimandjaro, dem Meru un den Umgebenden Massaisteppen Deutsch-Ostafrikas 1905–1906. Pp. 61–72.

1911a. Nomenclature des familles des hémiptères. Ann. Mus. Nat. Hungarici, vol. 9, 34 pp.

1911b. Miscellanea hemipterologica. 1–5. Ann. Mus. Nat. Hungarici, vol. 9, pp. 327–338, 1 pl.

1912a. Deux tingitides nouveaux du Congo Belge. Rev. Zool. Africaine, vol. 1, No. 3, pp. 353–355.

1912b. Species generis tingitidarum *Stephanitis*. Ann. Mus. Nat. Hungarici, vol. 10, pp. 319–339, 3 figs.

1925. Results of Dr. E. Mjöberg's Swedish Scientific Expeditions to Australia 1910–1913. Ark. Zool. Svenska Vetensk.-Akad., vol. 17a, No. 24, pp. 1–17, 9 figs.

1926. Hemipterologische notizen aus Neiderlandisch-Indien. Treubia, vol. 8, Nos. 3–4, pp. 327–333, 3 figs.

1929. New Tingitidae from the Ethiopian region. Ann. Mag. Nat. Hist., ser. 10, vol. 3, pp. 319–326.

Hurd, Margaret Poor

1945. A monograph of the genus *Corythaica* Stål (Hemiptera: Tingidae). Iowa State Coll. Journ. Sci., vol. 20, No. 1, pp. 79–99.

1946. Generic classification of North American Tingoidea (Hemiptera-Heteroptera). Iowa State Coll. Journ. Sci., vol. 20, No. 4, pp. 429–493.

Huxley, Thomas H.

1868. On the classification and distribution of the Alectoromorphae and Heteromorphae. Proc. Zool. Soc. London, pp. 294–319.

International Commission on Zoological Nomenclature

1922. Opinions rendered by the International Commission on Zoological Nomenclature. Smithsonian Misc. Coll., vol. 73, No. 1, pp. 16–18 (Opinion 71).

1943. Opinions rendered by the International Commission on Zoological Nomenclature, vol. 2, pp. 81–99 (Opinion 143).

1954a. Opinions and declarations rendered by the International Commission on Zoological Nomenclature. Opinions, vol. 5, No. 11, pp. 127–138 (Opinion 250, *Catoplatus*); vol. 5, No. 12, pp. 139–150 (Opinion 251, *Dictyonota*).

1954b. Opinions and declarations rendered by the International Commission on Zoological Nomenclature. Directions, vol. 2, No. 53, pp. 629–652 (Direction 4); vol. 2, No. 55, pp. 665–684 (Direction 6).

Jakovlev, B. E.

1871. Novoe Dopolnenie K Spisko Priviolzhskikh Hemiptera Heteroptera. Trudy Russ. Ent. Obsh., vol. 6, pp. 24–34. [In Russian.]

1880. Novyia Poluzhestkokrylyia (Hemiptera Heteroptera) Russkoi Fauny. Bul. Soc. Imp. Nat. Moscow, vol. 55, No. 1, pp. 127–144. [In Russian.]

Johnson, C. G.

1936. The biology of *Leptobyrsa rhododendri* Horváth (Hemiptera, Tingitidae), the rhododendron lacebug. Ann. Applied Biol., vol. 23, pp. 342–368, 3 pls.

Kiritchenko, Aleksandr N.

1951. True bugs of the European part of the U.S.S.R. Zool. Inst. Acad. Sci. U.S.S.R., vol. 42, pp. 1–423, 416 figs.

Kirkaldy, George W.

1900. Bibliographical and nomenclatorial notes on the Rhynchota. No. 1. Entomologist, vol. 33, pp. 238–243.

1902. Memoirs on Oriental Rhynchota. Journ. Bombay Nat. Hist. Soc., vol. 14, pp. 46–58, 294–309, 3 pls.

1904. Bibliographical and nomenclatorial notes on the Hemiptera. No. 3. Entomologist, vol. 37, pp. 279–283.

1905. Quelques tingides nouveaux ou peu connus. Bull. Soc. Ent. France, vol. 15, pp. 216–217.

1908a. Memoir on a few heteropterous Hemiptera from eastern Australia. Proc. Linnaean Soc. New South Wales, vol. 32, No. 4, pp. 768–788, 1 pl.

1908b. A catalogue of the Hemiptera of Fiji. Proc. Linnaean Soc. New South Wales, vol. 33, No. 2, pp. 345–391, 1 pl., 5 figs.

1909. Catalogue of the Hemiptera (Heteroptera). Vol. 1, Cimicidae, xl+392 pp.

Kormilev, Nicolás A.

1955. A new myrmecophil family of Hemiptera from the delta of Río Paraná, Argentina. Rev. Ecuat. Ent. Paras., vol. 2, Nos. 3, 4, pp. 465–477, 1 pl.

Laporte, Francis L. de (Comte de Castilneau)

1833. Essai d'une classification systematique de l'orde des hémiptères (hétéroptères.) Guerin Mag. Zool., Nos. 52–55, 88 pp. [The date has been cited erroneously as 1832 by many authors.]

Latreille, Pierre A.

1804. Histoire naturelle . . . des crustacés et des insectes. Vol. 12, 424 pp.

1810. Considérations générales sur l'order naturel des animaux. 444 pp.

1825. Familles naturelles du règne animal. 570 pp.

LeConte, John L.

1859. A description of the insects of North America by Thomas Say. Vol. 1, 412 pp., 54 col. pls.

Le Peletier de Saint Fargeau, A. L. M., and Serville, Audinet

1825–1828. Encyclopédie méthodique. Vol. 10, pt. 1, pp. 1–344, 1825; pt. 2, pp. 345–832, 1828.

Leston, Dennis; Pendergrast, John G; and Southwood, T. R. E.

1954. Classification of the terrestrial Heteroptera (Geocorisae). Nature, vol. 174, pp. 91–94.

Lethierry, Lucien, and Severin, Guillaume

1896. Catalogue général des hémiptères. Vol. 3, pp. 1–275.

Lindberg, Hakan

1927. Zur kenntnis der Heteropteren-Fauna von Kamtschatka Sowie der Amur- und Ussuri-Gebiete. Acta Soc. Fauna Flora Fennica, vol. 56, No. 9, pp. 1–26, 1 pl.

Lindroth, Carl H.

1957. The faunal connections between Europe and North America. 344 pp.

Linnaeus, Carl

1746. Fauna Svecica. 411 pp.

1758. Systema naturae. Ed. 10, 823 pp.

1767. Systema naturae. Ed. 12, vol. 1, pt. 2, pp. 533–1327.

LOUNSBURY, C. P.
1923. Report No. V. Entomology. Journ. Dep. Agr., Union of South Africa, vol. 7, No. 6, pp. 542–549.
MAYR, GUSTAV
1864. Diagnosen neuer Hempiteren. Zool.-Bot. Ges. Wien, vol. 15, pp. 429–446.
MONTANDON, ARNOLD L.
1892. Hémiptères-hétéroptères nouveaux. Rev. d'Ent., vol. 11, pp. 265–273.
MONTE, OSCAR
1938. Tingitídeos Neotrópicos. Bol. Biol., vol. 3, Nos. 3, 4, pp. 127–132, 1 fig.
1939. Lista preliminar dos tingitídeos de Minas Gerais. Rev. Soc. Brasileira Agr., vol. 2, No. 1, pp. 63–87.
1940a. Descriçaõ de um novo gênero e uma nova espécie de tingídeo (Hem.). Papeis Avulsos São Paulo, vol. 1, pp. 13–16, 1 fig.
1940b. Tingitídeos novos ou pouco conhecidos da fauna Americana. Arq. Inst. Biol., São Paulo, vol. 11, No. 34, pp. 283–300, 8 figs.
1941. Catálogo dos tingitídeos do Brazil. Arq. Zool., São Paulo, vol. 2, No. 3, pp. 65–174.
1942. Critica sobre alguns gêneros e espécies de tingitídeos. Papeis Avulsos, São Paulo, vol. 2, No. 6, pp. 103–115, 3 figs.
1946. Sôbre o gênero *Phatnoma*. com a descrição de uma nova espécie e a lista de suas espécies. (Hem. Tingidae.) Rev. Brasileira Biol., vol. 6, No. 2, pp. 247–254.
1947. Gêneros e genótipos dos tingídeos do mundo. Papeis Avulsos, São Paulo, vol. 8, No. 1, pp. 1–22.
MONTROUZIER, XAVIER
1864. Essai sur la faune entomologique de Kanala (Nouvelle-Calédonie) et description de quelques espècies nouvelles ou peu connues. Ann. Soc. Linnaean Lyon, vol. 11, pp. 46–256. (Hemiptera-Heteroptera, pp. 223–253.)
MOTSCHULSKY, VICTOR DE
1863. Essai d'un catalogue des insectes de l'Île Ceylan. Bull. Soc. Imp. Nat. Moscow, vol. 36, pt. 2, No. 3, pp. 1–153.
MULSANT, ETIENNE, AND REY, CLAUDIUS
1852. Description de quelques hémiptères hétéroptères nouveaux ou peu connus. Ann. Soc. Linnaean Lyon, pp. 76–141.
NEAVE, SHEFFIELD A.
1939–1950. Nomenclator zoologicus. Vols. 1–6, supplements. [Covers years through 1945.]
NOVAK, OTTOMAR
1877. Fauna der Cyprisschiefer des Egerer Tertiarbeckens. Sitzungsb. Kaiserlichen Akad. Wiss., vol. 76, pp. 71–96, 3 pls.
OSBORN, HERBERT, AND DRAKE, CARL J.
1916. The Tingitoidea or "lace-bugs" of Ohio. Ohio Biol. Surv., vol. 2 No. 4, pp. 217–247, 9 figs.
OSHANIN, BASIL
1908. Verzeichnis der Palaearctischen Hemipteren. 1. Heteroptera. 2 Tingididae-Acanthiidae. Pp. 395–586.
1912. Katalog der Paläarktischen Hemipteren. 187 pp.

Panzer, Georg W. F.

1806. Kritische revision der Insektenfaune Deutschlands nach dem system bearbeitet. Heft 99, Tabs. 1–24.

Parshley, Howard M.

1917. Notes on North American Tingidae (Hemiptera). Psyche, vol. 24, No. 1, pp. 13–24, 2 figs.

1922a. Tingitidae or Tingidae. Science, vol. 56, No. 1451, p. 449.

1922b. On the formation of family names like Tingidae. Science, vol. 56, No. 1461, pp. 754–755.

Perris, Edouard

1843. Genre 249. Anomaloptere. *Anomaloptera. In* Amyot et Serville, Hémiptères, pp. 302–303.

Philippi, Rudolph A.

1864. *Coleopterodes* Philippi, ein neues Geschlecht der Wanzen. Ent. Zeit., vol. 25, pp. 306–308.

Puton, Auguste

1847a. Notes pour servir a l'étude des hémiptères, Part 2. Ann. Soc. Ent. France, ser. 5, vol. 4, pp. 213–230.

1874b. Hemiptera nouveaux. Petites Nouv. Ent., vol. 6, No. 110, pp. 439–440.

1875. Catalogue des hémiptères. Ed. 2.

1876. Faunule des hémiptères de Biskria. Ann. Soc. Ent. France, vol. 5, No. 6, pp. 13–55.

1879. Synopsis des hémiptères-hétéroptères de France. Vol. 2, pp. 83–159.

1899. Catalogue des hémiptères (Hétéroptères, cicadines et psyllides). Ed. 4, 121 pp.

Réaumur, Rene A. F. de

1737. Memoires pour servir a l'histoire des insectes. 532 pp.

Reuter, Odo M.

1887. Ad cognitionem heteropterorum Madagascariensium. Ent. Tidskr., vol. 8, pp. 78–109.

Richter, H. C.

1869. A new insect from Ceylon. Hardwicke's Science Gossip, p. 84, 1 fig.

Sahlberg, Reginaldus F.

1848. Monographia Geocorisarum Fenniae. 154 pp.

Say, Thomas

1825. Descriptions of new hemipterous insects, collected in the expedition to the Rocky Mountains, performed by order of Mr. Calhoun, Secretary of War, under command of Major Long. Journ. Acad. Nat. Sci. Philadelphia, vol. 4, pp. 307–345.

1831. Descriptions of new species of heteropterous Hemiptera of North America. (From LeConte, 1859, vol. 1, pp. 310–368.)

1859. Complete writings. Vol. 1, pp. 310–368; vol. 2, pp. 237–250. (See LeConte, 1859.)

Schmidt, Karl P.

1954. Faunal realms, regions and provinces. Quart. Rev. Biol., vol. 29, No. 4, pp. 322–331, 3 maps.

Schmitz, Herman

1935. Over *Megaselia zonata* ♂ en *Diploneura diminuens* n. sp. (Phoridae, Dipt.) en over Tingidae pro Tingitidae. Natuurhist. Maandblad, vol. 24, p. 42.

Schouteden, Henri

1916. Tingides du Congo Belge. Rev. Zool. Africaine, vol. 4, No. 3, pp. 288–297.

1919. Tingides nouveaux du Congo Belge. Rev. Zool. Africaine, vol. 6, No. 1, pp. 138–144.

1923. Nouvelles notes sur les tingides du Congo Belge. Rev. Zool. Africaine, vol. 11, No. 1, pp. 82–110.

1953. Tingides Congolais nouveaux. Rev. Zool. Bot. Africaine, vol. 48, Nos. 3, 4, pp. 165–171.

1955. Tingides nouveaux des collections du Musée Royal du Congo Belge. Rev. Zool. Bot. Africaine, vol. 52, Nos. 1, 2, pp. 162–168.

1956. Un tingide nouveau Ruanda *Olastrida oleae* nov. gen. nov. spec. Rev. Zool. Bot. Africaine, vol. 53, Nos. 1, 2, pp. 205–207.

1957. Tingides de Madagascar. Rev. Zool. Bot. Africaine, vol. 55, Nos. 1, 2, pp. 82–89.

Schrank, Franz von Pavla

1782. Kritische revision des ostreichischen Insectenverzeichnisses. Neues Mag. Liebhaber Ent. vol. 1, pp. 135–168, 263–306.

1801. Fauna Boica. Vol. 2, pp. 1–374.

Schumacher, F.

1913. Eine neue paläarktische Gattung und Art aus der familie der Tingitiden. Mitt. Zool. Mus. Berlin, vol. 6, No. 3, pp. 457–458.

Sclater, Philip L.

1858. On the general geographic distribution of the members of the class Aves. Journ. Linnaeus Soc. (Zool.), vol. 2, pp. 130–145.

1874. The geographical distribution of mammals. Manchester Sci. Lect., ser. 5–6, pp. 202–219.

Scudder, Samuel

1882. Nomenclator zoologicus. Part 1. An alphabetic list of all generic names that have been employed by naturalists. xix+376 pp.; index, 340 pp.

1890. The Tertiary insects. U.S. Geol. Surv. Terr., vol. 13, 734 pp. 28 pls.

1891. Index to the known fossil insects of the world, including myriapods and arachnids. Bull. U.S. Geol. Surv., vol. 71, pp. 1–744.

Serres, Pierre M.

1829. Géognosie des terrains tertiaires du midi de France, ou tableau des principaux animaux invertébrés des terrains marins tertiaires de la France. Vol. 8, pp. 92–276.

Signoret, Victor

1863. Révision des hémiptères due Chili. Ann. Soc. Ent. France, ser. 4, vol. 3, pp. 541–588, 3 pls.

1865. Descriptions de quelques hémiptères nouveaux. Ann. Soc. Ent. France, ser. 4, vol. 4, No. 5, pp. 115–130.

1881. M. V. Signoret donne les descriptions de trois nouvelles espèces d'hémiptères. Bull. Ann. Soc. Ent. France, ser. 6, vol. 1, pp. xlv-lv.

Spinola, Maximilien

1837. Essai sur les genres d'insectes. 383 pp.

1850. Tavola sinottica dei generi spettanti alla classe degli insetti arthrodignati Hemiptera. MeM. Matem. Fis. Soc. Italiana Modena, vol. 25, pp. 43–100.

1852. Hemípteros. *In* Gay, Historia física y política de Chile. Zoologia. Vol. 7, pp. 113–320.

STÅL, CARL
1855a. Hemiptera fran Kafferlandet. Öfv. K. Vetensk.-Akad. Förh., vol. 12, No. 1, pp. 27–46.
1855b. Nya Hemiptera. Öfv. K. Vetensk.-Akad. Förh., vol. 12, pp. 181–192.
1858. Bidrag till Rio Janeiro-Traktens Hemipter-Fauna. K. Svenska Vetensk.-Akad. Handl., vol. 2, No. 7, pp. 1–84.
1859. Hemiptera. Species novas. Konglika Svenska Fregatten *Eugenies* Resa . . . 1851–53, vol. 4, pp. 219–298, 2 pls.
1862. Hemiptera Mexicana enumeravit speciesque novas descripsit. Ent. Zeit. Stettin, vol. 23, Nos. 7, 8, pp. 289–325.
1865. Hemiptera Africana. Vol. 3, pp. 1–200.
1868. Hemiptera Fabriciana, Part 1. K. Svenska Vetensk.-Akad. Handl., vol. 7, No. 11, pp. 1–148.
1870. Hemiptera insularum Philippinarum- bidrag till Philippinska öarnes Hemipter-fauna. K. Vetensk.-Akad. Förh., vol. 7, pp.607–776, 4 pls.
1873. Enumeratio hemipterorum. K. Svenska Vetensk.-Akad. Handl., vol. 11, No. 2, pp. 1–163.
1874. Genera Tingitidarum Europae disposuit. K. Vetensk.-Akad. Förh., vol. 3, pp. 43–60.

STEPHENS, JAMES F.
1829a. The nomenclature of British insects . . . . 68 pp.
1829b. A systematic catalogue of British insects. 2 parts.

SWAINSON, WILLIAM
1835. A treatise on the geography and classification of animals. 367 pp., 55 figs.

THUNBERG, CARL P.
1822. Dissertatio entomologica de hémiptères rostratis capensibus. Vol. 2, pp. 1–8.

UHLER, PHILIP R.
1886. Check list of the Hemiptera Heteroptera of North America. Brooklyn Ent. Soc., 29 pp.
1893. A list of the Hemiptera-Heteroptera collected in the Island of St. Vincent by Mr. Herbert H. Smith; with descriptions of new genera and species. Proc. Zool. Soc. London, 1893, pp. 705–719.
1896. Summary of the Hemiptera of Japan, presented to the United States National Museum by Professor Mitzukuri. Proc. U.S. National Mus., vol. 19, No. 1108, pp. 255–297.

VAN DUZEE, EDWARD P.
1907. Notes on Jamaican Hemiptera. Bull. Buffalo Soc. Nat. Sci., vol. 8, No. 5, pp. 1–79.
1916. Check list of the Hemiptera of America, north of Mexico. 111 pp.
1917. Catalogue of the Hemiptera of America, north of Mexico. 902 pp.

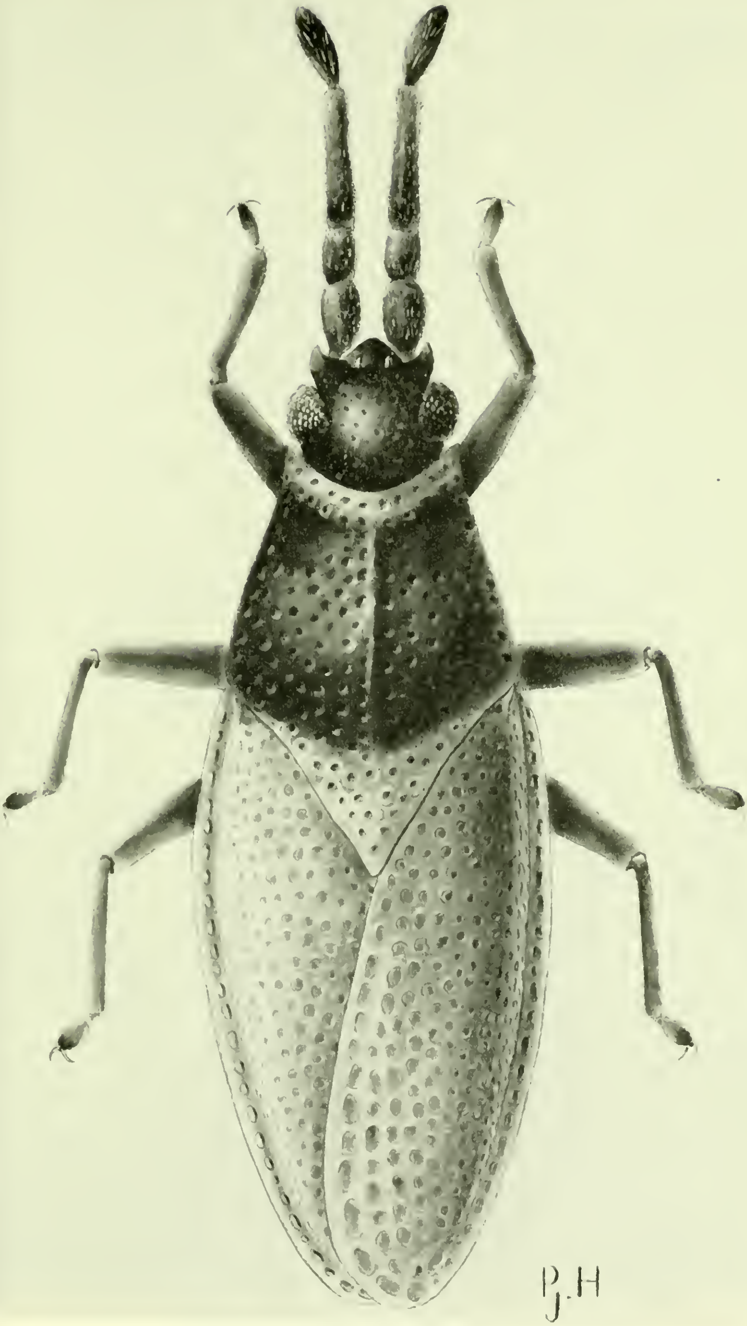
VOLLENHOVEN, SAMUEL C. SNELLEN VAN
1878. Hemiptera Heteroptera Neerlandica. 368 pp., 22 pls.

WAGNER, EDWARD
1941. Die deutschen Serenthia-Arten (Hem. Heteropt.). Verh. Ver. Naturw. Unterh. (Heimatf.) Hamburg., vol. 28, pp. 1–27, 11 figs.
1954. Revision der paläarktischen Arten der Gattung *Copium* Thbg. Deutsche Ent. Zeitschr., vol. 1, Nos. 3–5, pp. 200–209, 27 figs.

Walker, Francis
1873. Catalogue of the specimens of Hemiptera Heteroptera in the collection of the British Museum. Part 6, 210 pp.
Wallace, Alfred R.
1876. The geographic distribution of animals. 2 vols.
Waterhouse, Charles O.
1902. Index zoologicus. xii+421 pp.
1912. Index zoologicus. No. 2, iv+324 pp.
Westwood, John O.
1840. An introduction to the modern classification of insects. Vol. 2, xi+587 pp., 133 figs. Synopsis of the genera of British insects, 158 pp.
Wolff, Johann F.
1804. Incones cimicum descriptionibus illustratae. Fasc. 4, pp. 125–166, 4 pls.
Zoological Record
1864– Zoological record, Vols. 1–92.
1955.

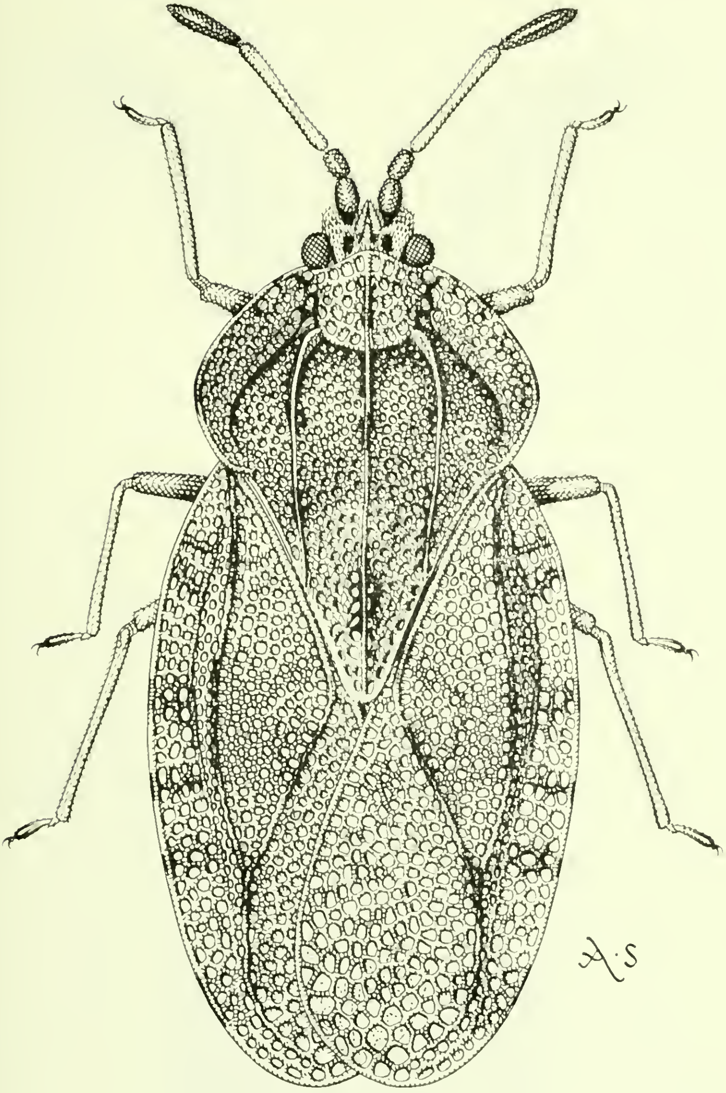
U.S. GOVERNMENT PRINTING OFFICE: 1960

PLATES 1–9

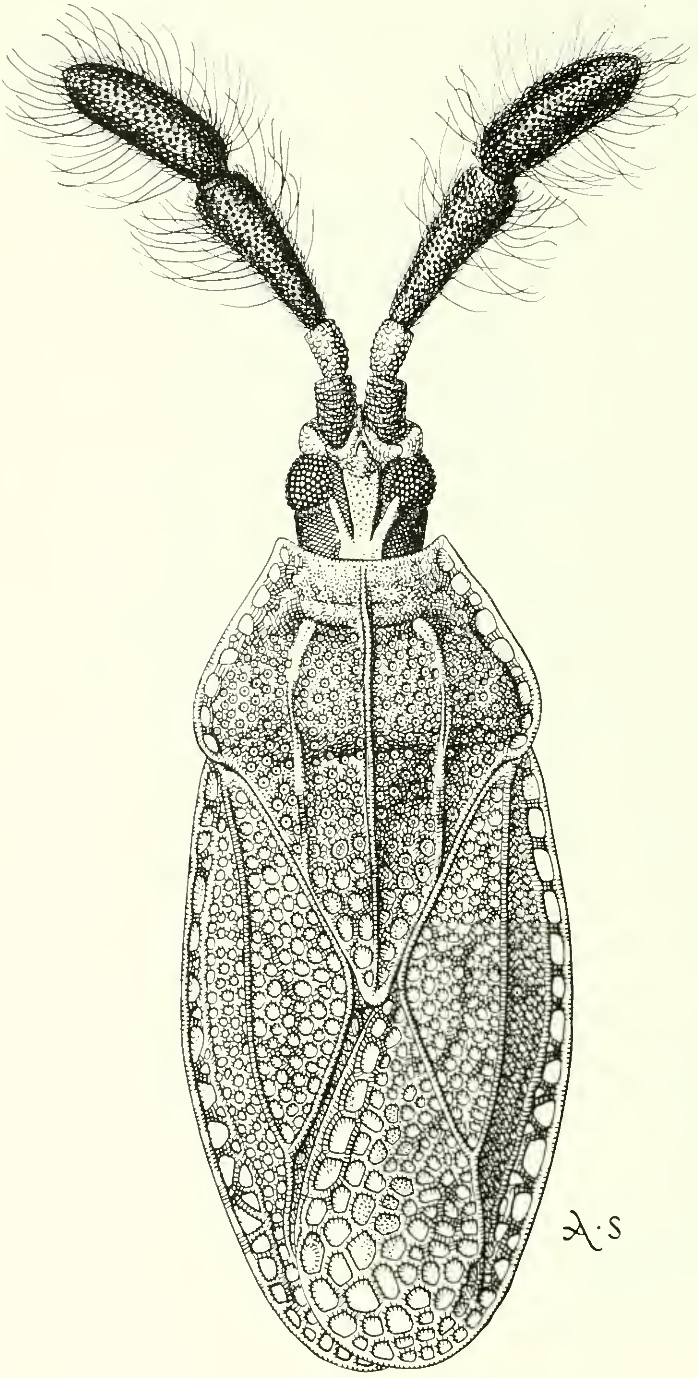


Agramma laeta (Fallén).

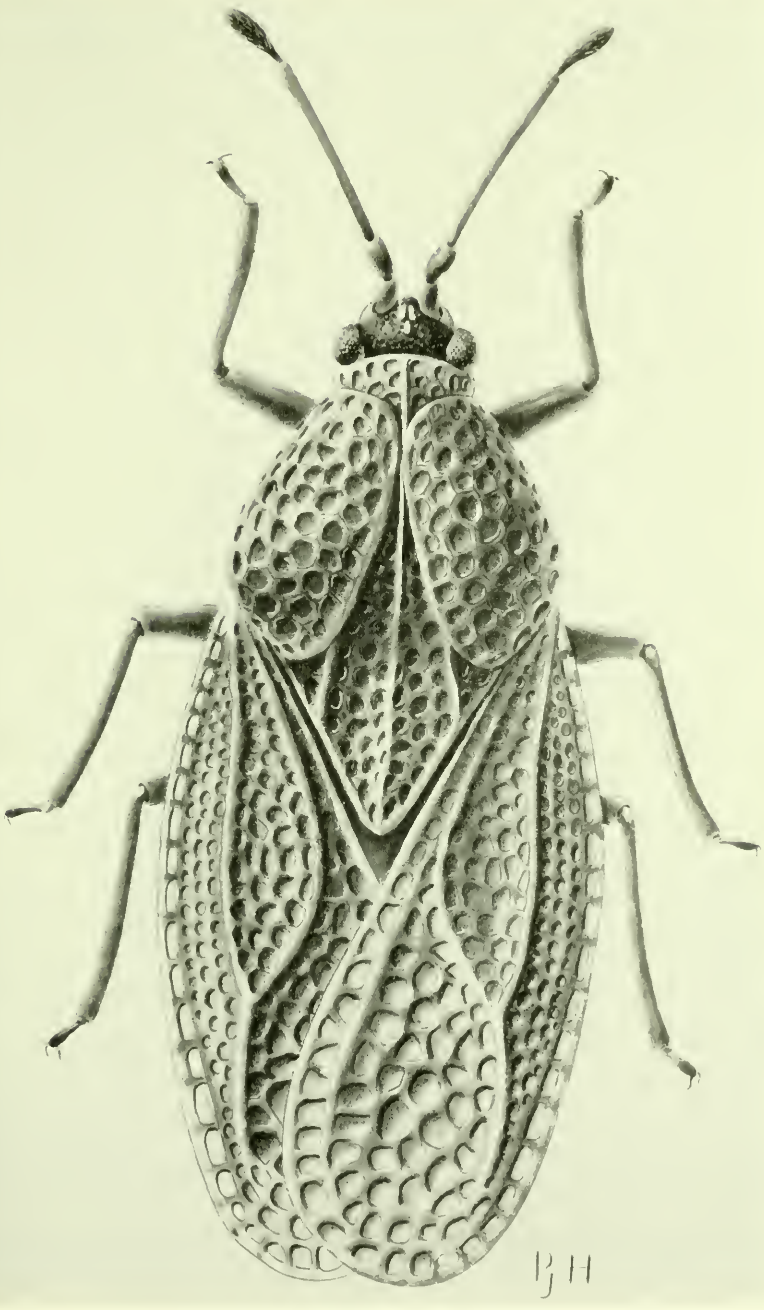
Cantacader quadricornis (Le Peletier and Serville).



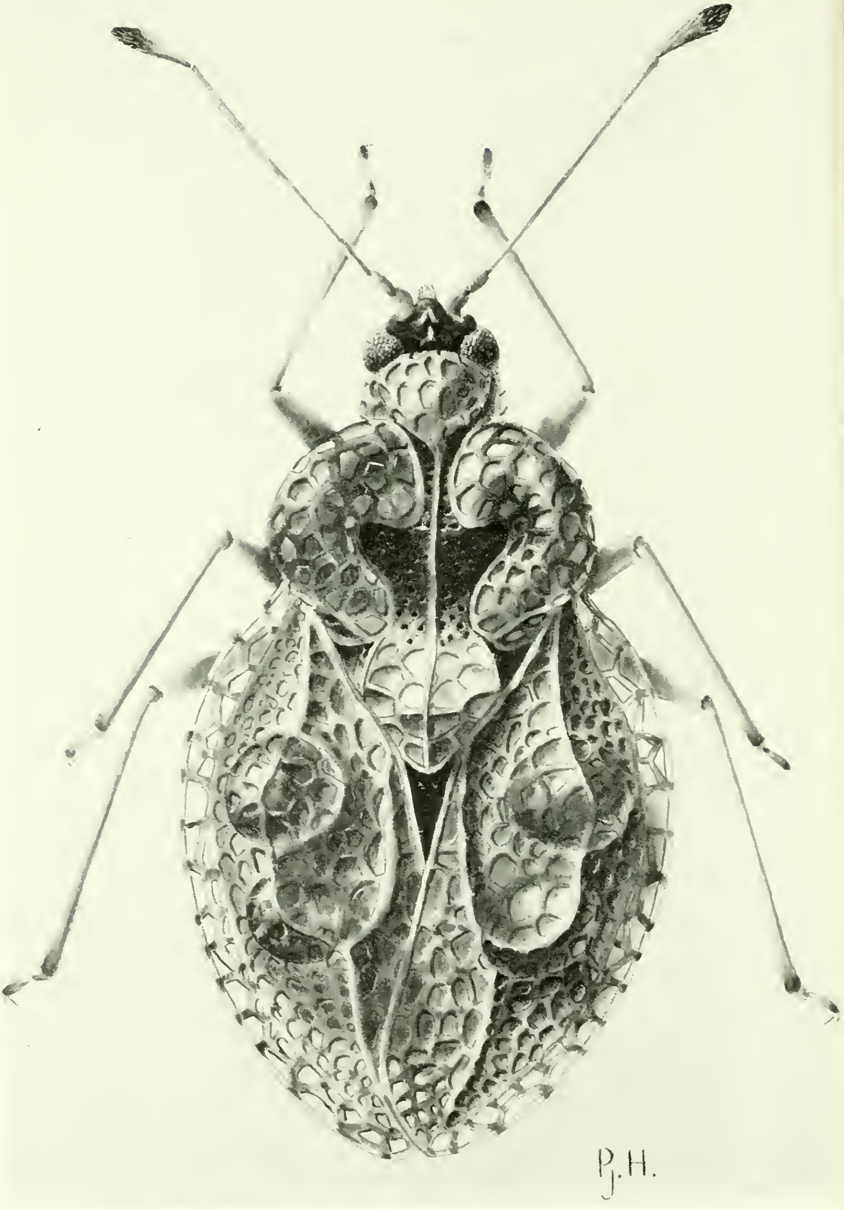
Tingis cardui (Linnaeus).



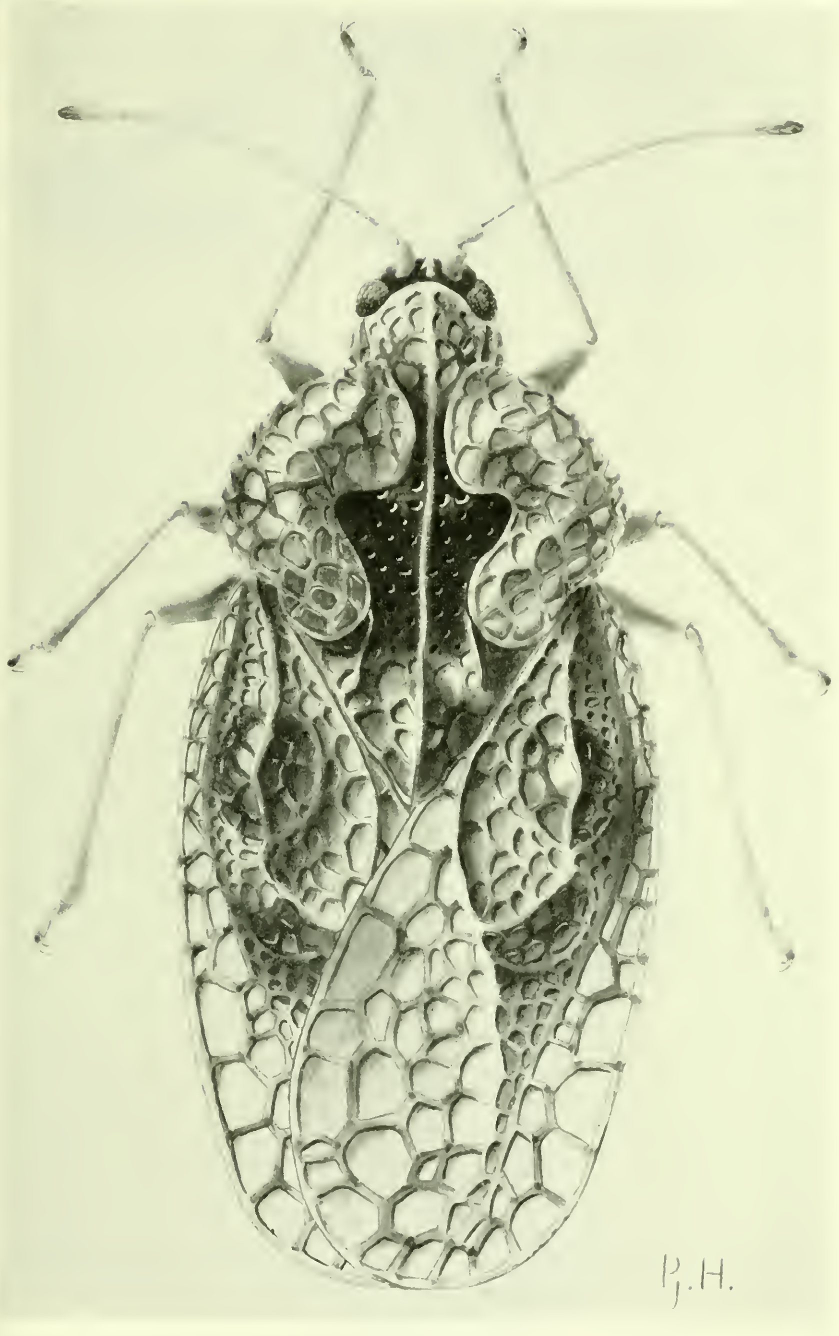
Copium clavicornis (Linnaeus), gall-making lace bug.



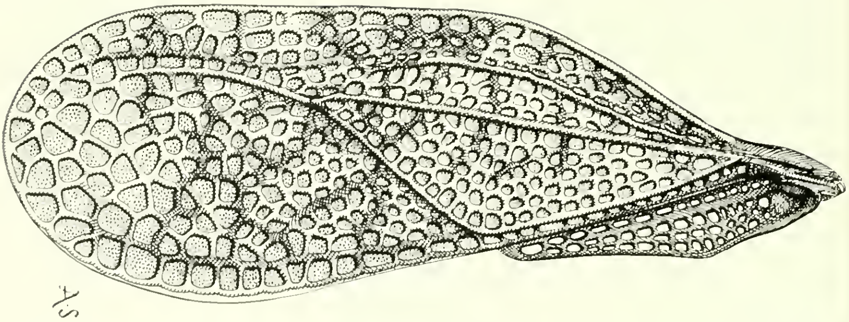
Dictyla platyoma (Fieber), type species of the genus.



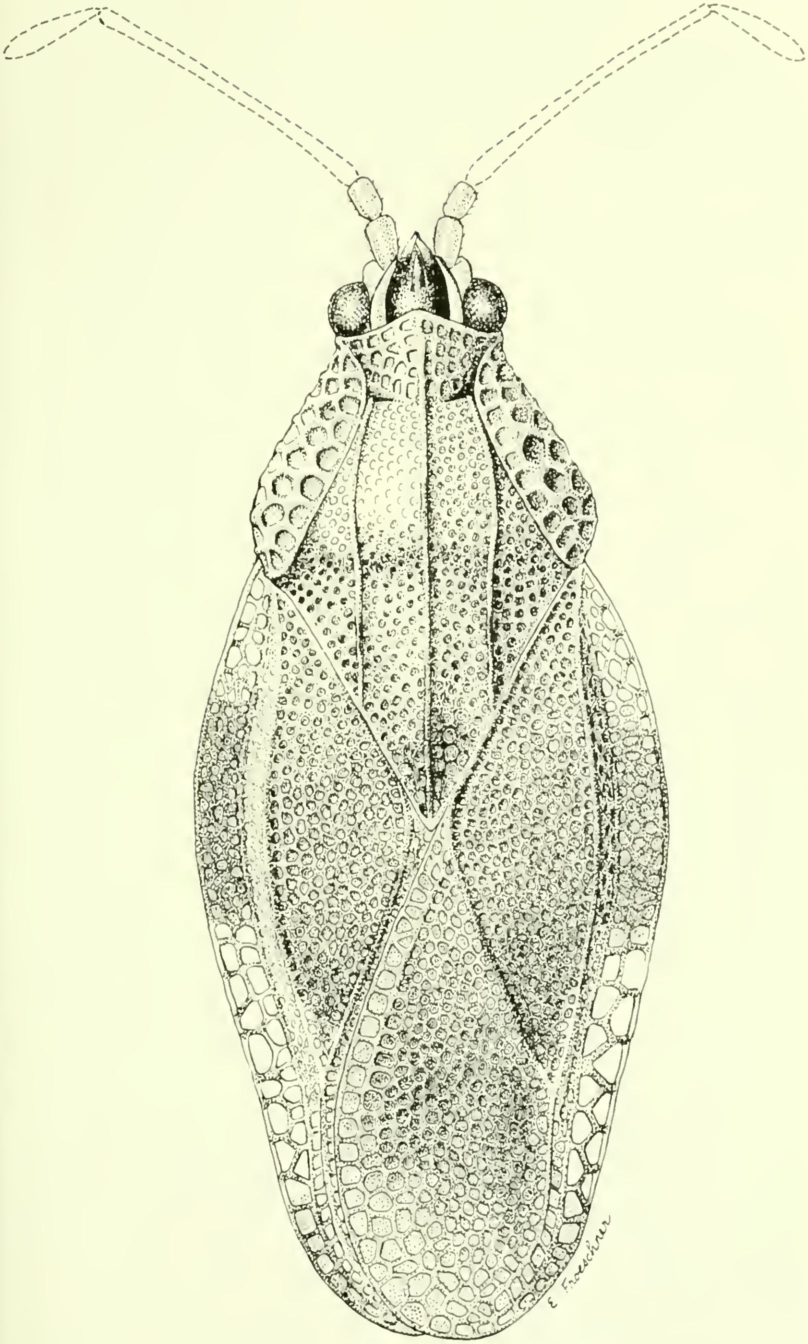
Octacysta rotundata (Herrich-Schaeffer), type species of *Octacysta*, new genus; brachypterous form



Octacysta rotundata (Herrich-Schaeffer); macropterous form.



Penottus monticollis (Walker). The hemelytron is all that remains of the type specimen.



Physatocheila costata (Fabricius). Illustration made from Fabricius' type specimen.

Proceedings of
the United States
National Museum

SMITHSONIAN INSTITUTION • WASHINGTON, D.C.

Volume 112 1960 Number 3432

FLIES OF THE FAMILY CONOPIDAE FROM EASTERN ASIA

By Sidney Camras

This paper is based mainly on specimens in the U.S. National Museum, particularly the collections of D. C. Graham in Szechwan, and T. D. A. Cockerell in Eastern Siberia. Only a few species of Conopidae have been recorded from Szechwan and Western China, but the material from better collected areas has yielded many important records. It has therefore been deemed worth while to list all the specimens examined.

This study has been especially aided by the interest and courtesy of C. W. Sabrosky, U.S. Department of Agriculture, who, besides arranging the loans of material, provided information on types in the Kröber Collection at the U.S. National Museum. Dr. R. Kano, Tokyo Medical and Dental University, has been most helpful by providing information and copies of Matsumura's works, and also some Japanese Conopidae. Dr. C. H. Curran loaned a small collection of the American Museum of Natural History with some very significant specimens.

Genus *Abrachyglossum* Kröber

Abrachyglossum Kröber, Arch. Naturg., vol. 83, Abt. A, Heft 7, p. 142, 1917.

Abrachyglossum cockerelli, new species

Female: Length 10 mm. (without antenna). Head yellow, dark brownish at ocellar tubercle and anterior half of front. Velvety black frontofacial mark. Antenna dark brown, dark yellow on ventral half of first segment, dark reddish on ventral half of second and third segments. Arista black. First antennal segment three times as long as wide. Second segment two times length of first. Third segment about 1½ times length of first. Proboscis black, shorter than length of head. Occiput yellow behind vertex and below, blackish above at sides.

Thorax black, faint white pollinose forming a distinct pleural stripe. Humeri and distal half of scutellum yellow. Metapleura reddish. Coxae black, white pollinose. Legs yellow, blackish in middle of femora forming a distinct black mark on dorsal apical half of hind femur. Tips of claws black. Wings yellowish hyaline, forming an indistinct brownish band between first and third veins and vena spuria. Calypters yellow. Halteres yellow, dark brown at base.

Abdomen black. Pale yellowish distal margin on first, second, fifth, and sixth segments. Blackish yellow distal margin on third and fourth segments. Yellowish white pollinose band on distal margin of second segment and sides of distal margin of first segment. Faint white pollinose on sixth and seventh segments. Theca triangular, about as long as wide.

Type: Holotype, female, USNM 64475, Kongaus, Siberia, August 1923, Cockerell.

This species is similar to *A. capitatum*, but has black on the femora and lacks the yellow pollinose bands on the third and fourth abdominal segments, although the paler areas preceding these bands are present. The frontofacial mark is very prominent in the new species, a character which has not been mentioned in descriptions of *capitatum*. In six specimens of *capitatum* examined, this mark is absent in three, faint in two, and distinct but not as prominent as in *A. cockerelli* in one.

Abrachyglossum wui Ouchi, the only other *Abrachyglossum* described for Asia, is here referred to *Siniconops elegans* (see below).

Genus *Conops* Linné

Conops Linné, Systema naturae, ed. 10, p. 604, 1758.

Conops vesicularis Linné

Conops vesicularis Linné, Fauna Suecica, p. 1903, 1761.

This widely distributed European species has been previously recorded in Asia only from "Siberia."

Material examined: Korea: Suigen, June 3, 1927, T. R. Gardner, 1 female, USNM.

Conops flavipes **Linné**

Conops flavipes Linné, Fauna Suecica, p. 1904, 1761.

The specimen from Suifu lacks the fourth abdominal tergite, but the fourth sternite is present beneath the third tergite. The Szechwan specimens have the scutellum mainly yellow, but otherwise the males agree with European specimens.

In the female, the yellow band on the third abdominal segment is separated in the center. This suggest *Conops licenti* Chen, but there are some other differences in the description of *licenti.*

Conops jozankeanus Matsumura also appears to be very similar, if not the same, as this species.

Material examined: Siberia: Okeanskaya, August 1923, Cockerell, 1 male, author's collection ex USNM; Smolenschina, Aug. 26, 1927, Cockerell, 1 male, USNM. Szechwan: Suifu, alt. 1,000–1,500 ft., June 1–21, 1928, D. C. Graham, 1 male, USNM; near Mupin, alt. 2–8,000 ft., July 1929, D. C. Graham, 1 male, USNM. Manchuria: Yalhenya, Pin-chang Province, July 1–10, 1939, M. I. Nikitin, 1 female, author's collection, ex Steyskal.

Conops thecoides**, new species**

Male: Length 10 mm. Head yellow. Reddish brown vertical stripe on front, widening above and below, divided by a yellow vertical stripe in the center. Antennal prominence above, and most of the facial grooves and keel black. Cheeks reddish posteriorly. Vertex and adjacent occiput translucent yellow. Vestigial ocellar tubercle present. Side of occiput yellow laterally, blackish centrally. Antenna dark reddish brown, more blackish on third segment and arista. Moderately long process on second aristal segment. Proboscis black, nearly 1½ times as long as head.

Thorax black, faintly yellow pollinose on dorsum. Humeri and scutellum entirely bright yellow. Metapleura yellow. Pleura partly reddish, no pollinose stripe. Coxae mainly black, partly dark reddish. Legs dark yellow, reddish on the femora. Middle third of posterior femur diffusely blackish. Apical tarsal segments and tips of claws blackish. Calypters bright yellow. Halteres bright yellow, dark reddish brown at base. Wings hyaline, with dark brown band from costa to fifth vein. Submarginal cell paler apically. Pale mark at center of anterior margin of first posterior cell. Discal cell entirely dark.

Abdomen black, indistinctly yellow pollinose. Orange yellow band on distal margins of first to fourth segments. This band is very narrow on the first segment except at the sides. Sternite of fifth segment very large and prominent, resembling a female theca. Genitalia dark reddish black.

Type: Holotype, male, USNM 64476, Uen Chuan, Szechwan, Aug. 7–14, 1924, D. C. Graham.

This species belongs to the *C. scutellatus* group in having the scutellum entirely yellow, and, as in *scutellatus*, the first abdominal segment has a narrow yellow distal margin. It differs conspicuously from *scutellatus* by the wing pattern, in addition to the unique fifth sternite.

Conops nigrifrons **Kröber**

Conops nigrifrons Kröber, Arch. Naturg., vol. 81, Abt. A, Heft. 11, p. 55, 1915.

Otherwise known only from the type male from Japan. This specimen agrees very well with Kröber's description, except that the cheeks are entirely yellow.

Material examined: Siberia: Okeanskaya, August 1923, Cockerell, 1 male, USNM.

Conops quadrifasciatus **DeGeer**

Conops quadrifasciatus DeGeer, Mémoires pour servir à l'histoire des insectes, vol. 6, p. 104, 1776.

This widely distributed European species has not been previously recorded east of Asia Minor. This specimen has some blackish on the femora, a character occasionally possessed by European individuals.

Material Examined: Siberia: Smolenschina, Aug. 26, 1927, Cockerell, 1 male, USNM.

Subgenus *Asiconops* Chen

Asiconops Chen, Notes d'entomologie chinoise, vol. 6, p. 170, 1939.

This subgenus is characterized by having transverse grooves on the front, anterior to the vertex. In a few species the transverse grooves of the front are relatively indistinct. In addition I have found in the female a tooth-shaped process extending from the middle of the posterior margin of the sixth abdominal segment. Most of the species have a frontofacial mark.

This subgenus dominates the Indo-Malayan representatives of the genus *Conops*.

Type: *Conops aureomaculatus* Kröber.

***Conops (Asiconops) kanoi*, new species**

Male: Length 15 mm. Front brownish yellow, with longitudinal grooves radiating from the antennal prominence and a few transverse grooves in the middle. Vertex and face yellow; most of face and posterior orbit gold pollinose. Lower third of facial keel dark brown. Occiput black. Antenna dark brown. First segment four times as long as wide. Second segment nearly twice as long as first. Third segment as long as first. Arista yellow at base of apical segment; process of second segment small. Proboscis 1½ times length of head, reddish on distal half.

Thorax black; dorsum faintly yellow pollinose, more distinct medial to the humeri, on metanotum, and on metapleura. Humeri dark reddish black. Pleura faintly white pollinose with indistinct pleural stripe. Coxae black, partly dark reddish. Femora black, rufous dorsally and on apical ventral third. Remainder of anterior and middle legs missing. Posterior tibia rufous. Posterior tarsus and tips of claws black. Remainder of claws and pulvilli yellow. Wings brownish yellow hyaline, darker between first and third veins and vena spuria, and along the fifth vein. Veins mainly black apically, yellowish basally. Calypters yellow. Halteres reddish yellow, dark reddish at base of stem.

Abdomen entirely black. Faintly gold pollinose on sides of first to third segments and indistinct narrow distal margin of fourth and fifth segments. Sixth segment faintly yellowish white pollinose.

Type: Holotype, male (author's collection), Niijima, Tokyo, Japan, Aug. 30, 1953, R. Kano.

This species is related to *C. curtulus* but is larger and darker, and differs conspicuously by the absence of the distinct abdominal bands.

Conops (*Asiconops*) *curtulus* Coquillett

Conops curtulus Coquillett, Proc. U.S. Nat. Mus., vol. 21, p. 328, 1898.

The type is a female according to Sabrosky. The brown punctures on the face and cheeks are at the insertions of small hairs and are more or less distinct in many species of *Conops*. *Conops kuriensis* Ouchi is very suggestive of this species.

Material Examined: Japan: Mitsukuri, 1 female paratype, USNM 4000, with second and third antennal segments missing.

Conops (*Asiconops*) *tristis* Chen

Conops (*A.*) *tristis* Chen, Notes d'entomologie chinoise, vol. 6, p. 180, 1939.

The specimens listed are referred here although they are not as dark as the description of *tristis*. The face is not largely infuscated in these specimens.

The specimen from Szechwan has more pollen on the abdomen than the one from Foochow, but no pale bands of ground color, except slightly laterally on apex of fourth segment.

Material examined: Fukien: Foochow, C. R. Kellogg, 1 female, USNM. Szechwan: Mount Omei, 5–11,000 ft., Aug. 24–27, D. C. Graham, 1 female, author's collection ex USNM.

Conops (*Asiconops*) *kulinicus* Chen

Conops (*A.*) *kulinicus* Chen, Notes d'entomologie chinoise, vol. 6, p. 180, 1939.

The specimen examined does not have the sixth abdominal segment gold pollinose, but it is rather "worn." The humerus is distinctly rufous, rather than a little reddish as described for *kulinicus*.

Material examined: Szechwan: Near Mupin, 2–8,000 ft., July 1929, D. C. Graham, 1 female, USNM.

Conops (*Asiconops*) *chinensis*, new species

Male: Length 17 mm. Front and vertical swelling dark rufous. Sides of vertex and adjacent front blackish brown. Frontofacial mark velvety black. Upper part of antennal prominence black. Face yellow, gold pollinose except for antennal prominence. Black at junction of facial and oral keel. Occiput dark reddish, partly blackish centrally. Yellow pollinose posterior orbit extending across back of vertex. Antenna dark reddish to black, rufous on proximal half of third segment. First segment four times as long as wide. Second segment nearly two times length of first. Third segment as long as first. Second segment of arista without definite process. Third segment of arista nearly three times length of first and second combined. Proboscis black, reddish on distal ventral half, about 1½ times length of head.

Thorax black, faintly yellow pollinose including a pleural stripe. More distinct yellow pollinose areas medial to the humeri anterior to the transverse suture, above base of wings, anterior to scutellum, upper half of postnotum, and on the metapleura. Reddish on humeri, calli, and tip of scutellum. Anterior coxae mainly rufous, posterior mainly black. Trochanters rufous. Anterior femur mainly rufous; middle femur blackish dorsally and on basal half; posterior femur black on basal two thirds. Tibiae rufous, blackish basally. Tarsi black, rufous on first segment, especially on posterior tarsus. Pulvilli and claws, except black tips, yellow. Wings faint yellowish brown hyaline, brown between first and third vein and vena spuria, and along fifth vein. Costal and basal cells yellow. Calypters yellow. Halteres yellow, blackish on club and base.

Abdomen black, very narrow reddish margin on third, fourth, and fifth segments and on the genitalia. Gold pollinose distal margins on all segments, the sixth nearly entirely gold pollinose.

Type: Holotype, male, Amer. Mus. Nat. Hist., Yenping, Fukien, June 14, 1917.

This species is related to what I have identified as *C. tristis*, but the front is predominantly rufous, and the humeri, calli, and apex of scutellum are rufous. It agrees with *tristis* in having an entirely dark abodmen. It is also apparently related to *C. hwangi* and *C. opimus,* but these species have a partially reddish abdomen.

Conops (*Asiconops*) *grahami*, new species

Male: Length 16 mm. Front and occiput brownish yellow. Face yellow, gold pollinose except for antennal prominence. Gold pollinose on orbits covering the black frontofacial mark. Spot at center of junction of vertex and front gold pollinose. Occiput brownish yellow, black centrally. Antenna dark reddish brown, black on second segment and on base and apex of arista. Process of second segment of arista relatively small.

Thorax black, humeri and most of scutellum rufous. Thorax faintly yellow pollinose, more distinct medial to the humeri, on the metanotum, and on the metapleura. Indistinct pollinose pleural stripe. Coxae mostly black, anterior coxa partly reddish and gold pollinose. Middle and posterior coxae white pollinose. Femora and tibiae entirely rufous. Tarsi and tips of claws black. Remainder of claws and pulvilli yellow. Wings brownish yellow hyaline with brown pattern between first and third veins and vena spuria, and along the fifth vein. Calypters yellow. Halteres yellow, dark reddish brown at base.

Abdomen black with distinct wide gold pollinose band on distal part of each segment. Sixth segment mostly gold pollinose. Second segment with the gold pollen forming a triangle on each side. Sixth segment rufous except for black spot at base on dorsum. Genitalia partly black, partly rufous.

Type: Holotype, male, USNM 64477, Uen Chuan Shien, Suifu, Szechwan, Aug. 7–14, 1924, D. C. Graham.

The ptilinum and lower front are inflated, but the specimen is not otherwise teneral.

This species seems related to *C. hwangi* but has very distinct pollinose abdominal bands. The pollen covering the frontofacial mark is a character not noted as yet in any other species.

Conops (*Asiconops*) *opimus* Coquillett

Conops opimus Coquillett, Proc. U.S. Nat. Mus., vol. 21, p. 329, 1898.

The specimen from Japan has a black frontofacial mark as does the type according to Sabrosky. The type is also a female.

The specimen from Kuliang is more rufous and thus varies toward *C. rufifrons* of Amboina. The specimens from China referred to *rufifrons* by Ouchi may be this form.

Conops izuoshimensis Ouchi, based on a male, is close to this species if not identical. However the wing veins are described as pale yellowish for *izuoshimensis*. *Conops flavonervosus* Kröber also has yellow wing veins and is closely related, but has the abdomen mainly reddish.

Material examined: Japan: K. Miyushi, 1 female, USNM (arranged as *opimus*, no type label, slightly grease stained). Fukien: Kuliang, 1925, H. A. Jaynes, 1 female, USNM.

Conops (Asiconops) rufomaculatus Kröber

Conops rufomaculatus Kröber, Arch. Naturg., vol. 81, Abt. A, Heft 11, p. 44, 1915.

The specimen examined has the dorsum of the thorax black, except for the humeri, sides, and scutellum. The first antennal segment is dark yellow, although the species was described as having the antenna black, third segment dark red brown.

I do not find any significant differences between this species and descriptions of *aureomaculatus* (=*pieli*).

Material examined: Formosa: Kagi, 1 female cotype, Kröber collection No. 24283, USNM.

Conops (Asiconops) szechwanensis, new species

Female: Length 13 mm. Front dark reddish yellow, more yellowish on the vertex. Indistinct rufous frontofacial mark. Face and grooves yellow, gold pollinose except for antennal prominence. Blackish at base of facial keel. Posterior orbit yellow pollinose. Occiput dark yellow, blackish centrally. Antenna black, dark reddish black on third segment. First segment four times as long as wide. Second segment less than twice as long as first. Third segment nearly as long as first. Process of second segment of arista small. Proboscis black, yellowish on apical half, about 1½ times length of head.

Thorax black, faintly yellowish pollinose more distinct medially to the humeri, on the metanotum, and on the metapleura. No definite pleural stripe. Humeri and apical margin of scutellum rufous. Coxae black, yellowish white pollinose. Trochanters black. Femora mainly black, partly rufous. Posterior femur rufous only at narrow base and apical ventral third. Tibiae rufous. Tarsi and tips of claws black, remainder of claws and pulvilli yellow. Wings dark yellowish hyaline with darker pattern between first vein and third vein and vena spuria, and along the fifth vein. Wing pattern yellowish at base, blackish apically. Halteres bright yellow, dark reddish brown at base.

Abdomen mainly black, reddish on posterior margin of second to fifth segments, sides of third and sixth segments, and most of the seventh segment. Theca black, as long as wide. Genitalia black.

Male: Length 14 mm. Similar to the female. Rufous frontofacial mark more distinct. Process on second segment of arista longer. Gold pollen on second segment of abdomen more extensive laterally.

Types: Holotype, female, USNM 64478. Allotype, USNM, Suifu to Hongya, Szechwan, alt. 1,000–1,400 ft., June 15–21, 1929, D. C. Graham. Paratype: Szechwan: 1 male, author's collection ex USNM, between Yachow and Suifu, 1–2,200 ft., May 27 to July 14, 1930, D. C. Graham.

This species is similar to *C. rufomaculatus* and *C. aureomaculatus*, but is darker with the femora being mainly black.

Conops (*Asiconops*) *thecus*, new species

Female: Length 14½ mm. Front dark reddish brown with distinct darker reddish brown frontofacial mark. Vertex more yellowish. Face and grooves yellow, gold pollinose except for antennal prominence. Black mark at junction of facila and oral keel. Occiput mainly black, dark reddish yellow laterally. Posterior orbit gold pollinose. First antennal segment rufous, four times as long as wide. Second segment less than twice the length of first, dark reddish black. Third segment as long as first, dark reddish basally. Arista black, process of second segment indistinct. Proboscis black, yellowish in the middle, about 1½ times length of head.

Thorax black, faintly yellowish pollinose. Humeri, posterior calli, and entire scutellum rufous. Coxae mainly black, partly reddish. Trochanters and narrow base of femora rufous. Apical dorsal third of femora reddish, apical ventral third rufous. Tibiae rufous. Tarsi yellowish proximally, black apically and on tips of claws. Remainder of claws rufous, pulvilli yellow. Wings pale yellow hyaline, darker between first and third veins and vena spuria, on anterior half of first basal cell, and along fifth and sixth veins. Calypters yellow. Halteres yellow, reddish on club and base of stem.

Abdomen mainly black, rufous on apex of second to fifth segments, apical half of sixth, and nearly entire seventh segment. This color on the sides of the second segment extending basally. Yellow pollinose on apical margin of first segment, sides of second segment, most of sixth and seventh segments, and indistinctly on the theca. Theca black, very large, twice as long as wide. Genitalia shiny black, partly reddish.

Type: Holotype, female, USNM 64479, Suifu, Szechwan, D. C. Graham.

This species is related to *C. opimus*, but has a rufous frontofacial mark and yet is darker in general coloration. Superficially it resembles *C. grahami* very much, but differs in the size of the theca and in the color of wing, scutellum, calli, trochanters, and other structures.

Conops (*Asiconops*) *rufigaster*, new species

Male: Length 15 mm. Front entirely deep black. Vertex dark reddish in middle. Velvety black frontofacial mark. Face yellow, gold pollinose except for antennal prominence, black at junction of facial and oral keel and on adjacent facial grooves. Occiput black. Yellow pollinose postorbitals extending across back of occiput. Antenna entirely black, faintly reddish on ventral part of first and third segments. First segment four times as long as wide. Second segment nearly two times as long as first. Third segment as long as first. Process of second aristal segment indefinite. Proboscis black, over 1½ times length of head.

Thorax black, reddish only on apical half of scutellum, faintly yellow white pollinose. Coxae mainly rufous, partly black. Trochanters rufous. Femora black, rufous on narrow base and basal ventral third. Distal third of posterior femur entirely rufous. Tibiae black, reddish on basal two thirds of posterior tibia. Tarsi and apical third of claws black. Pulvilli and remainder of claws yellow. Wings brownish hyaline, brown pattern from costa to fourth vein and vena spuria, and along fifth vein. Brown pattern gradually fading into the hyaline area. Calypters dark yellow. Halteres rufous, brown at base.

Abdomen entirely rufous except for black basal half of first segment and parts of the genitalia. Irregular and indefinite blackish area on third to fifth segments. White pollinose on distal half of first segment. Faintly yellow pollinose on apical part of sixth segment.

Type: Holotype, male, USNM 64480, Biliran Island, Philippines, Baker.

This species is related to some of the species of the *C. nubeculosus* group, having the abdomen almost entirely rufous. However, the antennae are mainly black.

***Conops (Asiconops) nubeculosus* Bigot**

Conops nubeculosus Bigot, Ann. Soc. Ent. France, ser. 7, vol. 6, p. 36, 1887.

The specimen from Malaya lacks a dorsal stripe as in the variety *indicus*, but has the wing entirely dark as in the variety *bigoti* (=*ornatus*). The specimen from the Philippines has three dark dorsal stripes and the tibia is white pollinose as in variety *bigoti*, but the wing is normally patterned.

Material examined: Malaya: Kepong, Selangor, August 1949, 1 male, author's collection ex USNM. Philippines: La Carlota, central Negros Occidental, Sept. 13, 1930, F. P. Goseca, 1 male, USNM.

***Conops nigriventris* Brunetti**

Conops nigriventris Brunetti, *in* Fauna of British India . . . , Diptera, vol. 3, p. 346, 1923.

This species has previously been known only from the description of two males from Assam.

The specimen examined has a slight elevation within a very slightly depressed area on the vertex. Such a change occurs in a few other species of *Conops* (s.s.), and represents a vestigial ocellar tubercle. Kröber in adding to the description of the type (Ann. Mag. Nat. Hist. ser. 11, vol. 5, p. 229, 1940), states that there is a distinct ocellar swelling (=tubercle) with two ocelli, and because of the spindle shaped abdomen, considers this species to be closely related to *C. nigripes*. However, this female shows that it is not at all related to *nigripes*, which belongs to *Siniconops*. The female has a small triangular theca with tip slightly hooked. The robust spindle shape of the abdomen is also entirely different from the long cylindrical abdomen of the female of *nigripes*.

This species is very distinctive structurally by having robust bristles on the sides of the dorsum of the thorax, and on the sternopleura. There is also a prominence of fine bristles on the dorsum of the thorax and on the abdomen.

Material examined: Siam: Chiengmai, Oct. 23, 1920, 1 female, Amer. Mus. Nat. Hist.

Genus *Siniconops* Chen

Siniconops Chen, Notes d'entomologie chinoise, vol. 6, p. 197, 1939.

Similar to *Conops*, but having an ocellar tubercle, usually with two ocelli; and usually with a vertical swelling. The third and fourth abdominal segments are enlarged in both sexes so that the male abdomen is spindle shaped, and the female abdomen is elongated and cylindrical. The fifth, sixth, and seventh segments are relatively small in the female, but the theca is proportionately large and tooth-shaped.

Type: *Sinoconops elegans* Chen.

I am using the term vertical swelling (i.e., swelling of the vertex) after Kröber, instead of ocellar vesicle as used by Séguy and Chen. Since ocellar vesicle is apt to be confused with ocellar swelling which Kröber and I have used for the ocellar tubercle, it is best to drop both of these terms. The ocellar tubercle is the small swelling within the ocelli (if present), at the anterior angle of the vertical swelling. The vertical swelling may be triangular and distinct from the vertex, or it may coincide with the vertex.

In addition to the species recorded here, *Physoconops microvalvus* Kröber belongs to this genus, although the base of the abdomen is relatively narrow.

Siniconops maculifrons (Kröber)

Conops maculifrons Kröber, Arch. Naturg. vol. 81, Abt. A, Heft 11, p. 41, 1915.

The frontofacial mark is weak, but present in the specimen from Manchuria. It is absent in the specimen from Siberia.

Material examined: Manchuria: Yalhenya, Pin-chang Province, Aug. 7–12, 1939, M. I. Nitkin, 1 female, author's collection ex Steyskal. Siberia: Kongaus, August 1923, Cockerell, 1 female, USNM.

Siniconops elegans Chen

Siniconops elegans Chen, Notes d'entomologie chinoise, vol. 6, p. 198, 1939.

Abrachyglossum wui Ouchi, Journ. Shanghai Sci. Inst., sec. 3, vol. 4 (1939) p. 195, 1940.

The males of this species differ from the males of the other species examined by having the apical abdominal segment more elongated dorsally, and more pointed (see illustration of *wui* Ouchi, ibid., pl. 17).

Material examined: Fukien: Amoy, 1 male, USNM; Yenping, July 19–Sept. 11, 1917, 2 males and 5 females, Am. Mus. Nat. Hist. and author's collection.

Siniconops curtirostris (Kröber)

Conops celebensis (Meijere) Kröber, Arch. Naturg., vol. 81, Abt. A, Heft 7, p. 52, 1915 (*C. curtirostris* Kröber cited as manuscript name on p. 53, under *celebensis*).

Conops curtirostris Kröber; Ann. Mag. Nat. Hist., ser. 11, vol. 5, p. 219, 233, 1940 (previously misidentified as *celebensis*).

This species is very close to *S. elegans*, but the front is almost entirely black, and the abdomen has less yellow.

Material examined: Sikkim, 1 female, USNM, labeled *celebensis* Kröber, determined 1914 (=cotype *Conops curtirostris*).

Siniconops nigripes (Kröber)

Conops nigripes Kröber, Ent. Mitt. Berlin, vol. 2, p. 278, 1913.

Similar to *S. elegans* but paler, wing more diffusely yellowish, and humeri and scutellum rufous.

Material examined: Formosa, Sauter, 5 males and 5 females, author's collection ex Hungarian Mus.

Siniconops species

The specimen examined is badly crushed and not suitable as the basis of a new species. Superficially it is very similar to *S. nigripes*, but the wing is less yellowish and the general coloration averages darker. The genitalia are mainly black, and the third antennal segment is proportionately longer. The junction between the subcostal and first vein (sc-r) is distal to the anterior crossvein (r-m).

Material examined: Szechwan: Near Mupin, 2–8,000 ft., June 28, 1929, D. C. Graham, 1 male, USNM.

Siniconops splendens, new species

Male: Length 16 mm. Front dark reddish, surrounded by velvety black. Vertex dark reddish and shiny. Ocellar tubercle blackish with two distinct yellow ocelli. Face dark reddish yellow at anterior orbit and in facial grooves. Posterior cheeks and median band in facial grooves velvety black. Occiput dark yellow with narrow velvety black posterior orbit and stripes from sides of vertex to neck. Antenna black, rufous on medioventral surface. First segment about two times as long as wide. Second segment three times as long as first. Third segment a little longer than first. Process on second segment of arista small. Third segment of arista three times as long as first and second combined. Proboscis as long as head, black, rufous basally.

Thorax velvety black, reddish on apex of scutellum and parts of pleura. Indistinct yellow pollen on thorax especially at metanotum, metapleura, and forming a diffuse pleural stripe. Coxae black, partly rufous on the anterior coxa. Anterior femur mainly rufous, a little blackish ventrally. Middle femur rufous above, blackish below. Posterior femur mainly blackish with a rufous longitudinal stripe, and rufous at apical ventral third. Tibiae dark yellowish, blackish apically on posterior tibia. Tarsi dark yellowish. Pilvilli and claws, except black tips, yellow. Wings grayish yellow hyaline, more yellowish basally between first and fourth vein, but no definite wing pattern. Junction of subcostal and first vein slightly proximal to anterior cross-vein. Calypters blackish. Halteres yellow, black at base.

Abdomen dull black on first and third segments. Reddish and then golden yellow on apical margin of second segment, apical half of third segment, and almost all of fourth segment. Fifth and sixth segments and genitalia entirely golden yellow. Narrow reddish distal margin on first segment.

Type: Holotype, male, USNM 64481, Yachow, Szechwan, Aug. 16, 1928, D. C. Graham.

Related to *nigripes*, but very distinct by having the black areas velvety, and the apical half of the abdomen mainly orange and gold pollinose.

***Siniconops grandens*, new species**

Male: Length 20.5 mm. Front and vertex yellow, slightly darker near back of antennal prominence and anterior to vertex. Vertical swelling and part of ocellar tubercle darker. Small velvety black frontofacial mark. Face yellow, cheeks blackish. Junction of facial and oral keel dark reddish. Posterior orbit and upper occiput yellow, remainder of occiput black. Antenna black, partly reddish on third antennal segment. First antennal segment two times as long as greatest width. Second segment three times as long as first. Third segment slightly longer than first. Process of second segment of arista is small but distinct. Third aristal segment short, hardly longer than first and second combined. Proboscis as long as head, black.

Thorax black, dark reddish yellow on humeri, most of scutellum, and parts of the pleura. Faint yellowish pattern on pleura forming indefinite pleural stripe. Coxae dark reddish. Femora reddish anteriorly, blackish posteriorly. Tibiae mainly dark rufous, partly black. Tarsi and tips of claws black. Pulvilli and remainder of claws dark reddish yellow. Wings dark yellowish hyaline. Dark brownish band between first and third veins and vena spuria, gradually diffusing with the hyaline area. Costal and basal cells more yellowish. Anterior cross-vein proximal to junction of subcostal and first vein. Calypters dark blackish red. Halteres yellow, partly rufous, brown at base.

Abdomen black on first segment, midline and anterior margin of second segment, most of third segment, sides of remaining segments and on the genitalia. Golden yellow pollinose on distal margin of first to third segments, sides of second segment, and most of remaining segments.

Type: Holotype, male, USNM 64482, Yachow, Szechwan, 2,200–5,000 ft., Aug. 21–25, 1930, D.C. Graham.

This very distinctive species is related to *S. maculifrons*, and *S. philippinensis* in having the second abdominal segment yellow with a black midline.

***Siniconops philippinensis* (Kröber)**

Conops philippinensis Kröber, Philippine Journ. Sci., vol. 34, p. 340, 1927.

The front of the specimen examined is predominantly black, although basically the front is yellow with a large black area in the center and velvety black laterally and dorsally. The black at the lower lateral margin forms a distinct frontofacial mark. These differences from the description of the type (male) are within the variation seen in *Siniconops nigripes* and *Siniconops microvalvus* (formerly placed in *Physoconops*).

Material examined: Philippines, Mount Makiling, Luzon Island, Baker, 1 female, USNM.

Genus *Archiconops* Kröber

Archiconops Kröber, Ann. Mag. Nat. Hist., ser. 11, vol. 4, p. 381, 1939.

***Archiconops erythrocephalus* (Fabricius)**

Conops erythrocephalus Fabricius, Entemologica systemica . . . , vol. 4, p. 392, 1805.

Conops niponensis Vollenhoven, Versl. Meded. Akad. Wet., vol. 15, p. 10, 1863.

Conops nigricans Matsumura, Thousand insects of Japan, Additamenta 2, p. 262, 1916.

The specimen from Siam is more shiny and violaceous than the specimens from China and Japan. The specimens from China have a variable amount of hyaline at the base of the wing, but not as much as the Japanese specimen. This variation is seen in the closely related *Archiconops morosus*, and it seems best at present to unite *erythrocephalus* and *niponensis*. *Conops nigricans* Matsumura also appears to be this species.

Material examined: Siam: "7-6-1928," Hugh Smith collection, 1 male, USNM. Chekiang: Hangchow, July 19, 1925, T. P. Chao, 1 female, author's collection ex USNM; Hangchow, July 11, 1927, C. Y. Wong, 1 female, USNM. Kiangsu: Penniu, July 17, 1926, W. Shien, 1 male, USNM. Japan: Mitsukuri, 1 male, USNM, determined *niponensis* by Coquillett.

Genus *Physocephala* Schiner

Physocephala Schiner, Wiener Ent. Monatschr., vol. 5, p. 137, 1861.

Physocephala rufifrons, new species

Female: Length 17 mm. Front and vertex dark rufous, blackish above antenna extending on each side in a line to upper part of face. Face and lateral margin of front yellow. Upper half of keel black. Cheeks brown. Occiput black, lower half of posterior orbit rufous Antenna predominantly dark reddish brown, brighter ventrally and medially. First segment two times as long as wide. Second segment over 2½ times length of first. Third segment two times length of first. Arista black. Process of second segment of arista very long, as long as distal segment. Proboscis black, nearly two times length of head.

Thorax mainly black, rufous on humeri and scutellum, reddish on sides of thorax and parts of pleura. Coxae black. Legs rufous. Posterior femur blackish, rufous at apex and base. Apical tarsi and tips of claws blackish. Pulvilli very dark. Wing dark brownish from costa to fifth vein. Costal cell slightly paler. Hyaline areas in submarginal cell, first posterior cell, and apical half of discal cell. Calypters dark brown. Halteres dark brown, yellowish on pedicel.

Abdomen reddish. First segment black except for sides. Second segment with a pair of large black marks on basal half. Dorsum of third segment mainly black. Basal half of fourth and fifth segments black. Paired marks at base of sixth and seventh segments black. Genitalia shiny black. Theca folded under abdomen.

Type: Holotype, female, USNM 64483, Ningyuenfu, Szechwan, 6,000-10,800 ft., July 24-26, 1928, D. C. Graham.

This species belongs to the *P. vittata* group, but has the front rufous.

Physocephala ammophiliformis Kröber

Physocephala ammophiliformis Kröber, Arch. Naturg., vol. 81, Abt. A, Heft 4, p. 122, 1915.

There is a variable amount of yellow on the lower lateral part of the front, so that the specimen from Mount Omei approaches having a black "T" pattern on the front. Another specimen is more reddish, with some black at the base of the hind femur, but no black ring.

Compared with a male and female of *P. gigas* from Java, which Kröber thinks may be synonymous, *gigas* differs by having barely a trace of reddish brown on the second abdominal segment. Also the legs are darker, but a black ring is distinguishable near the base of the hind femur, and the pedicle of the abdomen is more slender in *gigas*.

Material examined: Szechwan: Shin Kai Si Mount Omei, 3–5,000 ft., July–August 1923, D. C. Graham, 1 male, USNM; Kuanshien, 3,000 ft., Apr. 5–May 8, 1930, D. C. Graham, 2 males, USNM and author's collection.

Physocephala nigra (DeGeer)

Conops nigra DeGeer, Memoires pour servir à l'histoire des insectes, vol. 6, p. 105, 1776.

The abdomen of the specimen examined is grease stained so that the pollinose bands are not distinct. This species has not previously been recorded east of Turkestan.

Material examined: Manchuria: Tsingtao, July 1938, Weymarn, D. G. Hall collection, 1 female, USNM.

Physocephala obscura Kröber

Physocephala obscura Kröber, Arch. Naturg., vol. 80, Abt. A, Heft 10, p. 53, 1914.

The first four specimens listed agree with the original description but are smaller, 12–15 mm. The cotype agrees with the description of the female, but may represent another species. It is more robust, yellow pollinose, and more extensively rufous; and most of the front is reddish, not forming a midline.

Material examined: Siberia: Kongaus, August 1923, Cockerell, 2 males, USNM and author's collection; Okeanskaya, August 1923, Cockerell, 2 males, USNM and author's collection; "Wladiwastock," 1 male, cotype, USNM.

Physocephala chrysorrhoea (Meigen)

Conops chrysorrhoea Meigen, Systematische Beschreibung der bekannten Europäischen zweiflügeligen Insekten, vol. 4, p. 128, 1824.

The specimen examined belongs to the variety *P. truncata;* but the related new species described below, from the same locality, has the wing of the typical form.

Material examined: Hopeh: Chao Yang, July 13, 1921, A. P. Jacot, 1 female, USNM.

Physocephala theca, new species

Female: Length 10 mm. Front, face, and cheeks yellow; blackish on apex of vertex, at base of antenna, and in the middle of facial grooves. Vertex translucent dark yellow. Occiput black. Posterior orbit white pollinose above, yellow pollinose below. Antenna dark reddish brown, blackish above. First segment three times as long as wide. Second segment three times length of first. Third segment nearly one and one half times length of first. Process of proximal segment of arista moderate, nearly as long as apical segment of arista. Proboscis blackish, reddish in the middle, nearly two times length of head.

Thorax black. Distinct yellow pollinose pleural stripe. Yellow pollinose areas present adjacent to humeri, on metathorax and on postnotum. Humeri rufous, scutellum entirely black. Coxae dark reddish black, partially yellow pollinose. Legs bright rufous, darker on apex of posterior tibiae and on tarsi. Claws blackish, pulvilli yellow. Wings dark brownish from first to fifth vein. Costal and subcostal cells yellowish. Apical half of first basal cell hyaline. Apical half of first posterior cell abruptly hyaline. Apical two thirds of discal cell hyaline except for posterior margin. Calypters yellow. Halteres rufous, dark brownish at base.

Abdomen mainly black, rufous at junction of second and third segments. Dark reddish at base of seventh segment and on the theca. Gold pollinose at distal margin of first to fifth segments and diffusely on parts of sixth and seventh segments. Theca very large, twice as long as wide. Posterior black serrate area slightly longer than wide, rufous proximally.

Male: 9 mm. Similar to the female, but front entirely black. Abdomen grease stained, rufous on most of second and third segments and at apical half of sixth segment.

Types: Holotype, female, USNM 64484, Chao Yang, Hopeh, July 9, 1921, A. P. Jacot. Allotype, Chao Yang, Hopeh, July 20, 1921, A. P. Jacot, author's collection ex USNM.

This species is very close to *P. chrysorrhoea* differing by the very large theca. There are no good characters for distinguishing the male. *P. vaginalis* of Southern Europe, differs by having the theca light reddish brown, and the wing pattern extending only to the third vein.

Physocephala pusilla (Meigen)

Conops pusilla Meigen, Systematische Beschreibung der bekannten Europäischen zweiflügeligen Insekten, vol. 4, p. 131, 1824.

The second specimen listed is questionably referred here because it is very dark and there is a trace of an apical spot on the wing. However it is too small and slender for *P. sinensis*.

Material examined: Shantung: Tsinan, May 27, 1922, A. P. Jacot, 1 female, USNM. Hopeh: Chao Yang, Aug. 10, 1923, A. P. Jacot, 1 female, author's collection ex USNM.

Physocephala melana, new species

Female: Length 8 mm. Front and vertex dark yellowish. Black. ish in middle of front, and at groove at anterior margin of vertex- Face and cheeks yellow. Upper two thirds of facial groove and keel black. Occiput black, paler below. Posterior orbit white pollinose. Antenna dark reddish yellow, blacker dorsally. First segment two and one half times as long as wide. Second antennal segment three times length of first. Third segment one and one half times length of first. Process on proximal segment of arista moderate, as long as apical segment of arista. Proboscis dark, reddish in middle, nearly two times length of head.

Thorax black. Yellow pollinose pleural stripe. Yellow pollinose areas near humeri on metapleura and on postnotum. Humeri and narrow margin of posterior calli rufous. Scutellum entirely black. Coxae dark reddish brown, yellow pollinose. Legs rufous, darker on tarsi. Distal three fifths of posterior femur. except apex, black. Claws black, pulvilli yellow. Calypters dark brownish yellow. Halteres rufous, dark brown at base.

Abdomen short and robust, mainly black. Narrow dark reddish areas at junction of second and third segments and apical margins of third to sixth segments. Faint white pollinose in part, with gold pollinose areas on apical margin of third to sixth segments. Theca shorter than wide.

Type: Holotype, female, USNM 64485, Trang Bom, 30 miles northwest of Saigon, Cochin China, Aug. 8, 1932, M. Poilane.

This species is very close to *P. limbipennis* in coloration, but structurally it is quite distinct. The abdomen is relatively short and robust, and the theca is very short and wide. This short wide abdomen is one of the characters of *Pseudophysocephala,* but the head in this species is normal.

Physocephala sinensis Kröber

Physocephala sinensis Kröber, Ark. Zool., vol. 26, p. 15, 1933.

This species does not have any specific color character to distinguish it from *P. pusilla,* as the apical spot on the wing is not always present. However, this series is larger and more robust, and the abdomen is more club shaped, so that the specimens are readily separable from *pusilla*.

Material examined: Szechwan: Suifu, 1,000–1,500 ft., June 1–21, 1928, July 1929, D. C. Graham, 1 with abdomen missing, 1 male, USNM and author's collection; Suifu to Hongya, 1,000–1,450 ft., June 15–21, 1929, D. C. Graham, 1 male, 1 female, USNM; Chungking, 1–2,000 ft., May 6–27, 1930, D. C. Graham, 1 male, author's collection ex USNM; Yao-Gi, 4–8,000 ft., July 3, 1929, D. C. Graham, 1 male, author's collection ex USNM. Hupeh: Hsiang Shan, 1 female, USNM. Chekiang: Hangchow, June 27, 1927, July 15, 1927, C. Y. Wong, 2 females, USNM and author's collection. Kiangsu: Penniu, Aug. 15, 1925, C. Y. Wong, 1 male, USNM. Hopeh: Peking, August 1921, 1 male, Amer. Mus. Nat. Hist.

Physocephala bipartita (Doleschall)

Conops bipartita Doleschall, Natuurk. Tijdschr. Nederland. Indië, vol. 17 (1858–59), p. 100, 1858.

This species has previously been recorded from Java, Sumatra, Philippines, Mollueeas, and Celebes.

Material examined: Malaya: 16 miles north of Kuala Lumpur, Selangor, Malaya, March 1949, R. Traub, B. Insoll, 1 female, USNM.

Physocephala elongata, new species

Male: Length 9½ mm. Vertex, front, and face dark yellow. Blackish in middle at junction of vertex and front. Black on front forming an indistinct midline. Black above base of antenna extending indistinctly to upper part of face. Large black mark in middle of facial grooves including that part of the keel. Occiput yellowish black, paler below. Postorbitals yellowish white pollinose. Antenna nearly blackish on ventral and medial surfaces. First segment four times as long as wide. Second segment nearly 2½ times the length of first. Third segment nearly 1½ times length of first. Arista with elongated process on proximal segment as long as distal segment. Proboscis mainly yellowish, 2½ times length of head. Head nearly twice as high as long. Shiny triangular area at posterior margin of eye large and prominent.

Thorax dull black. Humeri and parts of pleura dark yellow. Yellow white pollinose pleural stripe, and pollinose area medial to humeri and on postnotum. Coxae reddish black, white pollinose. Legs dark yellow. Blackish above on femora, forming an indistinct subbasal ring. Tarsi darker. Pulvilli and claws, except black tips, dark yellow. Wing with dark pattern from costa to third vein extending to apex. Basal half of first posterior cell dark, remainder abruptly hyaline. Dark margin along sixth vein. Calypters dark yellowish brown. Halteres bright yellow, blackish at base.

Abdomen black. Second segment and basal half of third segment dark yellowish. Narrow distal margin on third, fourth, and fifth segments dark reddish yellow. Apical half of sixth segment and genitalia mainly dark reddish yellow. Pedicle of abdomen longer than club of abdomen.

Type: Holotype, male, USNM 64486, Ulu Gombak, Selangor, Malaya, Dec. 25, 1947, W. H. Lange.

This species is very close to *P. bipartita* in coloration, the differences being mainly structural. The abdomen is relatively long and slender and the head is relatively short (flattened), with a large triangular polished area on the posterior margin of the eye. The head characters are that of *Pseudophysocephala*, and Kröber did include one species with an elongated (instead of short) abdomen. However, the new species *Physocephala melana* is an intergrade, and there are species with a rounded head but large triangular eye area; so that at present I do not believe that *Pseudophysocephala* can be maintained.

Physocephala pielina **Chen**

Physocephala pielina Chen, Notes d'entomologie chinoise, vol. 6, p. 190, 1939.

The specimen examined agrees with the description, but is more brownish, less blackish; and the first basal cell is more hyaline.

Material examined: Fukien: Foochow, May 1924, C. R. Kellogg, 1 female, USNM.

Physocephala aterrima **Kröber**

Physocephala aterrima Kröber, Arch. Naturg., vol. 81, Abt. A, Heft 4, p. 122, 1915.

The specimen examined agrees very well with the original description, although the pollinose pleural stripe is relatively indistinct. Size: 12 mm.

This species has been previously recorded only from Sikkim and Chekiang, China.

Material examined: Indochina: Luang Prabang, 1,000 ft., June 30, 1929, Kelly-Roosevelt Expedition, 1 female, Chi. Nat. Hist. Mus.

Genus *Myopa* Fabricius

Myopa Fabricius, Systema entomologiae . . ., p. 798, 1775.

Myopa picta **Panzer**

Myopa picta Panzer, Faunae insectorum Germaniae initia, vol. 59, p. 22, 1798.
Myopa chusanensis Ouchi, Journ. Shanghai Sci. Inst., sec. 3, vol. 4 (1939), p. 205, 1940.

Kröber incorrectly describes the third antennal segment as being about as long as the second. However, his illustrations show the correct proportion. The other differences given by Ouchi for *chussanensis* fall into the range of variation. European specimens average darker and more distinctively colored, but the differences do not warrent a separate name.

Material examined: Shantung: Tsinan, Apr. 7, 1928, Apr. 8, 1930, A. P. Jacot, 2 males, author's collection and USNM. Kiangsu, Soochow, 1 male, USNM. Szechwan, Kuanshien, 3,000 ft., Apr. 5 to May 8, 1930, D. C. Graham, 1 male, USNM; Szechwan, D. C. Graham, 1 male, USNM. Chekiang; Hangchow, Apr. 10, 1926, T. P. Chao, 1 male, author's collection and USNM.

Myopa buccata (Linné)

Conops buccata Linné, Fauna Suecica, p. 1905, 1761.

Myopa sinensis Chen, Notes d'entomologie chinoise, vol. 6, p. 215, 1939.

In describing *sinensis*, Chen apparently misinterpreted Kröber's use of the term "wulst." *Myopa buccata* does not have any spots on the face, but does have some on the occipital swelling behind the face. As in the previous species, European specimens average darker with more contrast between light and dark areas.

Material examined: Shantung: Tsinan, Mar. 18 to Apr. 25, 1922, 1931, A. P. Jacot, 7 males, 1 female, USNM and author's collection. Szechwan: Kuanshien, 3,000 ft., Apr. 5–May 8, 1930, D. C. Graham, 1 male, USNM; no locality, D. C. Graham, 1 female, USNM. Chekiang: Hangchow, Mar. 20, 1930, 1 female, USNM; Hangchow, Mar. 27–Apr. 24, 1926, T. P. Chao, 3 males, USNM and author's collection.

Myopa curtirostris Kröber

Myopa curtirostris Kröber, Arch. Naturg., vol. 81, Abt. A, Heft 7, p. 32, 1915.

This species has previously been known only from the type female from Amur.

Material Examined: Manchuria: Tsingtao, July 1938, Weymarn, D. G. Hall collection, 1 female, USNM.

Myopa fasciata Meigen

Myopa fasciata Meigen, Klassifikazion und Beschreibung . . . , vol. 1, p. 286, 1804.

Material examined: Manchuria: Tsingtao, July 1938, Weymarn, D. G. Hall collection, 3 females, USNM and author's collection.

Myopa testacea (Linné)

Conops testacea Linné, Systema naturae, ed. 10, vol. 2, p. 1006, 1759.

Material examined: Shantung: Tsinan, Mar. 31–Apr. 18, 1922–1931, A. P. Jacot, 6 males, 2 females, 1 with abdomen missing, USNM and author's collection. Korea: Suigen, June 16, 1927, T. R. Gardner, 1 male, USNM.

Genus *Melanosoma* Robineau-Desvoidy

Melanosoma Robineau-Desvoidy, Bull. Soc. Sci. Yonne, vol. 7, pp. 92, 122, 1853.

Melanosoma pallipes (Wiedemann)

Myopa pallipes Wiedemann, in Meigen, Systematische Beschreibung der bekannten Europäischen zweiflugeligen Insekten, vol. 4, p. 149, 1824.

This species has been previously known from Europe to Central Asia.

Material examined: Shantung: Tsinan, Apr. 18, 1922, A. P. Jacot, 1 male, USNM.

Genus *Sicus* Scopoli

Sicus Scopoli, Entomologia carniolica . . ., p. 369, 1763.

Sicus abdominalis Kröber

Sicus ferrugineus var. *abdominalis* Kröber, Arch. Naturg., vol. 81, Abt. A, Heft 1, p. 88, 1915.

This species differs from *S. ferrugineus* by having a shorter and wider abdomen, and by having a larger distinct theca in the female. I feel certain that Kröber's type is a specimen having the abdomen flexed so that difference of the theca from *ferrugineus* is not apparent.

The illustrations by Ouchi (Journ. Shanghai Sci. Inst., sec. 3, vol. 4 (1939), p. 211, 1940) show the differences between this and the other species. This species is shown as *S. fusenensis* var. a and var. b. The difference between variety a and b is simply that in variety a the abdomen is extended, and in variety b the abdomen is flexed.

In this species, when viewed from above, the second abdominal segment is as long or somewhat longer than wide, and the third abdominal segment is wider than long. In *ferrugineus,* the second abdominal segment is much longer than wide, and the third abdominal segment is as long or longer than wide. In the female sex the abdomen is even more elongated in *ferrugineus,* and the differences between the two species are greater.

The series from Szechwan differs from the specimens from Siberia and Manchuria by averaging smaller, and by being paler and more pollinose. Also the latter have a pair of curved black marks on the second abdominal segment. These black marks, however, are present or absent in my series of *ferrugineus* from Europe, which includes a very dark male with the femora predominantly blackish.

Occemyia ogumae Matsumura (Thousand insects of Japan, Additamenta 2, p. 273, 1916) may be this species. The illustration shows the black marks on the second abdominal segment.

Material examined: Szechwan: Suifu, D. C. Graham, 3 males, 1 female, USNM and author's collection; Suifu, 1,000-1,500 ft., June

1–21, 1928, D. C. Graham, 1 male, USNM; Muping, 4,000–7,000 ft., July 1929, D. C. Graham, 1 male, author's collection ex USNM; O-Er, 26 miles north of Li Fan, 9,000 ft., 1933, D. C. Graham, 1 male, USNM; Wei Chow, 65 miles northwest of Chengtu, 9,000–12,500 ft., Aug. 15–21, 1933, D. C. Graham, 1 male, USNM. China-Tibet border: Yu-Long-Gong, 14,000 ft., Aug. 14. 1930, D. C. Graham, 1 female, USNM. Manchuria: Kaolingtze, July 15, 1941, V. N. Alin, 1 female, author's collection. Siberia: Kongaus, August 1923, Cockerell, 1 male, USNM; Kudia R., Amagu, July 1923, Cockerell, 1 male, author's collection ex USNM.

Sicus nigricans Kröber

Sicus ferrugineus var. *nigricans* Kröber, Ann. Mag. Nat. Hist., ser. 11, vol. 4, p. 370, 1939.

This species is similar to *S. abdominalis* in the shape of the abdomen, but differs in being predominantly dark, particularly on the dorsum of the thorax and second abdominal segment. While it might be considered a dark form of *abdominalis*, there are no intermediates in this series, and both occur at Kongaus.

Occemyia nishitapensis Matsumura (Thousand insects of Japan, Additamenta 2, p. 272, 1916) may be this species.

Material examined: Siberia: Kongaus, August 1923, Cockerell, 2 females, USNM. Japan: Tsuruga, June 29, Cockerell, 1 male, USNM; Senjogahara, Nikko, Aug. 9, 1953, R. Kano, 2 females, author's collection.

Sicus fusenensis Ouchi

Sicus fusenensis Ouchi, Journ. Shanghai Sci. Inst., sec. 3, vol. 4 (1939), p. 209, 1940.

This species is otherwise known only from the type female from Northern Korea. It is very similar to *S. ferrugineus*, and although the abdomen is not quite as elongated as *ferrugineus*, the third abdominal segment is much longer than wide.

The male is unknown, but will probably prove to be very similar to, if not indistinguishable from the male of *ferrugineus*. I have not seen any specimens of *ferrugineus* from Asia, and it is possible that such records may belong to *fusenensis*.

Material examined: China-Tibet border: Yu-Long-Gong, 14,000 ft., Aug. 14, 1930, D. C. Graham, 2 females, USNM and author's collection.

Genus *Thecophora* Rondani

Thecophora Rondani, Nuovi Ann. Sci. Nat. (Bologna), ser. 2, vol. 3, p. 15, 1845.

Occemya Robineau-Desvoidy, Bull. Soc. Sci. Yonne, vol. 7, p. 130, 1853.

Thecophora atra (Fabricius)

Myopa atra Fabricius, Species insectorum . . ., vol. 2, p. 469, 1781.

Each of the specimens examined differ from each other and from the typical European form. However additional material would be necessary to decide if any of these should be named.

The specimen from Siberia has more yellow on the anterior femora than the typical form, but this condition is matched by one or two specimens of a series from Cyprus in my collection.

The specimen from Yangchow has the pollen yellowish gray and the femora mainly yellowish and thus approaches *T. sauteri* of Formosa. However, it is paler than *sauteri* having the antennae and front mainly yellowish, and the wings are also yellowish. One of the two cotype males of *sauteri* sent by USNM for comparison has the abdominal pollen more grayish than yellowish.

The specimen from Szechwan has all of the femora almost entirely yellow, and the antennae are mainly yellowish.

This species has not been previously recorded from Siberia.

Material examined: Siberia: Ust Balei, July 1927, Cockerell, 1 male, USNM. Kiangsu: Yangchow, Aug. 18, 1924, C. Y. Wong, 1 male, USNM. Szechwan: Behluhdin, 6,000 ft., July 25–Sept. 1, 1936, D. C. Graham, 1 male, USNM.

Thecophora philippinensis, new species

Male: Length 4 mm. Vertex and front black. Narrow margin above base of antennae dark reddish. Face and facial grooves reddish-yellow. Posterior half of cheeks blackish. Occiput black. Antennae reddish-yellow, black on lateral surface and distal half of medial surface of third segment. Arista black. First segment as long as wide. Second segment four times length of first. Third segment 2½ times length of first. Proboscis missing beyond palpi.

Thorax black, with faint white pollinose areas leaving three indistinct black lines on dorsum. Legs black, basal two-fifths of posterior femur yellow. Base of tibiae, basal tarsi, pulvilli, and claws except black tips yellow. Wings hyaline. Calypters brownish. Halteres bright yellow, blackish at base.

Abdomen black, relatively distinct grayish yellow pollinose distal band on second, third, fourth, and fifth segments. Sixth segment indistinctly grayish yellow pollinose. Fifth sternite very prominent, resembling a theca.

Variation (in paratype): Length 4½ mm. No black on cheeks. Antennal proportions 1:3:2. Each of distal segments of proboscis about equal to length of head. Theca less prominent (abdomen flexed).

Types: Holotype, male, USNM 64487, Panal, Benguet, Luzon Island, Philippines, April 30, F. Rivera. Paratype: Philippines: 1 male, author's collection ex USNM, "Haight's Pl.," Benguet, Luzon Island, April 30, F. Rivera.

This species is related to *T. atra*, but is distinguished by the yellowish gray pollinose bands giving the abdomen an annulate appearance. The head is also characteristically dark, and although the legs are mainly black, the basal two-fifths of the hind femur is yellow.

Thecophora simillima (de Meijere) (Bijdr. tot de Dierkunde, vol. 18, afl. 17, p. 103, 1904) of Java, is described as similar to *T. atra*, but the white pollinose abdominal bands are very narrow and limited, and the second and third antennal segments are equal.

Genus *Dalmannia* Robineau-Desvoidy

Dalmannia Robineau-Desvoidy, Mem. Acad. Sci. Inst. France, vol. 2, p. 248, 1830.

Dalmannia affinis Chen

Dalmannia affinis Chen, Notes d'entomologie chinoise, vol. 6, p. 228, 1939.

Previously known only from the type series, 2 males and 2 females from Kiangsu.

Material examined: Shantung: Tsinan, Apr. 8, 1922, A. P. Jacot, 2 females, USNM and author's collection.

U.S. GOVERNMENT PRINTING OFFICE: 1960

Proceedings of
the United States
National Museum

SMITHSONIAN INSTITUTION • WASHINGTON, D.C.

Volume 112 1960 Number 3433

FIREFLIES OF THE GENUS PYRACTONEMA (COLEOPTERA: LAMPYRIDAE)

By **Frank A. McDermott**

Introduction

Solier (1849) described nine new species of Lampyridae from Chile and placed them in a new genus, *Pyractonema.* Fairmaire and Germain (1862) described as *Lucidota* three new species that were subsequently removed to *Pyractonema,* and Gemminger and Harold (1869) changed the specific trivial name of Solier's *P. compressicornis* to *depressicornis,* the former being preoccupied in *Lucidota.* The first species referred to in the literature belonging in this genus is *P. obscura* (G. A. Olivier, 1790) from Tierra del Fuego. To this species E. Olivier (1907, 1910) referred four of Solier's species and also two others; *P. bardelli* (le Guillou, 1844) and *P. bioculata* (Blanchard, 1853.) He also referred Solier's *P. rhododera* to this species, but *rhododera* is herein reestablished as a valid species. Since E. Olivier (1907, p. 6) had access to the collections of his grandfather, G. A. Olivier, and of Fairmaire (although he remarks, p. 62, that the latter is in "inextricable disorder"), it must be assumed that he made the comparisons necessary to convince him of this synonymy. Thus, of the 15 described species, E. Olivier (1907, 1910) recognized only 9. No other species definitely referrable to this genus appears to have been described since those of Fairmaire and Germain. E. Olivier (1902) described three Japanese species but subsequently transferred them to *Lucidina.*

It is noted that E. Olivier's (1907) generic description does not entirely agree with Solier's. Nor do the latter's descriptions of the species exactly meet his generic characters, a condition which my examination of the specimens at hand confirms.

Barber (1951, p. 16) designated *P. depressicornis* Gemminger (*compressicornis* Solier) as the type species. From the standpoint of being typical of the genus, this species, with wide pale elytral borders, is perhaps less satisfactory than say, *P. obscura*, although it is the first in Solier's descriptions.

POSITION OF PYRACTONEMA AMONG THE LAMPYRIDAE

E. Olivier (1907, 1910) placed *Pyractonema* in his subfamily Lucidotinae. As was noted above, Fairmaire and Germain called their species *Lucidota*, and there is, indeed, very little in the published descriptions to differentiate *Pyractonema* from many of the species commonly called *Lucidota*, the principal difference being the very depressed body of most species of *Pyractonema*. However, the large genus *Lucidota*, with over 100 species, is obviously composite and probably includes a considerable number that are properly *Ellychnia* and *Pyropyga*.

As was also mentioned, E. Olivier (1902) originally described three Japanese species as *Pyractonema* but subsequently removed them to *Lucidina* (Gorham, 1883). The chief distinguishing character of the latter genus is the deeply cleft tarsal claw resulting in a 3-clawed appearance, but in the writer's experience this condition is not constant in all claws of species of *Lucidina*. Occasional specimens of Chilean *Pyractonema* have some claws so divided. Thus, aside from the widely different geographic distribution, only the described long, apically attenuate pronotum of *Lucidina* distinguishes it from *Pyractonema*.

SOURCES OF MATERIAL STUDIED

I received from Luis E. Peña, of Santiago, Chile, a large series of Chilean lampyrids, the majority being of the *P. nigripennis* group, which must be very abundant, together with several larvae of at least two types. A rather striking feature of this collection is the great general similarity of the species, although they range from 5 to 24 mm. long. A few specimens of Chilean cantharids also resemble the lampyrids in their black elytra and reddish or black-striped red pronota. Apparently the adults are not appreciably luminous, if at all so, and the majority seem to be diurnal. If present, the luminous organs are rudimentary, frequently merely minute pale scales, or sometimes distinct red spots, occasionally centrally yellow, on the 8th ventral segment, where the residual larval luminous organs are situated in other lampyrids. Although Peña states that he has never seen a luminous firefly in Chile, he mentioned that one species, *P. depressicornis,* was only taken after sunset. In this species, the male has luminous organs nearly as large as in some species of *Diphotus,* though in the two females seen, these organs were very small.

Most of the specimens were collected in December, January, and February at altitudes from 600 to 1,700 meters, and between latitudes 33° and 38° S. A few were collected at lower levels and some on the island of Chiloe at latitude 42° S. For most of the species there is no evidence of restriction to a given locality or altitude, although *P. angustata* was collected only at relatively high stations. One specimen of *P. depressicornis* was taken at Nogueche and one at Concepción. All the others were from Pellehue and Tregualemo.

Subsequent to the examination of the material received from Peña, an opportunity was provided by J. W. Green of the California Academy of Sciences to examine 482 specimens of nonluminous South American Lampyridae, mostly *Pyractonema* from Chile, in the Reed Collections. For the most part, these specimens presented nothing not covered by Peña's specimens, except for the collecting stations. Among 108 specimens of *P. haemorrhoa,* there were a few which were intermediate between the large and smaller forms in Peña's shipment; one male of this species was distinctly brown and another was partially so; in several specimens the terminal abdominal segment was yellow instead of red, and in three the color was absent. A few specimens in the *nigripennis* group had yellow instead of red pronotal coloration; all brachelytral specimens were females. One small, brown, female specimen with a yellow pronotum looked rather clearly different from any other, and was identified as *P. vicina* Solier. A description prepared from this specimen and two males in the U.S. National Museum has been included with the other descriptions.

The specimens of *P. rhododera* in the California collection ranged from 3.5 to nearly 12 mm. long, measurements that agree with Solier's range. If a sharp segregation on length were possible, it would seem that two species are included under this name, but some were intermediate, and it seems unwise to make an arbitrary division on this basis, as is done in the *nigripennis* group, for a relatively scarcer species. Specimens 3.5 to 8 mm. long were collected at the same station and about three weeks apart. Two pairs (taken in copulation) were both of the small form.

A later shipment of Chilean insects received from Peña contained several specimens of a species of *Pyractonema* different from any previously described, particularly in their small size and the shape of the pronotum, which is markedly long in proportion to the width and widest at apical third. Because of their fragility and small size, they proved difficult to handle. The description is based on 6 males and

5 females. There were three pairs in copulation, and all were from the same locality. As in most other species of the genus, they are without developed luminous organs. Also in common with other species, the elytra of the females vary considerably in relative length, and from 1 to 3 abdominal segments are exposed. While occasional small specimens of *P. obscura*, *P. albomarginata*, and *P. rhododera* approach the length of this species, here named *P. minor*, these specimens may be distinguished by the specific characters. The holotype, female allotype, and five paratypes have been sent to Peña.

AEDEAGI

The aedeagi were extracted after they were relaxed in a moist chamber, dried in acetone a few minutes, and immediately mounted on Nylon filaments with Duco cement. The base of the filament was cemented to a point, which was then pinned like a specimen. Measurements were made on the mounted aedeagus, and outline drawings were made with a camera lucida.

Comparisons of the aedeagi revealed that by simple inspection of the specimens, *P. bifenestrata* could not be definitely separated from *P. obscura*. Small specimens provisionally classed as the former sometimes showed the aedeagus characteristic of the latter, and vice versa. Except for the aedeagus of *bifenestrata*, there is some general resemblance in this organ among the various species. In *P. nigripennis* and *P. depressicornis*, the lateral lobes were usually more or less spread as shown in the drawings. Since some of the species were originally described as *Lucidota*, it seemed worthwhile to compare the aedeagus of *Lucidota atra*, which, like *Pyractonema*, is diurnal and nonluminous, with those of the latter genus. The long, narrow structure of this organ in *atra*, however, is not comparable to that of any of the species of *Pyractonema* except possibly *bifenestrata*, and it lacks the broad cultriform median lobe of the latter. Somewhat surprising is the fact that the aedeagus of *bifenestrata* should be noticeably different from those of its congeners. The aedeagus of *Lucidina puerile* E. Olivier, from Japan, is similar in form to that of *P. bifenestrata*, but the median lobe is not cultriform and the lateral lobes have expanded apical portions.

The outline drawings which I have included are intended as aids in identification; however, I do not attempt to indicate internal structure or function of parts.

MISCELLANEOUS NOTES ON VARIANTS AND LARVAE

A few specimens, all males and mostly from Parral, did not quite meet the descriptions of the species given herein. Examination of the aedeagi showed them to be much like that of *P. bifenestrata*, and these specimens therefore probably represent some local variant of that species, although because of the much reduced pronotal infuscation, they are superficially more like a larger *P. latior.*

The almost startling similarity, especially in the pronotal appearance, of many of the species has been noted, and applies particularly to the *nigripennis* group, and also to *depressicornis* and *haemorrhoa.* Structurally as well as in coloration, most of the members of the genus are quite similar, which may be taken to indicate relatively recent speciation. The adaptation of *P. obscura* to the seemingly unfavorable habitat (from the lampyrid standpoint) of Tierra del Fuego, latitude 55° S., is interesting; *Lampyris noctiluca* in England and Europe is at about a corresponding latitude north but in a more favorable climate.

In the course of the work, it was noted that the odor of the collection, especially of the *nigripennis* group, was very similar to that of collections of the North American *Photinus pyralis,* though rather more pronounced. Alcoholic extracts of the specimens of this genus did not develop a blue fluorescence as do similar extracts of *Photinus.*

While nothing definite is known about the life history of *Pyractonema* or their habits, the mouth parts are complete, and it may be that the adults feed occasionally, probably on other insects, as is the case in *Photuris* and *Photinus.* More probably, most of the feeding is done in the larval stage as is usual among lampyrids, the principal food probably being snails (Peña). One specimen bore a minute tick.

The larvae in the collection do not differ materially in superficial appearance from those of North American lampyrids. The largest were 18.35 and 19.65 mm. long by 5.1 and 4.3 mm. broad at the mesonotal and metanotal segments, and taper posteriorly. The pronotum of the smaller of the larvae was but little narrowed in front and the head was unusually large with very long, slender, tapering mandibles, the distance across the bases of the latter being over 1.5 mm. The legs and antennae were also unusually long for a lampyrid larva. It was brown with yellow lateral borders on all the segments, and the abdominal segments have subtriangular laterally projecting plates, all of which present a serrate appearance. The larger larva was practically black, granulose, and had posterolateral angles on all segments which were yellow to a rather bright salmon-pink. The head was much smaller than in the smaller larva, black, cylindrical, and bore a pair of short mandibles slightly curved upwards. Both larvae had a pair of luminous organs, apparently functional, on the lateral thirds of the 8th abdominal segment. I concluded (1956) that the latter one represents a juvenile state of the giant glow worms found in South America.

Another larva was 15 mm. long, and uniformly 3 mm. broad from the second thoracic to the 6th abdominal segment. The head was small, the antennae relatively long, and the coxal cavities long, narrow, pointed distally and white basally. The dorsal surface above the luminous organs was translucent, the light evidently being visible from above. Except for the structure of the terminal abdominal segment, this larva might have been thought to be a larviform female.

The spiracles on all of these larvae were on the ventral surface of the lateral lobes of the abdominal segments. In the absence of rearing tests, it is usually impossible to say what species a given larvae represents and no attempt can be made to do so with these glow worms.

The advice of J. W. Green, T. J. Spilman, and C. W. Sabrosky is acknowledged with appreciation.

Genus *Pyractonema* Solier

Pyractonema Solier *in* Gay, Hist. Fis. Pol. Chile, vol. 4, Zool. pp. 445 ff., 1849.

Diagnosis: *Pyractonema* is a genus of nearly or entirely nonluminous lampyrids at present known only from Chile and adjacent parts of Argentina and possibly extending up the slopes of the Andes to Bolivia and Peru. The possibility that *Lucidina* should be included is at present ruled out. Before giving the key to the species, and their descriptions, it may be well to call attention to some points of general similarity which are not always repeated in the individual descriptions, and to some of the intraspecific variations which have been noted.

The body is noticeably dorsoventrally compressed in most species, sometimes so much so as to seem to leave little space for internal organs. While this condition may be an artifact in closely packed specimens, it appears to be a natural feature in this genus.

The pronotum is usually semicircular or semielliptical, frequently slightly prolonged apically, usually distinctly wider than long and frequently markedly so in females. The base may be nearly straight between the angles, slightly emarginate, or sinuate. The posterolateral angles may be posteriorly produced, salient to the lateral edges, or merely rounded. There may be a median, narrow, longitudinal channel or a relatively wide sulcus, or even a fine carina usually confined to the basal half or two-thirds. The lateral margins are usually reflexed, and the apical margin is slightly reflexed in most specimens. The disk is usually smooth or very finely punctulate, while the remainder of the surface is coarsely punctate, with a submarginal row of large punctures. The scutellum is asymmetrically diamond-shaped, the basal point being obtuse, and the apical half being longer with a rounded apex. The scutellum is dark brown or black, and usually hairy. The mesonotal plates are usually dull black. The elytra appear black in the closed position over the wings, but are a somewhat translucent dark brown by transmitted light; in all species they are finely and densely granulose. Costae usually number two or three but are often indistinct and frequently evanescent apically; explanate margins are generally narrow, except in the smaller variety of *P. haemorrhoa.*

The head and eyes are relatively rather small as compared with those of the luminous lampyrids. The frons is black or dark brown, and in some species appears to project bulbously between the antennal sockets. The mandibles are brown, approximately circularly curved. The maxillary palpi are black or dark brown, with a terminal article of conoidal outline flattened on the inside, and are rather large. The labial palpi are relatively small, brown, and modified securiform. The clypeus is not connate with the front, is short, black, or dark brown, and is usually semicircular, but it may be sinuate or even tridentate. The labrum may project forward of the clypeus as a white, membranous area.

The prosternum is usually almost entirely pink, as is most of the mesosternum. The metasternum is entirely black. Except in *P. haemorrhoa,* the abdominal segments are all black or dark brown, though the pygidium may be partly translucent. The "dentate" abdominal structure mentioned in the older descriptions refers to the posteriorly projecting lateral lobes on tergites 5, 6, and 7.

The legs are all black, although their vestiture may be brown. Claws are usually entire, rarely cleft, and sometimes with a short basal spur. Tibial spurs are very small, frequently indistinguishable at 30 × magnification.

The antennae are of the same general type in all of the species. Articles number 11, of which 1 is club shaped, 2 is short and conical, and 3–10 are usually wide and much compressed, this widening being much more pronounced in some species than in others. Articles 4 to 11 are attached at their bases to the outer edge of the apex of the preceding article, and thus give a somewhat serrate appearance, which is most pronounced in *P. depressicornis.* The terminal article is narrowly elliptical, and 4 to 11 are more or less hairy. In the males, the antennae are usually somewhat more than one-half the total length (pronotum plus elytra), and less than one-half in the females.

Remarks: From my work on this genus, it appears that the following species are valid: *albomarginata, bifenestrata, depressicornis, haemorrhoa, nigripennis, obscura, rhododera, subulipennis* (not seen), *vicina,* and the new species, *angustata, latior,* and *minor.*

On the basis of the comments of Ferris (1928), it has seemed worthwhile to redescribe the known species recognized in the material studied. The descriptions of new species and redescriptions of old species following the key below are arranged in alphabetical order of the specific names.

Key to the Species of *Pyractonema*

1\. Elytra uniformly black or dark brown 2
Elytra with pale borders 10

2\. Abdominal sternites black or dark brown, except rudimentary luminous organs 4
Abdominal sternites either completely or in part red or rarely yellow or white 3

3\. Eighth abdominal sternite red, rarely yellow or white; 10 to 19 mm. long.
Pyractonema haemorrhoa (Fairmaire and Germain)
All abdominal sternites red; elytra attenuate; 5.0 mm. long (not seen).
Pyractonema subulipennis (Fairmaire and Germain)

4\. Pronotum with two subrectangular or reniform red spots (these occasionally yellow) surrounded by wide black borders and vitta (PYRACTONEMA NIGRIPENNIS group) 5
Pronotal pigmentation otherwise 6

5\. 14 to 19.5 mm. long, or to 24 mm. in females.
Pyractonema nigripennis Solier
10 to 15 mm. long. . **Pyractonema bifenestrata** (Fairmaire and Germain)
5 to 11 mm. long . . . . **Pyractonema obscura** (G. A. Olivier)

6\. Pronotum yellow or red with irregular black markings; parallel; body less depressed than in most species; 9 to 12 mm. long.
Pyractonema vicina Solier
Pronotum reddish on disc 7

7\. Pronotum with lateral and apical borders colorless and translucent, or with a very narrow light brown border which is usually incomplete; narrow, parallel outline; 6.5 to 10 mm. long.
Pyractonema angustata new species
Pronotum with lateral and apical borders at least in part dark brown or black 8

8\. Pronotum orange-red or yellow in basal two-thirds; translucent apically; no median vitta; widest in apical third; insects very small and narrow; 3.5 to 5.0 mm. long . . . . **Pyractonema minor** new species
Pronotum coral-red, or pink to red 9

9\. Pronotum mainly red; narrow borders and usually incomplete median vitta, black; outline long-elliptical; 7.5 to 12 mm. long.
Pyractomena latior new species
Pronotum opaque coral-red, with narrow black border and rarely a very narrow black median vitta; outline parallel; 4 to 12 mm. long.
Pyractonema rhododera Solier

10\. Large insects, 11.5 to 18 mm. long; elytra with lateral and apical borders yellow . . . . . . **Pyractonema depressicornis** Gemminger and Harold
Smaller insects 7 to 11 mm. long; elytra with lateral and apical borders white . . . . **Pyractonema albomarginata** Solier

Pyractonema albomarginata Solier

Figure 1

Pyractonema albomarginata Solier, *in* Gay, Hist. Fis. Pol. Chile, vol. 4, Zool. p. 447, 1849.

Material: 51 specimens, of which 45, including 10 females, were of the typical variety, and 6 including 4 females were smaller. The latter are not given a varietal name, however, as it seems probable that intermediates will be found.

General: A small, nonluminous lampyrid easily distinguished by the white-margined elytra.

Dimensions: Typical males 7.65 to 11.65 mm. long by 2.35 to 2.42 mm. broad, average 9.4 by 2.9 mm. Females 6.75 to 9.6 mm. long by 2.45 to 3.45 mm. broad; average 7.9 by 2.9 mm. Smaller males 6.66 to 6.98 mm. long by 1.89 to 2.29 mm. broad; average 6.8 by 2.1 mm. Smaller females 4.72 to 6.45 mm. long by 2.02 to 2.55 mm. broad; average 5.69 by 2.28 mm.

Pronotum of males 1.2 to 1.7 mm. long by 1.92 to 2.6 mm. broad. General outline semicircular or semielliptical, sometimes a little extended apically especially in males, with a transverse subrectangular red spot occupying about half of the total area and not quite reaching the base. Marginal borders translucent, reflexed at sides and apex, rather coarsely and closely punctate. Basal border narrow. In occasional specimens the lateral and apical edges brown, the infuscation of the latter sometimes long-triangular, apex forward. One specimen had two black spots at lateral thirds adjacent to the posterior edge. Disc smooth, occasionally inflated, median channel sometimes infuscate. Posterolateral angles very variable, from dull rounded to acutely produced. Basal margin usually slightly sinuate, sometimes circularly curved. Maximum width usually from just forward of the angles to basal fifth. Females similar but relatively slightly wider and angles less prominent.

Scutellum black. One specimen had a small median red spot, and another a long red mark in the apical half. Mesonotal plates black.

Elytra black, with narrow, translucent white lateral borders, widened apically. No sutural borders. Subparallel to apical third or fourth, then tapering in lateral margin. Occasionally slightly widest at about midlength. Very narrow explanate margins.

Head black. Antennal sockets white or pink. Eyes small, width across them about 0.75 to 0.8 of pronotal width. Clypeus short, dark brown, usually feebly emarginate.

Antennae black. Articles 3 to 11 very compressed and of about equal length.

Tergites all black. Pygidium in male as wide as 7th segment, deeply emarginate, in female triangular.

Ventral segments 2 to 6 very dark brown to black, 7 and 8 black. Segment 8 medially bulbous in male to accomodate the aedeagus. No indication of luminous organs. In female, segment 8 ogival, with deep V-shaped median apical notch, not bulbous, and usually exposed beyond the elytra.

Legs black, hairy, compressed. Tibial spurs discernible with difficulty, pattern apparently 0–1–1. Claws without basal spurs.

Aedeagus as in figure 1.

A small species, readily recognizable by the white-margined elytra. Of this species there were 51 specimens, including 10 females, of which many were longer than the 7.7 mm. maximum given by Solier. There were also 6 smaller specimens, 4 of which were females.

***Pyractonema angustata*, new species**

Figure 2

Material: 7 males and 3 females, including one pair in copulation. Distinguishable from other species by narrow, parallel form and the absence of infuscation on the pronotum. Two of the females were brachelytral, leaving 3 abdominal segments exposed.

Type locality: Enco, Chile.

Holotype and 6 paratypes, USNM 62820.

General: A small narrow, nonluminous lampyrid with no pronotal infuscation and a transverse pink or red subrectangular disc.

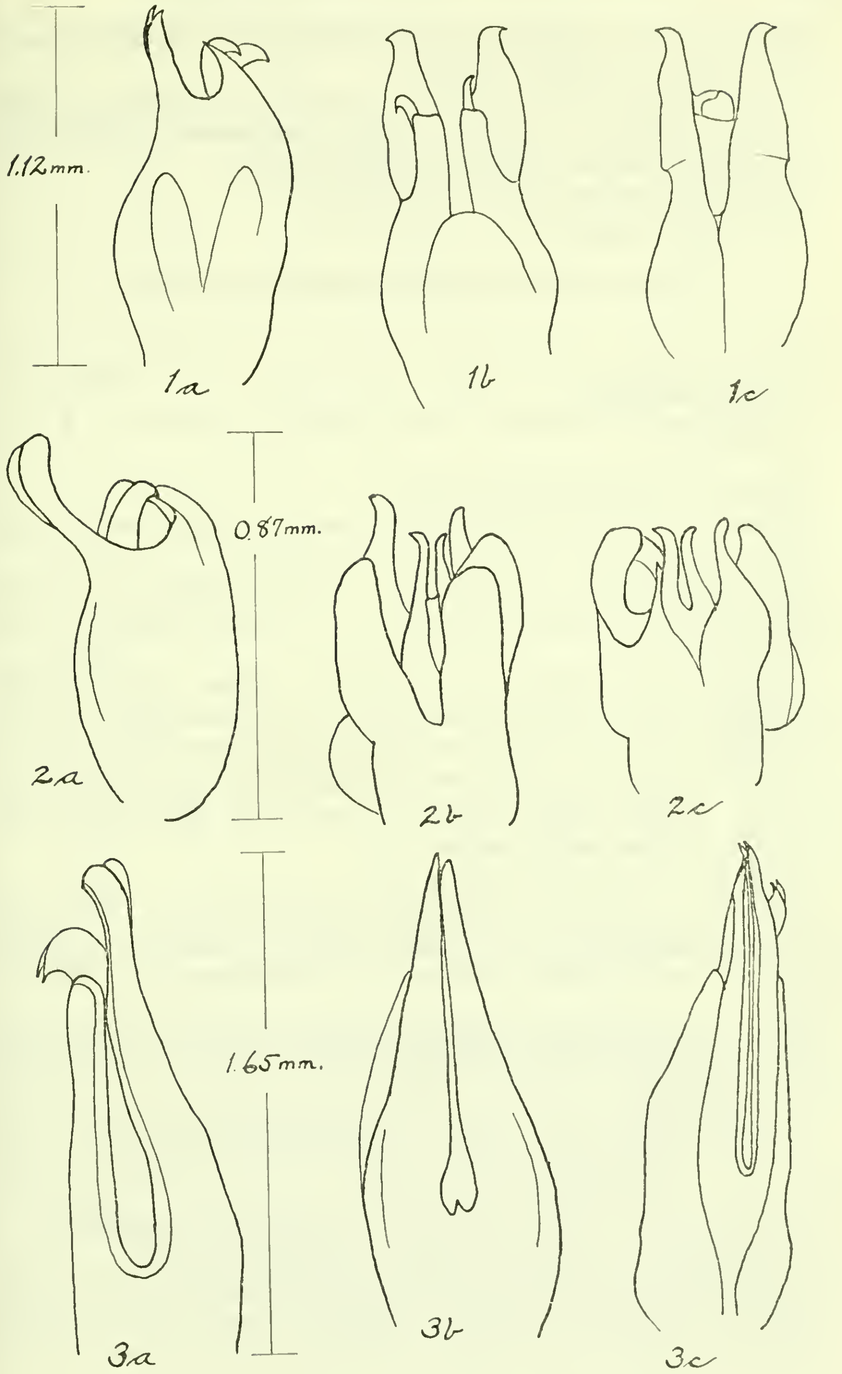
Dimensions: Males 6.69 to 9.59 mm. long by 2.04 to 2.70 mm. broad; average 7.83 by 2.31 mm. Females 6.87 to 9.03 mm. long by 2.04 to 2.8 mm. broad; average 7.91 by 2.29 mm.

Pronotum of males 1.28 to 1.66 mm. long by 1.58 to 2.24 mm. broad. Females 1.33 to 1.63 mm. long by 1.66 to 2.37 mm. broad. Usually widest in basal third or fourth. Apex slightly reflexed. Transverse subrectangular rose-red area in basal two-thirds and median three-fourths. No median vitta but frequently a narrow channel in basal half. No infuscate marginal borders (one female had a very narrow brown marginal line). Apical and lateral surfaces transparent, coarsely punctulate.

Scutellum black or dark brown. Mesonotal plates dull black or dark brown.

Elytra black (one male had narrow, pale, apical borders). Usually bicostate. About 0.8 of total length in male, frequently short in female, exposing 3 abdominal segments.

Antennae black, compressed. Structure much as in the *P. nigripennis* group.



Figures 1–3.—Aedeagus: 1, *Pyractonema albomarginata;* 2, *Pyractonema angustata;* 3, *Pyractonema bifenestrata.* (*a*, lateral view; *b*, dorsal view; and *c*, ventral view.)

Tergites black. Pygidium in male narrowed to an emarginate apex in apical third; in female, triangular.

Ventral segments: All black or very dark brown. Usually no trace of luminous organs, but one male had the last ventral medially pink with pink rudimentary luminous organs laterally.

Legs dark brown to black. Claws simple.

Aedeagus as in figure 2.

Pyractonema depressicornis **Gemminger and Harold**

Figure 4

Pyractonema depressicornis Gemminger and Harold, Cat. Col. Des. Syn. Syst.' vol. 6, p. 1639, 1870.

Pyractonema compressicornis Solier, *in* Gay, Hist. Fisc. Pol. Chile, vol. 4, Zool., p. 446, 1849.

Material: 35 males and 2 females.

General: A large, probably nonluminous lampyrid, with elytra bordered yellow.

Dimensions: Males 11.5 to 18 mm. long by 3.5 to 7.0 mm. broad; average 15.0 by 5.0 mm. Females 12.5 to 14.5 mm. long by 3.5 to 4.25 mm. broad.

Pronotum with lateral margins slightly reflexed, apical margin somewhat more so. Black except for two subrectangular red spots occupying about 0.3 of total area. Disc not deeply channeled if at all so, sometimes with a low carina in basal half. About 0.8 as long as wide. Outline nearly semicircular, except for slight apical prolongation, less marked in females.

Scutellum and mesonotal plates black.

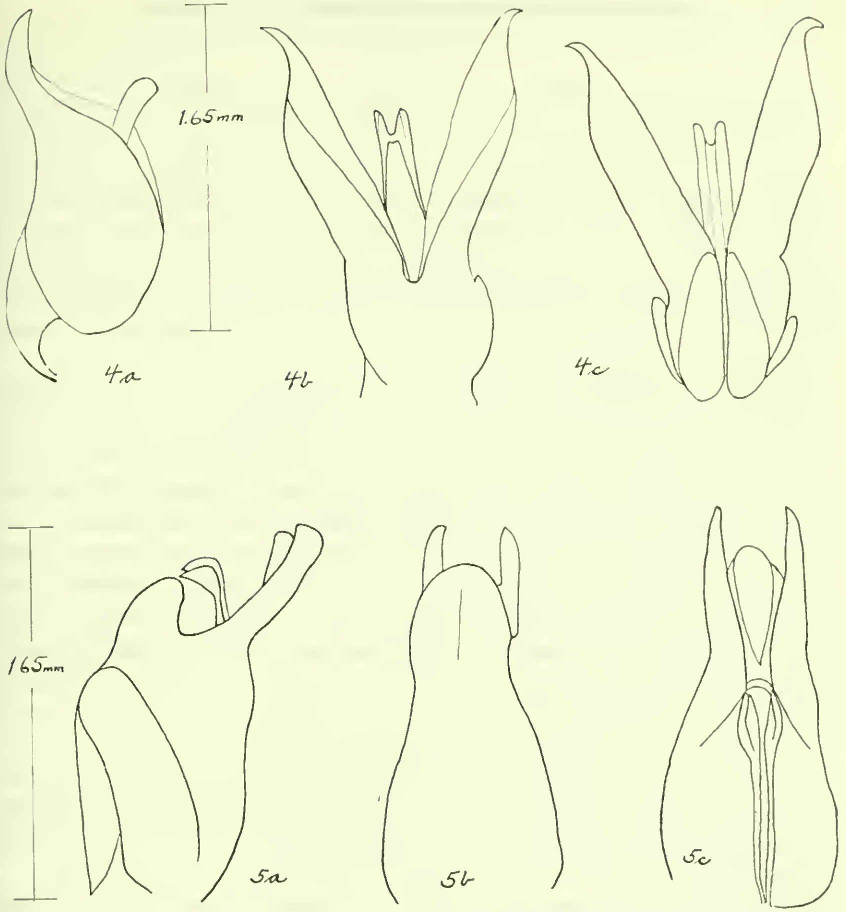
Elytra long, parallel or subparallel, usually tricostate. Black with pronounced yellow lateral and apical borders about 0.2 of elytral width. No sutural border. Very narrow explanate margins. Sparsely hairy.

Head with frons black, slightly prominent in front. Eyes small, width across them about 0.6 of pronotal width. Clypeus short, black, tridentate.

Antennae long, up to 0.75 of body length, shorter in females. Articles 3 and 4 shorter than 5 to 11. Short appressed vestiture with scattered longer brown hairs on edges.

Tergites all black with pronounced posterolateral projections on 5 to 7. Pygidium projects beyond the elytra in the female.

Ventral segments: All black, except small reddish, lateral, rudimentary (?) luminous organs on segment 8 in the male. These organs are smaller in the female and mostly hidden under the 7th



Figures 4–5.—Aedeagus: 4, *Pyractonema depressicornis;* 5, *Pyractonema haemorrhoa.* (*a*, lateral view; *b*, dorsal view; and *c*, ventral view.)

segment. In the male, segment 8 is narrow except for the lobes carrying the luminous tissue and bulbous over the aedeagus. In the female, 8 is small and raised medially over the ovidepositor. Male 7th is deeply emarginate, sometimes with a small median point.

Legs black, compressed, shorter in female. Tibial spurs very short, pattern apparently 0–1–1. Claws without basal spurs.

Aedeagus as in figure 4.

This is an easily recognizable species, of which 37 specimens were received, only two being females. Many of them were longer than the 14.3 mm. maximum given by Solier, and one was as small as 11 mm.

Pyractonema haemorrhoa (Fairmaire and Germain)

Figure 5

Lucidota haemorrhoa Fairmaire and Germain, Coleop. Chilensia, vol. 2, p. 2, 1862.

Material: About 180 specimens of the typical variety, including 19 females. One pair in copulation. None of these specimens was as small as 10 mm. long, as given in the original description, and the majority were 13 or more mm. long. Also, 20 shorter and more oval specimens, including 6 females, which are described separately below. 108 specimens in the collection of the California Academy of Sciences, including intermediate forms.

General: A medium to large size nonluminous lampyrid, with the apical ventral abdominal segment red, rarely yellow or white.

Typical form: Dimensions: Males 13.8 to 18.9 mm. long by 4.1 to 6.1 mm. broad; average 16.65 by 5.25 mm. Females 12.0 to 18.5 mm. long by 4.6 to 6.85 mm. broad; average 16.8 by 6.05 mm.

Pronotum black with two longitudinal subrectangular red areas usually with yellow lateral borders, occupying about 0.3 or more of the total surface, sometimes less in the females. Reflexed laterally and slightly so apically. About 0.7 to 0.75 as long as wide, proportionately slightly wider in the females. Approximately semicircular in outline, slightly prominent apically.

Scutellum and mesonotal plates black.

Elytra black, usually tricostate. Explanate margins narrow. About 0.75 to 0.8 of total length. In the male, the elytra are at least as long as the abdomen. In the female, segment 8 and sometimes 7 are exposed.

Head black, not markedly bulbous between the antennal sockets. Clypeus short, black, semicircular.

Antennae black, compressed. Articles 4, 5, and 6 may be widest, but usually 4 to 10 subequal. About 0.5 to 0.6 of body length in males, 0.4 to 0.5 in females.

Tergites all black, except that the red last ventral segment shows through the pygidium; the latter medially emarginate, longer, and nearly as wide as segment 7 in male, triangular in female.

Ventral segments 2 to 7 black, 8 almost entirely red, rarely yellow or white, but may have a black apical margin or lateral angles. Medially emarginate in male. A prominent "pore" on each rudimentary luminous organ. In female, segment 8 triangular, apically V-notched.

Legs black, compressed. Tibial spurs very inconspicuous. Claws not spurred, but may have a short "thumb" at base.

Aedeagus as in figure 5.

Atypical form: The 20 shorter specimens differ mainly in dimensions from the typical form, and naming them even as a variety does not seem justified.

General: Resembling the typical form, but shorter and proportionately broader, outline elliptical, with relatively wide explanate elytral margins.

Dimensions: Males 10.0 to 12.9 mm. long by 4.1 to 4.6 mm. broad; average 11.6 by 4.4 mm. Females 12.0 to 14.8 mm. long by 3.0 to 5.9 mm. broad; average 13.5 mm. by 5.3 mm.

Pronotum as in the typical form. Average length 0.67 of width in male, 0.69 in female.

Elytra 0.7 of body length in males, 0.77 in females.

Antennae tend to be relatively shorter than in the typical form, about 0.44 of body length.

Two of the males had no black on the pronotum, and another had only a brown spot in the apical fourth and a streak along the basal margin. One had a very narrow black border and an incomplete median vitta. In one specimen, the scutellum and mesonotal plates were pinkish brown. In all specimens, the latter were unusually wide. Two females had incomplete median vittae, and in one of these the black borders were also incomplete, and were very narrow in two specimens. In one male, the pygidium was largely black instead of the usual pink with black lateral and apical borders.

Elytral explanate margins conspicuously wider than in the typical form, usually widest at basal fourth.

The shorter body and elliptical outline suggest that this variant may have been the basis for the original description of the species.

P. haemorrhoa is apparently a clearly distinct species, and it is odd that Solier failed to mention the characteristic red terminal abdominal segments in any of his descriptions. About 180 specimens were among the material received from Peña, all of which were longer than Fairmaire's length of 10 mm., and 20 of which were of a smaller and proportionately broader form. The collection of the California Academy of Sciences contained specimens intermediate between these two forms.

***Pyractonema latior*, new species**

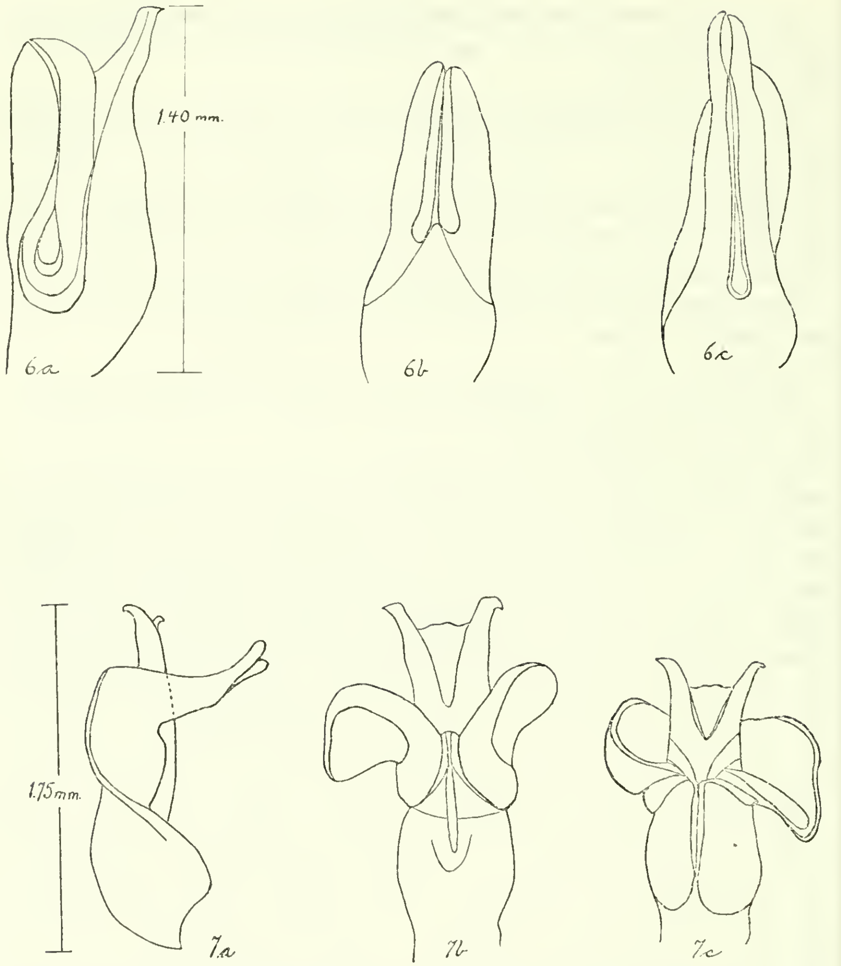
Figure 6

Material: 29 males and 11 females, including two pairs in copulation.

Type locality: Widely distributed, but Estero de Leiva, Parral, Chile, may be given.

Holotype and 4 paratypes, USNM 62821.

General: A small, rather broad, nonluminous lampyrid with a pink pronotal disc, usually partially divided by a narrow infuscate longi-



Figures 6–7.—Aedeagus: 6, *Pyractonema latior;* 7, *Pyractonema nigripennis.* (*a*, lateral view; *b*, dorsal view; and *c*, ventral view.)

tudinal vitta, and a narrow brown to black pronotal border, usually incomplete anterolaterally. Distinguishable from *P. angustata* by its broader, more elliptical outline and pronotal infuscation.

Dimensions: Males 7.4 to 12.3 mm. long by 2.55 to 4.3 mm. broad; average 9.45 by 3.33 mm. Females 7.1 to 10.0 mm. long by 2.55 to 4.05 mm. broad; average 8.45 by 3.1 mm.

Pronotum disc with subrectangular, transverse, red to pink area occupying half or more of the total surface of the pronotum. This area is usually at least partly divided by a narrow triangular brown to black vitta, the point basad. Narrow brown to black basal and lateral borders, the latter usually evanescent at apical two-thirds, but occasionally completing a narrow border around the apex. This border and/or the median vitta may be absent, but in these cases there is an indistinct triangular infuscation in the apical half. Remainder of pronotum transparent or at least translucent colorless to yellowish. Lateral edges reflexed, apically little if at all so.

Scutellum and mesonotal plates black to dark brown.

Elytra subparallel, giving a narrowly elliptical outline. Black. Explanate margins narrow, about one-sixth of elytral width.

Frons black. Not markedly bulbous between the antennae.

Antennae about half of body length in both sexes. Narrower than in the *P. nigripennis* group and appear only slightly serrate.

Tergites all dark brown to black. Pygidium in male may be truncate, bidentate, or tridentate, or sinuate: in female, tapering to a broadly rounded apex. Posterolateral pointed lobes on 5, 6, and 7 less developed in the female.

Ventral segments all dark brown to black. Sometimes with narrow black apical borders. Rudimentary luminous organs usually absent, sometimes represented by pale spots.

Legs black. Tibial spurs very small, pattern apparently 0–1–1. Claws simple.

Aedeagus as in figure 6.

***Pyractonema minor*, new species**

Material: 6 males and 5 females, 3 pairs in copulation, and portions of about a dozen other specimens. Holotype, allotype and 5 paratypes in the Peña collection.

Type locality: Quillota, Las Palmas, Valparaiso Province, Chile.

Dimensions: Males 3.5 to 5.1 mm. long by 1.0 to 1.65 mm. broad. Females 4.25 to 5.5 mm. long by 1.15 to 1.65 mm. broad.

Pronotum: Conspicuously nearly as long as broad, widest at apical third, narrowing slightly to base; angles obtuse. Apical and lateral borders black, with submarginal punctures. Basal two-thirds orange-red (yellow in one specimen). Apical third transparent back of black border. Disc flat and smooth. No median vitta.

Scutellum and mesonotal plates black.

Elytra black, parallel, rugose. Very narrow explanate margins which may appear paler than the disc. About 0.8 of total length in males, shorter in females, in which 1 to 3 abdominal segments may be exposed.

Body completely black. Thin and flat in horizontal plane. No indication of luminous organs. Pygidium trilobed.

Head black. Mouth parts very small and of same character as in other species.

Antennae black, compressed, scarcely serrate. Article 3 widest, 4 to 11 narrowing slightly progressively. In males about 0.55 of body length, in females about 0.45.

Legs black, compressed. Claws simple.

There are two specimens of this species, labeled "Chile" and "E. C. Reed" in the collection of the U.S. National Museum.

Pyractonema nigripennis group

(*nigripennis, bifenestrata, obscura*)

Of the several hundred specimens received from Peña, a series of 340 males selected without reference to the collecting station were mounted and measured. They furnished a complete series at 0.25 mm. intervals from 5 to 19 mm. long. Two more were 19.5 mm. In 147 females, a nearly complete series from 6 to 22 mm. long was obtained, two more being 24 mm. long. Plotting the number of male specimens falling in each 0.25 mm. group showed principal maxima at 9.5, 12.5, and 17 mm. lengths, and secondary maxima at 7 and 14 mm. The females distributed somewhat similarly, but less definitely. There were several pairs in copulation, and in each case the components were of approximately the same size.

On the basis of total length, it is possible to consider those from 15 to 19.5 mm. long (to 24 mm. in females,) as *nigripennis:* those 11 to 15 mm. long as *bifenestrata;* and those less than 11 mm. long as *obscura.* This designation is arbitrary, of course, and involves some overlapping between the species. Alternatively one must consider that they all represent a single species highly variable in size. Olivier's (1907) illustration of *nigripennis* gives a scale length of 14.75 mm., and it might therefore be either *nigripennis* or *bifenestrata* by the separation on total length proposed above. Collections made at the same station and time frequently contained specimens of several sizes. Study of the aedeagi showed that *nigripennis*, *bifenestrata*, and *obscura* exhibited different patterns.

In the initial separation of the specimens in this group, one series was picked out by their relatively small and narrow pronota. These specimens also proved to be intermediate in total length between the larger specimens here called *P. nigripennis*, and the smaller *P. obscura*, and constitute the majority of the specimens here classed as *P. bifenestrata.*

All of the specimens with short elytra, exposing up to 4 abdominal segments, were females, and it seems probable that *P. brevipennis* is a brachelytral form of the female in this group. The shortest elytra were usually found in the largest specimens, but all gradations from 1 to 4 abdominal segments exposed were noted.

In the original descriptions there is no essential difference other than size between *P. nigripennis*, *P. bifenestrata*, *P. binotata*, *P.*

lugubris, and *P. obscura*. *P. bardelli* and *P. bioculata* are described as brown, not black, and *P. brevipennis* differs only in the short elytra. In *nigripennis* the thoracic coloration is described as yellow, but Olivier's (1907) illustration shows it as red. One specimen in Peña's collection had yellow instead of red, as did some of those in the California collection, while one specimen of *P. vicina*, as noted, had red instead of yellow. Apparently yellow and red colorations are alternative in this genus. *P. fissicollis* may be dismissed as an abnormality, as noted by Olivier (1899). There were several hundred specimens representing this group in the material sent to me by Peña, the specimens ranging from 5 to 19.5 mm. long in the males and up to 24 mm. in the females. What bearing this situation has on taxonomy is discussed under the species descriptions.

In view of the great superficial similarity of the specimens (or species) in this group in characters other than size, a general description is given below that will apply to all; under the three species are given the dimensions of the admittedly arbitrary divisions for each. The smaller specimens appeared to be somewhat broader proportionately than the larger ones, a difference confirmed by the final measurements.

Pronotum with wide lateral and apical, narrow basal borders, and wide median longitudinal vitta black. Portions of apical edge in front of eyes may be brown. Disc with two subrectangular or reniform red areas (rarely yellow), the color not being particularly brilliant. The median vitta is broader in the females than in males and in *P. nigripennis* usually has an urn-shaped outline. The red area comprises 0.3 to 0.5 of the total surface. Basal edge usually sinuate, angles various. Lateral edges deeply and apical margin usually slightly reflexed. A depression just forward of each red spot. Shallow sulcus, frequently wide, in basal half or third.

Scutellum black. Mesonotal plates black to very dark brown.

Elytra black, tricostate in larger specimens, the costae becoming less pronounced in the smaller specimens. Explanate margins very narrow, about one-seventh or less of the elytral width In males longer than the abdomen or ending with it; in females usually exposing 1 to 4 abdominal segments. Elliptical outline.

Head with frons black, usually projecting more or less bulbously between the antennal sockets. Eyes relatively small, the distance across them being about 0.55 to 0.6 of the pronotal width. Clypeus short, black, hairy, semicircular, or medially emarginate.

Antennae black, compressed. Articles 3 to 10 subrectangular, base about 0.6 of apical width. Base of 4 to 11 attached near to the outer apical corner of the preceding article in the males, the point of attachment being more nearly median in the females. Vestiture short, black or dark brown, especially noticeable on the edges. Articles 5 to 8 generally the widest, 9 and 10 narrower, and 11 elliptical. Article 3 shorter than succeeding articles. Length usually 0.5 to 0.6 of the total length in males, about 0.4 in females.

Tergites all black to dark brown, except pygidium, which in males may be partly translucent, apically truncate, sinuate, emarginate, or distinctly tridentate, projecting widely laterally and apically over ventral segment 8. Pygidium triangular in female. 5 to 7 have posterolateral pointed lobes.

Ventral segments all black or dark brown, except for yellowish or pinkish rudimentary luminous organs on 8. These organs are occasionally not observable in the larger specimens and are usually absent in the smaller ones and females. In males, segment 8 is somewhat emarginate with a short median point. In the females, this segment is triangular with a deep apical V-shaped notch.

Legs all black or brown, somewhat compressed. Tibial spurs very small and short, pattern 0–1–1. Claws simple, but may have a basal enlargement.

There seems to be an error in Solier's measurement of the width of *P. binotata* (=*P. obscura*). The size is given as 3 to 3½ lines (6.35 to 7.4 mm.) long by 3¼ lines (6.88 mm.) broad, a measurement which hardly seems possible. Even 2¼ lines (4.77 mm.) would be too broad for any specimens I have seen which could be referred to this species. It seems probable that *P. binotata* was erected on the basis of an unusually broad specimen of *P. obscura*.

Of the remaining species previously described and now listed under *P. obscura*, *P. bardelli* and *P. bioculata* were probably pale or immature specimens of *P. obscura*. E. Olivier's grouping of them and *P. lugubris* as synonyms of *P. obscura* seems justified.

Pyractonema nigripennis **Solier**

FIGURE 7

Pyractonema nigripennis Solier, *in* Gay, Hist. Fis. Pol. Chile, vol. 4, Zool., p. 448, 1849.

Pyractonema brevipennis Solier, *in* Gay, Hist. Fis. Pol. Chile, vol. 4, Zool., p. 451, 1849.

Material: 100 males and 30 females.

Dimensions: Males 14.75 to 19.5 mm. long by 4.0 to 7.0 mm. broad; average 17.0 mm. by 5.7 mm. Females 14.5 to 24.0 mm. long by 4.0 to 7.0 mm. broad; average 18.1 by 5.3 mm.

Pronotum essentially semicircular, a little prolonged apically. Length about 0.67 of width. Median vitta with urn-shaped outline.

Elytra in males about 0.86 of total length. In females about 0.8.

Aedeagus as in figure 7.

P. nigripennis is described as having a maximum length of 17½ lines (37.1 mm.). This measurement should probably read 7½ lines (15.9 mm.), although it is less than many of the specimens seen.

There seem to be several misprints of dimensions in Solier's descriptions. *P. brevipennis* is described as 5⅔ lines (12 mm.) long by 4⅔ lines (9.0 mm.) broad. The latter figure is probably an error for 1⅔ or 2⅔ lines (3.53 or 5.65 mm.).

Pyractonema bifenestrata (Fairmaire and Germain)

FIGURE 3

Lucidota bifenestrata Fairmaire and Germain, Coleop. Chilensia, vol. 2, p. 2, 1862.

Material: 125 males and 38 females.

Dimensions: Males 9.6 to 15.0 mm. long by 3.0 to 5.0 mm. broad; average 12.3 by 4.1 mm. Females 10.5 to 14.0 mm. long by 3.5 to 5.5 mm. broad; average 12.7 by 4.3 mm.

Pronotum smaller and narrower than in *P. nigripennis*. About 0.8 as long as broad in males, 0.75 in females.

Elytra about 0.85 of total length in males, 0.7 in females.

Aedeagus as in figure 3.

It is noted that there is no reference in the descriptions or key to the "two windows" which should apparently be present on the pronotum of *P. bifenestrata*. Two translucent areas in the apical portion of the pronotum were observed in several specimens of different species, and it seems probable that these areas are a modification of the pronotal pigmentation which may occur generally in this genus.

Pyractonema obscura (Olivier)

FIGURE 8

Lampyris obscura G. A. Olivier, Ent. Coleop. vol. 2 (28), p. 18, 1790.

Lampyris bardelli le Guillou, Rev. Zool. vol. 7, p. 222, 1844.

Pyractonema lugubris Solier, *in* Gay, Hist. Fis. Pol. Chile, vol. 4, Zool., p. 449, 1849.

Pyractonema binotata Solier, *in* Gay, Hist. Fis. Pol. Chile, vol. 4, Zool., p. 449, 1849.

Chauliognathus bioculata Blanchard, *in* Dumont D'Urville, Voy. Pol Sud, vol. 4, p. 70, pl. 5, fig. 7, 1853.

Pyractonema fissicollis Solier, *in* Gay, Hist. Fis. Pol. Chile, vol. 4, Zool., p. 449, 1849.

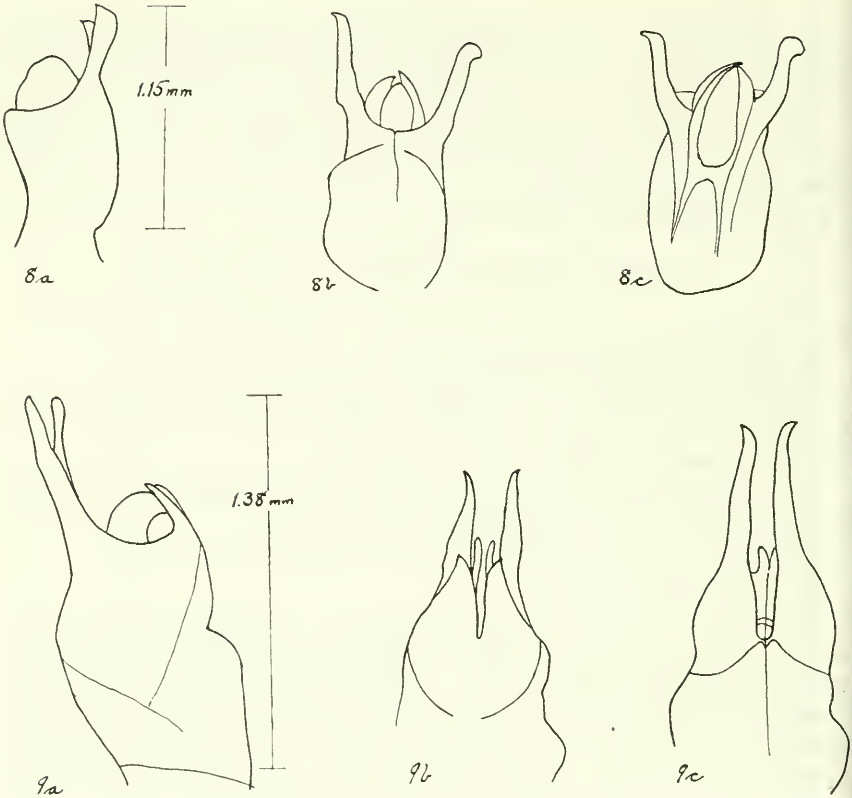
Material: 115 males and 79 females.

Dimensions: Males 5.0 to 11.0 mm. long by 2.0 to 4.6 mm. broad; average 9.5 by 3.25 mm. Females 6.0 to 14.0 mm. long by 2.2 to 3.45 mm. broad; average 10.2 by 3.1 mm.

Pronotum about as wide as in *P. bifenestrata* but proportionately shorter. Length about 0.63 of width.

Elytra about 0.8 of length in males. 0.7 of length in females with a slightly elliptical outline.

Aedeagus as in figure 8.



Figures 8–9.—Aedeagus: 8, *Pyractonema obscura;* 9, *Pyractonema rhododera.* (*a*, lateral view; *b*, dorsal view; and *c*, ventral view.)

Pyractonema rhododera Solier

Figure 9

Pyractonema rhododera Solier, *in* Gay, Hist. Fis. Pol. Chile, vol. 4, Zool., p. 449, 1849.

Material: 14 males and 1 female.

General: A small, narrow, nonluminous lampyrid with a relatively small coral-red pronotum.

Dimensions: Males 7.3 to 11.9 mm. long by 2.0 to 3.5 mm. broad; average 9.26 by 2.8 mm. Female 6.8 mm. long by 2.6 mm. broad.

Pronotum small, 0.8 as long as broad. Occasionally widest at basal third or half. Posterolateral angles variable in acuteness and position relative to the lateral margins. Laterally somewhat reflexed. Disc opaque coral-red, with no median vitta, but usually a sulcus in basal half. A narrow black border around the red area, sometimes brownish just forward of eyes.

Scutellum and mesonotal plates black, the latter dull.

Elytra in males about 0.85 of total length. In females about 0.8 of total length. Parallel, uniformly black. Very narrow explanate margins. No pale borders or other ornamentation.

Head presents no specific features and is very similar to that of the *nigripennis* group.

Antennae black, hairy, compressed, generally similar to those in the *nigripennis* group. In occasional specimens articles 3 to 10 were noticeably wider in proportion to length than usual.

Tergites all black. Pygidium truncate, sinuate, or tridentate apically, not greatly widened over last abdominal segments.

Ventral segments usually all black, sometimes medially brown. Little or no evidence of luminous organs.

Legs black. Tibial spurs not discernible. Claws simple.

Aedeagus as in figure 9.

Solier remarks on the wide range of size in this species. It is curious, however, that his description of this species says nothing definite about a "red neck," other than the two red spots on the pronotum, which would not differentiate it from the foregoing group of species. This description leads me to suspect that Solier may have missed the true specimens of *P. rhododera* and written his description from others belonging in the *P. nigripennis* group. The "red necks" here described somewhat resemble *P. albomarginata* but lack the pale elytral borders.

***Pyractonema subulipennis* (Fairmaire and Germain)**

Lucidota subulipennis Fairmaire and Germain, Coleop. Chilensia, vol. 2, p. 3, 1862.

No specimens representing this species, which has a red abdomen, were received.

***Pyractonema vicina* Solier**

Pyractonema vicina Solier, *in* Gay, Hist. Fis. Pol. Chile, vol. 4, Zool., p. 448, 1849.

Material: One female in the collection of the California Academy of Sciences, and two males in the U.S. National Museum identified by E. Olivier.

General: A small, rather narrow, nonluminous lampyrid usually with a yellow pronotum (sometimes red) bearing black markings.

Dimensions: 9.0 to 12.0 mm. long by 2.8 to 3.0 mm. broad.

Pronotum 0.67 as long as wide, nearly as wide at base as elytra at humeri. Ground color light yellow (red in one ♂). Reflexed lateral margins brown for about one half their width. Brown basal border and truncate longitudinal irregularly triangular area in apical three-fourths.

Scutellum and mesonotal plates brown, the latter ivory in one ♂ specimen.

Elytra 0.8 of total length, subparallel, distinctly bicostate, deflexed over abdominal segments, especially apically. Very narrow explanate margins. Terminal abdominal segments not exposed. Brown.

Head with frons brown, bent sharply backwards and transversely impressed above antennal sockets. Width across eyes 1.15 mm., between eyes 0.65 mm. Eyes rather small. Maxillary palpi dark brown, of the usual conoidal outline. Labial palpi dark brown, securiform. Clypeus brown, short, margin almost straight. Mandibles small, projecting forward.

Antennae nearly black, compressed but not markedly serrate. First article shorter than 3d. 5.1 mm. long.

Prosternum pinkish yellow. Mesosterna and metasterna brown.

Tergites and abdominal segments brown, with no evidence luminous organs.

Legs brown, with tibial spurs not distinguishable.

This species, usually having a yellow pronotum, was not represent in the Peña shipment.

Literature Cited

Barber, Herbert S.
1951. North American fireflies of the genus *Photuris*, Smithsonian Misc. Coll., vol. 117, No. 1, p. 16.

Blanchard, E.
1853. *In* Hombron and Jacquinot, Voyage au Pôle Sud et dans l'Oceanie sur les courvettes l'*Astrolabe* et la *Zelée*, exécuté . . . pendant . . . 1837–40, Zoologie, vol. 4, p. 70, pl. 5, fig. 7.

Fairmaire, Leon, and Germain, P.
1862. Coleóptères Chilensia, vol. 2.

Ferris, Gordon Floyd.
1928. The principles of systematic entomology. Stanford University Publications, University Series, Biological Science, vol. 5(3), 169 pp.

Gemminger, M., and von Harold, E.
1869. Catalogus coleopterorum hucusque descriptorum synonymicus et systematicus, vol. 6, pp. 1609–1800.

Gorham, H. S.
1883. Revision of the genera and species of malacoderm Coleoptera of the Japanese fauna. Trans. Ent. Soc. London, pp. 393–411.

le Guillou, E. J. F.
1844. Description de vingt insectes coléoptères recueillis pendant le voyage autour du monde de l'*Astrolabe* et la *Zelée*. Revue Zoologique, vol. 7, pp. 220–225.

McDermott, F. A.
1956. Gigantic glowworms in South America. Coleopterists' Bull., vol. 10, No. 2, pp. 17–19.

OLIVIER, ERNEST
1899. Les lampyrides typiques du museum. Bull. Mus. Hist. Nat. Paris, vol. 5, pp. 371–372.
1902. Coléoptères lampyrides recueillis aux environs de Tokio (Japon) par M. le Dr. Harmand. Nommés et décrits par M. Ernest Olivier. Bull. Mus. Hist. Nat., Paris, vol. 8, pp. 188–190.
1907. *In* Wytsman, Genera insectorum, fasc. 53, pl. 2, fig. 4.
1910. *In* Junk-Schenkling, Coleopterorum catalogus, pars. 9.
OLIVIER, G. A.
1790. Entomologie, ou histoire naturelle des insectes coléoptères, vol. 2, No. 28, pl. 2, fig. 13, p. 18. See also Fabricius, J. C., 1792, Entomologia systematica . . . , vol. 1, p. 99.
SOLIER, A. J. J.
1849. *In* Gay, Historia fisica y politica de Chile, vol. 4, Zoologie, pp. 445–511.

U.S. GOVERNMENT PRINTING OFFICE: 1960

Proceedings of
the United States
National Museum

SMITHSONIAN INSTITUTION • WASHINGTON, D.C.

Volume 112 1960 Number 3434

NORTH AND SOUTH AMERICAN COPEPODS OF THE GENUS HEMICYCLOPS (CYCLOPOIDA: CLAUSIDIIDAE)

By Richard U. Gooding [1]

Introduction

Species of the genus *Hemicyclops* Boeck have been found on both east and west coasts of the American continents. Those previously described are *thysanotus* Wilson, *callianassae* Wilson, *pugettensis* Light and Hartman, *purpureus* Boeck, *adhaerens* (Williams), *americanus* Wilson and *elongatus* Wilson; *subadhaerens* and *arenicolae* are added in this review. Little is known about their ecology or distribution, but all appear to be intertidal forms or inhabitants of shallow water and some to live in association with other animals. To the latter category belong at least one and possibly both of the new forms described.

This study forms the first part of a revision of the genus *Hemicyclops*. An attempt on the larger task has seemed inappropriate at present for two reasons. First, lack of information on the morphology of larval stages in the Clausidiidae (to which all the genera mentioned in this paragraph belong) prevents an adequate evaluation of Nicholls' suggestion (1944, pp. 49–51) that the genus *Saphirella* T. Scott represents "the young form of *Hemicyclops*." Second, although some trends shown by the species described in this paper suggest that the

---

[1] Zoology Department, University of Washington, Seattle.

genera *Hersiliodes* Canu (see Bocquet and Stock, 1957, for a discussion of the species currently included in this genus) and *Giardella* Canu can be synonymized with *Hemicyclops*, I have not had a chance to examine representatives of either.

Thus, no definition of the genus is given here. All the species discussed share with the type species (*H. purpureus* Boeck, 1873, coast of Norway) the lack of suckers on any of the appendages, a basic terminal mandibular armature of four articulated processes, the presence in the adult female of well-developed maxillipeds, and caudal rami whose length does not exceed five times their width. *H. thysanotus*, the first species treated here, since it was more intensively studied, has been described somewhat more fully. Descriptions of the females of the other species are intended to be read with reference to those preceding them; accounts of the males are, in addition, supplementary to the descriptions of their respective females. It is hoped that the illustrations, which represent in full the observations I have been able to make, will alleviate any inconvenience this arrangement may cause. A key to the American species is given on p. 165.

The terminology and abbreviations used are the same as those of a previous paper (Gooding, 1957), except that "protopodite" replaces "basipodal segments" and "element" replaces "articulated process"; "ornamentation" is restricted to "the complement of cilia and/or spinules of a particular structure"; and "armature" denotes "the complement of setae and/or spines of a particular structure." The last two definitions are, with permission, quoted from an unpublished thesis by Dr. Patricia Dudley. Terms such as "ventral," "anterior," and "right," when used in describing appendages or their parts, refer to these structures as they are oriented in the intact animal: e.g., "inner side of maxilliped" is the side nearest the animal's median longitudinal axis. For appendages which may change their orientation, the most usual position has been chosen for the description. Alternative terms are given in the legends to the figures. The phrase "burrow water" is used to refer to subsurface water accumulating in the hole created when digging for burrowing animals (in this case, callianassids).

To facilitate reference in the text, collections and collecting areas on the Pacific coast have been numbered thus:

C.1: Elkhorn Slough, Monterey Bay, California, lat. 36°49′ N., long. 123°16′ W., from *Callianassa californiensis* Dana, G.E. MacGinitie. For further details, see MacGinitie, 1935.

C.2: Tomales Bay, California, flats near Dillon Beach, lat. 38°15′ N., long. 122°58′ W., from 18 *Upogebia pugettensis* (Dana), J. W. Hedgpeth, June 1956.

C.3: Bodega Harbour, California, lat. 38°19′ N., long. 123°3′ W., muddy sand flats near Gaffney Ranch, from 19 *C. californiensis* and from 19 *U. pugettensis*, R. I. Smith, July 24, 1956.

C.4: Yaquina Bay, Oregon, lat. 44°38′ N., long. 124°3′ W., from 18 *U. pugettensis*, L. Aldrich, April 1957.

C.5: Willapa Bay, Washington, near Oysterville, lat. 46°33′ N., long. 124°0′ W., from 4 *C. californiensis*, H. Hetzel, May 5, 1957.

C.6: Kingston, Washington, a small lagoon about 1 mile southeast of the town, lat. 47°47′36″ N., long. 125°30′18″ W., muddy sand. I have found *C. californiensis* and a few *U. pugettensis* here.

C.7: Port Madison, Washington, lat. 47°42′ N., long. 122°31′ W.: *a*, a small lagoon in Fay Bainbridge State Park, soft muddy sand. I collected *C. californiensis* here on February 3, 1958. *b*, Seattle Yacht Club beach, muddy sand. *Callianassa gigas* Dana, *C. californiensis*, and *U. pugettensis* have all been taken here.

C.8: Bellingham Bay, Washington, lat. 48°45′ N., long. 122°45′ W., from 14 *C. gigas*, P. Wennikens, spring, 1956.

C.9: False Bay, Washington, lat. 48°29′ N., long. 123°4′ W. I have collected *C. gigas* and *U. pugettensis* from the southeast side of the mouth in muddy sand.

C.10: Hammond Bay, British Columbia, Piper's Lagoon, see Gooding, 1958.

C.11: Parksville, British Columbia, lat. 49°19′ N., long. 124°19′ W., soft sand, from 17 *C. californiensis*, Mrs. G. C. Carl (J. F. L. Hart), August 13, 1955.

No *Hemicyclops* were found in the following collections:

C. gigas: Humboldt Bay, California, lat. 40°48′ N., long. 124°12′ W., 1, J. Pearce, February 12, 1957.

C. californiensis: Collected by Mrs. G. C. Carl: Point Grey Beach, British Columbia, lat. 49°16′ N., long. 123°16′ W., 5, March 30, 1930. Brockton Point, British Columbia, lat. 49°18′ N., long. 123°8′ W., 1, November 29, 1929. Departure Bay, British Columbia, lat. 49°12′ N., long. 123°57′ W., 13, March 7, 1933; 23, April 26, 1933; 5, July 12, 1934. Witty's Lagoon, British Columbia, lat. 48°23′ N., long. 123°30′ W., 5, May 13, 1953; 3, June 10, 1953; 2, June 21, 1955. Cadboro Bay, British Columbia, lat. 48°27′ N., long. 123°17′ W., 9, January 9, 1956. Clam Bay, British Columbia, lat. 48°59′ N., long. 123°39½′ W., 4 ,August 22, 1957. Collected by W. Shapeero: Quilcene Bay, Washington, lat. 47°49′ N., long. 123°51′ W., 23, June 15–17, 1957. Collected by the Author: Burleigh Lagoon, Washington, lat. 46°23′ N., long. 123°38′ W., 6, June 7, 1956. C.7a: 6. Miller Bay, Washington, lat. 47°45′ N., 123°33′ W., 2, March 3, 1956. Mukkaw Bay, Washington, lat. 48°19′ N., long. 124°39½′ W., 3, May 15, 1956. Mission Bay, California, lat. 32°47½′ N., long. 117°14′ W., 9, March 28, 1956. C.5.

U. pugettensis: Collected by the author: C.10 (the Bay proper), 10, July 1956; numerous specimens also examined in the field, June 28, 1957. C.9, numerous specimens examined in the field, summers 1956 and 1957; also 3, August 1956. C.7b, 1, March 16, 1956. C.6, 1, February 11, 1956. Mission Bay, California (see above), 1, March 28, 1956. Collected by W. Shapeero: Quilcene Bay, Washington, 1, June 15–17, 1957.

Hermissenda crassicornis (Eschcholtz): Several specimens, mainly from pier at Friday Harbor Laboratories, San Juan Island, Washington, lat. 48°34′ N., long. 123°1′ W., summers 1956 and 1957.

Subsurface water: Golden Gardens City Park, Seattle, Washington, lat. 47°43′ N., long. 121°24′ W., 1,000 cc., from muddy sand with scattered stones, February 4, 1958.

The use of lactic acid in copepodological work has already been mentioned briefly (Gooding, 1957). This fluid is particularly suitable as a temporary mountant for small arthropods since it is directly miscible with most general preservatives, penetrates rapidly, clears satisfactorily, evaporates slowly, and has a low refractive index. It also renders specimens supple, so that dissection is facilitated. However, since it macerates the soft parts of the body, it cannot be used when the animals are required for study of the internal anatomy. The following procedure has proved very useful and should be applicable to small crustacea other than copepods.

A coverslip of sufficient size is fastened over the hole in a Bio-Plastic Micromount Holder (Ward's Natural Science Establishment, Inc., Rochester, N.Y.). Since this hole perforates the plastic slide, the two parts together form essentially a deep-well slide. The use of modelling clay for attaching the coverslip allows the latter to be removed easily whenever necessary. The specimen is then mounted in a small drop of lactic acid at the bottom of the "well" (i.e., centrally on the face of the coverslip nearest the slide). Staining is usually unnecessary and often undesirable but, if required, a weak solution of methyl blue in lactic acid may be used as the mountant.

When observations and drawings are being made, the slide should be placed coverslip uppermost so that the specimen is protected in a hanging drop within the cavity. If a coverslip of sufficient thinness is used initially, even an oil-immersion objective can be employed for examination, although, of course, some resolution is lost since the condenser cannot be oiled. The reverse position of the slide allows dissection and rearrangement of the animal or its appendages to be made with ease on the stage of a dissecting microscope. Any appendage which cannot be manipulated so as to show the relation of its parts satisfactorily can be removed to a standard microscope slide and flattened partially in a drop of lactic acid under a coverslip. Movement of the latter will usually produce the desired position (see the figures of "flattened" appendages included below, e.g., 5*d*).

Such temporary mounts will remain in good condition for long periods if protected from dust and if the lactic acid is renewed occasionally. Hoyer's medium (see Baker and Wharton, 1952, pp. 10–11, for formula) has proved satisfactory as a permanent mountant since specimens can be transferred to it directly from lactic acid.

A camera lucida was used in making all drawings. This device also permitted a simple and accurate method for comparing a series of specimens of one species. Drawings of the copepod first examined were viewed simultaneously with the images of later mounts similarly oriented through the appropriate combination of lenses. Scales of magnification for each of the lens combinations used were drawn from a stage micrometer. The method for stereoscopic microscopy described by Galbraith (1957) proved very helpful in determining the shape and relations of appendages.

Among the many persons and agencies who have assisted me from time to time, I wish to thank particularly Dr. Paul Illg for much helpful discussion, suggestions, and encouragement during all phases of this work; Drs. Ernst Florey and K. L. Osterud for their critical reading of the manuscript; Drs. Fenner A. Chace, Jr., and Thomas E. Bowman of the U.S. National Museum for arranging the loan of material from the National Museum collections; and several others named in the text for supplying me with specimens either of copepods or of their hosts and information. The State of Washington, through Dr. Illg, provided support for part of the work and some facilities.

Genus *Hemicyclops* Boeck

Hemicyclops Boeck, 1873, p. 42; etc.

Of the seven species of *Hemicyclops* previously described from North and South America, three are considered valid and one doubtful; two new ones are added. Although very few specimens of each species have been examined, the small amount of variation between individuals of a particular form has made it possible to be somewhat more definite on points of specific discrimination than the evidence available might seem to favor. The following morphological characters are considered to have taxonomic value in differentiating the species discussed: the nature of the genital segment in the adult female; the ornamentation of the antenna and its elements; the terminal armature of the mandible, maxilla and maxilliped; the ornamentation of the labium; the setal formula of the swimming legs; the relative lengths of elements on the fifth legs; the presence (and nature) or absence of sixth legs; and the modification of setae on the caudal rami. These characters permit us to divide the American species into two well-defined groups: the first comprising *thysanotus* (and *purpureus* if it occurs in these waters, see p. 176), the other including *adhaerens*, *subadhaerens*, *arenicolae*, and probably *elongatus*. (Lack of knowledge about the mouthparts and maturity of the only specimen available precludes any completely certain disposition of *elongatus*.)

It is difficult at this stage to determine whether the second group represents a polytypic species or a superspecific complex. I have preferred the latter alternative because the morphological differences between its members are approximately equivalent to those currently used (Humes, 1949, 1957) in characterizing the species of *Clausidium*, a genus belonging to the same family, and the ecological differences are much greater; also with respect to *adhaerens* and *arenicolae*, there is some evidence for sympatry, although no intermediates occurred among the specimens that I have examined.

This superspecies would be characterized mainly by the separation between genital and first abdominal segments and the well-developed sixth legs in the adult females; the reduced mandibular setation and presence only of simple terminal elements on the maxilla and of setulose exopod spines on all the swimming legs in both sexes; and the attenuated "scaly" tip of the male maxilliped. Its members are known only from the New World but appear morphologically quite similar to the species of *Giardella* that have been reported from the coasts of France and England.

The species discussed range from forms found free-living (*adhaerens*) to those which, under natural conditions, seem to remain in contact with their hosts (*thysanotus* and *elongatus*?). Intermediate between these extremes are associates which may inhabit the burrow but seldom stray onto the body of the host (*subadhaerens*), or apparently are equally common in the one as on the other (*arenicolae*). Further work is needed to determine whether species of the first type are really independent and, for forms associated with other animals, what are the relations of copepod and host.

A feature of the species *thysanotus* and *subadhaerens* (the only ones examined alive) is the presence, mainly in the prosome, of droplets of a red, oily-appearing material among the organs. It appears to be incorporated in the eggs, and to a lesser extent the spermatophores, and occurs in the nauplii. Such stored material is very characteristic of species of *Clausidium*, which are also associated with *Callianassa*. It is responsible for the bright red color of these copepods. Its presence seems not to depend on an association with callianassids, however, for Sars (1917) described a female of the apparently free-living *Hemicyclops purpureus* as having "bright red" ovarial tubes and ovisacs. These observations are consistent with what is known about carotenoid metabolism in copepods and other Crustacea and, if chemically of this nature, the substance probably has its origin in the organism's food (Fox, 1953). Thus, in species associated with *Callianassa*, it could presumably be derived from plant and/or bacterial matter, from the host's blood, or from the eggs of berried female mud shrimp.

The key below refers to the presently known species of *Hemicyclops* that I have examined from North and South America. It is applicable to the adults of both sexes but will probably also serve to distinguish immature specimens, at least to morphological group. The structure of the maxillipeds and the nature and position of the sixth legs will most easily differentiate adult males from females. Dissection should not be necessary in following the key but use of a compound microscope and generally some preliminary clearing treatment (discussed on p. 162) will be essential.

1. Setulose exopod spines only on first leg; terminal segment of antenna very little longer than wide . . . . **thysanotus** (p. 165)
   Setulose spines on exopods of all 4 swimming legs; last antennal segment more than 2 times as long as wide 2
2. Antenna with 2 large, elliptical patches of fine spinules on inner side of second and third segments; distal podomere of fifth legs without spinules on sides. **arenicolae** (p. 188)
   Antenna without spinules as above; distal podomere of fifth legs with some spinules on sides 3
3. Caudal rami more than 4 times as long as wide; body more than 2.7 mm. in length . . . . **elongatus** (p. 184)
   Caudal rami less than 3 times as long as wide; body less than 2.5 mm. in length 4
4. Innermost spine on distal segment of fifth legs about equal in length to adjacent seta; ventral spine on maxilliped with 2 denticles on anteroventral surface . . . . **adhaerens** (p. 176)
   Innermost spine on distal segment of fifth legs shorter than adjacent seta; ventral spine on maxilliped with 3–5 denticles on anteroventral surface . . . . **subadhaerens** (p. 181)

Hemicyclops thysanotus Wilson

FIGURES 1; 2; 3,*a–c*

Hemicyclops thysanotus Wilson, 1935, pp. 783–785, pl. 28, figs. 41–52.—Light and Hartman, 1937, pp. 179–180, pl. 12, figs. 3–4.—Nicholls, 1944, pp. 44, 49.—Sewell, 1949, pp. 67, 69.

Hemicyclops callianassae Wilson, 1935, pp. 782–783, pl. 27, figs. 25–35.—Light and Hartman, 1937, pp. 179, 180.—Nicholls, 1944, pp. 45, 49.—Sewell, 1949, p. 67.

Hemicyclops pugettensis Light and Hartman, 1937, pp. 179, 180, 181–182, 182, t.-figs. 12–20, pl. 12, figs. 5–6.—Nicholls, 1944, pp. 45, 49.—Sewell, 1949, pp. 67, 68, 69.—Gooding, 1958, p. 699 (part).

TYPES: "A single female bearing ovisacs and a male . . . from the outside surface of the eolid, *Hermissienda* [sic] *crassicornis*, in Elkhorn Slough, Monterey Bay" (Wilson, 1935), USNM 64063, here considered syntypes.

The designated types for *callianassae* were "a single female with attached male" (Wilson, 1935), USNM 60432. Of these only the male syntype appears to be still in existence (letter from Dr. T. E. Bowman, February 25, 1958). *H. pugettensis* was stated by Light and Hartman (1937, p. 182) to be based on a single specimen, but the catalog number that they quote (USNM 71678) comprises a (syntypic) series including females and males. There is no record of a holotype in the U.S. National Museum.

MATERIAL EXAMINED: From *Hermissenda crassicornis:* C.1 (see p. 160): 1 female, 1 male, syntypes of *thysanotus*. 5 females, 3 males, paratypes of *thysanotus*, USNM 64064. A slide, containing the parts of a dissected female, labelled "*Hemicyclops thysanotus*—Paratype." 1 female from body surface, August 20, 1927, identified by S. F. Light, USNM 90937, dissected.

From *Callianassa californiensis:* C. 1: 1 male syntype of *callianassae*. 12 females, 6 males, 6 juveniles, paratypes of *callianassae*, USNM 60433, all from gill chamber. Slide of a dissected female, labeled "*Hemicyclops callianassae*—Paratype." 20 females, 11 males from eggs, Wilson's *thysanotus* (figures 2*a–b*, *d*, *f–l*, and 3*a–c*, are based on a female and figure 1*a–d* (labrum), *e*, *g–p*, and *r* on a male of this lot). C.3: 1 female from debris in bottle.

From *C. gigas:* C.9: 12 females, 1 male from body surface, B. Blanchard, June 1936, syntypes of *pugettensis* (discussion of type locality in Gooding, 1958, p. 699). Slide of a dissected female labelled "*Hemicyclops pugettensis*—Type," Illg's collection. Several specimens from gill chamber and body surface, summers of 1956 and 1957, e.g., 2 females, 2 males from 2 hosts, July 27, 1957; 6 females, 2 males from 3 hosts, August 21, 1957; figure 2*c*, *e*, and *h*, was drawn from a female and figure 1*d* (labium), *f*, and *g* from a male, both of the first lot. C.7b: Several specimens from gill chamber and body surface, 1955–58, e.g., 19 females, 9 males, 1 juvenile from 3 hosts, March 16, 1956; 54 females, 27 males, 9 juveniles from 5 hosts, February 3, 1958. C.8: 4 females, 1 juvenile from debris in bottle.

From *Upogebia pugettensis* (a host of this copepod not previously mentioned in the literature): C.2: several specimens between gill filaments and in debris (one female was dissected). C.3: 9 females, 12 males, 10 juveniles from debris in bottle. C.4: 121 females, 88 males, 8 juveniles from debris in bottle; twenty specimens of each sex have been deposited in the U.S. National Museum, No. 101368.

Redescription of the female: Body 2.0 mm. in length (mean of 10 specimens, range 1.74–2.44 mm.); clearly divided into wide prosome (0.9 mm.; 0.77–0.97 mm.) and narrower urosome. Color in life (re-

Figure 1.—*Hemicyclops thysanotus* Wilson, male: *a*, Habitus, dorsal aspect. *b*, Right antennule, dorsal (anterior) view. *c*, Right antenna, dorsal (posterior) view. *d*, Labrum in dorsal, labium in ventral view. *e*, Right mandible, ventral (posterior) view. *f*, Right paragnath, ventral (posterior) view. *g*, Right maxillule, dorsal (posterior) view. *h*, Left maxilla, dorsal (anterior) view, with detail of base of setule-bearing seta from a different aspect. *i*, Right maxilliped, ventral (posterior) view. *j*, Right first swimming leg with coxal plate, ventral (anterior) view. *k*, Right second swimming leg with coxal plate, ventral (anterior) view. *l*, Right third swimming leg with coxal plate, ventral (anterior) view. *m*, Right fourth swimming leg with coxal plate, ventral (anterior) view. *n*, Right fifth leg, ventral view. *o*, Ventral view of genital segment showing position of sixth legs. *p*, Left sixth leg, lateral view. *q*, Spermatophore (somewhat swollen) expressed from genital segment. *r*, Right caudal ramus, dorsal view. Scale A (fig. 2) applies to *a*: D to *b* and *i–m*; E to *c–d*, *g–h*, and *n–r*; F to *e*; and G to *f*.

For Explanation, See Opposite Page

flected light) opaque white with red areas, mainly in the prosome around or coloring the oviducts, which tend to give a general reddish appearance on the whole body when viewed with the naked eye; fifth legs and caudal rami occasionally brown; eye and ovisacs bright red.

Prosome comprising a cephalothorax, with no trace of division between cephalosome and first pedigerous somite, and 3 metasomal segments whose terga are usually imbricate, with square or rounded corners. Prosome ovate but posteriorly truncate in dorsal outline, flattened in side view. Eye of the usual naupliar type. Rostrum (fig. 2*b*) a small fold, apparently in tergum of cephalothorax, producing this ventrally between bases of antennules. Postoral protuberance inconspicuous.

Urosome 5-segmented. Largest the genital segment, which almost certainly represents a complex of 2 somites, the boundary between them represented ventrally and occasionally in dorsal view by a thickened ridge. (Light and Hartman, 1937, give a very good picture of this segment in their figure 12. This figure shows the structure of the anterior part of the segment—i.e., genital somite proper—with its 2 pairs of small lateral expansions. The dorsal anterior pair of expansions are often joined along the dorsal surface by a thickened strip and make the anterior part of the segment wider than the posterior region—i.e., first abdominal somite.) Paired oviducal openings ventrolateral on anterior corners of genital segment. Ovisacs with numerous eggs, usually reaching ends of caudal rami, narrowly cylindrical. Three free abdominal segments, the last here termed the anal segment and carrying a row of fine spinules ventrally along each side of distal border near midline. Anus dorsal, without distinct anal operculum; oval-shaped area in figure 2*l* having a very thin integument.

Caudal rami more than 3½ times as long as wide; bearing 4 terminal setae and an outer lateral and an inner dorsolateral seta, all distally placed. Outermost terminal and usually outer lateral seta comprised of a basal shaft, ending in a small spiniform projection on one or both sides, and a terminal "flagellum" whose thickening is broken up into transverse rings. Two longest setae with usual "jointed" attachment at base.

Antennule 7-segmented. Attachment of basal segment to ventral exoskeleton of head region at right angles to plane of projection of remainder of appendage. Appendage in life carried perpendicular to sagittal plane of body. Last 3 segments slightly narrower than and their axis at an angle to preceding 4. Setation: 4 on first, 15 on second, 6 on third, 3 on fourth, 4 on fifth, 2 and an aesthete on sixth, 7 and an aesthete on seventh. Long setae on fourth and terminal segments very obvious. One seta on second and one on fifth segment the only ones completely ciliated but several with cilia near tips. Almost all setae with thickening in transverse rings. Aesthetes narrow and rather inconspicuous, with basally thickened walls.

Last 3 segments of tetramerous antenna typically bent at right angles to first and lying near mouth region. (Subsequent terminology with reference to this position.) Fourth segment offset in fashion typical of clausidiids; almost quadrate; bearing terminally on dorsal side a seta, with long heavy cilia, in a notch on the outer edge 2 spinulose setae, and 4 curved setae inserted linearly along width of distal border between the two groups. Two proximal of the 3 "comb rows" of spinules on this segment difficult to see. Outer corner of third segment produced distally for more than half length of fourth; 2 characteristically ornamented spines at its tip; a curved seta and another shorter seta in recess between this projection and insertion of fourth segment. Surface thickening of 5 curved setae on antenna irregular from region of initial curvature to tip; the latter either notched (in the longest 2) or finely toothed on the inner side. Other ornamentation and armature of appendage as shown in figure 2*d*.

Mouth region (fig. 2*e*) and adjoining appendages closely compacted in typical poecilostome fashion, their arrangement very similar to that of *H. australis* (Nicholls, 1944, fig. 21) or *purpureus* (Sars, 1917, pl. lxxxi, "Or. area"). Labrum protruding from ventral body surface; posterior border straight, its median portion with 2 rows of small denticles set one above the other. Each flange forming posterior corner of labrum with 2 rows of larger denticles; upper row turning dorsally (i.e., toward mouth) at its inner end. Sides of labrum nearest mouth cavity flaring sharply away from a median "prow" which overhangs mouth. Labium a flat rectangular surface delimited by thickenings in ventral exoskeleton of head region; its anterior half beset with rows of denticles pointing toward mouth. Between latter and labium is a square area, the roof of the mouth cavity, clothed in cilia and rising medially into a bilobed prominence. Paragnaths inserting laterally on roof of mouth cavity anterior to labial corners; thick, comma-shaped flaps profusely ciliated; oriented nearly at right angles to surface beneath, with tips approaching each other on midline.

Mandible with strongly thickened triangular base. Body of appendage curves toward midline, backwards and upward, fitting under sides of labral "prow" so that tip lies in mouth cavity. Terminal armature a heavy, curved element, a spinulose blade, and 2 setae with strong cilia; all articulated. Dorsal element dentate along one edge, with an incompletely toothed ridge at an angle on anterior side.

Flaplike maxillule distally bilobed: smaller lobe with 3, larger (outer) with 5 setae, majority strongly ciliated and with transverse

Only the 3 spines nearest base exopodite of first swimming leg with a terminal setule. Base of most median seta on third endopodite segment of legs 2–4 with a group of 3 or 4 strong cilia. Other ornamentation as shown in the figures.

Fifth legs 2-segmented; inserted on ventrolateral corners of thoracic segment. First podomere small and square, almost hidden in dorsal view by a lateral projection (which shows remnant of tergum) of thoracic segment; its seta, borne on a papilla on outer distal corner, nearly as long as terminal segment. Latter lamellar; with a slight outward and upward curve; bearing 2 spines set stepwise on outer edge of distal half, a long seta on a small papilla and a finely ciliated spine terminally. Terminal segment ornamented with spinules on outer and strong cilia on inner edge. (Several specimens from Puget Sound region have also a "sunburst" of well-developed cilia near base on ventral side.)

Sixth legs apparently absent.

REDESCRIPTION OF THE MALE: Body 1.53 mm. in length (mean of 6 specimens, range 1.50–1.54 mm.) and 0.65 mm. (0.64–0.70 mm.) wide; paler in color than female. Urosome longer in proportion to prosome and the latter more ovate. Genital segment not compound so that urosome 6-segmented. Paired genital ducts opening ventrolaterally in posterior half of genital segment. Spermatophores (fig. 1*q*) small kidney-shaped structures with a short stalk. (When attached to the female, they are rather smaller than indicated by the figure.) Caudal rami shorter in proportion to their width than those of female.

Ciliated seta on second segment of antennule not as well-developed as in female.

Antenna occasionally without patch of spinules on inner distal corner of second segment.

Posterior limit of labium difficult to distinguish; denticles present in female here reduced to small spinules or cilia.

Mandible and maxillule very similar to female condition, but former may apparently lack second seta on one or other side.

FIGURE 3.—*a-c*, *Hemicyclops thysanotus* Wilson, female: *a*, Right second swimming leg with coxal plate, ventral (anterior) view. *b*, Right third swimming leg with coxal plate, ventral (anterior) view. *c*, Right fourth swimming leg with coxal plate, ventral (anterior) view. *d–j*, *Hemicyclops adhaerens* (Williams), female: *d*, Left antennule, dorsal (anterior) view. *e*, Right antenna, ventral (anterior) view. *f*, Labrum from ventral side but with microscope focused so that dorsal structures are apparent. *g*, Labium, right paragnath and part of roof of mouth cavity, ventral view. *h*, Apex of left mandible, dorsal (anterior) view. *i*, Left maxillule, ventral (anterior) view. *j*, Distal half of right maxilla, dorsal (anterior) view (flattened, setule-bearing seta partly detached from base). Scale C (fig. 2) applies to *c*; D to *a–b*; E to *d*; F to *e–g*; and G to *h–j*.

For Explanation, See Opposite Page

Most ventral seta on second segment of female maxilla replaced here by a heavily sclerotised but unornamented hook which is confluent with the segment.

Maxilliped similar in basic plan to that of female but very different in appearance. Only 1 seta on basal segment; 2 on second, which is heart-shaped with several rows of spinules (the largest near base of segment), much reduced in size and ornamentation and widely separated. Terminal segment extended into a long, thick, curved process bearing 3 setae as shown in the figure. (Longest of these setae is very closely appressed to and often seems partially fused with basal region of process; this part may represent instead of a seta a partially separated membrane. It is difficult to homoligize the armature of this segment with that found in the female.)

Only change in armature of swimming legs is loss of spine on inner distal margin of first basipodite.

First podomere of fifth legs completely fused with thoracic segment but its seta and ornamentation remaining. Bases of this pair of legs connected ventrally by a thickened strip. Strong cilia on inner edge of terminal segment in female replaced by fewer spinules here and these more distal in position.

Sixth legs form paired flaps covering, in ventral view, most of posterior half of genital segment; a curved spine on each ventrolateral corner.

REMARKS: My observations support neither the differences educed by Wilson (1935) between *H. callianassae* and *thysanotus* nor the characters stressed as diagnostic for *pugettensis* by Light and Hartman (1937). Accordingly, the three species are here considered identical. Since *pugettensis* is clearly a junior synonym, the valid name must be selected from the other two.

H. callianassae and *thysanotus* were described in the same publication (Wilson, 1935); the former, since it was listed first and described in equal detail, would normally become the species name. However, I propose to take advantage of "the principle of the first reviser," reinstated in 1953 (International Commission on Zoological Nomenclature, pp. 66–67), and examine the problem posed in this instance by *Giardella*.

As mentioned earlier (p. 160), the genus *Giardella* Canu, whose type species (by monotypy) is *G. callianassae* Canu, 1888, is very closely related to *Hemicyclops*. In studying the literature, I have come to the conclusion that it may eventually be desirable to expand the generic concept of *Hemicyclops* so as to include this species. If page priority is strictly applied in the case of Wilson's form, however, and *callianassae* is chosen, any later merging of *Giardella* with *Hemicyclops* would make it necessary to alter the name of his species. I believe that there is thus sufficient reason for considering the "other things" not to be "equal" (the present wording of Article 28 of the Rules of Zoological Nomenclature), and hence in the interests of stability, I have preferred *thyanotus* to *callianassae* for designating this Pacific Coast species.

It should be noted that MacGinitie's order of listing (1935) cannot be used to support this choice (i.e., by dating Wilson's species from his paper) since, although technically the first mention of *thysanotus* and *callianassae* in the literature, his names per se must be considered nomina nuda.

H. thysanotus seems very close to *thomsoni* (Canu) and to *dilatatus* Shen and Bai. For the present, however, the following characters will serve to diagnose the species: the fusion of first abdominal and genital somites; the ornamentation of the antenna, particularly the heavy ciliation on one of its terminal setae; the armature of the last maxillar segment; the presence of setule-bearing spines on the exopodite of the first swimming leg only; the shape and ornamentation of the distal segment of the fifth legs; and the modified setae on the caudal rami. Specimens in the northerly part of its range are, as might be expected, larger and their appendages, particularly with respect to armature and ornamentation, often better developed; but no meristic differences among specimens have been observed. Nor could I find evidence for the existence of host-specific forms.

DISTRIBUTION: The species is known to range from San Juan Island, Washington, to Monterey Bay, California, and occurs on four hosts, the nudibranch *Hermissenda crassicornis* and the thalassinids *Callianassa gigas, C. californiensis,* and *Upogebia pugettensis.* All of these hosts are common within the copepod's entire range, but there are some puzzling irregularities in its geographical distribution on them. From Oregon south, *thysanotus* seems to be abundant on *Upogebia* and, in California (MacGinitie, 1935; MacGinitie and MacGinitie, 1949), on *Hermissenda* and *C. californiensis;* yet over a period of 2½ years of collecting, I have not found specimens on any of these three in the Puget Sound region. The statement in Gooding (1958), that *thysanotus* occurred on *C. californiensis* at Nanaimo was based on a misindentification. Locally, but apparently not in California, it is abundant on *C. gigas.*

The ecological factor common to *Hermissenda* and callianassids as habitats is also difficult to visualize. In association with the latter animals, *thysanotus* is generally found in the gill-chamber but may also occur on the surface of the body. Although it may leave its host for a short time when the latter is placed in a dish of seawater, the copepod has never been found in water from the burrows. On *Hermissenda, thysanotus* occurs on the body surface (MacGinitie). Nothing is known about its feeding habits; MacGinitie (1935) suggests that it may remove debris from among the eggs of *Callianassa* and, if so, it may also help to keep the gill-chamber clean. It is hoped that further collecting and possibly experimental work will make clear the host preferences and relations with the host of this copepod.

Immature specimens occasionally are found in debris from preserved *Callianassa;* the smallest corresponds to the second copepodid stage in other copepods. It is possible that the early stages are free living and dispersive, development only being completed when a host is found.

Hemicyclops purpureus Boeck

Hemicyclops purpureus Boeck, 1873, p. 42; etc.

This species was reported by Wilson (1936, pp. 368, 375) from plankton collected in Fox Channel (lat. 66–67° N., long. 80° W.), northern Canada, by Captain R. A. Bartlett in August 1933, but no diagnosis or figures are given. Taking into account both the restricted range otherwise known for *purpureus* (coasts of Norway, Sweden, and possibly Scotland) and Wilson's lapses in descriptions of other species in this genus, I do not think that his record can be accepted at present entirely without question. If correct, however, his record would be of great interest, and it is hoped that further collections in that area will confirm his identification. Such confirmation is unfortunately impossible now since the specimen (or specimens) that he examined are not in the U.S. National Museum, where the Bartlett collection was deposited (letter from Dr. T. E. Bowman, November 21, 1957).

Because I have not examined specimens, no other account of *purpureus* is given here and it is not included in the key. On the basis of Sars' redescription (1917), the species apparently differs from *thysanotus* in the proportions of the caudal rami and of the fifth legs and in the armature of the third segments of both rami on the fourth swimming leg. It may readily be distinguished from *adhaerens*, *subadhaerens*, *elongatus*, and *arenicolae* by the presence in these of the following: 6-segmented urosome, reduced mandibular setation, 4 simple terminal elements on the maxilla, shorter maxillipedal process (of the female) and different armature of the swimming legs.

Hemicyclops adhaerens (Williams)

FIGURES 3, *d–j*; 4

Lichomolgus adhaerens Williams, 1907, pp. 75-76, pl. 2.

Hemicyclops adhaerens, Wilson, 1932a, pp. 345–346, fig. 206.—Light and Hartman, 1937, pp. 179, 180.—Sewell, 1949, p. 67.

Hemicyclops americanus, Wilson, 1932b, pp. 44–45, pl. 5, figs. A–H.—Light and Hartman, 1937, pp. 179, 180.—Nicholls, 1944, p. 45.—Sewell, 1949, pp. 67–69.

TYPES: Williams (1907) stated that his specimens were from "Wickford, very abundant under small stones between tides." He did not designate a type nor mention where his specimens were deposited.

H. americanus was based (Wilson, 1932b) on a holotype which, together with one paratype, was deposited in the U.S. National Museum. The vial of his specimens received from there contained a "type" label (among others), which reads "Holotype Cat. No. 58563/To be selected/Paratype Cat. No. 63420," and two smaller unlabeled vials, each with a single copepod. There is no indication which of these Wilson intended to designate as the holotype, and hence they are here considered syntypes of *americanus*.

Specimens examined: Wickford, Rhode Island, 1 female from washings of intertidal rocks, G. M. Moore and N. W. Riser, June 13, 1957; this topotype was dissected and used for making all the figures; the slide has been deposited in the U.S. National Museum, USNM 101729. Chesapeake Bay, Maryland, 2 females from bottom tow, U.S. Bureau of Fisheries, Station R′ (off Cove Point), R. P. Cowles, June 2, 1921, syntypes of *americanus* (one was dissected).

Redescription of the female: Body very similar in appearance to *thysanotus* but genital segment not fused with first abdominal so that urosome is 6-segmented. Length 1.58 mm. (mean of 3 specimens, range 1.43–1.67 mm.); width of prosome 0.64 mm. (0.57–0.69 mm.). Genital segment roundish; genital openings median and lateral. Ovisacs (one specimen) proportionately wider than those of *thysanotus* but only reaching distal border of second abdominal segment. Lines of spinules on distal border of anal segment much stronger than in *thysanotus* and displaced outward.

Caudal rami 2–2½ times as long as wide, with relatively long inner dorsolateral seta and a tiny element (which may represent a rudimentary seta) near base on outer side. No setae modified as in *thysanotus*.

Antennule like that of *thysanotus* except for setation on first 2 segments (5 on first, 14 on second); long setae on second, fourth, and terminal segments relatively shorter and setae on second and fifth segments apparently lacking cilia.

Antenna with fourth segment elongate and distal corner of third hardly produced. Armature similar to *thysanotus* condition but spines on outer distal corner of third segment replaced by setae and these, together with that on first segment, with reduced ornamentation; isolated seta in terminal position bare. Curved setae with region of irregular surface thickening reduced to short length near position of greatest curvature and very thin flange often present here; tips all with notch some distance from the end. No patch of spinules on outer corner of second segment; third with 2 "comb rows" on inner side; last with only a row of spinules.

A single row of spinules on posterior border of labrum. Paragnaths of somewhat different appearance from those of *thysanotus*. Anterior median portion of labium flowing forward to merge with roof of mouth cavity; ornamentation on its surface confined to 2 irregularly curved rows of denticles. Two ciliated lobes on roof of mouth cavity just posterior to insertion of paragnaths.

Mandible with curved element and blade but only 1 seta; terminally curved element lacks incomplete roothed ridge, dentations on edge stronger.

Maxillule very similar in plan to that of *thysanotus* but angular projection poorly developed and more dorsal in position. Some differences in relative size and ciliation of setae.

Setule-bearing seta on first segment of maxilla larger than the other; terminal armature of second segment (ventral to dorsal) a strong curved spine, 2 smaller ones almost side by side—the anterior notched at its tip, the other strongly ciliated—and a longer spine with strong cilia.

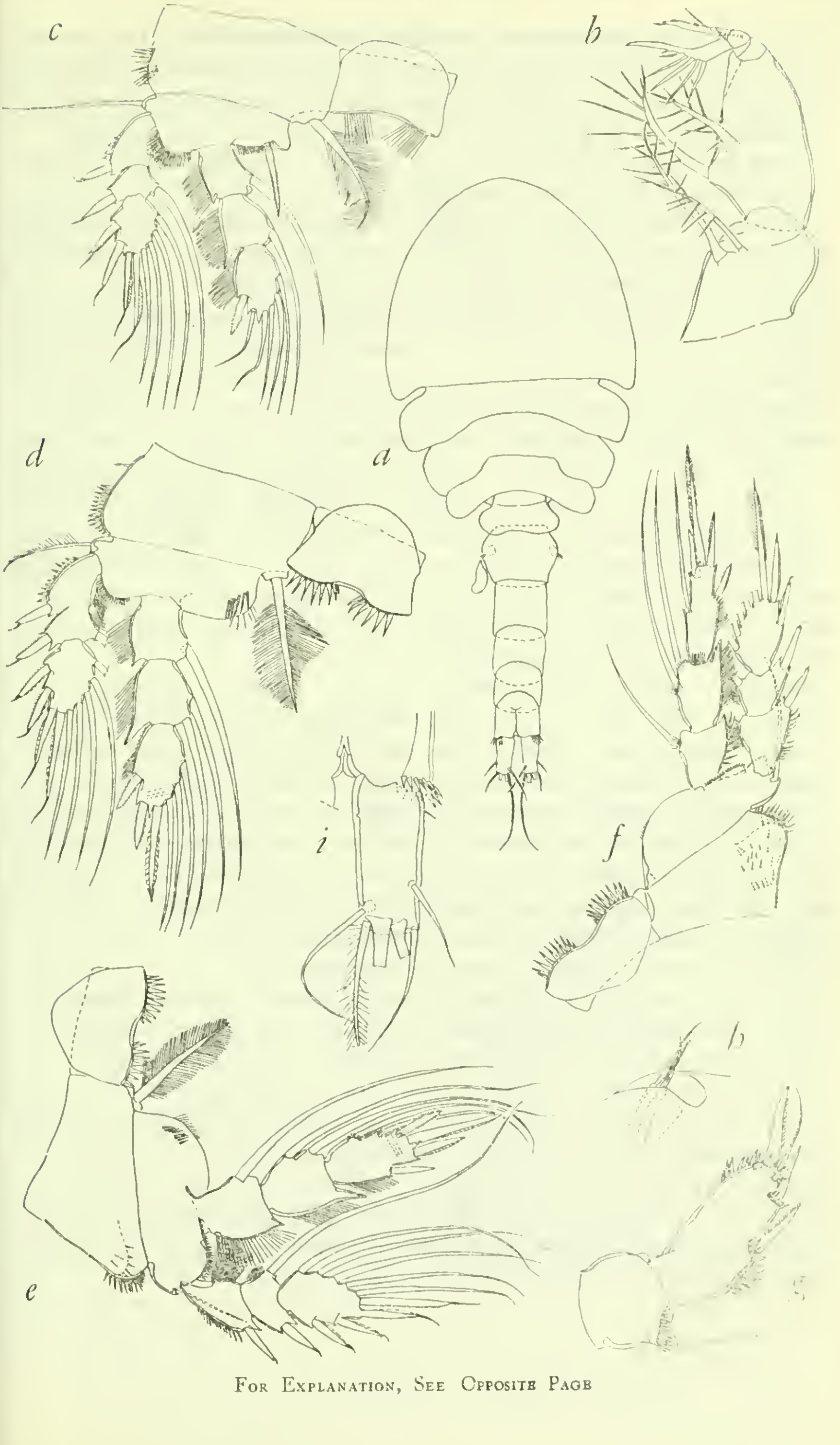
Maxilliped with no seta on third, 2 on terminal segment: longest seta on anterior side, other on base of dorsal process. (It is difficult to homologize the smaller seta with any on the *thysanotus* maxilliped.) Ventral spine bearing only 2 spinules on anteroventral surface and terminating in a setule inserted near tip. Both setae on first segment with very long cilia.

Swimming legs similar to those of *thysanotus* except in armature, which is:

	Protopodite				Endopodite						Exopodite					
	1		2		1		2		3		1		2		3	
	Si	Se	Si	Se	Si	Se	Si	Se	Si	Se	Si	Se	Si	Se	Si	Se
P1	1	--	I	1	1	--	1	--	5	I	--	I	1	I	4	IV
P2	1	--	--	1	1	--	2	--	3	III	--	I	1	I	5	IV
P3	1	--	--	1	1	--	2	--	2	IV	--	I	1	I	5	IV
P4	--	--	--	1	1	--	2	--	1	IV	--	I	1	I	5	III

Terminal setules on spines of all exopodites; group of strong cilia on base of median seta on third endopodite segment only in second and third legs.

FIGURE 4.—*Hemicyclops adhaerens* (Williams), female: *a*, Habitus, dorsal aspect. *b*, Right maxilliped, dorsal (anterior) view. *c*, Right first swimming leg with coxal plate, ventral (anterior) view. *d*, Right second swimming leg with coxal plate, ventral (anterior) view. *e*, Right third swimming leg with coxal plate, ventral (anterior) view. *f*, Right fourth swimming leg with coxal plate, ventral (anterior) view. *g*, Right fifth leg, ventral view. *h*, Left sixth leg, dorsal view. *i*, Right caudal ramus, dorsal view. Scale B (fig. 2) applies to *a*; E to *c–f*; F to *b*, *g*, and *i*; and G to *h*.



For Explanation, See Opposite Page

Seta on proximal segment of fifth legs short; distal podomere a shape different from that of *thysanotus*, with spinules on inner and outer sides mainly in 2 patches near spines; seta on this segment subterminal, only as long as spine on its inner side.

Sixth legs consisting of 3 setae, borne on a papilla sunk between 2 flaps, near middle of genital segment.

No male has yet been reported. A spermatophore was, however, attached to the genital segment of the female depicted (fig. 4*a*); it is similar to those found in this position on *thysanotus*.

Remarks: Williams' description and figures make it relatively easy to identify my specimen with his species in spite of some discrepancies. That of maxillipedal segmentation is probably due to a difference in interpretation; others (such as ciliation of some antennular setae and armature of third antennal, terminal maxillar, and last maxillipedal segments) may be differences in observation; but the presence of a single element on the mandible can only be explained, in my opinion, by supposing that this appendage was mutilated in his specimen. Since the mouthparts are very difficult to dissect free in poecilostome copepods, and since Williams implied in his description that he was uncertain about the exact relation of parts in this region, this assumption does not seem unreasonable.

Wilson (1932b) did not differentiate his species in any way from *adhaerens;* nor did he state what features of *americanus* he considered diagnostic. Examination of his type specimens failed to disclose any evidence for partial fusion of the genital with the first abdominal segment, an additional seta on the second antennal segment, the peculiar ornamentation of the terminal curved setae on the antenna, or the extensive spinulation and fourth spine on the fifth leg. In other respects, his descriptions and figures are close both to Williams' account and my own observations, and the name of his species is thus considered a synonym of *adhaerens*.

H. adhaerens is quite distinct from *thysanotus* as the description above indicates. Its differences from the other species discussed in this paper are considered in the accounts of those species.

Distribution: Specimens have been found only at Wickford, Rhode Island, and in Chesapeake Bay. None occurred in the only collection made locally for it (p. 162). Correspondence with Dr. C. J. Fish and the presence of a single female in a collection made specifically for this copepod by Drs. Moore and Riser suggest that the species may no longer be abundant in the type locality, or that the proper habitat is still unknown.

Hemicyclops subadhaerens new species

FIGURES 5–7

Hemicyclops pugettensis, Gooding, 1958, p. 699 (second paragraph), not Light and Hartman, 1937.

TYPES: The holotype, an ovigerous female, USNM 101730, was obtained in "burrow water" (see p. 160), C.6, April 6, 1958; it has been dissected. The allotype male, USNM 101731, from which figures 6, *e–i*, and 7 were drawn, was found in washings from a *Callianassa californiensis* collected at the same place, February 11, 1956. Paratypes from several localities have also been deposited in the U.S. National Museum, Nos. 101371–101378.

OTHER MATERIAL EXAMINED: From "burrow water": C.6: 6 females, 11 males, 7 juveniles, February 2, 1958. 11 females, 7 males, 1 juvenile, April 6, 1958. C.7a: 1 male, February 3, 1958. C.7b: 4 females, 1 juvenile, February 3, 1958.

From washings of *Callianassa californiensis:* C.3: 2 females, 1 male from 6 of 19 hosts. C.6: 1 female, 1 juvenile from 2 of 12 hosts, February 11, 1956. 1 male from 1 of 6 hosts, February 25, 1956. 1 female from 1 of 4 hosts, March 16, 1956. 2 females from 1 of 12 hosts, February 2, 1958. C.10: 2 females from 40 hosts; figure 6*a* is based on one and figures 5 and 6*b–d* on the other. C.11: 1 female.

DESCRIPTION OF THE FEMALE: As that for *adhaerens* (p. 177), except for the following characters. Body 2.08 mm. (mean of 7 specimens, range 1.97–2.24 mm.) in length; width of prosome 0.91 mm. (0.74–1.2 mm.). Inner dorsolateral seta on caudal rami rather longer in proportion to the others. Armature and ornamentation of appendages in general more strongly developed. Denticles on labium much stronger and more widely spaced; arranged in 2 deep crescents, one on either side of midline. Mandible with a rudimentary second seta. Ventral spine on terminal segment of maxilliped with 3–5 denticles on anteroventral side. Terminal spine on fifth legs proportionately smaller; setae on both podomeres longer: specifically, seta on terminal segment longer than terminal spine. Ornamentation of distal segment stronger and more extensive. Color in life very similar to that of *thysanotus*.

DESCRIPTION OF THE MALE: Size of body, unlike condition in *thysanotus*, more or less equaling that of female: 2.05 mm. (mean of 7 specimens, range 1.9–2.3 mm.) long, width of prosome 0.8 mm. (0.77–0.84 mm.). General appearance very similar. Spermatophores attached to genital segment of female all flattened but, when in body of male, like those of *thysanotus*.

Antennule, antenna, mandible, maxillule, and maxilla essentially the same as in female, although maxilla has a peculiar hump on outer side of base of second segment which is not found in that of female.

Maxilliped, as is usual in poecilostomes, a prehensile structure, similar to that of *thysanotus*, but: first segment with a small hooklike process and 2 setae on inner face; second segment not as wide and bearing a peculiar "cock's comb" projection also on inner face; last segment with attenuated tip, ornamented with scalelike thickenings, and 2 setae (if element on inner side of angle—like that similarly placed in *thysanotus*—actually represents a seta).

Endopodites of second and, to a lesser extent, third legs very much more elongate than those of female, as are spines—particularly the innermost—on these rami; but setae on third segment somewhat reduced. Armature of all legs as represented in table for female *adhaerens* (p. 178) and ornamentation shown in figure 5*f*–*i*; both like those of female.

Spines on outer edge distal segment of fifth legs rather more offset; lengths of terminal spine and seta next to it not as divergent as, and ornamentation rather less than, in female.

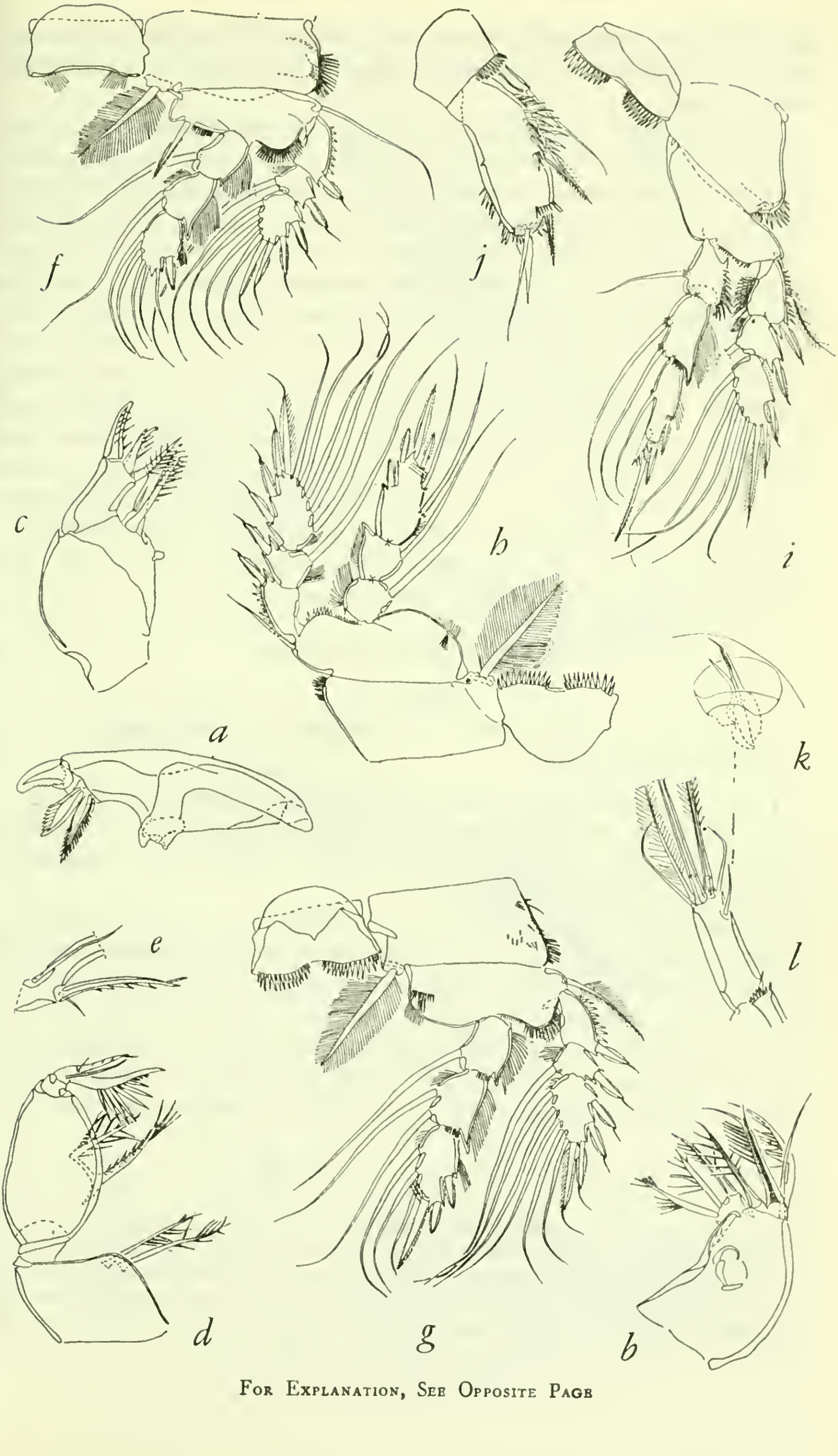
Sixth legs covering a much smaller area of genital segment than in *thysanotus* and spine usually extending posteriorly, but general structure of appendage similar to male of that species.

Remarks: As the descriptions and figures show, this species is very close to *adhaerens* (hence its name). The differences between the females (it is unfortunate that the male *adhaerens* is unknown) seem almost of subspecific rank. However, with no intermediate morphological forms, well-separated ranges and the apparent difference in habitat, I think that their relation can at present be best indicated by making *subadhaerens* of equal rank.

Since this species apparently occupies the same range as *thysanotus* and is also associated with *Callianassa* (see below), it might represent one of the forms now equated with *thysanotus* (*callianassae* or *pugettensis*). However, reference to the literature showed that the only evidence in favor of this view was Wilson's figure (1935, pl. 27,

---

Figure 5.—*Hemicyclops subadhaerens*, new species, female: *a*, Left mandible, ventral (posterior) view. *b*, Left maxillule, dorsal (posterior) view. *c*, Left maxilla, dorsal (anterior) view. *d*, Right maxilliped, ventral (posterior) view (flattened). *e*, Detail of ventral terminal spine on the maxilliped. *f*, Left first swimming leg with coxal plate, ventral (anterior) view. *g*, Left second swimming leg with coxal plate, ventral (anterior) view. *h*, Left third swimming leg with coxal plate, ventral (anterior) view. *i*, Left fourth swimming leg with coxal plate, ventral (anterior) view. *j*, Left fifth leg, ventral view. *k*, Left sixth leg, ventrolateral view. *l*, Left caudal ramus, dorsal view. Scale D (fig. 2) applies to *f*–*j* and *l*; E to *c*–*d*; F to *a*–*b* and *k*; and G to *e*.



For Explanation, See Opposite Page

fig. 25) of the female *callianassae*, and a study of the type material of the latter (p. 165) has made it plain that Wilson was not dealing with *subadhaerens*.

It is necessary nonetheless to distinguish *subadhaerens* from *thysanotus*. In life, a difference is easily seen since *subadhaerens* carries the fourth legs characteristically at right angles to the ventral body surface. It is possible to distinguish even the youngest stages that I have examined in this way. Preserved adults can easily be separated by the condition of the genital segment in the females and the sixth legs in the males. It is only when dead immature specimens are being sorted that one need resort to the key characters given (p. 165).

DISTRIBUTION: This species has been found from Nanaimo, British Columbia, to Bodega Bay, California. The data available suggest that both sexes are associated with *Callianassa californiensis* but occur in the burrow rather than on the body of the animal. This behavior is most clearly shown by the collection at C.6 on February 2, 1958, when 24 specimens were recovered from "burrow water"—in this case about 200 cc.—and only 2 from 12 hosts. Only the later developmental stages have been found.

***Hemicyclops elongatus* Wilson**

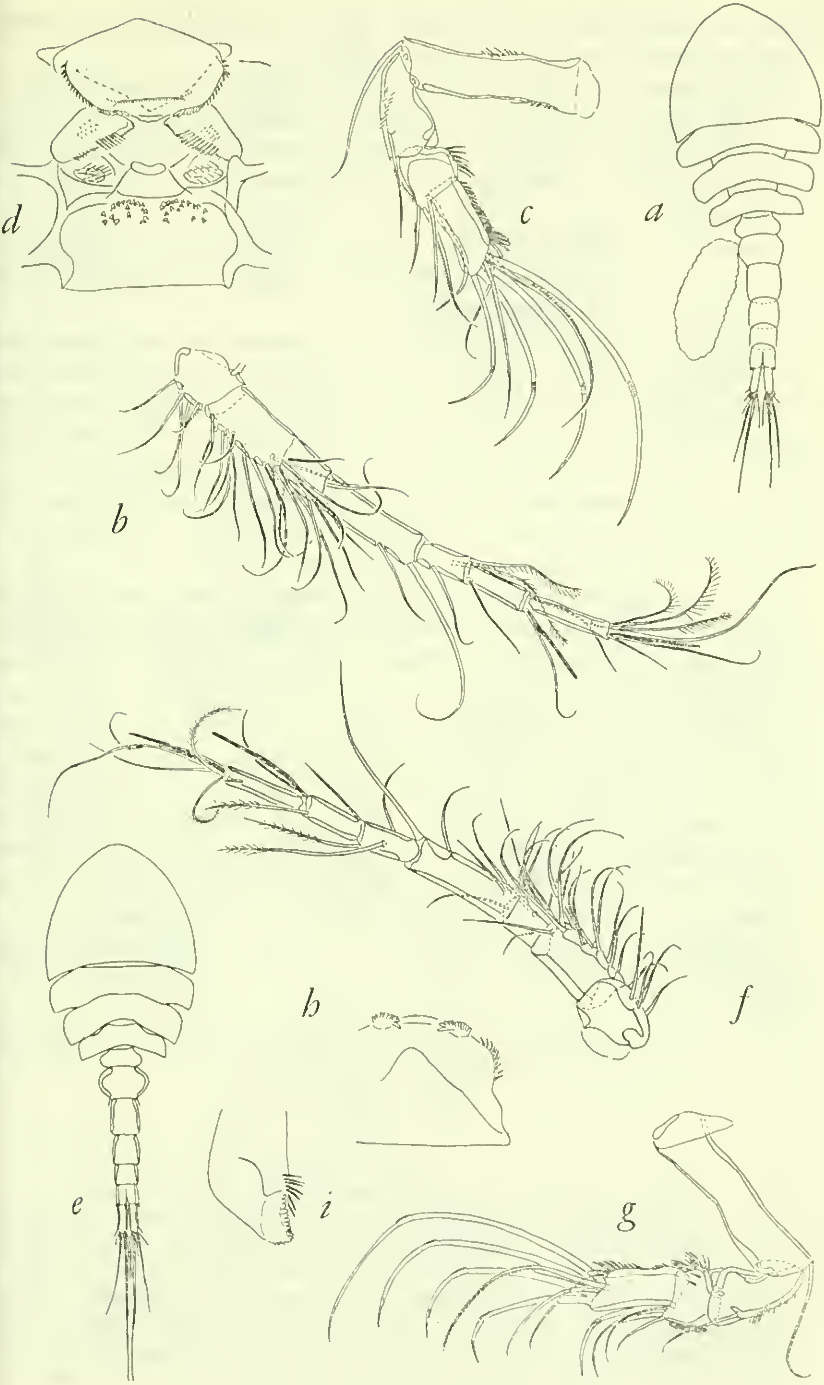
FIGURE 8

Hemicyclops elongatus Wilson, 1937, pp. 206–208, figs. 1–6.—Nicholls, 1944, p. 49.—Sewell, 1949, pp. 68–69.

TYPE AND SPECIMEN EXAMINED: Holotype female, USNM 60431, from gill cavity of *Callianassa* sp., Salaverry, North Peru, F. Sears, October 21, 1926. This, the only known specimen, was examined without dissection in alcohol.

REDESCRIPTION OF THE FEMALE: Habitus of body agreeing with Wilson's description except that terga of prosomal segments now not "closely imbricate" (compare Wilson's, 1937, fig. 1 and my fig. 8*a*) possibly due to shrinkage during prolonged immersion in alcohol. The apparent fold in the exoskeleton at the anterior end of the cephalothorax and the fact that my measurements make the body somewhat smaller (length 2.7 mm. instead of 3.0 mm., 0.89 mm. wide rather than 0.90

FIGURE 6.—*Hemicyclops subadhaerens*, new species: *a–d*, Female: *a*, Habitus, dorsal aspect. *b*, Right antennule, ventral (posterior) view. *c*, Left antenna, dorsal (posterior) view. *d*, Oral area (without mouthparts), ventral view. *e–i*, Male: *e*, Habitus, dorsal aspect. *f*, Left antennule, dorsal (anterior) view. *g*, Right antenna, dorsal (posterior) view. *h*, Labrum, dorsal view. *i*, Right paragnath, ventral (posterior) view. Scale A (fig. 2) applies to *a* and *e*; D to *b* and *f*; E to *c–d* and *g–h*; and G to *i*.



For Explanation, See Opposite Page

mm.) may also be due to this cause. Line of small denticles following outside of each distal edge of anal segment.

Caudal rami more than 4 times as long as wide. In addition to 4 terminal setae mentioned by Wilson, a small seta borne dorsally a short way from tip on outer side and a longer one in usual position near inner corner. Rudimentary basal element on outer side was not observed.

Antennules 7-segmented but division between first and second segments indistinct. Several setae with transverse rings of thickening; ciliation not observed on any.

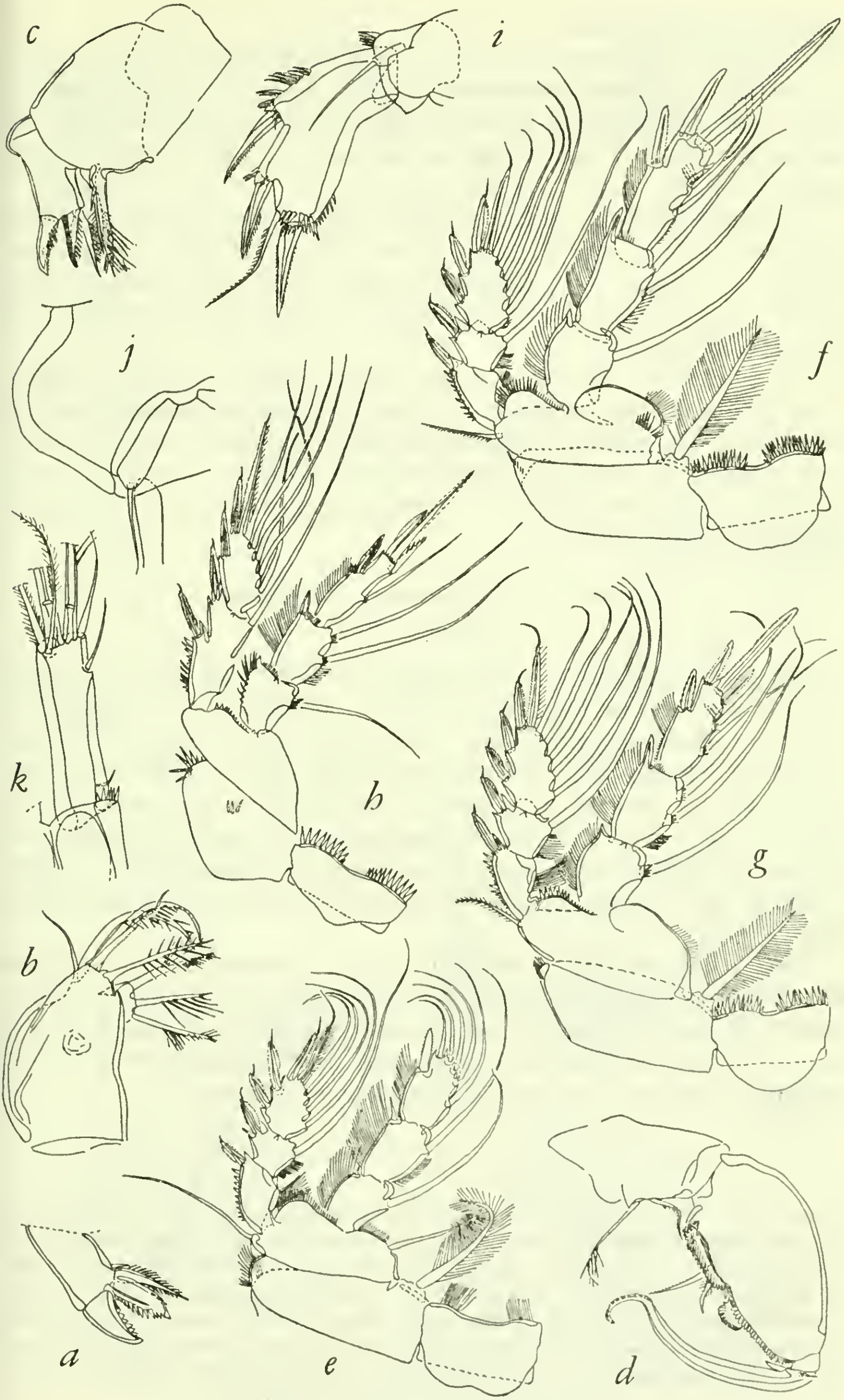
Details of appendages between antennules and swimming legs could not be determined. (Figure 8*d* of the maxilliped is approximate only and absence from it of features which might be expected should not be considered evidence that they do not occur.) Antenna 4-segmented; inner distal corner of its penultimate segment bearing a slender curved seta and other setalike elements; the terminal with curved and normal setae. The appendage may thus be presumed to resemble that of *adhaerens* or *subadhaerens*.

Swimming legs as in figure 8*e–h*; armature and basic ornamentation same as that given for *adhaerens* (p. 178) except for possible lack of a seta on outer side basipodite of fourth legs. (Wilson's "fourth leg," 1937, fig. 5, is clearly a reversed view of the first and thus bears little resemblance to the actual appendage.) "Spines" on outer distal corners of first and second endopod segments not true spines, as Wilson's description and figures would imply, but unarticulated projections of these podomeres. Only 2 of the "row of four short spines around the tip" of third endopod segment in first leg discernible and these—here termed spinules—occur similarly on second leg.

Contrary to Wilson's statement (1937, p. 208) and his figure 6, a seta occurs on proximal segment of fifth legs. Spinules on distal podomere not extending further along outer margin than base of first spine.

Sixth legs represented by 3 setae (not 2) near oviducal openings; appendage apparently like that of *adhaerens*.

Figure 7.—*Hemicyclops subadhaerens*, new species, male: *a*, Tip of left mandible, ventral (posterior) view (flattened). *b*, Right maxillule, dorsal (posterior) view. *c*, Left maxilla, ventral (posterior) view. *d*, Right maxilliped, ventral (posterior) view. *e*, Left first swimming leg with coxal plate, ventral (anterior) view. *f*, Left second swimming leg with coxal plate, ventral (anterior) view. *g*, Left third swimming leg with coxal plate, ventral (anterior) view. *h*, Left fourth swimming leg with coxal plate, ventral (anterior) view. *i*, Left fifth leg, dorsal view. *j*, Right sixth leg, ventral view. *k*, Left caudal ramus, dorsal view. Scale D (fig. 2) applies to *d–h*; E to *c* and *i–k*; and F to *a–b*.



For Explanation, See Opposite Page

mm.) may also be due to this cause. Line of small denticles following outside of each distal edge of anal segment.

Caudal rami more than 4 times as long as wide. In addition to 4 terminal setae mentioned by Wilson, a small seta borne dorsally a short way from tip on outer side and a longer one in usual position near inner corner. Rudimentary basal element on outer side was not observed.

Antennules 7-segmented but division between first and second segments indistinct. Several setae with transverse rings of thickening; ciliation not observed on any.

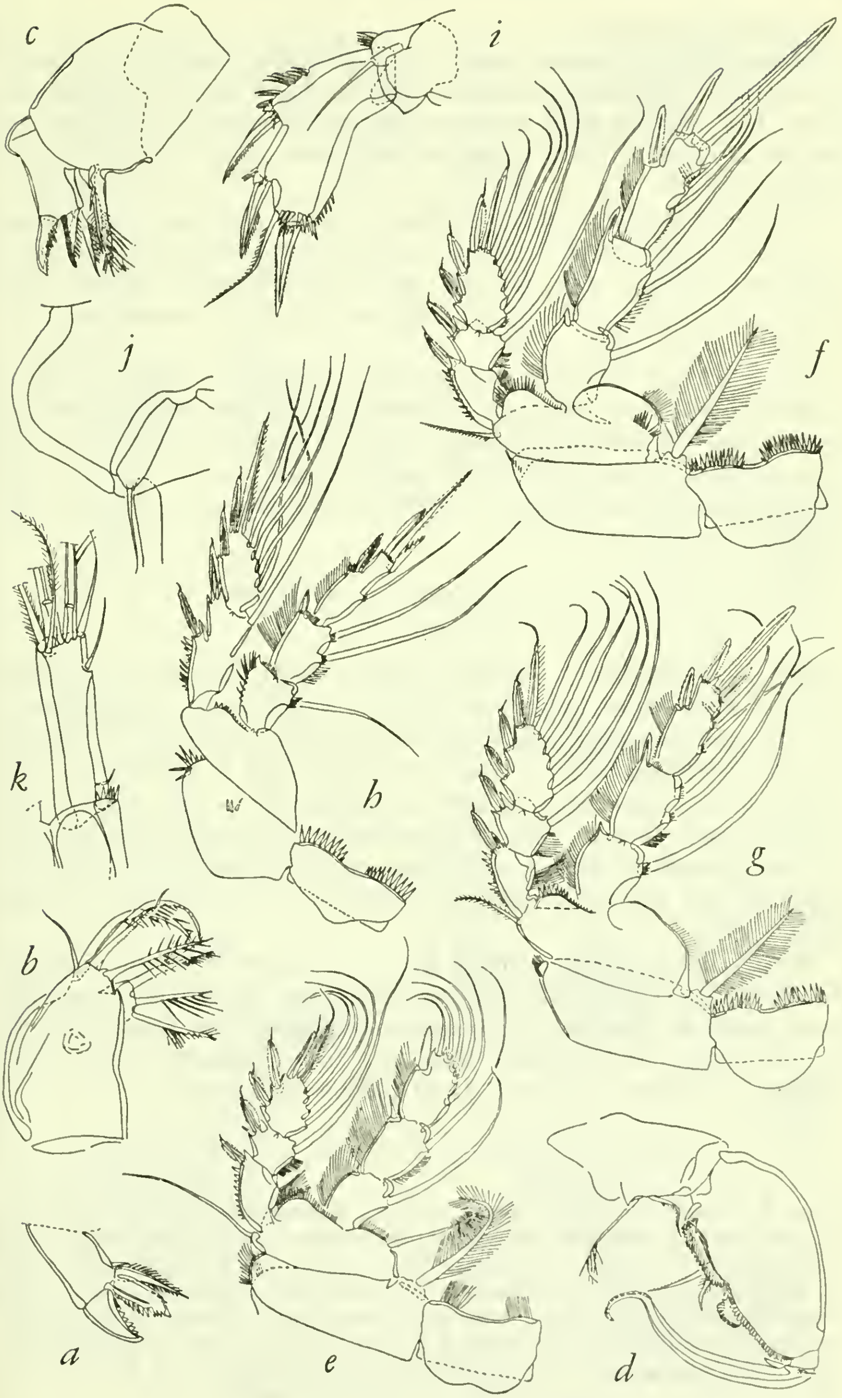
Details of appendages between antennules and swimming legs could not be determined. (Figure 8*d* of the maxilliped is approximate only and absence from it of features which might be expected should not be considered evidence that they do not occur.) Antenna 4-segmented; inner distal corner of its penultimate segment bearing a slender curved seta and other setalike elements; the terminal with curved and normal setae. The appendage may thus be presumed to resemble that of *adhaerens* or *subadhaerens*.

Swimming legs as in figure 8*e–h*; armature and basic ornamentation same as that given for *adhaerens* (p. 178) except for possible lack of a seta on outer side basipodite of fourth legs. (Wilson's "fourth leg," 1937, fig. 5, is clearly a reversed view of the first and thus bears little resemblance to the actual appendage.) "Spines" on outer distal corners of first and second endopod segments not true spines, as Wilson's description and figures would imply, but unarticulated projections of these podomeres. Only 2 of the "row of four short spines around the tip" of third endopod segment in first leg discernible and these—here termed spinules—occur similarly on second leg.

Contrary to Wilson's statement (1937, p. 208) and his figure 6, a seta occurs on proximal segment of fifth legs. Spinules on distal podomere not extending further along outer margin than base of first spine.

Sixth legs represented by 3 setae (not 2) near oviducal openings; appendage apparently like that of *adhaerens*.

FIGURE 7.—*Hemicyclops subadhaerens*, new species, male: *a*, Tip of left mandible, ventral (posterior) view (flattened). *b*, Right maxillule, dorsal (posterior) view. *c*, Left maxilla, ventral (posterior) view. *d*, Right maxilliped, ventral (posterior) view. *e*, Left first swimming leg with coxal plate, ventral (anterior) view. *f*, Left second swimming leg with coxal plate, ventral (anterior) view. *g*, Left third swimming leg with coxal plate, ventral (anterior) view. *h*, Left fourth swimming leg with coxal plate, ventral (anterior) view. *i*, Left fifth leg, dorsal view. *j*, Right sixth leg, ventral view. *k*, Left caudal ramus, dorsal view. Scale D (fig. 2) applies to *d–h*; E to *c* and *i–k*; and F to *a–b*.



For Explanation, See Opposite Page

The male is unknown.

Remarks: This species cannot with absolute certainty be placed in the genus *Hemicyclops* without further knowledge of its mouthparts, but there is good evidence for and apparently none against placing it here. There is also no assurance that the holotype is mature.

H. elongatus is very similar to *adhaerens* and *subadhaerens* in general characters of body and the appendages known. The only important differences appear to be its size, greater length:width ratio of the caudal rami and last antennular segment, and the segmentation of the latter appendage.

Distribution: The only information is that given above. Again, there is insufficient evidence to place the species definitely as an associate of *Callianassa,* although Wilson's statement that the holotype occurred in the gill-chamber is more positive than our present knowledge about *subadhaerens.* But it is possible that *elongatus* also occurs in burrow water.

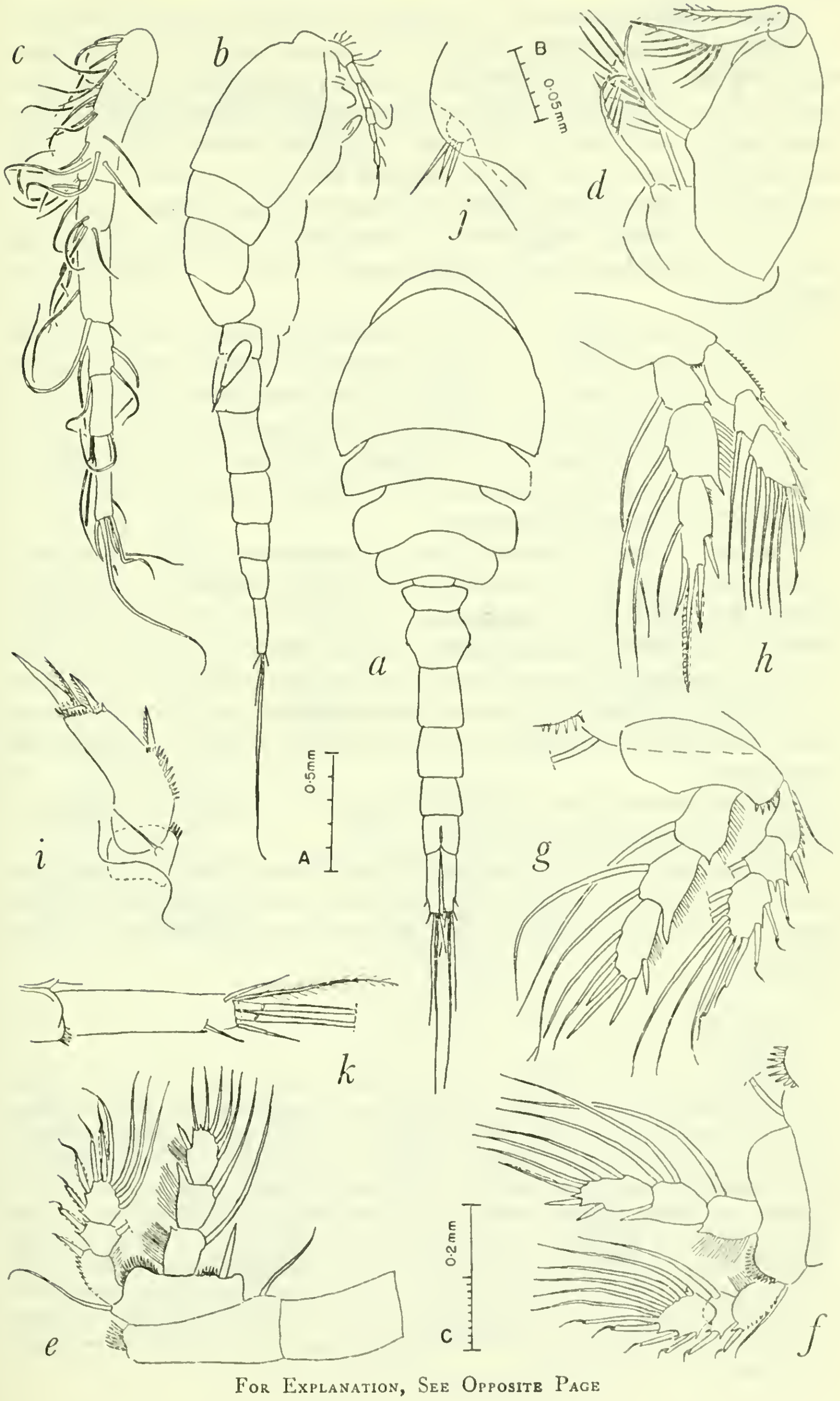
***Hemicyclops arenicolae*, new species**

Figures 9–10

Specimens examined: Wellfleet Harbor, Cape Cod, Massachusetts, 26 females, 27 males, and 13 juveniles from burrows and body surface of 4 *Arenicola cristata* Stimpson, sand and rubble beach, G. M. Moore and M. Pettibone, July 3, 1954; 2 females and 2 males were dissected; figures 9*a*–*c* and *f*–*p* and 10 are based on one of each sex. Lackey's Bay, Woods Hole, Massachusetts, 3 females, 4 males, and 1 juvenile from the same host, Moore and Pettibone, July 31, 1954; 1 female and 1 male of this lot were dissected; figure 9*d*–*e* is from this female.

Types: The holotype, USNM 101732, a dissected female, and the allotype male, USNM 101733, are both from the Wellfleet sample. Paratypes from Wellfleet, 21 females and 21 males, and, from Lackey's Bay, 2 females and 3 males, have also been deposited in the U.S. National Museum, Nos. 101370 and 101369 respectively.

Figure 8.—*Hemicyclops elongatus* Wilson, female: *a*, Habitus, dorsal aspect. *b*, Habitus, lateral aspect. *c*, Right antennule, ventral (posterior) view. *d*, Left maxilliped, ventral (posterior) view. *e*, Left first swimming leg with coxal plate, ventral (anterior) view. *f*, Left second swimming leg with part of coxal plate, ventral (anterior) view. *g*, Left third swimming leg with part of coxal plate, ventral (anterior) view. *h*, Left fourth swimming leg, ventral (anterior) view. *i*, Left fifth leg, dorsal view. *j*, Left sixth leg, dorsal view. *k*, Left caudal ramus, dorsal view. All appendages were drawn in situ. Scale A applies to *a* and *b*; B to *d* and *j*; and C to the remainder.



For Explanation, See Opposite Page

Description of the female: Body 2.65 mm. in length (mean of 6 specimens, range 2.54–3.0 mm.). Prosome narrower (0.89 mm., 0.84–0.94 mm.) in proportion to its length than in any of the other species; terga separated, their corners rounded. Urosome more than twice length of prosome. Ovisacs long and narrow. First 3 abdominal segments with narrow ventral membrane posteriorly; anal segment with row of small spinules along posterior border.

Length of caudal rami about 3 times width; hairlike element on outer side near base less well-developed than in *H. adhaerens* or *subadhaerens.*

Antennule as in figure 9*b*. Curved seta on outer side of slightly protruding distal corner on third segment of antenna rather stouter than in the other species; spines on tip of projection like those of *thysanotus.* Inner faces of second and third segments swollen; with large patches of regularly arranged spinules; rows of larger spinules (which have a peculiar flattened and frayed appearance) on outer sides third and terminal segments.

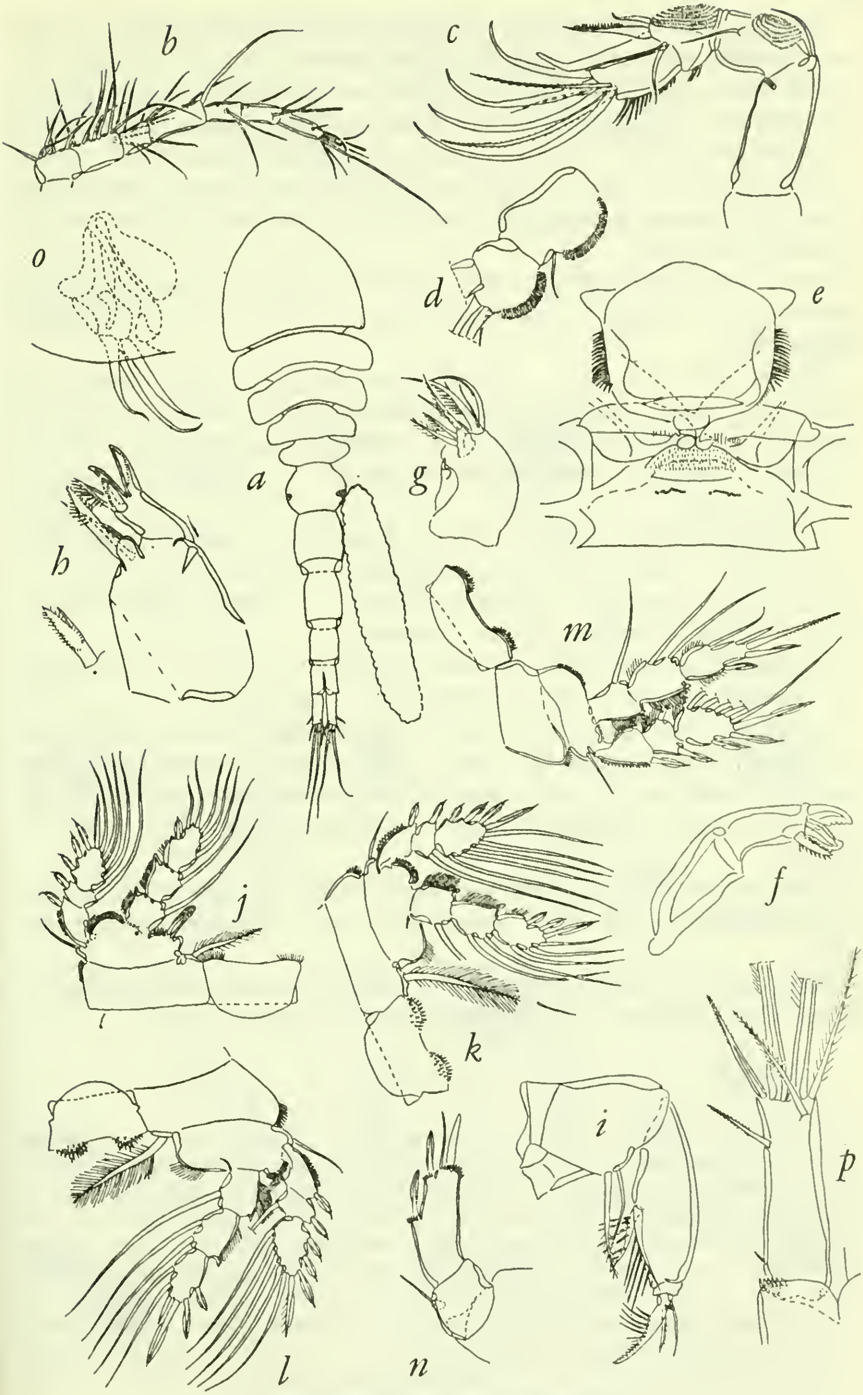
Spinules on labrum confined to a row along each edge. Paragnath with cutting edge notched; row of long cilia on posterior surface not as well developed as in *adhaerens.* Labium with very fine spinules confined to raised median portion which abuts on roof of mouth cavity; occasionally a row of small denticles on each side behind these.

Mandible may have no trace of a second seta in addition to curved element and blade. Latter somewhat curved, unlike condition in the other species.

Maxillule much like that of *adhaerens* but with well-developed anterodorsal prominence.

Terminal armature of maxilla similar to condition in *adhaerens;* setule-bearing seta on first segment even more enlarged. On one maxilla of holotype, armature on this segment is that shown on inset to figure 9*h*.

Figure 9.—*Hemicyclops arenicolae*, new species, female: *a*, Habitus, dorsal aspect. *b*, Left antennule, ventral (posterior) view. *c*, Left antenna, dorsal (posterior) view. *d*, Second and third antennal segments, lateral (outer) view. *e*, Mouth area (without appendages), ventral view. *f*, Right mandible, ventral (posterior) view. *g*, Left maxillule, dorsomedial (posteromedial) view. *h*, Left maxilla, ventral (posterior) view, with detail of unusual element on basal segment of right maxilla. *i*, Left maxilliped, dorsal (anterior) view. *j*, Left first swimming leg with coxal plate, ventral (anterior) view. *k*, Left second swimming leg with coxal plate, ventral (anterior) view. *l*, Left third swimming leg with coxal plate, ventral (anterior) view. *m*, Right fourth swimming leg with coxal plate, ventral (anterior) view. *n*, Left fifth leg, ventral view. *o*, Left sixth leg, dorsal view. *p*, Right caudal ramus, dorsal view. Scale A (fig. 2) applies to *a*; C to *b* and *j–n*; E to *c–i* and *p*; and G to *o*.



For Explanation, See Opposite Page

Ventral spine on terminal segment of maxilliped rather reduced; large process stout and, as in the other species, strongly ciliated.

Swimming legs like those of *adhaerens;* armature represented by same formula (p. 178) and ornamentation similar except that spinules on coxal plates of second and third legs form patches rather than being confined to edge, setules on exopod spines shorter and strong ciliation at base of median seta on third endopod segment apparently absent on all legs.

Fifth and sixth legs also very similar to those of *adhaerens* but former lacking spinules on basal segment and on edges of distal podomere.

Description of the male: Body longer (2.83 mm., mean of 10 specimens, range 2.67–3.24 mm.) than that of female; width of prosome 0.9 mm. (0.84–0.94 mm.). Genital segment almost square in dorsal view. No spermatophores found. Caudal rami like those of female.

Antennule similar to, but patches of spinules on second and third segments of antenna more extensive than in female.

Mandible occasionally with a small setule in addition to the normal seta. Maxillule and maxilla as in female.

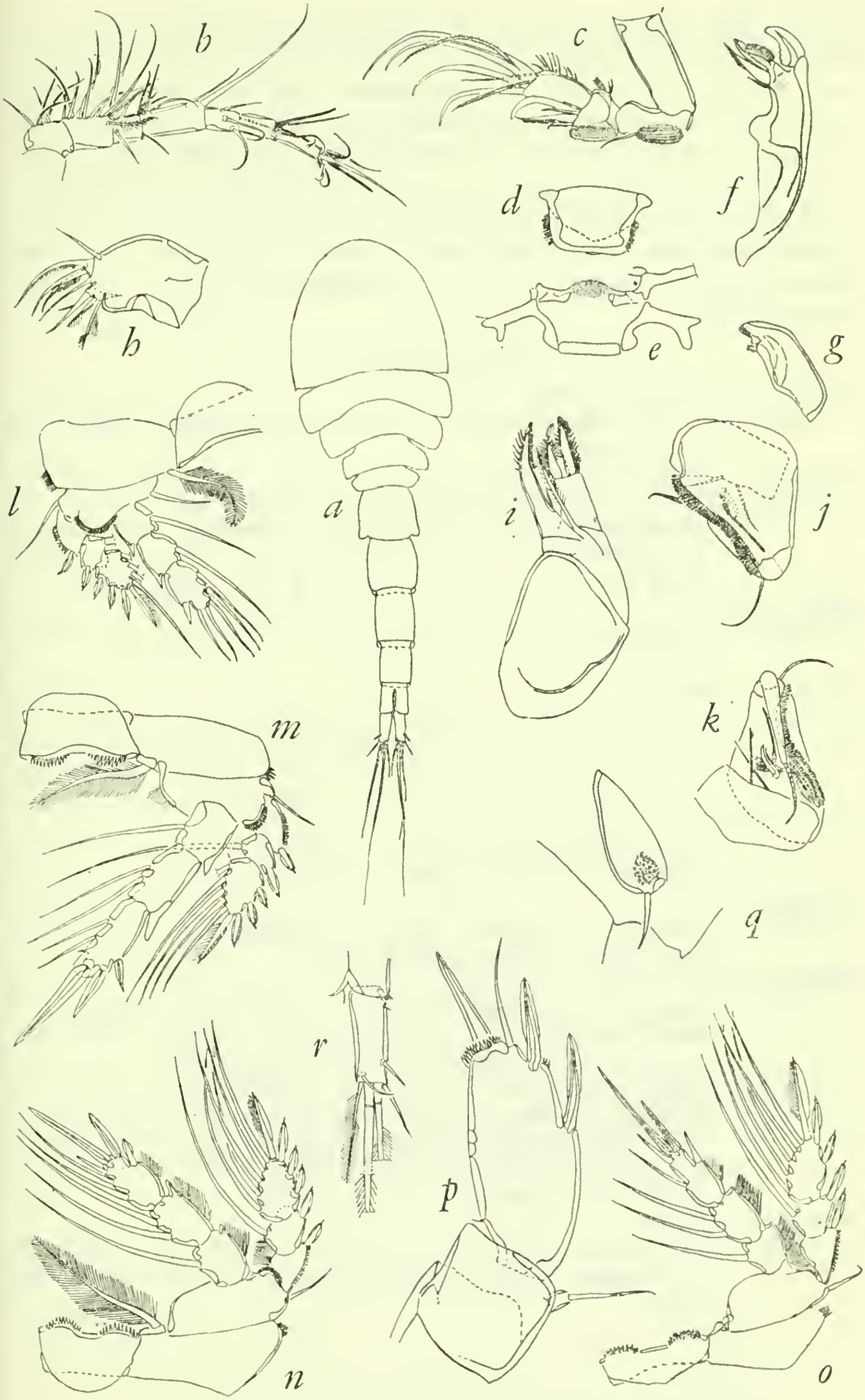
Maxilliped similar to that of male *subadhaerens* but with 1 long seta on last segment and lacking "cock's comb" on second.

Swimming legs larger than those of female; spines longer and better developed, but armature the same. Endopodites of second and third legs, like condition in male *subadhaerens,* longer than those of female but here last seta on third podomere of second leg reduced to a minute setule.

Fifth leg with basal podomere partly fused to thoracic segment. Ornamentation reduced to a ventral line of spinules at base of terminal spine.

Sixth legs like those of *subadhaerens* male but completely hidden in dorsal view; patches of fine denticles on their ventral surface.

Figure 10.—*Hemicyclops arenicolae*, new species, male: *a*, Habitus, dorsal aspect. *b*, Right antennule, dorsal (anterior) view. *c*, Right antenna, dorsal (posterior) view. *d*, Labrum, ventral view. *e*, Labium, ventral view. *f*, Left mandible, ventral (posterior) view. *g*, Left paragnath, ventral (posterior) view. *h*, Right maxillule, ventral (anterior) view. *i*, Right maxilla, anterodorsal view. *j*, Right maxilliped, ventrolateral view. *k*, Left maxilliped from inner side. *l*, Right first swimming leg with coxal plate, ventral (anterior) view. *m*, Left second swimming leg with coxal plate, ventral (anterior) view. *n*, Right third swimming leg with coxal plate, ventral (anterior) view. *o*, Right fourth swimming leg with coxal plate, ventral (anterior) view. *p*, Right fifth leg, ventral view. *q*, Left sixth leg, ventral view. *r*, Right caudal ramus, dorsal view. Scale A (fig. 2) applies to *a*; C to *b*, *d–e*, *j–o*, and *r*; D to *c*; and E to *f–i* and *p–q*.



For Explanation, See Opposite Page

REMARKS: The species may be distinguished from *adhaerens* and *subadhaerens* mainly by its length, the proportions of body and caudal rami, greater development of the curved seta on third antennal segment and ornamentation of that appendage, armature of maxilliped, and ornamentation of fifth legs and from *H. elongatus* by the third to seventh of these characters. It is not particularly close to any other form.

DISTRIBUTION: All that is known at present is that both sexes are external associates of *Arenicola cristata* from either side of Cape Cod, Massachusetts. Only the later copepod stages are represented in the two collections.

Literature Cited

BAKER, E. W., AND WHARTON, G. W.

1952. An introduction to acarology, New York, Macmillan Co., xiii + 465 pp., 377 figs.

BOCQUET, CHARLES, AND STOCK, JAN H.

1957. Copépodes parasites d'invertébrés des côtes de France I. Sur deux genres de la famille des Clausidiidae, commensaux de mollusques: *Hersiliodes* Canu et *Conchyliurus* nov. gen. Proc. Kon. Nederl. Akad. Wetensch., ser. C, vol. 60, No. 2, pp. 212–223, 5 figs.

BOECK, AXEL

1873. Nye slaegter og arter ab saltvands-copepoder. Forh. Vid. Selsk. Christiania, vol. 14, pp. 35–60.

DUDLEY, PATRICIA L.

1957 (unpublished). The development of the notodelphyoid copepods and the application of larval characteristics to the systematics of some species from the northeastern Pacific. Doctoral dissertation, University of Washington, 626 pp., 2 figs., 54 pls.

FOX, DENIS L.

1953. Animal biochromes and structural colours, Cambridge University Press, xiv + 379 pp., 37 figs.

GALBRAITH, W.

1957. A method for high-power stereoscopic microscopy. Quart. Journ Micr. Sci., vol. 98, pt. 1, pp. 9–13, 1 fig.

GOODING, RICHARD U.

1957. On some Copepoda from Plymouth, mainly associated with invertebrates, including three new species. Journ. Marine Biol. Assoc. United Kingdom, vol. 36, No. 2, pp. 195–221, 6 figs.

1958. "*Callianassa pugettensis*" (Decapoda, Anomura), type host of the copepod *Clausidium vancouverense* (Haddon). With a note on *Hemicyclops pugettensis* Light and Hartman, another copepod associated with callianassids. Ann. Mag. Nat. Hist., ser. 12, vol. 10, No. 117, pp. 695–700, 1 fig., 1 pl. (1957).

HUMES, ARTHUR G.

1949. A new copepod (Cyclopoida: Clausidiidae) parasitic on mud shrimps in Louisiana. Trans. Amer. Micr. Soc., vol. 68, No. 2, pp. 93–103, 3 pls.

1957. Une nouvelle espèce de *Clausidium* (Copepoda, Cyclopoida) parasite d' une *Callianassa* au Sénégal. Bull. Inst. Français Afrique Noire, vol. 19, ser. A, No. 2, pp. 485-488, 2 pls.

INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE

1953. Copenhagen decisions on zoological nomenclature, ed. Francis Hemming, London, 135 pp.

LIGHT, S.F., AND HARTMAN, OLGA

1937. A review of the genera *Clausidium* Kossmann and *Hemicyclops* Boeck (Copepoda, Cyclopoida) with the description of a new species from the northeast Pacific. Univ. California Publ. Zool., vol. 41, No. 14, pp. 173-188, 20 figs.

MACGINITIE, GEORGE E.

1935. Ecological aspects of a California marine estuary. Amer. Midl. Nat., vol. 16, No. 5, pp. 629-675, 21 figs.

MACGINITIE, GEORGE E., AND MACGINITIE, NETTIE

1949. Natural history of marine animals, New York, McGraw-Hill, xii + 473 pp., 282 figs.

NICHOLLS, AUBREY G.

1944. Littoral Copepoda from South Australia (II) Calanoida, Cyclopoida, Notodelphyoida, Monstrilloida and Caligoida. Rec. South Australian Mus., vol. 8, No. 1, pp. 1-62, 28 figs.

SARS, GEORGE OSSIAN

1917. Clausidiidae, Lichomolgidae (part), *in* An account of the Crustacea of Norway (Bergen Museum), vol. 6, Copepoda, Cyclopoida, pts. 11 and 12, pp. 141-172, pls. lxxxi-xcvi.

SEWELL, R. B. SEYMOUR

1949. The littoral and semiparasitic Cyclopoida, the Monstrilloida and Notodelphyoida. Sci. Reps. John Murray Exped., vol. 9, No. 2, 199 pp., 41 figs.

WILLIAMS, LEONARD W.

1907. List of the Rhode Island Copepoda, Phyllopoda, and Ostracoda, with new species of Copepoda. Ann. Rep. Comm. Inland Fish. Rhode Island, 37, special paper No. 30, pp. 69-79, 3 pls.

WILSON, CHARLES BRANCH

1932a. The copepods of the Woods Hole region, Massachusetts. U.S. Nat. Mus. Bull. 158, xix + 635 pp., 316 figs., 41 pls.

1932b. The copepod crustaceans of Chesapeake Bay. Proc. U.S. Nat. Mus., vol. 80, No. 15, pp. 1-54, 1 fig., 5 pls.

1935. Parasitic copepods from the Pacific coast. Amer. Midl. Nat., vol. 16, No. 5, pp. 776-797, pls. 25-30.

1936. Copepods from the Far North collected by Capt. R. A. Bartlett. Jour. Washington Acad. Sci., vol. 26, No. 9, pp. 365-376.

1937. Two new semi-parasitic copepods from the Peruvian coast. Parasitology, vol. 29, No. 2, pp. 206-211, 17 figs.

U.S. GOVERNMENT PRINTING OFFICE: 1960

Proceedings of
the United States
National Museum

SMITHSONIAN INSTITUTION • WASHINGTON, D.C.

Volume 112 1960 Number 3435

CHIRONOMID MIDGES OF CALIFORNIA.

I. CHIRONOMINAE, EXCLUSIVE OF TANYTARSINI (=CALOPSECTRINI)

By James E. Sublette[1]

The nonbiting midges of the family Chironomidae occurring in California have been reviewed by Wirth and Stone (1956). Only the Clunioninae (Wirth, 1949) and the Tendipedini (Townes, 1945) have been adequately treated. The Chironominae exclusive of Tanytarsini are dealt with here. Of the 71 species of Chironomini reported here as occurring in the State, 47 were not previously listed. The Tanytarsini of California will be incorporated in a revision of the Nearctic species which I now have in progress. A projected second part to this paper will include the remaining subfamilies exclusive of Clunioninae.

Genitalia mounts were made of all male specimens studied. The genital capsule, after KOH clearing, was mounted in "Permount," a synthetic mounting resin, on a small celluloid strip following the technique used by workers in the British Museum (Natural History). The technique was modified by using a cover glass on the mount. The celluloid strip was then pinned under the locality label on the specimen pin. In some instances accessory slides were made of antennae and legs.

The terminology of wing venation used follows Townes (1945) for consistency although Freeman (1955) favors the Tillyard modification of the Needham-Comstock system.

---

[1] Northwestern State College, Natchitoches, Louisiana.

While measurements of size (especially wing length) and various body ratios have been utilized in species descriptions, in many instances they are of little diagnostic value because of inadequacy of sample size in the original description. For example, Townes (1945) averaged only three measurements of each characteristic of each species. While admitting its inadequacy from the standpoint of population statistics, a compromise was effected here by measuring a minimum of three specimens (where available) from each locality and date for each species; thus both seasonal and geographic variations are included. For each series of measurements the range is given, followed by the mean with the number of specimens upon which the statistic is based given in parenthesis.

The nomenclature is essentially that used by Townes (1945) but with some modifications as given by Freeman (1957, 1958) in his recent monographic series on African midges. A summary of the changes incorporated here is given by Dendy and Sublette (1959).

This paper is based on four of the larger collections of California Chironomidae. For making them available, I thank Dr. J. N. Belkin, Department of Entomology, University of California, Los Angeles; R. E. Darby, formerly a graduate student at the University of California, Davis, now at the Life Sciences Department, Sacramento State College, Sacramento, California; Dr. A. T. McClay, University of California, Davis, and Dr. W. W. Wirth, U.S. Department of Agriculture, Washington, D.C.

The holotypes and material collected by Dr. Wirth are deposited in the U.S. National Museum. The deposition of specimens is indicated in parenthesis immediately after locality and collector. The names of the following collectors have been abbreviated in the text as follows: Willis W. Wirth (W), R. E. Darby (D), J. N. Belkin (B) and A. T. McClay (M). Location of the specimens is shown before each entry; abbreviations are used for U.S. National Museum (USNM), University of California (UC), and University of California at Los Angeles (UCLA). All localities mentioned are in California.

For her indispensable aid in preparing the genitalia mounts and for her assistance in the preparation of the manuscript I should like to thank my wife, Mary Smith Sublette. Appreciation is also due Dr. Willis W. Wirth for reading the manuscript and making many helpful suggestions.

Pseudochironomus richardsoni Malloch

Pseudochironomus richardsoni Malloch, Bull. Illinois State Lab. Nat. Hist., vol. 10, p. 500, 1915.

Males: Wing length, range 2.22–2.89; mean 2.55 mm. (8); leg ratio, range 0.84–0.94; mean 0.88 (4); antennal ratio, range 1.74–2.62; mean 2.21 (6).

Females: Wing length, range 2.22–3.15; mean 2.62 mm. (3); leg ratio 0.7 (1).

Material examined: In UCLA: 1 male, 1 female, Whitmore Tub, Mono Co., Aug. 3, 1952, W. A. McDonald; 5 males, 1 female, Resting Springs, May 29, 1955; 1 male, 1 female, 1000 Palm Canyon, Riverside Co., Mar. 20, 1954; B. In USNM: 6 males, Hume Lake, July 20, 1947, W; 1 female, Mono Lake, Mono Co., June 7, 1948, lake margin, W. In UC, Davis: 1 female, Manzanita Lake, Lassen National Park, June 16, 1941, J. R. Fisher.

Lauterborniella agrayloides (Kieffer)

Tanytarsus (*Calopsectra*) *agrayloides* Kieffer, Bull. Soc. Hist. Nat. Metz., vol. 27, pp. 45, 51, 1911.

Males: Wing length, range 1.44–1.66; mean 1.54 mm. (3); leg ratio 1.31 (1); antennal ratio, range 1.05–1.2; mean 1.11 (3).

Material examined: In USNM: 1 male, 6 miles east of Orosi, July 8, 1947; 2 males, Orosi, Tulare Co., June 5, 1947, W; 1 male, Tahoe City, June 17, 1920, H. G. Dyar.

Microtendipes caducus Townes

Microtendipes caducus Townes, Amer. Midl. Nat., vol. 34, p. 24, 1945.

Males: Wing length, range 2.96–3.44; mean 3.13 mm. (5); leg ratio 1.0, 1.12 (2); antennal ratio, range 2.0–2.08; mean 2.04 (5).

Material examined: In USNM: 4 males, Wheeler's Spring, Ventura Co., light trap, June 16, 1948, W; 1 male, Springville, July 10, 1947, W.

Previous California records: Tahoe City, Placer Co., Townes, 1945, p. 24.

Microtendipes pedellus var. *stygius* Townes

Microtendipes pedellus var. *stygius* Townes, Amer. Midl. Nat. vol. 34, p. 26, 1945

These specimens agree with the description of *M. pedellus* except for their higher antennal ratio. Two specimens were entirely dark while the other had the scutellum and legs stramineous except for the apical 0.1 of femora and basal and apical 0.1 of tibiae, which are blackish.

Males: Wing length, range 3.7–3.89; mean 3.76 mm. (3); leg ratio 1.1, 1.09 (2); antennal ratio 3.64, 3.37 (2).

Material examined: In UCLA: 2 males, 1000 Island Lake, Madera Co., Aug. 5, 1952, W. A. McDonald; 1 male, Lee's Lake, Chatworth, Los Angeles Co., Aug. 5, 1950, B.

Paratendipes fuscitibia, new species

FIGURE 1,*a*

Holotype male: USNM 64709, Whitewater Canyon, Riverside Co., April 7, 1949, W.

Head dark brown; mouth parts and antennae infuscate. Thorax dark brown, shining; vittae blackish brown, not strongly contracting; scutellum somewhat lighter brown; halteres white. Fork of Cu distal to r–m; R_{4+5} terminates proximal to the point of termination of M. Squama well fringed. Femora, except bases, which are stramineous, and tibiae mostly concolorous brown. Basal two-thirds of proximal tarsal joint white; apical one-third brown, strongly contrasting; remaining tarsal joints brown.

Wing length 2.59 mm.; leg ratio 0.94; antennal ratio 1.53 (slide).

Abdomen blackish-brown, incisures somewhat lighter.

Genitalia scarcely distinguishable from *P. albimanus* (Meigen).

Paratype: One male collected with type (USNM).

Wing length 2.59 mm.; fore tarsi missing; antennal ratio 1.59.

Female: Unknown.

This species may be distinguished from the closely related *P. albimanus* (Meigen) by the darkened tibiae, the slightly larger size, and the smaller leg ratio.

Paratendipes albimanus (Meigen)

Chironomus albimanus Meigen, Systematische Beschreibung der Europäischen zweiflügeligen Insekten, vol. 1, p. 40, 1818.

Males: Wing length, range 1.74–2.07; mean 1.94 mm. (6); leg ratio, range 1.24–1.35; mean 1.3 (3); antennal ratio, range 1.44–1.51; mean 1.49 (4).

Material examined: In USNM: 2 males, Springville, Aug. 10, 1947, W; 3 males, 6 miles east of Orosi, July 8, 1947, W; 1 male, Visalia, July 4, 1947, W.

Previous California records: Clio, Plumas Co., Lake Tahoe, Townes, 1945, p. 29.

Paratendipes subaequalis (Malloch)

Chironomus subaequalis Malloch, Bull. Illinois State Lab. Nat. Hist., vol. 10, p. 440, 1915.

Thorax dark brown instead of black as described (Malloch, 1915; Townes, 1945). However, the distinctive superior appendage of the male genitalia is diagnostic.

Males: Wing length, range 1.48–1.52; mean 1.49 mm. (4); leg ratio 1.33, 1.2 (2); antennal ratio 0.81 (1).

Material examined: In UCLA: 5 males, 1000 Palm Canyon, Riverside Co., Mar. 20, 1954, B.

Figure 1.—Male genitalia: *a*, *Paratendipes fuscitibia*, new species; *b*, *Paratendipes thermophilus* Townes; *c*, *Polypedilum* (*Polypedilum*) *labeculosum* (Mitchell); *d*, *Polypedilum* (*Polypedilum*) *californicum*, new species; *e*, *Polypedilum* (*Polypedilum*) *subcultellatum*, new species; *f*, *Stenochironomus totifuscus*, new species; *g*, *Tendipes* (*Wirthiella*) *modocensis*, new species.

Paratendipes thermophilus Townes

FIGURE 1,*b*

Paratendipes thermophilus Townes, Amer. Midl. Nat., vol. 34, p. 31, 1945.

The superior appendage of the genitalia in this species usually appears somewhat abbreviated because of the point being oriented dorsally. Figure 1, *b*, shows a variation in appearance, due to mounting technique, where the point of the superior appendage is fully appressed on the slide.

Males: Wing length 1.63, 1.59 mm. (2); fore tarsi missing; antennal ratio 1.51 (1).

Material examined: In UCLA: 1 male, Saratoga Springs, Death Valley, May 28, 1955; 1 male, Resting Springs, Inyo Co., May 29, 1955.

Paralauterborniella subcincta subcincta (Townes)

Apedilum subcinctum Townes, Amer. Midl. Nat., vol. 34, p. 33, 1945.

Males: Wing length, range 1.04–2.11; mean 1.48 mm. (61); leg ratio, range 0.95–1.36; mean 1.1 (33); antennal ratio, range 0.78–1.9; mean 1.28 (39).

Female: Wing length, range 1.29–1.55; mean 1.39 (7); leg ratio, range 1.0–1.17; mean 1.07 (7).

This is an exceedingly variable species which probably forms a North-South cline. The thorax varies from dark brown to black while the abdomen presents even greater differences. Some of the abdominal color patterns by locality are as follows: Davis: Segments 1 and 2 entirely dark brown; segments 3 to 5 with a narrow yellowish green posterior border, or segments entirely dark with only faintly lighter posterior margins. Rio Linda: Anterior half of tergites 1 to 4 brown; posterior half pale yellow. Resting Springs, Saratoga Springs, Death Valley: Abdomen largely pale green (fading to yellow or pale brown), occasionally with dorsum slightly infuscate.

The anal point of the male genitalia presents much variation due to differences in mounting technique. Not infrequently the anal point is obscured and in a few instances, particularly if lateral distortion has occurred, the point cannot be seen.

Paralauterborniella elachista (Townes) may be a synonym of this species. I have examined the type at the U.S. National Museum but cannot be certain without additional topotypic material that the species actually lacks an anal point.

Material examined: In Darby: 16 males, 7 females, Rio Linda, July 19, Sept. 22, 1957, D. In USNM: 4 males, Lee's Lake, Chatworth, Los Angeles, July 25, 1950, B; 1 male, Saratoga Springs, Death Valley, May 30, 1953, B; 5 males, 3 females, June 16, 19, 1954, Belkin and McDonald; 1 male, Selma, July 10, 1947, W; 1 male, Hume Lake, Aug. 20, 1947, W; 3 males, Oso Flaco Lake, San Luis Obispo Co., June 23, 1948, W; 1 male, Davis, May 19, 1954, W. H. Lange. In UCLA: 58 males, Saratoga Springs, Death Valley, Mar. 19, May 28, 1955; 9 males, Lee's Lake, Chatworth, Los Angeles, Aug. 10, 1950, July 25, 27, 1952, B; 10 males, Whitmore Tub, Mono Co., Aug. 3, 9, 1952, W. A. McDonald; 2 males, Aliso Creek, Orange Co., May 8, 1955, C. L. Hogue; 2 males, Fish Spring, Salton Sea, Imperial Co., Oct. 18, 19, 1954, Whitney. In UC, Davis: 1 male, 1.5 miles northeast of Red Lake, Alpine Co., July 25, 1955, E. I. Schlinger; 1 male, Sacramento, June 6, 1957, M; 1 male, Elkhorn Ferry, Yolo Co., Apr. 16, 1952, E. I. Schlinger.

Paralauterborniella subcincta alamedensis new subspecies

Holotype male: USNM 64710, Sunol, Alameda Co., Sept. 9, 1947; W.

Head, thorax, and abdomen entirely blackish brown; palpi, antennae and legs concolorous dark brown. Thorax and abdomen with heavy silvery pruinosity when viewed obliquely. Prealar bristles 2 (may be rubbed); dorsolateral bristles in a single row. Scutellum rubbed but with punctae of a straight, transverse, anterior row of at least 12 bristles. Wings pale, anterior veins pale brown. Halteres basally infuscate, distally pale. Fore tarsi with a short beard. Abdomen heavily pilose.

Wing length 2.22 mm.; leg ratio 0.96; antennal ratio 2.14.

The genitalia is indistinguishable from that of *P. subcincta subcincta* (Townes).

Paratypes: In USNM: 3 males, 2 collected with the type. In UCLA: 1 at Huntington Beach, Feb. 21, 1950.

Wing length, range 2.15–2.41; mean 2.32 mm. (3); leg ratio, range 0.91–1.0; mean 0.96 (3); antennal ratio 2.05, 2.45 (2).

P. subcincta alamedensis may be distinguished from *P. subcincta subcincta* (Townes) by its darker color, larger size, higher antennal ratio and generally lower leg ratio.

Polypedilum (Polypedilum) labeculosum (Mitchell)

FIGURE 1,*c*

Chironomus labeculosum Mitchell, Journ. New York Ent. Soc., vol. 16, p. 14, 1908.

This species was known only from three females from Hot Springs, Arizona. It is separated from all other Nearctic *Polypedilum* by a disconnected spot in cell Cu_1. The male, described below, is associated on the basis of this diagnostic feature.

Head, thorax and abdomen dark brown. Mesonotum with 2 conspicuous stripes of silvery pruinosity, narrowly separated on midline and extending back to scutellum. Dorsomedian and dorsolateral bristles erect, in a single row. Prealar bristles about 4. Halteres white. Scutellum with 2 transverse rows of erect bristles. Wings distinctly spotted similar to *P. pardus* Townes and *P. parvum* Townes but with a disconnected spot in cell Cu_1. Femora dark brown with a conspicuous preapical white annulus; remainder of legs lighter brown, the tibiae with bases somewhat darker.

Wing length 2.0, 1.89 mm. (2); leg ratio 1.6 (1); antennal ratio 1.12 (slide) (1).

Abdomen with incisures marked by a very thin band of lighter color; conspicuously pilose.

Genitalia similar to *pardus* Townes but with the ninth tergite narrower and more elongate.

Material examined: In UCLA: 2 males, Resting Springs, May 30, 1955.

Polypedilum (Polypedilum) californicum, new species

FIGURE 1,*d*

Holotype male: USNM 64711, Saratoga Springs, Death Valley, May 27, 1955.

Head, thorax, and abdomen blackish brown. Dorsomedial and dorsolateral bristles erect, conspicuous, in a single row. Haltere knob black, pedicel somewhat paler. Wings pale; anal angle obtuse, correlated with small size; wing margin fringe quite long. Legs beyond coxae infuscate stramineous.

Wing length, 1.33 mm.; fore tarsi missing; antennal ratio 0.76 (slide).

Genitalia near *floridense* Townes but superior and inferior appendages not apically narrowed. Inferior appendage shows reduction of bristles to 4 as in *floridense* Townes (5 in paratype).

Paratype males: In UCLA and USNM: 2 males collected with type. Prealar bristles apparently 4.

Wing length, range 1.18–1.33; mean 1.27 mm. (4); leg ratio 1.66, 1.62 (2); antennal ratio 0.78 (2).

This species may be distinguished from *P. floridense* Townes by the male genitalia which has the anal point less truncate and the superior and inferior appendages scarcely narrowed apically.

Polypedilum (Polypedilum) subcultellatum, new species

FIGURE 1,*e*

Holotype male: USNM 64712, 6 miles east of Orosi, California, July 8, 1947.

Head light brown except for basal segment of antenna which is whitish. Postocular bristles long and conspicuous, overhanging eyes; laterally in a single row, medially becoming doubled.

Thorax with a pale yellowish brown ground color; median vittae dark brown; lateral vittae and postnotum blackish-brown. Prealar bristles about 6; dorsolateral bristles in a double row. Scutellum and halteres yellowish white, the former with 2 irregular transverse rows of bristles. Fork of Cu distal to r–m; R_{2+3} and R_1 slightly but distinctly separated at apex. R_{4+5} and M equidistant, terminating slightly before wing apex. Legs light brown, no tarsal beard.

Wing length 2.66 mm.; leg ratio 1.53; antennal ratio 2.0.

Abdomen light brown; first segment with a thin, slightly oblique longitudinal brown line; segments 2 to 5 with the apical one-third occupied by a dark brown band; segments 6 to 7 almost completely darkened.

Genitalia of this species is unique among Nearctic *Polypedilum* in having several bristles beyond the base on the superior appendage. It is very similar to the European *cultellatum* Goetghebuer (Goethgebuer, 1937). It differs by not having the inferior appendage widened and by having the blade of the superior appendage recurved, not acute.

Paratype male: Collected with type (USNM).

Wing length 2.26 mm.; leg ratio 1.6; antennal ratio 1.83.

Polypedilum (*Polypedilum*) *scalaenum* (Schrank)

Tipula scalaena Schrank, Fauna Boica . ., vol. 3, p. 73, 1803.

Male: Wing length 1.55 mm.; fore tarsi missing; antennal ratio 1.5. The specimen is unusual in lacking the characteristic point on either side of the base of the anal point. In all other respects the individual is normal.

Females: Wing length 1.59, 2.22 mm. (2); leg ratio 1.58 (1).

Material examined: In UCLA: 1 male, 1 female, Davis, June 20, 1953, A. A. Grigarick; 1 female, Davis, March 30, 1954, M.

Previous California records: Laguna Canyon, Wirth and Stone, 1956, p. 421.

Polypedilum (*Polypedilum*) *parvum* Townes

Polypedilum (*Tripodura*) *parvum* Townes, Amer. Midl. Nat., vol. 34, p. 40, 1945.

Males: Wing length, range 1.41–1.63; mean 1.56 mm. (3); fore-tarsi and antennae missing.

Material examined: In USNM: 3 males, Palo Verde, Imperial Co., April 8, 1949, W.

Polypedilum (*Polypedilum*) *apicatum* Townes

Polypedilum (*Tripodura*) *apicatum* Townes, Amer. Midl. Nat., vol. 34, p. 39, 1945.

Male: Wing length 1.47 mm.; fore tarsi and antennae missing.

Female: Wing length 1.66 mm.; fore tarsi missing.

Material examined: In UCLA: 1 male, 1 female, China Ranch, Inyo Co., May 30, 1955.

Polypedilum (*Polypedilum*) *albinodus* Townes

Polypedilum (*Tripodura*) *albinodus* Townes, Amer. Midl. Nat., vol. 34, p. 41, 1945.

Scarcely discernable cloudiness along Cu_2 and below 2A. Antennal ratio somewhat higher than Townes' figure and anal point with a slight notch; otherwise as his description.

Male: Wing length 2.66 mm.; leg ratio 1.48; antennal ratio 1.81.

Material examined: In USNM: 1 male, Berkeley, Strawberry Creek, Apr. 20, 1948, W.

Polypedilum (*Polypedilum*) *isocerus* Townes

Polypedilum (*Tripodura*) *isocerus* Townes, Amer. Midl. Nat., vol. 34, p. 42, 1945.

Previous California records: Fallen Leaf, Lake Tahoe; Virginia Creek, Mono Co., Townes, 1945, p. 42.

Polypedilum (*Polypedilum*) *simulans* Townes

Polypedilum (*Tripodura*) *simulans* Townes, Amer. Midl. Nat., vol. 34, p. 43, 1945.

Males: Wing length 1.55, 2.18 mm. (2); fore tarsi missing; antennal ratio 1.02, 1.88 (2).

Females: Wing length 1.48; 1.55 mm. (2); fore tarsi missing.

Material examined: In USNM: 1 male, Shafter, Kern Co., June 1946, light trap, B. Brookman; 1 male, 2 females, 6 miles east of Orosi, July 8, 1947, W.

Polypedilum (*Polypedilum*) *digitifer* Townes

Polypedilum (*Tripodura*) *digitifer* Townes, Amer. Midl. Nat., vol. 34, p. 45, 1945.

Males: Wing length, range 1.66–1.96; mean 1.84 mm. (3); leg ratio 1.66 (1); antennal ratio, range 1.86–2.2; mean 2.06 (3).

Female: Wing length 2.18 mm.; leg ratio 1.55.

Material examined: In UCLA: 1 male, San Vincente Lake, San Diego Co., July 9, 1952, R. X. Schick. In Darby: 1 male, Rio Linda, Aug. 2, 1957; 1 male, Aug. 14, 1958; 1 female, Sept. 3, 1957, D. In USNM: 1 male, Seeley, Imperial Co., Apr. 5, 1949, at light, W.

Previous California records: Bakersfield, Townes, 1945, p. 45.

Polypedilum (*Polypedilum*) *halterale* (Coquillett)

Chironomus halteralis Coquillett, Ent. News, vol. 12, p. 17, 1901.

Male: Wing length 1.89 mm.; fore tarsi missing; antennal ratio 2.2.

Female: Wing length 2.22 mm.; leg ratio 1.71.

Material examined: In USNM: 1 male, 1 female, Valley Home, Sept. 3, 1947, under bridge, W.

Polypedilum (Polypedilum) laetum (Meigen)

Chironomus laetus Meigen, Systematische Beschreibung der Europäischen zweiflügeligen Insekten, vol. 1, p. 38, 1818.

Male: Wing length 2.04 mm.; fore tarsi missing; antennal ratio 1.45.

Material examined: In USNM: 1 male, Kaweah River, Tulare Co., July 13, 1947, W.

Previous California records: Lake Tahoe, Townes, 1945, p. 50.

Polypedilum (Polypedilum) artifer (Curran)

Chironomus artifer Curran, Bull. Amer. Mus. Nat. Hist., vol. 61, p. 32, 1930.

Males: Wing length 2.74, 3.66 mm. (2); leg ratio 1.55 (1); antennal ratio 1.06 (1).

Material examined: In USNM: 1 male, Willow Creek, Humboldt Co., Aug. 12, 1948, W; 1 male, Hely Creek, Humboldt Co., Aug. 11, 1948, W.

Polypedilum (Polypedilum) pedatum excelsius Townes

Polypedilum (Polypedilum) pedatum excelsius Townes, Amer. Midl. Nat., vol. 34, p. 55, 1945.

Male: Wing length 3.18 mm.; leg ratio 1.08; antennal ratio 1.05.

Material examined: In USNM: 1 male, Elk Valley, Del Norte Co., January 1948, light trap, R. Coleman.

Previous California records: Clio, Plumas Co.; Crescent City, Townes, 1945, p. 55.

Polypedilum (Polypedilum) nigritum Townes

Polypedilum (Polypedilum) nigritum Townes, Amer. Midl. Nat., vol. 34, p. 56, 1945.

Males: Wing length range 2.18–2.29; mean 2.25 mm. (4); leg ratio, range 1.34–1.49; mean 1.4 (3); antennal ratio, range 1.3–1.44; mean 1.38 (4).

Material examined: In USNM: 5 males, Lagunitas Creek, Marin Co., Oct. 19, 1947, W.

Polypedilum (Polypedilum) illinoense (Malloch)

Chironomus illinoensis Malloch, Bull. Illinois State Lab. Nat. Hist., vol. 10, p. 471, 1915.

Male: Wing length 2.29 mm.; leg ratio 1.62; antennal ratio 1.9.

Material examined: In USNM: 1 male, Sunol, Alameda Co., Nov. 2, 1947, R. Coleman.

Polypedilum (*Polypedilum*) *ophioides* Townes

Polypedilum (*Polypedilum*) *ophioides* Townes, Amer. Midl. Nat., vol. 34, p. 57, 1945.

Male: Wing length 2.7 mm.; leg ratio 1.75; antennal ratio 2.20.

Material examined: In USNM: 1 male, Heather Lake, Sequoia National Park, 9,000 ft., Aug. 9, 1947, W.

Polypedilum (*Polypedilum*) *sulaceps* Townes

Polypedilum (*Polypedilum*) *sulaceps* Townes, Amer. Midl. Nat., vol. 34, p. 58, 1945.

Male: Wing length 2.1 mm.; fore tarsi missing; antennal ratio 1.84.

Material examined: In USNM: 1 male, Visalia, July 4, 1947, W.

Polypedilum (*Polypedilum*) *aviceps* Townes

Polypedilum (*Polypedilum*) *aviceps* Townes, Amer. Midl. Nat., vol. 34, p. 61, 1945.

Previous California records: San Jose, Santa Clara Co., Townes, 1945, p. 61.

Polypedilum (*Pentapedilum*) *tritum* (Walker)

Chironomus tritus Walker, Insecta britannica, Diptera, vol. 3, p. 162, 1856.

Males: Wing length, range 1.85–2.66; mean 2.45 mm. (5); leg ratio, range 1.42–1.47; mean 1.45 (4); antennal ratio, range 1.67–1.91; mean 1.83 (4).

Female: Wing length 2.29 mm. (1); leg ratio, 1.5 (1).

Material examined: In USNM: 16 males, Heather Lake, Sequoia National Park, 9,000 ft., Aug. 9, 1947; 1 male, 1 female, Orosi, Tulare Co., June 5, 1947, W.

Stictochironomus quagga (Townes), new combination

Tanytarsus (*Stictochironomus*) *quagga* Townes, Amer. Midl. Nat., vol. 34, p. 81, 1945.

Previous California records: Lake Tahoe; Truckee, Townes, 1945, p. 81.

Stictochironomus naevus (Mitchell), new combination

Chironomus naevus Mitchell, Journ. New York Ent. Soc., vol. 16, p. 14, 1908.

Male: Wing length 4.03 mm.; fore tarsi missing; antennal ratio 2.96.

Material examined: In UC, Davis: 1 male, Davis, Mar. 29, 1952.

Phaenopsectra albescens (Townes), new combination

Tanytarsus (*Tanytarsus*) *albescens* Townes, Amer. Midl. Nat., vol. 34, p. 73, 1945.

Males: Wing length, range 3.7–4.22; mean 3.92 mm. (3); leg ratio 1.03, 1.14 (2); antennal ratio, range 2.33–2.66; mean 2.53 (3).

Female: Wing length 4.14 mm.; fore tarsi missing.

Material examined: In USNM: 2 males, 1 female, Mount Shasta City, Siskiyou Co., July 20, 1948, W; 1 male, Alturas, Modoc Co., June 1948, R. Coleman.

The specimen from Alturas has the abdomen entirely black but is apparently referable to this species.

Previous California records: Gold Lake Camp, Plumas Co., Townes, 1945, p. 73.

Phaenopsectra profusa (Townes), new combination

Tanytarsus (*Tanytarsus*) *profusus* Townes, Amer. Midl. Nat., vol. 34, p. 73, 1945.

Males: Wing length, range 2.48–3.44; mean 2.97 mm. (7); leg ratio, range 1.13–1.2; mean 1.16 (3); antennal ratio, range 1.9–2.2; mean 2.04 (6).

Females: Wing length 2.81–2.89; mean 2.85 mm. (3); leg ratio 1.22, 1.25 (2).

Material examined: In USNM: 1 male, Big Sur River, Monterey Co., Feb. 11, 1948, stream margin, W; 1 male, Pollock Pines, Eldorado Co., July 14, 1948, at light, W; 1 male, 1 female, Springville, July 10, 1947, W; 1 male, Shafter, Kern Co., June 1946, light trap, B. Brookman; 1 male, 1 female, Hume Lake, July 20, 1947, W. In Darby: 1 male, 1 female, Sacramento, Oct. 16, Nov. 21, 1957, D. In UCLA: 1 male, Keen Camp, Riverside Co., Aug. 10, 1952. In UC, Davis: 1 male, 1 female, Green Valley, Sonalo Co., June 19, 1953, E. I. Schlinger; 1 male, Quincy, 4 miles west, Plumas Co., July 16, 1949, W. F. Ehrhardt; 1 male, Strawberry, Tuolumme Co., July 15, 1951, D. P. Lawfer; 1 female, Benton Station, Mono Co., July 20, 1950, H. A. Hunt; 1 female, Davis, May 16, 1952, E. I. Schlinger.

Previous California records: Clio, Plumas Co.; Fallen Leaf, Lake Tahoe; Palo Alto; Truckee, Townes, 1945, p. 73.

Phaenopsectra dyari (Townes), new combination

Tanytarsus (*Tanytarsus*) *dyari* Townes, Amer. Midl. Natl., vol. 34, p. 75, 1945.

Males: Wing length 3.44, 3.15 mm. (2); leg ratio 1.07, 1.13 (2); antennal ratio 1.71, 1.83 (2).

Females: Wing length, range 2.77–3.59; mean 3.13 mm. (3); leg ratio 1.14 (1).

Material examined: In USNM: 2 males, Fallen Leaf, Lake Tahoe, June 13, 1916, H.G. Dyar. This topotypic material was in the unidentified series at USNM and was apparently overlooked by Townes. In USNM: 1 female, Sanger, Fresno Co., Apr. 25, 1949, R. E. Ryckman; 2 females, Lagunitas Creek, Marin Co., Oct. 19, 1947, W.

Previous California records: Fallen Leaf, Lake Tahoe; Fieldbrook, Townes, 1945, p. 75.

Phaenopsectra sp.

One male in USNM, wing length 2.81 mm; leg ratio 1.21; antennal ratio 2.06, Visalia, June 30, 1947, W. This specimen is probably a color variety of *dyari* (Townes). Genitalia indistinguishable from *dyari;* abdomen solid dark brown.

Phaenopsectra flavipes (Meigen), new combination

Chironomus flavipes Meigen, Systematische Beschreibung der Europäischen zweiflügeligen Inschten, vol. 1, p. 50, 1818.

Previous California records: Blue Lake, Humboldt Co., Townes, 1945, p. 76.

Stenochironomus totifuscus, new species

FIGURE 1, *f*

Holotype male: USNM 64713, 6 miles east of Orosi, Calif., July 8, 1947, W.

Head brown except flagellum which is stramineous and mouthparts which are blackish-brown. Thorax dark brown, heavily pollinose especially between median and lateral lobes of the mesonotum giving it a vittate appearance. Prealar bristles about 5. Dorsolateral bristles in a single row anteriorly, becoming staggered posteriorly, giving the appearance of a double row. Scutellum somewhat lighter brown than the postnotum which is entirely dark brown. Halteres white. Wing membrane and veins pale except r–m and f–Cu which are brown. Fork of the Cu distinctly distal to r–m. Legs almost uniformly stramineous except apices of femora which are faintly suffused with brown.

Wing length 2.44 mm.; leg ratio 1.1; antennal ratio 1.56.

Abdomen pale greenish white; segments 2 to 3 with a brown band on apical 0.13; segment 4 with the brownish band on apical 0.09; segment 5 suffused with brown, becoming almost black posteriorly; segment 6 almost entirely blackish.

Genitalia near *cinctus* Townes.

Paratypes: Two males, collected with type in USNM.

Wing length 2.37, 2.32 mm. (2); leg ratio 1.16, 1.17 (2); antennal ratio 1.51, 1.58 (2).

Allotype in USNM, Visalia, Calif., July 4, 1947, W.

As the male except that the thorax is somewhat lighter in color and the abdominal segments are uniformly pigmented with each segment having a slightly lighter colored apex.

Wing length 2.85 mm.; leg ratio 1.27.

This species is very near *cinctus* Townes but differs in lacking a central dusky wing band, in having a uniformly darkened postnotum, and in having slight differences in the male genitalia.

Stenochironomus colei (Malloch)

Chironomus colei Malloch, Proc. California Acad. Sci., vol. 9, p. 255, 1919.

Males: Wing length 2.55 mm. (1); leg ratio 1.17 (1); antennal ratio 2.4 (1).

Females: Wing length 3.15 mm. (1); leg ratio 1.3 (1).

The single female has the hind tibial band as wide as Townes' describes for *pulchripennis* (Coquillett). However, since the basal band of color on the wing membrane between C and R is lacking the specimen is clearly *colei.*

Material examined: In USNM: 2 males, Pollock Pines, Eldorado Co., July 14, 1948, at lights, W; King's River Bridge, Stratford, July 15, 1947, W; 1 female, Alturas, Modoc Co., July 18, 1947, R. Coleman. In UC, Davis: 1 female, Sacramento, May 29, 1956, S. M. Fidel; 2 females, Davis, April, 1941, G.E. Bohart.

Previous California records: Smith River, Cresent City, Townes, 1945, p. 88.

Stenochironomus taeniapennis (Coquillett)

Chironomus taeniapennis Coquillett, Proc. U.S. Nat. Mus., vol. 23, p. 607, 1901.

Previous California records: Lake Tahoe, Townes, 1945, p. 90.

Tendipes (Tendipes) fulvipilus (Rempel)

Chironomus fulvipilus Rempel, Zool. Anz., vol. 127, p. 210, 1939.

Males: Wing length 2.33, 2.59 mm. (2); leg ratio 1.52, 1.9 (2); antennal ratio 2.6, 2.8 (2).

Material examined: In UCLA: 2 males, Laguna Lake, Imperial Co., June 9, 11, 1950.

Tendipes (Tendipes) stigmaterus (Say)

Chironomus stigmaterus Say, Journ. Acad. Nat. Sci. Philadelphia, vol. 3, p. 15, 1823.

Males: Wing length, range 4.44–4.99; mean 4.65 mm. (8); leg ratio, range 1.33–1.43; mean 1.37 (8); antennal ratio, range 4.68–5.3; mean 4.99 (5).

Females: Wing length, range 4.55–5.36; mean 5.07 mm. (4); leg ratio, range 1.32–1.42; mean 1.38 (3).

Material examined: In USNM: 1 male, Oso Flaco Lake, San Luis Obispo Co., June 22, 1948, W. In UCLA: 1 male, Westminster, Orange Co., June 5, 1939; 7 males, Huntington Beach, Feb. 20, 21, 1950; Beardsley, Los Angeles Co., June 9, 1955, J. G. Shanafelt; 4 females, Saratoga Springs, Death Valley, Mar. 19, April 23, 24, 1955. In UC, Davis: 1 female, Davis, Nov. 30, 1950, E. I. Schlinger;

1 female, Davis, May 12, 1958, A. D. Telford; 1 female, Edgemar, San Mateo Co., Aug. 10, 1950, E. C. Carlson.

Tendipes (Tendipes) attenuatus (Walker)

Chironomus attenuatus Walker, List of specimens of dipterous insects in the British Museum, pt. 1, vol. 1, p. 20, 1848.

Males: Wing length, range 2.59–4.55; mean 3.59 mm. (51); leg ratio, range 1.29–1.64; mean 1.46 (48); antennal ratio, range 2.75–4.1; mean 3.4 (42).

Females: Wing length, range 3.37–4.44; mean 3.86 mm. (15); leg ratio, range 1.24–1.72; mean 1.44 (11).

Although there is a considerable difference between the figure for antennal ratio given by Townes and that presented here, I do not consider it to be biologically significant but rather a reflection of the few measurements used by Townes.

Material examined: In Darby: Four males, 2 females, Davis, July 1, 29, 1957, D; 1 male, 1 female. Rio Linda, July 19, 24, 1957, D; 1 male, 1 female, Aug. 16, 1958, 1 male, Aug. 2. 1958, 1 female, July 24, 1957, D. In UCLA: 2 males, 2 females, Huntington Beach, Feb. 20, 1950, J. G. Shanafelt; 1 female, Mar. 9. 1949, G. Barnes; 3 males, 3 females, Devil's Gate Dam, Flintridge, Los Angeles Co., Apr. 12, May 10, 1955; 1 male, Lee's Lake, Chatworth, Los Angeles Co., Aug. 10, 1950, B; 1 male, 1 female, El Centro, Imperial Co., July 9, 1950; 2 males, Bradley, Monterey Co., Aug. 28, 1949, B; 1 male, Sherwood Lake, Ventura Co., July 26, 1952, R. X. Schick; 1 male, San Vincente Lake, San Diego Co., July 9, 1952, R. X. Schick; 12 males, 10 females, Midway City, Mar. 21, 1955, J. G. Shanafelt; 3 males, 4 females, Topanga Canyon, Los Angeles, May 14, 1952; 1 male, 1 female, Indian Wells, Riverside Co., May 9. 1952; 3 females, Whitmore Tub, Mono Co., Aug. 3, 1952, McDonald; 3 females, Bradley, Mono Co., Aug. 28, 1949, B; 1 female, Atwood, Mar. 18, 1955, J. G. Shanafelt; 1 female, Tanbark Flat, Los Angeles Co., June 28, 1950, W. A. McDonald; 1 female, Beverly Glen, Los Angeles Co., Feb. 22, 1951; 1 female, Cypress, Mar. 25, 1949, J. G. Shanafelt; 4 females, Buena Park, May 1, 1951, J. G. Shanafelt. In USNM: 1 male, Berkley, Strawberry Canyon, Alameda Co., June 5, 1948, W; 1 male, 1 female, June 1, 1948; 1 male, May 24, 1948, W; 1 male, Feb. 1949; 1 female, Apr. 20, 1948, W; 2 males, 2 females, Visalia, June 30, 1947, W; 1 male, Ventura Co., June 16, 1948, W; 1 male, Pismo Beach, San Luis Obispo Co., June 24, 1948. W; 1 male. Selma, July 10, 1947, W; 2 males, Richmond, Contra Costa Co., June 2, 1949, R. E. Ryckman; 3 males, 1 female, Loma Linda, San Bernardino Co., Apr. 25, 27, 1949, R. E. Ryckman; 11 males, 3 females, Stratford, July 8, 1947, W; 1 male, Hume Lake, July 20, 1947, W; 1 male, Pine Creek, Inyo Co., June 6, 1948, W; 1 male, Santa Barbara Co., June 23, 1948, W; 11 males, Benicia Brooks, Apr. 15, 1907; 1 male, Lagunitas Creek, Marin Co., Oct. 19, 1947, W; 1 male, Dos Palos, Merced Co., Dec. 2, 1947, Ed Smith; 11 males, 1 female, Shafter, Kern Co., June 1946, light trap, B. Brookman; 1 male, Black Lake Canyon, San Luis Obispo Co., Aug. 19, 1948, W; 4 males, Mad River Beach, Humboldt Co., Aug. 13, 14, 1948, W; 1 male, Hydesville, Humboldt Co., Aug. 11, 1948, W; 1 male, Corcoran, Aug. 22, 1947, W; 6 males, 1 female, Springville, July 10, 1947, W; 1 female, Tule River, July 29, 1947, W; 4 males, Palo Verde, Imperial Co., Apr. 8, 1949, W; 1 female, Bolinas, June 5, 1949, R. E. Ryckman; 1 male, Tahoe City, June 17, 1920, H. G. Dyar; 1 female, Alturas, Modoc Co., July 14, 1948, W; 1 male, Garcia River, Mendocino Co., July 30, 1948, W. In UC, Davis: 5 males, 1 female, Sacramento, Apr. 19, 1956, Jack Fowler; 5 males, 1 female, Sacramento, Mar. 19, 1957, sewage plant, Jack Fowler; 3 males, 4 females, Davis, Apr. 30, 1951, E. I. Schlinger; 7 males, 4 females, Davis, April 1941, G. E. Bohart; 2 males, Davis, May 12, 1955, D. L. Dahlsten; 1 male, Davis, June 24, 1955, M; 1 male, Davis, Apr. 18, 1955, M; 3 males, Davis, Nov. 15, 1950, E. I. Schlinger; 1 male, 4 females, Davis, Aug. 4, 1955, E. I. Schlinger; 1 male, Davis, May 1955, D. C. Force; 1 male, Davis, July 28, 1955, M; 1 male, Davis, July 24, 1955, M; 1 male, Davis, June 1, 1949, E. I. Schlinger; 1 male, 4 females, Bear-Cache Creek Junction, Yolo Co., Apr. 19, 1954, E. I. Schlinger; 4 females, Davis, June 8, 1950, J. C. Hall; 1 female, Davis, May 14, 1952, E. I. Schlinger; 1 female, Davis, Dec. 8, 1950, E. I. Schlinger; 1 female, Green Valley, Solano Co., May 17, 1955, R. W. Bushing; 1 female, Hamilton City, Glenn Co., Apr. 25, 1956, S. M. Fidel; 1 female, Tanbark Flat, Los Angeles Co., July 19, 1952, M.

Tendipes (Tendipes) atrella Townes

Tendipes (Tendipes) atrella Townes, Amer. Midl. Nat., vol. 34, p. 124, 1945.

Male: Wing length 4.44 mm.; leg ratio 1.28; antennal ratio 3.64.

The specimen differs from Townes' original description in having a short, spare tarsal beard.

Material examined: In UC, Davis: One male, Pollock Pines, Eldorado Co., April 22, 1956, E. I. Schlinger.

Previous Calif. records: Tahoe City, Townes, 1945, p. 124.

Tendipes (*Tendipes*) *riparius* (Meigen)

Chironomus riparius Meigen, Klassifikazion und Beschreibung der Europäischen zweiflügeligen Insekten, p. 13, 1804.

Male: Wing length 4.37 mm.; leg ratio 1.5; antennal ratio 3.65.

Females: Wing length, range 3.55–4.14; mean 3.88 mm. (5); leg ratio, range 1.5–1.73; mean 1.59 (5).

Material examined: In USNM: 1 male, 2 females, Alturas, Modoc Co., July 14, 1948, W; 3 females, Nevada Co., northwest of Cisco, May 16, 1948, W. In UC, Davis: One male, Hat Creek Post Office, Shasta Co., July 10, 1955, A. J. Mueller.

Tendipes (*Tendipes*) *utahensis* (Malloch)

Chironomus utahensis Malloch, Bull. Illinois State Lab. Nat. Hist., vol. 10, p. 438, 1915.

Males: Wing length, range 4.1–4.92; mean 4.46 mm. (10); leg ratio, range 1.1–1.37; mean 1.17 (10); antennal ratio, range 4.76–5.8; mean 5.25 (9).

Females: Wing length, range 3.89–6.66; mean 4.81 mm. (7) leg ratio, range 1.15–1.3; mean 1.21 (7).

Material examined: In USNM: 2 males, 3 females, Stronghold, Modoc Co., July 17, 1948, W; 4 males, Westwood, Lassen Co., May 16, 1948, W; 1 female, Topaz Lake, Mono Co., July 25, 1948, R. Coleman; 6 females, June 5, 1948, W; 3 males, Topaz Lake, July 10, 1919; 6 males, Lake Crowley, Bishop, Inyo Co., June 11, 1949, P. R. Needham. In UC, Davis: One female, Topaz Lake, Mono Co., June 26, 1957, H. Axelrod; Blanco's Corral, White Mountains, Mono Co., 10,000 ft.; July 5, 1958, W. D. McLehan.

In addition to the above there are 2 females, Moss Beach, San Mateo Co., March 21, 1948, W and 1 female, Convict Lake, Mono Co., June 6, 1948, lake margin, W, both in USNM, which probably are referable to this species although they have unusually high leg ratios. The larger size rules out *T. atrella* Townes. Wing length, range 4.7–6.11; mean 5.21 mm. (3); leg ratio, range 1.36–1.5; mean 1.42 (3).

Previous California records: Alkali Lake in Antelope Valley, Townes, 1945, p. 127.

Tendipes (*Tendipes*) *staegeri* (Lundbeck)

Chironomus staegeri Lundbeck, Vidensk. Meddel. Nat. For. København, vol. 50, p. 271, 1898.

Males: Wing length, range 3.96–4.74; mean 4.41 mm. (7); leg ratio, range 1.21–1.35; mean 1.28 (6); antennal ratio, range 3.75–4.44; mean 4.13 (5).

Material examined: In USNM: 4 males, Lake Almanor, Plumas Co., May 16, 1948, W; 3 males, Westwood, Lassen Co., May 16, 1948, W. In UC, Davis: 1 male, Lakeport, Apr. 18, 1957, S. M. Fidel; 1 male, Maraga, Jan. 25, 1936.

Tendipes (*Tendipes*) *anthracinus* (Zetterstedt)

Chironomus anthracinus Zetterstedt, Diptera scandinaviae disposita et descripta, vol. 14, p. 6499, 1860.

Male: Wing length 5.18 mm.; leg ratio 1.41; antennal ratio 4.1.

Material examined: In USNM: 1 male, Fallen Leaf, Lake Tahoe, June 15, 1916, H. G. Dyar.

Previous California records: Golden Lake Camp, Plumas Co., Townes, 1945, p. 130.

Tendipes (*Tendipes*) *plumosus* (Linné)

Tipula plumosa Linné, Systema naturae, ed. 10, p. 587, 1758.

Males: Wing length, range 4.51–6.29; mean 5.27 mm. (13); leg ratio, range 1.2–1.31; mean 1.24 (12); antennal ratio, range 4.14–5.8; mean 4.89 (12).

Females: Wing length, range 4.88–6.74; mean 5.61 mm. (10); leg ratio, range 1.14–1.24; mean 1.2 (8).

Material examined: In Darby: 1 male, 1 female, Davis, June 26, 1957, D. In USNM: 2 males, Stratford, July 8, 1947, W; 2 males, Loma Linda, San Bernardino Co., Apr. 25, 1949, R. E. Ryckman; 3 males, Clear Lake, Oct. 11, 1947, W; 2 males, Shafter, Kern Co., June 1946, B. Brookman; 5 males, 1 female, Lake Crowley, Bishop, Inyo Co., June 11, 1949, P. R. Needham. In UCLA: 2 males, Whitmore Tub, Mono Co., Aug. 3, 1952, W. A. McDonald; 1 male, 12 females, Alturas, Modoc Co., Aug. 21, 1952, B. Tuiglof; 1 male, Mohave, Kern Co., Apr. 2, 1933; 3 females, Huntington Beach, Feb. 21, 1950; 1 female, Indian Wells, Riverside Co., May 9, 1952; 1 male, Saratoga Springs, Mar. 20, 1955, B; 1 female, Gorman, Los Angeles Co., Feb. 2, 1953, J. W. Warren; 2 females, Lancaster, Los Angeles Co., May 13, 1953. In UC, Davis: 5 males, Clear Lake Oaks, Lake Co., Apr. 19, 1954, E. I. Schlinger; 1 male, Lake Almanor, Plumas Co., July 8, 1949, 3 females, Riverside, June 28, 1954, J. C. Hall; 1 female, Ryder Island, May 3, 1923, F. H. Wymore; 1 male, Soda Bay, Lake Co., July 25, 1958, R. E. Dolphin; 1 female, Three Rivers, Tulare Co., July 3, 1955, H. R. Moffitt; 1 male, 1 female, Topaz Lake, Mono Co., June 26, 1957, H. Axelrod; 1 female, Davis, May 12, 1949, M; 1 female, Davis, April 1941, G. E. Bohart; 1 male, Davis, May 13, 1952, E. M. Evans; 1 male, Davis, May 13, 1952, R. M. Bohart; 1 male, 1 female, Davis, May 13, 1952, W. J. Wall; 1 male, 1 female, Davis, Apr. 10, 1951, E. I. Schlinger and R. C.

Bechtel; 2 females, Davis, May 12, 1955, D. L. Dahlstep; 1 male, 1 female, Davis, Nov. 6, 1937, G. Spurlock; 1 male, Antioch, May 18, 1936.

Previous California records: Los Angeles; Palmdale; San Diego, Townes, 1945, p. 132.

Tendipes (*Tendipes*) *dorsalis* (Meigen)

Chironomus dorsalis Meigen, Systematische Beschreibung der Europäischen zweiflügeligen Insekten, vol. 1, p. 25, 1818.

Male: Wing length 3.85 mm.; leg ratio 1.6; antennal ratio 3.0.

Material examined: In Darby: One male, Carmichael, Sacramento Co., Dec. 8, 1957, D.

In addition there is one female which probably belongs here, with a wing length of 3.22 mm. and a leg ratio of 1.68. Material examined: (USNM), Heather Lake, Sequoia National Park, 9,000 ft., Aug. 9, 1947.

Wirthiella, new subgenus

Diagnosis: Pronotum broad, collarlike; scarcely narrowed medially, with a very slightly discernable notch; slightly inferior to anterior end of mesonotum; palpi of normal length; fork of Cu distal to r–m; R_{2+3} distinctly separated from R_1 and terminates half way between R_1 and R_{4+5}; tarsal beard present.

Male genitalia: Superior appendage elongated, beaklike; inferior appendage extremely widened apically, with numerous conspicuous bristles.

Type species: *Tendipes* (*Wirthiella*) *modocensis*, new species.

It is with pleasure that I name this subgenus in honor of Dr. Willis W. Wirth.

Tendipes (*Wirthiella*) *modocensis*, new species

FIGURE 1,*g*

Holotype male: USNM 64714, inspection station, Alturas, Modoc Co., May 15, 1948, stream margin, W.

Head entirely black; antennal pedicels large, contiguous, thus making it impossible to see if frontal tubercles are present or absent. Palpi normal, ratio 10:32:25:26.

Thorax black except small infuscate yellowish pleural area; lightly greyish pruinose; mesonotum with 2 inconspicuous tubercles on the median line, one at the anterior end of the prescutellar area, the other at the posterior, immediately in front of the scutellum; prealar bristles about 5; dorsolateral bristles in a single, staggered row; haltere knob infuscate yellow, stalk black; scutellum with many strewn bristles; fore tarsi heavily bearded; legs black except for trochanters, which are brownish.

Wing length 4.07 mm.; leg ratio 1.25; antennal ratio 3.62.

Abdomen black; each segment pruinose except apically, heavily pilose.

Female: Unknown.

This species may be distinguished from all other Nearctic Chironomini by the elongate, beaklike superior appendage and the extremely widened inferior appendage of the male genitalia.

Tendipes (*Endochironomus*) *nigricans* (Johannsen)

Chironomus nigricans Johannsen, Bull. New York State Mus., vol. 86, p. 219, 1905.

Males: Wing length, range 3.33–4.51; mean 3.97 mm. (3); leg ratio, range 1.06–1.25; mean 1.15 (3); antennal ratio 2.5, 2.83 (2).

Females: Wing length, range 3.78–5.47; mean 4.36 mm. (4); leg ratio, range 1.13–1.23; mean 1.16 (3).

Material examined: In Darby: 1 male, Rio Linda, July 16, 1957, D. In USNM: 2 males, Moss Beach, San Mateo Co., Mar. 21, 1948, W; 1 male, Stratford, King Co., July 19, 1947, W; 2 females, Lemoore, King Co., Aug. 31, 1947, W; 1 female, Mad River Beach, Humboldt Co., Aug. 13, 1948, W.

Previous California records: Crescent City, Palo Alto, Townes, 1945, p. 64.

Tendipes (*Tribelos*) *hesperius*, new species

FIGURE 2,*a*

Holotype male: USNM 64715, Corcoran, Aug. 22, 1947, W.

Head dark brown; antennae somewhat lighter brown. Mesonotum and scutellum yellowish brown; postnotum darker brown; halteres pale at base, blackish on knob; dorsolateral bristles in a staggered partially doubled row; prealar bristles apparently 4; scutellum with a transverse straight row of about 12 long erect bristles which emerge from conspicuously darkened alveoli; middle and hind legs entirely stramineous, front legs slightly darker; wing hairs along anterior veins pale and short, not especially conspicuous.

Wing length 2.22 mm.; leg ratio 1.16; antennal ratio 1.85.

Abdominal segment 1 brown; segment 2 with basal half brown to dark brown, the apical half paler brown; segments 3 to 5 with the apical band of lighter brown progressively narrowed posteriorly; segments 6 to 8 largely dark brown.

Allotype: Collected with the holotype.

Slightly darker than the male; abdomen with the segments progressively darker posteriorly, apex of segments 1 to 4 slightly lighter, segments 5 to 8 blackish-brown. Wing length 2.22 mm.; leg ratio 1.2.

Paratypes: Eight males, 1 female, collected with holotype and allotype, in USNM.

Males: Wing length, range 2.11–2.41; mean 2.22 mm. (5); leg ratio, range 1.07–1.13; mean 1.11 (5); antennal ratio, range 1.8–2.0; mean 1.88.

Female: Wing length, 2.29 mm.; leg ratio, 1.19.

This species most closely resembles *T. fuscicornis* (Malloch) from which it may be distinguished by its black knobbed halteres and hairs of the anterior wing veins which are pale and of normal length.

Subgenus *Tribelos* Townes, previously under the genus *Tanytarsus* (i.e., *Phaenopsectra*), is here considered to be a unit of *Tendipes* (vide Dendy and Sublette, 1959).

Tendipes (*Dicrotendipes*) *californicus* (Johannsen)

Chironomus californicus Johannsen, Bull. New York State Mus., vol. 86, p. 217, 1905.

Males: Wing length, range 2.04–3.6; mean 2.61 mm. (25); leg ratio, range 1.39–1.75; mean 1.57 (23); antennal ratio, range 2.29–2.83; mean 2.57 (19).

Females: Wing length, range 2.52–3.81; mean 3.07 mm. (11); leg ratio, range 1.5–1.77; mean 1.62 (10).

Material examined: In Darby: 1 male, 4 females, Carmichael, Dec. 8, 18, 1957, D; 4 males, 6 females, Rio Linda, Aug. 2, 6, 1957, D. In UCLA: 1 female, Saratoga Springs, May 28, 1955; Huntington Beach, 3 males, Feb. 21, 1950, 7 males, Apr. 6, 1949; 4 males, Resting Springs, May 29, 30, 1955; 12 males, Lee's Ranch, Chatworth, Los Angeles, July 25, 1950; 4 males, 1000 Islands, Madera Co., Aug. 5, 1952, W. A. McDonald; 1 female, Indian Wells, Riverside Co., May 9, 1952. In USNM: 6 males, Clear Lake, Lake Co., Oct. 11, 1947, W; 1 male, Wheeler's Springs, Ventura Co., June 16, 1948, W; 2 females, Shafter, Kern Co., June 8, B. Brookman. In UC, Davis: 1 male, Davis, June 3, 1949, R. C. Bechtel.

This species was highly variable as to size and ratios and, at first glance, was made of several populations that approached subspecific level. However, a plot of measurements indicated sufficient overlap so as to show lack of population isolation necessary for subspecific identity.

Previous California records: Pasadena, Johannsen, 1905, p. 217; Los Angeles, Townes, 1945, p. 105.

Tendipes (*Dicrotendipes*) *modestus* (Say)

Chironomus modestus Say, Journ. Acad. Nat. Sci. Philadelphia, vol. 3, p. 13, 1823.

Male: Wing length 2.29 mm.; leg ratio 1.57; antennal ratio 2.27.

Material examined: In Darby: One male, Rio Linda, July 21, 1957, D.

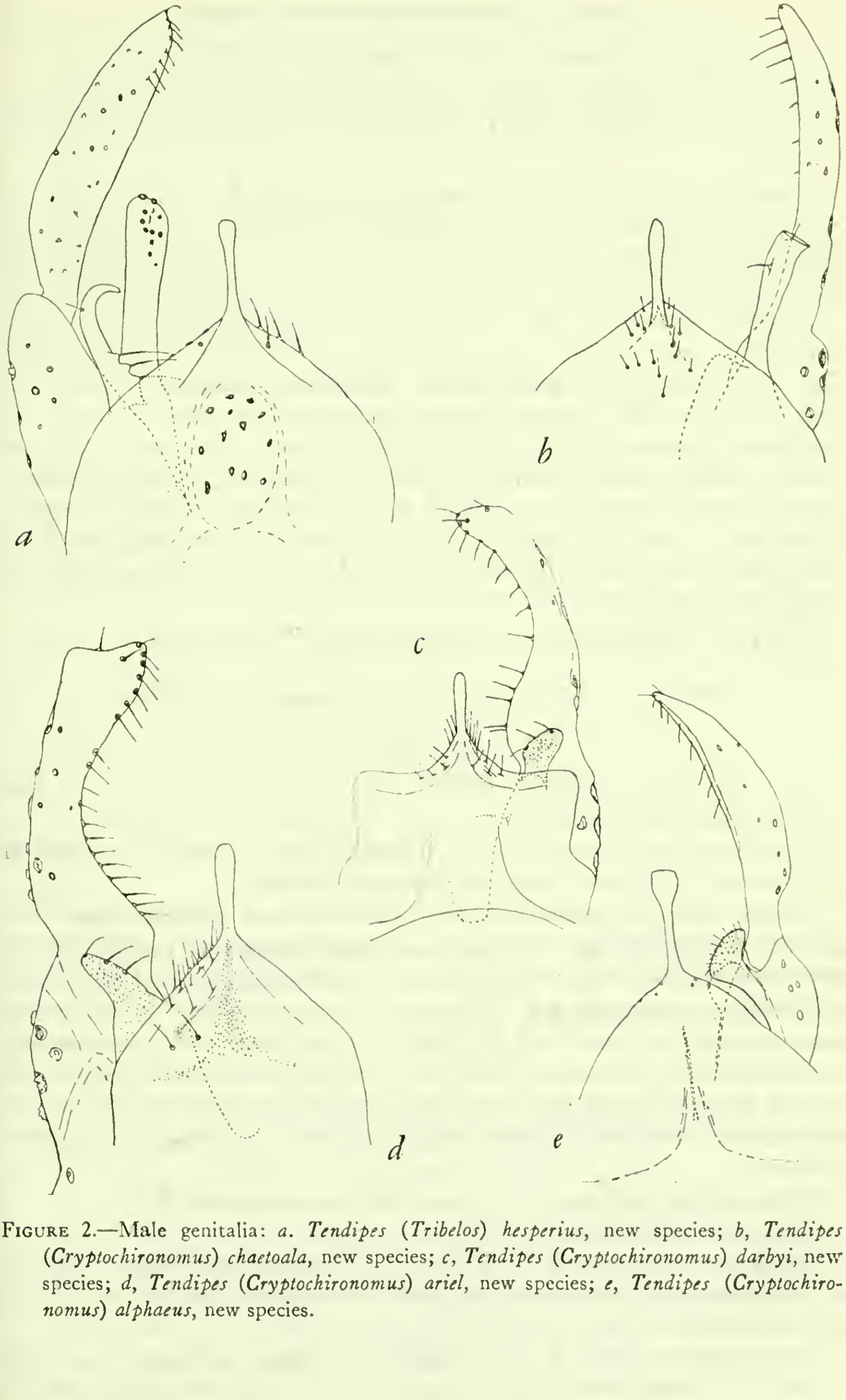


FIGURE 2.—Male genitalia: *a*. *Tendipes* (*Tribelos*) *hesperius*, new species; *b*, *Tendipes* (*Cryptochironomus*) *chaetoala*, new species; *c*, *Tendipes* (*Cryptochironomus*) *darbyi*, new species; *d*, *Tendipes* (*Cryptochironomus*) *ariel*, new species; *e*, *Tendipes* (*Cryptochironomus*) *alphaeus*, new species.

Tendipes (*Dicrotendipes*) *nervosus* (Staeger)

Chironomus nervosus Staeger, Naturhist. Tidsskr., vol. 2, p. 567, 1839.

Males: Wing length, range 2.22–2.96; mean 2.57 mm. (6); leg ratio, range 1.47–1.58; mean 1.53 (4); antennal ratio, range 2.63–3.13; mean 2.93 (5).

Intersex: Wing length 2.18 mm.; leg ratio 1.7. This individual was apparently parasitized by a mermithid nematode as indicated by the swollen abdomen. Most body features were those of the female except that the genitalia were those of the male, reduced in size.

Material examined: In Darby: 2 males, 1 intersex, Rio Linda, June 20, Sept. 3, 1957, D. In USNM: 1 male, Clear Lake, Lake Co., Oct. 11, 1947, W; 2 males, Oceano Beach, San Luis Obispo Co., Aug. 20, 1948, W; 2 males, Sunol, Alameda Co., Nov. 2, 1947, R. Coleman; 2 males, W.M. on 1 slide, Nice, Oct. 1938, Lindquist and Roth; 1 male, Orosi, Tulare Co., June 5, 1947, W; 1 male, Heather Lake, Sequoia National Park, 9,000 ft., Aug. 9, 1947; 1 male, Rockwell Pond, Selma, Aug. 4, 1947, W; 1 female, Oso Flaco Lake, San Luis Obispo Co., June 23, 1948, W. In UC, Davis: 1 male, Davis, Apr. 3, 1949, R. C. Bechtel.

Previous California records: Lake Tahoe, Townes, 1945, p. 108.

Tendipes (*Cryptochironomus*) *chaetoala*, new species

Figure 2,*b*

Holotype male: USNM 64716, Lee's Ranch, Chatworth, Los Angeles, July 25, 1950.

Head greenish, the color more intensified on the occiput; pedicel of the antenna yellowish, flagellum infuscate brown.

Thorax largely yellowish-brown, the anterior pleural areas pale green; prealar bristles 4 to 5; dorsolateral bristles in partial double row; halteres yellowish; scutellum pale green with 12 erect bristles in a straight transverse row (paratype); wing membrane with sparce macrotrichia at tips of cell R_{4+5} and M, the hairs in R_{4+5} extending more than half the way to the base; squama well fringed; hind tibial combs close together, the inner spine slightly longer than the outer; no beard; femora and tibiae stramineous, tarsi darkened, the foretarsi more so.

Wing length 1.85 mm.; leg ratio 1.52; antennal ratio 2.14.

Abdomen light green.

Genitalia very similar to *potamogeti* (Townes) but differs in mode of attachment of the anal point and in details of structure of the superior appendage.

Paratypes: In UCLA and USNM: 4 males collected with the holotype; 2 males collected at type locality, Aug. 10, 1950; 1 male, Selma, July 10, 1947, W. In Darby: 1 male, July 15, 1957, 1 male, July 8, 1957, 2 males, July 31, 1957, 3 males, Aug. 4, 1958, D.

Wing length, range 1.77–2.0; mean 1.88 mm. (7); leg ratio, range 1.47–1.61; mean 1.56 (4); antennal ratio, range 1.97–2.43; mean 2.24 (6).

Female: Unknown.

The presence of space macrotrichia on the wing membrane serves to distinguish this species from all other Nearctic *Cryptochironomus*. The male genitalia most closely resembles that of *T. potamogeti* (Townes) but differs in having the lateral bristle of the superior appendage more proximal.

Tendipes (*Cryptochironomus*) *darbyi*, new species

FIGURE 2,*c*

Holotype male: USNM 64717, Rio Linda, Sacramento Co., July 10, 1957, D.

Head pale green becoming brown on clypeus and mouthparts. Antennal pedicel blackish brown, flagellum and plumes pale brown. Thoracic ground color pale green; vittae, mesosternum, a small spot on pleura ventral and slightly anterior to wing bases, and posterior half of postnotum blackish brown, strongly contrasting with the ground color; anterior end of median and posterior end of lateral darker brown than remainder of vittae. Prealar bristles 2; dorsolateral bristles in a single row; scutellum with a transverse row of 6 pale, erect bristles; halteres pale green. Wings milky by reflected, brown by transmitted light; squamal fringe with about 8 hairs (paratype). Legs pale green; fore leg entirely dusky beyond middle of femur; middle and hind legs dusky only on tarsi.

Wing length 2.5 mm.; leg ratio 1.27; antennal ratio 2.5.

Abdominal segments 1 to 4 pea green becoming dark brown on segments 5 to 8 (paratype).

Genitalia very similar to that of *T. ariel*, new species but less massive.

Female: Unknown.

Paratypes: In USNM: 2 males, Stratford, July 8, 1947; 1 male, collected with the type. In Darby: 1 male, Davis, July 3, 1957, D. In UC, Davis: 1 male, Davis, June 8, 1958, J. C. Hall.

Wing length, range 1.55–1.74; mean 1.68 mm. (4); leg ratio, range 1.34–1.4; mean 1.37 (3); antennal ratio, range 2.6–2.82; mean 2.71 (4).

This species with its dusky fore legs and its distinctive genitalia can only be confused with *T.* (*Cryptochironomus*) *ariel*, new species. *T. darbyi* can be separated by its smaller size, lighter color, smaller antennal ratio and different genitalia.

I am happy to name this species after R. E. Darby.

***Tendipes* (*Cryptochironomus*) *ariel*, new species**

FIGURE 2,*d*

Holotype male: USNM 64718, Topaz Lake, Mono Co., June 5, 1948, W.

Head, thorax and abdomen blackish-brown with a faint suggestion of a dark olive green ground color. Dorsolateral bristles in a single row; prealar bristles about 5. Haltere knob whitish, pedicel blackish-brown. Wings somewhat milky by reflected light, brownish-purple by transmitted light; squama with 10–12 hairs. Legs dark brown; basal one-third of femora somewhat paler; fore tarsi heavily bearded.

Wing length 2.59 mm.; leg ratio 1.37; antennal ratio 3.47.

Abdomen heavily pilose, the long hairs arising from very distinct alveoli.

Genitalia: The shape of the ninth tergite as figured for *T. darbyi* and this species would indicate a distinctiveness which is not real, as is shown by intermediates in the paratypic series of this species. The difference is interpreted as a variation in mounting technique.

Female: Unknown.

Paratypes: Five males collected with the holotype (USNM).

Wing length, range 2.41–2.74; mean 2.6 mm. (5); leg ratio, range 1.24–1.46; mean 1.37 (5); antennal ratio, range 3.17–3.5; mean 3.34 (5).

Of the Nearctic fauna, this species can be confused only with *T. darbyi*, new species. The two species may ultimately prove to be extremes of a clinal series. However, in the absence of individuals with intermediate characteristics the two are considered separate species.

***Tendipes* (*Cryptochironomus*) *alphaeus*, new species**

FIGURE 2,*e*

Holotype male: USNM 64719, King's River Canyon, July 20, 1947, W.

Head and most of thorax dark brown; anterior pleural areas, spaces between vittae and scutellum somewhat paler; mesonotum and antennal pedicel heavily dusted with greenish-gray pollen; halteres whitish, base somewhat infuscate; squama with at least 3 hairs; middle and hind tibiae each with 2 spurs; legs stramineous, knees somewhat darker.

Wing length 1.92 mm.; leg ratio 1.64; antennal ratio 1.8.

Abdomen brown with a dark olive green tinge; incisures slightly darker; apical segments progressively darkened to a dark brown.

Genitalia very similar to *undine* (Townes) but differing in having a more spatulate anal point, a superior appendage of a slightly different shape and orientation and an inferior appendage which is shorter and broader.

Female: Unknown.

This species is separated from others of the *Cladopelma* group on the basis of its distinctive male genitalia.

Tendipes (*Cryptochironomus*) *fulvus* (Johannsen)

Chironomus fulvus Johannsen, Bull. New York State Mus., vol. 86, p. 224, 1905.

Males: Wing length, range 2.32–3.03; mean 2.74 mm. (16); leg ratio, range 1.37–1.68; mean 1.55 (14); antennal ratio, range 2.55–3.44; mean 3.03 (14).

Females: Wing length, range 2.41–3.03; mean 2.70 mm. (3); leg ratio 1.46, 1.68 (2).

Material examined: In USNM: 5 males, 1 female, Clear Lake, Co., Oct. 11, 1947, W; 3 males, 2 females, Stratford, July 8, 1947, W; 3 males, 1 female, Hume Lake, July 20, 1947, W; 1 male, Palo Verde, Imperial Co., Mar. 8, 1949. In Darby: 4 males, 1 female, Rio Linda, Aug. 2, Sept. 3, 1957; 2 males, Aug. 14, 1958, D; 1 male, Sacramento, Oct. 16, 1957, D; 1 male, Davis, July 27, 1957, 1 male, Aug. 25, 1958, D. In UCLA: 2 males, 2 females, Huntington Beach, Apr. 6, 1949. In UC, Davis: 1 male, Davis, May 13, 1952, A. A. Grigarick; 1 male, 1 female, Davis, May 13, 1952, M.

Previous California records: Clear Lake, Nice, Townes, 1945, p. 98.

Tendipes (*Cryptochironomus*) *digitatus* (Malloch), new combination

Chironomus digitatus Malloch, Bull. Illinois State Lab. Nat. Hist., vol. 10, p. 483, 1915.

Previous California records: Truckee, Townes, 1945, p. 100.

Tendipes (*Cryptochironomus*) *frequens* (Johannsen), new combination

Chironomus frequens Johannsen, Bull. New York State Mus., vol. 86, p. 230, 1905.

Males: Wing length, range 2.52–2.89; mean 2.69 mm. (8); leg ratio, range 1.24–1.32; mean 1.26 (8); antennal ratio, range 2.86–3.22; mean 3.09 (7).

Female: Wing length 2.85 mm.; leg ratio 1.28.

Material examined: In USNM: 2 males, Hume Lake, July 20, 1947, W. In Darby: 2 males, 1 female, Rio Linda, July 5, Oct. 3, 1957; 8 males, Aug. 14, 1958, D; 2 males, Davis, June 26, Aug. 26, 1957, D.

Tendipes (*Cryptochironomus*) *monochronomus* (Wulp)

Chironomus monochronomus Wulp, Tijdschr. Ent., vol. 17, p. 129, 1874.

Males: Wing length, range 1.77–2.0; mean 1.88 mm. (9); leg ratio, range 1.43–1.53; mean 1.49 (4); antennal ratio, range 2.17–2.5; mean 2.34 (8).

Material examined: In USNM: 11 males, Woodlake, July 28, 1947, W; 1 male, Tule River, Springville, July 29, 1947, W. In Darby: 1 male, Rio Linda, Aug. 21, 1958, D.

Tendipes (*Cryptochironomus*) *tenuicaudatus* (Malloch)

Chironomus tenuicaudatus Malloch, Bull. Illinois State Lab. Nat. Hist., vol. 10, p. 475, 1915.

Males: Wing length, range 1.85–2.22; mean 2.05 mm. (8); leg ratio, range 1.35–1.53; mean 1.43 (5); antennal ratio, range 2.17–2.53; mean 2.4 (6).

Material examined: In Darby: 7 males, Rio Linda, July 14, Sept. 15, 1957, 3 males, Davis, Aug. 25, 1958, D. In UCLA: 3 males, Lee's Lake, Chatworth, Los Angeles, Aug. 10, 1950, B.

Tendipes (*Cryptochironomus*) *nigrovittatus* (Malloch), new combination

Chironomus nigrovittatus Malloch, Bull. Illinois State Lab. Nat. Hist., vol. 10, p. 456, 1915.

Males: Wing length, range 1.48–1.81; mean 1.55 mm. (7); leg ratio, range 1.2–1.38; mean 1.31 (6); antennal ratio, range 2.1–2.35; mean 2.22 (5).

Material examined: In USNM: 3 males, Woodlake, July 28, 1947, W; 3 males, W. M. on 1 side, Nice, Oct. 1938, Lindquist and Roth; 3 males, Palo Verde, Imperial Co., Apr. 8, 1949, W. In UCLA: 1 male, San Vincente Lake, San Diego Co., July 9, 1952, R. X. Schick.

Tendipes (*Cryptochironomus*) *curtilamellatus* (Malloch), new combination

Chironomus curtilamellatus Malloch, Bull. Illinois State Lab. Nat. Hist., vol. 10, p. 474, 1915.

Males: Wing length, range 1.92–2.18; mean 2.05 mm. (5); leg ratio, range 2.0–2.1; mean 2.03 (5); antennal ratio, range 2.6–3.04; mean 2.8 (5).

Material examined: In Darby: 5 males, Davis, June 26, 1957, D.

Tendipes (*Cryptochironomus*) *edwardsi* Kruseman

Tendipes (*Parachironomus*) *edwardsi* Kruseman, Tijdschr. Ent., vol. 76, p. 194, 1933.

Wing length, range 1.55–1.96; mean 1.7 mm. (4); leg ratio, range 1.55–1.6; mean 1.58 (4); antennal ratio 2.23 (1).

Material examined: In USNM: 2 males, Woodlake, July 28, 1947, W; 1 male, Hume Lake, July 20, 1947, W; 1 male, Selma, July 10, 1947, W.

Tendipes (Cryptochironomus) amachaerus (Townes)

Harnischia (Harnischia) amachaerus Townes, Amer. Midl. Nat., vol. 34, p. 168, 1945.

Males: Wing length 1.55, 1.7 mm. (2); leg ratio 1.6, 1.73 (2); antennal ratio 2.68 (1).

Material examined: In USNM: 2 males, Selma, July 10, 1947, W.

Tendipes (Cryptochironomus) viridulus (Linné), new combination

Tipula viridulus Linné Systema naturae, ed. 12, p. 975, 1767.

Male: Wing length 1.96 mm.; leg ratio 1.81; antennal ratio 2.3.

Material examined: In USNM: 1 male, Hume Lake, July 20, 1947, W.

Glyptotendipes (Phytotendipes) lobiferus (Say)

Chironomus lobiferus Say, Journ. Acad. Nat. Sci. Philadelphia, vol. 3, p. 12, 1823.

Males: Wing length, range 2.59–4.14; mean 3.51 mm. (11); leg ratio, range 1.17–1.39; mean 1.32 (10); antennal ratio, range 3.6–5.0; mean 4.24 (11). Tarsal joint 2:3, range 1.28–1.47; mean 1.38 (10). Length of scar on 6th abdominal segment:segment length, range 0.57–0.74; mean 0.69 (9). Scar on 6:scar on 2, range 2.5–4.44; mean 3.39 (9).

Females: Wing length, range 3.81–4.29; mean 4.09 mm. (3); leg ratio, range 1.4–1.44; mean 1.42 (3). Tarsal joint 2:3, 1.47, 1.37 (2). Scar on abdominal segment:segment length 0.58–0.74; mean 0.64 (3). Scar on 6:scar on 2, 3.33 (1).

Material examined: In USNM: 1 male, 1 female, Tulare Co., May 1947, W; 3 males, 1 female, King's River, Stratford, July 15, 1947, W; 2 males, 1 female, Clear Lake, Lake Co., Oct. 11, 1947, W; 1 male, Selma, July 10, 1947, W; 1 male, Woodlake, July 28, 1947, W; 1 female, Hanford, July 8, 1947. In Darby: 5 males, 1 female, Rio Linda, July 24, Oct. 7, 1957, D; 1 female, July 25, 1956; 1 male, Aug. 4, 1958, Davis, D. In UC, Davis: 2 females, Vacaville, July 27, 1948, M.

References

DENDY, J. S., and SUBLETTE, JAMES E.

1959. The Chironomidae (=Tendipedidae: Diptera) of Alabama with descriptions of six new species. Ann. Ent. Soc. Amer., vol. 52, pp. 506–519.

FREEMAN, PAUL

1955. A study of African Chironomidae. Part I. Bull. British Mus. (Nat. Hist.) Ent., vol. 4, pp. 1–67.

1957. A study of the Chironomidae (Diptera) of Africa south of the Sahara. Part III. Bull. British Mus. (Nat. Hist.) Ent., vol. 5, pp. 321–426.

1958. A study of the Chironomidae (Diptera) of Africa south of the Sahara. Part IV. Bull. British Mus. (Nat. Hist.) Ent., vol. 6, pp. 261–363.

GOETGHEBUER, MAURICE

1937. Tendipedidae (Chironomidae). (b) Subfamilie Tendipedinae (Chironominae), *in* Linder, Die Fliegen der Palaearktischen Region, Lief. 109, pp. 49–73.

JOHANNSEN, O. A.

1905. Aquatic nematocerous Diptera. Part II. New York State Mus. Bull. 86, pp. 76–331.

TOWNES, H. K., JR.

1945. The Nearctic species of Tendipedini [Diptera, Tendipedidae (=Chironomidae)]. Amer. Midl. Nat., vol. 34, pp. 1–206.

WIRTH, WILLIS W.

1949. A revision of the clunionine midges with descriptions of a new genus and four new species (Diptera: Tendipedidae). Univ. California Publ. Ent., vol. 8, pp. 151–182.

WIRTH, WILLIS W., and STONE, ALAN

1956. Aquatic Diptera, *in* Aquatic insects of California, ed. Robert L. Usinger, University of California Press, 508 pp.

U.S. GOVERNMENT PRINTING OFFICE: 1960

Proceedings of
the United States
National Museum

SMITHSONIAN INSTITUTION • WASHINGTON, D.C.

Volume 112 1960 Number 3436

REVISION OF THE MILLIPED GENUS CHEROKIA (POLYDESMIDA : XYSTODESMIDAE)

By Richard L. Hoffman[1]

Introduction

The student of humus fauna who pursues field work in the circum-Appalachian region of southeastern United States cannot help but become impressed with the abundance and variability of millipeds of the genus *Cherokia.* It is a well-marked ensemble of xystodesmids which in many areas is the most conspicuous element of the diplopod fauna. Besides the interest engendered by the broad ecological tolerance and geographic variability of its forms, *Cherokia* has a still more compelling claim upon our attention, for despite the diversity of body form, color pattern, and morphological details which occurs in the genus, the male gonopods remain essentially similar.

Generally, species in xystodesmid genera tend to be remarkably similar in external body form, specific individuality being expressed solely in the gonopods, which often assume bizarre shapes of great specific constancy. *Cherokia* represents an apparent departure from this condition, and in working out the systematics of this genus one faces the problem whether to assume the occurrence of heteromorphic species—with external differentiation in body form at the expense of the normally variable gonopods—or a single highly variable species within the genus.

---

[1] This paper was written while the author was affiliated with the Biology Department, Virginia Polytechnic Institute, Blacksburg, Virginia.

Solution of this difficulty involves more than merely clarifying systematics and phylogeny within the small confines of *Cherokia,* and will provide insight into the problem of coping with related genera composed of heteromorphic "species" held together by a constant gonopod structure. The ultimate challenge in this direction is the large neotropical genus *Rhysodesmus,* already with about 80 named forms despite only desultory collecting in the region it occupies.

The considerable quantity of material of *Cherokia* now at hand from a large number of localities facilitates a fairly thorough examination of speciation and geographic variation in diplopod genera characterized by basically uniform gonopod structure. It is hoped that the following account will be of interest and value to other investigators who find pleasure and reward in unraveling the intricacies inherent in this neglected class of arthropods.

REVIEW OF THE LITERATURE

Apparently the first specimens of this genus to be collected were obtained in Georgia by L. M. Underwood. During the summer of 1887, he secured material at Macon, Lookout Mountain, Indian Springs, and Tallulah, and two years later Charles H. Bollman described from it two species referable to *Cherokia.* These were *Fontaria georgiana,* based on numerous specimens from Piedmont localities, and *Fontaria tallulah,* the types of which are two immature females from Tallulah Falls on the edge of the Blue Ridge province. Bollman recognized the similarity of these two species in most respects and made the separation between them primarily on the basis of differences in the color patterns.

Remarkably enough, no further information on the genus was published for 50 years. In 1939, R. V. Chamberlin described material from Soco Gap, North Carolina, under the name *Mimuloria ducilla,* and followed it a year later with the closely related *Mimuloria furcifer.* These names were considered to be synonyms of *georgiana* by H. F. Loomis (1943), who had seen Bollman's types and felt that only a single form was involved. Under the name *Dynoria parvior,* Chamberlin (1947) described another local population of *Cherokia* from north Georgia and compared it only with *Dynoria icana* although the two species clearly are not congeneric. This fact was pointed out in a subsequent paper by Loomis and Hoffman (1948), who considered *parvior* to be a junior synonym of *georgiana.*

For a decade, specimens belonging to this genus were referred to *Mimuloria* (Chamberlin, 1928) although the type species, *M. missouriensis* Chamberlin, had never been described sufficiently to give any idea of its attributes. Finally in 1949 Chamberlin set up the new genus *Cherokia* and designated *Fontaria georgiana* Bollman as the type species, but he did not stipulate which other names belonged in *Cherokia.*

During the summer of 1949, I acquired considerable field experience with *Cherokia* in the southern Appalachians. In a paper appearing the following year, I discussed variation and distribution in the genus and concluded that of the five which had been proposed, only a single specific name was valid. This synonymy was based on topotypes of *tallulah* and *ducilla,* specimens from near the type locality of *furcifer,* and Bollman's types of both *tallulah* and *georgiana.* No attempt was made to consider the general problem of geographic variation over the entire range. But in subsequent years, with the acquisition of rich collections made in Georgia, Alabama, and Tennessee by Leslie Hubricht, I found it necessary to review the status of the genus, and the outcome of the investigation is presented in the following paper.

MATERIALS AND ACKNOWLEDGMENTS

The material studied is included in more than 105 lots and totals well over 400 individuals. Probably 95 percent of these are in my personal collection (RLH), thanks to the kindness of many friends who have picked up millipeds incidental to their own line of special interest. Specimens have also been examined in the following collections: American Museum of Natural History (AMNH), New York City, Chicago Natural History Museum (CNHM), Chicago; and U.S. National Museum (USNM), Washington, D.C.

The type specimens of *Fontaria georgiana* and *F. tallulah* of Bollman are in the U.S. National Museum and have been studied. Topotypes of *tallulah, Mimuloria ducilla,* and *M. furcifer* have been seen in life and have provided an idea of the basis of those three names. Specimens collected less than 20 miles from the type locality of *Dynoria parvior,* while not strictly topotypical, are nonetheless representative of the population described under that name and make its evaluation possible with considerable confidence.

Methods of study outlined in previous papers have been followed and need no repetition here. Because of the confused state of nomenclature in the genus, all previously published information was rejected as prejudicial. Specific characters and the distribution of populations thus defined were worked out at the beginning; only after this work had been done was the application of available names undertaken.

Particular attention has been paid to the evaluation and comparison of localized populations in order to determine geographic variation. In this respect, likewise, each of the structural variables found useful in diagnosis has been separately plotted cartographically. These precautions have been found useful in light of the remarkably uniform gonopod structure in all of the specimens, a condition which compelled my giving attention to details of body form.

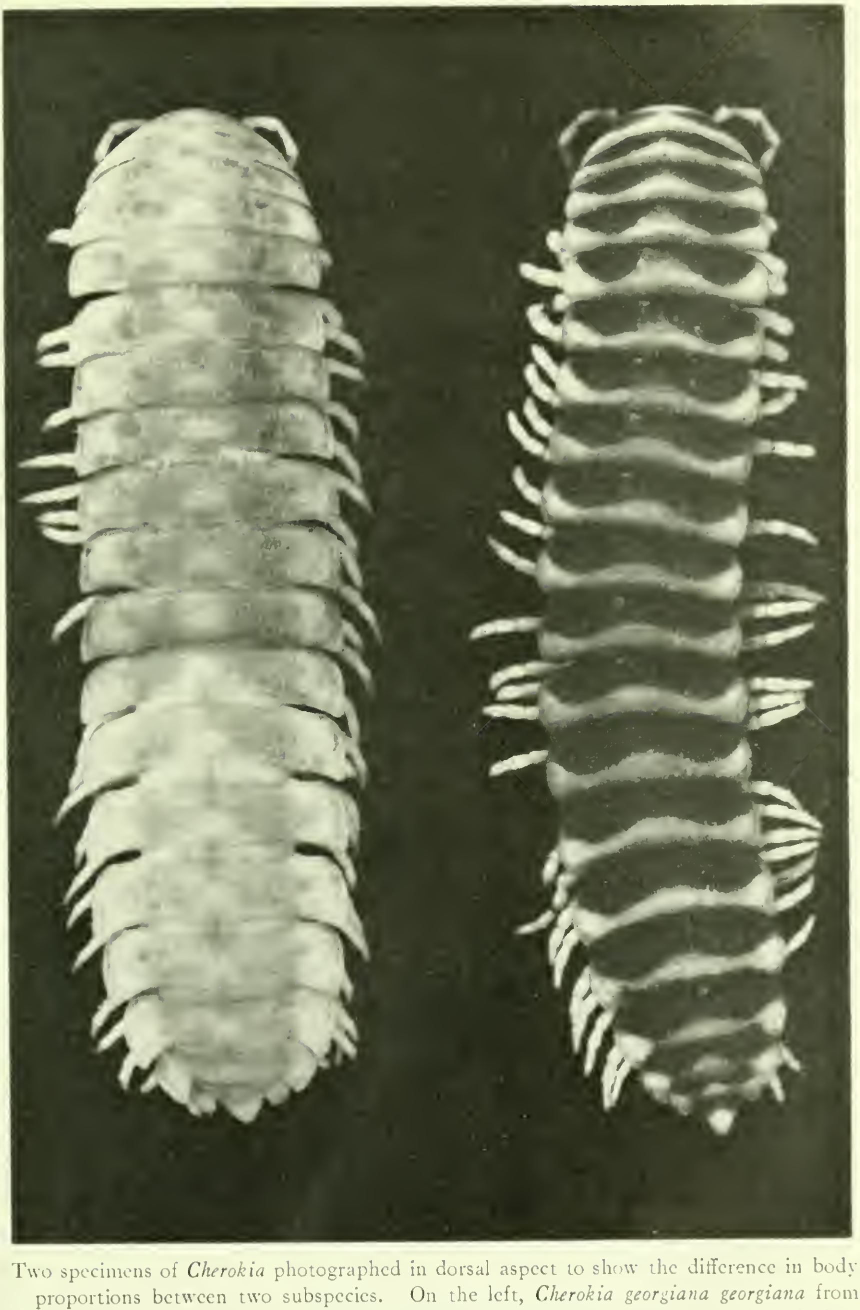
The pronounced geographic variation in color pattern obtaining in *Cherokia* imposes a higher premium on knowledge of the living colors in this genus than in most other. Much of the material of *C. georgiana latassa*—with which I have had little field experience—was sent to me by Leslie Hubricht soon after collection, with the colors still fresh. Of *C. g. georgiana* and *C. g. ducilla*, which intergrade extensively, I have been most fortunate in being able to collect living specimens at more than 30 localities, chiefly through two summers of residence at the Highlands Biological Station. This first-hand knowledge of subtle color details has facilitated numerous inferences about microevolution which could never be made from faded specimens. Most of the work with color characters was done during the summer of 1958 through the aid of a National Science Foundation grant administered by the Highlands Station. Special thanks are due its director, Professor Thelma Howell, for her continued interest and material aid during the past decade of my summer investigations at Highlands.

For the loan of material, I am indebted to Dr. Ralph E. Crabill, Jr. (USNM), Dr. Willis J. Gertsch (AMNH), and Drs. Henry S. Dybas and Rupert L. Wenzel (CNHM). Those who have generously donated specimens are named in the lists of material examined, but special mention must be made of the outstanding contribution of Leslie Hubricht, whose superb collections form the basis of this revision.

TAXONOMIC CHARACTERS

The most casual inspection of *Cherokia* specimens from different parts of the generic range reveals a remarkable amount of geographic variation in body form, shape of the paranota, color pattern, and details of the gonopods. In addition, there is considerable individual or sporadic local variation in tergal sculpture, convexity of the dorsum, shape of the caudalmost paranota, and size of the coxal and prefemoral spines, but these low order variations may for the present be subordinated in favor of those which are correlated to some extent with distribution. Although clear cut and easily defined, such characters are by no means easy to analyze. As will become apparent, only infrequently do we find that two or more characters coincide, a fact which renders their utility in the recognition of taxonomic groups somewhat subjective.

Body form: Perhaps the most striking variation observed in *Cherokia* is in body form—e.g., the ratio of greatest width to length. Specimens from the Great Smokies are so different from lowland animals in this respect that without knowledge of the intermediates which occur, one would naturally assume full specific distinction. The narrow graceful body of a specimen from the Smokies is in strong con-



Two specimens of *Cherokia* photographed in dorsal aspect to show the difference in body proportions between two subspecies. On the left, *Cherokia georgiana georgiana* from Chatooga Ridge, Oconee County, South Carolina; on the right, *C. g. ducilla* from Indian Gap, Sevier County, Tennessee. Despite the differences in form and the probable inability to intermate, these two subspecies are connected by a spectrum of intermediate populations in extreme western North Carolina.

trast to the broad robust form occuring in north Georgia, as can be seen from the accompanying photograph (see plate 1) of two specimens typical of the extremes in this variable character.

Determination of relative body width is by no means a precise operation, yet by uniform measuring techniques the error is held to a minimum. Naturally only well-preserved specimens can be used, with the body lying flat and straight, and not noticeably telescoped. In this position nearly all specimens have the first few segments a little arched (due to the curling reflex) and the collum declined at an angle of about 45 degrees. Efforts to reduce this arching usually result in either breaking the specimen or unduly extending the front end. Measurements have been made with vernier-scale calipers, length to an accuracy of 0.5 mm. and width to 0.1 mm. The greatest width normally occurs at the midbody segments but may be further caudad. The width was in every case checked by moving the calipers along the body until the widest segment was located.

The simple ratio of width divided by length yields a value which ranges from 19 to 28 percent. At any given locality from which a series of measurements is available, the range of variation in this ratio is not over 3 percent, and this magnitude is almost certainly due to the errors inherent in measuring the length of preserved specimens. Nonetheless, the mean value of the W/L ratio, plotted cartographically from as many samples as possible, produces an interesting sort of distributional pattern. Figure 1 is a map reflecting geographic variation in body form, the isophenes inclosing populations the mean W/L ratio of which falls within the specified limits.

From this map, it is seen that broad specimens with a ratio of 26 percent or more occur over most of the generic range, chiefly but not exclusively in low country. In the high ranges of the Great Smoky-Unaka Mountains the ratio is less than 24 percent, while populations with intermediate values (24 to 26 percent) occupy a large part of southwestern North Carolina in the Cowee, Nantahala, and Balsam ranges.

It has been found desirable to rely largely upon ratios derived from male specimens, these generally being in greater supply and usually easier to flatten and measure. A large number of females were studied, however, and these show a certain amount of sexual dimorphism in being slightly wider at any given locality than the males, the W/L ratio of the females being about 1 percent higher.

SHAPE OF PARANOTA: Close examination of the lateral projections of the metazonites shows the occurrence of two rather distinct forms. In one of these forms (fig. 3,*a*), the paranotal scapulorae (new term, from the Latin "scapula," a shoulder, and "ora," the rim of a shield) as seen in dorsal aspect are strictly marginal; that is, they form the

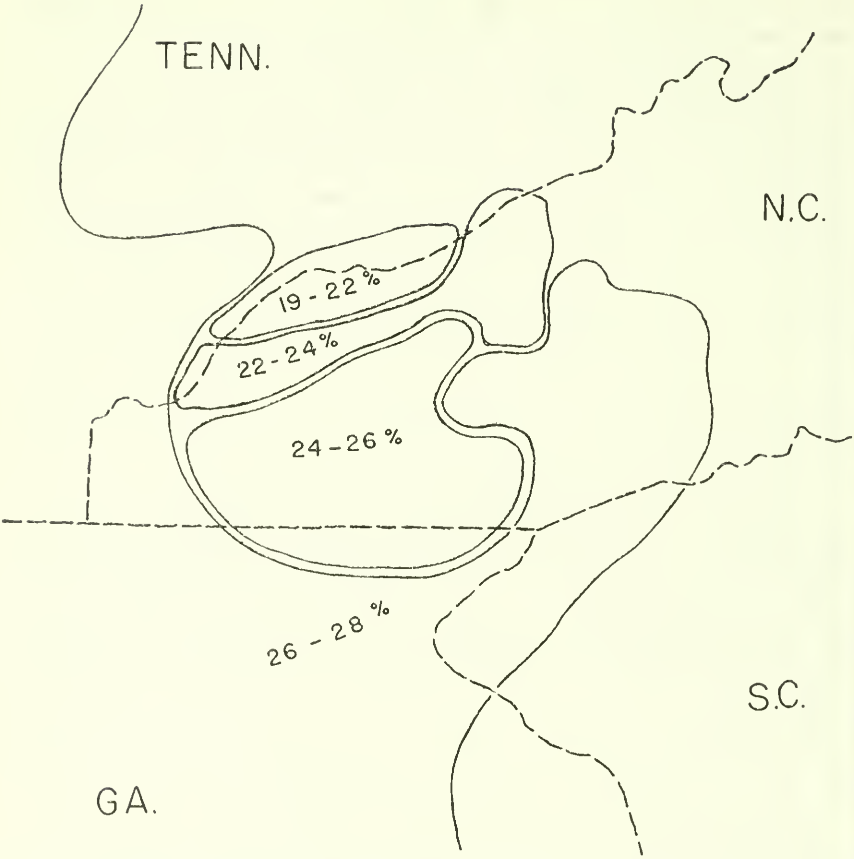


Figure 1.—Extreme western North Carolina and adjacent parts of Tennessee, Georgia, and South Carolina, showing the distribution of body proportion in *Cherokia* in the southern Blue Ridge. The isophenes enclosing the 26–28 percent interval extend south, west, and north to encompass the remaining majority of the range of the genus (see also fig. 7).

anterior rim of the paranota on all segments. The other form (fig. 3,*b*) differs in that the scapulorae turn rather abruptly mesiad at the paranotal shoulder and are submarginal in position, with a considerable portion of the cephalic face of the paranota visible below and in front of them as seen in dorsal aspect. The map (fig. 2) shows the distribution of these two structural variants, which are apparently largely complementary.

In the occurrence of two discrete paranotal types we find a situation not hitherto observed in the xystodesmid genera studied in detail, although a similar relationship may occur in the related genera *Rhysodesmus* and *Boraria*, both of which are known to be highly variable in general body form.

Shape of solenomerite of gonopods: In *Cherokia* the male gonopod (fig. 4,*a*) is superficially bifid distally. This impression is created by a subtriangular, retrorse solenomerite (SLM) and a normally smaller subapical spur. Examination of the gonopods under considerable magnification reveals that in the mountains of North Carolina there is a tendency for the solenomerite to become elongated with evenly converging sides (fig. 4,*f*), while over most of the remainder of the generic range, the solenomerite is much shorter and frequently somewhat curved, with one margin convex and the other concave (fig. 4,*e*). Unfortunately this variation is not as constant as might be wished; its distribution is fraught with exceptions and intermediate forms.

Occurrence of tibiotarsal marginal spur: In most specimens of *Cherokia* the coxal margin of the tibiotarsus is provided with a distinct acute spur of varying size (fig. 4,*b*, TTS). In the Great Smokies, the spur is typically absent in all specimens. Southward, the percentage of absence decreases to 88 at Soco Gap in the Balsams, 68 in the Cowees, 12 in the Nantahalas, 44 around Highlands, North Carolina, and 36 at Brasstown Bald, Georgia. Throughout the remainder of the generic range, the spur is absent in less than 25 percent of the specimens examined.

The inference to be drawn from these phenomena is that the spur is occasionally absent in most of the populations of *Cherokia*, but becomes progressively suppressed in the southern end of the Blue Ridge and totally so in the Smokies.

Variation in color pattern: Modifications of color pattern in *Cherokia* are numerous and complex, and full appreciation of such characters can be had only through knowledge of living colors. This information is available at least for the critical region of the western Carolinas and north Georgia, and permits some inferences on evolution and migration routes in the mountainous region where the genus is, structurally least stable. The different patterns may be classified roughly as follows:

A. Bimaculate, no median row of spots
B. Trimaculate
    1. Small median spots
    2. Broad median spots
C. Banded
    1. Red bands superimposed on the trimaculate phase
    2. Bands formed by very wide median spots
    3. Complete, characteristically wide crossbands.

There is a sort of progression represented by this breakdown, from A through B1, B2, and C2 to C3. Normally, however, each group is isolated geographically.

Bimaculation has been observed only in one sample, a small series from Lee County, Alabama, on the southern periphery of the generic range. Freshly preserved material showed only the yellow paranotal spots, with no trace of any median spots. However, the probable derivation of this phase from the normal trimaculate pattern can be inferred from a large series (35 specimens) from a single locality in Transylvania County, North Carolina, on the extreme northeastern edge of the range. Here there is a strong tendency for the median spots to diminish in size, especially anteriorly. The characteristics of this series are summarized as follows:

Condition	*Males*	*Females*
Collum immaculate	1	0
Collum with anterior spot only	4	0
Collum with large anterior and very small posterior spot	3	7
2nd segment without median spot	3	0
2nd and 3d segments without median spot	2	0
Collum and following segments with small but distinct spots	7	7

Immature specimens taken at the same time and place are rather typical of last-stadium forms of the genus; that is, they have moderately large and distinct median spots, a fact permitting the inference that departure from the trimaculate condition is an evolutionary specialization.

Broad median spots, usually lunate or crescentic in form, occur at various places in the range but are most characteristic of the populations in the Smokies, Balsams, and Unakas. Here the spots are up to 50 percent of the width of the segments, and in some females nearly or actually touch the paranotal spots. The same general pattern recurs in the Kentucky segment of the *Cherokia* population.

The pattern characteristic of the population in much of the western Carolinas and adjoining states is that of small yellow paranotal spots, with yellow median subtriangular spots of equal size. This pattern has been seen in the Blue Ridge of South Carolina and Georgia, in the Nantahalas and Cowees of North Carolina, and in the ranges west of the Unakas in southeast Tennessee.

An interesting variation in the pattern occurs in a restricted area of the Blue Ridge. In this phase the three yellow spots of each segment are connected by a transverse chestnut or reddish band, the intensity of which increases adjacent to the yellow spots and produces a most attractive effect. In addition, the legs of this form are pink instead of the typical yellow. Such specimens have been found at four localities: on Chatooga Ridge, north of Mountain Rest, South Carolina; the gorge of the Chatooga River south of Cashiers, North Carolina; around Highlands, North Carolina; and at Walnut Creek Gap in the Cowee Range, 8 miles northwest of Highlands. At all of these places, this variation occurs along with the typical form. None has been found beyond this limited range, a condition shown by the light stipple in figure 6. Altitudinally the variation ranges from about 1,500 feet at Chatooga Ridge to 4,800 feet at Walnut Creek Gap.

Crossbands formed by lateral prolongation of the median spots are characteristic of the majority of the *Cherokia* population over Georgia, Alabama, and a part of Tennessee. In this phase the band is widest at the middorsal line and pinches somewhat at the base of the paranota.

True crossbands, transversely parallel and rather broad, occur at widely separated localities and doubtless represent the end product of local specialization. In the extreme northwest, on the western Highland Rim of Tennessee, occurs a form with bands almost half as wide as the length of the metazonite and deep red in color. This population clearly derives from adjacent forms to the southeast, which are trimaculate with red or chestnut, but a good picture of the situation cannot be gained at the present with the few available collections from northwest Alabama.

Of more immediate interest is the independent recurrence of a yellow-banded form at two isolated places in the southern Blue Ridge. One of these occupies the northwestern end of the Cowee Range in Macon and Jackson counties, North Carolina. In this region, river valleys do not constitute formidable barriers to gene flow, but the intercalated mountain ranges afford by their height something analagous to the effects of insular isolation, local populations normally attaining greatest differentiation and stability at higher elevations. The *Cherokia* occurring on Cowee Bald (elevation 4,800 feet) is a striking animal—glossy black with broad lemon-yellow crossbands and legs—and the population there seems to be a homogeneous one. Cowee Bald is set off from the rest of the range by a rather low gap just northeast of Franklin, North Carolina, but the development of its local form is presaged by the occasional collection of similar appearing individuals as far to the southeast as Highlands, North Carolina.

Snould local populations in this genus ever be considered as eligible for subspecific names (a course which is avoided at the present writing), the Cowee population would seem at first to be an outstanding contender for a name. But its claim is challenged by an identical population which has developed in Cades Cove, on the western base of the Smokies in Blount County, Tennessee. In this case the transition from the trimaculate population to the south is seen in a collection from the southern edge of Cades Cove, containing both forms and one intermediate. This banded population is, in a sense, as isolated as its counterpart on Cowee Bald, for although it is geographically contiguous to the northeast with the narrow-bodied form of the Great Smokies, it seems very unlikely that gene flow takes place between them. In addition to the difference in size and proportions of the two, they are separated by a considerable difference in elevation.

Aside from the variation in dorsal coloration, there is some local differentiation in the pigmentation of other parts. Normally the legs and underparts of *Cherokia* are yellow, but in the Smokies the pleural regions and anal valves become nearly black; in the vicinity of Highlands, North Carolina, the legs may be pink instead of yellow. In xystodesmids generally, the legs assume the same color as the paranota and are brightest on the distal joints—those which extend beyond the paranota when the animal is walking, a coloration giving the impression of much greater body width.

Evaluation of characters: From the preceding accounts, one can draw several inferences. To begin with, five characters have been detected which seem to vary significantly with respect to the spatial distribution of the genus. As a complicating factor, in only a few cases do any of the variational phases coincide in any given region, and at least one character—color pattern—is subject to a great amount of localized regional variation, sometimes three separate color phases occurring together. What significance is to be assigned to these structural variations in the definition of taxonomic categories?

Of the five characters, one is represented by two quite different forms, which are geographically exclusive in their distribution (fig. 2). This character is the structure of the paranotal scapulorae. Most of the specimens seen so far fall readily into one category or the other and make a strong case for full specific value. There is, however, some evidence suggesting that the geographic and morphologic gaps between these two populations are more apparent than real, something to be discussed under a subsequent heading (page 258). There is reason to believe that intergradation between the two populations occurs in extreme western Georgia, an area from which no material was available. Since other structural characters in the genus, such as male gonopods, size, body form, and color pattern, transgress the boundary between the paranotal types, the latter are considered as diagnostic of a wide-ranging western subspecies of *Cherokia georgiana,* rather than of a different species.

Of the various names which have been based upon specimens of *Cherokia*, all apply to the form characterized by submarginal scapulorae. Of them, the oldest available name is Bollman's *Fontaria georgiana,* proposed for specimens from Macon and Tallulah, Georgia. To the best of my knowledge, there is no name available for the population of Tennessee and Alabama with marginal scapulorae, and a new one is herein proposed.

The latter is quite uniform over its range with respect to body form, but the distribution of the more eastern *georgiana* includes specimens

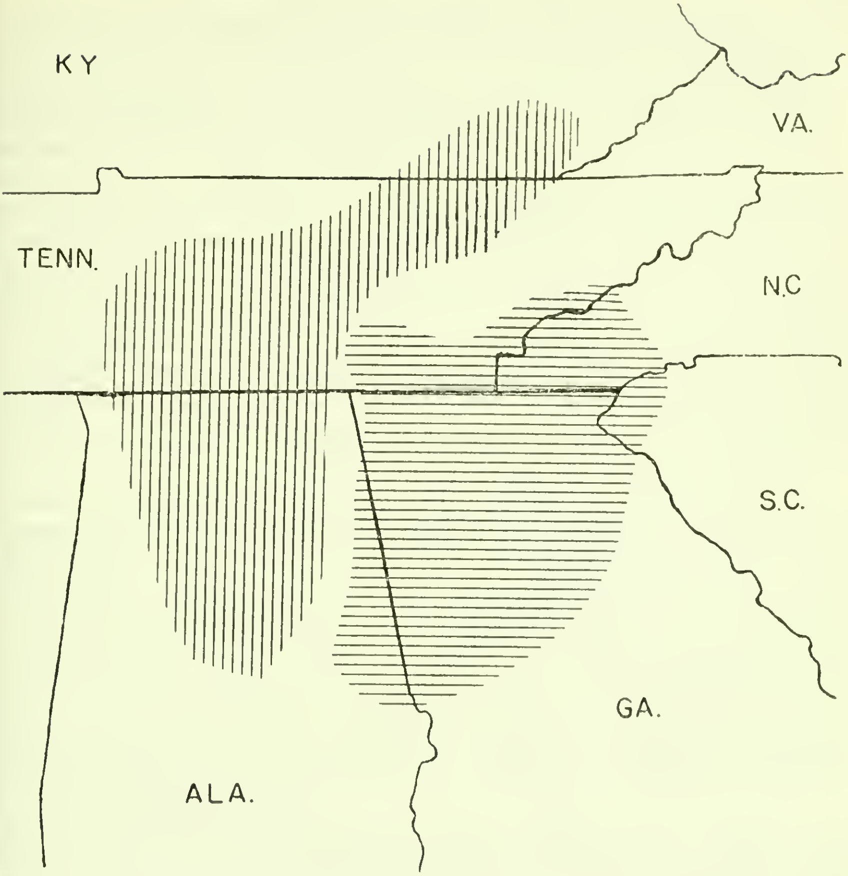


Figure 2.—Distribution of the two paranotal forms discussed in the text and illustrated in figure 3,*a–b*. The open area between the two patterns represents merely a gap in the distributional data. Vertical shading represents the extent of marginal scapulorae, and horizontal that of submarginal.

ranging from 20 to 28 percent in the ratio of body width to length (fig. 1). Over most of this area, comprising the northern half of Georgia and the western part of South Carolina, the ratio is fairly stable at 26–28 percent, but as the species invades the high country of the Blue Ridge, there is a striking tendency toward a narrowed body form with much lower W/L ratios, the trend culminating in the high reaches of the Unicoi and Great Smoky Mountains. Even with this clinal variation, however, one can utilize the fact that the change from the normal broad body to the unusually narrow form occurs over a relatively small area, and that the narrow form maintains itself as a stable unit in a region where several other characters likewise attain their strongest development. Despite the great dissimilarity of the extremes, there is an area of intermediate types, and body form can be given a value no higher than that of a subspecific character.

Nearly the same summary can be made concerning the distribution of the tibiotarsal spur of the gonopod, which becomes obliterated in a more or less sporadic fashion throughout the range of the species *georgiana*, but which is invariably wanting in the region occupied by the slender-bodied subspecies. From a normal absence of about 25 percent in most of the generic range, the tibiotarsal spur is absent from 36 percent of a sample from Towns County, Georgia, from 44 percent of the population around Highlands, North Carolina, and from 66 percent of specimens collected in the Cowee Mountains. It is missing in 100 percent of the millipeds from the Great Smokies. Here is a case of variational coincidence which certainly reinforces the desirability of recognizing the slender-bodied population as subspecifically distinct.

The variation of color pattern hardly needs review. The tendency for localized color races is pronounced, and if subspecies were recognized on this basis alone, one could name about eight. Since most such populations would not correlate with groupings made on more fundamental structural bases, it is felt that in *Cherokia*, at least, no practical ends would be served by the wholesale application of names to color forms. This view is particularly true when we recall that one distinctive phase has arisen independently at two different and widely separated localities, and that elsewhere two or more color phases occur together both typically and with various intermediate forms.

At only one place does a color pattern phase coincide with other local structural divergence—again in the Smokies, where, for instance, the typical pale color of the pleurites is replaced by dark burnished brown or dilute black. The combination of at least three distinct localized character variants makes it impossible to discount the importance of evolution in this region, even though all the characters merge into the more typical phases of *C. g. georgiana* by gradual gradations, which however do not progress at the same rates of modification.

In summary, working with geographic variation in paranotal form, body proportions, and coloration, we can divide *Cherokia* into three mutually exclusive populations, a partition which is supported by such other characters such as those of the gonopods and cyphopods (fig.5). However, either direct or presumptive evidence indicates that all these populations merge where their ranges meet, and should be regarded as geographic races of a single species, *Cherokia georgiana* (Bollman.) One is recognizable by a very distinct modification of the paranota which holds uniform over a rather extensive geographic range. The other two, which share another paranotal form, differ from each other in three or four characters. The lowland population of Georgia carries the name of the nominate subspecies. That which occurs in the Great Smokies may be recognized as the third subspecies. A name is already available for this form, *ducilla* Chamberlin, based on specimens from Soco Gap, North Carolina.

Genus *Cherokia* Chamberlin

Cherokia Chamberlin, 1949, p. 3.—Hoffman, 1950, p. 23.—Chamberlin and Hoffman, 1958, p. 26.

Type species: *Fontaria georgiana* Bollman 1889, by original designation.

Diagnosis: A genus of moderate-size, compact xystodesmids of variable form and appearance, with the following characters in common:

Head smooth and polished, vertigial groove evident but not terminating in a shallow depression. Facial setae as follows: four supra-antennal, two interantennal, two subantennae, and two frontal setae. Genae almost flat, without median depressions, their ends not surpassing margin of cranium. Antennae long and slender, articles 2–6 subequal in size and shape, with four sensory cones.

Body shape variable, either broad (the width up to 28 percent of length) or very narrow (as little as 19 percent of length), depending upon width of paranota. The latter slightly interrupting slope of dorsum, their dorsal surface coriaceous, the lateral edges smooth and rounded, pores opening dorsally in elongate pyriform peritremata, the pore formula normal.

Sterna smooth and glabrous, forming a gradually inclined podosternum between the legs, this area divided by a transverse groove, and produced into small conicles at the base of each leg; pleural regions smooth and unmodified. Sterna of 4th and 5th segments of males with low rounded knobs between the legs.

Coxae of male gonopods moderate size, cylindrical, attached to a weakly sclerotized but distinct sternite; lacking apical apophyses or other modifications, socket of solenite well removed from the distal margin. Telopodite attached to coxite at a right angle, extending cephalad between legs of 6th segment, the two gonopods parallel with the distal ends usually in contact; prefemora elongate, tapering distad, densely setose mesially, with a short simple acicular prefemoral process. Remainder of telopodite set off from prefemur by a conspicuous, flexible, cingulum but continuing in the same axis, distally with a short falcate process (here provisionally regarded as tibia) projecting mesiad from the mesial margin and with two terminal tarsal processes, a slender parasolenomerite from the upper margin, and a short recurved solenomerite from the lower.

Gonopod aperture very wide, almost diamond-shaped prozonite; of 7th segment reduced to a mere thin transverse vestige in front of the aperture.

Cyphopods (fig. 5) very strongly compressed, the inner valve much smaller than the outer; receptacle completely lost, a detail which separates *Cherokia* from all other xystodesmid genera. Epigynal region not differentiated or modified.

RANGE: Southeastern United States, in the Piedmont, southern section of the Blue Ridge Province, and the Cumberland Plateau. All of western North Carolina south of the French Broad River, extreme western South Carolina, the northern half of Georgia and Alabama, most of the Cumberland Plateau as well as the Valley and Ridge Province south of the French Broad River in Tennessee, and extreme southeastern Kentucky (Harlan, Bell, and Laurel Counties).

SPECIES: One, *Cherokia georgiana* (Bollman), with three subspecies, separable by the contrasts stipulated in the key given below.

Key to Subspecies of *Cherokia georgiana*

1. Scapulorae marginal, anterior surface of paranota concealed in dorsal aspect (fig. 3,*a*); central Alabama north through the Cumberland Plateau to southeastern Kentucky . . . . . . **georgiana latassa,** new subspecies

   Scapulorae submarginal, in dorsal aspect anterior face of the paranota is exposed (fig. 3,*b*); distribution not as outlined above 2

2. Width of body 26 to 28 percent of the length; tibiotarsal marginal spur of male gonopods (fig. 4,*b*, TTS) normally present; color of legs and undersides whitish to yellowish . . . . **georgiana georgiana** (Bollman)

   Width of body 19 to 24 percent of the length; tibiotarsal marginal spur of gonopods absent from virtually all specimens; color of pleurites and anal valves brown to nearly black; Great Smoky and Unaka Mountains, intergrading widely with the preceding in western North Carolina. **georgiana dueilla** (Chamberlin)

***Cherokia georgiana georgiana* (Bollman)**

FIGURES 3,*d;* 4,*e;* 5,*a;* 6; 7

Fontaria georgiana Bollman, 1889, p. 344.

Fontaria tallulah Bollman, 1889, p. 344. Type locality: Tallulah Falls, Habersham County, Georgia; type specimens, USNM 2302, two females.

Mimuloria furcifer Chamberlin, 1940, fig. 3, p. 282. Type locality: Bent Creek Experimental Forest, Buncombe County, North Carolina; type specimen, Chamberlin collection, male.

Mimuloria georgiana Loomis, 1943, p. 402.—Chamberlin, 1946, p. 151.—Loomis and Hoffman, 1948, p. 52 (in part).

Dynoria parvior Chamberlin, 1947, fig. 4, p. 10. Type locality: Neel Gap, Union County, Georgia; type specimen, Chamberlin collection, male.

Cherokia georgiana Chamberlin, 1949, fig. 1, p. 3.—Hoffman, 1950, figs. 9–12, p. 23.—Chamberlin and Hoffman, 1958, p. 26.

Type specimens: Male holotype and female paratype, USNM 750, from Macon, Bibb County, Georgia, collected in 1887 by L. M. Underwood.

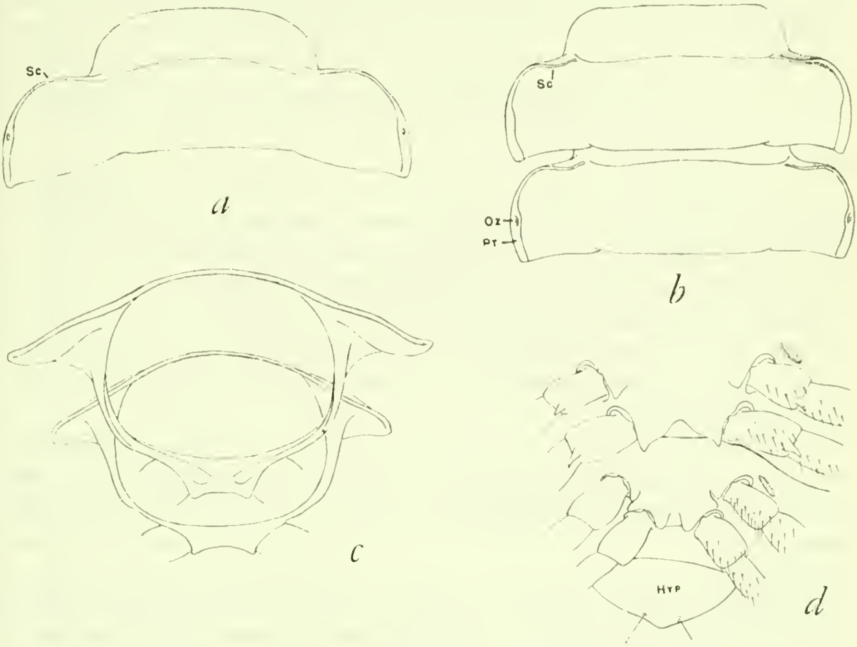


Figure 3.—Structural details of *Cherokia: a* and upper part of *c*, dorsal and caudal aspects of a midbody segment of *Cherokia georgiana latassa* from Jackson Co., Alabama; *b* and lower part of *c*, the same views of *C. g. ducilla* from Soco Gap, North Carolina; *d*, ventral aspect of caudal end of body of *C. g. georgiana* from Banks Co., Georgia, showing sternal spines, bases of legs, and hypoproct. Abbreviations: Hyp., hypoproct; Oz, ozopore; Pt, peritreme; and Sc, scapulora.

Diagnosis: A broad, flat subspecies (w/l 26–28 percent) of *Cherokia georgiana* of which the scapulorae are submarginal and expose the anterior face of the paranota.

Description: Two male specimens from Banks County, Georgia, were compared with the holotype and are virtually identical with it. A broad, compact, robust form, the width/length ratio from 26 to 28 percent, paranota only slightly depressed from the horizontal and interrupting slope of the slightly convex dorsum. Metazonites of segments 5–16 of essentially full width (8.5–9.5 mm.); width of collum about 7.0 mm.

Head capsule normal in appearance, oval, convex, smooth and polished. Setae of vertex 2–2, forming a strongly procurved row with the innermost seta of each pair set a little lower on the vertex than the outer, the space between the pairs greater than the distance between the setae of each. Two narrowly separated setae in the isthmus between the antennae, and another pair of more widely separated setae at the level of the lower edge of the sockets. A pair of widely spaced frontal setae, and a submarginal row of three closely set setae on the lower part of each gena. Clypeal setae long and closely set, in a row of 30 or more; labral setae equally long but wider spaced, about 20 in the series. Genae not margined, nearly flat, with only a vague median depression; the ends broadly rounded and not surpassing adjacent margin of cranium.

Antennae long (8–9 mm.) and slender, reaching back to caudal margin of 3d segment. Article 1 broadest, short, cylindrical, glabrous. Articles 2–6 subequal in size and shape, each slightly clavate. Article 7 very short, slightly conical, the distal edge not inturned between the 4 small widely separated sensory cones. Antennae nearly glabrous proximally (the setae of article 2 mostly on the ventral side), becoming increasingly invested distally, the setae of article 6 very numerous, long, and procumbent.

Collum broad, smooth or finely coriaceous, its caudal edge almost transverse. Lateral thirds of the anterior edge strongly curved caudolaterad and strongly margined, forming a bluntly acute angle with the posterior edge. Lateral ends of collum not exceeding width of following segments.

Tergites of body segments smooth medially, becoming increasingly coriaceous on the paranota, especially toward the end of the body. Paranota slightly depressed, inclined cephaloventrad, much longer than median length of the metatergites. Caudal edges of paranota directed caudolaterad on all segments posterior to 4th, becoming increasingly angular caudad; paranota of segment 18 forming almost true isosceles triangles, the apices pointing directly caudad. Paranota of segment 19 forming blunt lobes including only half the length of the epiproct.

Caudal edges of paranota not margined, lateral ends set off as elongate, nearly parallel-sided peritremata (fig. 3,*b*, PT), the pores opening dorsally near cephalic end of swelling, at about the midlength of the paranota. Anterior to the pore, the peritreme is extended forward as a strong, high marginal ridge (the scapulora), its free edge reflexed caudad over the deeply impressed paranotal surface just behind. In dorsal aspect the scapulorae extend in an irregular line directly mesiad from the scapular convexity, and reveal the anterior face of the paranotum sloping downward At juncture with the body cylinder the scapulorae are so strongly reflexed caudad as to become appressed and merged with the dorsum.

No distinct interzonal furrow present, the surface of metazonites somewhat lower than that of prozonites, which it meets at a sharply defined fault line. Dorsolateral rugosity of metazonites not carried over onto prozonites, which are completely smooth. Aside from coriaceous texture, the metazonites are provided with minute setiferous tubercules, most conspicuous posteriorly, which tend to form three irregular transverse rows. The caudalmost of these rows normally consist of about 22 (up to 28 in some cases) tubercules, three widely separated near the caudal paranotal edge, and 14 to 16 set much closer across the dorsum itself. The other two rows are less regular in number and distribution, the widely spaced tubercules ranging from 10 to about 16.

Epiproct evenly conical in dorsal aspect, its surface mostly smooth except for some basal striations and distinct setiferous tubercules, the appex decurved slightly and bearing four terminal compound setae. Peripheral areas of disc of anal valves vertically costate, the median area elevated and smooth, with a single paramedian setiferous socket. Free edges of valves produced into distinct marginal swellings, becoming thicker upwards, the point of greatest breadth including the marginal seta. Hypoproct a broadly oval plate (fig. 3,*d*), the surface smooth and unmodified, paramedian apical setae widely separated from each other and well removed from the caudal margin of plate. Apical projection very small or wanting.

Pleural areas unmodified, surface finely granular except for the caudal edge, which is set off as a depressed, smooth, parallel-sided margin, the edge strongly sigmoidally curved ventrad, ending on dorsal curve of coxal socket. Interzonal furrow more definitely formed down sides and across venter.

Sternal areas smooth and glabrous, tending to form a raised area (podosternum) between the legs but this area sloping gradually cephalad to the interzonal furrow. Each podosternum divided by a vague transverse groove which becomes accentuated laterally where it is preceeded by a low conical knob formed by the sternum at the base of the anterior leg pair. Sternum between posterior leg pair projecting shelflike caudad, its margin transverse except for the strongly produced corners, which become increasingly larger and more acute back to the 18th segment (fig. 3,*d*). Sternum of 7th segment flat, without subcoxal spines or very low ones. Midbody legs separated by a distance up to 2.5 mm., equalling or exceeding length of prefemur. Sternum of 4th segment of male produced into two low rounded knobs between the legs, anterior leg pair of 5th segment separated by two larger, more transverse, and cephalically directed processes. Sternum of 6th segment broad, flat, unmodified.

Legs long, those of midbody segments up to 9.0 mm., the joints in decreasing order of length, 3–6–2–5–4–1. The basal two joints glabrous but for a ventral row (coxa) or field (prefemur) of setae, other joints with setae becoming increasingly larger and denser distally, the four terminal joints each with a distal whorl of large robust setae, tarsal joint with most vestiture on its dorsal (outer) surface. Tarsal claw long and evenly curved except on leg pairs 3–15 of males, where they are bisinuate and compressed, distinctly ellipsoidal in cross-section, the upper edge thin and carinate.

Prozonite of 7th segment reduced to a mere thin vestige midventrally in front of gonopod aperture. The latter broadly transverse, up to 2.4 mm wide, its caudolateral edges elevated and flared laterad,

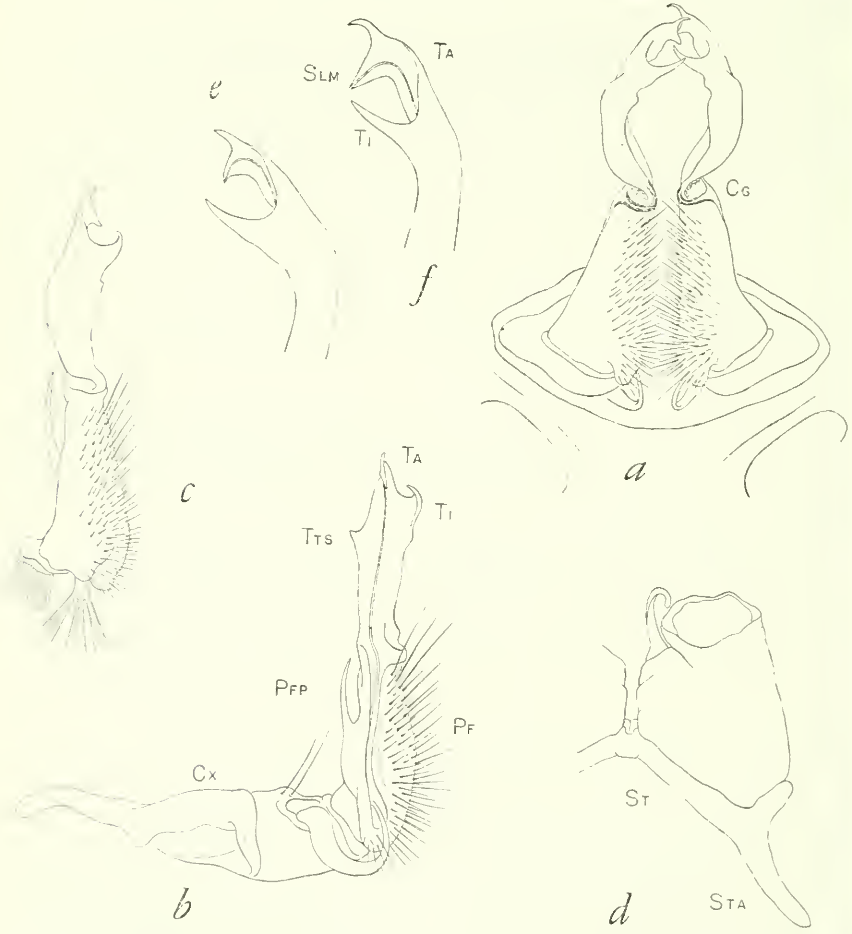


FIGURE 4.—Gonopod structure in *Cherokia georgiana latassa* (a–d), *C. g. georgiana* (e), and *C. g. ducilla* (f): *a*, ventral aspect of gonopods in situ; *b*, mesial aspect of left gonopod; *c*, sublateral aspect of right gonopod; *d*, cephalic aspect of gonopod sternite, its apodemes, and coxa of right side; *e*, ventral aspect of tibiotarsal region; *f*, same, slightly enlarged, of another subspecies. Abbreviations: Cg, cingulum; Cx, coxa; Pf, prefemur; Pfp, prefemoral process; Slm, solenomerite; St, sternite; Sta, sternal apodeme; Ta, tarsus; and Ti, tibia.

caudal rim between 8th leg pair set off by a low marginal ridge, the adjacent sternal area narrow and depressed. Gonopods rather small, the coxae normally retracted into the body, the elongate, nearly straight telopodites exposed, parallel to each other, directed cephalad between the legs of the 6th segment. Prefemur elongate, setose, the setae becoming longer distally, coxal side provided with a short, acicular prefemoral process. Gonopod in mesial aspect almost identical with that of *C. g. latassa* (fig. 4,*b*), the distal end with a rather short subtriangular solenomerite and nearly straight subapical process (fig. 4,*e*).

Epigynal region of 3d segment of females without special lobes or other modifications. Cyphopods elongate-reniform in outline, the basal two-thirds with scattered large setae, the operculum with longer and more profuse vestiture. Width of outer valve nearly uniform, not somewhat greater near the base as apparently is the case in the other two subspecies (fig. 5,*a*).

Dorsum glossy blackish, with the paranotal and broad median series of spots yellowish orange, the underparts whitish gray with the legs becoming yellow distally. The median dorsal spots are sublunate, and extend laterad almost to the paranota.

VARIATION: The body form of the typical subspecies is quite uniform over its range. Some minor geographic variation can be noted, however, for several structural details.

Male specimens from eastern Alabama and most of Georgia are provided with fairly conspicuous subcoxal sternal knobs on the 7th segment. These become reduced in the mountain region and are obliterated in the intergrade population of western North Carolina. The solenomerite of the male gonopod tends to increase in length northward.

The color pattern is somewhat variable. The population of extreme eastern Alabama appears to be bimaculate. In central and northern Georgia the median spots are enlarged and lunate in form and in the males often contact the lateral series of spots and forming transverse bands of yellow. In southeastern Tennessee the three rows of spots are of about the same size, except in the western foothills of the Great Smokies in Blount County, where a local population has developed striking crossbands. It is of some interest to note that in the same region specimens of the normally trimaculate *Apheloria montana* are likewise transversely banded, and we may have a case of mimicry or a very improbable coincidence.

The largest male specimen of *C. g. georgiana* measured is from Banks County, Georgia: 9.2 mm. wide and 34.5 mm. long. The largest female is from Pickens County, South Carolina: 9.0 mm. by 37.0 mm.

Synonymy: Dissatisfied with the full specific status originally accorded the various new names proposed in this genus, subsequent authors have at one time or another considered them all to be strictly junior synonyms of *georgiana*, a feeling tentatively embodied in Chamberlin and Hoffman's "Checklist of the millipeds of North America." With diagnostic characters in *Cherokia* now being drawn from nonsexual modifications, a reappraisal of the names is very much in order.

Fontaria tallulah was based by Bollman upon two female specimens collected by Underwood at Tallulah Falls, Habersham County, Georgia. The name thereupon fell into complete obscurity and was not investigated until 1949, when I had the opportunity to search for topotypes. Despite unfavorable climatic conditions, I was able to obtain in the penultimate instar two female millipeds which matched Bollman's description closely. These specimens were later found, on direct comparison, to be conspecific with the the types of *tallulah*. The name is based upon a population of *Cherokia* which cannot be separated from typical *georgiana*, Bollman apparently not having realized that his types were immature and that the final moult appreciably modifies the color pattern. My

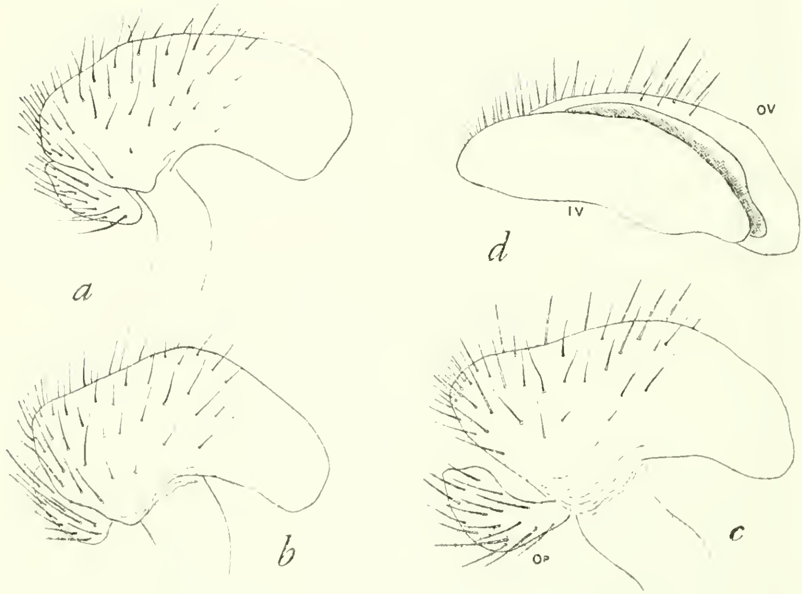


Figure 5.—Cyphopods of subspecies of *Cherokia georgiana: a*, *C. g. georgiana*, Stephens County, Georgia, lateral aspect of right cyphopod; *b*, *C. g. ducilla*, Sevier County, Tennessee, same aspect; *c*, *d*, *C. g. latassa*, Jackson County, Alabama, lateral and mesial aspects of right and left cyphopods, respectively. Abbreviations: IV, inner valve; OV, outer valve; and Op, operculum.

paper of 1950 placed *tallulah* into a genus for the first time since the partition of the old name *Fontaria*, and correctly regarded it a junior synonym of *georgiana*, which has a one page priority in Bollman's paper.

Exactly 50 years after the proposal of the name *georgiana*, Chamberlin (1939) described a new xystodesmid under the name *Mimuloria ducilla*, the types coming from Soco Gap, North Carolina. The diagnosis was very brief, but included an accurate illustration of the gonopod. Loomis (1943) subsequently considered *ducilla* to be a synonym of *georgiana*, in which he was followed by my later discussion of the matter, largely because of the gonopod structure. I have now studied two series of topotypes of *ducilla*, both obtained personally, and find that the population at Soco Gap is representative of the narrow-bodied montane subspecies of *georgiana*, to which the name *ducilla* must now be applied.

Mimuloria furcifer was described also by Chamberlin, on the basis of four specimens collected by A. S. Pearse in the Pisgah National Forest near Asheville, North Carolina. The form was contrasted only with *ducilla*, with differences in size, color, and gonopod minutae being noted. These are all differences which are here considered to distinguish *ducilla*, but it was apparently not realized by Chamberlin that *furcifer* might be the same as *georgiana*. After several unsuccessful visits to the type locality, I was finally rewarded in July 1958 by the collection of several immature specimens, which, when reared to maturity, turned out to be representative of the intermediate population between *ducilla* and *georgiana*, and closer to the latter in most respects. These topotypes agree closely with other specimens from the same general region in having the median row of spots conspicuously reduced (see p. 234).

Finally, once again Chamberlin (1947) proposed a new name for a species of *Cherokia*, but unfortunately placed it in the genus *Dynoria*, which probably belongs in a different subfamily. The types of *Dynoria parvior* came from Neel Gap, in the Blue Ridge country of north Georgia, and were very briefly described with respect to color, size, and gonopod structure. The contrasts with *Dynoria icana* are, of course, meaningless. The size range is given as 18–19 mm. in length, with a width of 7 mm. Correction of the length dimension to 28–29 mm. would yield a normal W/L ratio.

I have not seen material from the type locality, but do have a fair series taken less than 20 miles away in the same mountain range. These specimens belong to the widespread trimaculate phase of the intergrade population, to which the name *parvior* (now no longer appropriate) is allocated as a strict junior synonym of the nominate subspecies of *georgiana*. This synonomy is not new; it was first made by Loomis and Hoffman in 1948 and was repeated by me in 1950.

I hope that the information contained in the present paper will be sufficient to prevent any additions to the list of junior synonyms in this genus.

DISTRIBUTION: From extreme western South Carolina west to southeastern Tennessee, south through Georgia to central eastern Alabama and western Florida. Material has been examined from the following localities:

SOUTH CAROLINA: OCONEE COUNTY: Chatooga Ridge, 2 miles north of Mountain Rest, 3 ♀, July 22, also 4 ♂, 2 ♀, July 29, 1958, Hoffman, RLH.

GEORGIA: HABERSHAM COUNTY: Tallulah Falls, 2 ♀, 1887, L.M. Underwood, USNM, types of *Fontaria tallulah*; 6 ♂, 4 ♀, October 10, 1928, O. F. Cook, USNM; 2 ♀, July 17, 1949, Hoffman, RLH. Panther Creek Picnic Area, 4 miles south of Tallulah Falls, 1 ♀, August 2, 1958, Hoffman, RLH. STEPHENS COUNTY: Cool Springs Picnic Area, 7 miles northeast of Toccoa, 1 ♂, 2 ♀, July 16, 1958; also 3 ♂, 3 ♀, July 30, 1958, Hoffman, RLH. BANKS COUNTY: 7 miles north of Commerce, April 4, 1953, 2 ♂, Leslie Hubricht, RLH. BIBB COUNTY: Macon, ♂ and ♀, 1887, Underwood, USNM, types of *Fontaria georgiana*.

TENNESSEE: POLK COUNTY: Benton, 2 ♂, June 20, 1950; 2 miles east of Ocoee, 6 ♂, 4 ♀, May 5, 1951; Oswald Dome on Beans Mountain, 1 ♂, 2 ♀, June 12, 1953; Sugarloaf Mountain near Parksville, 2 ♀, May 10, 1954, all by Hubricht, RLH. BLOUNT COUNTY: Townsend, 2 ♂, June 21, 1950, Hubricht, RLH. Cades Cove, 1 mile east of Ranger Station, 3 ♂, 6 ♀, May 4, 1951, Hubricht, RLH. SEQUATCHIE COUNTY: 11 miles south of Dunlap, 2 ♀, May 9, 1951, Hubricht, RLH. HAMILTON COUNTY: Signal Mountain, 1 ♀, August 18, 1956, Hoffman, RLH.

ALABAMA: LEE COUNTY: Auburn, 8 ♂, 10 ♀, 1897, C. F. Baker, USNM. Bluff on Little Uchee Creek, 17 miles southeast of Opelika, ♂ and ♀, May 6, 1954, Hubricht, RLH.

The species has also been reported from Atlanta, Georgia, by Chamberlin (1946), from Lookout Mountain, Georgia, by Bollman (1889), and from Liberty County, Florida, by Loomis (1943).

INTERGRADATION WITH *C. g. ducilla*: The apparent structural uniformity of *georgiana* over much of its namesake state is subject to considerable disintegration when the species enters the high country of the Blue Ridge province. Thence, both north directly into the mountains or northeast along the eastern flanks of the Blue Ridge, profound modifications of body form and color pattern are imposed upon the species. Some of the variations thus encountered are gradational in nature, such as the decrease in body width and loss of the tibiotarsal spur. Color pattern tends to vary more sporadically, with local modifications superimposed upon vaguely defined geographic progressions. Some of these phases have already been discussed, or mentioned, in a preceding section. It remains to relate them to the taxonomic status of the animals under study.

The accompanying map (fig. 6) indicates the location of the samples which I have examined from western North Carolina and adjoining parts of other states. The symbols reflect the nomenclatorial disposition made of each local population, the decision in most cases being made on the basis of characters taken in combination. Solid triangles represent the northernmost specimens of *C. g. georgiana* seen, solid spots indicate all known localities for *C. g. ducilla*, and open circles represent populations considered intermediate between the two.

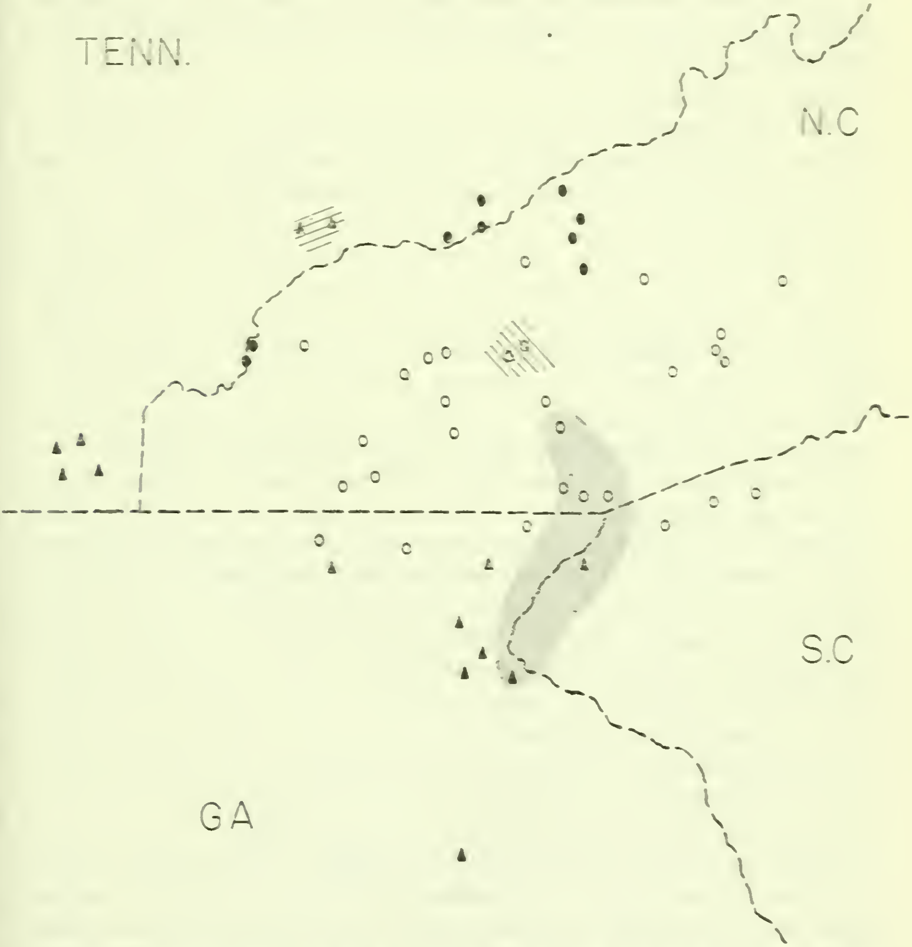


FIGURE 6.—Intergradation and local variation in *Cherokia georgiana* in western North Carolina and adjacent region. Solid triangles, *C. g. georgiana*; solid dots, *C. g. ducilla*; open circles, intergrades. Diagonal right to left shading in Tennessee indicates location of a yellow-banded population of *georgiana*, and left to right shading in North Carolina shows location of an identically marked but narrower-bodied phase of the intergrade population. Fine stipple-shading reflects distribution of the red-banded and pink-legged color phase affecting both typical *georgiana* and intergradient populations.

The distribution of the samples does not, in some cases, coincide exactly with that of certain key characters stipulated in the key and diagnoses. For instance, specimens with a W/L ratio of 26 percent or more occur across the western edge of South Carolina and into North Carolina as far as Pisgah Ridge. This segment of the species is regarded as intergradient rather than as *georgiana* because both color pattern and gonopod details reflect the characters of *ducilla*. It does seem probable, however, that migration to the northeast has carried the wide body form more successfully than the invasion of the mountains directly north of Georgia, although the typical lowland color patterns have been lost in both cases (a matter discussed at greater length on p. 251).

The reader may be curious concerning the arbitrary selection of value upon which the isophenes of figure 1 are based. For the most part, the higher values (26–28 percent) occur throughout most of the generic range with little or no geographic variation. The narrow body form, however, coincides closely with the loss of tibiotarsal marginal spurs and the appearance of dark pleurites, and the ratio values were selected deliberately to include the population so characterized. The subspecies diagnosed by the stipulated aggregate features is thus seen to be restricted to the Great Smokies and the adjacent Unicoi ranges. The mutual development of characters within this area reflects the natural integrity of the population.

It is anticipated that some critics of the subspecific category might assume the decreasing body form to be a function of elevation. This relationship is partly true, but is not the entire answer. Specimens with a ratio of 25 percent or more are available from the vicinity of Highlands, 3,800–4,000 feet; from Walnut Creek Gap, 4,800 feet; and from Cowee Bald, 5,000 feet—all in the Cowee Range. Specimens of *ducilla* with a ratio of 23 percent and less, are from Soco Gap, 3,800 feet; from Mount Sterling, 4,000 feet; and from Chimneys Campground on the north side of Newfound Gap at less than 3,000 feet elevation. The specimens from the last-named locality are the narrowest of the genus, their ratio being 19 percent, and I think these figures prove that the distribution is more horizontal than vertical.

There can be no doubt that the extensive high country of the Smokies has contributed to the ultimate differentiation of the localized segment of the species. I contend, however, that these mountains have received merely the culmination of the gradual northward progression of several variable tendencies which can be traced for more than a hundred miles from the upper Piedmont of Georgia. Specimens from the Tallulah River drainage in northeastern Georgia and those from the basin of the Ocoee River in southeastern Tennessee agree well both in body form and color pattern with typical *georgiana* from farther south.

Intermediate specimens from the Nantahala Range, at Wayah Bald, for instance, are the narrowest outside the range of *ducilla*, the average W/L being 24.3 percent. Millipeds from Smokemont, at a low elevation (about 2,000 feet) at the very base of the Smokies and less than 10 miles from Newfound Gap, are closer in every respect to the Nantahala population than to *ducilla*. Specimens from the type locality of *ducilla* are the broadest of the subspecies, five measurable males averaging 23.4 percent. These topotypes agree with narrower specimens from the high Smokies in color pattern and gonopod structure, however even though certainly not structurally typical of the population here called *ducilla*. Soco Gap is located in the Plott Balsam Mountains, a southeasterly trending satellite of the Great Smoky massif, which forms the boundary between Jackson and Haywood Counties, North Carolina, for about 30 miles. At its southeastern end, perhaps 20 miles below Soco Gap, the local *Cherokia* population bears little close resemblence to typical *ducilla*.

The local picture with reference to color pattern is somewhat more complicated. *C. g. georgiana* of the lowlands is either transversely banded or trimaculate with very broad median spots (these absent, however, from a single local population in southeastern Alabama). In the Blue Ridge foothills of north Georgia the median spots tend to become smaller, and this reduction produces the trimaculate *Cherokia*, which is characteristic of the intermediate population as shown by hollow circles on the map. To the northeast, along the South Carolina border and into Pisgah Ridge, however, the median spots tend to become even smaller and create a local variant (discussed on page 234), in which they are obviously being lost.

The basic color pattern in *Cherokia* (and many other xystodesmid genera) appears to be trimaculation. This inference is drawn both from its prevalence and from the fact that the penult instars of cross-banded adults are trimaculate. In some genera, as well, support is drawn from the geographic location of bimaculate or banded populations on the periphery, or at extremes, of the range of vicarious trimaculate populations. With so little known of the main *georgiana* lowland population, it would be premature to speculate on the independent recurrence of bands and spots in the range, but it is certainly noteworthy to disclose microevolutionary developments within the intergrade population.

Aside from the tendency toward reduction of the median spots, there are two local phenomena. First, in a very localized region shown by fine stipple on the map, many of the specimens (perhaps a third or half of the population sampled) have the basic yellow trimaculation, but additionally the spots are connected by a narrow chestnut-red band on the caudal edge of the tergites. This red does not merge with the yellow, but becomes more intense at the point of contact. In this form, the distal joints of the legs are pinkish or reddish instead of yellow. Specimens of this variety have been taken at the southern

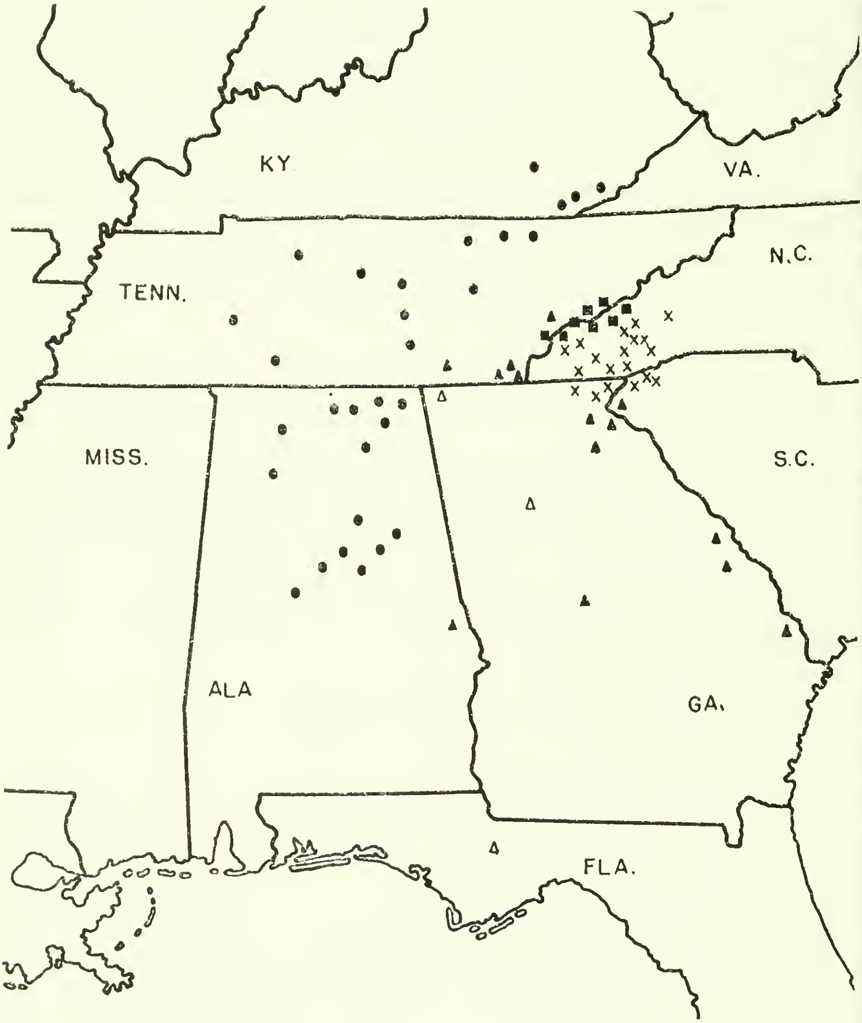


FIGURE 7.—Known localities for the subspecies of *Cherokia georgiana* based upon specimens examined and literature records. Localities: ▲ *C. g. georgiana*, ● *C. g. latassa;* ■ *C. g. ducilla;* X, specimens intermediate between *C. g. georgiana* and *C. g. ducilla.*

end of the Cowee Range, in the vicinity of Highlands, North Carolina, and at several localities in the Chatooga River drainage shared by the two Carolinas and Georgia.

At two places, Chatooga Ridge north of Mountain Rest, South Carolina, and Cool Springs, northeast of Toccoa, Georgia, specimens of the red-banded phase occur with fairly typical *georgiana*. At the latter locality, in addition to these, I found a male specimen with broad lemon yellow crossbands, all of which suggests considerable genetic instability at least as far as color is concerned.

The second of the color variants occurs in the vicinity of Highlands, North Carolina. The median spots of many specimens of the normal trimaculate form tend to be quite wide, especially in females, and occasionally may touch those of the paranotal series. Occasional specimens will show a neat narrow yellow band on each tergite. In going northwest along the Cowee Mountains the red-banded form drops out at Walnut Creek Gap, 8 miles north of Highlands. Only 7 miles farther, at Cullowhee Gap, I found no specimens so marked. The extreme end of the Cowee Range, however, is taken over by a very attractive color form occuring in and around Cowee Bald, north of Franklin, North Carolina, as shown on the map (fig. 6) by the diagonal shading. In this form the tergites have a straight transverse yellow bar, which does not widen anteriorly on the paranota, nor middorsally except in a few females. As this phase seems to occur to the exclusion of all others at the isolated end of the Cowees (perhaps isolated by a rather low gap northeast of Franklin), this phase might form the subject of future work on genetics in xystodesmids, work I hope will soon be undertaken.

From the occasional capture of similar individuals in the very heterogeneous population around Highlands, one might postulate that the gene for this color pattern has been carried along the Cowees by a branch of what I think must have been a general northward migration of *georgiana* into the mountains.

As can be appreciated from a glance at the map, the Highlands region is one of great importance in the distribution of color patterns in *C. georgiana*. This region shares one color phase with lowland *C. g. georgiana*, has the normal trimaculate pattern, is located adjacent to the area where the median spots are being suppressed, and, possibly, is the point of origin of a distinctive yellow-banded form. Further than this statement I cannot go, and commend investigation to someone with the time and knowledge to perform controlled studies on pattern inheritance with the Highlands population.

Concerning one other key character stipulated for *ducilla*—the complete absence of the tibiotarsal marginal spur—there is less to say. In the Smokies the spur is uniformly absent; in the Cowee Range, it is absent in about 66 percent of the male specimens; further south at Highlands it is missing in about half. Eight males from western South Carolina have the spur well developed in each gonopod. In north Georgia in the Blue Ridge and Nantahalas, the spur is absent in about 36 percent. For the rest of the species' range, there are no adequate series for comparison.

Specimens considered to be intergrades between *Cherokia g. georgiana* and *C. g. ducilla* have been examined from the localities given below. In some cases assignation to this intermediate category rather than to one of the subspecies has necessarily been a little arbitrary, particularly in the northern portion of Georgia. The specimens examined are as follows (all collections in RLH and by RLH unless otherwise stated):

GEORGIA: RABUN COUNTY: Glade Mountain, about 5 miles south of Highlands, North Carolina, 1 ♂, 2 ♀, July 27, 1949. Rabun Bald, 1 ♂, June 23, 1954, J. T. Darlington; Clayton, 4 ♂, July, 1910, W. T. Davis, AMNH. Rabun Beach, 5 miles west of Lakemont, 2 ♂, 2 ♀, July 11, 1958. Enota Glade Picnic Area, east of Brasstown Bald, 11 ♂, June 7, 1953, Hubricht. Brasstown Bald, 1 ♀, June 23, 1954, Darlington. TOWNS COUNTY: Unicoi Gap, 2,950 feet, south of Presley, 1 ♂, June 6, 1953, Hubricht. West side of Dicks Creek Gap, 1 ♂, 3 ♀, July 11, 1958.

SOUTH CAROLINA: OCONEE COUNTY: Jocassee, 3 ♂, 3 ♀, July 15, 1949, R. E. Gordon and R. L. Hoffman. PICKENS COUNTY: Rocky Bottom, 2 ♀, July 16, 1949, Gordon and Hoffman. Table Rock State Park, 1 ♂, July 16, 1958.

NORTH CAROLINA: BUNCOMBE COUNTY: Bent Creek Experimental Forest, about 7 miles southwest of Asheville, 1 ♂, 1 ♀, July 14, 1958. CLAY COUNTY: White Oak, Bottom, 1 ♀, June 18, 1954, 1 ♀, August 21, 1955, J. T. Darlington. Tuni Gap, July 20, 1952, 1 ♂, 2 ♀, Thelma Howell. Buck Creek, 6 ♂, June 5, 1952, C. E. Wood, Jr., and C. L. Rodgers. Glade Gap, 3,673 feet, 1 ♀, July 20, 1954, Thelma Howell. GRAHAM COUNTY: Santeetla Creek Road, 3,600 feet, 3 ♀, July 25, 1955, Arnold Van Pelt. HAYWOOD COUNTY: Waynesville, 1 ♂, August 18, 1953, M. J. Westfall. Wagon Road Gap, south of Cruso, 2 ♂, July 14, 1958. JACKSON COUNTY: Below Jones Knob, Plott Balsam Mountains, 5,000 feet, 1 ♀, May 26, 1958, L. Hubricht, perhaps referable to *ducilla*. Whiteside Cove, 4 miles south of Cashiers, 2 ♂, 3 ♀, July 9, 1958. Walnut Creek Gap, south of Glenville, 4 ♂, 4 ♀, July 17, 1958. MACON COUNTY: Highlands, 3,800–4,000 feet, about 30 ♂, 30 ♀, July, 1949, 1953, 1958. Horse Cove, 2 miles east of Highlands, 3 ♂, July 8, 1958. Chatooga River gorge, about 6 miles southeast of Highlands, 2 ♂, August 1, 1958. Cullowhee Gap road, north of Cullasaja, 3 ♂, 2 ♀, July 9, 1958. Wayah Bald, 4 ♂, 1 ♀, June 13, 1953, Hubricht. Wesser Bald, 3 ♂, July 28, 1949. Cowee Bald, north of Franklin, 5,000 feet, 2 ♀, July 1952, Thelma Howell, 4 ♂, 1 ♀, July 17, 1958. SWAIN COUNTY: 8 miles southwest of Bryson City, 2 ♂; base of Cliff Ridge at Nan-, tahala 1 ♂, 2 ♀; near Blowing Spring, 3 miles north of Nantahala 3 ♂, May 6, 1951, L. Hubricht. Smokemont Camp Ground, 6 miles north of Cherokee, 2 ♂, June 22, 1950, Hubricht. TRANSYLVANIA COUNTY: Pink Beds Recreation Area, 20 ♂, 14 ♀, July 28–30, 1958; Looking Glass Creek, 6 ♂, June 13, 1953, T. Howell M. J. Westfall, Hoffman.

Cherokia georgiana ducilla (Chamberlin), new status

FIGURES 3,*b–c;* 4,*f;* 5,*b;* 6; 7

Mimuloria ducilla Chamberlin, 1939, fig. 12, p. 7.
Mimuloria georgiana Loomis, 1943, p. 402 (in part).—Causey, 1950, p. 6.
Cherokia georgiana Hoffman, 1950, p. 23 (in part).

TYPE SPECIMENS: Male holotype and female paratype, Chamberlin collection, from Soco Falls, east of Cherokee, Jackson County, North Carolina, collected on April 29, 1939, by Nell B. Causey.

DIAGNOSIS: A small, narrow-bodied subspecies of *Cherokia georgiana,* the width less than 24 percent of the length, in which the tibiotarsal spur is absent from the male gonopod and the sides of the segments are brown or black instead of yellow. The solenomerite of the gonopod is generally more elongate than in the other two subspecies; the cyphopod a little more highly arched as seen in lateral aspect.

VARIATION: Within the small geographic range occupied by this subspecies, there is an appreciable amount of variation in minor details, probably a reflection of evolutionary recency as well as of the rugged terrain inhabited by *ducilla.*

The smallest specimen examined is a male from Indian Gap in the Smokies, measuring 27.5 mm. in length and 6.1 mm. in width; the largest, a female from Soco Gap, 36.5 mm by 8.7 mm. The average of several dozen male specimens is 30.5 mm. long and 6.5 mm. wide. The W/L ratio ranges from 19 percent, in a male from Chimneys Campground, near Gatlinburg, Tennessee, to 24.5 percent in a male from Soco Falls, North Carolina. Two other males from that locality, however, are much more slender, with ratios of 22.8 and 22.9 percent. The Soco Gap population, typical in the nomenclatorial sense, is not typical of the subspecies in most structural characters, but is representative enough to impose its name upon the population at large. The W/L ratio averages about 22 percent in males from various localities in the Great Smokies.

There is likewise some variability in color pattern, with the median dorsal row of spots chiefly affected. These spots may be either rather broad or smaller than the lateral series, apparently without respect to elevation or locality. The most typical coloration is that described in the following notes made from life at Indian Gap, Tennessee, on August 4, 1958:

Dorsum and head rich glossy black; legs, paranota, and median dorsal spots creamy white. Antennae brownish; sternites brown, pleurites tan in females, dark brown in males, anal valves nearly black in both sexes. Median spots lenticular in females, nearly complete transverse bands in males, anterior collum spot wider than posterior, but collum almost completely ringed in some males.

Subsequent measurements show the median spots of the males from Indian Gap to be as much as 70 percent as wide as the metatergite; at Soco Gap the spots merge with those of the paranota forming complete bands. Smaller median spots prevail both north and south away from the central part of the Smokies, their width only 30 percent of the metatergite width in the vicinity of Mount Sterling, at Chimneys Campground, and in the Unicoi range south of the Little Tennessee River.

Specimens from the Unicois are not entirely typical of *ducilla*; they have lighter colored pleurites (the anal valves quite dark, however), and the tibiotarsal spur is variously developed in 4 of 8 males examined. The body form remains narrow, however; it averages 21.7 percent in 6 males from Little Haw Knob and 22.2 percent in 2 males from Stratton Gap. Whether this segment of *ducilla* has been isolated from that of the Great Smokies by the gorge of the Little Tennessee or has evolved independently from a common ancestral stock in the Nantahala region remains to be established. There would seem to be little chance for genetic exchange between the two isolated populations at the present time.

Remarks: One of the most interesting aspects of the taxonomy of *ducilla* lies in the fact that to the east and southeast it grades almost imperceptibly into *georgiana* in all its diagnostic characters. To the west, fairly typical *georgiana* occurs in Cades Cove at the base of the Smokies, and *ducilla* in the same region attains its smallest and slenderest body form. No intergradation has been detected here, and I doubt that it occurs, the two forms being so radically different in size and shape.

I hope that someone having the opportunity for extensive studies in the Great Smokies will be able to work out the relationships of the two local forms of *Cherokia* there, particularly in the region between Newfound Gap and Cades Cove, and along the main ridge between Clingman's Dome and Gregory Bald.

Despite having collected *ducilla* at several places and different times, I have learned very little of its life history and activity. The mating season is somewhat later than that of *georgiana*; no mated pairs were collected until August 4, 1958, when some were taken at Indian Gap. Here specimens taken singly paired up while being carried in my hand, and remained clasped in a jar of humus overnight. No doubt the brevity of the warm season at such high elevations influences the maturation of individuals and postpones the mating activities.

Confinement of energetic males from Indian Gap with females of *georgiana* taken near Toccoa, Georgia, resulted in nothing. The males were about 2 mm. narrower, and probably would have been unable to secure a suitable grip even had pairing been attempted.

DISTRIBUTION: The Great Smokies and perhaps also the Unicois along the boundary of North Carolina and Tennessee, generally above an elevation of 3,000 feet. The northern known locality is Mount Sterling; the easternmost, Soco Gap. Whether *ducilla* occurs north of the Pigeon River remains to be determined. Approximately 72 preserved specimens, representing 14 collections, have been studied, as well as several dozen observed in the field but not retained. All of the material listed is in my collection.

NORTH CAROLINA: GRAHAM COUNTY: Stratton Gap, 4,300 feet, Unicoi Mountains, 3 ♂, 2 ♀, May 27, 1958, Leslie Hubricht. Little Haw Knob, 5,000 feet, 6 ♂, 1 ♀, May 27, 1958, Hubricht. HAYWOOD COUNTY: Mount Sterling, 4,800 feet, 3 ♂, July 20, and Cove Creek Gap, 4,000 feet, 2 ♂, 1 ♀, July 21, 1955, Richard Highton. JACKSON COUNTY: Soco Gap Falls, 10 miles east of Cherokee, 6 ♂, 2 ♀, July 28, 1949, Hoffman; also 5 ♂, 4 ♀, May 20, 1956, W. T. Keeton, W. C. Lund, and R. L. Hoffman. SWAIN COUNTY: Heintooga Ridge, 8 miles northeast of Smokemount, 8 ♂, 6 ♀, June 13, 1952, Thelma Howell, M. J. Westfall, and R. L. Hoffman; also 3 ♂, July 22, 1955, Arnold Van Pelt. Balsam Mountain Campground, 5,600 feet, 1 ♀, Van Pelt.

TENNESSEE: SEVIER COUNTY: Clingman's Dome, 6,600 feet, 1 ♂, June 14, 1954, Howard E. Evans; also July 24, 1955, 1 ♀, Arnold Van Pelt. West side of Indian Gap, 5,000 feet, 4 ♂, July 14, 1958, John F. Hanson; also 4 ♂, 4 ♀, August 4, 1958, Hoffman. Chimneys Campground, 5 miles southeast of Gatlinburg, 4 ♂, July 28, 1949, Hoffman.

This subspecies has also been reported from several localities in the Great Smoky Mountains National Park by Loomis (1943) and Causey (1950), all within Sevier County, Tennessee.

Cherokia georgiana latassa, new subspecies

FIGURES 3,*a,c;* 4,*a–e;* 5,*c–d;* 7

Mimuloria georgiana Loomis, 1943, p. 412 (in part); 1944, p. 173 (in part).—Loomis and Hoffman, 1948, p. 52 (in part).

Cherokia georgiana Chamberlin and Hoffman, 1958, p. 26 (in part).

TYPE SPECIMENS: Male holotype and two paratypes, USNM Myriapod type No. 2532, (Diplopod No. D–512), from a bluff on the Caney Fork River, one mile northeast of Rock Island, Warren County, Tennessee, collected on May 9, 1951, by Leslie Hubricht.

DIAGNOSIS: A subspecies of *Cherokia georgiana* in which the scapulorae are completely marginal, concealing the anterior surface of the paranota when seen in dorsal aspect (fig. 3, *a*). In details of structure agreeing almost completely with the detailed description given for the nominate subspecies.

VARIATION: The material examined shows very little structural variation. The size is remarkably uniform, the length ranging from 32 to 35 mm. in most of the specimens and the width from 8.0 to 9.5 mm. The largest male seen is from Campbell County, Tennessee: 37.5 mm.

long and 9.5 mm. wide. The largest female is from Talladega County, Alabama: 35.0 by 10.0 mm.

The coloration is somewhat variable, the specimens from Kentucky and Tennessee generally trimaculate with broad median spots. A tendency for crossbanding increases southward, where the collum also develops an anterior yellow border. In northern Alabama (e.g., Jackson County), the transition from trimaculate to banded patterns may often be noted on a single specimen, the bands being on the anterior half of the body and lunate spots being on the posterior half. Two females from Cheatham County, Tennessee, seem to have been crossbanded with chestnut in life; a male from directly south in Perry County, Tennessee, is typically trimaculate with yellow.

Alabama specimens likewise tend toward development of somewhat more acute sternal spines, and in many males the 7th segment is provided with two small conical sternal lobes at the base of the 8th legs. This occurrence can be traced as far north as Mountain View, Grundy County, Tennessee. With the available material, this structural variation cannot be regarded other than as clinal, and even so is of a very low order of magnitude.

The solenomerite of the male gonopod becomes, on the average, slightly more elongated from north to south, but without sufficient constancy to indicate more than a gradual trend. All the variants noted for the species proceed in a north to south direction, but there seems to be no point where an abrupt change occurs in any of them.

DISTRIBUTION: Extreme southeastern Kentucky, west and south through most of the Cumberland Plateau in Tennessee as far as the Western Highland Rim, south through Alabama to the general vicinity of Tuscaloosa; not yet known from the Coastal Plain of this state. In Tennessee it occurs abundantly in the Cumberland Plateau but apparently only west of the Sequatchie Valley, the form occurring on Walden Ridge being *C. g. georgiana*. Specimens have been examined from the following localities (all collections in RLH and by Leslie Hubricht unless otherwise stated):

KENTUCKY: LAUREL COUNTY: 1 mile northwest of Baldrock, 1 ♂, 2 ♀, May 26, 1952. BELL COUNTY: Kentucky Ridge State Forest near Pineville, 3 ♂, June 22, 1950. Pine Mountain State Park, 1 ♂, 2 ♀, June 23, 1950, J. A. Fowler and R. L. Hoffman. HARLAN COUNTY: Pine Mountain, 1 ♂, June 1946, W. L. Necker, CNHM.

TENNESSEE: CAMPBELL COUNTY: 1.5 miles southeast of Morley, 1 ♂, April 30, 1954. FENTRESS COUNTY: 5 miles north of Jamestown, June 28, 1957. SCOTT COUNTY: 1.7 miles northeast of Winfield, 1 ♂, May 30, 1958. Just north of Elgin, 1 ♂, May 30, 1958. CUMBERLAND COUNTY: Ozone Falls, 1 ♂, 3 ♀, May 9, 1951. WARREN COUNTY: 9 miles southeast of McMinnville, 1 ♂, and 1 mile northeast of Rock Island, 2 ♂, 1 ♀, May 9, 1951. DEKALB COUNTY: 0.8 miles southeast of Dowelltown, 1 ♀, July 5, 1958. PERRY COUNTY: Near Campbell Cave, 2.5 miles east of Linden, 1 ♂, June 16, 1957. CHEATHAM COUNTY: 1.5

miles southeast of Pleasant View, 2 ♀, September 10, 1955. LAWRENCE COUNTY: 3 miles east of Lawrenceburg, 1 ♀, September 25, 1955. GRUNDY COUNTY: 1.5 miles north of Monteagle, 1 ♂, June 21, 1957. Mountain View, 1 ♂, June 20, 1950.

ALABAMA: JACKSON COUNTY: Keel Mountain near Paint Rock, 1 ♂, 3 ♀, June 18, 1957. North side of Poorhouse Mountain, 2 miles west of Scottsburo, 1 ♂, 1 ♀; also near Blowing Cave, 5 miles southeast of Limrock, 2 ♂, 1 ♀, June 19, 1957. Side of Sand Mountain, 1,200 feet, 0.8 miles west of Fabius, 1 ♂, June 20, 1957. MADISON COUNTY: Huntsville Mountain, 800 feet, 4 miles south of Huntsville, 4 ♂, 4 ♀, May 8, 1954. Scott Cave, 5.5 miles northeast of Maysville, 6 ♂, June 18, 1957. LAWRENCE COUNTY: Kings Cove, 1 ♂, June 29, 1950, George E. Ball. MARSHALL COUNTY: 1.5 miles south of Guntersville, 1 ♂, May 6, 1954 ST. CLAIR COUNTY: Steele, 1 ♂, April 4, 1948, Howard E. Evans. SHELBY COUNTY: Oak Mountain, 3 miles east of Acton, 1 ♀, June 10, 1953. BIBB COUNTY: 3.6 miles north of Brent, 1 ♂, June 10, 1953. CLEBURNE COUNTY: top of Cheaha Mountain, 4 ♂, June, 1953. TALLADEGA COUNTY: 6 miles southeast of Sylacauga, 1 ♀, May 7, 1954. 3 miles south of Cheaha State Park, 2 ♀, May 8, 1954. 2.7 miles north of Sylacauga, 2 ♂, May 6, 1954. Renfroe Mountain, east of Renfroe, 1 ♂, May 7, 1954.

In addition, *latassa* has been reported in the literature, under the name *georgiana*, from Monte Sano State Park, Madison County, Alabama, Hubricht, by Loomis (1943, p. 402); from Haleyville, Winston County, Alabama, V. E. Shelford, by Loomis (1944, p. 173); and from Pelham, Shelby County, Alabama, C. J. and M. Goodnight, by Loomis and Hoffman (1948, p. 52).

INTERGRADATION: Throughout its wide range, *Cherokia g. latassa* is remarkably stable as regards its principal diagnostic character. In fact, this structural integrity, coupled with the quality level of its difference from typical *georgiana*, led me to consider *latassa* as a distinct species for some time. This opinion gradually altered as a result of the realization that other equally important taxonomic characters were distributed without regard to the two paranotal types, and with the discovery of several specimens which, while clearly referable to *latassa*, indicate the probability of intergradation with *georgiana*.

A male from Steele, St. Clair County, Alabama (H. E. Evans), is of interest in two respects: First, the scapulorae are completely marginal but become somewhat crenulated in outline toward the body; they resemble the form taken in *georgiana*. Second, the sternal spines are much longer than normal for *latassa* and also appear as distinct subcoxal conicles on the 7th segment.

A male from 3.5 miles northeast of Brent, Bibb County, Alabama (L. Hubricht), does not have distinct subcoxal cones on the 7th segment, but the scapulorae are almost directly transverse instead of convex anteriorly, and thereby nearly submarginal. While these two specimens alone do not constitute direct evidence of intergradation, they show that the two paranotal types can be joined by intermediate forms.

Phylogenetic Relationships

To the best of my knowledge no one has yet expressed an opinion concerning the systematic position of *Cherokia* or its relationships to other genera, aside from a remark in my 1950 treatment that: "The disparity in sizes of the [cyphopod] valves suggests relationships with *Zinaria*, as does the nature of the sternites and male gonopods." Since then I have found no reason to revise this statement, but have come to recognize other genera as perhaps even more closely related to *Cherokia*. These form a discrete natural group worthy of formal tribal recognition:

Rhysodesmini, new tribe

I propose this tribe for xystodesmid genera in which the coxae of the gonopods are attached to a distinct slender sternite and join the prefemora at a right angle and in which the postcoxal division of the telopodite is typically nearly straight and the prefemur elongate and not globosely enlarged basally. When present, the prefemoral process is simple, slender, and acicular. These genera include polymorphic species of very variable form, in which the general form of the male gonopod is subject to little, if any, specific modifications.

The following genera (the validity of some of which seems not to be beyond challenge) at present constitute the tribe:

Rhysodesmus Cook, 1895
Cruzodesmus Chamberlin, 1943
Acentronus Chamberlin, 1943
Boraria Chamberlin, 1943
Howellaria Hoffman, 1950
Cherokia Chamberlin, 1949
Pleuroloma Rafinesque, 1820[2]

The first five names of the list represent closely allied species groups, which some authors might prefer to unite in a single genus. The last two are much more strongly differentiated, to the extent that probably no one would question their claim to generic rank. *Rhysodesmus*, in particular, is highly variable and about 80 species have so far been described. The others are less extensive, and their rate of evolution seems to be more moderate.

With the recognition of but a single species in this genus, attention need be paid only to the status of the three geographic races of *C. georgiana*.

That these three groups are conspecific is, I believe, obvious. While remarkably dissimilar in appearance and probably unable to intermate, *C. g. georgiana* and *C. g. ducilla* are nonetheless connected by a broad zone of intermediate populations which bridge by small gradations the gaps in all the diagnostic characters. The two named subspecies are fairly constant over their ranges—as defined by the sum of several characters taken in combination—but it has been sometimes

---

[2] Some may prefer to retain the name *Zinaria* Chamberlin, 1939, pending confirmation of the older ***Pleuroloma*** as the correct one for the genus.

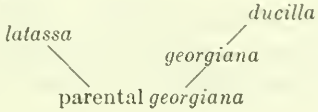
difficult to determine whether a certain local population should be considered as part of a subspecies or of the intergrading series. This fact seems a common and entirely reasonable consequence of geographically induced speciation.

On the other hand, *C. g. georgiana* and *C. g. latassa* differ mainly in but a single character, but in such a profound one that it separates all the material examined into one group or the other. The reasons for considering these two groups as conspecific have already been set forth: The virtual identity in all other structural details; separate distributions; the occurrence of some specimens of *latassa* which presage the appearance of intergradient characters; and the sharing by the two groups of sternal knobs on segment 7, in the region where intergradation is presumed to occur.

The inference I draw from the relationship of *latassa* to *georgiana* is one of a division of the parent population into two parts, with the barrier subsequently withdrawn before specific divergence had been achieved. Judged from present distributions, the Tennessee River seems entirely possible as the isolating mechanism because of the change in course to the southwest through eastern Alabama. That such a diversion occurred is contended by numerous zoologists, although there is by no means complete agreement. Reestablishment of the river in its present course curving westward through northern Alabama would permit an eastward migration of the subspecifically differentiated *latassa* and eventual contact and intergradation with *georgiana* in the region where, today, the evidence suggests it occurs.

The relationship of *ducilla* to *georgiana* seems more intimate and suggests virtually uninterrupted contact between the two, with *ducilla* representing a recent terminal race of the migration northward into the mountains. So far as I know, *georgiana* does not cross the French Broad River, whereas *latassa* ranges much farther north, into Kentucky. From the great variability of *georgiana* in western North Carolina, and its relatively narrow distribution there, I judge that the species' occupation of the mountains is a fairly recent event. Presumably the roughness of the terrain enhances or imposes localized variability; *latassa* varies less over a range thirty times as great.

It therefore seems reasonable to assume that *georgiana* and *latassa* diverged first, and in only one character. The race *ducilla* is a younger offshoot of *georgiana*, and differs in several characters because of the opportunities afforded by the invasion by its parental stock of a strongly dissected country with different climatic conditions. The relationship may be expressed thus:



In recent years several opponents of the subspecies category have, most correctly, pointed out that many workers have erected subspecies on the basis of a single character in a limited region, without consideration of the total variability within the entire species involved. In such cases, whenever another (and perhaps equally important) character is emphasized as the basis for separation, an entirely different pattern of "subspecies" emerges. The present work has been done in complete cognizance and appreciation of such circumstances, but although all the populations in the genus *Cherokia* are held to be conspecific, three of them appear to be so distinctive and so constant throughout their ranges that recognition as subspecies seems to be warranted and actually desireable. Those who wish to discard trinomials may refer to *latassa* as the Cumberland Plateau population, to *georgiana* as the Georgia population, and to *ducilla* as the Great Smokies population, of *Cherokia georgiana*, but I do not see what is to be gained by the substitution of polynomial vernacular names in place of short Latin designations carrying the same implication.

Summary

A number of local populations within the genus *Cherokia* have been given specific names in the past, in many cases the diagnostic characters being more apparent than real. A restudy of the genus, based upon more than 400 specimens and typical material of most of the names, shows that most of these species are merely local populations of one variable species. The gonopods are remarkably similar in all the material examined, and the external body form is equally variable. It is concluded that the most extreme variants in the genus are eventually connected by intergradient populations, and that *Cherokia* is monotypic.

The importance of this conclusion rests in its presumable effect on the definition of species in the family Xystodesmidae. Common practice of the past decade has resulted in the erection of numerous specific names for millipeds from single localities, differing solely in color pattern or other minor features. Such forms have been apparently proposed in a sort of taxonomic vacuum which presupposed that any difference must be of specific value. One paper (Causey, 1951), attempted to justify such an approach with the philosophical suggestion that in some genera, specific differences obtain only in nonsexual features, with the gonopods remaining identical or nearly so in the different forms. Such species were designated by the special term "isogenitive."

It must be obvious that the validity of the idea of "isogenitive species" rests entirely upon what was never proved, that the named forms involved are actually different species. Presumably, as long

as one examined only small samples of specimens, from widely separated localities, such reasoning might have some appeal. It seems more reasonable to me, however, to assume that such local variants are nothing more than populations, perhaps sometimes subspecifically distinct, of widespread polymorphic species. The phenomenon of geographic variability in most species has been recognized and understood for quite a long time.

In disposing of "isogenitive species" as doubtlessly only the results of localized microevolution, which is far from reaching the species level, I note that even the term appears to be incorrectly formed, presumably from the Greek "isos" (equal) and the Latin "genitivus" (possessive case). From the usage of the word, the meaning isogenital was implied—"isos"+"genitalis" (of the sexual organs)—but even this usage is objectionable because of its hybridity.

The present study has shown that populations of one species may be so divergent that, given only specimens of the typical forms, one would be justified in considering them specifically different. This discovery should be of considerable aid in the evaluation of species in large genera such as *Rhysodesmus*, in which the gonopods are remarkably similar, and in which species have been erected on characters such as size and color, and even then only by overlooking previously named species from the same general regions.

Literature Cited

Bollman, Charles Harvey

1889. Notes upon some myriapods belonging to the U.S. National Museum. Proc. U.S. Nat. Mus., vol. 11, pp. 343–350.

Causey, Nell Bevel

1950. A collection of xystodesmid millipeds from Kentucky and Tennessee. Ent. News, vol. 61, pp. 5–7, figs. 1–3.

1951. The milliped assembly *Zinaria butlerii* isogen. (Xystodesmidae). Proc. Arkansas Acad. Sci., vol. 4, pp. 73–88, pls. 1, 2, figs. 1–12.

Chamberlin, Ralph Vary

1928. Some chilopods and diplopods from Missouri. Ent. News, vol. 39, pp. 153–155.

1939. On some diplopods of the family Fontariidae. Bull. Univ. Utah, biol. ser., vol. 5, No. 3, pp. 1–19, figs. 1–37.

1940. Four new polydesmoid millipeds from North Carolina (Myriapoda). Ent. News, vol. 51, pp. 282–284, figs. 1–4.

1943. On Mexican millipeds. Bull. Univ. Utah, biol. ser., vol. 8, No. 3, pp. 1–103, figs. 1–172.

1946. On some millipeds from Georgia. Ent. News, vol. 57, pp. 149–152, figs. 1–9.

1947. Seven new American millipeds. Proc. Biol. Soc. Washington, vol. 60, pp. 9–16, figs. 1–8.

1949. A new genus and four new species in the diplopod family Xystodesmidae. Proc. Biol. Soc. Washington, vol. 62, pp. 3–6, figs. 1–6.

CHAMBERLIN, RALPH VARY, AND HOFFMAN, RICHARD LAWRENCE

1958. Checklist of the millipeds of North America. U.S. Nat. Mus. Bull. 212, iii+236 pp.

COOK, ORATOR FULLER

1895. Introductory note on the families of Diplopoda, *in* Cook and Collins, The Craspedosomatidae of North America. Ann. New York Acad. Sci., vol. 9, pp. 1–9.

HOFFMAN, RICHARD LAWRENCE

1950. Records and descriptions of diplopods from the southern Appalachians. Journ. Elisha Mitchell Sci. Soc., vol. 66, pp. 11–33, figs. 1–32.

LOOMIS, HAROLD FREDERICK

1943. New cave and epigaean millipeds of the United States, with notes on some established species. Bull. Mus. Comp. Zool., vol. 92, No. 7, pp. 371–410, figs. 1–18, pl. 1.

1944. Millipeds principally collected by Professor V. E. Shelford in the eastern and southeastern United States. Psyche, vol. 51, pp. 166–177, figs. 1–6.

LOOMIS, HAROLD FREDERICK, AND HOFFMAN, RICHARD LAWRENCE

1948. Synonymy of various diplopods. Proc. Biol. Soc. Washington, vol. 61, pp. 51–54.

RAFINESQUE, CONSTANTINE SAMUEL

1820. Annals of nature, or annual synopsis of new genera and species of animals and plants discovered in North America. First annual number for 1820, pp. 1–20.

U.S. GOVERNMENT PRINTING OFFICE: 1960

Proceedings of
the United States
National Museum

SMITHSONIAN INSTITUTION • WASHINGTON, D.C.

Volume 112 1960 Number 3437

REEXAMINATION OF SPECIES OF PROTURA DESCRIBED BY H. E. EWING

By F. Bonet and S. L. Tuxen[1]

In 1948 F. Bonet went to Washington on a Guggenheim Memorial Scholarship to study the Ewing collection of Protura. He redescribed three of Ewing's species of *Eosentomon* in 1950 without, however, giving figures. In 1956 S. L. Tuxen, supported by the Carlsberg Foundation, Copenhagen, also went to Washington for the same purpose, after having discussed matters with Bonet in Mexico. They arranged to publish the redescriptions of Ewing collection jointly. Tuxen took Bonet's notes to Washington and limited himself to a study of the characters which Bonet had not taken into consideration. All figures in the present paper were made by Tuxen when it is not expressly stated "drawn by Bonet." The present paper was completed in 1957 and submitted for publication in November of that year.

The authors wish to express their sincerest thanks to the foundations which have supported their studies, and extend special thanks to Grace Glance without whose kind help they could not have made the studies.

---

[1] The former is associated with Laboratorio de Zoologia y Paleontologia, Escuela Nacional de Ciencias Biologicas, I.P.N., Mexico, D.F.; the latter is with Zoologisk Museum, Copenhagen, Denmark.

For the systematics of the Protura it seems of paramount importance to be able to define with certainty which species the first describers had before them. In his redescriptions of the species described by Berlese and Silvestri, Tuxen (1956) stressed characters not known by these authors: The setae and sensillae of the foretarsus, the female genital squama, and the chaetotaxy. In 1958 Tuxen did the same for a species described by Stach. In the present paper a similar study has been made of the species which were described by Ewing and are now kept in the U.S. National Museum, Washington.

Ewing described his species in several papers. In 1921 he described *Acerentulus barberi*, the first American proturan to be identified since Silvestri's specimen, collected in the vicinity of New York in 1909 and called *Eosentomon wheeleri*. The type specimen of *wheeleri* was supposed lost, until its rediscovery was reported by Tuxen (1960).

In 1921 Ewing also described 10 more species from the United States. They were placed in three old and three new genera. The specimens were all found near Washington, D.C. The next year he briefly mentioned the then known distribution of Protura in the United States. In 1924 he described a new species from Florida, and in 1927 a new species from the western states. In 1936 he compiled a "synonymy and synopsis" of the genera then known. A larger paper in 1940 summed up all the knowledge of the North American Protura and contained the descriptions of six new species. Thus 19 species were described by Ewing, besides the redescription of *E. wheeleri* Silvestri. Of these species, he identified *A. tenuiceps* as a synonym of *A. barberi* and, erroneously, *E. minimum* as a synonym of *E. pallidum* in 1940. The types of the remaining species will be discussed in the present paper.

The 1940 paper by Ewing is based on much more material than the types, in all about 200 slides. Part of this material is incorrectly determined and part of it probably comprises new, hitherto undescribed species, but it does not seem advisable to describe more species as long as the species of Ionescu and Womersley have not been reexamined. In 1960 Tuxen finished this task.

A small, ridiculous difficulty in describing arose. In 1949 both of us invented systems of numbering the dorsal abdominal setae, but unfortunately in opposite directions, Tuxen made the median setae No. 1, while Bonet made the lateral ones No. 1. Bonet used his system in 1949 and 1950. Tuxen used his system in 1949 and in the papers since 1955. Among the latter were the redescriptions of Berlese's and Silvestri's species. Since it is easier to define the position of the median setae than that of the lateral ones (the pleura are not always distinguishable from the terga), the "Tuxen-system" of numbering will be used in this and all future papers by us. The setae and sensillae of the foretarsus are numbered on the figures according to the system described by Tuxen in 1955 and 1958. Readers of the Bonet papers of 1949 and 1950 should be aware of this difference.

The 18 species whose types we shall deal with here are the following:

- Genus *Eosentomon* Berlese:
  - *E. vermiforme* Ewing
  - *E. pallidum* Ewing
  - *E. minimum* Ewing
  - *E. yosemitense* Ewing
  - *E. rostratum* Ewing
  - *E. pusillum* Ewing
- Genus *Protentomon* Ewing:
  - *P. transitans* Ewing
- Genus *Microentomon* Ewing:
  - *M. minutum* Ewing
- Genus *Acerentomon* Silvestri:
  - *A. americanum* Ewing
  - *A. conurus* Ewing
  - *A. andrei* Ewing
  - *A. christensoni* Ewing
  - *A. occidentalis* Ewing
- Genus *Acerentulus* Berlese:
  - *A. barberi* Ewing (=*A. tenuiceps* Ewing)
  - *A. oculatus* Ewing
  - *A. bicolor* Ewing (=*Acerentuloides bicolor*)
  - *A. floridanus* Ewing (=*Acerentomon floridanum*)
  - *A. aureitarsus* Ewing

A neotype of *Acerentomon californicum* (Hilton) (=*Acerentulus californicus* Hilton) is described and a redescription is given of *Eosentomon wheeleri* Silvestri on the basis of Ewing's specimens.

Of Ewing's genera only *Protentomon* is valid, and of his 19 species only the following are valid: *Eosentomon vermiforme, E. pallidum, E. yosemitense, E. rostratum, E. pusillum, Protentomon transitans, Acerentomon andrei, Acerentulus americanus, A. barberi, A. floridanus,* and *A. aureitarsus.*

The concept of *Acerentomon* and *Acerentulus* used in this paper is based on the labrum and the maxillary palpi, and holds good in extreme cases, but transitional forms may be found. The justification of the two genera needs reexamination.

Eosentomon wheeleri **Silvestri**

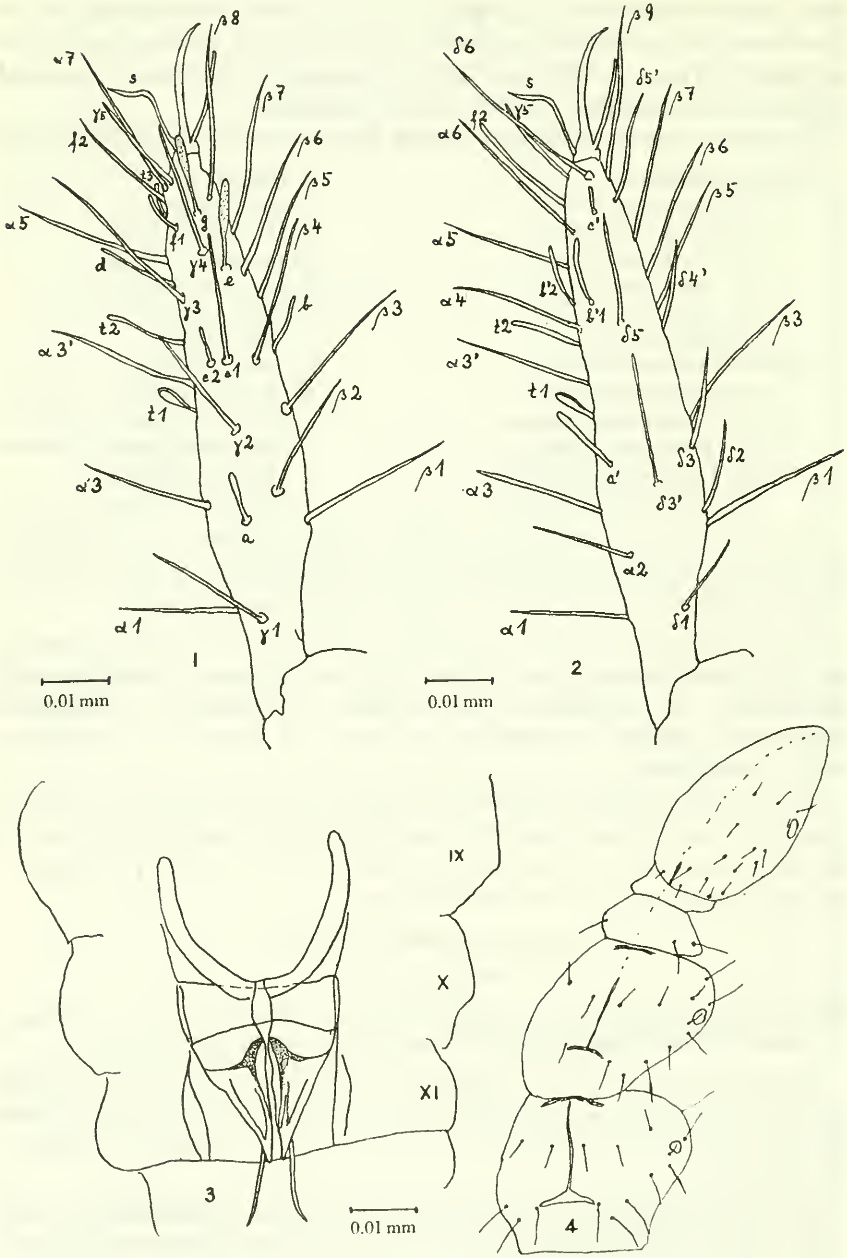
FIGURES 1–14

Eosentomon wheeleri Silvestri, 1909, p. 8.—Ewing, 1940, p. 523.—Not *Eosentomon wheeleri* Bonet, 1942, p. 15 (=*E. boneti* Tuxen, 1956b, p. 719).

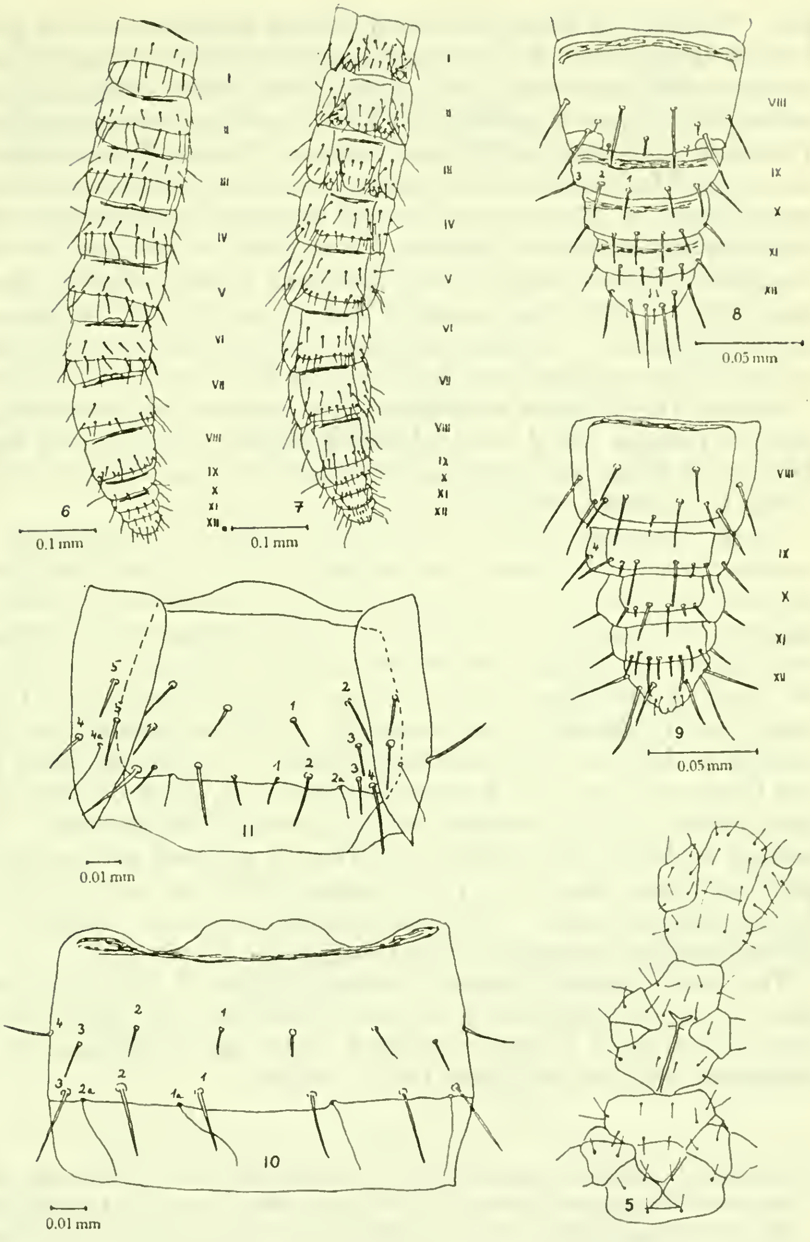
The species described by Silvestri in 1909 as *wheeleri* was collected in humus in woods around New York. The type was said (Tuxen 1956b, p. 719) to be missing from Silvestri's collection of Protura in Portici.

In 1940 Ewing described a species as *wheeleri* from material collected in Maryland, Virginia, and Texas. He had not seen the type specimen.

In 1942 Bonet described a species as *wheeleri* from several localities in Mexico. In 1956 Tuxen decided to make a specimen of this latter species the neotype of *wheeleri,* since the holotype was supposedly



Figures 1–4.—*Eosentomon wheeleri* Silvestri: 1, foretarsus, exterior side; 2, foretarsus, interior side; 3, female squama genitalis; 4, tergal chaetotaxy of head and thorax.



FIGURES 5–11.—*Eosentomon wheeleri* Silvestri: 5, sternal chaetotaxy of head and thorax; 6, tergal chaetotaxy of abdomen; 7, sternal chaetotaxy of abdomen; 8, tergal chaetotaxy of abd. VIII–XII; 9, sternal chaetotaxy of abd.VIII–XII; 10, abdominal tergum IV; 11, abdominal sternum IV.

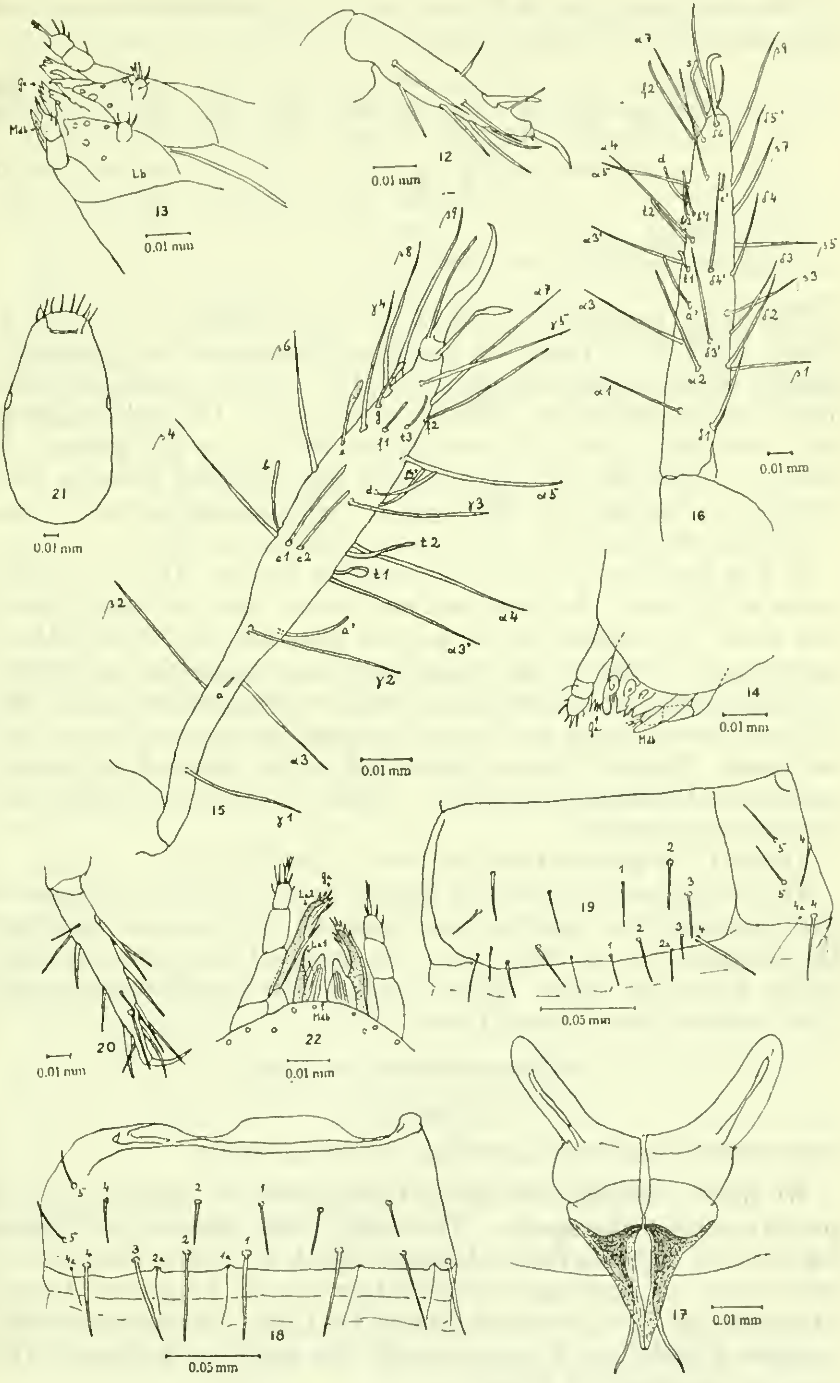
lost. However, as Bonet had stated that his *wheeleri* had never been found outside Mexico, and as it was specifically different from Ewing's *wheeleri*, which was found in the eastern United States, it then seemed preferable to choose a specimen of Ewing's *wheeleri* for the neotype. Therefore, in his paper on Silvestri's types of Protura, Tuxen changed the name of Bonet's *wheeleri* to *boneti*, new name, and postponed the redescription of *wheeleri* until he had examined Ewing's material. In preparing the present paper we chose from this material for our description a female bearing the data Mount Rogers, Virginia, elevation 5,000 ft., under dead chestnut bark, Sept. 19, 1938, Ewing and Gurney collectors. Now that the actual holotype has been recovered, we find that our redescription agrees with it (see Tuxen, 1960, p. 298).

Some of the drawings were made from another slide containing 3 males, 3 females, and 2 maturi juniores labeled, under bark of logs, Elk Garden Ridge, Jefferson National Forest, Virginia, Sept. 18, 1938, Ewing and Gurney collectors.

On the foretarsus (figs. 1–2), compared with the drawings of *E. armatum* Stach(=*E. transitorium* Berlese) by Tuxen (1958), the following differences are noticed: The t 1 has a very characteristic thickening along one margin, in some cases making it appear to be a twined sensilla, the disc being more or less invisible. The a, c 1, e, and g are longer; d and f 2 are shorter in *wheeleri* than in *transitorium;* t 1 is nearer $\alpha 3'$ in *wheeleri,* a fact especially important inasmuch as the relation of the part of the foretarsus outside t 1 to the one inside t 1 will thus be 8:7 (=1.15), while in *transitorium* it is 8:8 (=1.00), the part outside t 1 being measured to the beginning of the pretarsus. We propose to denote this relation by the sign d:p (distal part:proximal part), and state that d:p=1.15 in *wheeleri* Silvestri and d:p=1.00 in *transitorium* Berlese. On the interior side of the foretarsus, a′ is shorter than in *transitorium;* it just reaches the tip of t 1.

The female squama genitalis is shown in figure 3 from the dorsal side. It is very different from that of *transitorium.* The head of processus sternales is slightly rounded, rather like the squama of *E. mexicanum* Silvestri and *boneti* Tuxen (1956b).

Figures 12–22.—*Eosentomon wheeleri* Silvestri: 12, tarsus III; 13, mouth parts seen from the ventral side, obliquely, Ga=galea, Lb=labium, Mdb=mandible; 14, mouth parts seen from above. *Eosentomon vermiforme* Ewing: 15, foretarus, exterior side, holotype; 16, foretarsus, interior side, paratype. 17, female squamta genitalis, holotype; 18, tergal chaetotaxy of abd. V; 19, sternal chaetotaxy of abd. V, 20, tarsus III, paratype; 21, shape of head, holotype; 22, mouth parts seen from above; La 1 and La 2=1st and 2nd lacinia.



For explanation, see opposite page.

The chaetotaxy (figs. 4–9) schematically is as follows (the pleural setae included in the tergal ones):

	Th. I	II	III	Abd. I	II–III	IV	V	VI	VII	VIII	IX–X	XI	XII
t	4	10/12	10/12	4/[c]10	12/14	12/14	[a]10/14	[a]10/14	[b]8/14	6/7	8	8	9
s	14	14	16	4/4	6/4	6/10	6/10	6/10	6/10	2/7	6	8	10

[a] "3" is missing.

[b] "1" and "3" are missing.

[c] "3*a*" is extremely short, not much longer than its pit.

The most remarkable features are the following: 1. s VIII 2/7. Bonet (1949–50) divided the species of *Eosentomon* into groups according to the number of setae in s VIII. The *mexicanum* group has two anterior setae and no central posterior seta. The *pallidum* group has no anterior setae; *E. transitorium* belongs to this group. *E. wheeleri*, which has two anterior setae and a central posterior seta, belongs to a third group. We may call this the *wheeleri* group. Tuxen (1956b) shows that *E. boneti* belongs to the last group.

2. The presence of "3" in the anterior row of t III–IV, making a row of 12 setae. In *boneti* and *mexicanum* there are only 10 anterior setae. In *transitorium* 12 anterior setae are present in t III–IV as well as in V and VI, but these latter ones are missing in *wheeleri*.

The accessory setae are longer than the principal ones, as is also the case in *mexicanum* and especially *boneti*, but in *transitorium* they are equal. Figure 10 shows this as well as the shape of the lamina, anterior to the anterior apodeme. Figure 11 shows the sternal part of the same segment.

Tarsus III is provided with a distinct spine (fig. 12).

The mouth parts are shown in figures 13–14. Until now the mouth parts have not been used in the systematics of *Eosentomon*, but from the description of the next species it is apparent that they may differ widely within the genus. Those of *wheeleri* do not differ very much from those of *transitorium* (Berlese 1909).

Eosentomon vermiforme Ewing

FIGURES 15–22

Eosentomon vermiforme Ewing, 1921b, p. 194; 1940, p. 522.

We have examined and drawn figures from the holotype and a paratype slide of this species. The holotype was collected from decaying leaves in Takoma Park, Maryland, by H. E. Ewing, February 14, 1921, and the paratypes in dead leaves from Plummers Island, Maryland, by R. C. Shannon, March 18, 1924. The paratype slide contains 1 male and 2 females; only the male has foretarsi. The holotype specimen is a female.

On the foretarsus (figs. 15–16), t 1 resembles to some degree sensilla t 1 of *wheeleri* in having the thickening along one margin of the disc; the disc itself is often quite invisible. The a is very short, c 2 longer, and c 1 shorter than in *E. wheeleri;* they are nearly alike in size; e and especially g are shorter. The t 1 is located very near the base of α 3′; d:p is 8:11 (=0.75). The empodium is longer in relation to the claw than in *wheeleri;* the relation is 8:9 (=0.9). We will call this relation e:u, empodium:unguis; in *wheeleri* it is 3:5 (=0.6).

The female squama genitalis (fig. 17) resembles that of *wheeleri,* only the outer angles of the well-sclerotized part are longer and proceed proximally to a larger degree. Processus sternalis is as it is in *wheeleri.*

The chaetotaxy is schematically as follows (the pleurals are included in the tergum):

	Abd. I	II–III	IV	V–VI	VII	VIII	IX–X	XI	XII
t	$\frac{4}{10}$	$\frac{12}{14}$	$\frac{12}{14}$	[a] $\frac{10}{14}$	[b] $\frac{8}{14}$	$\frac{6}{7}$	8	8	9
s	$\frac{4}{4}$	$\frac{6}{4}$	$\frac{6}{10}$	$\frac{6}{10}$	$\frac{6}{10}$	$\frac{2}{7}$	6	8	12

[a] "3" is missing.
[b] "1" and "3" are missing.

Figures 18–19 show the chaetotaxy of abd. V. It is apparent that the accessory setae in the terga are a little shorter than the principal ones, "1a" in VII being as usual very much shorter. The shape of the anterior tergal lamina is also shown.

On the basis of the chaetotaxy of s VIII, the species belongs to the *wheeleri* group; it is apparent that the chaetotaxy exhibits no difference at all from this species.

Tarsus III has a spine which is weaker than that usually found in the genus, although it is distinctly stronger than even the strongest of the setae. Figure 20 shows that the setae on the tarsus are of extremely different development.

The most significant characters are found in the mouth parts and in the slender shape of the head (fig. 21). The mouth parts (fig. 22) exceed the foremargin of the head so that the tip of the mandibles, which is equipped with distinct striae, is easily seen. The galea and outer lacinia (La 2) are nearly as long as the maxillary palpus. Both laciniae have a very characteristic appearance different from that of *E. wheeleri* and *E. transitorium.*

Eosentomon pallidum **Ewing**

FIGURES 23–28

Eosentomon pallidum **Ewing, 1921b, p. 194; 1940, p. 525.—Bonet, 1950, p. 116.**

This species, especially the chaetotaxy, was redescribed in 1950 by Bonet, but without figures. In 1940 Ewing supposed *E. minimum*

Ewing (1921b) to be synonymous with this species; however, a reexamination of the holotype of *minimum* showed it to be *E. vermiforme* Ewing.

The holotype, a female, was collected from decaying leaves at Takoma Park, Maryland, by H. E. Ewing, April 3, 1921.

The drawings were all made from the holotype except figures 25–26 and 28, which were made from a female collected in Fayette County, Kentucky, by Ritcher and Sanderson on May 6, 1947, and determined by Bonet.

No foretarsus (see fig. 23) was found lying in a position suited for drawing it from the interior side. The t 1 is remarkable in its pointed shape, without the thickening along the margin as seen in the two former species. In other respects the shape and size of the sensillae are equal to those of *vermiforme;* however, b is stouter, and a and f 1 are much longer in *E. pallidum.* The t 1 is placed rather near α 3 and away from α 3′; d:p=75:80 (=0.95); e:u=22:24(=0.9).

The female squama genitalis (fig. 24) is of a peculiar shape, different from that of the two former species. The processus sternales have no sharp edges as in *E. transitorium* nor any beak-shaped rounding as in *wheeleri* and *vermiforme.*

The chaetotaxy is described by Bonet (1950, note that for denoting the setae he uses other numbers than we do). Schematically it is given as follows:

	Abd. I	II–III	IV	V–VI	VII	VIII	IX–X	XI	XII
t	$\frac{4}{10}$	$\frac{12}{14}$	$\frac{12}{14}$	[a]$\frac{10}{14}$	[b]$\frac{6}{14}$	$\frac{6}{7}$	8	8	9
s	$\frac{4}{4}$	$\frac{6}{4}$	$\frac{6}{10}$	$\frac{6}{10}$	$\frac{6}{10}$	$\frac{0}{7}$	6	8	10

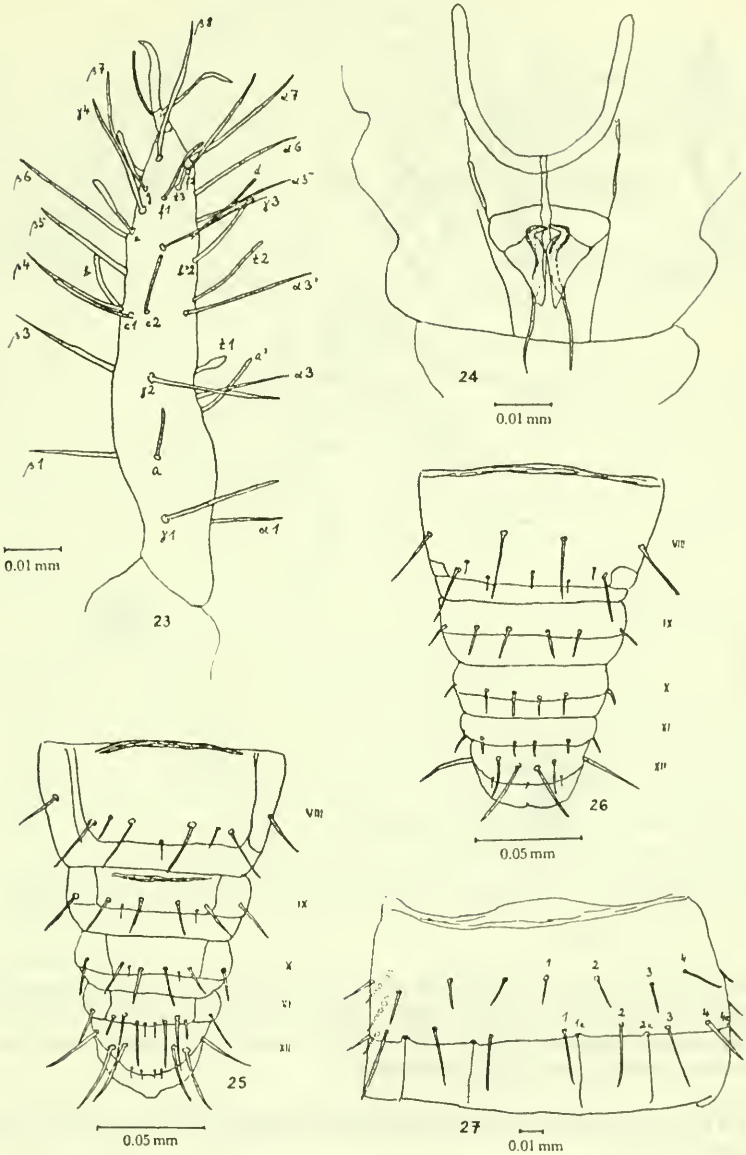
[a] "3" missing.
[b] "1–3" missing.

The most remarkable facts are the missing anterior row of s VIII (Bonet, 1950, built the *pallidum* group on this character), and the missing six interior setae in the anterior row of t VII; only the lateral one and the two "pleural" ones on each side are present. In the first character *pallidum* resembles *transitorium;* in the second one it does not.

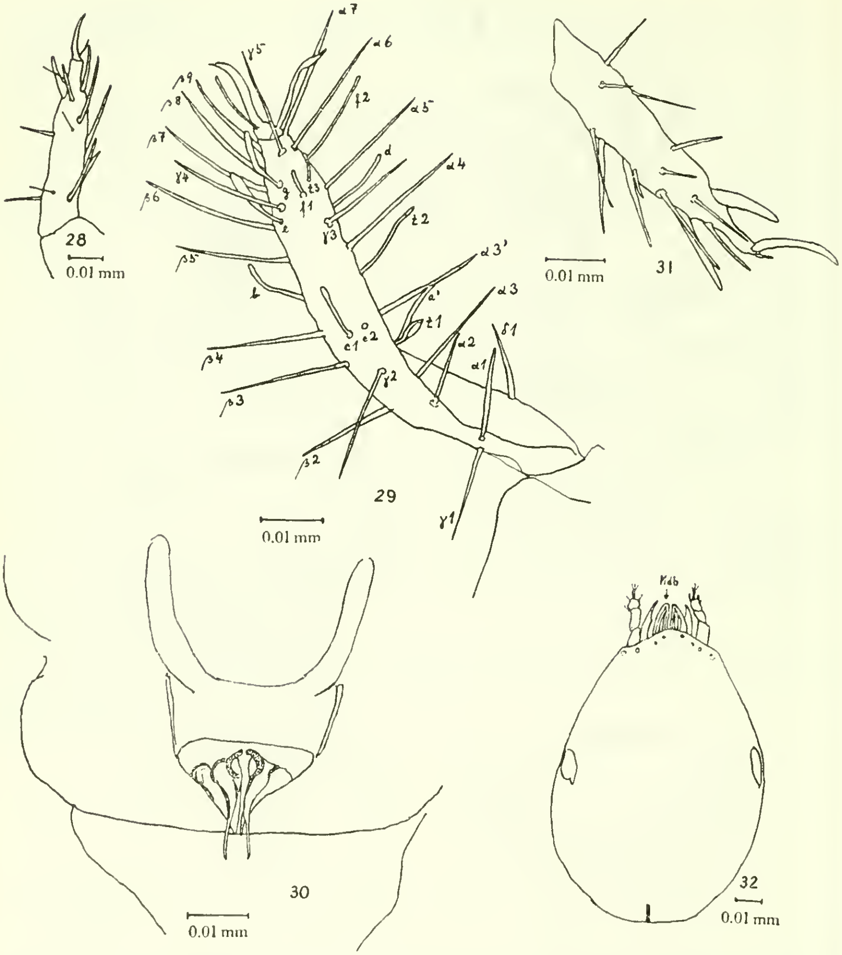
Figures 25–26 show the position of the ventral and tergal setae in abd. VIII–XII from the specimen determined by Bonet.

Figure 27 is of the holotype and shows t IV; it is apparent that the accessory setae are much longer than the principal ones. The lamina anterior to the anterior apodeme is nearly invisible.

Tarsus III (fig. 28) shows a very distinct spine. It is further remarkable in its long empodium. The drawing is from the specimen determined by Bonet.



Figures 23–27.—*Eosentomon pallidum* Ewing: 23, foretarsus, exterior side, holotype; 24' female squama genitalis, holotype; 25, sternal chaetotaxy of abd. VIII–XII, specimen from Fayette County; 26, tergal chaetotaxy of abd. VIII–XII, same specimen; 27, tergal chaetotaxy of abd. IV, holotype.



Figures 28–32.—*Eosentomon pallidum* Ewing: 28, tarsus III, specimen from Fayette County. *Eosentomon yosemitense* Ewing: 29, foretarsus, exterior side, holotype; 30, female squama genitalis, holotype; 31, tarsus III, holotype; 32, mouth parts and head seen from above of holotype; Mdb=mandible.

The mouth parts were not suited for drawing; they resemble those of *wheeleri*.

Eosentomon minimum Ewing

Eosentomon minimum Ewing, 1921b, p. 195.

In 1940 Ewing abandoned *E. minimum* and stated that it is a synonym of *E. pallidum* Ewing (1940, p. 525). He made a mistake; an examination of his holotype in the U.S. National Museum has shown that it is a specimen of *E. vermiforme* Ewing. Therefore, *E. minimum* Ewing is a synonym of *E. vermiforme* Ewing.

Eosentomon yosemitense Ewing

FIGURES 29–32

Eosentomon yosemitensis Ewing, 1927, p. 146; 1940, p. 528.—Bonet, 1950, p. 123

According to grammatical rules the spelling should be *yosemitense* since *Eosentomon* is neuter.

The species was redescribed, especially in respect to the chaetotaxy, by Bonet (1950) without figures.

The holotype is the only specimen of the species known, and bears the label, floor of Yosemite Valley, California, in decaying leaves and twigs, H. E. Ewing collector, April 15, 1927. It is impossible to give a complete description of all characters.

Only one of the foretarsi (see fig. 29) is present on the holotype and is somewhat damaged. The sensillae on the interior side as well as some of the exterior ones are not visible. The t 1 has the same thickened rim as in *E. vermiforme*, but is situated more proximally to $\alpha\ 3'$; d:p=7:6(=1.15). The a could not be seen, and c 2 seems to be broken off; b is situated distally to c 1–c 2, not in a row as in *vermiforme;* e:u=10:12(=0.85).

In 1940 Ewing remarked that "the dorsal setae of tarsus I arise from tubercles." This statement is incorrect; we can see no difference in this respect from the other *Eosentomon* species.

The female squama genitalis (fig. 30) is very different from that of the other species, the processus sternales forming a kind of ring, open at two sides, surrounding the opening of the oviduct. It must be pointed out that the squama in the drawing is seen from the ventral side, but in the drawings of the other American species, from the dorsal side. However, this change cannot account for the great difference (see also the drawings of the squama of *E. armatum* (=*E. transitorium*) from both sides in Tuxen, 1958). The "ring" is not horizontal but somewhat oblique.

The chaetotaxy schematically is as follows:

	Abd. I	II–III	IV	V–VI	VII	VIII	IX–X	XI	XII
t	$\frac{4}{10}$	$\frac{12}{14}$	[a] $\frac{10}{14}$	[b] $\frac{8}{14}$	[c] $\frac{6}{14}$	$\frac{6}{7}$	8	8	9
s	$\frac{4}{4}$	$\frac{6}{4}$	$\frac{6}{10}$	$\frac{6}{10}$	$\frac{6}{10}$	$\frac{0}{7}$	4	8	10

[a] "2" is missing.

[b] "2" and "3" are missing.

[c] "1–3" are missing.

The missing anterior row of s VIII places the species in the *pallidum* group of Bonet; characteristic are the missing No. 2 in the anterior row of t IV and Nos. 2–3 in the anterior row of t V–VI; in other cases the setae will be lacking in the following order (from abd. IV–VII): "3," "1," and "2." Also the small number of setae in s IX–X is characteristic.

Generally speaking the accessory setae are longer than the principal ones; no drawing has been made to show this. Bonet (1950) states that the principal setae are very short.

Tarsus III (fig. 31) bears a distinct spine and a short empodium.

The mouth parts (fig. 32) were only roughly sketched during the stay in Washington and could not be checked at a later time. They resemble those of *vermiforme,* in exceeding the foremargin of the head and in having mandibular striae.

Eosentomon rostratum **Ewing**

Figures 33–36

Eosentomon rostratum Ewing, 1940, p. 520.

This species was described by Ewing as having a very long labrum, unique in the genus *Eosentomon.* Curiously, Ewing (1940) stated that formerly he "doubtless confused this labrum with the mandibles." In fact the species does not have a labrum.

There are two specimens on the holotype slide, and the data are, Highlands, North Carolina, on molding hemlock and deciduous tree leaves, May 8, 1936, V. R. Watson collector. These specimens were mentioned by Brimley (1938, p. 502) as *E. vermiforme.*

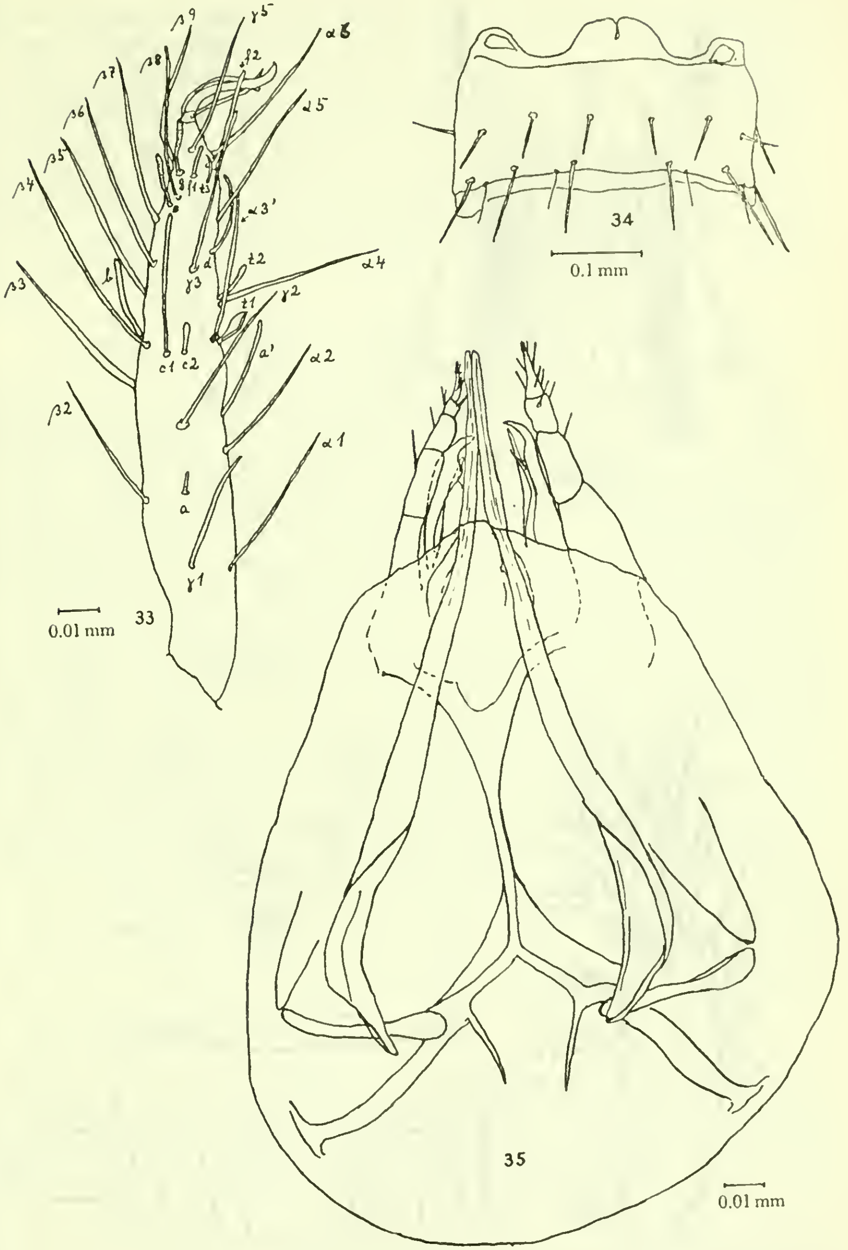
Only one other specimen of this species is known, collected at Ganntown, Illinois, December 29, 1932, by B. Harper and determined by Bonet. This specimen also has been used for the present description. It is a male.

Only one foretarsus (see fig. 33) was present on the holotype slide, and it was clearly visible only from the exterior side. The t 1 has a thickened rim, a is very short, c 2 extremely short, and c 1 long; b, c 1, and c 2 are in a line just as they are in *E. wheeleri* and *vermiforme.* The t 2 is short and d long; e and g are insignificantly broadened; a′ is very long, t 1 just at the base of α 3′; d:p=58:90(=0.65), a very unusual proportion probably due to some degree to the foretarsus not lying horizontally in the mount; e:u=20:26 (=0.75).

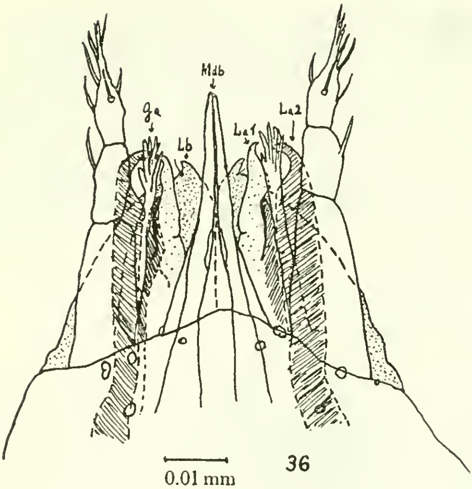
The chaetotaxy in every respect is equal to that of *vermiforme,* with the exception that s IX–X=4, not 6. Figure 34 of tV shows that the accessory setae are shorter than the principal ones, as they are in *vermiforme.*

Tarsus III has a distinct spine.

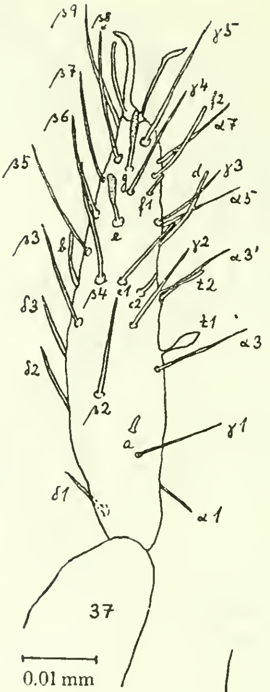
The mouth parts (figs. 35–36) are characterized by the very long and slender mandibles, which proceed very far in front of the foremargin of the head; in the holotype they even exceed the maxillary palpi. The galea and laciniae resemble in shape the corresponding ones in *vermiforme.* The mandibles are striated as in *vermiforme.*



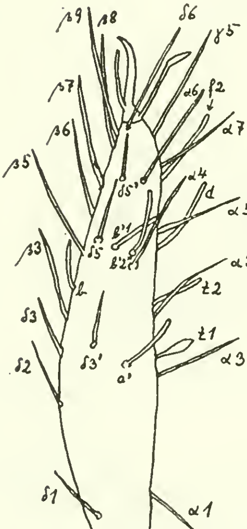
Figures 33–35.—*Eosentomon rostratum* Ewing: 33, foretarsus, exterior side, holotype; 34, tergal chaetotaxy of abd. V, holotype; 35, head and mouth parts seen from above, holotype.



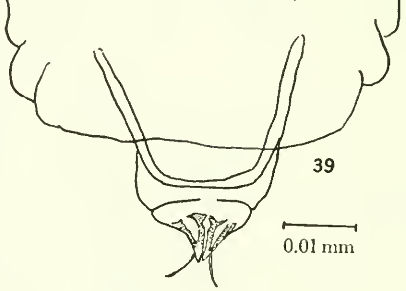
36



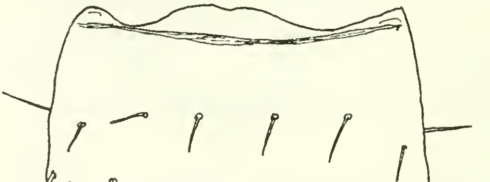
37



38



39



40

For explanation, see opposite page.

We have given figures of the mouth parts of both the holotype and the specimen determined by Bonet.

The female squama genitalis could not be drawn from the holotype as the tip of the abdomen is bent downwards; so far as could be seen it resembles that of *vermiforme*.

Although this species has very many features in common with *vermiforme*, we think that it is a different species because of the very curious mandibles, the different sizes of the sensillae a′ and especially the proportion c 2:c 1, and the difference in the number of setae in s IX–X.

Eosentomon pusillum **Ewing**

FIGURES 37–42

Eosentomon minimum Ewing, 1924, p. 46.—Not Ewing, 1921b, p. 195.
Eosentomon pusillum Ewing, 1940, p. 527.—Bonet, 1950, p. 111.

Bonet redescribed *pusillum* in 1950 without figures. There are only two slides present of this species, a female holotype in good condition and three paratypes in poor condition. Data for holotype and paratypes are, Orlando, Florida, in decaying leaves and twigs, H. E. Ewing collector, May 26, 1922.

On the foretarsus (figs. 37–38), t 1 is without a thickened rim; a is very small; the other sensillae are as they are in *E. wheeleri*. The empodium is nearly as long as the claw; e:u=15:17(=0.9). The t 1 is near α 3, not α 3′; d:p=55:45(=1.2). The c′ and t 3 were not visible on the only foretarsus present on the four specimens.

The female squama genitalis (fig. 39) is very different from that of the other species; the processus sternales has pointed edges.

The chaetotaxy as given by Bonet schematically is as follows:

	Abd. I	II–III	IV	V–VI	VII	VIII	IX–X	XI	XII
t	$\frac{4}{10}$	$\frac{12}{14}$	$\frac{12}{14}$	$\frac{12}{14}$	[a] $\frac{8}{14}$	$\frac{6}{7}$	8	8	9
s	$\frac{4}{4}$	$\frac{6}{4}$	$\frac{6}{10}$	$\frac{6}{10}$	$\frac{6}{10}$	$\frac{2}{7}$	6	8	10

[a] "1" and "3" are missing.

The most important points in the chaetotaxy are the presence of all anterior setae on t V–VI and the fact that only four setae are missing on t VII. Having two anterior setae on s VIII and a central posterior one, the species belongs to the *wheeleri* group.

FIGURES 36–40.—*Eosentomon rostratum* Ewing: 36, Head and mouth parts, seen from above of the specimen from Ganntown; Ga=galea; La 1 and La 2= 1st and 2nd lancinia; Lb, hyaline membrane of labium; Mdb=mandible. *Eosentomon pusillum* Ewing: 37, foretarsus, exterior side, holotype; 38, foretarsus, interior side, holotype; 39, female squama genitalis, holotype; 40, tergal chaetotaxy of abd. V, holotype.

Figure 40 shows the accessary setae to be much longer than the principal ones. It also shows the shape of the lamina before the anterior apodeme.

Tarsus III possesses only a very insignificant spine (fig. 41), the existence of which one would deny if he were not prepared to find it.

The pseudoculi (fig. 42) are extraordinarily large. The mouth parts have not been examined, but must resemble those of *wheeleri*.

Protentomon transitans **Ewing**

Figures 43–44

Protentomon transitans Ewing, 1921b, p. 196.—Ewing, 1940, p. 532.

Ewing mentions only one specimen, the holotype, of this tiny species, but in fact two more are present in his collection. Data for the holotype are, Takoma Park, Maryland, in decaying leaves, H. E. Ewing collector, April 24, 1921. Data for the other two specimens are Jasper County, Georgia, in peach orchard soil, William F. Turner collector, July 24, 1936. They were determined by Ewing as *Protentomon* and *Proturentomon* respectively, but the abdominal comb being without teeth indicates that they belong to *Protentomon* (see Tuxen 1956a).

We have drawn the foretarsus from the exterior side and the abdominal comb of the holotype (figs. 43–44) to show the likeness with *Protentomon perpusillum* Berlese as described by Tuxen (1956a, pp. 247–252); in fact there is no difference at all in these characters. The only difference is found in the chaetotaxy, and it is very slight. Tuxen (1956a) did not venture to decide whether *Protentomon perpusillum* Berlese and *Protentomon thienemanni* Strenzke were in fact different species on account of the small chaetotactical differences. The chaetotaxy of *Protentomon transitans* is in accordance with neither of them.

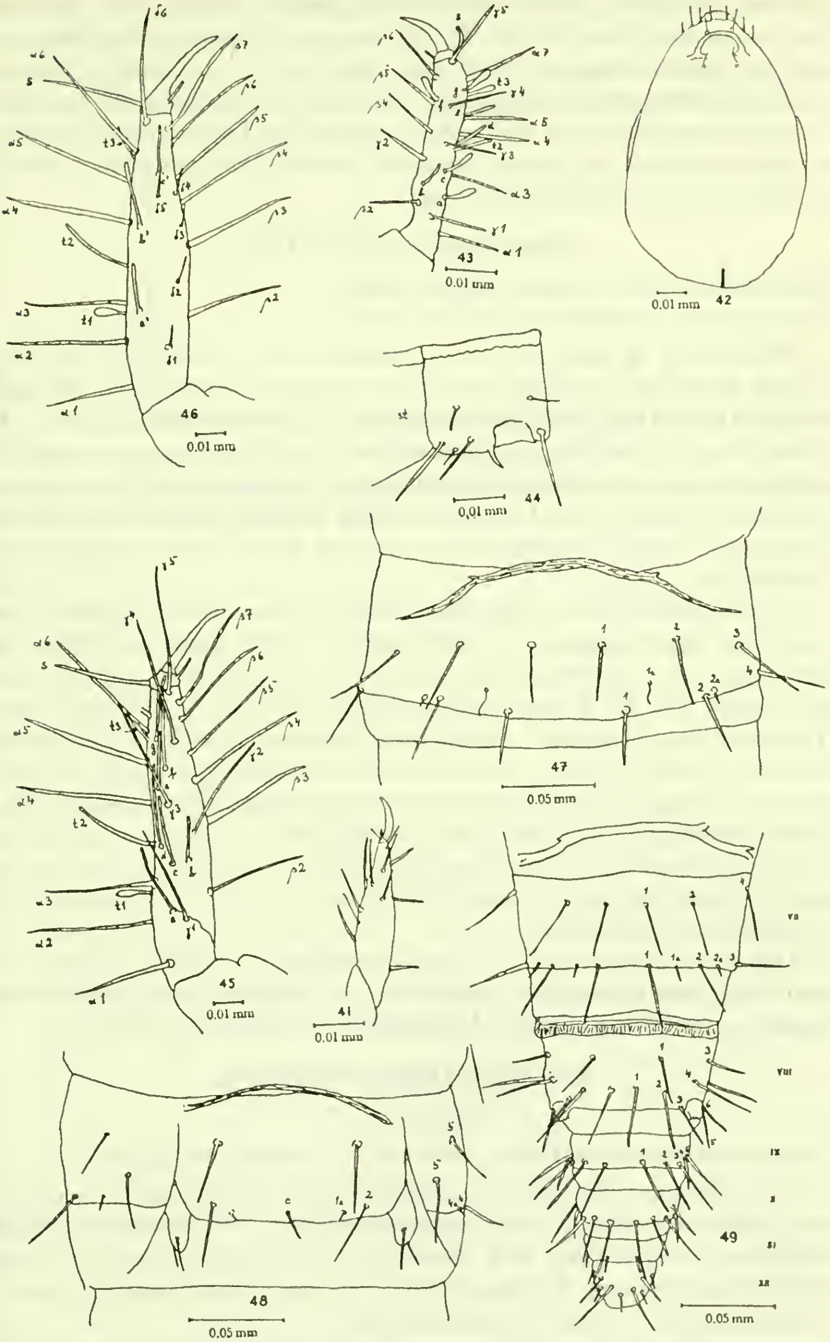
Thus the difference is stated schematically as follows:

	perpusillum	*thienemanni*	*transitans*
t VIII ant.	4	6	4
t X	8	6	10
s XI	4	6	6

We should warn, however, against placing to much stress on these differences in chaetotaxy. For instance, it is worth noticing that in

---

Figures 41–49.—*Eosentomon pusillum* Ewing: 41, tarsus III, holotype; 42, shape of head, holotype. *Protentomon transitans* Ewing: 43, foretarsus, exterior side, holotype; 44, comb on abd. VIII, holotype. *Acerentomon americanum* Ewing: 45, foretarsus, exterior side, holotype; 46, foretarsus, interior side, holotype; 47, tergum of abd. III, specimen from Luray Caverns, Virginia; 48, sternum of abd. III, same specimen. 49, terga of abd. VII–XII, same specimen.



For explanation, see opposite page.

the two specimens of *transitans*? from Jasper County, only the two long setae on either side of XI are present, in *perpusillum* the long and the short setae on either side and in one specimen of *thienemanni* all three setae are present. Probably the number of setae may vary to some degree, as was already shown by Tuxen (1955); so until a larger series of the three "species" is available, we cannot decide whether to give them specific rank.

Microentomon minutum Ewing

Microentomon minutum Ewing, 1921b, p. 200.
Microentomon perpusillum Ewing, 1940, p. 533.

The history of this species is a curious one (Tuxen 1956a, p. 249). Ewing described it in 1921 from three immature specimens, although he said that he had often seen specimens (supposedly adult) alive. In 1936 he stated that the tarsi are without sensillae, that the second abdominal legs are one segmented, and that the genus should be included in the subfamily Protentomoninae (with 2-segmented second abdominal leg). In 1940 he even synonymized it with Berlese's *Acerentulus perpusillus*.

All three slides were originally labeled *Microentomon minutum*, but two were later changed to *perpusillum*. Two slides including the holotype bear the data, Takoma Park, Maryland, in decaying leaves and twigs, H. E. Ewing collector, April 10, 1921; the third one, Takoma Park, Maryland, under bark of decaying twig, H. E. Ewing collector, April 24, 1921. All three specimens are immature and have only 10 abdominal segments; all very distinctly possess one-segmented second abdominal legs and furthermore have a distinct comb on the eighth abdominal tergum. They are evidently young specimens of an acerentomid, and very probably of Ewing's *Acerentomon conurus*, with which they were found.

The genus *Microentomon* should therefore be entirely abandoned, and the species *minutum* considered as identical with *Acerentomon conurus*, a junior synonym of *Acerentulus americanus* (Ewing).

Acerentomon americanum Ewing

FIGURES 45–54

Acerentomon americanum Ewing, 1921b, p. 197.—Ewing, 1940, p. 536.

Two slides are labeled as this species, but they probably belong to two different species, one of them undescribed. We shall here confine ourselves to describing and drawing the holotype, a female. Data for the holotype are Takoma Park, Maryland, from decaying leaves, March 27, 1921, H. E. Ewing collector.

The foretarsus (figs. 45–46) is typically acerentomid (Tuxen 1955). The t 1 is placed proximally on the tarsus; d:p=70:35(=2). The empodium is short; e:u=8:28(=0.3); a is long, c longer than b, d very long, and f much longer than g. The t 3 is long, lancetlike, t 1 long, claviform. The b′ and c′ are longer than a′.

The chaetotaxy (figs. 47–50) schematically is as follows (pleurals as usual included in the tergals):

	Abd. I	II–III	IV–VI	VII	VIII	IX	X	XI	XII
t	6 / 12	[a]8 / [b]14	[b]8 / [b]14	[c]8 / 16	6 / 14	10	10	4	9
s	3 / 2	3 / 5	3 / 8	3 / 8	4 / 2	4	4	6	6

[a] "4" is missing.
[b] "3" is missing.
[c] "3" is missing.

It is characteristic that 1a in the posterior row of the terga is situated anteriorly to the other setae of the row (fig. 47); also characteristic are the setae missing in the anterior and posterior rows of the terga. The s VIII has two posterior setae. Ewing drew t VII and made a point of the next to lateral seta in the anterior row being situated "in front of and out of line with the other setae of the row." He did not realize, however, that the next to lateral seta in t VII is No. 4, while in the first six terga it is No. 3, which as usual is situated out of line, but behind the other setae of the row.

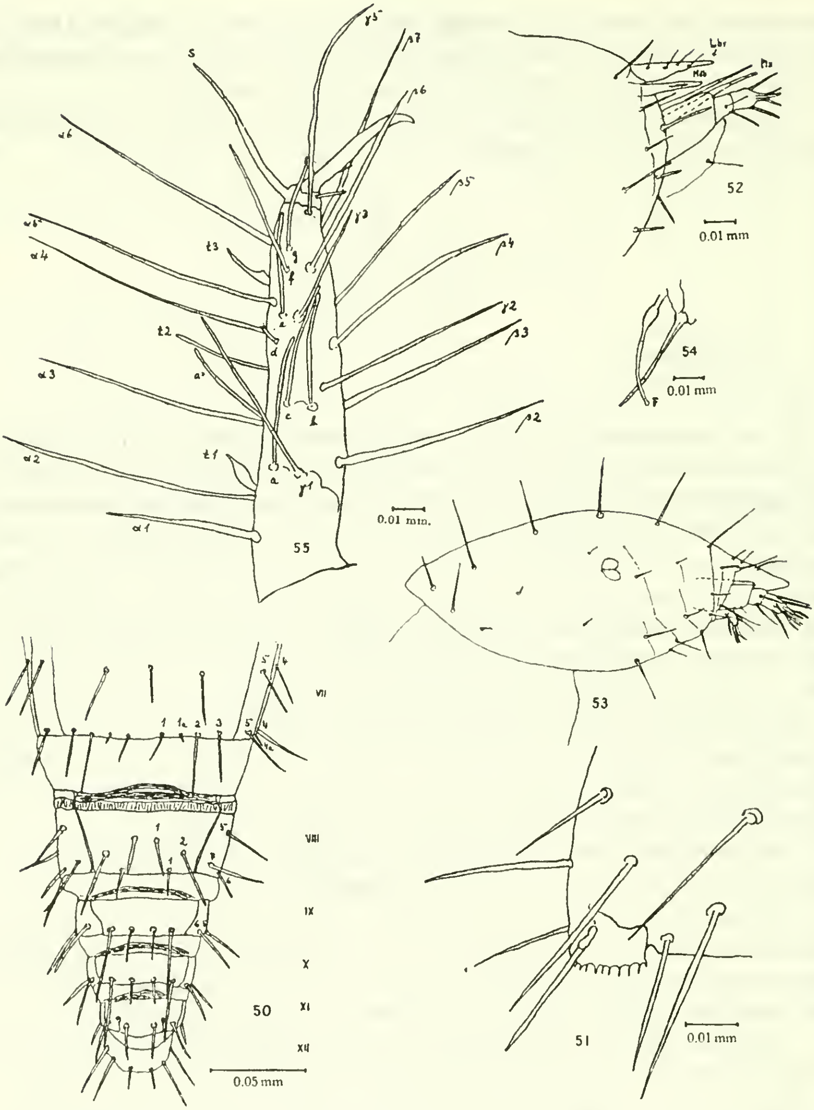
The drawings of the chaetotaxy were made from two specimens determined by Bonet with the label Luray Cavern, Virginia, June 4, 1948, E. W. Baker and F. Bonet collectors. The anterior apodeme is only slightly branched, not as much as shown by Ewing.

The comb on abd. VIII (fig. 51) has about 10 equally long teeth. There is no other comb or row of teeth either on abd. V or VIII–X.

The mouth parts of the holotype are drawn in figure 52. A short labrum is present, a mandible with a small split, pointed maxilla lobes, and a rather slender maxillary palpus. The whole as seen from the side and showing the chaetotaxy is drawn in figure 53 by Bonet.

The filamento di sostegno is shown in figure 54 from the holotype and therefore from the side; it is short and without remarkable features.

Because of the shape of the maxillary palpus (3-segmented, according to Berlese, i.e., without a limit between the outermost segment and the tusk of hairs on its tip) and the very small labrum, we are inclined to put the species in the genus *Acerentulus* without, however, having made up our minds as to the justification of keeping *Acerentulus* and *Acerentomon* apart, or even perhaps dividing them into more genera. In extreme cases there seems to be no doubt that the species belongs to one or the other genus, but some cases are doubtful. Therefore, for the present, the species should be called *Acerentulus americanus* (Ewing).



Figures 50–55.—*Acerentomon americanum* Ewing: 50, sterna of abd. VII–XII, specimen from Luray Caverns; 51, comb on abd. VIII, holotype; 52, foremost part of head with "labrum" (Lbr) and mouth parts of holotype; Mdb=mandible; Mx=maxilla; 53, chaetotaxy of head, holotype, drawn by Bonet; 54, filamento di sostegno, holotype. *Acerentomon andrei* Ewing: 55, foretarsus, exterior side, holotype.

Acerentomon conurus Ewing

Acerentomon conurus Ewing, 1921b, p. 197.—Ewing, 1940, p. 541.

There are several slides determined by Ewing as *conurus*, among them the holotype, with the label, Takoma Park, Maryland, in decaying leaves and twigs, April 10, 1921, H. E. Ewing collector. The holotype specimen lies on this slide in such a way that the foretarsus appears to be very greatly shortened. The mutual size and placement of the sensillae therefore look different from those of *Acerentulus americanus*. It would be misleading to print the drawing of this foretarsus, as in fact there is no difference between the foretarsus of the other specimens of *conurus* and *americanus*. They are alike in every feature.

The chaetotaxy, the comb of abd. VIII, the shape of the head, and the filamento di sostegno are also the same in every respect as they are in *americanus*. A small difference might be found in the placement of the two small setae anteriorly and posteriorly to the pseudoculus. In *americanus* the distance of the two setae from the pseudoculus is the same; in *conurus* the postocular seta is nearer to the pseudoculus than the preocular one. We should not like to make this difference, which might even be subject to individual variation, a specific character, however, and so we feel justified in stating that *Acerentomon conurus* Ewing is a synonym of *Acerentulus americanus* (Ewing), the latter name having priority.

Acerentomon andrei Ewing

FIGURES 55–65

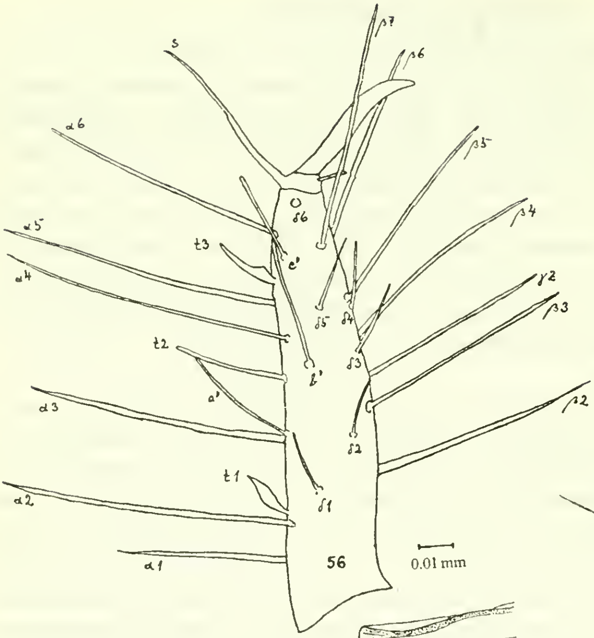
Acerentomon andrei Ewing, 1940, p. 537.

The holotype female is the only specimen present, with the label, Utah, Salt Lake, dead leaves, Aug. 3, 1937, F. Andre collector.

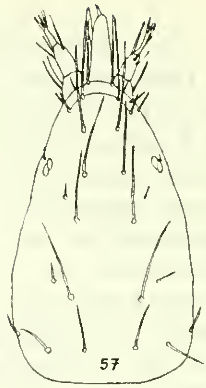
On the foretarus (figs. 55–56), t 1 has a curious shape, clavate but pointed; d:p=99:34(=3.0); t 3 is long, lancetlike. All sensillae are long, including probably also d, which is broken; b and c are of the samel ength; f is much longer than g; f reaches halfway out on the claw. The a′, b′, and c′ are also very long. The empodium is short; e:u=10:45(=0.2).

The chaetotaxy (figs. 57–62) schematically is as follows:

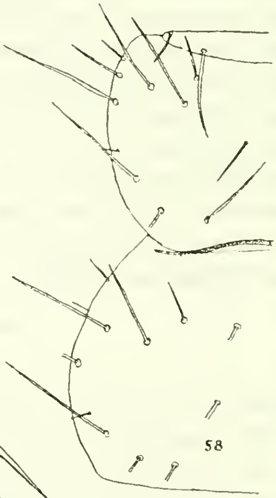
	Abd. I	II–III	IV–V	VI	VII	VIII	IX	X	XI	XII
t	$\frac{4}{12}$	$\frac{10}{16}$	$\frac{10}{16}$	$\frac{10}{16}$	$\frac{8}{16}$	$\frac{6}{15}$	12	12	6	9
s					$\frac{3}{9}$	$\frac{4}{2}$	4	4		6



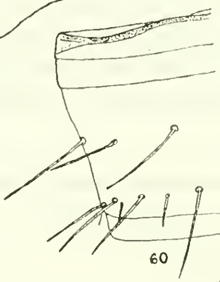
56



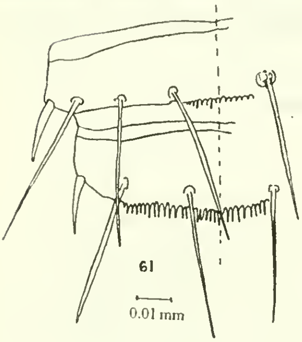
57



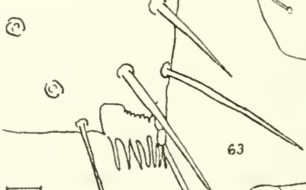
58



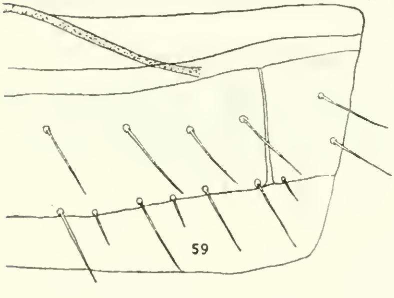
60



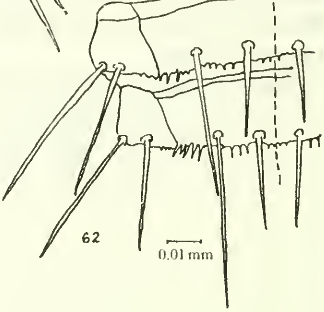
61



63



59



62

For explanation, see opposite page.

Figure 57 gives the tergal chaetotaxy of the head and figure 58 that of the thorax; figures 59–60 give that of abd. II and VII; all were drawn by Bonet.

The presence of a posterior row of setae in s VIII and a central seta in the posterior row of t VIII is important.

A row of teeth is found on the hind margin of terga IX and X; about 20 small teeth are on t IX, and about 40 larger ones are on t X (fig. 61). The hind margins of the pleura and sterna of these segments also show rows of teeth (fig. 62). No row of teeth is present on the pleuron of abd. VIII or V.

The comb of abd. VIII (fig. 63) consists of 7–8 long teeth. As is well known, this comb marks the lower border of the opening of the large abdominal glands. A row of quite small teeth is also present on the upper lid of this opening in the present species.

There is a well developed labrum, nearly one-fourth the length of the head (fig. 64). The maxillary palpi are long and the outermost tusk of each seta is clearly defined as a fourth segment. All long setae of the head are extremely long.

The filamento di sostegno (fig. 65) is short.

The species belongs, without doubt, to the genus *Acerentomon* as defined by Berlese (1909).

Acerentomon christensoni Ewing

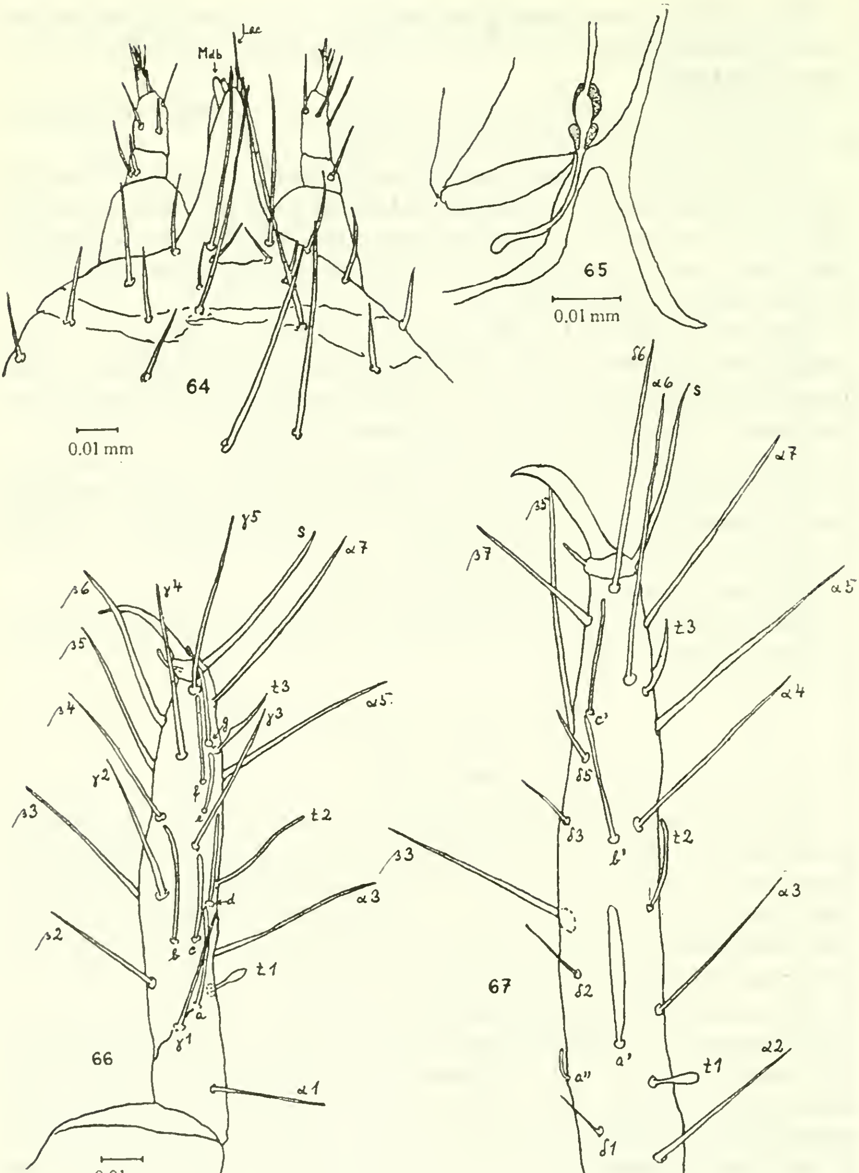
FIGURES 66–69

Acerentomon christensoni Ewing, 1940, p. 537.

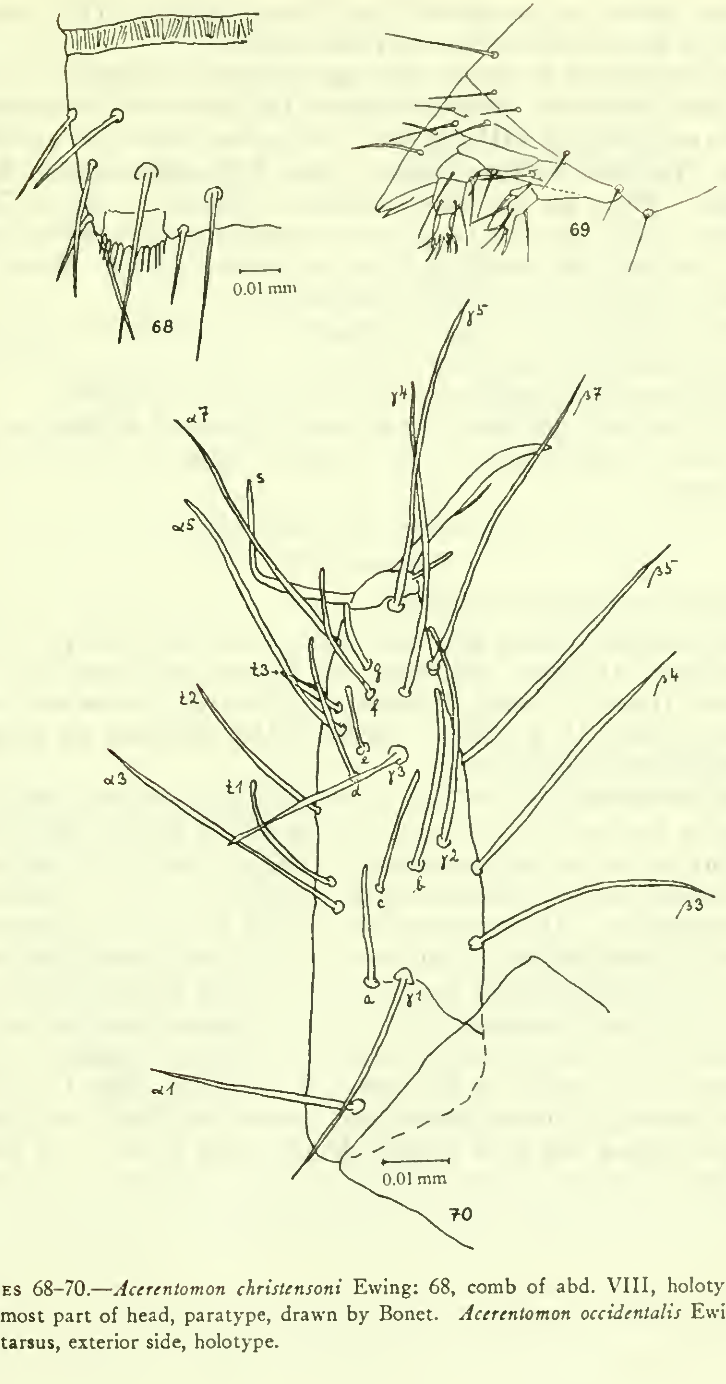
Several slides of this species are present. We have made descriptions and drawings from the type slide which contains 4 females, and a paratype slide with 3 females. Data of the type slide are, Brigham, Utah, in peach orchard soil, April 20, 1938, L. D. Christenson collector. The paratype slide bears the data, Medford, Oregon, in peach orchard soil, Sept. 12, 1938, L. D. Christenson collector.

The exterior side of the foretarsus (figs. 66–67) was drawn from a specimen on the type slide, of one of the paratypes. The t 1 is clavate, t 3 long, lancetlike. The difference from *Acerentulus americanus* is seen in b being longer than c, g longer than f, d short; and what is very remarkable, a′ is broad and long, and a small a″ (=β1) is present. In all these characters the foretarsus resembles that of *Acerentulus*

FIGURES 56–63.—*Acerentomon andrei* Ewing: 56, foretarsus, interior side, holotype; 57, chaetotaxy of head, holotype, drawn by Bonet; 58, chaetotaxy of thorax, holotype, drawn by Bonet; 59, tergum of abd. II, holotype, drawn by Bonet; 60, tergum of abd. VII, holotype, drawn by Bonet; 61, terga of abd. IX–X, holotype; 62, sterna of abd. IX–X, holotype; 63, comb of abd. VIII, holotype.



Figures 64–67.—*Acerentomon andrei* Ewing: 64, foremost part of head seen from above holotype; Lac=lacinia; Mdb=mandible; 65 filamento di sostegno, holotype. *Acerentomon christensoni* Ewing: 66, foretarsus, exterior side, holotype; 67, foretarsus, interior side, paratype.



Figures 68–70.—*Acerentomon christensoni* Ewing: 68, comb of abd. VIII, holotype; 69, foremost part of head, paratype, drawn by Bonet. *Acerentomon occidentalis* Ewing: 70, foretarsus, exterior side, holotype.

confinis Berlese as reexamined by Tuxen (1956a). The broad a′ seems to be very characteristic of this species.

The chaetotaxy is exactly like that of *confinis;* therefore, we shall not give it in detail. Also the shape of the apodemes is the same.

The comb of abd. VIII (fig. 68) is drawn from one of the specimens on the type slide, because it seems to be a little different from that of *confinis.* There are the same number of teeth, about 12, but Tuxen (1956a, p. 232) states that one of the central teeth of *confinis* is longer than the rest; this condition is not so in *christensoni.* We do not, however, consider this difference important.

The head (fig. 69) is drawn by Bonet from a specimen on the type slide; it is a typical *Acerentulus* head.

The filamento di sostegno is exactly like that of *confinis.*

Thus we conclude that *Acerentomon christensoni* is identical with *Acerentulus confinis* Berlese and should be lowered to the rank of a synonym.

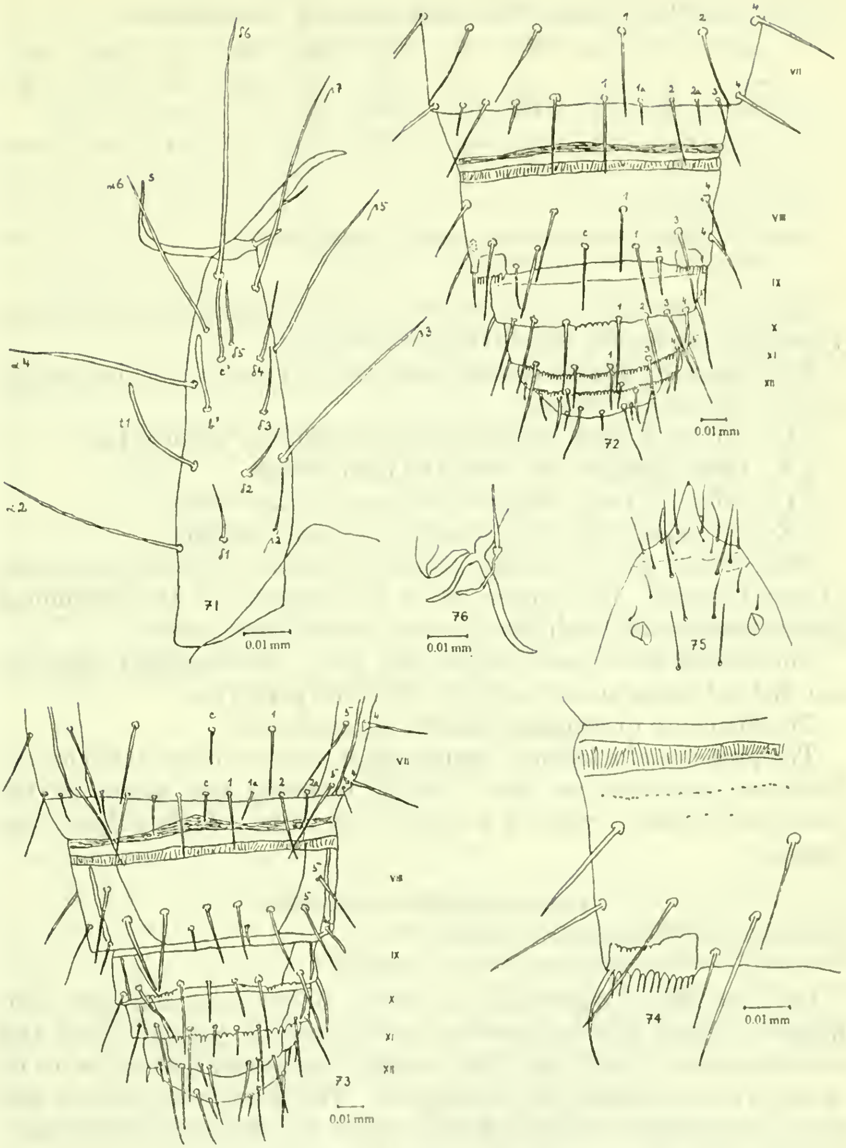
Acerentomon occidentalis Ewing

Figures 70–76

Acerentomon occidentalis Ewing, 1940, p. 540.

There are three slides present of this species, the holotype and two paratypes. All three specimens are females and bear the data, floor of Yosemite Valley, California, in decaying leaves and twigs, April 15, 1927, H. E. Ewing collector. Our drawings are from the holotype and one paratype.

The foretarsus (figs. 70–71) is extremely broad and short compared with the foretarsi of other acerentomids known to us. The ratio of the claw to the rest of the tarsus is 53:150, i.e., nearly 1:3; in *Acerentulus americanus,* for instance, it is 32:105, i.e., 1:3.5; this ratio is more common. Also the ratio of breadth to length of foretarsus (without pretarsus) is 45:140, about 1:3; in *americanus* it is 20:100 or 1:5, as is more or less the case in the other species. This ratio, however, is only discernible if the specimen is seen from the side, not from above or below. The t 1 is long and slender, not clavate, placed exactly in the middle of the tarsus; d:p=70:70. The t 3 is long, lancet shaped; b is much longer than c; d and f are long, e and g short. On the interior side a′ is missing; b′ is a little broader and shorter than c′.



Figures 71–76.—*Acerentomon occidentalis* Ewing: 71, foretarsus, interior side, holotype; 72, terga of abd. VII–XII, paratype; 73, sterna of abd. VII–XII, paratype; 74, comb of abd. VIII, holotype; 75, foremost part of head, holotype, drawn by Bonet; 76, filamento di sostegno, paratype.

The chaetotaxy (figs. 72–73) schematically is as follows:

	Abd. I	II	III	IV–V	VI	VII	VIII	IX	X	XI	XII
t	[a] $\frac{6}{12}$	$\frac{10}{16}$	$\frac{10}{16}$	$\frac{10}{16}$	$\frac{10}{16}$	[b] $\frac{8}{16}$	$\frac{6}{13}$	12	10	4	9
s	$\frac{4}{4}$	[c] $\frac{4}{5}$	$\frac{3}{5}$	$\frac{5}{8}$	[d] $\frac{4}{8}$	$\frac{3}{9}$	$\frac{4}{2}$	4	4	6	6

[a] "1," "2," and "5."

[b] "3" is missing.

[c] "4" in the paratype, "5" in the holotype; both are probably abnormal.

[d] "4" in the paratype, probably abnormal; "5" in the holotype.

There is some difference between the holotype and one of the paratypes, due, no doubt, to individual variation.

Very characteristic are several rows of small teeth on the hind margin of abd. IX–XI, as follows:

s IX: about 6 small teeth dispersed outside the outer setae.
s X: teeth dispersed all along the hind margin.
t IX: about 6 teeth dispersed between the inner setae.
t X–XI: closely set teeth all along the hind margin.

The comb of abd. VIII (fig. 74) possesses about 12 rather long teeth of equal length. The upper lid of the opening of the abdominal glands bears small teeth like those in *Acerentomon andrei.*

The species has a small labrum (fig. 75). The maxillary palpi are not distinct either in the holotype or in the paratype.

The filamento di sostegno (fig. 76) is very small.

The presence of a labrum, though short, and the many teeth on the hindmost segments, we think, justify retaining this species in the genus *Acerentomon,* where it is a junior synonym of *A. californicum* (Hilton).

Acerentulus californicus Hilton

Acerentulus californicus Hilton, 1929, p. 132.
Acerentulus barberi californicus, Ewing, 1940, p. 550.

In 1929 Hilton described *Acerentulus californicus* and gave two figures. These figures, however, give only the general shape and numerous setae, which are often wrongly placed and far too few to be of any value in identifying the species. The description is short and does not contain anything which would not fit any acerentomid. The type is said to be in the Pomona College collection.

Ewing (1940) made a new description based on a female specimen sent to him by Hilton and part of some material from the type locality.

We both independently wrote to Professor Hilton asking him about his types. He replied that he had been unable to locate the types, but that he had sent some specimens to the U.S. National Museum, and that he did not possess any more material. Hilton's types of *Acerentulus americanus* (Tuxen 1955, p. 125) and *A. cali-*

fornicus are not in the U.S. National Museum, as we both had the opportunity of ascertaining when we were in Washington. They must therefore be regarded as lost.

The *californicus* slide on which Ewing based his short redescription, however, is present. It bears the label in Hilton's writing, *A. calif.* ♀ Cobell's Canyon, Calif., Jan. 1938. As this seems to be the only known specimen of the species, and as it was determined by Hilton, we designate it as a neotype. It is a well preserved female, cleared and stained.

Now it appears that this specimen is exactly identical with the type of *Acerentomon occidentalis* Ewing. The foretarsi are visible from above and therefore do not appear to be as broad as those in the type specimen of this species, but all sensillae are visible and of the same length and position as in *occidentalis*. The chaetotaxy is exactly alike, the only differences being within the range of variability (see above), viz., s II–III=$5/5$, s VI=$5/8$. The teeth on t IX–XI and s IX–X are exactly alike, as are the labrum and the filamento di sostegno. It is impossible for us to see any difference, and so we must state that *Acerentulus californicus* Hilton is a synonym of *Acerentomon occidentalis* Ewing. As *californicus* is the older name, it has priority in spite of the poor description given by Hilton. Thus, the species should be called *Acerentomon californicum* (Hilton).

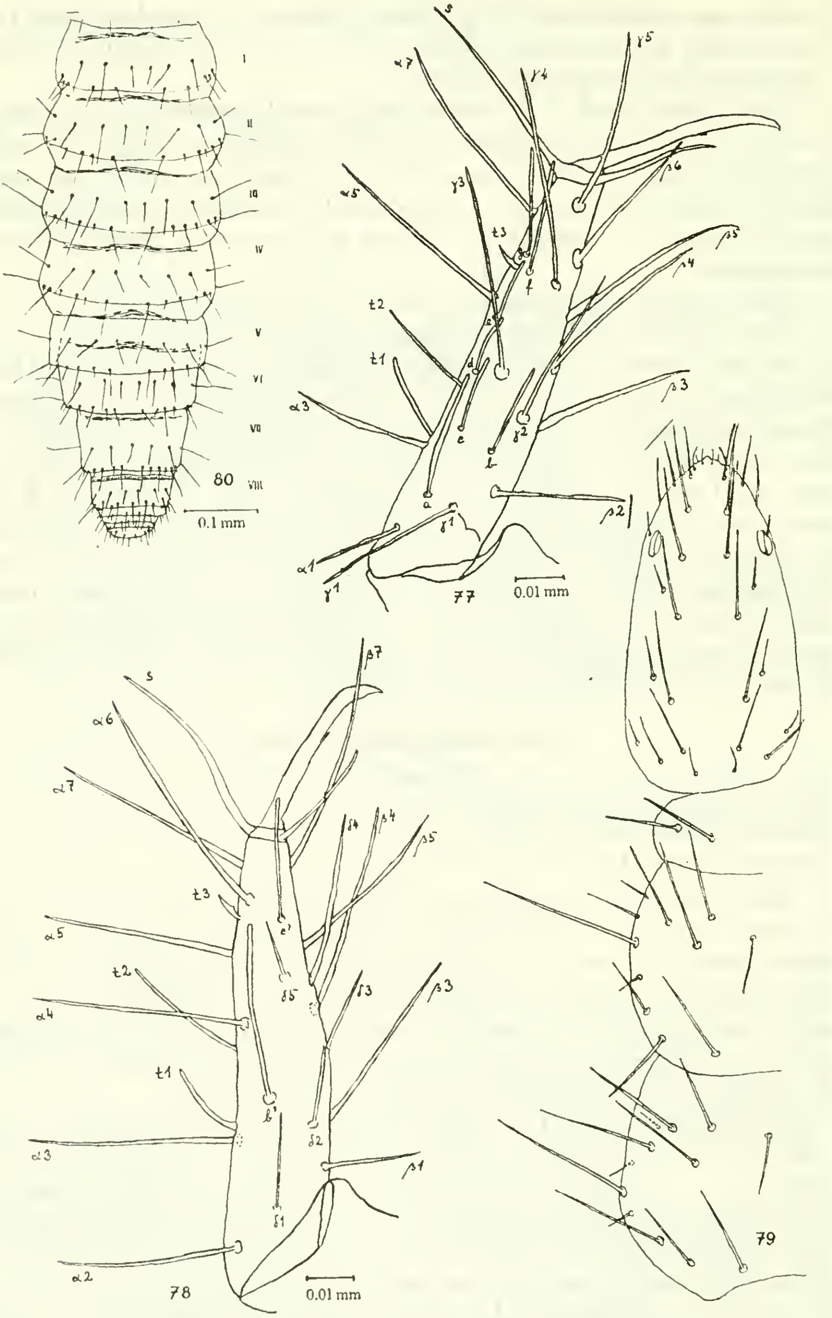
Acerentulus barberi Ewing

FIGURES 77–83

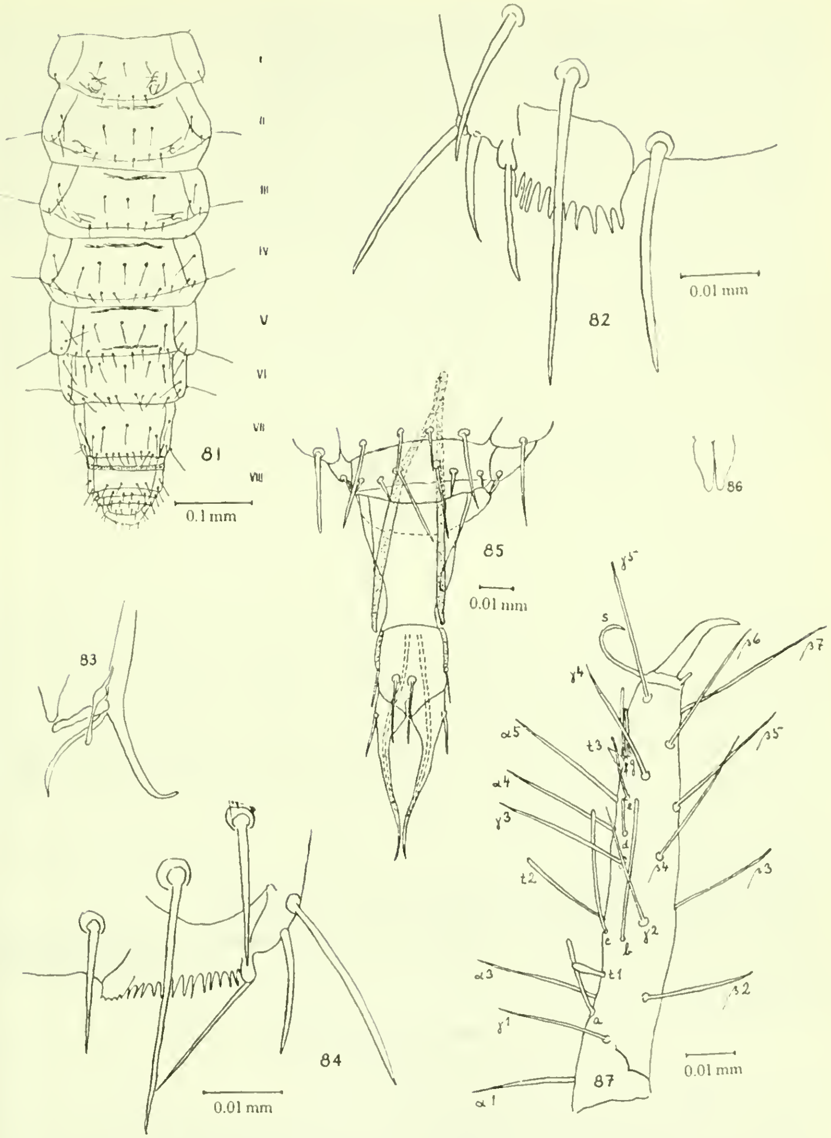
Acerentulus barberi Ewing, 1921a, p. 240.
Acerentulus tenuiceps Ewing, 1921b, p. 198.
Acerentulus barberi barberi Ewing, 1940, p. 549.

This was the first American proturan to be described after Silvestri's *E. wheeleri*. There are many slides in the collection, some of them marked *barberi* and others *tenuiceps*. Ewing realized in 1940 that these two species described by him were identical. Then he called the species *barberi barberi*, as he thought Hilton's *californicus* was a variety of it. It has been shown above, however, that this is correct; so the species should keep its binary name.

The holotype bears the label, Takoma Park, Maryland, Feb. 14, 1921, from decaying leaves, H. E. Ewing collector. In addition to the holotype, we examined a male and a female determined as *barberi* and labeled, Chesterville, Illinois, Oct. 18, 1921, in decaying leaves and twigs, killed Nov. 7, 1921, H. E. Ewing collector (we will call these "specimens 2 and 3"), and also a male and a female determined as *tenuiceps*, but corrected by Ewing to *barberi* and bearing the label, Takoma Park, Maryland, April 3, 1921, from decaying leaves, H. E. Ewing collector (we will call these "specimens 4 and 5").



FIGURES 77–80.—*Acerentulus barberi* Ewing: 77, foretarsus, exterior side, specimen 4; 78, foretarsus, interior side, same specimen; 79, chaetotaxy of head and thorax, holotype, drawn by Bonet; 80, abdominal terga, specimen 2.



FIGURES 81–87.—*Acerentulus barberi* Ewing: 81, abdominal sterna, specimen 2; 82, comb of abd. VIII, specimen 2; 83, filamento di sostegno, holotype, drawn by Bonet. *Acerentulus oculatus* Ewing: 84, comb of abd. VIII, male in copula; 85, male squama genitalis seen from the ventral side, male in copula. *Acerentulus bicolor* Ewing: 86, preimaginal male squama genitalis, holotype, drawn by Bonet. *Acerentulus floridanus* Ewing: 87, foretarsus, exterior side, paratype.

The foretarsus (figs. 77–78) is characterized by t 1 being long and slender, not clavate, and placed proximally on the tarsus; d:p=85:45(=2); t 2 is longer and more slender than t 1; t 3 short, lancet-like. Exteriorly the long and broadly spindle-shaped a is noticeable; interiorly the very long a′ (erroneously, b′ on fig. 88) is also noticeable; b′ is missing; e is placed in the middle between d and f; f and g are near each other. Also peculiar is the very long seta δ 4. The empodium is a little more than half the claw; e:u=35:65.

The chaetotaxy schematically is as follows (the pleurals as usual are included in the tergals; the dorsal chaetotaxy of head and thorax are shown in fig. 79, of the holotype; figs. 80–81 were made from specimen 2):

	Abd. I	II–III	IV–VI	VII	VIII	IX	X	XI	XII
t	$\frac{6}{12}$	$\frac{10}{18}$	$\frac{10}{18}$	[a] $\frac{8}{18}$	$\frac{8}{13}$	12	8	6	9
s	$\frac{3}{4}$	$\frac{3}{5}$	$\frac{5}{8}$	$\frac{5}{9}$	4	4	4	6	6

[a] "1" is missing.

There is a small variability among the five specimens. In the anterior row of t VI, one specimen has only nine setae, one even eight. In t VII, two specimens have nine setae. Two specimens have only two setae in the posterior row of s I.

Unfortunately in all specimens the outermost segments (IX–XII) were pulled so closely together, that it was impossible to make clear drawings of them.

The comb of abd. VIII (fig. 82) consists of 10 rather long and irregular teeth.

The filamento di sostegno (fig. 83) is very short.

The species is without a labrum and has short, blunt, three-segmented maxillary palpi. It belongs without doubt to Berlese's genus *Acerentulus.*

***Acerentulus oculatus* Ewing**

FIGURES 84–85

Acerentulus oculatus Ewing, 1921b, p. 198;1940, p. 545.

Only a few specimens are present. We have examined the holotype, a female labeled, Takoma Park, Maryland, from decaying leaves, March 6, 1921, H. E. Ewing collector; and another specimen labeled, male, taken in copula in breeding cell, March 4, 1922.

It appears that in nearly all characters the specimens are identical with the specimens of *Acerentulus barberi.* In the foretarsus the characteristic spindle-shaped a, the long and slender t 1, the extraordinarily long δ 4 show the identity with *barberi*. In the chaetotaxy the only difference from the scheme given for *barberi* is that only 2 setae are found in the posterior row of s I, but this variation was also found in specimens of *barberi*.

The only other difference is found in the shape of the comb of abd. VIII (fig. 84). The innermost part is separated as a small lobe with 4–5 very small teeth. We have never seen this feature before in any acerentomid and cannot say if it is an individual variation, which we think most probable, or a specific character. It was found in both specimens examined.

The specimen taken in copula has a distended copulatory apparatus, which we have drawn (fig. 85), as it shows the shape and chaetotaxy of this organ very distinctly.

Thus we conclude that *Acerentulus oculatus* Ewing is synonymous with *A. barberi* Ewing, the latter name having priority.

Acerentulus bicolor Ewing

FIGURE 86

Acerentuloides bicolor Ewing, 1921b, p. 199.
Acerentulus bicolor Ewing, 1940, p. 543.

Four slides are present in the series of this species, but two of them (from Florida) are *Acerentulus floridanus* Ewing. The holotype of *bicolor* is labeled, Takoma Park, Maryland, in decaying leaves and twigs, April 10, 1921, H. E. Ewing collector. It is a male preimago. The paratype, with the same label but only dated 1921, is a maturus junior. We have examined these two specimens.

The foretarsus is exactly like that of *Acerentulus americanus*, except that in the holotype b is a little longer than c; in *americanus* the opposite is the case. The chaetotaxy, abdominal comb, and filamento di sostegno are all alike.

Womersley in 1927 abandoned the genus *Acerentuloides* as based on immature specimens. Ewing in 1936 kept the genus, saying that it was based on a female, but abandoned it in 1940 as based upon variable characters. In fact the holotype is not a female, but a preimaginal male (fig. 86), a mistake which even Berlese made (*Acerentulus cephalotes*, see Tuxen, 1956a, p. 234).

Unfortunately Bonet did not give the setae in his drawing of the squama genitalis, and Tuxen forgot to correct this when in Washington.

It is therefore concluded that not only the genus *Acerentuloides* should be abandoned, but also the specific name *bicolor* Ewing, due to the following synonymy: *Acerentuloides bicolor* Ewing=*Acerentulus americanus* (Ewing).

Acerentulus floridanus **Ewing**

Figures 87–93

Acerentomon floridanum Ewing, 1924, p. 44.
Acerentulus floridanus Ewing, 1940, p. 546.

We have examined and made drawings of two specimens of this species, the holotype, a female, and a paratype with extended female genitalia; both specimens are labeled, Orlando, Florida, May 26, 1922, in decaying leaves and twigs, H. E. Ewing collector.

The foretarsus (figs. 87–88) has a clavate t 1 and a small, rather blunt, lancetlike t 3; d:p=84:40(=2.10). The most characteristic features are the very long sensillae b and c, and the short f and g; f and g are rather close; e is in the middle between d and f; b′ is missing (a′ given erroneously as b′ in fig. 88). The empodium is short; e:u=4:27(=0.15).

	Abd. I	II–III	IV–V	VI	VII	VIII	IX	X	XI	XII
t	$\frac{4}{12}$	$\frac{\text{[a]}8}{\text{[b]}14}$	$\frac{8}{14}$	$\frac{\text{[c]}8}{16}$	$\frac{\text{[d]}6}{16}$	$\frac{6}{14}$	14	12	6	9
s	$\frac{3}{4}$	$\frac{3}{5}$	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{3}{8}$	4	4	4	6	6

[a] "4" is missing.
[b] "4" is missing.
[c] "3" is missing.
[d] "1" and "3" are missing.

The comb of abd. VIII (fig. 92) is very peculiar, having teeth which appear to be coalesced nearly to the tip. There are about 8–10 teeth, and only the outermost tips of them are free, but their borders seem to be visible within the lamina.

The filamento di sostegno (fig. 93) is very short.

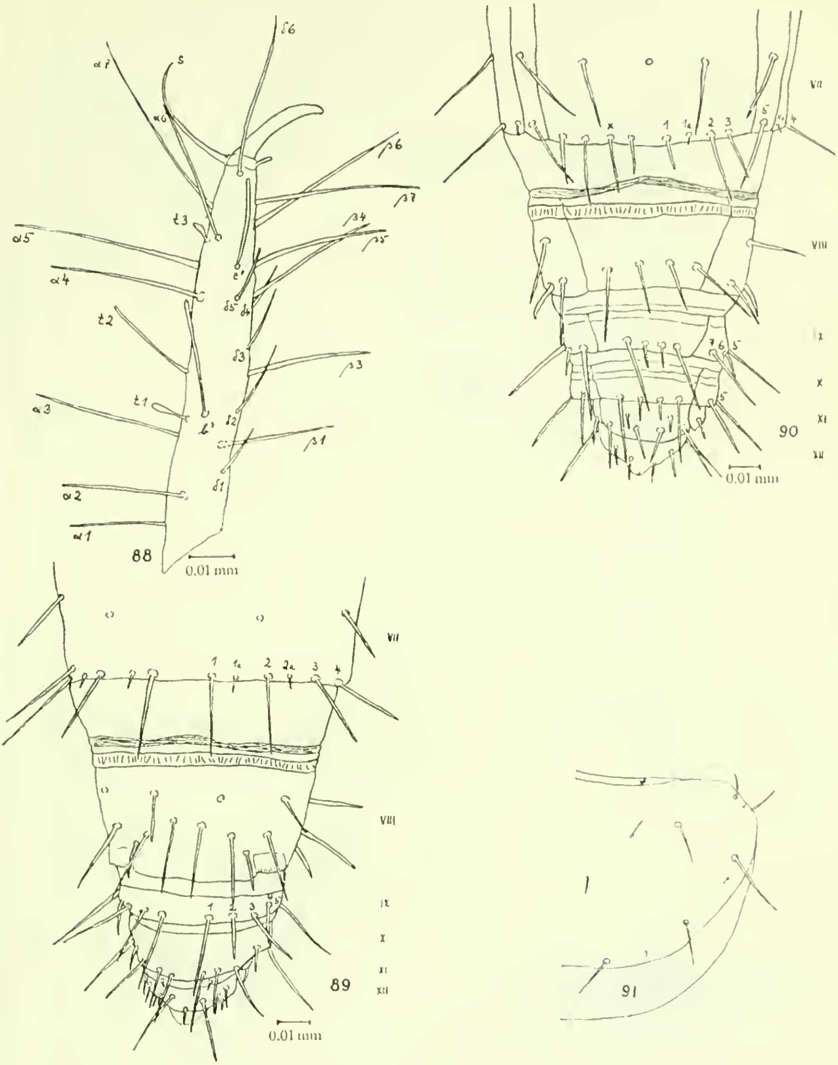
The characters mentioned are identical in the two specimens and there seems to be no doubt about the specific rank of the species on account of the large sensillae b and c of the foretarsus and the very characteristic comb. The species belongs to the genus *Acerentulus.*

Acerentulus aureitarsus **Ewing**

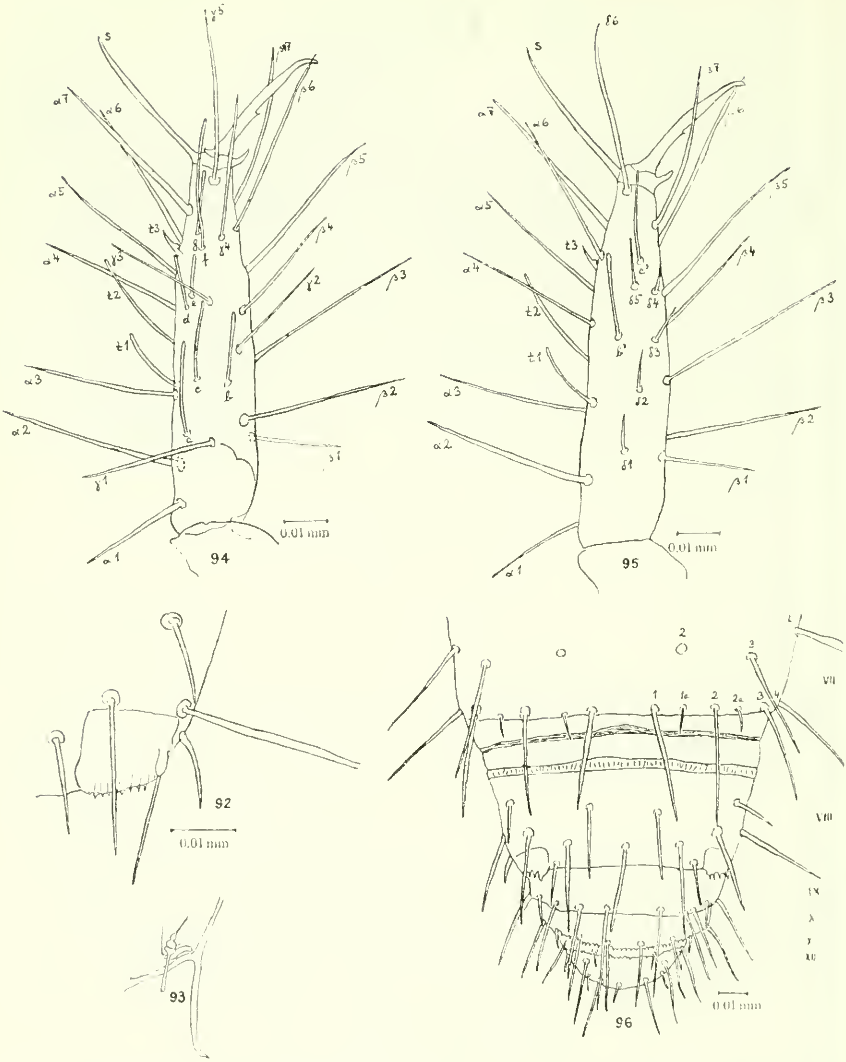
Figure 94–103

Acerentulus aureitarsus Ewing, 1940, p. 544.

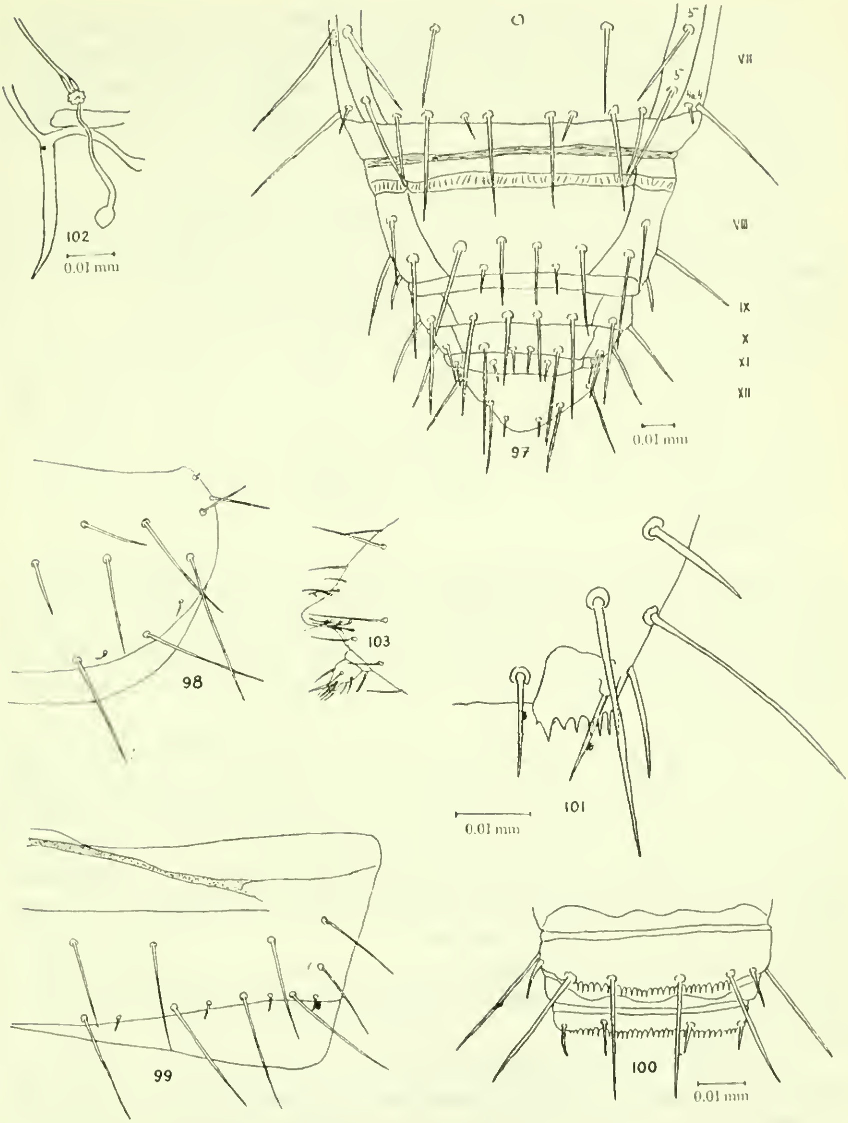
Only two slides are present of this species, the holotype, a maturus junior, labeled, Difficult Run, Virginia, Sept. 4, 1938, Snodgrass and Ewing collectors; and a paratype, also a maturus junior, labeled, near Prospect Hill, Virginia, Sept. 25, 1921, in decaying leaves and twigs, H. E. Ewing collector. We have also examined four specimens determined by Bonet with the label, Dead Run, Virginia, May 29, 1948, E. A. Chapin collector.



FIGURES 88–91.—*Acerentulus floridanus* Ewing: 88, foretarsus, interior side, paratype; 89, terga of abd. VII–XII, paratype; 90, sterna of abd. VII–XII of paratype; x is an abnormally long 1a; 91, chaetotaxy of mesonotum, holotype, drawn by Bonet. The a′ is erroneously given as b′ in figure 88.



FIGURES 92–96.—*Acerentulus floridanus* Ewing: 92, comb of abd. VIII, paratype; 93, filamento di sostegno, holotype, drawn by Bonet. *Acerentulus aureitarsus* Ewing: 94, foretarsus, exterior side, paratype; 95, foretarsus, interior side, paratype; 96, terga of abd. VII–XII, specimen from Dead Run, Virginia.



Figures 97–103.—*Acerentulus aureitarsus* Ewing: 97, sterna of abd. VII–XII, specimen from Dead Run, Virginia; 98, chaetotaxy of mesonotum, holotype, drawn by Bonet; 99, chaetotaxy of tergum of abd. IV, holotype, drawn by Bonet; 100, terga of abd. X–XI, specimen from Dead Run, Virginia; 101, comb of abd. VIII, paratype; 102, filamento di sostegno, specimen from Dead Run, Virginia; 103, foremost part of head, paratype, drawn by Bonet.

The specimens determined by Bonet agree with the holotype in every character (sensillae of foretarsus, comb, filamento di sostegno, teeth on hind border of terga X and XI), except in the chaetotaxy; as they are mature specimens, however, we shall give the chaetotaxy on the basis of them, and show afterward the deviation from the holotype.

On the foretarus (figs. 94–95), t 1 is long and slender, not clavate; t 3 long, lancetlike; d:p=75:50(=1.5). The e is rather short and situated extraordinarily near d; f is much longer than g. The a′ is missing. The empodium is small; e:u=9:46(=0.2).

The chaetotaxy (figs. 96–97) schematically is as follows:

	Abd. I	II	III	IV–VI	VII	VIII	IX	X	XI	XII
t	$\frac{6}{14}$	$\frac{10}{18}$	$\frac{10}{18}$	$\frac{10}{18}$	$\frac{\text{[a]}8}{\text{[b]}16}$	$\frac{6}{13}$	12	10	6	9
s	$\frac{3}{4}$	$\frac{3}{5}$	$\frac{5}{5}$	$\frac{5}{8}$	$\frac{3}{8}$	$\frac{4}{2}$	4	4	2	6

[a] "1" is missing.
[b] "3a" is missing.

The chaetotaxy of the holotype differs in the following points: s I posterior row, 2 setae (in all other specimens, including the paratype, 4 setae); s III–V anterior row, 3 setae (also in the paratype; in the other specimens, 5 setae); s VI anterior row, 4 setae (which must be abnormal).

It is remarkable that the microchaeta "3a" is present in t II–VI (fig. 99). Another unique feature is the difference between the number of setae in the anterior row of s II and s III, a difference which does not seem to develop until the adult stage.

On the hind margin of t X and t XI there is a row of fine teeth which are smaller in the maturi juniores and larger in the adults (fig. 100). No teeth are visible on the sterna.

The comb of abd. VIII (fig. 101) is remarkable in that its median tooth is broad and has a small secondary tooth in the middle; there are 7–8 teeth.

The filamento di sostegno (fig. 102) is rather long, with a large spherical bulb at the end; the swelling is not smooth but verrucous.

The head (fig. 103) shows a very small labrum; however, this condition does not justify transferring the species to *Acerentomon.* The palpi maxillares are distinctly like those of *Acerentulus.*

Literature Cited

BERLESE, A.

1909. Monografia dei myrientomata. Redia, vol. 6, pp. 1–182.

BONET, F.

1942. Sobre algunos proturos de México (nota preliminar). Ciencia, vol. 3, pp. 14–17.

1949. Descripción preliminar de especies nuevas del género *Eosentomon* (Protura). I. El grupo del *E. mexicanum*. Rev. Soc. Mexicana Hist. Nat., vol. 10, pp. 225–34.

1950. Descripción preliminar de especies nuevas del género *Eosentomon* (Protura). II. El *E. pallidum* Ewing y sus especies afines. Anal. Esc. Nac. Cienc. Biol., vol. 6, pp. 109–130.

BRIMLEY, C. S.

1938. The insects of North Carolina, North Carolina Department of Agriculture, 560 pp.

EWING, H. E.

1921a. A second nearctic species of Protura, *Acerentulus barberi*, new species. Ent. News, vol. 32, pp. 239–241.

1921b. New genera and species of Protura. Proc. Ent. Soc. Washington, vol. 23, pp. 193–202.

1922. Nearctic proturans. Science, vol. 55, No. 1453, pp. 1–3.

1924. Florida proturans. Ent. News, vol. 35, pp. 44–46.

1927. The occurrence of proturans in western North America. Proc. Ent. Soc. Washington, vol. 29, pp. 146–147.

1936. Synonymy and synopsis of the genera of the order Protura. Proc. Biol. Soc. Washington, vol. 49, pp. 159–166.

1940. The Protura of North America. Ann. Ent. Soc. America, vol. 33, pp. 495–551.

HILTON, W. A.

1929. Another proturan from California. Journ. Ent. and Zool., vol. 21, pp. 131–132.

SILVESTRI, F.

1909. Descrizioni preliminari di varii artropodi, specialmente d'America. Atti Accad. Lincei, Rend. Sci. Fis., Mat. e Nat., ser. 5, vol. 18. pp. 7–10.

TUXEN S. L.

1949. Über den Lebenszyklus und die postembryonale Entwicklung zweier dänischer Proturengattungen. Danske Vidensk. Selsk., Biol. Skr., vol. 6, No. 3, pp. 1–49.

1955. The first record of Canadian Protura. With systematic notes on *Acerentulus*. Ent. Medd., vol. 27, pp. 113–128.

1956a. Neues über die von Berlese beschriebenen Proturen. Redia, vol. 41, pp. 227–258.

1956b. Neues über die von Silvestri beschriebenen Proturen. Boll. Lab. Zool. Portici, vol. 33, pp. 718–729.

1958. Neues über *Eosentomon armatum* Stach. Acta Zool. Cracov., vol. 2, pp. 621–636.

1960. Ergänzendes über die von Silvestri und Berlese beschriebenen Proturen. Ent. Medd. Kjøbenhavn, vol. 29, pp. 294–303.

U S GOVERNMENT PRINTING OFFICE: 1960

Proceedings of
the United States
National Museum

SMITHSONIAN INSTITUTION • WASHINGTON, D.C.

Volume 112 1960 Number 3438

STUDIES IN NEOTROPICAL MALLOPHAGA, XVII: A NEW FAMILY (TROCHILIPHAGIDAE) AND A NEW GENUS OF THE LICE OF HUMMINGBIRDS

By M. A. Carriker, Jr.

I wish to express my thanks to Dr. J. F. Gates Clarke and other members of the Division of Entomology of the U.S. National Museum for having reviewed a preliminary draft of parts of the present paper. My thanks are also due to Colonel K. C. Emerson for the loan of material and other assistance. All measurements are in millimeters. I drew all illustrations accurately to scale by means of an eye-piece micrometer with a No. 10 eye piece, Nos. 16 and 4 objectives.

On the basis of the nomenclature now currently applied to the Mallophaga of the Trochilidae, two genera of the suborder Amblycera are normally but not abundantly found on the Trochilidae: *Trochiloecetes* and *Ricinus*. The former are known only from the Trochilidae, but the latter are common parasites of many species of passerine birds. Any other genus of Mallophaga which may have been recorded from the hummingbirds are patently stragglers and should be disregarded.

The genus *Trochiloecetes* is the more abundant of the two. I have specimens of it from 32 species of hosts ranging from Mexico to Bolivia, whereas I have taken *Ricinus*-like forms from only 20 species of hosts. Only 4 species of hummingbirds have yielded both genera of lice, and only once have both genera been taken on the same individual host. Specimens of the males of both genera are extremely rare. There are in my collection only 7 species of *Trochiloecetes* represented by males, and only 1 species of the *Ricinus*-like form, it being represented by two males (from *Selasphorus flammula*).

Generally speaking, *Trochiloecetes* and *Ricinus* are not strikingly different in appearance, except in the shape of the head and prothorax, and in the male genitalia. In overall appearance the species of *Ricinus* which parasitize the hummingbirds resemble closely a few species of the genus found on other families of hosts. The mouth parts, however, are entirely different and resemble those of *Trochiloecetes*.

The first species of *Trochiloecetes* to be described was *prominens*, under the old generic term of *Physostomum*, from *Calypte costae*. In 1903 *doratophorus* was described by the present author from *Selasphorus flammula*. In 1913 Paine and Mann described a third species, *emiliae*, and placed it in the new genus *Trochiloecetes*. They designated *Physostomum prominens* Kellogg and Chapman the type of this new genus. A fourth species, *ochoterenai*, was described by Zavaleta in 1943, from *Selasphorus rufus* of Mexico, but the status of this species is in doubt, as will be explained below.

Meanwhile, none of the various authors who had worked with the genus seem to have noted that the mouth parts were entirely different from those of all other Mallophaga. In 1949 Clay published a short article which briefly described the differences and showed that the mandibles are not of the ordinary chewing type, but of a piercing character.[1] This condition would seem to be ample proof that this insect feeds on blood instead of feathers and scales of skin; however, the theory was further substantiated by the presence of a long, slender tube lying between the mandibles, the tube apparently used for sucking blood from the punctures or scarifications made by the pointed mandibles (see fig. 1*a*). Clay has elaborated somewhat on the details of these structures and has advanced theories as to their origin.

As stated above, the species of *Ricinus* (auct.) found on the Trochilidae possess mouth parts similar to those of *Trochiloecetes* (see fig. 1*f*), but quite different from those of the species of *Ricinus* (auct.) found on other families of birds. These mouth parts are of a somewhat different type than those of other genera of Amblycera, the differences being in the type of articulation and in the absence of "teeth" on the inner side of the mandibles in *Ricinus*.

Some forms of *Ricinus* (auct.) have mandibles that are exceedingly minute (*Dysthamnus mentalis*, fig. 1*b*), but not more so than in some other genera of Amblycera, and others (*Phlegopsis n. nigromaculatus*,

---

[1] Nature, vol. 164, p. 617, Oct. 8, 1949.

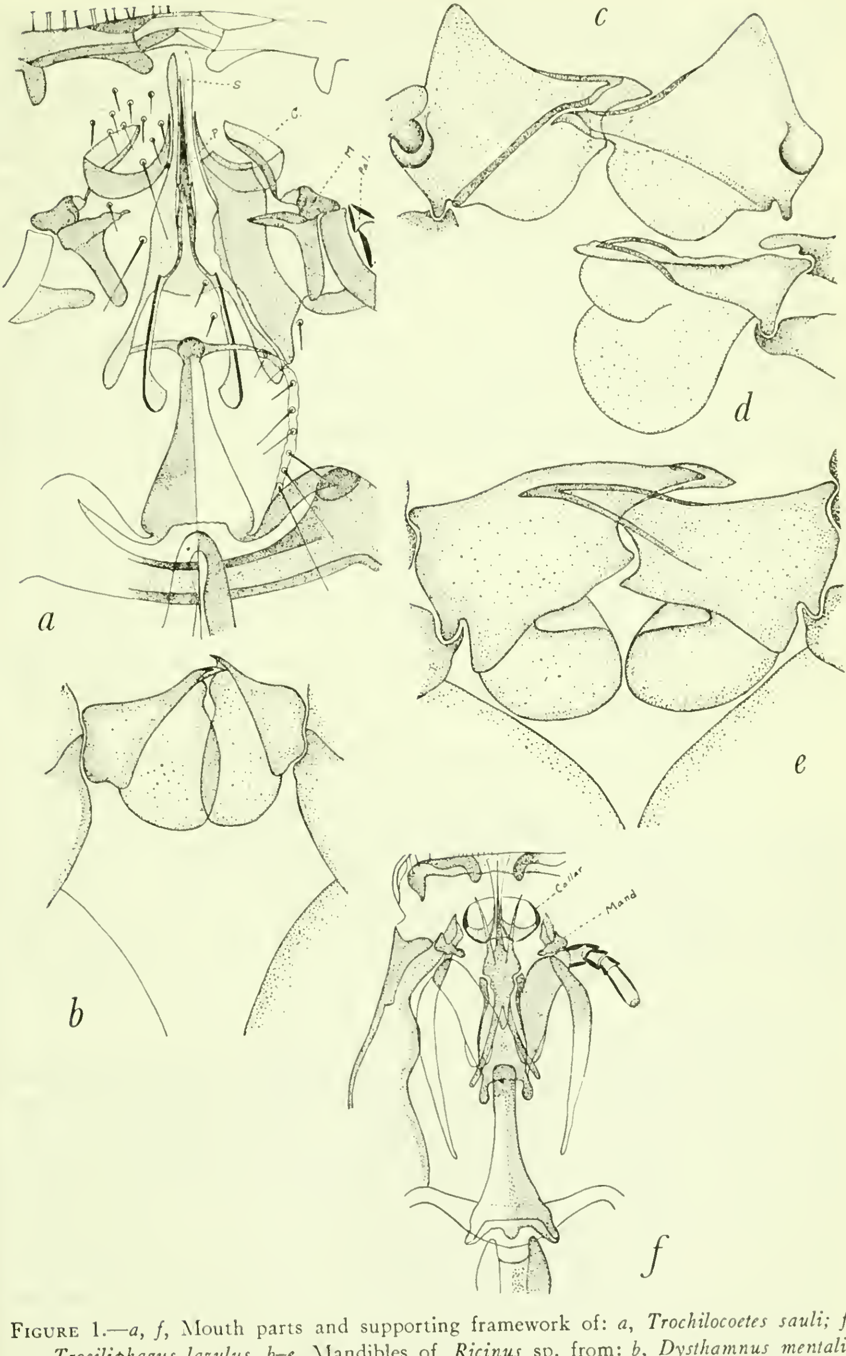


Figure 1.—*a, f,* Mouth parts and supporting framework of: *a, Trochilocoetes sauli; f, Trociliphagus lazulus. b–e,* Mandibles of *Ricinus* sp. from: *b, Dysthamnus mentalis cumbreanus; c, Phlegopsis n. nigromaculatus; d, Myiospiza aurifrons; e, R. subangulatus* (Carriker), from *Thraupis virens diaconus. Abbreviations: p, stylet; s, sheath; c, collar; m, mandible, pal, palpi.*

fig. 1*c* and *Thraupis virens episcopus*, fig. 1*e*) have fairly large mandibles, but none possess the serrated inner surfaces.

In *Trochiloecetes* the mandibles are without visible condyles. The anterior portion, at the angle of the "L," is fused with a small projection on the inner side of the marginal carina, just in front of the palpi. The long, posterior tip seems to be without support; it moves transversely along a short band projecting from the premarginal nodus, but it probably has a muscular attachment to the band, a condition that would allow a forward and backward movement of the pointed, anterior portion of the "L."

In species of *Ricinus* (auct.) the mandibular condyles differ greatly in the amount of their development. Those from *Phlegopsis* have well developed articulations (see fig. 1*c*), especially of the anterior condyle, while those from *Dysthamnus* (typical of the small mandible type) have the articulation rudimentary, but nevertheless present.

In all the species of *Trochiloecetes* that I have examined there is a great similarity in the shape and situation of the mandibles, as may be seen from the figures of the species described on succeeding pages.

Although Clay asserts that the tip of the left mandible is bipartite, I have not been able to confirm this statement. It is true that the tip of the left mandible in *Ricinus* (auct.) is bipartite, but apparently it is not in *Trochiloecetes*.

Clay states further: "There are three closely associated stylet-like structures, almost certainly of hypopharyngeal origin, which are joined by a common membrane, only the distal ends being free." Actually, the median stylet is the sucking tube, while the two lateral ones form the sheath that supports and shields it. This structure is not always clearly visible, but in some specimens all details are clearly defined. There is considerable variation in the details of these structures, but generally speaking the same pattern is found throughout the genus.

Clay mentions the outgrowths from the dorsal wall of the preoral cavity as forming a groove to hold and guide the hypopharyngeal apparatus, but this is slightly misleading. These outgrowths are the anchorages to which are fused the sides of the collarlike structure, and it is through this structure that the hypopharyngeal apparatus is protruded and retracted. Clay also states: "The mandibles are lightly sclerotized and the piercing blades lie parallel to the median structure." The long, posterior portion of the mandibles does lie parallel to the sucking apparatus, but the actual piercing blades are at the anterior end, pointing inward, at right angles to the median structure. The mandibles are L-shaped, the long arm pointing backward and the short, piercing blade pointing inward.

Undoubtedly the genus *Ricinus* is the progenitor of the abnormal, *Ricinus*-like form found on the Trochilidae, as well as the more dissimilar *Trochiloecetes,* since both of these forms are unquestionably blood-sucking parasites and hence degenerates. Further support for this theory is found in the presence of *Ricinus* on such a large and varied number of hosts, while the blood-sucking degenerates are found only on the Trochilidae.

In my own collection I have specimens of *Ricinus* from 16 passerine families embracing 101 genera and 136 species. Three records from nonpasserine hosts have been discarded as being probable stragglers.

The original *Ricinus*-like form must have been parasitic on the progenitor of the hummingbirds at a very early stage of its existence, and, not finding their type of feathers suitable food, must have gradually developed the present type of piercing mandibles and the very complicated sucking apparatus, an evolutionary process which must have been extremely slow.

Such a difference in the most basic anatomical character of these insects certainly entitles the group to special nomenclatural distinction. I therefore propose a new family for the two groups parasitic on the Trochilidae, viz., the genus *Trichiloecetes* and those species which are now called (incorrectly) *Ricinus* but which should be given generic distinction.

Suborder Amblycera Kellogg, 1896

Family Trochiliphagidae, new family

Type genus: *Trochiloecetes* Paine and Mann.

The outstanding characters of this family are the minute, more or less fixed, piercing or scarifying mandibles and the complicated sucking apparatus lying between them. The mandibles of *Trochiloecetes* are L-shaped, with their attachment at the angle of the L, the short piercing arm pointing inward and the long arm backward (for further details see under the genus, below).

The mandibles of the new genus, *Trochiliphagus* are minute, roughly cone-shaped, with irregular outline and usually blunt points and with bases fused to the nodi, to which are attached the palpi (see also fig. 2).

The sucking apparatus is supported by a very complicated framework, differing considerably from species to species. The sucking portion consists of a needlelike tube, tapering slightly to a slender point and lying within a sheath open at the apical end. The sheath is composed of two portions separated distally and ending in very slender tips, so that there seems to be three stylets.

The sucking apparatus bears a certain resemblance to that found in Anoplura. In the new family, however, the sucking apparatus lies completely within the head, is accompanied by a pair of piercing

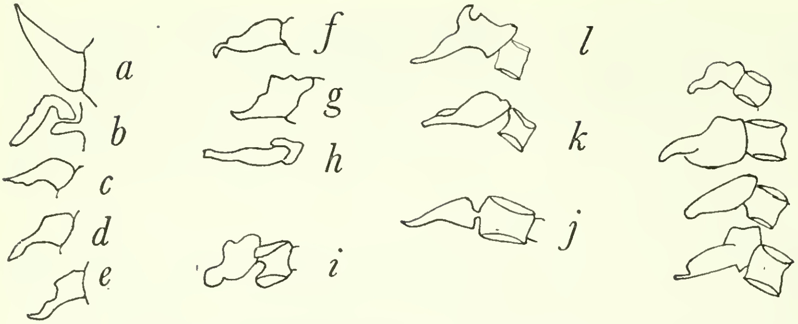


Figure 2.—Right hand mandible of 16 species of *Trochilophagus: a,* species not described from *Haplophoedia a. aurelia; b,* species not described from *Aglaiocercus kingi mocoa; c, T. irazuensisus; d, T. mexicanus; e, T. latitemporalis; f,* species not described from *Leucippus fallax cervina; g, T. brevicephalus; h, T. oenonae; i,* species not described from *Amazilia fimbriata nigricauda; j,* species not described from *Amazilia lactea bartletti; k, T. abdominalis; l, T. peruanus; m, T. mellivorus; n,* species not described from *Lepidopyga luminosa; o,* species not described from *Thalurania furcata jelskii; p, T. multicarinae.*

mandibles, and is entirely retractile (see fig. 1*a* showing muscular attachments). The oesophageal sclerite and accompanying glands are absent.

Genus *Trochiloecetes* Paine and Mann, 1913

Trochiloecetes Paine and Mann, Psyche, vol. 20, p. 21, 1913.

Type species: *Physostomum prominens* Kellogg and Chapman, 1899.

Key to the Species of *Trochiloecetes*

MALES

Body length 1.60 or less . . . . Section A
Body length 1.70 to 1.80 . . . . Section B
Body length more than 1.90 . . . . Section C

SECTION A

a. Sides of frons angulated; sides of temples slightly convex and with eye prominent; occipital margin strongly sinuate; prothorax not extending under the head and with posterior margin flatly rounded; frontal carina wide medially, with large, circular aperture; abdominal submarginal carinae narrow, with prominent articulations . . . . **aglaeacti**

a′. Sides of frons rounded; frontal carina narrow and with small aperture; sides of temples strongly convex; eye not prominent; occipital margin uniformly concave, with slight median angle; prothorax extending far under occiput; abdominal submarginal carinae wide, with articulations scarcely swollen. **quibdoensis**

SECTION B

a. Frons concave.

b. Frons narrow (0.30); temples angulated at eye; occipital margin strongly sinuate; submarginal transverse carina across frontal region faintly pigmented, as well as preantennary carinae; temples with posterior portion bluntly angulated; prothorax extending under head; body 1.72; head 0.47×0.50 . . . . **coartatia**

b′. Frons broad (0.37); submarginal transverse carina of front largely pitchy black, as well as posterior portion of preantennal carinae; temples uniformly rounded; sides of prothorax extending far under head in form of lateral black points; body 1.78; head 0.50×0.55 . . . . . . **malvasae**

a′. Frons transverse.

b. A concave, submarginal line across frons, with area between it and margin hyaline; sides of temples uniformly convex; sides of pterothorax almost straight; prominent median and lateral sternites in pterothorax (see fig. 3*f*); body 1.74; head 0.49×0.53 . . . . **simplex**

b′. Frontal area uniformly colored; sides of temples with angulation at eye; sides of pterothorax strongly convex, with no visible sternal plates; length 1.70; head 0.48×0.55 . . . . **latitemporis**

SECTION C

a. Body length 1.97.

b. Frons wide (0.40) and deeply concave; head 0.52×0.63; temples strongly convex, with prominent eye; occipital margin sinuate, angulated medially; prothorax large and extending under occiput, and with prominent pitchy black lateral, submarginal carinae; prominent median prosternal plate and lateral metasternal sclerites . . . . **grandior**

b′. Frons narrow (0.33), with uniformly rounded sides and slightly concave anterior margin; head 0.49×0.55; prothorax small (0.29×0.43); pterothorax small, with straight sides; lateral carinae broken and mostly submarginal . . . . **rhodopis**

a′. Body length 2.27. Frons faintly concave; eye prominent; sides of temples with irregular margin; numerous short, spinelike setae on head, prothorax, and legs; head 0.60×0.65 . . . . **columbianus**

FEMALES

Body length less than 2.00 (1.80 to 1.95) . . . . Section A
Body length more than 2.05 (2.08 to 2.25) . . . . Section B
Body length more than 2.35 (2.37 to 2.57) . . . . Section C

SECTION A

a. Frons slightly concave and wide (0.34), with sides only slightly convex; sucking apparatus very slender, with both basal prongs and main stylet, also very long (0.24); length 1.82; head 0.49×0.56 . . . . . . **coartatia**

a′. Frons transverse and narrow (0.15), with sides strongly divergent to ends of submarginal, transverse carina, where it is 0.29 wide; stylet of sucking apparatus extremely slender, with basal portion thickened, and total length only 0.20 . . . . **angustifrons** and **prominens**

SECTION B

a. Frons noticeably concave.

b. Sides of frons bluntly angulated.

c. Occipital margin angulated medially; sucking apparatus with apical half very slender and basal portion much thickened; prosternum long, extending under head; a large, entire, prosternal plate in posterior portion of segment; piercing points of mandibles short. Length 2.25; head 0.57×0.68; frons 0.43 . . . . **grandior** *c′*. Occipital margin not angulated medially; sucking apparatus thickened, with only short tip slender and with basal prongs bifurcated; prosternum short, not reaching to occiput; a large median pterothoracic sternite of more or less horse-shoe shape; abdomen very large (1.19×1.06) . . . . **abdominalis**

b′. Sides of frons strongly rounded; temples expanded laterally; occipital margin strongly sinuate; sucking apparatus slender, tapering from base to tip and with basal prongs very slender but widening distally.

c. Head larger (0.57×0.63); eye obsolete; propulsion sclerite short and thickened; prosternum short, with sides uniformly convex; pterothorax short (0.37), with sides constricted medially; numerous short, stout setae on legs . . . . **pinguis**

c′. Head small (0.55×0.61); eye prominent; propulsion sclerite long and slender; prosternum long, with sides constricted medially; pterothorax long (0.43), with sides strongly and uniformly convex. **doratophorum**

a′. Frons transverse, or almost so.

b. Anterior portion of head, anterior to transverse carina, more or less uniformly colored, with no concave line across front (see (fig. 8*a*); eye prominent.

c. Frons narrow, not more than 0.32; sucking apparatus long and very slender, with slender supporting filaments from sides of basal prongs extending almost to tip of stylet; no sternal setae in gular area.

d. Temples wide (0.58), strongly swollen laterally; occipital margin strongly sinuate; head 0.03 longer at occiput than at temples; prothorax not extending under head . . . . **complexus**

d′. Temples narrow (0.54), very slightly swollen laterally, and with a slight constriction at eye; prothorax extending far under head; occipital margin less sinuate; less than 0.01 difference between length of head at temples and occiput . . . . **bolivianus**

c′. Frons wide (0.34 to 0.35); sucking apparatus short and heavy, especially posterior half; a row of 4 to 5 short setae on each side of gular area; prothorax scarcely extending beneath head.

d. Heavy, deeply colored temporal carinae, curving backward from in front of eye almost to prosternum, where they are fused to base of sclerite which extends to basal prongs of sucking apparatus (see fig. 8*a*) . . . . **fasciatus**

d′. No temporal carinae, merely marginal carinae, broken by eye. **oenonae**

b′. Anterior portion of head, in front of transverse carina, with a strongly concave line across frons, the area in front of which is almost hyaline, behind it strongly pigmented (see fig. 3*f*); median mesothoracic and lateral metathoracic sternites; temples uniformly convex; eye obsolete; length 2.25; head 0.49×0.53; frons 0.33 . . . . **simplex**

SECTION C

a. Frons deeply concave, with rounded lateral angles and without submarginal, concave transverse line; line of five setae on each side of gular area.

b. Size large, body 2.54; head 0.61×0.63; frons 0.44; transverse carina wide, deeply colored and extending to lateral margins of head; prominent submarginal, transverse, sinuate, occipital carina, deeply colored; heavy lateral, submarginal carinae on prothorax and heavy marginal carinae on pterothorax; mandibles short and thickened; joints of submarginal, abdominal carinae scarcely swollen . . . . . **multicarinae** *b′*. Size small. Body 2.44; head short and wide (0.55×0.65); frons 0.43. Transverse frontal carina slender and composed of two narrow bands not reaching to lateral margins of head; no submarginal transverse carina across occipital region; carinae of prothorax and pterothorax more slender; mandibles longer, less thickened; joints of lateral, abdominal carinae much swollen . . . . **illumani**

a′. Frons very slightly concave, not transverse, with rounded sides.

b. Area anterior to transverse carina of frons more or less uniformly colored, without submarginal concave line, sides of temples with strongly irregular margins; eye prominent.

c. Size large, body more than 2.50 (body 2.57; head 0.60×0.67; frons 0.46). A heavy, submarginal, strongly sinuate carina across occiput; extensile muscles that push forward the sucking apparatus are longer; head longer at temples than at occiput; pterothorax longer (0.78), with straight, slightly undulating sides; sucking apparatus very heavy, with short slender tip . . . . **sauli**

c′. No submarginal occipital carina; sucking apparatus long and slender, with long, slender basal prongs; propulsion sclerite also long and slender; numerous short, stout, pustulated setae scattered over head, pterothorax, and legs; pterothorax short (0.35×0.78) and with sides uniformly convex . . . . **columbianus**

b′. A submarginal, concave line across frons, with area anterior to it almost hyaline. Head short and wide, with shorter body (2.37); head 0.53×0.64; frons 0.42; temples strongly expanded laterally, line of margins broken at prominent eye; sucking apparatus heavy basally, with thickened basal prongs; propulsion sclerite short and thickened; sides of pterothorax slightly concave medially . . . . **mandibularis**

Trochiloecetes prominens (Kellogg and Chapman), 1899

Physostomum prominens Kellogg and Chapman, Occ. Pap. California Acad. Sci., vol. 6, p. 137, pl. 9, fig. 5, 1899. Host: *Calypte costae* (Bourcier).

With a transverse frons and length of 2.00, this species falls in the key between sections A and B, and could be included in either. Placed under section A, it would go with *angustifrons* under *a′*, but it differs decidedly from that species in the much wider frons, the sides of which are rounded, not divergent; temples moderately convex laterally, occiput only slightly sinuate. I have examined the type, which is almost adult, but recently molted. The authors attribute the fading out of the submarginal, abdominal carinae posteriorly to immaturity, but this assumption is incorrect, the fading out being a universal character.

Trochiloecetes doratophorus (Carriker), 1903

Physostomum doratophorum Carriker, Univ. Nebraska Studies, vol. 3, p. 165, pl. 5, fig. 4, 1903. Host: *Selasphorus flammula* Salvin.

There is little to be added to the original description. The frons is concave; eye prominent; sides of temples strongly convex; stylet of sucking apparatus, with basal support, measures 0.26; head at temples 0.52×0.61; frons 0.40. The type, a female, is in the collection of the author; also 1 ♀ paratype. When this species was described, the author remarked that it was being provisionally placed in the genus *Physostomum*, since a closely related species (*prominens*) had been placed there by Dr. Kellogg, but in the opinion of the author, further collecting from hummingbirds would produce additional species upon which a new genus could be safely erected. Ten years later this new genus was described by Paine and Mann.

Trochiloecetes emiliae **Paine and Mann, 1913**

Trochiloecetes emiliae Paine and Mann, Psyche, vol. 20, p. 21, fig. 5, 1913. Host: *Thalurania* (*furcata*) *furcatoides* Gould.

Without seeing the type it is difficult to place this species in the key. However, it falls into Section B, *c′*, with *doratophorum*, but has a smaller head than this species (0.52×0.56 against 0.55×0.61). The head is longer at the occiput than at the temples; the transverse frontal carina is very short (if the figure given is correct); it falls far short of the lateral margins of the head (a very unusual condition if true). The author gives incorrect measurements for *doratophorum*, perhaps because he compared *emiliae* with some species wrongly identified as that form.

Trochiloecetes ochoterenai **Zavaleta, 1943**

Trochiloecetes ochoternai Zavaleta, Tesis Univ. Mexico, Fac. Sci., Dept. Biol., p. 54, pl. 5, fig. c, 1943. Host: *Selasphorus rufus* (Gmelin).

I have been unable to secure a copy of the description of this species. Colonel Emerson sent me from its host a pair of specimens that he supposed were the *Trochiloecetes* in question, but unfortunately they proved to be species of the *Ricinus*-like genus described on succeeding pages of this paper. It is not impossible that both *Trochiloecetes* and *Trochilophagus* (the new genus) would be found on the same host, since I have them both from *Selasphorus flammula*. Until further information can be secured concerning the species, it may be provisionally left in *Trochiloecetes*.

Trochiloecetes aglaeacti, **new species**

FIGURE 3,*a–b*

Type, male adult, from *Aglaeactis c. cupripennis* (Bourcier), collected by the author at Malvasá, Dep. Cauca, Colombia, Jan. 22, 1957, in the collection of the author. Represented by a single ♂, the holotype.

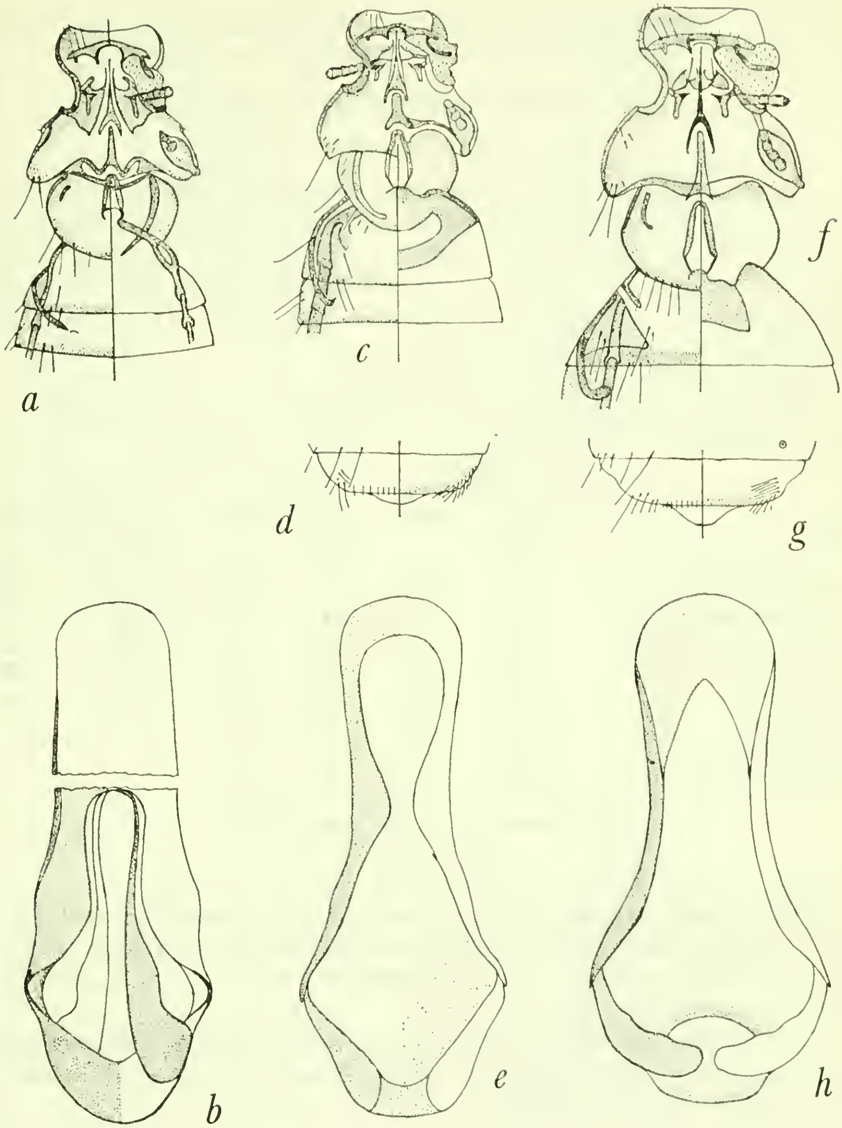


FIGURE 3.—*a–b*, *Trochiloecetes aglaiacti* ♂: *a*, head, thorax, and abdominal segment I; *b*, genitalia. *c–e*, *T. quibdoensis* ♂: *c*, head, thorax, and abdominal segment I; *d*, tip of abdomen; *e*, genitalia. *f–h*, *T. simplex: f*, ♀, *head and thorax; g*, ♀, tip of abdomen; *h*, ♂, genitalia.

The distinguishing characters for the species may be found in the preceding key. Measurements follow the next species.

Trochiloecetes quibdoensis, new species

FIGURE 3,*c–e*

Types, male and female adults, from *Amazilia t. tzactl* (de la Llave), collected by the author at Quibdó, Dep. Chocó, Colombia, Mar. 11, 1918, in the collection of the author. The species is represented by the ♂ holotype, ♀ allotype, 1 ♂ and 1 ♀ paratypes, and 1 ♀ from the type host collected by the author at Villa Felisa, Dep. Norte de Santander, Colombia, Nov. 1, 1947.

For descriptive characters, see the key.

The measurements (in mm.) of *T. aglaeacti* and *T. quibdoensis* are as follows:

	T. aglaeacti		*T. quibdoensis*			
	Male		*Male*		*Female*	
	Length	*Width*	*Length*	*Width*	*Length*	*Width*
Body	1.56	--	1.57	--	1.95	--
frons	--	0.30	--	0.30	--	0.33
Head temples	.45	.50	.44	.47	.51	.52
occiput	.45	--	.42	--	.52	--
Prothorax	.25	.35	.27	.33	.26	.42
Pterothorax	.28	.52	.28	.49	.25	.67
Abdomen	.76	.63	.76	.67	1.08	.85
Basal plate	.34	.09	.30	.09		
Parameres	.07	.11	--	--		
Endomeral sac	.09	.13	.08	.14		

Trochiloecetes simplex, new species

FIGURE 3,*f–h*

Types, male and female adults, from *Amazilia amazilia caeruleigularis* Carriker, collected by the author at Nazca, Peru, Mar. 28, 1931, in the collection of the author. Represented by the ♂ holotype, ♀ allotype, and 3 ♀ paratypes.

Distinguished by the transverse frons, with a concave, submarginal line across front, with area between it and margin hyaline. Measurements follow the next species.

Trochiloecetes latitemporis, new species

FIGURE *4,a–b*

Type, male adult, from *Colibri c. coruscans* (Gould), collected by the author at Buenos Aires, Dep. Norte de Santander, Colombia, Sept. 16, 1945, in the collection of the author. Species represented by ♂ holotype only.

Similar to the preceding species except that the frontal area is uniformly colored, with no submarginal, concave line crossing it.

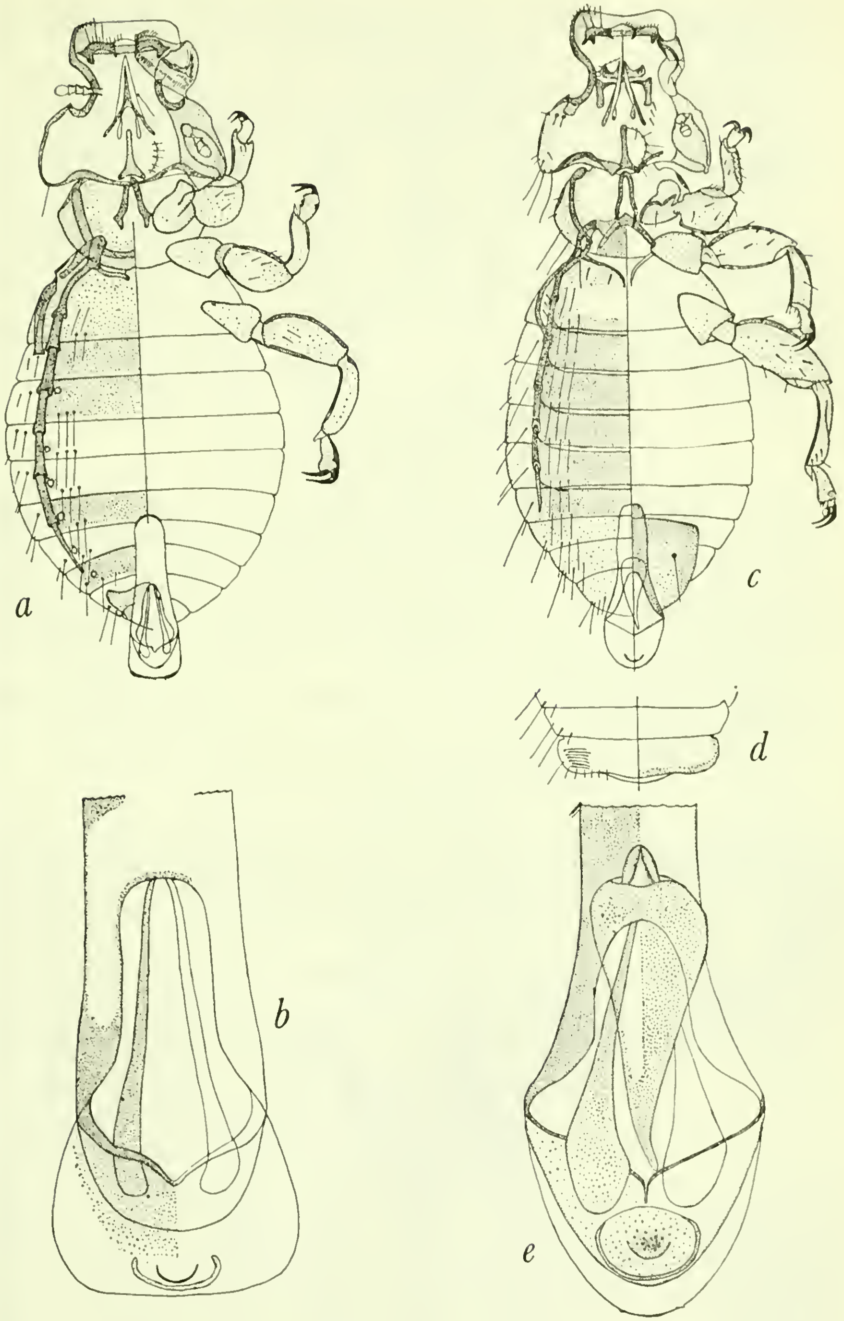


FIGURE 4.—*a–b*, *Trochiloecetes latitemporis* ♂: *a*, entire body; *b*, genitalia. *c–e*, *T. coartatia:* *c*, ♂, entire body; *d*, ♀, tip of abdomen; *e*, ♂, genitalia.

The measurements (in mm.) of *T. simplex* and *T. latitemporis* are as follows:

		T. simplex				*T. latitemporis*		
		Male		*Female*		*Male*		
		Length	*Width*	*Length*	*Width*	*Length*	*Width*	
Body		1.74	--	2.75	--	0.17	--	
Head	frons	--	0.33	--	0.37	--	0.33	
	temples	.49	.53	.54	.58	.48	.55	
	occiput	.48	--	.53	--	.47	--	
Prothorax		.26	.39	.32	.47	.28	.43	
Pterothorax		.28	.71	.33	.80	.30	.65	
Abdomen		.85	.85	1.28	.93	.84	.79	
Basal plate		.29	.10			.35	.09	(distal end)
Parameres		.10	.16			.10	.16	
Endomeral sac		.10	.17			.15	.11	

***Trochiloecetes coartatia*, new species**

FIGURE 4,*c–e*

Types, male and female adults, from *Ocreatus u. underwoodi* (Lesson); ♂ holotype collected by the author at La Bodega, Dep. Antioquia, Colombia, June 13, 1951; the ♀ allotype at Las Ventanas, Dep. Norte de Santander, Colombia, Sept. 21, 1916; ♂ USNM 64883 and ♀ in the collection of the author. Species represented by the types only.

Measurements follows the next species. See the key for distinguishing features.

***Trochiloecetes malvasae*, new species**

FIGURE 5,*a–b*

Type, male adult, from *Coeligena lutetiae* (De Lattre and Bourcier), collected by the author at Malvasá, Dep. Cauca, Colombia, Jan. 24, 1957, in the collection of the author. Represented by ♂ holotype, only.

Distinguished by unusually broad concave frons (0.37) and pitchy black color of certain head markings.

The measurements (in mm.) for *T. coartatia* and *T. malvasae* are as follows:

		T. coartatia				*T. malvasae*	
		Male		*Female*		*Male*	
		Length	*Width*	*Length*	*Width*	*Length*	*Width*
Body		1.72	--	1.82	--	1.78	--
Head	frons	--	0.30	--	0.34	--	0.37
	temples	.46	.50	.48	.56	.50	.55
	occiput	.47	--	.49	--	.50	--
Prothorax		.26	.41	.32	.46	.29	.43
Pterothorax		.32	.50	.29	.66	.35	.78
Abdomen		.83	.72	1.00	.79	.84	.75
Basal plate		.35	.09			.42	.08
Parameres		--	--			.12	.16
Endomeral sac		.12	.17			.12	.16

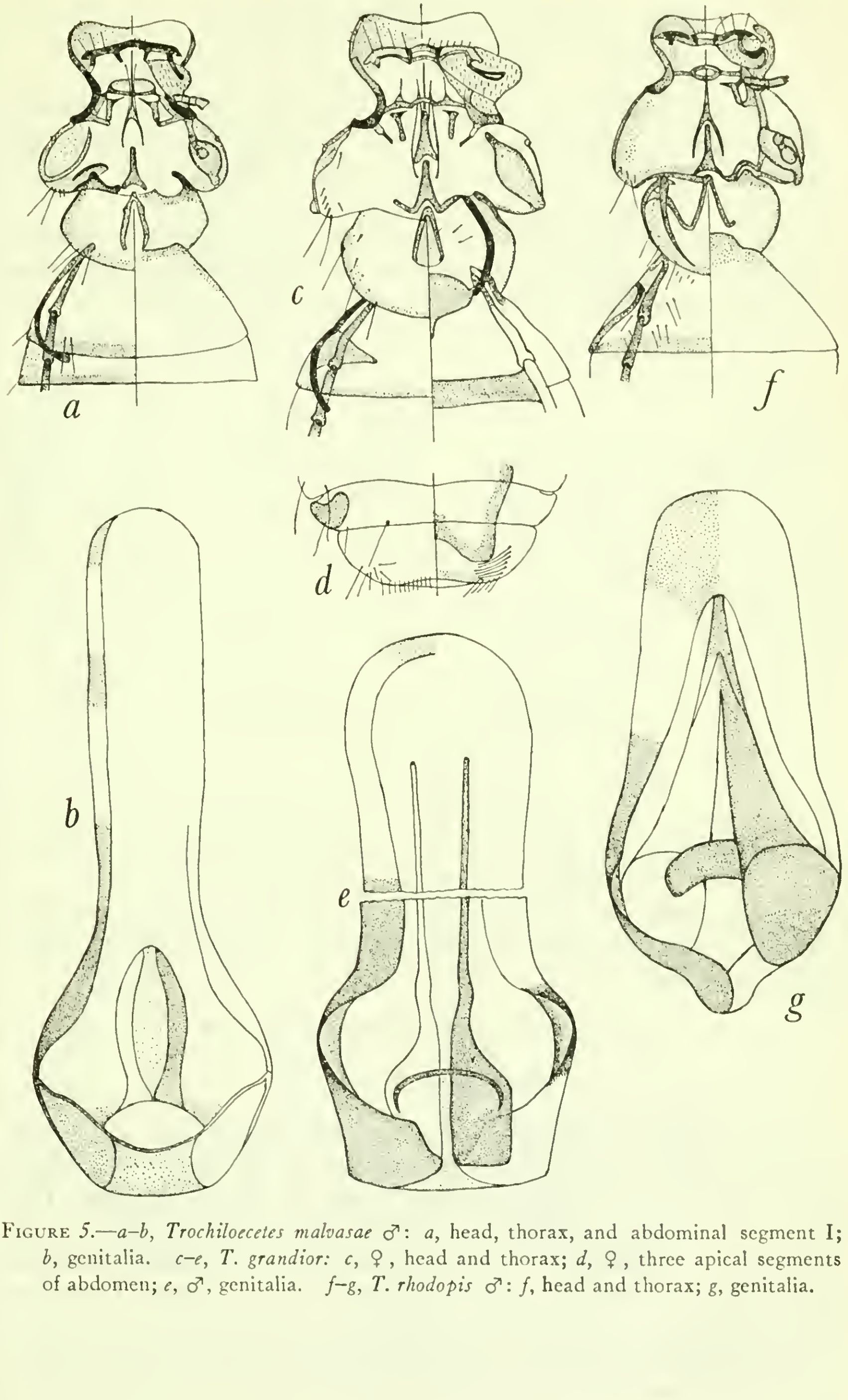


FIGURE 5.—*a–b*, *Trochiloecetes malvasae* ♂: *a*, head, thorax, and abdominal segment I; *b*, genitalia. *c–e*, *T. grandior*: *c*, ♀, head and thorax; *d*, ♀, three apical segments of abdomen; *e*, ♂, genitalia. *f–g*, *T. rhodopis* ♂: *f*, head and thorax; *g*, genitalia.

Trochiloecetes grandior, new species

FIGURE 5,*c–e*

Types, male and female adults, from *Phaethornis guy corcuscus* Bangs collected by the author on the Volcán Turrialba, Costa Rica, April 1903, in the collection of the author. Species represented by the ♀ holotype, ♂ allotype, and 2 ♀ paratypes.

Distinguished by large size, wide frons, large prothorax extending far under head, and by pitchy-black submarginal carinae of prothorax.

The measurements (in mm.) for *T. grandior* are as follows:

		T. grandior		
	Male		*Female*	
	Length	*Width*	*Length*	*Width*
Body	1. 95	--	2. 23	--
Head: frons	--	0. 39	--	0. 43
Head: temples	. 52	. 61	. 55	. 67
Head: occiput	. 54	--	. 56	--
Prothorax	. 37	. 48	. 35	. 52
Pterothorax	. 22	. 50	. 26	. 59
Abdomen	1. 00	. 93	1. 28	. 96
Basal plate	. 35	. 13		
Parameres	. 11	. 28		
Endomeral sac	. 13	. 26		

Trochiloecetes rhodopis, new species

FIGURE 5,*f–g*

Type, male adult, from *Rhodopis v. vesper* (Lesson), collected by the author at Huáncano, Dep. Ica, Peru, Mar. 6, 1921, in the collection of the author. Species represented by ♂ holotype only.

Distinguished by large size, narrow, slightly concave frons with rounded sides, and small thoracic segments. Measurements follow the next species.

Trochiloecetes columbianus, new species

FIGURE 6,*a–c*

Types, male and female adults, from *Heliothrix barroti* (Bourcier). Female holotype collected by the author at Río Esmeralda, upper Río Sinú, May 12, 1949 and male allotype by author at Simití, Dep. Bolívar, Colombia, Apr. 11, 1947, USNM 64884. Represented by the ♀ holotype, ♂ allotype, 1 ♂ and 2 ♀ paratypes from Rio Esmeraldas, and 1 ♀ from type host taken at El Tambo, Dep. Chocó, Colombia, Apr. 1, 1918.

Species distinguished by numerous short, spinelike setae on head, pterothorax, and legs; also large size (♂=2.27).

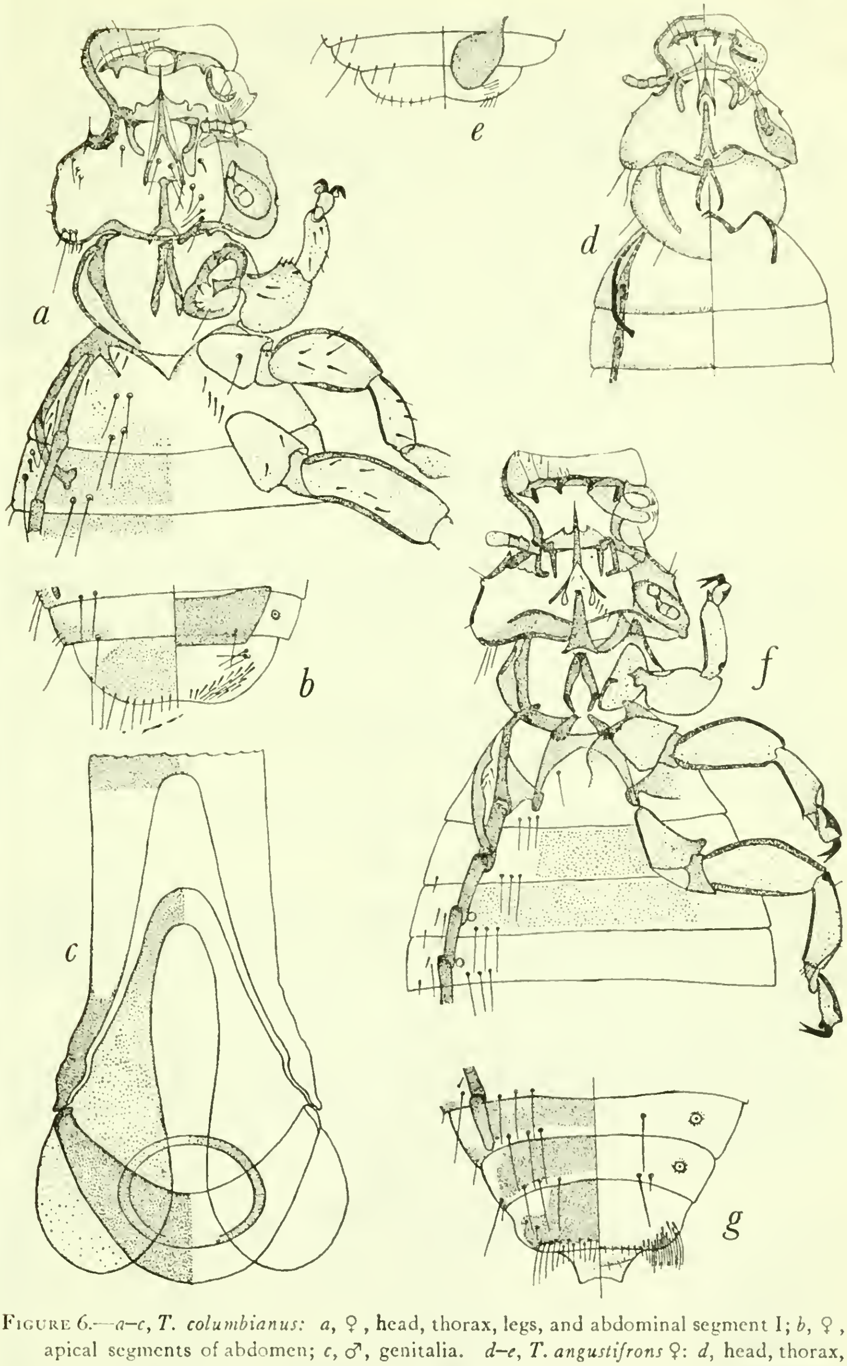


FIGURE 6.—*a–c*, *T. columbianus:* *a*, ♀, head, thorax, legs, and abdominal segment I; *b*, ♀, apical segments of abdomen; *c*, ♂, genitalia. *d–e*, *T. angustifrons* ♀: *d*, head, thorax, and abdominal segment I; *e*, apical segments of abdomen. *f–g*, *T. abdominalis* ♀: *f*, head, thorax, legs, and abdominal segments I–III; *g*, apical segments of abdomen.

The measurements (in mm.) for *T. rhodopis* and *T. columbianus* are as follows:

		T. rhodopis		*T. columbianus*			
		Male		*Male*		*Female*	
		Length	*Width*	*Length*	*Width*	*Length*	*Width*
Body		1. 98	--	2. 27	--	2. 53	--
Head	frons	--	0. 33	--	0. 43	--	0. 41
	temples	. 49	. 55	. 60	. 65	. 57	. 65
	occiput	. 49	--	. 59	--	. 57	--
Prothorax		. 29	. 43	. 35	. 50	. 36	. 50
Pterothorax		. 35	. 78	. 41	. 82	. 35	. 78
Abdomen		1. 08	. 87	1. 17	. 98	1. 55	1. 17
Basal plate		. 24	. 11 (distal)	. 41	. 14 (distal)		
Parameres		. 09	. 16	. 12	. 21		
Endomeral sac		. 13	. 16	. 13	. 19		

***Trochiloecetes angustifrons*, new species**

Figure 6,*d–e*

Type, female adult, from *Thalurania furcata colombica* (Bourcier), collected by the author at Hacienda, Las Vegas, Dep. Magdalena, Colombia, May 18, 1913, in the collection of the author. Represented by the ♀ holotype only.

Distinguished by small size, very narrow, transverse frons, with strongly divergent sides; sucking apparatus with thickened basal portion and very slender stylet. Measurements follow the next species.

***Trochiloecetes abdominalis*, new species**

Figure 6,*f–g*

Type, female adult, from *Florisuga m. mellivora* (Linné), collected by the author at Bellavista, Dep. Norte de Santander, Colombia, July 10, 1943, in the collection of the author. Known from the ♀ holotype only.

Distinguished by concave frons and sides bluntly angulated—prothorax not extending under occiput—and by very large abdomen.

The measurements (in mm.) for *T. angustifrons* and *T. abdominalis* are as follows:

		T. angustifrons		*T. abdominalis*	
		Female		*Female*	
		Length	*Width*	*Length*	*Width*
Body		1. 90	--	2. 19	--
Head	frons	--	0. 29	--	0. 29
	temples	. 46	. 53	. 54	. 63
	occiput	. 48	--	. 53	--
Prothorax		. 29	. 46	. 33	. 48
Pterothorax		. 30	. 72	. 32	. 82
Abdomen		1. 06	. 83	1. 19	1. 06

Trochiloecetes pinguis, new species

FIGURE 7,*a*

Type, female adult, from *Chalybura buffoni micans* Bangs and Barbour, collected by the author at Socarré, upper Río Sinú, Colombia, Mar. 31, 1949, USNM 64885. Represented by the ♀ holotype only.

Characterized by the concave frons, with strongly rounded sides; sinuate occipital margin and very slender sucking apparatus, with propulsion sclerite short and thickened. Measurements follow the next species.

Trochiloecetes complexus, new species

FIGURE 7,*b–c*

Type, female adult, from *Glaucis hirsuta affinis* Lawrence, collected by the author at Sapasóa, Dep. San Martin, Peru, Nov. 1, 1933, in the collection of the author. Known from ♀ holotype only.

Recognized by the narrow, transverse frons (0.32); frontal area uniformly colored; sucking apparatus long and very slender; and no sternal gular setae.

The measurements (in mm.) for *T. pinguis* and *T. complexus* are as follows:

	T. pinguis		*T. complexus*	
	Female		*Female*	
	Length	*Width*	*Length*	*Width*
Body	2. 14	--	2. 16	--
Head: frons	--	0. 42	--	0. 33
Head: temples	. 57	. 63	. 47	. 58
Head: occiput	. 58	--	. 50	--
Prothorax	. 37	. 52	. 30	. 46
Pterothorax	. 37	. 72	. 35	. 73
Abdomen	1. 08	1. 04	1. 13	. 91

Trochiloecetes bolivianus, new species

FIGURE 7,*d–e*

Type, female adult, from *Ocreatus underwoodi addae* (Bourcier), collected by the author at Calabatéa, Dep. La Paz, Bolivia, Nov. 10, 1934, in the collection of the author. Known from ♀ holotype only.

Characterized by narrow, transverse frons (0.32) uniformly colored; temples narrow (0.54); and prothorax extending far under occiput. Measurements follow the next species.

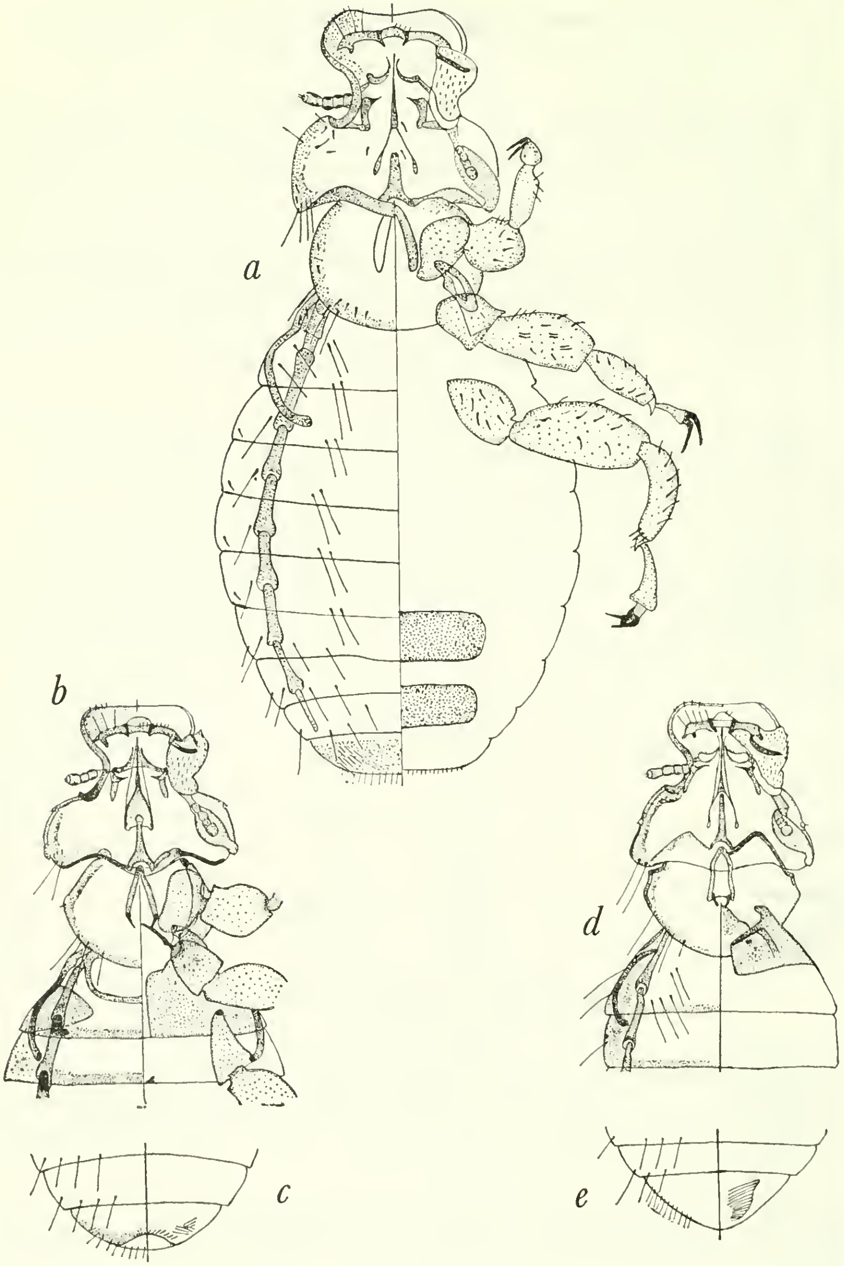


Figure 7.—*a, Trochiloecetes pinguis* ♀, complete body. *b–c, T. complexus* ♀ : *b*, head, thorax, portion of legs, and abdominal segment I; *c*, apical segments of abdomen. *d–e, T. bolivianus* ♀ : *d*, head, thorax, and first abdominal segment; *e*, apical segments of abdomen.

Trochiloecetes fasciatus, new species

Figure 8,*a–c*

Type, female adult, from *Lesbia nuna pallidiventris* (Simon), collected by the author at Cajabamba, Dep. Cajabamba, Peru, Apr. 22, 1933, in the collection of the author. Known from ♀ holotype only.

Frons transverse and uniformly colored; frons wider (0.34 to 0.35); sucking apparatus short and heavy; 4 to 5 short setae on each side of gular area; heavy, deeply colored temporal carinae, curving backward from near eye almost to prosternum.

The measurements (in mm.) for *T. bolivianus* and *T. fasciatus* are as follows:

		T. bolivianus		*T. fasciatus*	
		Female		*Female*	
		Length	*Width*	*Length*	*Width*
Body		2.08	--	2.25	--
Head	frons	--	0.32	--	0.35
	temples	.47	.54	.50	.58
	occiput	.48	--	.49	--
Prothorax		.33	.46	.33	.47
Pterothorax		.30	.67	.33	.78
Abdomen		1.16	.82	1.40	.98

Trochiloecetes oenonae, new species

Figure 8,*d–e*

Type, female adult, from *Chrysuronia oenona longirostris* Berlepsch, collected by the author at Convención, Dep. Norte de Santander, Colombia, Jan. 20, 1943, in the collection of the author. Known from a single ♀ the holotype.

Similar in many ways to *fasciatus*, but without temporal carinae, merely marginal carinae, broken by eye. Measurements follow *T. illumani*.

Trochiloecetes multicarinae, new species

Figure 8,*f–g*

Type, female adult, from *Boissoneaua f. flavescens* (Loddiges), collected by the author at Buenos Aires, Dep. Norte de Santander, Colombia, Oct. 2, 1946, in the collection of the author. Known from a single ♀, the holotype.

Distinguished by large size (2.54); frons deeply concave, uniformly colored and with rounded sides; 5 setae on each side of gular area; transverse, frontal carinae wide and deeply colored; heavy, deeply colored marginal and submarginal carinae on thoracic segments. Measurements follow the next species.

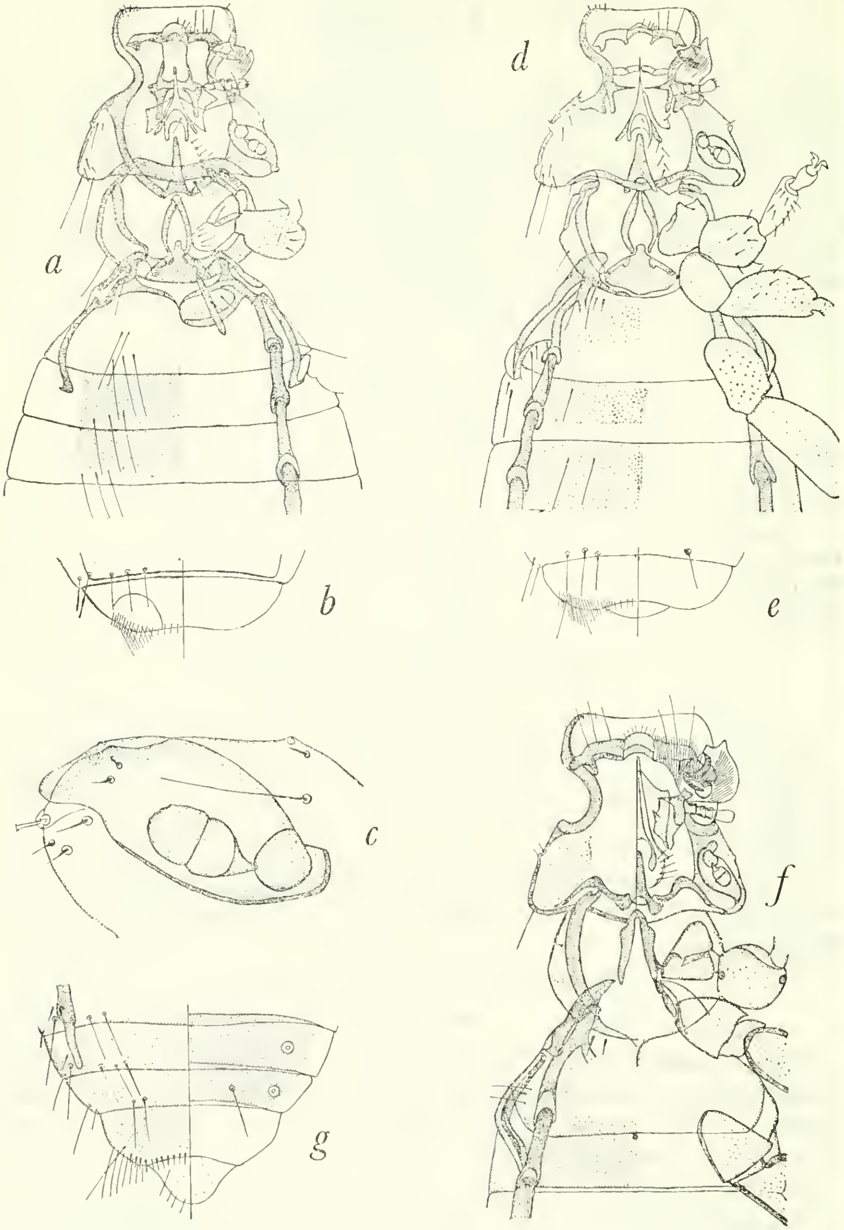


Figure 8.—*a–c*, *Trochiloecetes fasciatus* ♀ : *a*, head, thorax, and adbominal segments I–II; *b*, apical segments of abdomen; *c*, antennary fossa, with antennae. *d–e*, *T. oenonae* ♀ : *d*, head, thorax, legs, and abdominal segments I–II; *e*, apical segments of abdomen. *f–g*, *T. multicarinae* ♀ : *f*, head, thorax, portion of legs, and abdominal segment I; *g*, apical four segments of abdomen.

Trochiloecetes illumani, new species

FIGURE 9,*a–b*

Type, female adult, from *Pterophanes cyanoptera peruvianus* Boucard, collected by the author at Hichulóma, Dep. La Paz, Bolivia, Dec. 30, 1934, in the collection of the author. Represented by the ♀ holotype and 1 ♀ paratype.

Slightly smaller than previous species, with head shorter and wider (0.55 × 0.65); transverse frontal carina slender and composed of two narrow bands; joints of abdominal carinae much swollen; carinae of thorax slenderer.

The measurements (in mm.) for *T. oenonae*, *T. multicarinae*, and *T. illumani* are as follows:

		T. oenonae		*T. multicarinae*		*T. illumani*	
		Female		*Female*		*Female*	
		Length	*Width*	*Length*	*Width*	*Length*	*Width*
Body		2. 18	--	2. 54	--	2. 44	--
Head	frons	--	0. 33	--	0. 44	--	0. 43
	temples	. 51	. 60	. 59	. 63	. 55	. 65
	occiput	. 54	--	. 61	--	. 54	--
Prothorax		. 33	. 47	. 40	. 52	. 36	. 54
Pterothorax		. 38	. 78	. 40	. 82	. 43	. 76
Abdomen		1. 20	1. 05	1. 41	1. 02	1. 31	. 95

Trochiloecetes sauli, new species

FIGURE 9,*c–d*

Type, female adult, from *Lafresnaya l. lafresnayi* (Boissoneau), collected by the author at Tijeras, Moscopán, Dep. Cauca, Colombia, Mar. 8, 1954, in the collection of the author. Known from ♀ holotype only.

Frons very slightly concave, with rounded sides; frontal area uniformaly colored; margins of temples irregular; size large (2.57); a heavy, submarginal, strongly sinuate carina across occiput; sucking apparatus very heavy, with short, slender tip. Measurements follow the next species.

Trochiloecetes mandibularis, new species

FIGURE 9,*e–f*

Type, female adult, from *Threnetes leucurus rufigastra* Cory, collected by the author at Sapasóa, Dep. San Martin, Peru, Nov. 4, 1933, in the collection of the author. Species represented by the ♀ holotype only.

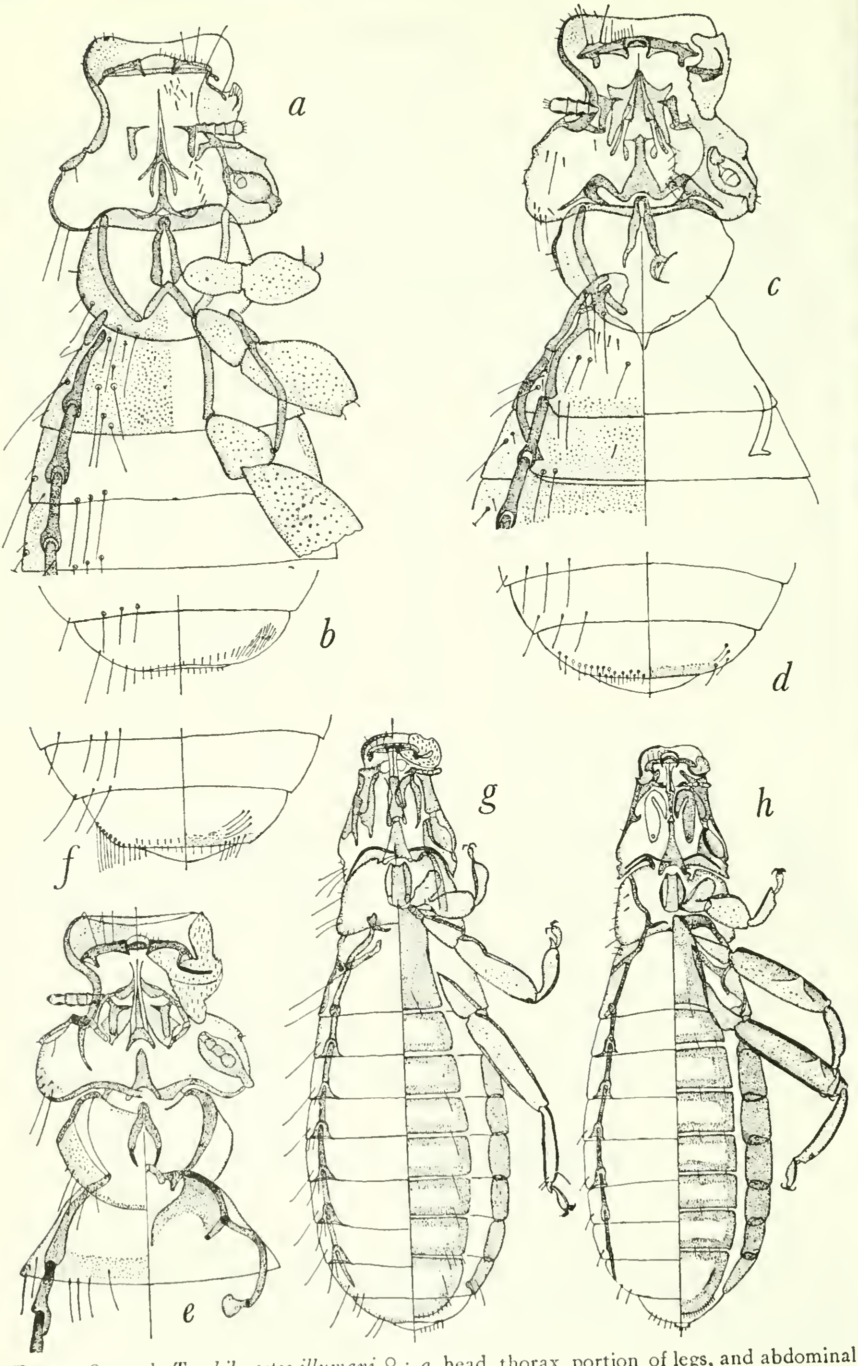


Figure 9.—*a–b*, *Trochiloecetes illumani* ♀ : *a*, head, thorax, portion of legs, and abdominal segments I–II; *b*, apical segments of abdomen. *c–d*, *T. sauli* ♀ : *c*, head, thorax, and abdominal segments I–II; *d*, apical three segments of abdomen. *e–f*, *T. mandibularis* ♀ : *e*, head and thorax; *f*, apical three segments of abdomen. *g*, *Trochiliphagus lazulus* ♀ , entire body. *h*, *T. mexicanus* ♀ , entire body.

Similar to *sauli* but differs from it in having a concave, submarginal line across frons; head short and wide, 0.53×0.64; frons 0.42; temples strongly expanded laterally with line of margin broken at prominent eye; sucking apparatus heavy basally, with thickened basal prongs; propulsion sclerite short and thickened.

The measurements (in mm.) for *T. sauli* and *T. mandibularis* are as follows:

	T. sauli		*T. mandibularis*	
	Female		*Female*	
	Length	*Width*	*Length*	*Width*
Body	2. 57	--	2. 37	--
Head: frons	--	0. 46	--	0. 42
Head: temples	. 60	. 67	. 53	. 64
Head: occiput	. 59	--	. 52	--
Prothorax	. 40	. 50	. 33	. 51
Pterothorax	. 41	. 78	. 35	. 72
Abdomen	1. 40	1. 15	1. 37	1. 04

Trochiliphagus, new genus

Type species: *Trochiliphagus lazulus*, new species.

Diagnosis: Similar to certain species of *Ricinus* in general shape and structure of the head, thorax, and abdomen, but with the same type of sucking mouth parts as in *Trochiloecetes.* The mandibles, instead of being L-shaped, as in *Trochiloecetes*, consist of minute, tapering sclerites, often of irregular shape and with the distal end varying between a point and a rounded tip. Their bases are attached to the inner edge of the premarginal carinae, the attachment apparently being flexible (see figs. 1*f* and 2).

The sucking apparatus is smaller than in *Trochiloecetes* and with certain differences in structure clearly illustrated in figure 1, *a* and *f*. There is a generic conformity in the general shape of the head and in the absence of darker markings, following the type of *Ricinus microcephalum* Kellogg, except that the head is longer and usually narrower at the temples.

The thoracic and abdominal structure is similiar to the genus *Ricinus.* I have two males of this genus from *Selasphorus flammula*, the same individual host from which was taken the type of *Trochiloecetes doratophorus.* These genitalia are very similiar to those of *Trochiloecetes columbianus*, and not at all like those of *Ricinus*, of which I have examined numerous specimens, and of which a figure is presented (see fig. 12*c–e*).

The labral lobes are always well developed, often enormously expanded, curving forward to the line of the frons. Even those of lesser development protrude noticeably beyond the lateral margins of the head.

Key to the species of *Trochiliphagus*

Body length less than 2.80 . . . . Section A
Body length not less than 3.00 or more than 3.40 . . . . Section B
Body length more than 3.50 . . . . Section C

SECTION A

Body length 2.57; head 0.63×0.64; frons 0.29 (female). Frons uniformly circular; transverse, frontal, and preantennary carinae narrow; propulsion sclerite of sucking apparatus long and narrow; gular setae very long; sides of prothorax straight; submarginal, abdominal carinae narrow, with small articulations; pleurites very wide, extending considerably beyond spiracles . . . **irazuensis**

SECTION B

a. Frons uniformly rounded, with or without a slight median emargination.
  b. Frons with a slight, median emargination. Body 3.29; head 0.78×0.65; frons 0.38. Sides of prothorax straight; abdomen slender (1.08); submarginal, abdominal carinae narrow, with prominent articulations; pleurites wide and strongly pigmented . . . . **mexicanus**
  b′. Frons without median emargination; gular setae well developed, 5 to 6.
    c. Head wide, both at frons (0.37) and temples (0.68); prothorax with prominent, rounded anterlateral angles, bearing a spine and 1 long seta, and with concave sides; preantennary carinae with a branch extending backward from median portion to antennary fossae. **grandior**
    c′. Head narrow, frons 0.32; temples 0.63; prothorax without anterior angles and without setae except in posterolateral portion, and with sides convex and undulating; preantennary carinae without branch to antennary fossae, but they bend inward in anterior portion to base of mandibles . . . . **peruanus**
a′. Frons flatly convex, or transverse with two slight protuberances; pterothorax with concave sides and definite anterior angles.
  b. Frons flatly convex.
    c. Head small (0.69×0.60; frons 0.34); sides of prothorax undulating; pleurites wide, with submarginal carinae in their median portion. **jimenezi**
    c′. Head large (0.76×0.63; frons 0.37); sides of prothorax straight; pleurites very narrow, not reaching to submarginal carinae; basal propulsion sclerite of sucking apparatus short and thick . . . . . **mellivorus**
  b′. Frons transverse (a slight protuberance) in center of lateral half; frontal, transverse carina wide, deeply and uniformly colored; sides of prothorax undulating; pleurites very wide, extending inward beyond spiracles. **brevicephalus**

SECTION C

a. Frons uniformly rounded. Size smaller (body 3.56; head 0.80×0.67; frons 0.37); sides of prothorax slightly concave; pterothorax constricted, slightly forward of middle; pleurites extending inward only to inner edge of submarginal carinae . . . . **lazulus**
a′. Frons uniformly rounded. Size large, body 3.75 to 3.80; head 0.73 to 0.80 in width at temples.

b. Head large (0.89×0.80; frons 0.40); sides of prothorax undulating; pleurites extending beyond inner margin of abdominal carinae; anterior sclerite of sucking apparatus, bearing stylet, very short and without basal prongs; abdomen narrow (1.17) . . . . **latitemporalis**

b′. Head narrow (0.90×0.73; frons 0.39); sides of prothorax slightly concave, as wide as temples; pleurites narrow, not reaching to submarginal carinae; anterior sclerite of sucking apparatus long and slender, with well developed basal prongs; abdomen very wide (1.52) . **abdominalis**

Trochiliphagus lazulus, new species

FIGURE 9,*g*

Type, female adult, from *Campylopterus falcatus* (Swainson), collected by the author at La Africa, Sierra Perijá, Colombia, June 8, 1942, USNM 64886. Represented by the ♀ holotype and 4 ♀ paratypes (type is the right-hand specimen on slide containing 2 ♀).

Measurements follow the next species.

Trochiliphagus mexicanus, new species

FIGURE 9,*h*

Type, female adult, from *Phaethornis superciliosus veracrucis* Ridgway, collected by the author at Cerro Tuxtla, Veracruz, Mexico, May 10, 1940, USNM 64887. Represented by the ♀ holotype, 1 adult ♀ paratype, and 1 nymph paratype.

The measurements (in mm.) for *T. lazulus* and *T. mexicanus* are as follows:

		T. lazulus		*T. mexicanus*	
		Female		*Female*	
		Length	*Width*	*Length*	*Width*
Body		3.56	--	3.29	--
Head	frons	--	0.37	--	0.38
	temples	.80	.67	.78	.65
	occiput	.71	--	.68	--
Prothorax		.52	.72	.49	.68
Pterothorax		.61	.92	.59	.90
Abdomen		1.74	1.17	1.80	1.09

Trochiliphagus mellivorus, new species

FIGURE 10,*a*

Type, female adult, from *Florisuga mellivora* (Linné), collected by the author at Huanay, Río Bópi, Bolivia, Aug. 13, 1934, in the collection of the author. Represented by the ♀ holotype only.

Diagnosis: Frons flatly convex; sides of prothorax straight; pleurites very narrow, not reaching to submarginal carinae; basal propulsion sclerite of sucking apparatus short and thick. Measurements follow the next species.

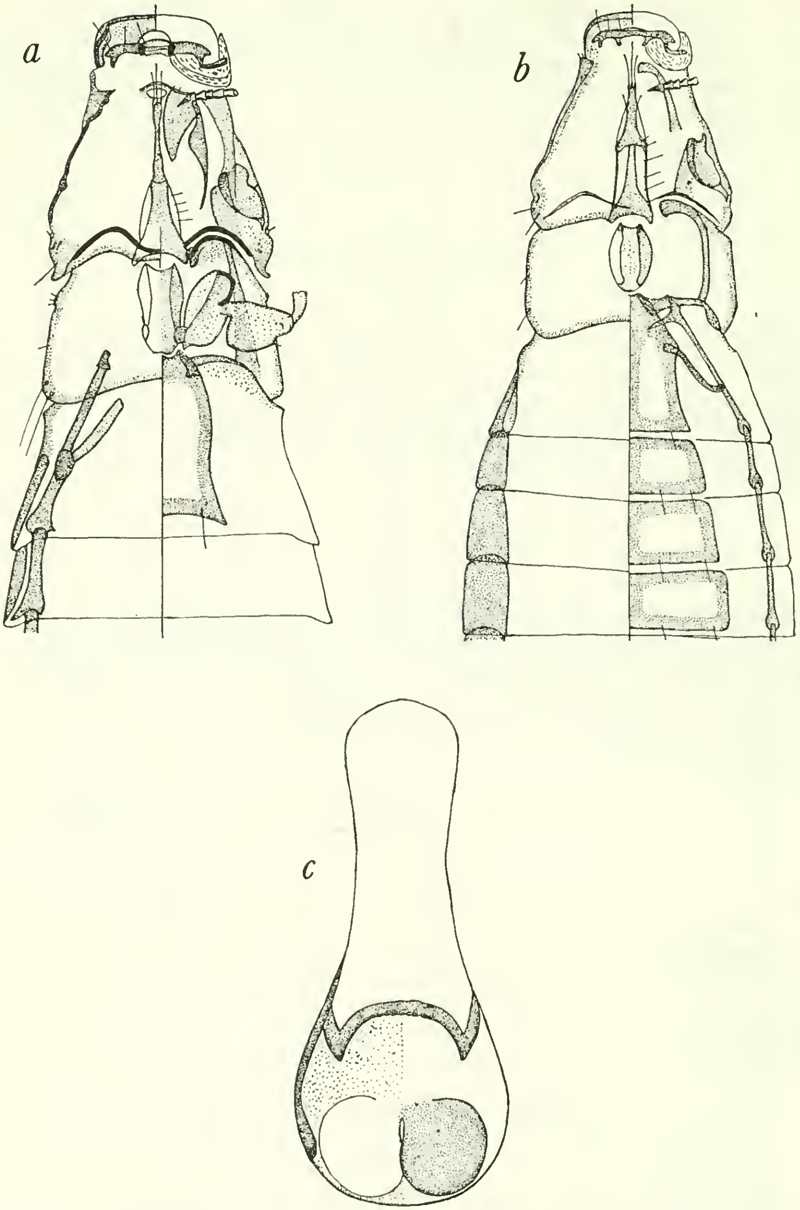


FIGURE 10.—*a, Trochiliphagus mellivorus* ♀, head, thorax, 1st segment of abdomen, and 1st leg. *b–c, T. irazuensis: b,* ♀, head, thorax, and abdominal segments I–III; *c,* ♂, genitalia.

Trochiliphagus irazuensis, new species

Figure 10,*b–c*

Types, male and female adults, from *Selasphorus flammula* Salvin, collected by the author on Volcán Irazú, Costa Rica, February 1902, in the collection of the author. Species represented by ♀ holotype, ♂ allotype, and ♂ paratype.

Diagnosis: Recognized by its small size (length 2.57, ♀); frons uniformly circular; cephalic carinae narrow; propulsion sclerite of sucking apparatus long and narrow; sides of prothorax straight; abdominal carinae narrow and pleurites very wide and deeply pigmented.

The measurements (in mm.) for *T. mellivorus* and *T. irazuensis* are as follows:

	T. mellivorus		*T. irazuensis*			
	Female		*Male*		*Female*	
	Length	*Width*	*Length*	*Width*	*Length*	*Width*
Body	3.21	--	2.36	--	2.57	--
frons	--	0.37	--	0.28	--	0.29
Head temples	.76	.63	.62	.56	.63	.64
occiput	.71	--	.59	--	.58	--
Prothorax	.50	.68	.42	.55	.46	.62
Pterothorax	.58	.89	.41	.70	.43	.81
Abdomen	1.76	1.04	1.21	.78	1.39	.96
Basal plate			.28	.09 (distal end)		
Endomeral sac			.14	.14		

Trochiliphagus grandior, new species

Figure 11,*a*

Type, female adult, from *Boissonneaua f. flavescens* (Loddiges) collected by the author at Buenos Aires, Dep. Norte de Santander, Colombia, Sept. 14, 1946, in the collection of the author. Species represented by ♀ holotype and 2 ♀ paratypes.

Diagnosis: Frons uniformly rounded; head wide, both at frons (0.37) and temples (0.68); prothorax with prominent, rounded anterolateral angles, bearing a spine and 1 long seta, and with concave sides; preantennary carinae with a branch extending backward from median portion to antennary fossae. Measurements follow the next species.

Trochiliphagus brevicephalus, new species

Figure 11,*b*

Type, female adult, from *Phaethornis a. augusti* (Bourcier), collected by the author at Ocaña, Norte de Santander, Colombia, Nov. 3, 1946, in the collection of the author. Represented by the ♀ holotype only.

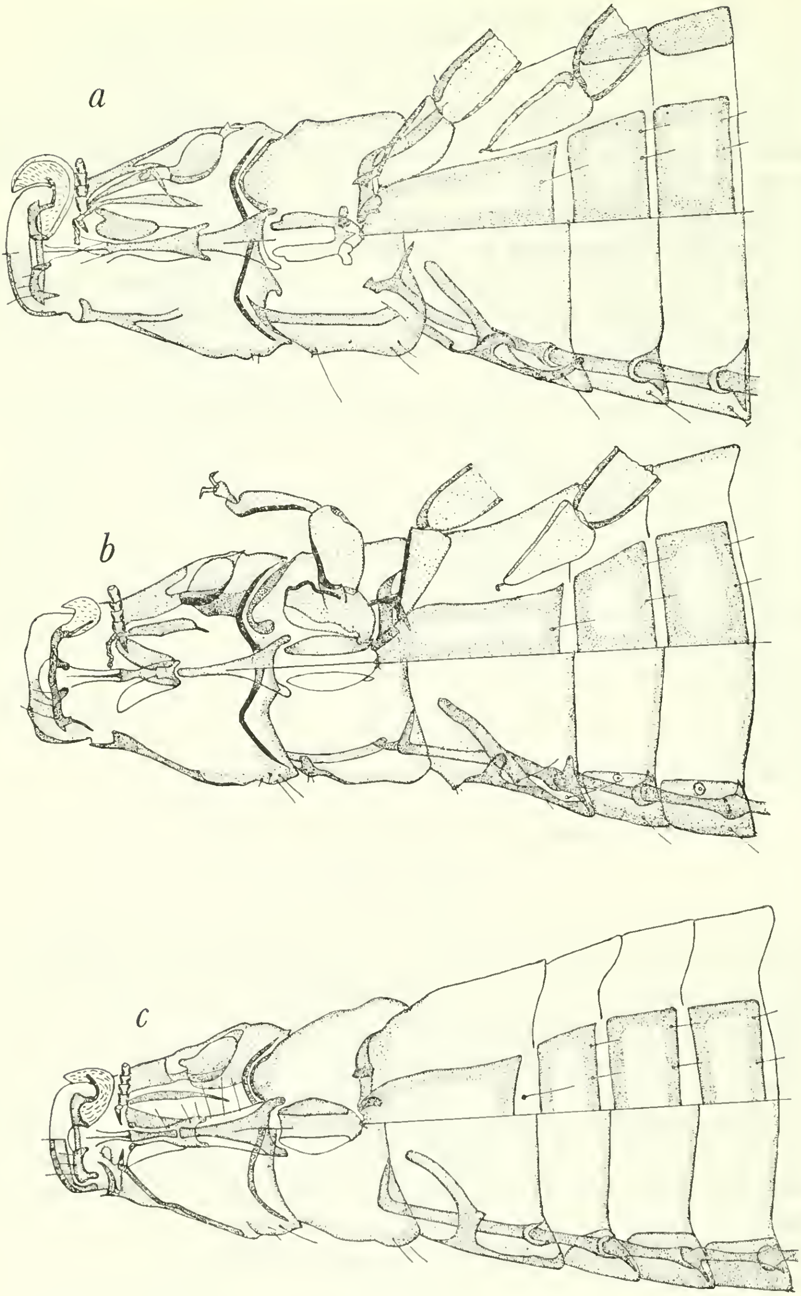


Figure 11.—*a*, *Trochiliphagus grandior* ♀, head, thorax, and abdominal segments I–II. *b*, *T. brevicephalus* ♀, head, thorax, and abdominal segments I–II. *c*, *T. peruanus* ♀, head, thorax, and abdominal segments I–III.

Diagnosis: Frons transverse, with two slight, median protuberances; frontal, transverse carinae wide and deeply and uniformly colored; sides of prothorax undulating; pleurites very wide, extending inward beyond spiracles.

The measurements (in mm.) for *T. grandior* and *T. brevicephalus* are as follows:

	T. grandior		*T. brevicephalus*	
	Female		*Female*	
	Length	*Width*	*Length*	*Width*
Body	3. 40	--	3. 33	--
Head: frons	--	0. 37	--	0. 38
Head: temples	. 82	. 68	. 77	. 67
Head: occiput	. 75	--	. 72	--
Prothorax	. 46	. 70	. 54	. 67
Pterothorax	. 65	1. 00	. 61	. 96
Abdomen	1. 76	1. 22	1. 81	1. 17

***Trochiliphagus jimenezi* (Carriker), 1903**

Physostomum jimenezi Carriker, Univ. Nebraska Studies, vol. 3, p. 163, pl. 5, fig. 1, 1903. Host: *Amazilia t. tzacatl* (Delallave), Juan Viñas, Costa Rica, March 1902.

Represented by the ♀ holotype and 1 ♀ paratype, in the collection of the author.

Diagnosis: Frons flatly convex; pterothorax with concave sides and definite anterior angles; head small (0.76×0.63; frons 0.37); sides of prothorax undulating; pleurites wide, with submarginal carinae across their median portion. Measurements follow the next species.

***Trochiliphagus peruanus*, new species**

FIGURE 11,*c*

Type, female adult, from *Adelomyia melanogenys inornata* (Gould), collected by the author at Santo Domingo, Peru, June 30, 1931, in the collection of the author. Known from the ♀ holotype only.

Diagnosis: Frons uniformly rounded; gular setae well developed (5–6); head rather narrow, frons 0.32; temples 0.63; prothorax without anterior angles and with undulating, convex sides; anterior portion of preantennary carinae bent inward to join base of mandibles.

The measurements (in mm.) for *T. jimenezi* and *T. peruanus* are as follows:

	T. jimenezi		*T. peruanus*	
	Female		*Female*	
	Length	*Width*	*Length*	*Width*
Body	3. 00	--	3. 03	--
Head: frons	--	0. 34	--	0. 32
Head: temples	. 69	. 60	. 71	. 63
Head: occiput	. 65	--	. 69	--
Prothorax	. 45	. 63	. 48	. 72
Pterothorax	. 55	. 78	. 59	. 91
Abdomen	1. 65	. 90	1. 62	1. 13

***Trochiliphagus latitemporalis*, new species**

FIGURE 12,*a*

Type, female adult, from *Eutoxeres aquila munda* Griscom, collected by the author at Rio Jurubidá, Dep. Chocó, Colombia, Mar. 28, 1951, USNM 64888. Represented by the ♀ holotype only.

Diagnosis: Size large (body 3.75; head 0.89×0.80; frons 0.40); frons uniformly rounded; sides of prothorax undulating; pleurites extending beyond inner edge of abdominal carinae; anterior sclerite of sucking apparatus, bearing stylet, very short and without basal prongs; abdomen narrow (1.17). Measurements follow the next species.

***Trochiliphagus abdominalis*, new species**

FIGURE 12,*b*

Type, female adult, from *Anthrocothorax nigricollis iridescens* (Gould), collected by the author at Villa Felisa, Norte de Santander Colombia, Oct. 22, 1947, in the collection of the author. Known from ♀ holotype only.

Diagnosis: Frons uniformly rounded; size large (length 3.80; head 0.90×0.73); sides of prothorax slightly concave, same width as temples; pleurites narrow, not reaching to submarginal carinae; anterior sclerite of sucking apparatus long and slender, with well-developed basal prongs; abdomen very wide (1.52).

The measurements (in mm.) for *T. latitemporalis* and *T. abdominalis* are as follows:

		T. latitemporalis		*T. abdominalis*	
		Female		*Female*	
		Length	*Width*	*Length*	*Width*
Body		3. 75	--	3. 80	--
Head	frons	--	0. 40	--	0. 39
	temples	. 89	. 80	. 90	. 73
	occiput	. 82	--	. 83	--
Prothorax		. 54	. 76	. 54	. 76
Pterothorax		. 61	. 96	. 56	1. 22
Abdomen		2. 10	1. 17	2. 00	1. 52

***Trochiliphagus* (?) *ochoterenai* (Zavaleta), 1943**

Trochiloecetes ochoterenai Zavaleta, Tesis Univ. Mexico Fac. Cien., Dep. Biol., p. 54, pl. 5, fig. c, 1943. Host: *Selasphorus rufus* (Gmelin).

I have examined two females of a *Trochiliphagus* from *Selasphorus rufus* from the collection of Col. Emerson. One is fully adult, the other slightly immature. They are extremely close to *T. irazuensis* (Carriker), from *S. flammula*, the actual differences being too small to merit nomenclatural recognition.

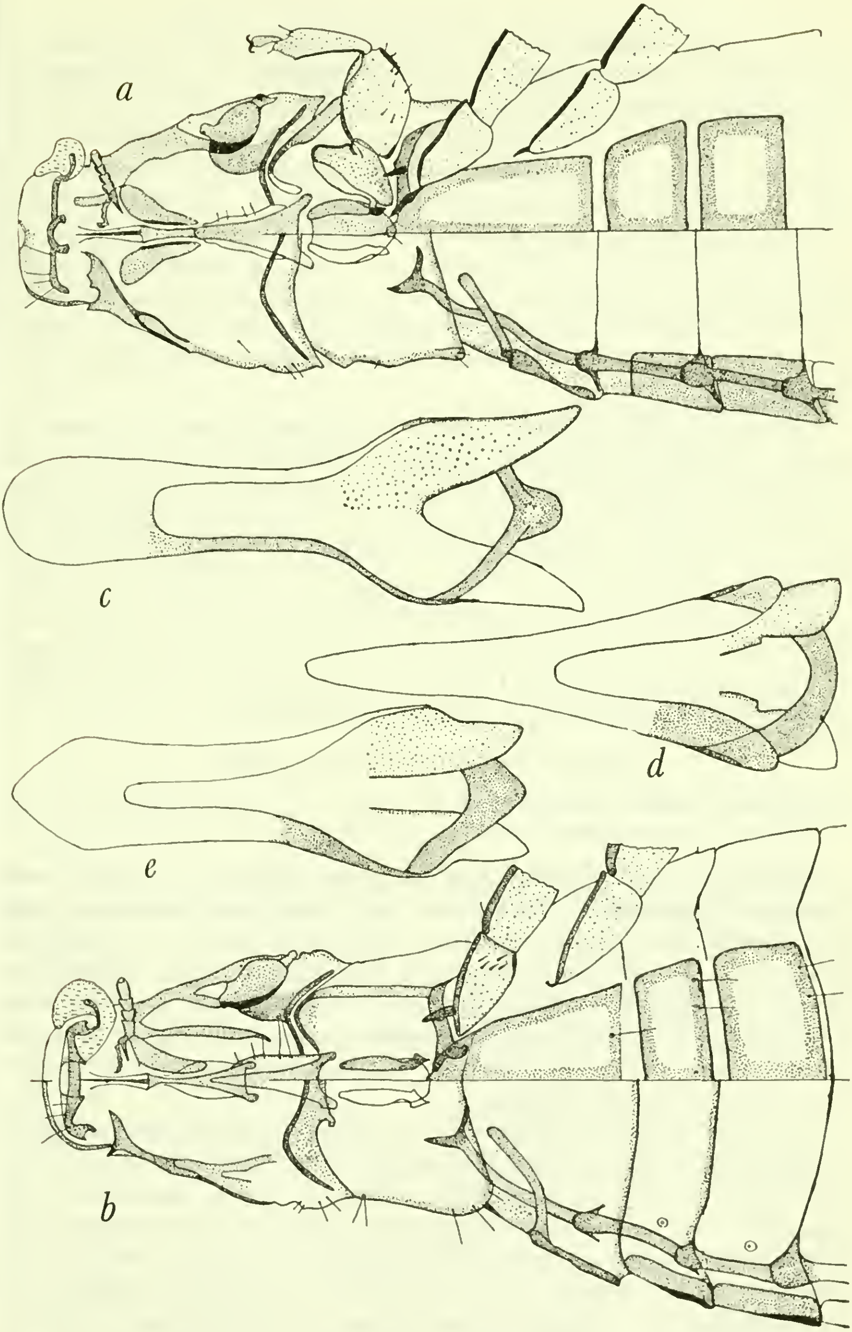


Figure 12.—*a*, *Trochiliphagus latitemporalis* ♀ , head, thorax, legs, and abdominal segments I–II. *b*, *T. abdominalis* ♀ ,head thorax, portion of legs, and abdominal segments I–II. *c–e*, Genitalia from *Ricinus* species: *c*, *R. leptosomus* (Carriker); *d*, not described from *Synallaxis albescens australis*, Bolivia; *e*, not described from *Elaenia o. obscura*, Peru.

Body length 2.54 against 2.57; head (temples) 0.62×0.58 against 0.63×0.64; frons 0.29 against 0.29; prothorax 0.40×0.58 against 0.36×0.62; pterothorax 0.43×0.78 against 0.43×0.80; abdomen 1.32×0.91 against 1.39×0.95. There are but two differences of any importance—viz, width of head at temples (0.58 against 0.64) and the prothorax, which is longer and narrower. The details of the sucking apparatus are not clearly defined either in the type of *irazuensis* or in the specimens from *S. rufus*, but those visible seem to be identical, as well as the transverse, frontal carina, the pleurites, and the submarginal abdominal carinae. The two hosts are closely related, and it would serve no useful purpose to attempt their separation.

The uncertainty surrounding the generic position of *T. ochoterenai* makes it impossible for me to allocate that species generically. I have not been able to see a copy of the description, and while the species was placed under *Trochiloecetes* in the 1952 "Checklist of Genera and Species of Mallophaga" (Hopkins and Clay); there is some doubt of its correctness. If it is actually a *Trochiloecetes*, it may well be a synonym of *T. doratophorum* (Carriker), from *Selasphorus flammula*, since the species of *Trochiliphagus* from these two hosts are practically the same. If it is a *Trochiliphagus*, it would then probably be a synonym of *T. irazuensis* (Carriker)

Physostomum lineatum Osborn, 1896

Physostomum lineatum Osborn, Bull. U.S. Bur. Ent., n.s., p. 248, 1896. Host: *Trochilus colubris* Linné.

This species was placed under the genus *Ricinus* in Hopkins' and Clay's 1952 checklist. Dr. Osborn says that three specimens were sent to him for identification from Cornell University. I communicated with Dr. Dietrich, Curator of Entomology of the Museum of Zoology at Cornell, and he informed me that he has not been able to find any of Osborn's types described in the 1896 paper, and has no idea where they may be located. Osborn stated that the specimens had been returned to Cornell.

A careful scrutiny of Osborn's description of this species shows that it could not have been a *Trochiloecetes* and that it was either a *Trochiliphagus* or else a true *Ricinus*, with a wrongly labelled host. He says: "Front rounded, with a few short hairs; palettes small; lateral angles of temples produced; prothorax widening a little behind and posterior margin concave." None of these characters would apply to *Trochiloecetes*. I suggest that it was a *Trochiliphagus*, since no mention was made of any darker markings on the sides of the head, a common character in many species of *Ricinus*.

Hosts and Parasites Treated in this Paper

Hosts:	Parasites:
Calypte costae (Bourcier):	*Trochiloecetes prominens* (Kellogg and Chapman)
Selasphorus flammula Salvin:	*Trochiloecetes doratophorus* (Carriker) *Trochiliphagus irazuensis* new species
Thalurania (furcata) furcatoides Gould:	*Trochiloecetes emiliae* Paine and Mann
Selasphorus rufus (Gmelin):	*Trochiloecetes ochoterenai* Zavaleta
Aglaiactis cupripennis (Bourcier):	*Trochiloecetes aglaiacti* new species
Amazilia t. tzactl (de la LLave):	*Trochiloecetes quibdoensis* new species *Trochiliphagus jimenezi* (Carriker)
Amazilia amazilia caeruleigularis Carriker:	*Trochiloecetes simplex* new species
Colibri c. coruscans (Gould):	*Trochiloecetes latitemporis* new species
Ocreatus u. underwoodi (Lesson):	*Trochiloecetes coartatia* new species
Ocreatus underwoodi addae (Burcier):	*Trochiloecetes bolivianus* new species
Coeligena lutetiae (de Lattre and Bourcier):	*Trochiloecetes malvasae* new species
Phaethornis guy coruscus Bangs:	*Trochiloecetes grandior* new species
Phaethornis superciliosus veracrucis Ridgway:	*Trochiliphagus mexicanus* new species
Phaethornis a. augusti (Bourcier):	*Trochiliphagus brevicephalus* new species
Rhodopis v. vesper (Lesson):	*Trochiloecetes rhodopis* new species
Heliothrix barroti (Bourcier):	*Trochiloecetes columbianus* new species
Thalurania furcata colombica (Bourcier):	*Trochiloecetes angustifrons* new species
Florisuga mellivora (Linné):	*Trochiloecetes abdominalis* new species *Trochiliphagus mellivorus* new species
Chalybura buffoni micans Bangs and Barbour:	*Trochiloecetes pinguis* new species
Glaucis hirsuta affinis Lawrence:	*Trochiloecetes complexus* new species
Lesbia nuna pallidiventris (Simon):	*Trochiloecetes fasciatus* new species
Chrysuronia oenona longirostris Berlepsch:	*Trochiloecetes oenonae* new species
Boissonneaua f. flavescens (Loddiges):	*Trochiloecetes multicarinae* new species *Trochiliphagus grandior* new species
Pterophanes cyanoptera peruvianus Boucard:	*Trochiloecetes illumani* new species
Lafresnaya l. lafresnayi (Boisson):	*Trochiloecetes sauli* new species
Threnetes leucurus rufigaster Cory:	*Trochiloecetes mandibularis* new species
Campylopterus falcatus (Swainson):	*Trochiliphagus lazulus* new species
Adelomyia melanogenia inornata (Gould):	*Trochiliphagus peruanus* new species
Eutoxeres aquila munda Griscom:	*Trochiliphagus latitemporalis* new species
Anthrocothorax nigricollis irridescens (Gould):	*Trochiliphagus abdominalis* new species
Trochilus colubris Linne:	*Trochiliphagus lineatus* (Osborn)

In the author's collection but not included in this paper are specimens of *Trochiloecetes* from the following list of hosts (it would be impossible to illustrate some of them with any degree of accuracy because of their poor condition):

Acestrura heliodor astreans Bangs, ♀, Hacienda, Cincinnati, Magdalena, Colombia.
Aglaiocercus emmae caudata (Berlepsch), ♀, La Palmita, Dep. Norte de Santander, Colombia.
Aglaiocercus kingi mocoa (DeLattre and Bourcier), ♀, Belén Dep., Huila, Colombia.
Amazilia fimbriata apicalis (Gould), ♀♀ ♀ ♀, San Felix, Río Orinoco, Venezuela.
Amazilia fimbriata nigricauda (Elliot), ♀, Todos Santos, Bolivia.
Amazilia lactea bartletti (Gould), ♀, Perené, Chanchamayo, Peru.
Amazilia tobaci caurensis (Berlepsch and Hartert), ♀ ♀, Ciudad Bolívar, Venezuela.
Archilochus colubris (Linné), ♀, Volcán Irazú, Costa Rica.

This specimen could not possibly represent *Physostomum lineatum* Osborn, from the same host. It is a typical *Trochiloecetes*, but is not in sufficiently good condition to be described and figured.

Calliphlox amethystina (Boddaert), ♀, San German, Venezuela.
Chalybura melanorrhoa (Salvin), ♀ ♀, El Hogar, Costa Rica.
Chrysuronia oenone josephinae (Bourcier and Mulsant), ♀, Calabatea, La Paz, Bolivia.
Damophila julie julie (Bourcier), ♀, Volador, Dep. Bolívar, Colombia.
Haplophaedia a. aureliae (Bourcier and Mulsant), ♀ ♀ ♀, Belén, Dep. Huila, Colombia.
Haplophoedia aureliae caucensis (Simon), ♀, Frontino, Dep. Antioquia, Colombia.
Lepidopyga l. luminosa (Lawrence), ♀, La Raya, Río Cauca, Colombia.
Leucippus fallax cervina (Gould), ♀, Nazaret, La Goajíra, Colombia.
Metallura theresiae Simon, ♀, Atuen, Peru.
Polyonomus caroli (Bourcier), ♀, Yanac, Peru.
Talaphorus taczanowskii (Sclater), ♀ ♀, Yuramarca, Peru.
Thalurania furcata fannyi (DeLattre and Bourcier), ♀ ♀, Andagóya, Chocó, Colombia.
Thalurania furcata jelskii Taczanowski, ♀, Chiñiri, Río Beni, Bolivia.

U.S. GOVERNMENT PRINTING OFFICE: 1960

Proceedings of
the United States
National Museum

SMITHSONIAN INSTITUTION • WASHINGTON, D.C.

Volume 112 1960 Number 3439

THE PELAGIC AMPHIPOD GENUS PARATHEMISTO (HYPERIIDEA : HYPERIIDAE) IN THE NORTH PACIFIC AND ADJACENT ARCTIC OCEAN

By Thomas E. Bowman

Among the marine planktonic Crustacea, the amphipods frequently play an important role in the economy of the sea. In general they rank third in numerical abundance; they are far exceeded by the copepods and euphausiids. In tropical and subtropical regions pelagic amphipods are not usually found in large numbers, but in the cooler parts of the oceans they are often extremely abundant. Members of the genus *Parathemisto* (=*Themisto* auct.) overwhelmingly dominate the cool-water epipelagic amphipod fauna, and their importance in the north Atlantic (including the Arctic Atlantic) has been pointed out by Bigelow (1926), Bigelow and Sears (1939), Stephensen (1923, 1924), and Dunbar (1946, 1957). Only cursory attention has been given to north Pacific representatives. The present paper is an attempt to fill in a few gaps in our knowledge of the distribution and life history of species of *Parathemisto* in the north Pacific and the Arctic Ocean north of Alaska and western Canada.

The amphipods upon which this report is based were obtained from plankton collections from several sources: (1) Off the Pacific coast of the United States from the latitude of the Columbia River to that of Punta Eugenia in middle Baja California, in connection with the California Cooperative Oceanic Fisheries Investigation (CCOFI). (2)

The *Northern Holiday* Expedition of the Scripps Institution of Oceanography, August and September 1951. (3) Cruises of the United States Fisheries steamer *Albatross* in the northern Pacific. (4) Cruises of the U.S.S. *Burton Island* to the Chukchi and Beaufort Seas during August 1950 and August and September 1951, and to Amundsen Gulf and Prince of Wales Strait during August 1953. (5) Northern Pacific stations of cruise VII of the *Carnegie*, 1928–29. (6) Samples from Japanese waters, sent to me by Dr. Sigeru Motoda and Mr. Zinziro Nakai. (7) Samples from Korean waters provided by Mr. Won Tack Yang.

Five species of *Parathemisto* were obtained from these collections. Each species is considered separately below with respect to its taxonomy, distribution, and ecology. A sixth species, doubtfully identified from the Yellow Sea by Yamada, is also considered.

Much of the work reported herein was carried out under the supervision of Dr. Martin W. Johnson, Scripps Institution of Oceanography, to whom I am grateful for many valuable suggestions and for forwarding to me the amphipods from the 1951 *Burton Island* Cruise. Dr. Robert Bieri, Antioch College, kindly sent me the amphipods from the 1953 *Burton Island* Cruise. I also wish to thank Dr. Sigeru Motoda, Hokkaido University, and Mr. Zinziro Nakai, Tokai Regional Research Laboratory, for sending me specimens of *Parathemisto* from Japanese waters. Mr. Won Tack Yang, Central Fisheries Experiment Station, Pusan, obligingly sent me specimens from several localities around Korea. Dr. Isabella Gordon, British Museum (Natural History), made it possible for me to examine *Challenger* specimens of *Parathemisto pacifica* Stebbing.

Genus *Parathemisto* Boeck

Themisto Guérin, 1825, p. 772.—Stephensen, 1923, p. 19; 1924, p. 94.
Parathemisto Boeck, 1870, p. 87.—Bovallius, 1889, p. 248.—Barnard, 1930, p. 419.
Euthemisto Bovallius, 1887, p. 21; 1889, p. 275.

DIAGNOSIS (FAMILY CHARACTERS OMITTED): Head moderately large, globular. P1 (pereopod 1) simple. P2 chelate; carpal process narrow, concave on anterior margin. Carpus of P3 and P4 more or less dilated, forming a prehensile organ with propodus. P5–7 longer than P3 and P4. Uropods narrow, elongate. Type species, by monotypy, *Themisto gaudichaudii* Guérin.

In 1870 Boeck established the genus *Parathemisto*, which was to be distinguished from *Themisto* Guérin by P5 not being much longer than P6 or P7. Noting that *Themisto* had been preoccupied in 1815 by a nudibranch mollusk, Bovallius (1887) changed the amphipod name to *Euthemisto*. Stephensen (1924) combined the two genera, since the relative lengths of P5–7 of the male of *Themisto gracilipes* Norman placed it in *Euthemisto,* while the female had to be referred to *Parathemisto.* In combining the two genera, Stephensen returned to the oldest generic name, apparently not realizing that it had been preoccupied. K. H. Barnard (1930) pointed out that *Themisto* was not available and that Boeck's name had to be used. In spite of this, some authors continue to refer to the genus as *Themisto.*

K. H. Barnard (1930) retains *Parathemisto* and *Euthemisto* as subgenera of *Parathemisto,* a course which is followed by Hurley (1955) and Vinogradov (1956). I believe this is the most satisfactory way to deal with this group of amphipods. Although the differences between *Euthemisto* and *Parathemisto* are sufficiently clear cut so that there is no difficulty in assigning all the known species to one or the other, they are not as great as those which separate the other genera of the family Hyperiidae.

Keys to species of *Parathemisto* have been given by Barnard (1930, p. 420), Stephensen (1923, p. 19, European species), and Hurley (1955, New Zealand species).

Subgenus *Parathemisto* Boeck

Dorsal spines absent. Flagellum of female antenna 1 slender, straight. Carpus of P3–4 only slightly expanded. P5–7 subequal in length. Peduncle of uropod 3 strongly produced at inner distal angle. Inner ramus of uropod 3 serrate on medial and lateral margins. Type species, by subsequent designation, *Parathemisto abyssorum* Boeck.

Key to the Species of the Subgenus *Parathemisto*

1. In length P5>P7>P6; dactyls not pectinate. Posterior margin of P1 propodus bearing several long setae. Maxilliped without a distal row of setae on basal plate . . . . **abyssorum** Boeck

   In length P6>P7>P5; dactyls of P5–6 pectinate at base. Posterior margin of P1 propodus serrate but without setae on distal margin. Maxilliped with distal row of long setae on basal plate 2

2. Antennae 1 and 2 of female subequal. Length of adult 4.5–8.5 mm. **pacifica** Stebbing

   Antenna 2 longer than antenna 1. Length of adult 9–17 mm. **japonica** Bovallius

Parathemisto (*Parathemisto*) *pacifica* Stebbing

FIGURES 1; 2,*a,j–k*; 3,*a–c*; 4–10

Parathemisto pacifica Stebbing, 1888, pp, 1420–1423 [no figures].—Bovallius, 1889, p. 263.

Parathemisto oblivia (Krøyer), Holmes, 1904, p. 233.

Themisto abyssorum (Boeck), Shoemaker, 1930, pp. 132–133 [specimens from Nanaimo, British Columbia only].—Wailes, 1929, p. 5.

Parathemisto abyssorum (Boeck), Thorsteinson, 1941, pp. 90–91.
Parathemisto japonica Bovallius, Hurley, 1956, pp. 15–16.—Vinogradov, 1956, pp. 211–212.

Diagnosis: Total length of adult ♀, excluding antennae, 4.5–8.5 mm. Body more chunky in appearance than in most species of *Parathemisto*. Dorsal to antennal groove head is less roundly produced in lateral view than in *P. abyssorum*, i.e., slope of this part of head is directed more posteriad than in *P. abyssorum*. Pleonites with a few minute teeth along ventral margins, posterior lateral corners produced into small points. Female antenna 2 about as long as antenna 1, slightly shorter than head plus first 2 pereonites. Molar process of mandible about twice as long as incisor process. Maxilliped with row of long spines at distal end of basal plate. Propodus of P1 serrate but not spinous on posterior margin. In length P6>P7>P5. Posterior distal corners of carpus of P6–7, but not of P5, with conspicuous spines. Dactyls of P5–6 pectinate at base. Peduncle of uropod 3 from 2 to 2.5 times as long as telson.

Remarks: K. H. Barnard (1930, p. 419) suggested that Stebbing's *P. pacifica* was a synonym of *P. japonica*. Barnard did not have specimens of either species, and his conclusion was a reasonable one to draw from a comparison of the descriptions by Bovallius and Stebbing. I suspect that Stebbing would have reached the same conclusion, for at the time he described *P. pacifica*, Bovallius had published only a brief, unillustrated description of *P. japonica*. If Bovallius' more detailed and illustrated description published in 1889 had been available to Stebbing, he might not have described *P. pacifica* as a separate species, for the differences emphasized by Stebbing and listed below are actually not valid for distinguishing the two species:

1. The propodus of P3 of *P. pacifica* is longer than the carpus and is pectinate rather than smooth on the posterior margin. While Bovallius (1889) states that the propodus is a little shorter than the carpus, he also says that the propodus is finely pectinated, and in his figure 35, plate 12, it is shown as pectinate and slightly longer than the carpus.

2. In *P. pacifica*, the outer ramus of uropod 3 is shorter than the inner ramus. Although Bovallius (1889) states that the two rami are of equal length in *P. japonica*, his figure 43, plate 12, shows the outer one to be slightly shorter. Stebbing does not say how much shorter the outer ramus of *P. pacifica* is, and provides no figures. In my specimens of *P. japonica* and *P. pacifica*, the outer ramus is slightly shorter.

Although the above criteria are worthless for distinguishing between *P. pacifica* and *P. japonica*, I nevertheless consider them as distinct

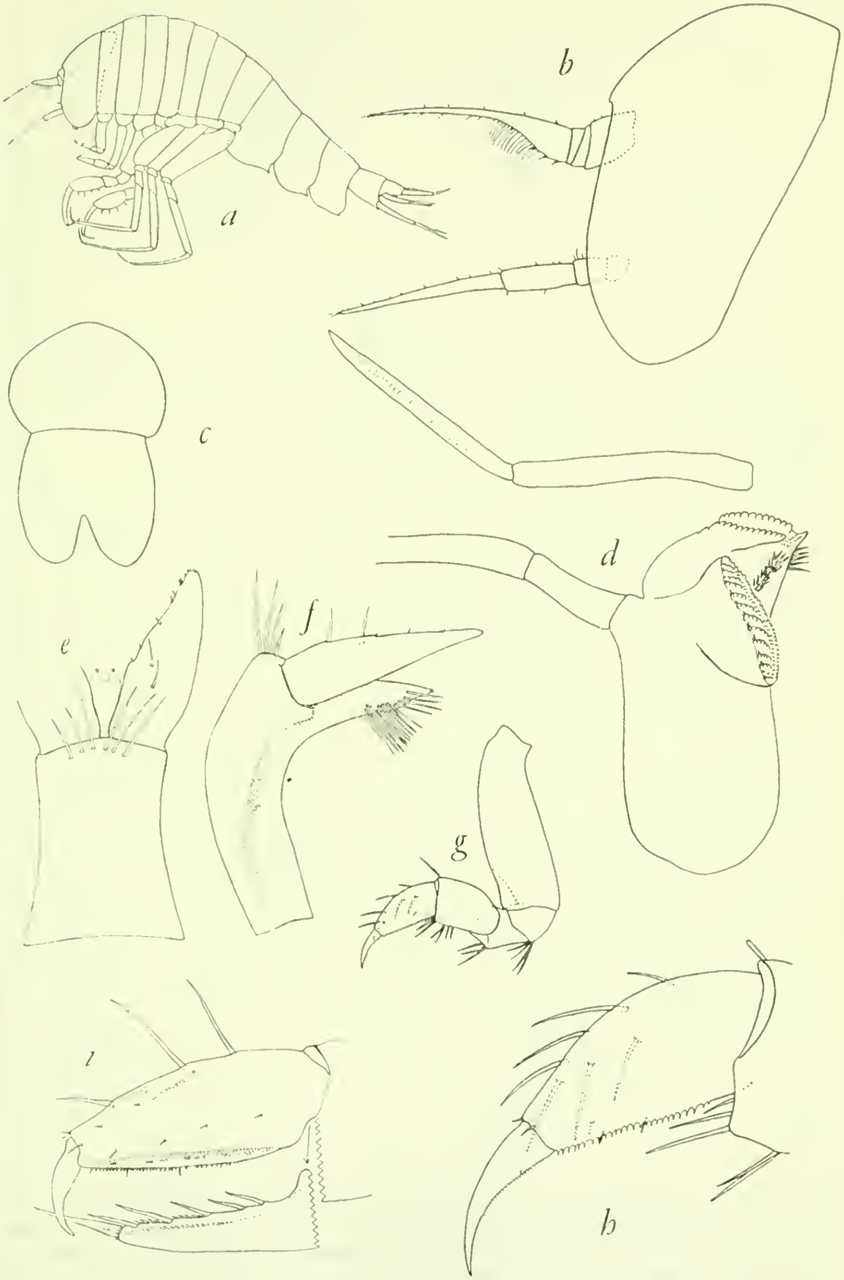


Figure 1.—*Parathemisto pacifica* Stebbing: *a*, Lateral view of female, 5.0 mm. in length; *b*, head and antennae, lateral view; *c*, labrum, male; *d*, left mandible, male; *e*, maxilliped, posterior surface; *f*, maxilliped, lateral view; *g*, *h*, pereopod 1, female; *i*, pereopod 2, female. Scales various.

FIGURE 2.—*Parathemisto pacifica* Stebbing: *a*, Antenna 1, adult male, off California. *Parathemisto japonica* Bovallius, *b*, *c*, *f*, *g*, *h*, from adult female, 11.0 mm. in length, southern Sea of Okhotsk: *b*, Pereopod 2; *c*, pereopod 3; *d*, pereopod 4, slightly smaller female; *e*, pereopod 6, juvenile female, 6.7 mm., off Cape Esan, Japan; *f*, pereopod 5; *g*, pereopod 6; *h*, pereopod 7, dactyl broken, undamaged dactyl drawn from slightly smaller specimen, same locality; *i*, pereopod 6, ovigerous female, 9.5 mm., off Cape Esan. *Parathemisto pacifica* Stebbing, pereopod 6: *j*, Ovigerous female, 7.0 mm., off Cape Esan; *k*, adolescent female, 6.7 mm., Bering Sea. Scale same for *c*-*k*; enlargement 3.8 times greater in *a*, and 1.5 times greater in *b*.

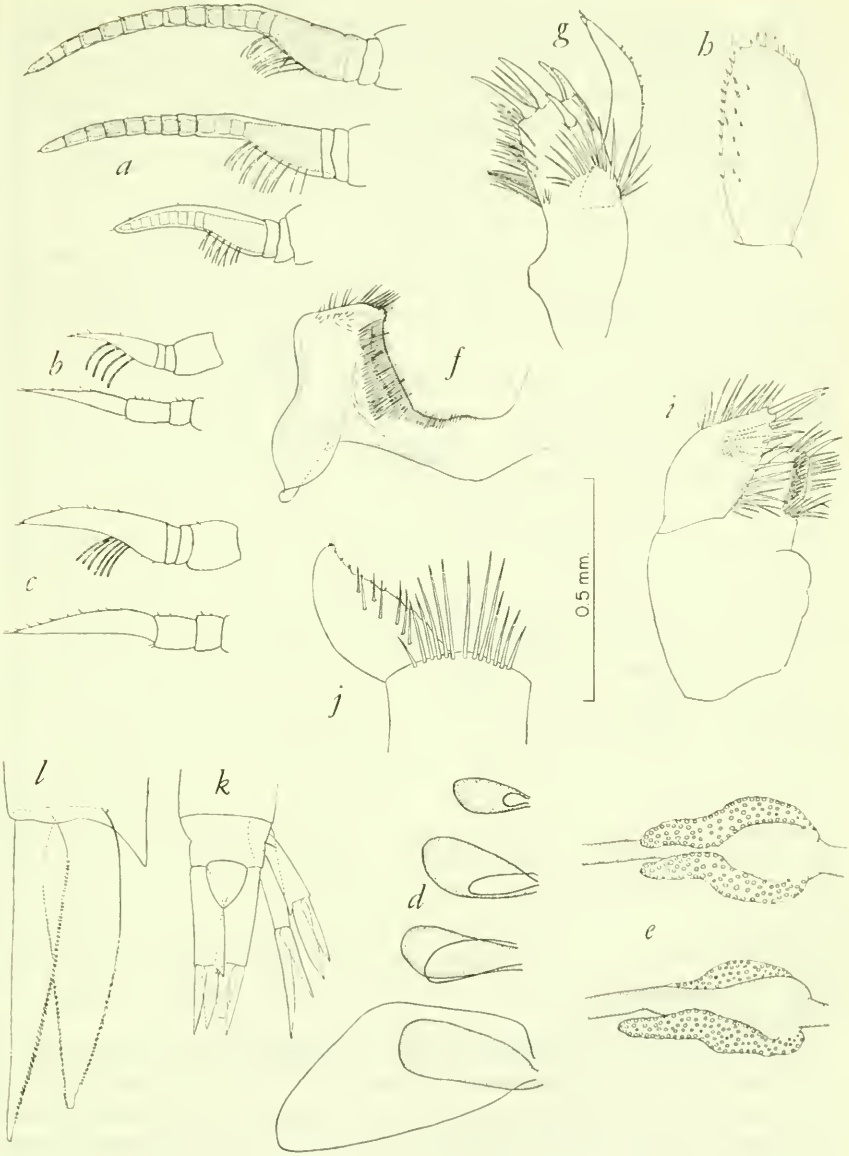


FIGURE 3.—*Parathemisto pacifica* Stebbing: *a*, Three stages in the development of male antenna 1, from specimens 3.8, 4.5, and 5.0 mm. in length, off California; *b*, antennae 1 and 2 of very young female; *c*, same of very young male; *d*, four stages in the development of oostegites (unshaded outline) showing size relative to gills (shaded outline); *e*, dorsal (above) and dorsolateral views of portion of digestive system, showing origin of digestive caecae from anterior part of midgut. *Parathemisto japonica* Bovallius: *f*, Labium; *g*, maxilla 1; *h*, palp of maxilla 1, flattened; *i*, maxilla 2; *j*, maxilliped, inner plate and left outer plate omitted; *k*, uropods and telson; *l*, uropod 3, distal end. Scale applies to *f–j*.

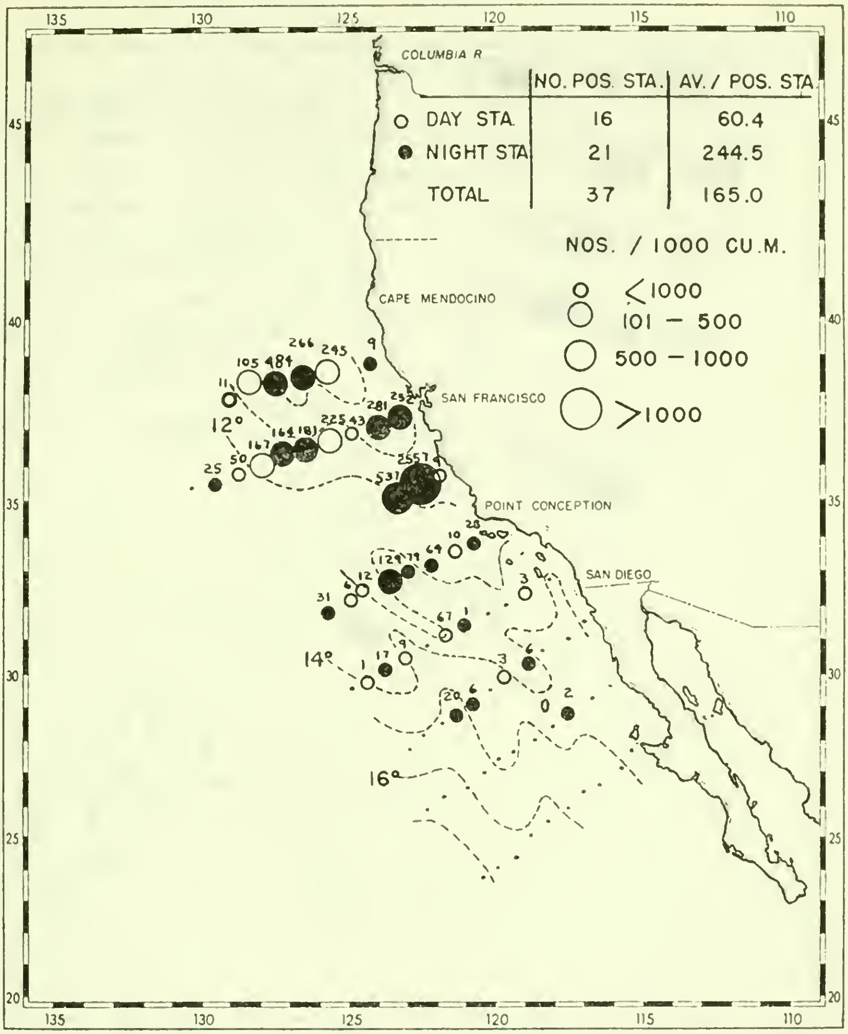
but very closely related species, which may be told apart by the larger size, greater development of the pereopodal setae, and unequal antennae of *P. japonica*. In addition to the small morphological differences, the two species have different geographical distributions. *P. japonica* occurs in the Japan and Okhotsk Seas and in a limited region east of Japan and the southern Kuriles; *P. pacifica* inhabits subarctic water in the rest of the Pacific.

The type material of *P. pacifica* consisted of 7 specimens, 3 females and 4 males, taken at the surface at *Challenger* station 240 (32°20′ N., 153°39′ E.). Stebbing's description was based on a male which seems not to be extant, for I am informed by Dr. Isabella Gordon (in litt.) that the collections of the British Museum (Natural History) contain 3 females and 3 males but no dissected male. Through her kindness I have been able to examine a male and a female with ova from the *Challenger* material. The female, 6.7 mm. in length, has fully developed oostegites and subequal antennae 1 and 2. The male, measuring 6.5 mm., is not fully mature, for the antennae are only slightly longer than the height of the head. Since Stebbing did not select a holotype, the *Challenger* specimens are all syntypes. The above mature female is herewith designated as the lectotype of *P. pacifica*.

COLOR: Eyes red, with black centers. General body color purplish red due to rather large, dark-red chromatophores, which are visible through the transparent cuticle. The chromatophores are most abundant on the pereon, and make it quite dark. Food in the gut may add to the darkness of the pereon. On the pleon the chromatophores occur slightly less than halfway down the sides of the pleonites and on the middle of the dorsal surface of the third and sometimes also the second pleonite. One or two chromatophores are located on the dorsal surface of the peduncle of uropod 3. The mouthparts have a reddish appearance. P1–2 have a few chromatophores, and P3–4 may have chromatophores at the distal end of the basipods. P5–7 are without chromatophores.

DISTRIBUTION: The distribution of *P. pacifica* will be considered in three sections: (1) in the area surveyed by CCOFI, off the coasts of California and Baja California; (2) in the northwestern Pacific Ocean adjacent to Japan and the Kurile Islands; (3) in the north Pacific Ocean as a whole.

1. CCOFI Area: Figures 4 to 7 show the distribution of *P. pacifica* encountered during four CCOFI cruises. At the stations shown, oblique hauls of 20 minutes duration were made with one-meter plankton nets from a depth of about 70 m. (140 m. in cruise 20 except for the northernmost line of stations) to the surface. Details of net construction and methods by which the hauls were made are given by Ahlstrom (1948, 1952). The volume of water strained during a haul was meas-



	NO. POS. STA.	AV. / POS. STA
○ DAY STA.	16	60.4
● NIGHT STA.	21	244.5
TOTAL	37	165.0

FIGURE 4.—*Parathemisto pacifica* Stebbing, distribution in March 1949, CCOFI cruise 1.

ured with an Atlas-type current meter fastened in the center of the mouth of the net. This measure has been used to correct the counts of the numbers of amphipods in the samples studied to numbers per 1,000 cubic m. of water.

In the CCOFI area *P. pacifica* is by far the most abundant amphipod. The southern extent of its range lies within the CCOFI area, and by comparing the southern boundaries with the superimposed isotherms at a depth of 30 m., it is possible to estimate the limiting temperatures. In cruise 1 this temperature is estimated to be about

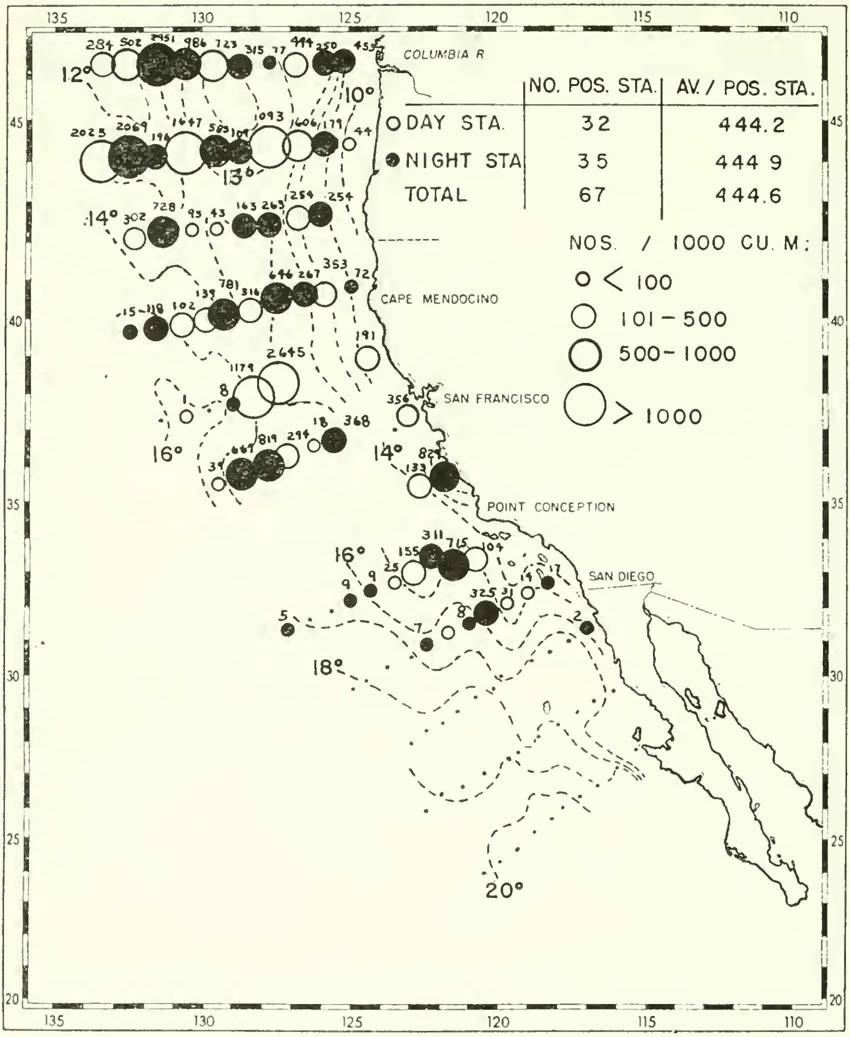


FIGURE 5.—*Parathemisto pacifica* Stebbing, distribution in July 1949, CCOFI cruise 5.

15° C., and for cruises 5 and 9 about 17°. The data of cruise 20 are very limited, but here the 18° isotherm may be limiting.

The numbers found at the different stations of a cruise vary considerably. Near the southern limits the numbers decrease somewhat, but elsewhere the variation appears to be random and not related to available measurements of oceanographic conditions. An unsuccessful attempt was made to determine the causes behind this variation in numbers in cruise 5. Using the northern four lines of stations in order to eliminate the limiting effect of higher temperatures to the

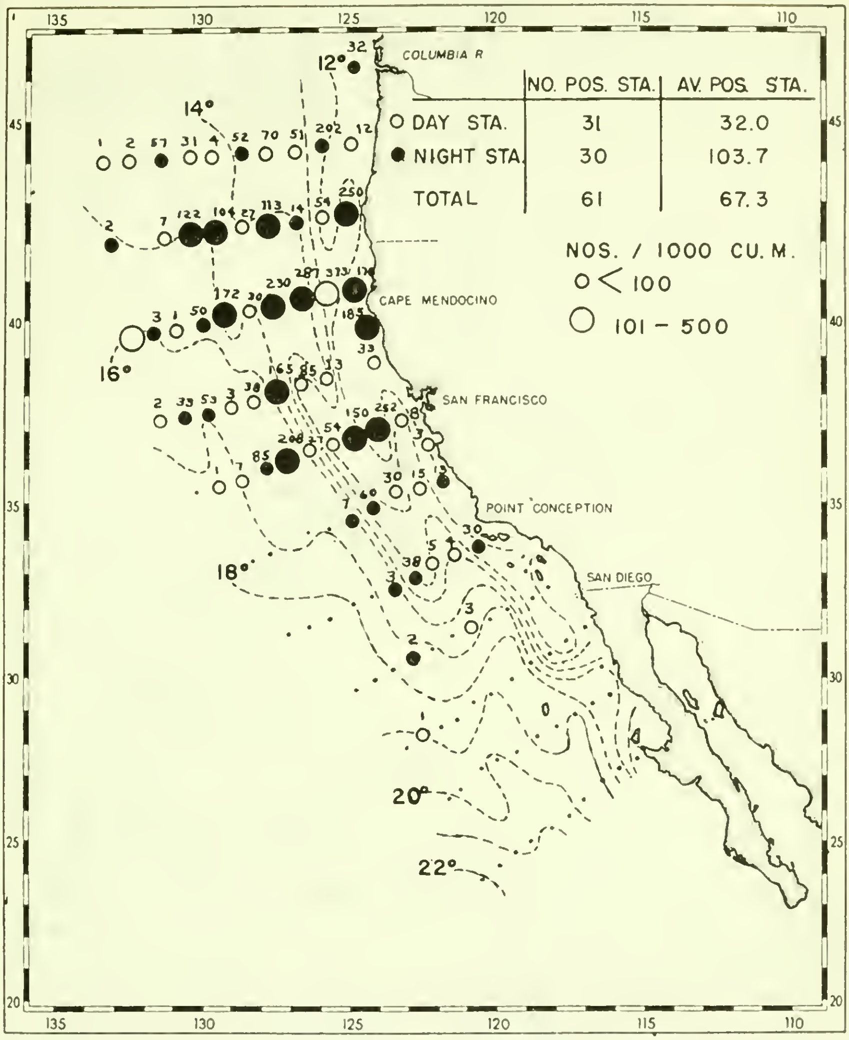
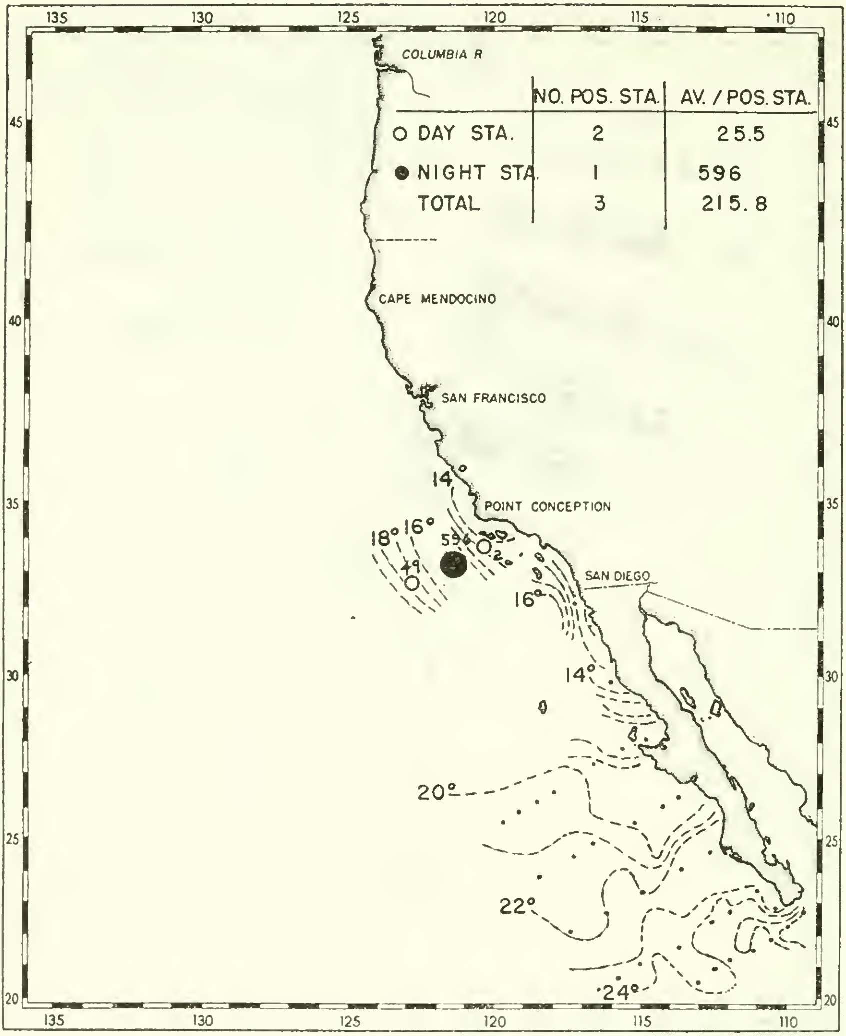


FIGURE 6.—*Parathemisto pacifica* Stebbing, distribution in November 1949, CCOFI cruise 9.

south, it was not possible to find any relation between the numbers taken at a station and the temperature, salinity, depth of haul, depth of thermocline, or the percent of the haul which was made below the thermocline.

The seasonal variation in numbers is of considerable interest. The average number per 1,000 cubic m. at the positive stations in 1949 increased from 165 in March to 445 in July, and then decreased to only 67 in November. Part of the March–July increase may be at-



	NO. POS. STA.	AV. / POS. STA.
○ DAY STA.	2	25.5
● NIGHT STA.	1	596
TOTAL	3	215.8

FIGURE 7.—*Parathemisto pacifica* Stebbing, distribution in November 1950, CCOFI cruise 20.

tributed to the fact that in March the four northernmost lines of stations were not occupied, and the average number is more heavily affected by the small numbers in the southernmost lines. But even if we consider only lines 5–8 of cruise 1, the mean number per station is increased only to 229, which still falls far short of the mean number for July, 445, or the mean number for lines 5–8 in July, 404. In November not only is there a notable decrease in numbers, but the range is slightly more restricted because of the higher temperatures of offshore waters.

Part of the variation in numbers may be caused by seasonal changes in the intensity of breeding. However, females with ova or embryos in the brood pouch were abundant at all but the southernmost stations on all three cruises. Juveniles which had recently left the brood pouch were also widespread, and it is apparent that breeding goes on during most if not all of the year.

Another possible explanation for the seasonal change in catch is that the population inhabited deeper water in March and November than in July. Some evidence for this is found in a comparison of day and night hauls. In both March and November the mean number per positive haul was much greater for the night hauls than for the day hauls, nearly five times as great in March and more than three times as great in November. These differences suggest that diurnal vertical movements were occurring during these months, and that during the day part of the population was below the level of the net hauls. In July, however, there was almost no difference between the mean number per station for the day hauls and that for the night hauls. Here diurnal vertical migrations were very limited or lacking, and probably at least most of the populations were living at depths not greater than 70 meters.

2. Northwestern Pacific: I have been able to examine a limited number of plankton samples from the northwestern Pacific. In addition to *Albatross* samples, principally from the Sea of Japan, I have studied specimens from *Carnegie* stations, material sent to me by Motoda, Nakai, and Yang, and a few specimens from salmon stomachs forwarded to me by William Aaron of the University of Washington.

All the samples from the Japan and Okhotsk Seas contained *P. japonica*. In addition *P. japonica* was found at *Albatross* stations 4805 (east of Iturup Island, Kuriles) and 4806 (east of Cape Yerimo, Hokkaido), and in one of Motoda's samples from east of Cape Esan, Hokkaido. In these latter three samples *P. pacifica* also occurred, but in much smaller numbers than *P. japonica*.

Further east only *P. pacifica* occurs. Detailed planktonic surveys are needed to establish the eastern boundary of *P. japonica*. *P. pacifica* extends to Japanese coastal waters, but does not occur in the Japan Sea and probably not in the Sea of Okhotsk, where it is replaced by the larger *P. japonica*.

In 1948 Irie reported on the distribution of a number of pelagic amphipods in waters adjacent to Japan, including a species of *Parathemisto* which was listed as "*Parathemisto* sp. A." In a later paper (1957b) this species is illustrated under the name *Themisto gracilipes* Norman, but the illustrations are clearly of *Parathemisto japonica*. Probably both *P. japonica* and *P. pacifica* were present in Irie's collections, and possibly *P. gracilipes* in the stations south of Japan.

In figure 8 I have plotted the distribution of *Parathemisto* in the vicinity of Japan from Irie's data. To these data I have added some *Albatross* and *Carnegie* stations as well as the localities reported by Nakai (1955). While the occurrences in the Japan and Okhotsk Seas are undoubtedly *P. japonica*, those east of Japan probably include both *P. japonica* and *P. pacifica*. Since the temperatures limiting southward penetration are similar for *P. japonica* in the Japan Sea (see p. 366) and for *P. pacifica* along the California coast, Irie's data on the occurrence of *Parathemisto* east of Japan can be applied to both *P. japonica* and *P. pacifica*. His data show that these species are most abundant north of Japan. Irie (1948) states that *Parathemisto* is abundant between 40° and 50° N., common between 35° and 40° N., but very rare between 25° and 35° N. Figure 8 indicates that the southern boundary falls at about 36° N.

P. pacifica inhabits cold water, and the extent of its southern penetration along the eastern coast of Japan must depend on the relative influences of the Kuroshio and the Oyashio. The warm Kuroshio leaves the coast of Japan and turns east or northeast at Cape Inubozaki (35°40′ N.), with a variable amount of north-south meandering (Masuzawa, 1955). Koizumi (1953) reported on the temperature variations at 39° N., 153° E., a locality which is sometimes covered with water of Kuroshio origin, at other times with cold water of Oyashio origin. Here the temperature at a depth of 25 m. in 1948 varied from 10.80° C. in March to 21.64° C. in September. Clearly the southern boundary of the Oyashio and of its inhabitants, including *P. japonica* and *P. pacifica*, is subject to fluctuation.

In the region where the two current systems meet, the Oyashio may underlie the Kuroshio to a limited extent. Tanaka (1953) observed that in the waters near the Izu Peninsula the warm-water copepod species of the Kuroshio were confined to the upper 200 m., while the cold-water species of the Oyashio were obtained chiefly from below 200 m.

Recently several Russian biologists of plankton have set up faunal zones and zoogeographic boundaries in the region east of Japan and southeast of the Kurile Islands. This work is summarized by Beklemishev and Semina (1956) and by Bogorov (1958). *P. japonica* (=*P. japonica* + *P. pacifica*) is listed by Bogorov and Vinogradov (1955) as an inhabitant of their boreal epipelagic zone, extending south to about 40–42° N. and having surface temperatures of from 9–15° C. This zone is also characterized by the copepods *Calanus tonsus* and the chaetognaths *Sagitta elegans* and *Eukrohnia hamata*. Brodsky (1955a) refers to it as the "*Calanus tonsus* Zone," and it undoubtedly corresponds to Hida's (1957) "Subarctic Zone" in the mid-Pacific.

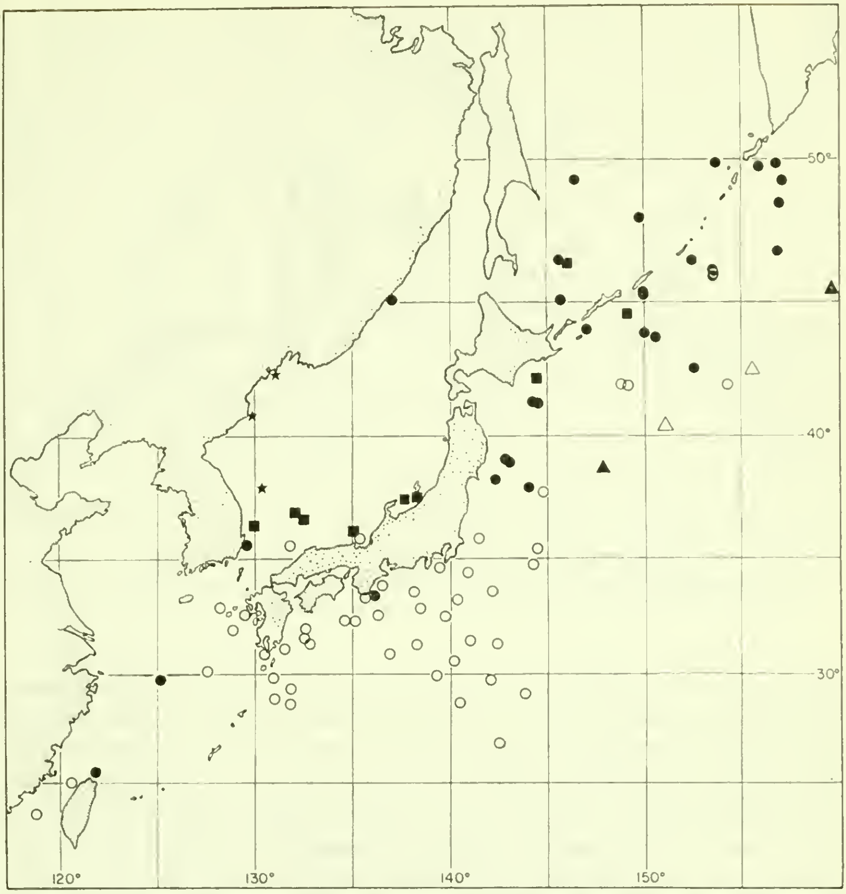


FIGURE 8.—Distribution of *Parathemisto pacifica* and *P. japonica* in the northwestern Pacific. Positive stations indicated by solid symbols, negative stations by open symbols. Circles, stations reported by Irie (1948). Squares, *Albatross* stations. Stars, stations reported by Nakai (1955). Triangles, *Carnegie* Stations. The two southernmost stations reported by Irie probably had *P. gracilipes.* Only *P. japonica* was present at the *Albatross* stations in the Japan and Okhotsk Seas; both *P. japonica* and *P. pacifica* at the two *Albatross* stations east of Japan; only *P. pacifica* at the *Carnegie* stations.

3. North Pacific Ocean: In figure 9 I have attempted to show the probable limits of distribution of *P. pacifica* across the entire North Pacific. The approximate southern boundary east of about 160° W. is based not only on CCOFI material, but also on samples from cruise VII of the *Carnegie* and the *Northern Holiday* Expedition of the Scripps Institution of Oceanography. In the region between 170° E. and 160° W., no collections have been made available to me, but extensions of the boundaries in the CCOFI area and in the northwestern

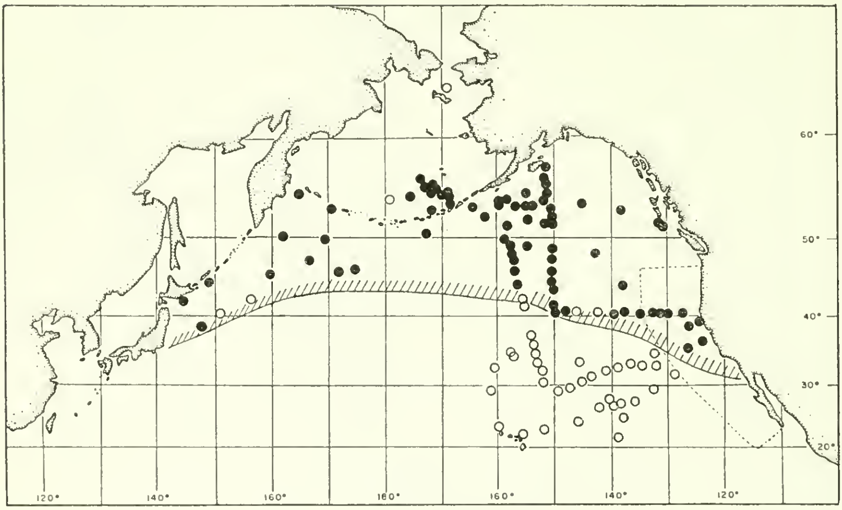


Figure 9.—Distribution of *Parathemisto pacifica* Stebbing. Solid circles, positive stations; open circles, negative stations. CCOFI area outlined by dashed line. Approximate southern limit of distribution shown by hachured line.

Pacific gives us a boundary line in the north central Pacific between latitudes 42° and 43° N. On the basis of an analysis of the distribution of chaetognaths and pteropods in about the same region (22°–50° N., 170° E.–145° W.), Hida (1957) established the Subarctic Zone, the southern limit of which was defined by the occurrence in abundance of the chaetognaths *Sagitta elegans* and *Eukrohnia hamata*. Hida found this boundary to lie between 43° and 45° N.; this finding agrees reasonably well with my suggested boundary for *Parathemisto pacifica*. It has already been mentioned that Bogorov and Vinogradov (1955) cited *P. japonica* as well as the above-mentioned chaetognaths as characteristic species of a faunal zone corresponding to Hida's Subarctic Zone. In Brodsky's (1955b) scheme for dividing the north Pacific into zoogeographical provinces according to the copepod faunas, *P. pacifica* fits roughly into his epipelagic temperate province. However, *P. pacifica* extends somewhat farther south and not so far to the north, for Brodsky's temperate province includes the southern part of the Chukchi Sea.

The northern limits of the area inhabited by *P. pacifica* are not known in detail. The species has not been reported from the Arctic Ocean, and I have not found it in any of the plankton samples which I have examined from the Beaufort and Chukchi Seas. Three investigators have reported it from the Bering Sea as *P. japonica* (Behning, 1939; Bulycheva, 1955, Vinogradov, 1956). Further collections in the

Bering Sea are needed to determine its northern boundary. The investigations of Johnson (1934, 1953, 1956) and Stepanova (1937) show that certain zooplanktonic species characteristic of the Bering Sea and north Pacific Ocean may be carried into the Chukchi Sea by the northward drift through the Bering Strait. *P. pacifica* does not seem to undergo such transport.

The boundaries of the area inhabited by *P. pacifica,* described above and shown in figure 9, are in fairly close agreement with the boundaries of north Pacific Subarctic Water as described and illustrated by Sverdrup et al (1946, p. 712, figures 202, 209*a*). It is apparent that *P. pacifica,* like *Sagitta elegans* and *Eukrohnia hamata,* is by virtue of its temperature requirements an inhabitant of sub-Arctic Water, and like these chaetognaths can serve as a biological indicator of this cold water of low salinity. However, its distribution differs from that *Sagitta elegans,* recently charted by Bieri (1959), in that it penetrates farther to the south and does not enter the Arctic Ocean, where *S. elegans* is common. The euphausiid, *Euphausia pacifica* Hansen, judging from the details given by Boden, Johnson, and Brinton (1955), has a distribution more nearly like that of *P. pacifica* than does *S. elegans.*

Temperature and body size: It is well known that the size of marine poikilotherms is related to the temperature of the water in which they develop (Sverdrup et al., 1946, pp. 855–857; Marshall and Orr, 1955, pp. 81–89). This relationship has been investigated for *P. pacifica,* and is summarized in figure 10. The mean length of the adult females was determined for each station and plotted against the temperature at a depth of 30 meters.

The results show a slight trend toward greater size at lower temperatures. Coefficients of correlation for cruises 1, 5, and 9 are respectively −0.526, −0.571 and −0.582. For the numbers of pairs of observations, 14, 20, and 19, the values of r required at the 5 percent level of significance are 0.532, 0.444, and 0.456. On this basis the correlation between *Parathemisto* body length and 30-meter temperature is significant for cruises 5 and 9, and nearly significant for cruise 1.

It can be seen from figure 10 that in July (cruise 5) *Parathemisto* averaged somewhat larger than in March or November. The mean length of adult female *Parathemisto* from all stations of a cruise was 5.07 mm. in March, 6.22 mm. in July, and 5.25 mm. in November. Several explanations are possible for this seasonable variation in length:

1. The *Parathemisto* populations sampled during the three cruises may belong to successive generations, the July generation having developed under conditions which resulted in greater size at maturity

than the March or November generations. If this explanation is correct, it means that several generations are produced each year, with each generation living only a few months or less. In contrast, Dunbar (1957) proposes a life cycle of 18 months to 2 years for *P. libellula* in the eastern Canadian Arctic, and Bogorov (1940) gives evidence for a 2-year life cycle for *P. abyssorum* in the Barents Sea. However, there is considerable evidence, much of it summarized by Dunbar, that marine poikilotherms from warm water grow to maturity more rapidly than do those from cold water. It is reasonable to suppose that *P. pacifica* passes through its life cycle more quickly than its Arctic relatives.

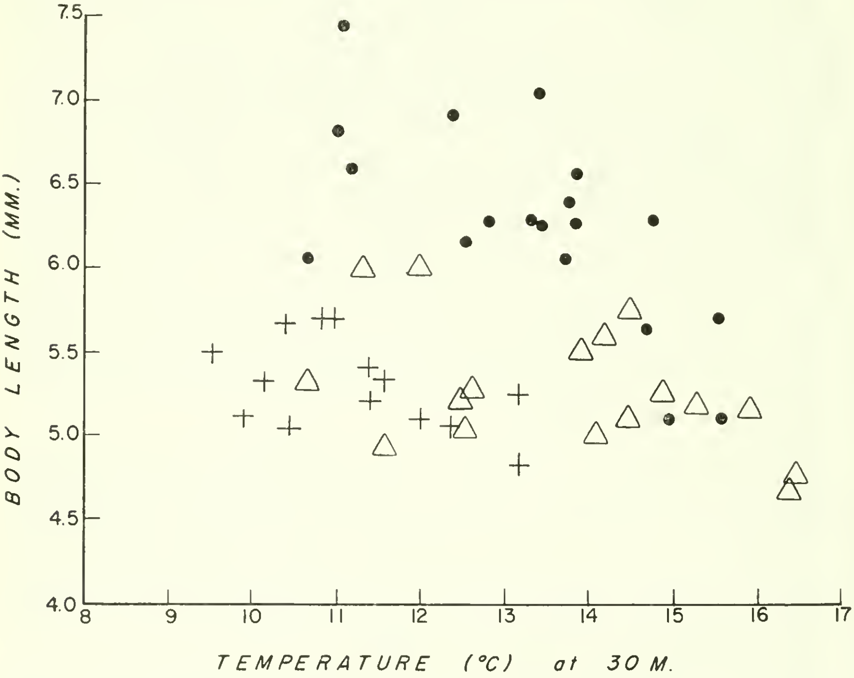


FIGURE 10.—*Parathemisto pacifica* Stebbing, relation between body length and temperature at a depth of 30 meters. Plus signs, cruise 1, March 1949; circles, cruise 5, July, 1949; triangles, cruise 9, November 1949. Each symbol represents the average length of the adult females from one station.

2. The *Parathemisto* population sampled in July may be older, hence larger individuals of the generation sampled in March. The November population, composed of smaller individuals than the July population, must represent a different generation. This interpretation requires that an individual breed more than once during its lifetime. Dunbar concluded that *P. libellula* breeds only once and then dies, but

this finding is not necessarily true for *P. pacifica.* On the contrary, examination of the ovaries of females with eggs or young in the brood pouch provides strong evidence that more than one generation of offspring is produced by the individual female. The ovaries can be readily seen through the transparent ventral body wall of the pereon; they lie on either side of the posterior midgut and anterior hindgut, above and in close association with the digestive diverticulae. In the ovigerous females that I examined, I saw new groups of eggs developing in the ovaries. The presence of a second group of eggs indicated that another clutch of eggs would be laid.

The above evidence indicates that the individual *P. pacifica,* in contrast to *P. libellula,* produces at least two and perhaps more sets of offspring during its lifetime. It is therefore possible that the July-breeding females are the older and larger members of the generation sampled in March, and that they have already produced one or more litters.

3. Because of a seasonal difference in vertical distribution, larger specimens, which lived in deeper water in March, were within the range of the nets in July. Earlier in this paper it was deduced from a comparison of day and night hauls that the *Parathemisto* population lives nearer the surface in July than in March or September. This habit would account for the larger average length as well as the larger numbers of the specimens collected in July. It is well established that in most, but not all zooplankters, the adults live at greater depths than the juveniles, and adults from deeper water average larger than those nearer the surface. Bogorov (1940) found that the young of *P. abyssorum* in the Barents Sea prefer the upper water layers, but according to Dunbar (1946), *P. libellula* has a marked phototropism and stays near the surface, especially on sunny days. In the Gulf of Maine the young *P. gaudichaudii* are most numerous near the surface, while adults occur mainly in net hauls made below the surface (Bigelow, 1926, p. 163).

4. The larger individuals collected in July lived in colder waters to the north in March and were carried south by the California Current. This hypothesis would not account for the smaller size of the November specimens, which would have to belong to a different generation. The California Current is slow and meandering, and has numerous eddies. It seems unlikely that any considerable segment of the *Parathemisto* population that inhabits the California Current is unable to maintain itself latitudinally against the southward flow. I regard this explanation as highly improbable.

It is improbable that any of the above explanations can, by itself, fully account for the observed seasonal variation in size of *P. pacifica.* The cruises from which I have studied material are too widely separated in time to provide the details needed for a satisfactory explanation.

DEVELOPMENT: As in almost all amphipods, the eggs and early juveniles are carried loosely in the marsupium between the ventral wall of the pereon and the oostegites. Counts made of the number of eggs ranged from 20 to 60, with an average number of about 35. Behning (1939) found up to 200 eggs per female in the much larger (8.5–17 mm.) *P. japonica.*

When the young leave the marsupium there is almost no difference between the sexes. The young are miniature editions of the adults, except that there are fewer setae on the pereopods, and the flagella of antennae 1 and 2 are unisegmental in both sexes. Of course the oostegites are entirely absent from the female.

Even at this early stage it is possible to distinguish males from females in almost all cases by the shapes of the antennal flagellae, especially those of antennae 1. In the early juvenile male the flagellum of antenna 1 is longer and broader; the portion distal to the sensory filaments, which in the female is shorter and sharply pointed, tapers more gradually and is half the length of the whole flagellum. The flagellum of antenna 2 is also longer and heavier in the male.

As development proceeds, the male flagellum becomes segmented. In males about to molt, the segmentation which the flagellum will have during the following instar can be seen through the cuticle. Consequently it has been possible to estimate the number of instars from the last stage characterized by a unisegmental flagellum to the adult male stage.

The instars may be defined as follows:

1. Flagellum of antenna 1 short, unisegmental.
2. Flagellum slightly shorter than height of head, 8–10 segmented.
3. Flagellum about as long as pereonites 1–5 combined, 11–12 segmented.
4. Adult male, flagellum about as long as pereon, 13–15 segmented.

The additional segments are added from the distal end of the long first flagellar segment. In the male about to molt, it can be seen that two or three segments are formed here. The segments distal to the first one apparently do not divide further after being formed.

This method of forming additional segments differs from that of the gammarids *Pontoporeia affinis* Lindström (Segerstråle, 1937) and *Gammarus chevreuxi* Sexton (Sexton, 1924). In *Pontoporeia* males, new segments are formed, as in *Parathemisto,* by division of the proximal segment. At first this is the only method, but later the remaining segments begin to divide into two, after which they do not divide again. In the female the distal segments do not divide, and the process is essentially similar to that in *Parathemisto.* In

Gammarus new segments are formed by division of the two (or three in older animals) proximal flagellar segments with the result that two (or three) new segments are added at each molt. Segerstråle found that the antennal segments of the male *Pontoporeia* become greatly lengthened at the last molt; lengthening at this time must also occur in *Parathemisto* (compare figs. 2*a* and 3*a*).

It is apparent that after an unknown number of instars during which the antennal flagellum remains unisegmental, the male *Parathemisto* passes through a minimum of three additional instars. According to Mogk (1926), the male *Phronima sedentaria* (Forskål) passes through five instars with an unsegmented flagellum. Segments first appear in the sixth instar, and the male reaches maturity in the seventh instar. In *Phronima atlantica* Guérin segmentation is also first apparent in the sixth instar, but the adult condition is not reached until the eighth instar.

In the first stage after leaving the marsupium, the flagellum of antenna 1 of *Gammarus chevreuxi* Sexton (Sexton, 1924), *G. fasciatus* Say (Clemens, 1950), and *Pontoporeia affinis* Lindström (Segerstråle, 1937) consists of four segments. By the fourth stage the segments number 8 for *G. chevreuxi* and 9 for *G. fasciatus;* and in the fifth postmarsupial instar there are 10 and 9 segments, respectively. On the assumption that the first instar of *P. pacifica* with segmented flagella corresponds to the fourth or fifth instar of *Gammarus*, we can postulate that there are 3 or 4 postmarsupial instars of *Parathemisto* with unsegmented flagellae, or a total of 5 to 6 postmarsupial molts required to attain sexual maturity. In gammarideans which have been studied, from 7–14 molts are required (Sexton, 1924, 1928; Roux, 1933; Clemens, 1950; Kinne, 1953, 1959).

Oostegites first appear in the female when she is quite small (3.1 mm. in the earliest stage illustrated). At this stage, the oostegites are very small lobes arising mediad to the gills and only about one-third the length of the gills. During subsequent molts the oostegites increase in size, and in the adult they are transparent, membranous and much larger than the gills. No marginal setae are present. Development of the oostegites in *P. libellula* is identical (Dunbar, 1957).

The size at which maturity is reached varies widely. As an example, 382 females and 491 males from station 702, cruise 1, were examined for maturity, judged in the males by the elongate antennae and in the females by the presence of fully developed oostegites. The results are given in table 1.

The males attain maturity at a slightly smaller size than the females, though not necessarily at a younger age.

Food: Reports of the food habits of *P. gaudichaudii* and *P. libellula* have been given by Bigelow (1926, p. 107) and Dunbar (1946) respec-

TABLE 1.—*Length and maturity in* Parathemisto pacifica.

Specimens	*Length (mm.)*											
	3.6	*3.8*	*4.0*	*4.2*	*4.4*	*4.6*	*4.8*	*5.0*	*5.2*	*5.4*	*5.6*	*5.8*
Females:												
Number examined	–	165	32	37	24	23	29	24	20	17	11	7
Percent mature	–	0	3	0	13	35	48	83	90	77	82	100
Males:												
Number examined	165	55	60	63	51	26	26	20	6	7	–	–
Percent mature	0	2	0	21	41	74	90	100	83	100	–	–

tively. Both species are predominately carnivorous, sometimes cannibalistic, but also ingest some vegetable matter.

I have examined the midgut contents of a few specimens of *P. pacifica.* Consisting of minute greenish or brownish particles, much of the material was unrecognizable, but some fragments of diatoms and crustaceans were identified. The crustacean parts included copepod swimming legs and mouthparts (one mandible was recognizable), spines of undetermined origin, and crystalline cones from compound eyes. It seems reasonable to conclude that the food habits of *P. pacifica* are similar to those of *P. gaudichaudii* and *P. libellula.*

ANATOMY OF DIGESTIVE TRACT: The structure of the alimentary canal of *P. libellula* is considered briefly by Dunbar (1946). He describes an interesting "gastric apparatus" formed of dorsolateral and ventral sheets projecting backward in the midgut, which he compares with the peritrophic membrane of insects and onychophorans. Dunbar also states that there are no caeca or diverticula of any kind. On this point my findings do not agree with his.

In *P. pacifica* a pair of caecae arise laterally from the midgut near its anterior end. They extend posteriorly along the entire length of the pereon and run along in close association with the lateral parts of the midgut and with the gonads which lie dorsal to them. The caecae usually have a coarsely vesicular appearance; in section the vesicles are seen to be large vacuolate cells. The vacuoles are filled with an oily or fatty material, and vary greatly in size. In some individuals the vacuolate cells are so large that the lumena of the caecae are nearly obliterated; in others the vacuoles are small and the lumena well defined.

Contrary to Dunbar's statement, a pair of caecae is also present in *P. libellula.* Because they are closely applied to and partially fused with the gut wall, their true nature is not obvious in dissected specimens, and if the lumen is sufficiently encroached on by the large vacuolate cells, it may be difficult to interpret the caecae correctly in sectioned material. I have also found the same caecae in *P. gaudichaudii* from the Gulf of Maine, and they are probably characteristic of all species of *Parathemisto*.

Although I have not made a detailed study of the histology of the digestive caecae, it seems reasonable to suppose that their principal function is the storage of reserve food supplies. The large fat cells can scarcely be interpreted otherwise. In some specimens of *P. gaudichaudii* which had been stored in alcohol for a long period, the caecae have the appearance of a foamy network, and must be made up almost completely of fat cells. I have found no structure in *Parathemisto* comparable to the fat body of gammarids, and the storage of reserve food in this genus is probably carried out by the digestive diverticula. It is interesting to note that Nakai (1955) found the crude fat content of *P. japonica* from Korean waters to be nearly 40 percent of the dry weight.

***Parathemisto* (*Parathemisto*) *japonica* Bovallius**

FIGURES 2,*b–i;* 3,*f–l;* 8; 16,*c*

Parathemisto japonica Bovallius, 1887, p. 21; 1889, pp. 258–263, pl. 12, figs. 17–43.—Behning, 1939, pp. 362–363, fig. 1.
Parathemisto sp. (11) Yamada, 1933, p. 7, pl. 2, fig. 10,*a–g*.
Parathemisto sp. Nakai, 1955, pp. 14–15.
Parathemisto sp. A. Irie, 1948, p. 36.
Themisto gracilipes Norman, Irie, 1957b, p. 353, figs. 16–1, 16–2.
Themisto japonica, Irie, 1959, pp. 20, ff.

DIAGNOSIS: Total length of adult ♀, excluding antennae, 9–17 mm. Identical with *P. pacifica* in almost all characters except size, but female antenna 2 much longer than antenna 1, slightly longer than head plus first 3 pereonites. Setae of pereopods more conspicuous, more numerous on gnathopods.

REMARKS: While I am not unalterably convinced that *P. japonica* and *P. pacifica* are distinct species, all the evidence at my disposal leads to this conclusion. Except for mutilated specimens, I have had almost no difficulty in assigning specimens to one or the other species. The geographic ranges are different, with some overlap east of northern Japan and the southern Kuriles. In the three samples where both species occurred, I have found no intergrades, and thus no evidence of interbreeding.

Since the number of pereopodal setae increases with age in some species of hyperiids (unpublished observation), it may be argued that *P. japonica* is an older and larger form of *P. pacifica*. However, it is possible to distinguish the young stages of the two species. Antenna 2 is longer than antenna 1 even in very young specimens of *P. japonica*. The difference in the development of setae on pereopod 6, especially on the posterior margin of the propodus, is shown in figure 2*j* of a 7.0 mm. adult female *P. pacifica* and figure 2*e* of a 6.7 mm. juvenile *P. japonicus*, both of which were taken in the same net tow off Cape Esan, Hokkaido, Japan.

The correlation between temperature and body length in *P. pacifica* raises the possibility that the large size of *P. japonica* is attributable to the low temperatures at which it lives. *P. pacifica* is abundant in the Gulf of Alaska, where adult females commonly measure 6.0–7.0 mm. in length. This size is much smaller than the size of *P. japonica*, and yet surface temperatures in the Gulf of Alaska are similar to those in the colder parts of the Sea of Japan (compare Robinson, 1957, fig. 18, and Uda, 1934, figs. 5 and 9).

With this evidence, the best course is to treat *P. japonica* and *P. pacifica* as closely related, but distinct, species. If intensive collections from the region of overlapping distributions should reveal extensive intergradation, it would then be necessary to reduce their status to that of subspecies. In the limited number of samples at my disposal, however, there is no indication of such intergradation.

The Japanese zoologist Zinziro Nakai believes that the hyperiid which I have described as *P. japonica* Bovallius is an undescribed species of *Parathemisto*. He has assigned to it the Japanese name "Usumurasaki-uminomi" (light purple sea flea) and intends to describe it as a new species (Nakai, 1955). Nakai states (in litt., Oct. 23, 1954) that his decision is based on many discrepancies between Bovallius' descriptions and the structure of specimens from Japanese waters, and on Bovallius' statement (1889) that *P. japonica* occurs in the subtropical region as well as in the northern temperate region of the Pacific. Nakai believes that *P. japonica* is distributed south of Japan and has not been discovered since Bovallius' description of 1889, while "usumurasaki-uminomi" is the common species found north of Japan.

In my opinion, Nakai places too much confidence in the detailed accuracy of Bovallius' descriptions and illustrations. I believe the differences that Nakai finds between Bovallius' account of *P. japonica* and "usumurasaki-uminomi" can be explained as inaccuracies of Bovallius or as variations in the structure of *P. japonica*.

DISTRIBUTION: Okhotsk Sea, Sea of Japan, western north Pacific off the east coasts of northern Japan and the southern Kuriles.

East of Japan and the southern Kuriles, *P. japonica*, like *P. pacifica*, inhabits Subarctic Water and penetrates about as far south along the Japanese coast as the cold Oyashio. The extent of its eastward distribution is unknown, but at some distance it is replaced by *P. pacifica*.

In the Sea of Japan the scattered records from *Albatross* stations show that *P. japonica* extends south nearly to the Straits of Korea.

The findings of Yamada (1933) are more instructive. In his report on plankton collected from a series of stations off both coasts of Korea, he found *P. japonica* present off the east coast south to nearly 38°, but absent from the Tusima Straits and the Yellow Sea. This distribution correlates well with the hydrography of the Sea of Japan. As Uda (1934) has shown, the water on the Asiatic mainland side is much colder than that on the Japanese side. The cold water flows south along the mainland coast (Liman Current) to the latitude of about 36°–38° N. and forms several counterclockwise eddies as it flows. Only a small amount of mixing occurs between this cold water, presumably formed by excessive cooling in winter, and the warm, north-flowing water of the Tusima Current, a branch of the Kuroshio.

Yamada's findings suggest that *P. japonica* is distributed in the Sea of Japan according to the extent of the cold water, as Tokioka (1940) found for the chaetognath, *Sagitta elegans*. The occurrence of *P. japonica* at *Albatross* stations along the west coast of Honshu makes this hypothesis improbable. Uda's (1934) isotherm charts show that in June most of the Sea of Japan is characterized by temperatures at least as low as those of the southern boundary of the Oyashio. The Oyashio boundary temperatures in Uda's charts are 17°–19° C. at the surface and at 25 m., about 17° at 50 m., and about 15° at 100 m. Most of the water of the Sea of Japan at these depths is as cold or colder, while the water of the southward-flowing current in the west is considerably colder. Hence a wide distribution of *P. japonica* in the Sea of Japan is to be expected from our knowledge of its distribution off the east coast of Japan.

It is reasonable to believe that *P. japonica* evolved from *P. pacifica* or from a common ancestor of both species as a result of geographical isolation. The current patterns in the Japan Sea provide little opportunity for *P. pacifica* to enter from the Pacific Ocean. Almost all the water entering the Sea of Japan is warm water derived from the Kuroshio; only a very small quantity of cold water enters through Tartary Strait between the Asiatic coast and Sakhalin Island. Water leaves the Japan Sea by way of the Straits of Soya (La Pérouse) and Tsugaru, north and south of Hokkaido, respectively. Information concerning water movements in the Okhotsk Sea is still scanty. According to Bruns (1958) there is some exchange of water with the Pacific Ocean through the Kuriles. The very limited collections available to me indicate that this exchange of water has been insufficient to allow *P. pacifica* to become established in the Okhotsk Sea.

Actually, therefore, the *P. japonica* population in the Okhotsk Sea and especially in the Sea of Japan is effectively isolated from extensive gene flow from the *P. pacifica* population. The three northwestern Pacific occurrences of *P. japonica* reported in this paper may be explained as being derived from the Japan or Okhotsk Seas. For some as yet unknown reason, *P. japonica* has not been able to extend its range far beyond the immediate vicinity of its site of origin.

***Parathemisto (Parathemisto) abyssorum* Boeck**

FIGURE 11,*j–k*; 12–13

Parathemisto abyssorum Boeck, 1870, p. 87(7).—Barnard, 1959, pp. 125–127, pls. 17–19.

Themisto abyssorum (Boeck), Stephensen, 1923, pp. 20–24, chart 4; 1924, pp. 95–97, figs. 36–38; 1944, p. 12.—Shoemaker, 1930, pp. 132–133; 1955, p. 72.

DIAGNOSIS: Length of adult 10–21 mm. Larger and more slender than *P. pacifica*, and head more roundly produced. Maxilliped without a distal row of setae on the basal plate. P1–4 with more surface setae than in *P. pacifica*; posterior margin of propodus of P1 serrate and bearing several long setae. Carpal process of P2 with long end spine. In length P5>P7>P6; no long spines at posterior distal corners of carpi; dactyls not pectinate. Peduncle of uropod 3 about 3 times as long as telson.

DISTRIBUTION: Ekman (1953, p. 340) mentions *P. abyssorum* as an example of an "arctic-bathy-subarctic" species. In this category he includes plankters which live primarily in Arctic waters, but are also found in deep water in lower latitudes. A detailed discussion of the distribution of *P. abyssorum* in the Atlantic is given by Stephensen (1923, pp. 22–24, chart 4). Found throughout the Arctic and Sub-Arctic Atlantic, it is very common in the vicinity of Greenland and between Norway and Iceland. Stephensen believes that Bonnier's (1896) record of 9 mm. ovigerous *P. oblivia* taken at a depth of 950 m. in the Bay of Biscay should be referred to this species. On the western side of the Atlantic it occurs occasionally in the Gulf of Maine (Bigelow, 1926) and is widely distributed in and around the Gulf of St. Lawrence (Shoemaker, 1930; Bousfield, 1951). Bousfield believes that the permanent deep layer of very cold water in the Gulf of St. Lawrence enables the species to breed there successfully, as evidenced by the large numbers of young and immature stages taken near the surface.

I have not found *P. abyssorum* in any plankton collections from the Pacific Ocean. It was, however, the most commonly collected amphipod during the 1950 and 1951 expeditions of the *Burton Island* to the Beaufort Sea and in the 1953 expedition to Amundsen Gulf and Prince of Wales Strait. Station positions and locality records for *P. abyssorum* are shown in figure 12. Plankton hauls were made vertically with a one-half-meter Nansen type plankton net. In 1950 the hauls were made from various depths, usually 100–0 m., and in 1951 all

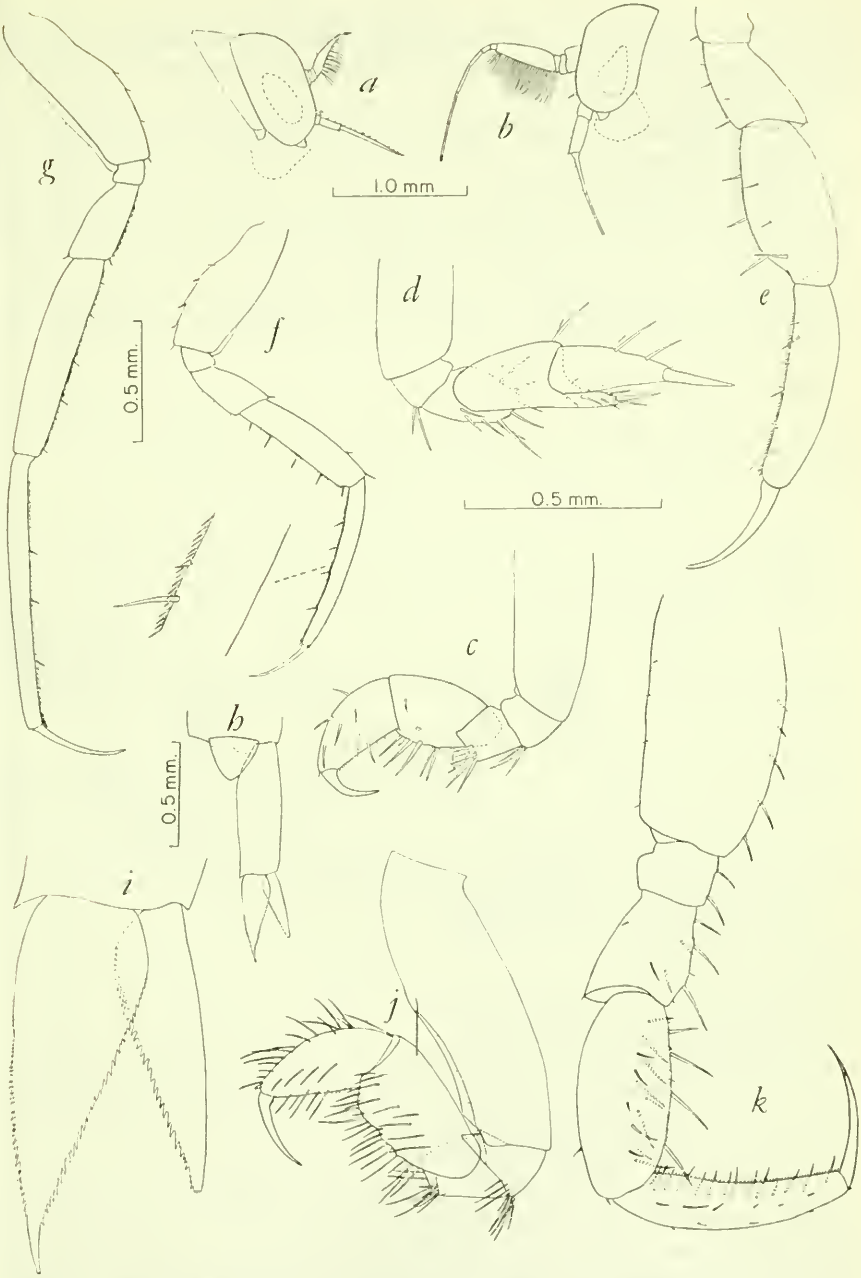


Figure 11.—*Parathemisto gracilipes* (Norman), Eastern Sea, west of Kyusyu, Japan: *a*, Head, female; *b*, head, male; *c*, pereopod 1, male; *d*, pereopod 2, male; *e*, pereopod 3, male; *f*, pereopod 5, female; *g*, pereopod 5, male; *h*, uropod 3 and telson, female; *i*, distal end of uropod 3, female. *Parathemisto abyssorum* Boeck, juvenile female, Beaufort Sea, west of Banks Island, U.S.S. *Burton Island* 1950 cruise, station 44: *j*, Pereopod 1; *k*, pereopod 3. Scale same for *a–b*, *c–e*, and *f–g*.

hauls were 100–0 m. except where the depth of the water was less than 100 m. In 1953 hauls were made from the bottom (usually less than 100 m.) to the surface.

In both 1950 and 1951 *P. abyssorum* occurred at about half the stations occupied and in about the same numbers. The average number per station (adjusted to 100 m. vertical tow) was 2.3 in 1950 and 2.6 in 1951. Distribution in the Beaufort Sea appeared not to be associated with variations in temperature or salinity.

P. abyssorum was somewhat less numerous in the 1953 *Burton Island* samples, and was captured at only 4 of the 25 stations in the Prince of Wales Strait. The average number per station was 0.75; the average number per positive station, 1.50.

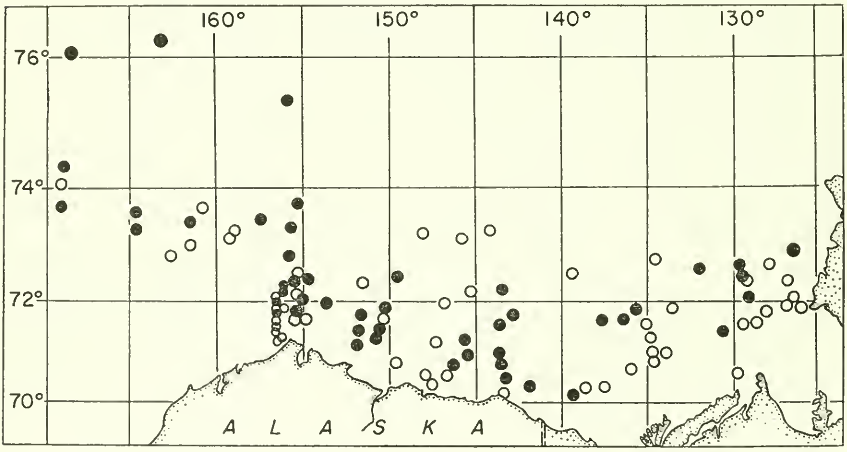


FIGURE 12.—*Parathemisto abyssorum* Boeck, distribution in the Chukchi and Beaufort Seas, U.S.S. *Burton Island* 1950 and 1951 cruises combined. Solid circles, positive stations; open circles, negative stations.

All the specimens of *P. abyssorum* collected on the *Burton Island* cruises were juvenile, with the exception of one ovigerous female, 14 mm. in length, taken at station 3, off Cape Parry, in a tow from 420 m. to the surface, August 8, 1953.

Little is known about the life history of *P. abyssorum.* Bogorov (1940) studied the life cycle in the Barents Sea and concluded that spawning occurs in "the second half of the winter season (about February)." He further concluded that the individual requires 2 years to grow to maturity, breeds once, and dies. The breeding season appears to be more prolonged than indicated by Bogorov, since at least some breeding occurs in the Beaufort Sea in August (see above), and Stephensen (1933) reported ovigerous females taken June 12 and

July 14 in waters west of Greenland. In the collections of the U.S. National Museum is a lot consisting of three adult males, 13, 14, and 14.5 mm. in length, and a female 14.8 mm., with fully developed oostegites, taken on May 18, 1902, between the Shetland and Faroe Islands.

Several records of *P. abyssorum* or *P. oblivia* in the Pacific Ocean are probably erroneous, since the authors almost certainly had *P. pacifica* or *P. japonica.* These include the records of Shoemaker (1930) and Thorsteinson (1941) from near Nanaimo, British Columbia, and that of Holmes (1904) from Humboldt Bay, Popof Island, Alaska (about 55° N., 161° W.). Possibly the specimens of "*P. oblivia*" from stations 13 and 14 of the Canadian Arctic Expedition (Shoemaker, 1920) were *P. japonica,* and those from stations 21 and 27 were *P. abyssorum.* Irie's (1957a) record from the Tusima Straits is probably *P. japonica.*

The puzzling thing about the distribution of *P. abyssorum* is that it has not been able to establish itself in the Pacific (fig. 13). This absence cannot be simply a matter of temperature, since the Okhotsk Sea and the western Bering Sea are regions of very low temperatures. In fact *P. libellula,* an Arctic species which does not penetrate as far to the south in the Atlantic as *P. abyssorum,* occurs in the Bering and Okhotsk Seas.

Three possible explanations may be given for the absence of *P. abyssorum* from the Pacific:

1. The current flow through the Bering Strait has made it mechanically impossible for *P. abyssorum* to enter the Pacific Ocean. The hydrographic evidence for a northward flow of water from the Bering Sea into the Chukchi Sea (Barnes and Thompson, 1938; LaFond and Pritchard, 1952) is corroborated by Johnson's (1956) report of the presence of characteristic Bering Sea copepods in the Chukchi Sea (*Eucalanus bungii bungii* Johnson, *Metridia lucens* Boeck). While the penetration of Arctic plankters into the Pacific would be retarded by this northward current, it is unreasonable to suppose that it would be completely inhibited. On the extreme west of Bering Strait there appears to be some movement of water southward, and Sewell (1948, pp. 399–401) believes that this movement has carried certain Arctic planktonic copepods into the north Pacific.

2. *P. abyssorum* is unable to compete successfully with the closely related north Pacific species, *P. japonica* and *P. pacifica.* All three species are very similar in structure and probably occupy similar if not identical ecologic niches. Possibly the Pacific species evolved during a time of isolation of the Pacific from the Arctic by emergence of Bering Strait. Bering Strait has been above sea level during much of geologic history. Hopkins (1959) has recently reviewed the Cenozoic history of the Bering Land Bridge. Evidence of the

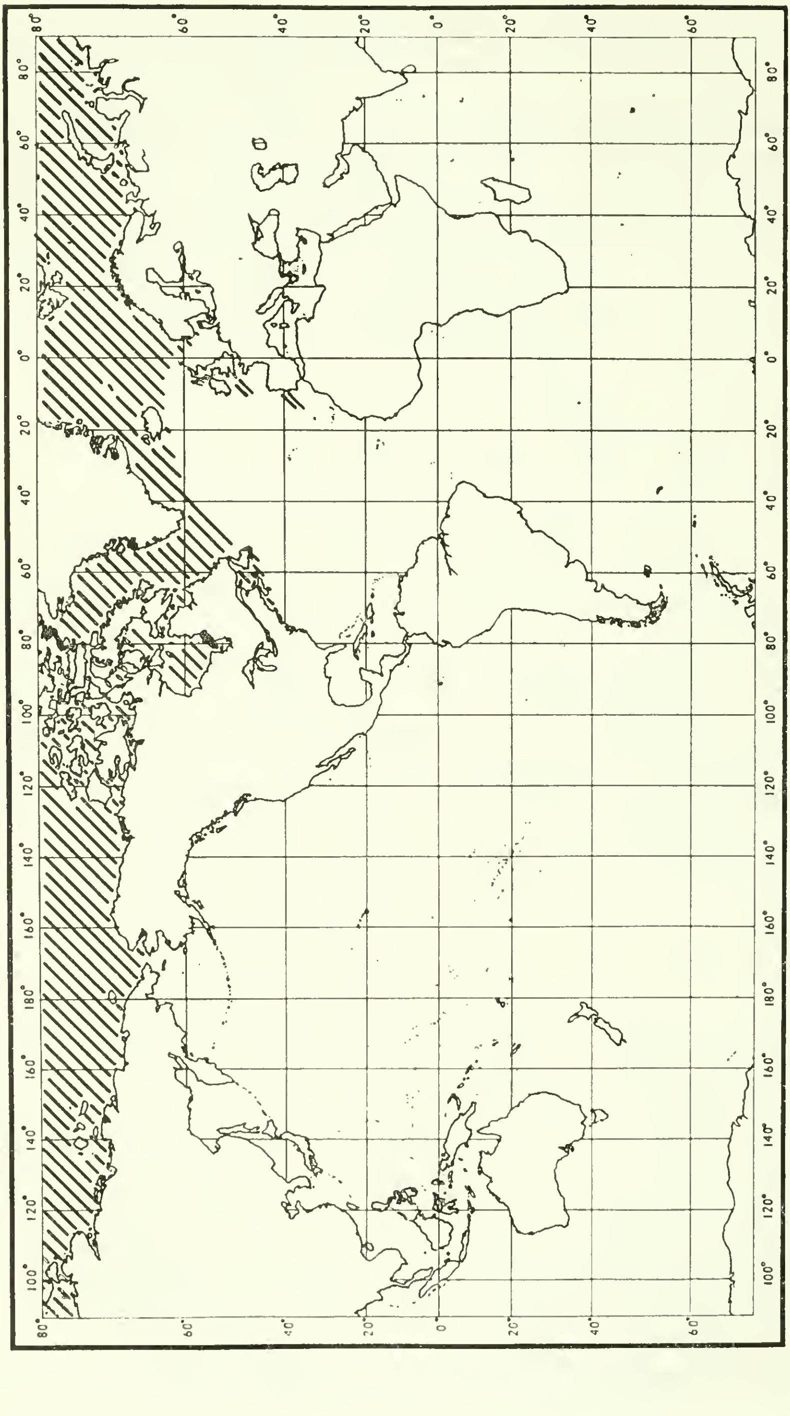


FIGURE 13.—*Parathemisto abyssorum* Boeck, world distribution. The records south of Ireland and west of Portugal are from deep water.

interchange of land mammals strongly suggests that the bridge was submerged during middle Eocene time (Simpson, 1947a, 1947b), although physical evidence in support of this submergence has not yet been found in Alaska or the islands of the Bering Sea. During most of the remainder of the Tertiary Period the bridge was above sea level. After middle Pleiocene time but before the beginning of the Pleistocene epoch, the bridge was again submerged. The bridge emerged during each glacial interval and submerged during each interglacial interval of the Pleistocene; it sank below sea level for the last time between 11,000 and 12,000 years ago. There has thus been ample opportunity for the evolution of species in the north Pacific differing from their arctic relatives. If the northward flow of the current in the Bering Strait severely limits the numbers of *P. abyssorum* entering the Bering Sea, it is evident that this species would be markedly handicapped in establishing itself in competition with the abundant *P. pacifica.*

3. *P. abyssorum* avoids shallow water, hence does not enter the shallow Bering Strait. As suggested by the specific name, *P. abyssorum,* according to Stephensen (1923, p. 23), is found, as a rule, where the depth of the sea is considerable, 400–3,127 meters. It occurs in shallower water, as in the Gulf of St. Lawrence, where Bousfield (1951) reports it from stations where the water was less than 100 m. deep, though it was rare in the shallow water inside the Belle Isle Strait. Curiously, Bousfield found that *P. abyssorum* was an indicator of the relatively warm Gulf of St. Lawrence water, rather than, as might be expected of an Arctic species, of the cold water of the Labrador Current, which enters the gulf on the north side of the Belle Isle Strait. It is most abundant at the deep water stations of the gulf, which do not happen to be in the region influenced by the Labrador Current. It probably enters the gulf through Cabot Strait, rather than through the shallow Belle Isle Strait; this entrance also accounts for the larger numbers at the stations in the southern part of the gulf.

The depths of the sea at the stations in the Beaufort and Chukchi Seas occupied by the *U.S.S. Burton Island* ranged from 18 to 4,050 m. The depths at which *P. abyssorum* occurred are summarized in table 2.

The shallowest station at which *P. abyssorum* was taken was 53 m. The entire Bering Strait is less than 50 m. deep, much of it considerably less, and this shallowness may be an important factor in preventing *P. abyssorum* from gaining entrance to the Pacific Ocean. The comparative scarcity of *P. abyssorum* in the Prince of Wales Strait may be related to the shallowness of the water there; the deepest station was 150 m., and only five stations were more than 100 m.

Probably none of the three explanations given above can by itself account for the absence of *P. abyssorum* from the Pacific Ocean. A combination of them may, however, be effective, the shallowness of the Bering Strait and the northward set of the currents preventing all but a small number from entering the Bering Sea, while competition with *P. pacifica* prevents those that do enter from establishing themselves.

TABLE 2.—*Depth of the water and occurrence of* Parathemisto abyssorum *in the Beaufort and Chukchi Seas, 1950 and 1951* Burton Island *Cruises combined.*

Stations	*Depth (meters)*			
	0–100	*101–200*	*201–500*	*500*
Number occupied	23	18	20	44
Number positive	5	7	8	28
Percent positive	21. 7	38. 9	40. 0	63. 6

Subgenus *Euthemisto* Bovallius

Dorsal spines present or absent. Flagellum of female antenna 1 curved, heavier than in subgenus *Parathemisto* (except in *P.* (*E.*) *libellula*). Carpus of P3–4 usually more expanded than in subgenus *Parathemisto.* P5 much longer than P6–7 (except in some females of *P.* (*E.*) *gracilipes*). Peduncle of uropod 3 only slightly produced at inner distal end.

Key to the Species of the Subgenus *Euthemisto*

(Modified from Barnard, 1930)

1. Female antenna 1 slender, straight. Dactyls of P5–7 pectinate at base. **libellula** Lichtenstein
   Female antenna 1 stouter, hooked. Dactyls of P5–7 unarmed at base . . 2
2. Inner ramus of uropod 3 serrate only on outer margin. **gaudichaudii** (Guérin)
   Inner ramus of uropod 3 serrate on both margins 3
3. Inner margin of uropod 3 peduncle smooth throughout. **gracilipes** (Norman)
   Inner margin of uropod 3 peduncle distally serrulate. **australis** (Stebbing)

Hurley (1955) discusses in detail the difficulties in distinguishing between *australis*, *gracilipes*, and *gaudichaudii* in collections from New Zealand waters. The three species show clear differences in general appearances, but these are very difficult to set down in words. Hurley notes that *P. australis* is shorter and stockier than the other species, with no sign of dorsal spines, and with coarse serrations on the inner ramus of uropod 3. *P. gaudichaudii* is characterized by larger size (up to 18 mm.), very distinct dorsal spination in adults, and the lack of serration along the inner margin of uropod 3 inner ramus and peduncle. In *P. gracilipes* the peduncle of uropod 3 of the very largest specimens appears serrulate when viewed under very high power, but is not at all comparable to that of *P. australis*. The serration of uropod 3 inner ramus is poorly developed in the female of *P. gracilipes*.

Parathemisto (Euthemisto) gracilipes **(Norman)**

FIGURES 11,*a–i*; 14–15; 16,*b*

Hyperia gracilipes and (?) *H. oblivia* Norman, 1869, p. 287.

Themisto gracilipes (Norman), Stephensen, 1924, pp. 97–103, figs. 39–42 [lit. and syn.]; 1949, p. 54.—Pirlot, 1929, p. 128.—Candeias, 1934, pp. 4–5, fig. 4.

Parathemisto (*Euthemisto*) *gracilipes* (Norman), Barnard, 1930, p. 421.—Hurley, 1955, pp. 153–161, figs. 133, 158, 176, 178.

[?] *Parathemisto* sp. (12), Yamada, 1933, p. 8, pl. 2, fig. 12a–e.

DIAGNOSIS: Total length of adult, excluding antennae, 4–7 mm., rarely up to 9 mm. (Stephensen, Mediterranean and Atlantic specimens); 6.5–14 mm. (Hurley, New Zealand specimens); 4.1–5.6 mm. (specimens from Tusima Straits and Eastern Sea). Only slight tendency to dorsal spination. Carpus of P2 extends about two-thirds along propodus, has one stout end spine. Uropod 3, inner ramus pectinate on both margins; inner margin of peduncle finely toothed in male (teeth very inconspicuous or absent in female).

REMARKS: The above diagnosis is based largely on that of Hurley (1955, p. 153), who has studied abundant material of *P. gracilipes*, *P. gaudichaudii*, and *P. australis* from New Zealand waters. I have had at my disposal a limited number of specimens from two surface-plankton tows—one made in Tusima Straits (34°20.7′ N., 130°47.3′ E.) and the other in the East China Sea west of Kyusyu, Japan (32°06.4′ N., 128°57.0′ E.), kindly sent to me by Zinziro Nakai. In addition, Won Tack Yang sent me three lots from off the southern coast of Korea. The characters which Hurley regards as diagnostic for *P. gracilipes* are found in these specimens. The Japanese specimens are small; two adult females measure 4.8 and 5.4 mm., and eight adult males range in length from 4.1–5.6 mm. and average 4.9 mm. The setal armature of the pereopods resembles Stephensen's (1924, figs. 39–41) rather than Hurley's drawings (1955, text-figs. 8–9). This fact may be attributed to the larger size of the New Zealand specimens.

In the Japanese specimens the serrulations of the inner margin of the male and female uropod 3 peduncle are barely discernible under high (×440) magnification, even less evident than that figured by

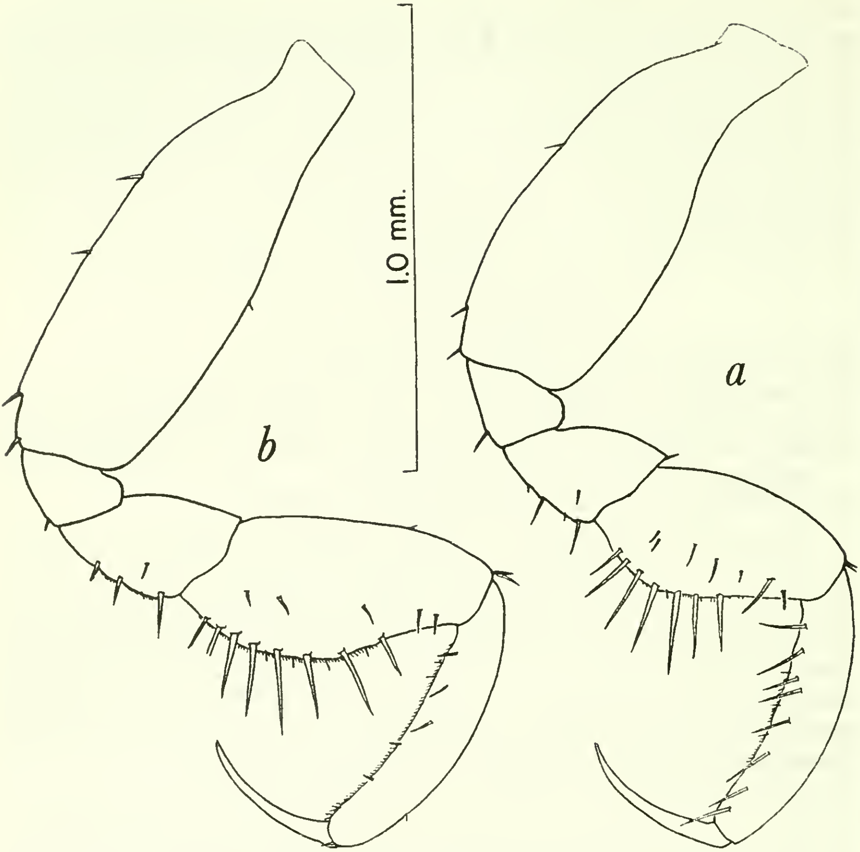


Figure 14.—*Parathemisto gracilipes* (Norman), "long-legged" form, adult female from Yellow Sea, west of Mok Po, Korea: *a*, Pereopod 3; *b*, pereopod 4.

Hurley. This near absence of serrulations is also probably due to the small size of the Japanese specimens. As in Hurley's description, the inner margin of uropod 3 inner ramus is more finely serrate in the female than in the male. In the female P5 and P7 are subequal, slightly longer than P6. In the male, P5 is relatively longer; the distal end of P6 propodus reaches about three-fourths to the distal end of P5 propodus.

The Korean specimens agree in general with the Japanese ones, which appear to represent Stephensen's (1924) "short-legged" form, but one lot collected west of Mok Po (34°30′ N., 125°0′ E.), consisting of an adult female and a juvenile, agrees with Stephensen's "long-legged" form, except in the shape of the carpus of P3–4. In the adult female, P6 extends one-fourth the distance down the propodus of P5 and has a high comb of setae on its anterior margin. P3–4 carpus (fig. 6) are of the form typical for *P. gaudichaudii* forma *bispinosa* (=*antarctica*), in which the carpus is wide proximally and narrows distally; the posterior margin is convex in the proximal part and becomes straight or slightly concave distally. A tendency toward this form is evident in the New Zealand specimens illustrated by Hurley (1955, text-fig. 9, Nos. 155–156). According to Stephensen, there are no fine teeth along the posterior margin between the long setae in the female, but these are present in both the New Zealand and Korean specimens.

Yamada (1933) illustrates a "*Parathemisto* sp. (12)" which he found to be widely distributed in the Yellow Sea. Although he did not identify it specifically, he stated that using Barnard's key (1930) the specimens keyed out to *P. gaudichaudii.* This statement implies that the inner margin of the inner ramus of uropod 3 appeared smooth to him. In my Korean "long-legged" *P. gracilipes,* the serrations of this margin are quite weak, and it is possible that they escaped Yamada's notice. If so, his "*Parathemisto* sp. (12)" is *P. gracilipes* rather than *P. gaudichaudii,* for in other respects "*Parathemisto* sp. (12)" agrees reasonably well with my" long-legged" *P. gracilipes.* Yamada's specimens attained a length of 7–8 mm.; this length is short for *P. gaudichaudii,* but about right for *P. gracilipes.* Moreover, on the basis of the temperatures at which they live in other regions, *P. gracilipes,* rather than *P. gaudichaudii,* would be expected to occur in the East China and Yellow Seas.

Although it thus seems probable that Yamada's "*Parathemisto* sp. (12)" is *P. gracilipes,* the possibility remains that his tentative identification of it as *P. gaudichaudii* was correct. This problem cannot be solved until extensive collections from the Yellow Sea are available.

Distribution: Figure 15 shows the known distribution of *P. gracilipes.* It is evident that much remains to be learned about its distribution, especially in the southern hemisphere. The record of Stewart (1913) from off Brazil is probably erroneous, since members of the genus *Parathemisto* are not known to inhabit tropical waters. Stephensen (1949) regarded his identification of specimens from Tristan da Cunha as doubtful.

The collections of the U.S. National Museum contain 7 specimens of *P. gracilipes* collected in the vicinity of the Juan Fernandez Islands by the yacht *Vagabondia.* Comparable in size to Hurley's New Zealand specimens, these specimens range from 7.9–8.5 mm. in length and agree well with Hurley's description.

P. gracilipes lives in warmer water than *P. gaudichaudii.* This preference is clearly shown in the distribution of the two species in the north Atlantic (see figs. 15 and 17; see also Stephensen, 1923 and

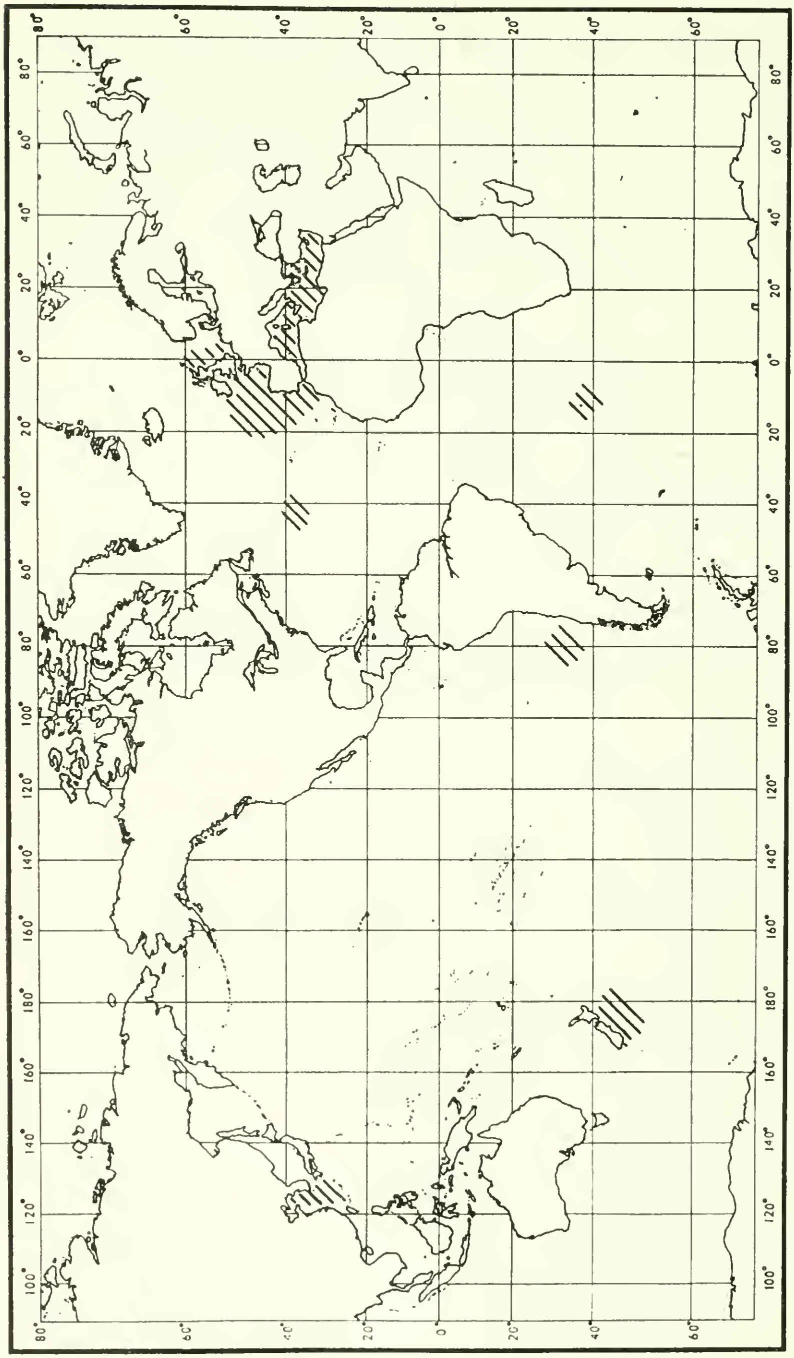


FIGURE 15.—*Parathemisto gracilipes* (Norman), world distribution.

1924 and Pirlot, 1939). Bary (1959) showed a similar difference in temperature preference in southern New Zealand waters. The absence of *P. gracilipes* from the Atlantic coast of the United States results from the rapid change of temperature over the range inhabited by *P. gracilipes* so that it literally has no living room. Hurley (1955) pointed out that *P. gracilipes* inhabits more neritic water than *P. gaudichaudii* in the New Zealand area, and Bary's (1959) detailed analysis confirms this view. In the north Pacific the occurrence of *P. gracilipes* in the east China and Yellow Seas may reflect its preference for coastal waters. Both of these seas are shallow and subject to much runoff from rivers.

In the vicinity of Plymouth, England, *P. gracilipes* undergoes a diurnal vertical migration; it moves close to the surface at night and descends during the day (Russell, 1925). Bary's data show evidence of a similar migration in New Zealand waters.

***Parathemisto (Euthemisto) gaudichaudii* (Guérin)**

FIGURES 16,*a*; 17

Themisto gaudichaudii Guérin, 1825, p. 774.
Themisto compressa Goës, Stephensen, 1924, pp. 103–110, figs. 43–49.
Euthemisto compressa (Goës), Chevreux, 1935, pp. 191–192.
Euthemisto bispinosa Boeck, Chevreux, 1935, p. 191.
Themisto gaudichaudii Guérin, Stephensen, 1933, pp. 63–64; 1944, pp. 10–12; 1947, pp. 76–77; 1949, p. 54.—Pirlot, 1939, p. 39.
Parathemisto (*Euthemisto*) *gaudichaudii* (Guérin), Barnard, 1930, p. 420; 1932, pp. 280–282 (synonomy).—Hurley, 1955, pp. 161–164, figs. 159–174.
[?] *Parathemisto* sp. (12) Yamada, 1933, p. 8, pl. 2, fig. 12, *a–e*.
Euthemisto antarctica (Dana), Ealey and Chittleborough, 1956, p. 22.

DIAGNOSIS (SLIGHTLY ALTERED FROM HURLEY, 1955): Length of adult, 7–25 mm. Strong dorsal spines in animals of more than 10 mm. total length. Carpus of P2 extends three-fourths along propodus. P3 male carpus widest proximally, width nearly one-half the length; like *P. gracilipes*, but rather more spines on surface and margin; carpus and propodus subequal. P4 male carpus oblong-ovate, width slightly more than one-half the length, fringe of small even bristles on posterior margin; about 12 strong spines. Uropod 2 outer ramus about three-fifths length of inner. Uropod 3 outer ramus two-thirds length of inner; inner ramus with smooth inner margin; inner margin of peduncle entirely smooth. P3 female carpus oblong-ovate and widest proximally, width about two-thirds the length; numerous fine surface spines, 10 marginal spines, marginal bristles throughout. P4 female has about 18 surface spines on carpus.

REMARKS: As Hurley has pointed out, the most dependable criterion by which *P. gaudichaudii* can be identified is the completely smooth inner margins of the peduncle and inner ramus of uropod 3.

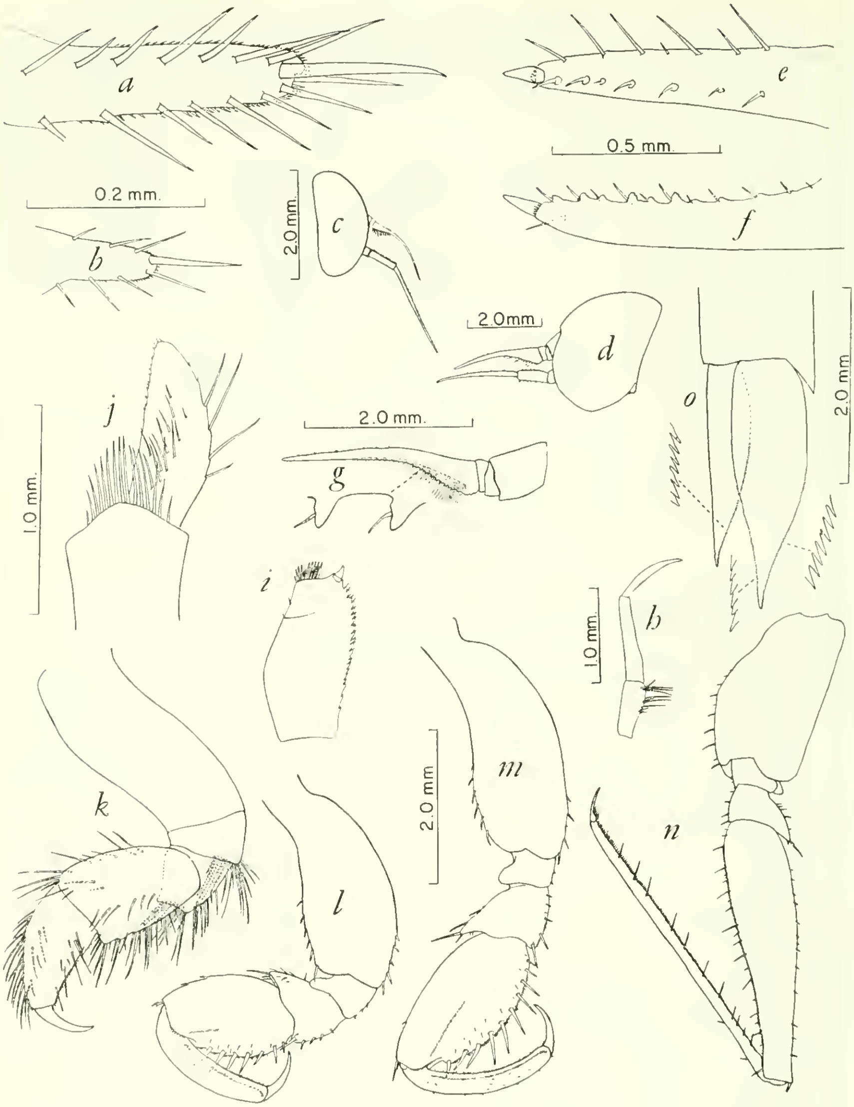


FIGURE 16.—*Parathemisto gaudichaudii* (Guérin), Gulf of Maine: *a*, Pereopod 2, carpal process, seen from above. *Parathemisto gracilipes* (Norman), west of Kyusyu, Japan: *b*, Same. *Parathemisto japonica* Bovallius, off Cape Esan, Japan: *c*, Head and antennae female. *Parathemisto libellula* (Lichtenstein), Point Barrow, Alaska: *d*, Same; *e*, pereopod 2, carpal process, seen from above; *f*, same, lateral view; *g*, antenna 1, lateral view; *h*, mandibular palp; *i*, maxilla 1, palp; *j*, maxilliped, inner plate and right outer plate omitted; *k*, pereopod 1; *l*, pereopod 3; *m*, pereopod 4; *n*, pereopod 5; *o*, distal end of uropod 3. Scale same for *a–b*, *e–f*, *i–j*, and *l–m*.

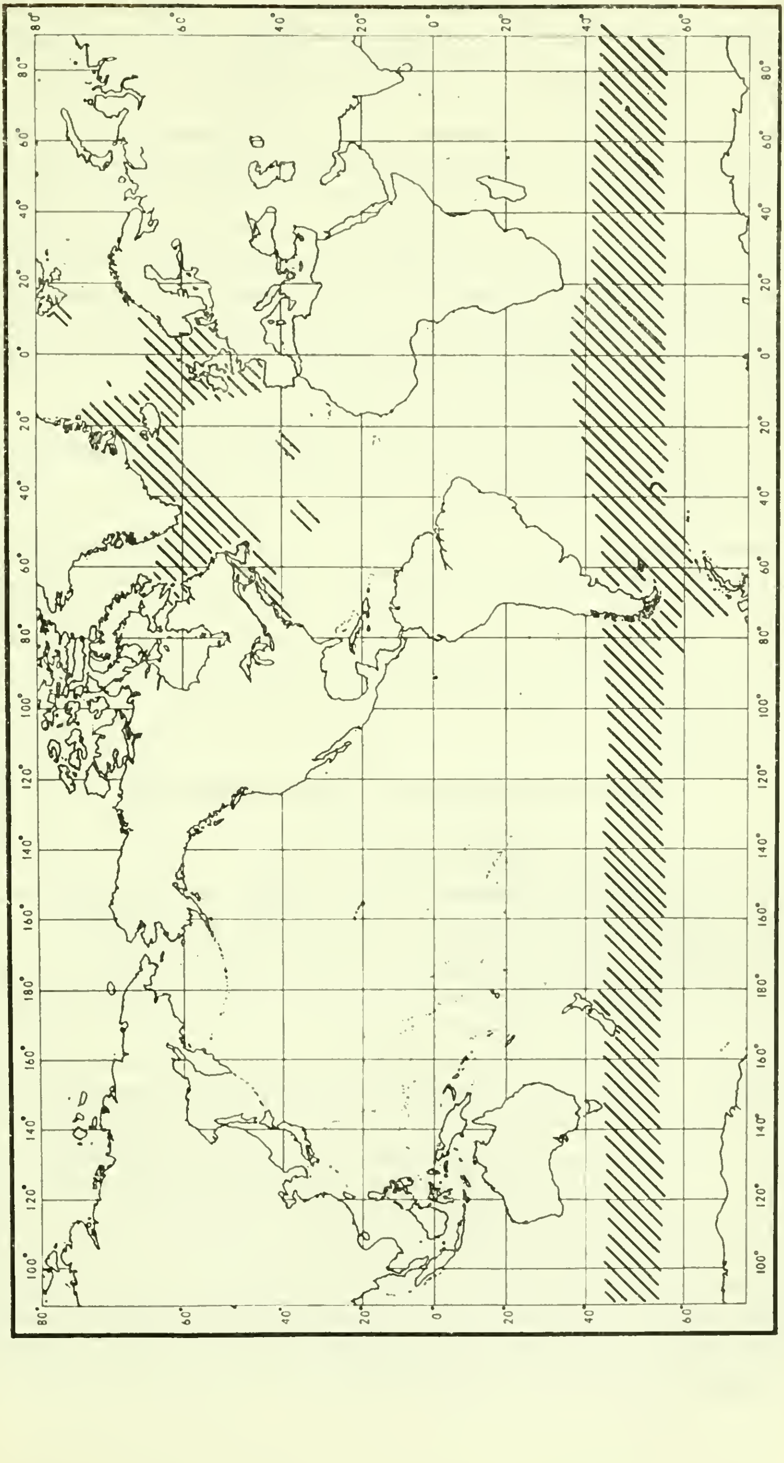


Figure 17.—*Parathemisto gaudichaudii* (Guérin), world distribution. The poleward limits in the southern hemisphere are uncertain.

Some care must be exercised, since Hurley observed that some female *P. gracilipes* have nearly smooth inner margins on the inner rami of uropod 3; these margins are nearly smooth in North Pacific specimens also.

According to Hurley's diagnoses, the carpal process of *P. gaudichaudii* P2 has several end spines, while that of *P. gracilipes* has one stout end spine. The carpal processes of these species are shown in figures 16*a–b*, looking down on the concave surface. Each has one large, stout spine inserted near the distal end, and a series of shorter, more slender spines distributed along the margins. The carpal process of the large specimen of *P. gaudichaudii* has about twice as many marginal spines as that of the small *P. gracilipes*, and the process is longer in relation to its breadth.

I have not seen any specimens of *P. gaudichaudii* from the North Pacific, and it is included in this paper because of the possibility, discussed under *P. gracilipes*, that Yamada's "*Parathemisto* sp. (12)" may belong here.

DISTRIBUTION: As shown in figure 17, *P. gaudichaudii* is widely distributed in the cooler part of the north Atlantic with a few scattered records from warm water. Records in the southern hemisphere are less complete than in the north Atlantic, but it probably occurs throughout the Antarctic Ocean; i.e., the area between the Antarctic Continent and the Antarctic Convergence (Sverdrup, Johnson, and Fleming, 1942).

***Parathemisto* (*Euthemisto*) *libellula* (Lichtenstein)**

FIGURES 16, *d–o*; 18; 19

Gammarus libellula Lichtenstein, *in* Mandt, 1822, p. 32.

Themisto libellula (Mandt), Stephensen, 1923, pp. 24–26, chart 5 [distribution].—Shoemaker, 1926, p. 4; 1955, p. 72.—Dunbar, 1946; 1957 [biology].

Euthemisto libellula (Mandt), Bovallius, 1889, pp. 281–283, pl. 12, figs. 1–31.—Sars, 1895, pp. 13–14, pl. 6, fig. 1.—Shoemaker, 1920, pp. 23–24, 28.

Parathemisto libellula (Mandt), Vinogradov, 1956, p. 211, fig. 10 [distribution].—Barnard, 1959, pp. 123, 125, pls. 22–23.

DIAGNOSIS: The largest species of *Parathemisto*, reaching a length of 60 mm. Body segments not produced into spines dorsally. Female antennae 1 and 2 subequal; antenna 1 slender, straight, lower margin of flagellum serrate. First segment of mandibular palp setiferous. Maxilliped with distal row of long setae on basal plate and several long setae on lateral margins of outer plates. Carpal process of P2 with short end-spine and rounded lobes behind the spines on the lateral margins. P5 much longer than P6; P7 slightly shorter than P6; dactyls of P5–7 strongly pectinate at their bases. Inner ramus of uropod 3 serrate on both margins; peduncle strongly produced at inner distal corner.

Remarks: The straight antenna 1 and the produced inner distal corner of uropod 3 are characteristic of subgenus *Parathemisto*, but the elongate P5 places *P. libellula* in subgenus *Euthemisto*. The species is easily recognized by the pectinate dactyls of P5–7.

Although Mandt has always been cited as the author of this species, Mandt expressly states that the name and description were prepared by Lichtenstein. The name "*libellula*" must therefore be attributed to Lichtenstein rather than to Mandt.

Distribution (figures 18, 19): Circumpolar in the Arctic Ocean. Its distribution in the eastern part of the north Atlantic is given in detail by Stephensen (1923). He reports it from many localities near Greenland and Iceland. In the Norwegian Sea it is not found below 70° N. In the western North Atlantic the southernmost records are from the Gulf of St. Lawrence and the east coast of Newfoundland. In the Pacific Ocean Behning (1939) records it from the Bering Sea and from the Okhotsk Sea as far south as about 46° N. (southeast of Sakhalin Island). Bulycheva (1955) also reports it from the Bering and Okhotsk Seas. I have identified specimens taken in September 1958 at four stations in the vicinity of Afognak Island, Alaska, by the University of Washington M/V *Brown Bear*. No other records from the Gulf of Alaska are known to me. Vinogradov (1956) summarizes the known distributional records in his figure 10.

Aside from *P. abyssorum*, *P. libellula* was the only commonly collected amphipod in the 1950, 1951, and 1953 expeditions of the *Burton Island*. In 1950 it occurred at about one-third and in 1951 at about one-fifth of the stations occupied. The average number per station (100 m. vertical tow) was 0.66 in 1950 and 0.30 in 1951. The average number per positive station was 2.2 in 1950 and 1.5 in 1951. No correlation with variations in temperature or salinity was found.

P. libellula was taken at 5 of the 25 *Burton Island* stations in the Prince of Wales Strait in 1953. The average number per station was 1.13; the average number per positive station was 1.80.

Life history: The life history has been studied in some detail by Dunbar (1946, 1957), who points out the importance of *P. libellula* in the ecology of the eastern Canadian Arctic. It is fed on heavily by the Arctic char and especially by the ringed seal. Dunbar postulates a life cycle of 2 years, with spawning beginning in September of the second year and extending through the winter until some time in May or June. The individual is believed to breed once and then to die. If this alternating or 2-phase breeding cycle remained undisturbed, adjacent year classes would be reproductively isolated. There is evidence that a few juveniles of each year breed the following winter, so reproductive isolation of the two coexisting year classes is not complete.

All the specimens taken in the net-tow collections of the *Burton Island* were juveniles ranging in length from 4.5 to 21.5 mm. None of the females had even rudimentary oostegites. The 1950 and 1951 collections were made in August, but the 1951 collections were made from August 12 to September 21. Thus the *Burton Island* collections gave no evidence for breeding in August or September, although they may not be truly representative of the *P. libelulla* population. Dunbar (1957) found maturing females in ringed seal stomachs in August 1953 and July 1954, but a 2-meter stramin net hauled at 5 knots failed to collect maturing females during these months.

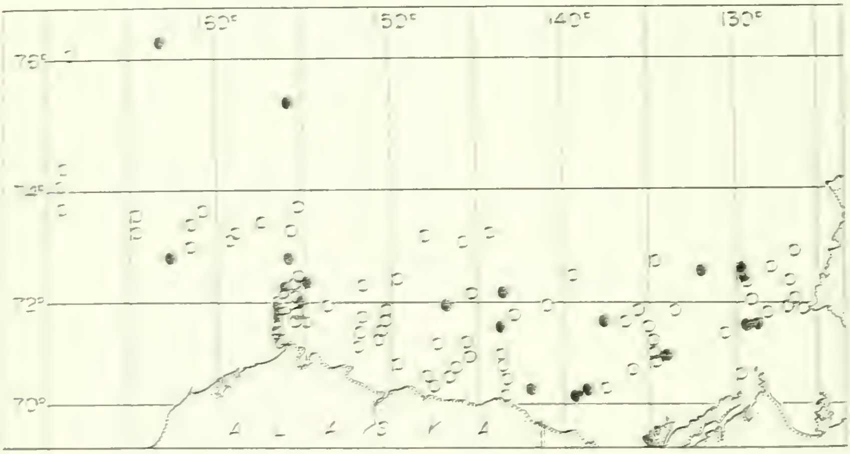


FIGURE 18.—*Parathemisto libellula* (Lichtenstein), distribution in the Chukchi and Beaufort Seas, U.S.S. *Burton Island* 1950 and 1951 cruises combined. Solid circles, positive stations; open circles, negative stations.

Shoemaker (1955) reports a collection of about 1,000 specimens washed ashore at Point Barrow, Alaska, September 12, 1949. I have examined and measured 100 specimens from this lot. They vary in length from 19 to 29 mm., with a mode of 24 mm. Most of the females have minute oostegites less than half the size of those figured by Dunbar (1957, fig. 9) to illustrate the "adolescent" female stage. The males are juveniles with segmented antennae only slightly longer than the head in the largest individuals. Some males as large as 25 mm. had unsegmented antennae. Apparently the breeding season had not arrived.

Several small lots of *P. libellula* from the Bering Sea are present in the collections of the U.S. National Museum, mostly *Albatross* collections made in early August 1893. Juveniles, adolescents, and

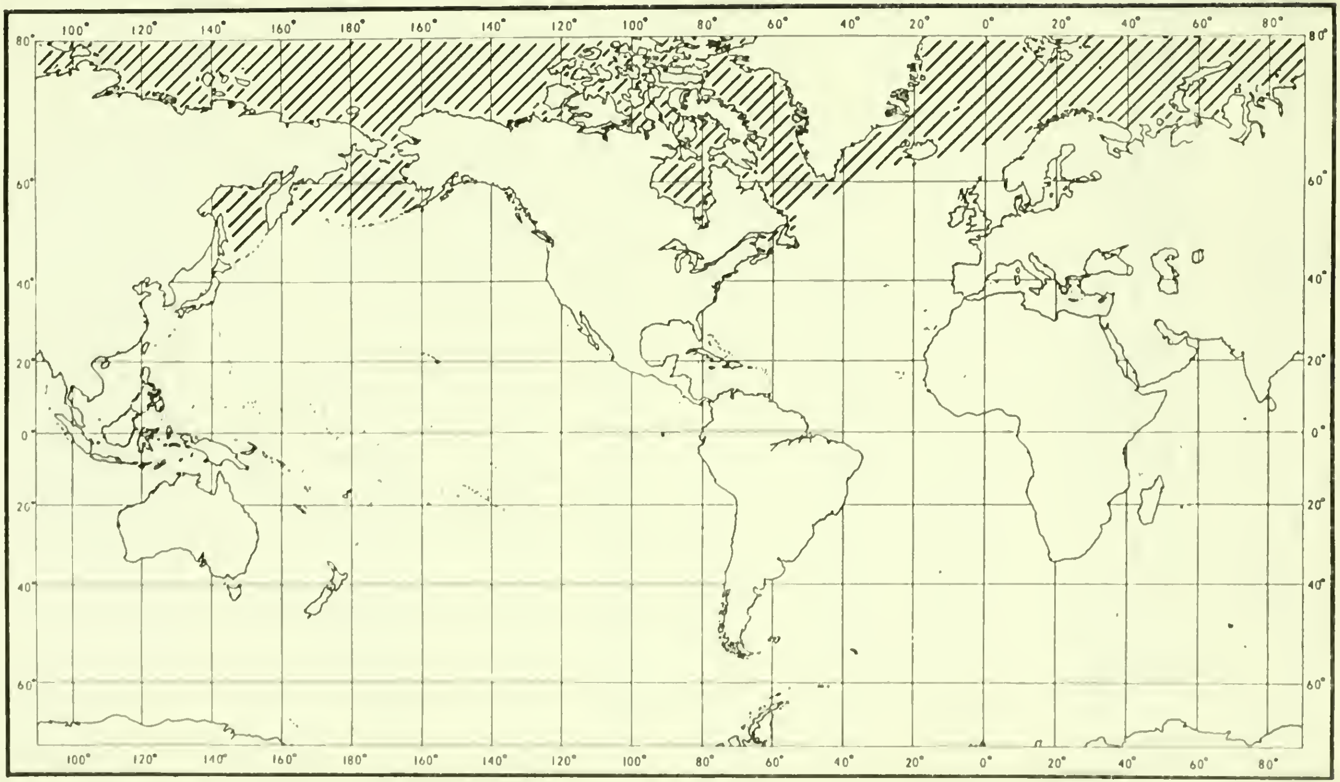


FIGURE 19.—*Parathemisto libellula* (Lichtenstein), world distribution.

maturing females are all present, and at Station 3518 (60°22′ N., 171°42′ W., August 3, 1893) an ovigerous female, 30 mm. in length, was collected. Evidently some breeding takes place during early August in the Bering Sea.

Dunbar's work on the life history of *P. libellula* and his proposed breeding cycle are of considerable interest. Much additional collecting, especially in the winter months, is needed before the validity of his conclusions can be adequately assessed.

Literature Cited

AHLSTROM, ELBERT H.

1948. A record of pilchard eggs and larvae collected during surveys made in 1939 to 1941. U.S. Fish and Wildlife Service, Spec. Sci. Rep., Fisheries, no. 54, pp. 1–76.

1952. Pilchard eggs and larvae and other fish larvae, Pacific Coast, 1950. U.S. Fish and Wildlife Service, Spec. Sci. Rep., Fisheries, no. 80, pp. 1–58.

BARNARD, J. LAURENS

1959. Epipelagic and under-ice Amphipoda of the central Arctic basin. Geophys. Res. Pap. no. 63, Scientific Studies at Fletcher's Ice Island, T-3, 1952–1955, vol. 1, pp. 115–152, pls. 1–23.

BARNARD, K. H.

1930. Crustacea. Part XI. Amphipoda. British Antarctic (*Terra Nova*) Expedition 1910, Nat. Hist. Rep., Zool., vol. 8, no. 4, pp. 307–454.

1932. Amphipoda. *Discovery* reports, vol. 5, pp. 1–326, figs. 1–174 in text, pl. 1 (in color).

BARNES, C. A., and THOMPSON, T. G.

1938. Physical and chemical investigations in Bering Sea and portions of the North Pacific Ocean. Univ. Washington Publ. Oceanog., vol. 3, no. 2, pp. 35–79.

BARY, B. M.

1959. Ecology and distribution of some pelagic Hyperiidea (Crustacea, Amphipoda) from New Zealand waters. Pacific Science, vol. 13, no. 4, pp. 317–334.

BEHNING, A.

1939. Die Amphipoda-Hyperiidea der den Fernen Osten der Ud. SSR umgrenzenden Meere. Intern. Rev. Ges. Hydrobiol. Hydrogr., vol. 38, pp. 353–367, figs. 1–6.

BEKLEMISHEV, K. V., and SEMINA, G. L.

1956. On the structure of the biogeographical boundary between the boreal and tropical regions in the pelagial of the northwestern Pacific Ocean. Doklady Akademii Nauk SSSR, vol. 108, no. 6, pp. 1057–1060 (in Russian, translation by W. G. Van Campen).

BIERI, ROBERT

1959. The distribution of the planktonic Chaetognatha in the Pacific and their relationship to the water masses. Limnol. and Oceanogr., vol. 4, no. 1, pp. 1–28.

BIGELOW, H. B.

1926. Plankton of the offshore waters of the Gulf of Maine. Bull. U.S. Bureau of Fisheries, vol. 40 (1924), pt. 2, pp. 1–509.

BIGELOW, H. B., and SEARS, MARY

1939. Studies of the waters of the Continental Shelf, Cape Cod to Chesapeake Bay, III. A volumetric study of the zooplankton. Mem. Mus. Comp. Zool., vol. 76, pp. 429–581.

BODEN, BRIAN P., JOHNSON, MARTIN W., and BRINTON, EDWARD
1955. The Euphausiacea (Crustacea) of the North Pacific. Bull. Scripps Inst. Oceanogr. Univ. California, vol. 6, no. 8, pp. 287–400.

BOECK, AXEL.
1870. Crustacea Amphipoda borealia et arctica. Vidensk. Selsk. Forh., pp. 81–200.

BOGOROV, B. G.
1940. Longevity and ecological characteristics of *Themisto abyssorum* in the Barents Sea. Doklady Akademii Nauk SSSR, vol. 27, no. 1, pp. 68–70.

1958. Biogeographical regions of the plankton of the north-western Pacific Ocean and their influence on the deep sea. Deep-Sea Research, vol. 5, no. 2, pp. 149–161.

BOGOROV, B. G., and VINOGRADOV, M. E.
1955. On zooplankton of the northwestern part of the Pacific Ocean. Doklady Akademii Nauk SSSR, vol. 102, no. 5, pp. 835–838 (in Russian).

BONNIER, JULES
1896. "Edriophthalmes." Résultats scientifiques de la campagne du "Caudan" dans le Golfe de Gascogne, Août-Septembre, 1895. Ann. Univ. Lyon, vol. 26, pp. 527–689.

BOUSFIELD, E. L.
1951. Pelagic Amphipoda of the Belle Isle Strait region. Journ. Fish. Res. Board Canada, vol. 8, no. 3, pp. 134–163.

BOVALLIUS, CARL
1887. Systematical list of the Amphipoda Hyperiidea. Svenska Vet. Akad. Handl., vol. 11, no. 16, pp. 1–50.

1889. Contributions to a monograph of the Amphipoda Hyperiidea. Pt. I, 2. The families Cyllopodidae, Paraphronimidae, Thaumatopsidae, Mimonectidae, Hyperiidae, Phronimidae, and Anchylomeridae. Svenska Vet. Akad. Handl., vol. 22, pp. 1–434, pls. 1–18.

BRODSKY, K. A.
1955a. On the distribution of plankton in the northwestern part of the Pacific Ocean. Doklady Akademii Nauk SSSR, vol. 101, no. 5, pp. 961–964 (in Russian).

1955b. Zoogeographical provinces of the pelagial of far eastern seas and the northern part of the Pacific Ocean. Doklady Akademii Nauk SSSR, vol. 102, no. 3, pp. 649–652 (in Russian).

BRUNS, ERICH
1958. Ozeanologie. Band I. Einführung in die Ozeanologie. Ozeanographie, Berlin, pp. 1–420.

BULYCHEVA, A. I.
1955. Hyperiids (Amphipoda-Hyperiidea) of the northwestern part of the Pacific Ocean. Doklady Akademii Nauk SSSR, vol. 102, no. 5, pp. 1047–1050 (in Russian).

CANDEIAS, A.
1934. Crustáceos planctónicos das Costas de Portugal. Mem. Mus. Zool. Univ. Coimbra, ser. 1, no. 75, pp. 1–8.

CHEVREUX, EDOUARD
1935. Amphipodes provenant des campagnes scientifiques du Prince Albert I^{er} de Monaco. Résultats des campagnes scientifiques accomplies sur son yacht par Albert I^{er}, Prince Souverain de Monaco, Fasc. 90, pp. 1–214, pls. 1–16.

CLEMENS, HOWARD P.

1950. Life cycle and ecology of *Gammarus fasciatus* Say. Franz Theodore Stone Institute of Hydrobiology, Ohio State Univ., Contrib. no. 12, pp. 1–63.

DUNBAR, M. J.

1946. On *Themisto libellula* in Baffin Land coastal waters. Journ. Fish. Res. Board Canada, vol. 6, no.6, pp. 419–434.

1957. The determinants of production in northern seas: A study of the biology of *Themisto libellula* Mandt. "Calanus" series no 14. Canadian Journ. Zool., vol. 35, no. 6, pp. 797–819.

EALEY, E. H. M., and CHITTLEBOROUGH, R. G.

1956. Plankton, hydrology and marine fouling at Heard Island. Australian National Antarctic Research Expeditions Interim Reports, no. 15, pp. 1–81.

EKMAN, SVEN

1953. Zoogeography of the sea, London, Sidgwick and Jackson, xii+417 pp.

GUÉRIN, F. E.

1825. Encyclopédie méthodique histoire naturelle. Entomologie ou histoire naturelle des crustacés, des arachnides et des insects. Tome dixième, par MM. Latreille, Le Peletier de Saint-Fargeau, Serville, et Guérin, Paris.

HIDA, THOMAS S.

1957. Chaetognaths and pteropods as biological indicators in the North Pacific. U.S. Fish and Wildlife Service, Spec. Sci. Rep., Fisheries, no. 215, pp. 1–13.

HOLMES, SAMUEL J.

1904. Amphipod crustaceans of the expedition. Harriman Alaska Expedition, vol. 10, pp. 233–246.

HOPKINS, DAVID M.

1959. Cenozoic history of the Bering land bridge. Science, vol. 129, no. 3362, pp. 1519–1528.

HURLEY, DESMOND E.

1955. Pelagic amphipods of the sub-order Hyperiidea in New Zealand waters. 1. Systematics. Trans. Roy. Soc. New Zealand, vol. 33, pt. 1, pp. 119–194.

1956. Bathypelagic and other Hyperiidea from California waters. Occ. Pap. Allan Hancock Foundation, no. 18, pp. 1–25.

IRIE, HARUHIKO

1948. Preliminary report on pelagic amphipods in the adjacent seas of Japan. Journ. Fac. Agric. Kyushu Univ., vol. 9, no. 1, pp. 33–40.

1957a. Pelagic amphipods in the western seas of Kyusyu. Bull. Fac. Fish. Nagasaki Univ., no. 5, pp. 41–52.

1957b. 25 species of pelagic amphipods, Hyperiidea, in the adjacent seas of Japan, Suisangaku Shusei, March 1957, Tokyo Univ. Press, pp. 345–355.

1959. Studies on pelagic amphipods in the adjacent seas of Japan. Bull. Fac. Fish. Nagasaki Univ., no. 8, pp. 20–42.

JOHNSON, MARTIN W.

1934. The production and distribution of zooplankton in the surface waters of Bering Sea and Bering Strait, pt. II, *in* Report of oceanographic cruise U.S. Coast Guard Cutter *Chelan*, 1934, pp. 45–82 (mimeographed).

Johnson, Martin W.

1953. Studies on plankton of the Bering and Chukchi Seas and adjacent areas. Proc. 7th Pacific Sci. Congress (1949), vol. 4, Zoology, pp. 480–500.

1956. The plankton of the Beaufort and Chukchi Sea areas of the Arctic and its relation to the hydrography. Arctic Inst. North America Tech. Pap. no. 1, pp. 1–32.

Kinne, Otto

1953. Zur Biologie und Physiologie von *Gammarus duebeni* Lillj., I. Zeitschr. Wiss. Zool., vol. 157, pp. 427–491.

1959. Ecological data on the amphipod *Gammarus duebeni.* Monograph, Veröff. Inst. Meeresforschung Bremerhaven, vol. 6, pp. 177–202.

Koizumi, Masami

1953. On the annual variation in oceanographical elements at a fixed point (39° N, 153° E) in the Pacific Ocean. Rec. Oceanogr. Works Japan, n.s., vol. 1, no. 1, pp. 36–43.

Lafond, E. C., and Pritchard, D.W.

1952. Physical oceanographic investigations in the eastern Bering and Chukchi Seas during the summer of 1947. Journ. Marine Res., vol. 11, no. 1, pp. 69–86.

Mandt, Martin W.

1822. Observationes in historium naturalem et anatomiam comparatum in itinere Groenlandico factae, Dissertatio inauguralis, Berlin, viii+ 40 pp.

Marshall, Sheina M., and Orr, A. P.

1955. The biology of a marine copepod, *Calanus finmarchicus* (Gunnerus), London, Oliver and Boyd, viii + 186 pp.

Masuzawa, Jotaro

1955. Preliminary report on the Kuroshio in the Eastern Sea of Japan (currents and water masses of the Kuroshio system III). Rec. Oceanogr. Works Japan, n.s., vol. 2, no. 1, pp. 132–140.

Mogk, H.

1926. Versuch einer Formanalyze bei Hyperiden. (Zugleich ein Beitrag zu einer neuer Methode der Artbeschreibung). I. Vorarbeiten an der Gattung *Phronima.* Intern. Rev. Ges. Hydrobiol. Hydrogr., vol. 14, pp. 276–311.

Nakai, Zinziro

1955. The chemical composition, volume, weight, and size of the important marine plankton. Tokai Regional Fisheries Research Laboratory, Spec. Publ. no. 5, pp. 12–24.

Norman, A. M.

1869. Last report on dredging among the Shetland Isles. Pt. 2. Crustacea. Rep. British Assoc. Adv. Sci. for 1868, pp. 247–336.

Pirlot, Jean M.

1929. Résultats zoologiques de la croisière *Atlantique* de l' *Armauer Hansen* (Mai-Juin 1922). 1. Les amphipodes hypérides. Travaux de l'Institut Université de Liége, fasc. 1., pp. 1–196. [Memoires de la Societé royale des Sciences de Liége 3^{e} série, tome 15, fasc. 2].

1939. Sur des amphipodes hypérides provenant des croisières du Prince Albert I^{er} der Monaco. Résultats des campagnes scientifiques accomplies sur son yacht par Albert I^{er}, Prince Souverain de Monaco, fasc. 102, pp. 1–63, pls. 1–2.

ROBINSON, MARGARET K.

1957. Sea temperature in the Gulf of Alaska and in the northeast Pacific Ocean, 1941–1952. Bull. Scripps Inst. Oceanogr., vol. 7, no. 1, pp. 1–98, figs. 1–61, 1 chart.

ROUX, M. L. le,

1933. Recherches sur la sexualité des gammariens. Croissance, reproduction, determinisme des caractères sexuels secondaires. Bull. Biol. France Belg. Supp. no. 16, pp. 1–138.

RUSSELL, F. S.

1925. The vertical distribution of marine macroplankton. An observation of diurnal changes. Journ. Mar. Biol. Assoc., n.s., vol. 12, no. 4, pp. 769–809.

SARS, G. O.

1895. An account of the Crustacea of Norway, vol. 1, Amphipoda, pp. 1–711, pls. 1–240, suppl. pls. 1–8.

SEGERSTRÅLE, SVEN G.

1937. Studien über die Bodentierwelt in südfinnländischen Küstengewassern III. Zur Morphologie und Biologie des Amphipoden *Pontoporeia affinis*, nebst einer Revision der *Pontoporeia*-Systematik. Soc. Sci. Fennica Commentationes Biol., vol. 7, no. 1, pp. 1–183, pls. 1–19.

SEWELL, R. B. SEYMOUR

1948. The free-swimming planktonic Copepoda, geographical distribution. John Murray Exped., Sci. Rep., vol. 8, no. 3, pp. 317–592, 2 charts.

SEXTON, E. W.

1924. The moulting and growth stages of *Gammarus*, with descriptions of the normals and intersexes of *G. chevreuxi*. Journ. Mar. Biol. Assoc., n.s., vol. 13, pp. 340–397, pls. 1–21.

1928. On the rearing and breeding of *Gammarus* in laboratory conditions. Journ. Mar. Biol. Assoc., n.s., vol. 15, pp. 33–55.

SHOEMAKER, CLARENCE R.

1920. Crustacea. Part E: Amphipods. Rep. Canadian Arctic Exped. 1913–18, vol. 7, pp. 1–30.

1926. Report on the marine amphipods collected in Hudson and James Bays by Fritz Johansen in the summer of 1920. Contrib. Canadian Biol. and Fish., vol. 3, no. 1, pp. 1–11.

1930. The amphipods of the Cheticamp Expedition of 1917. Contrib. Canadian Biol. and Fish., vol. 5, no. 10, pp. 221–359.

1955. Amphipoda collected at the Arctic Laboratory, Office of Naval Research, Point Barrow, Alaska, by G. E. MacGinitie. Smithsonian Misc. Coll., vol. 128, no. 1, pp. 1–78.

SIMPSON, GEORGE GAYLORD

1947a. Evolution, interchange, and resemblance of the North American and Eurasian Cenozoic mammalian faunas. Evolution, vol. 1, no. 3, pp. 213–220.

1947b. Holarctic mammalian faunas and continental relationships during the Cenozoic. Bull. Geol. Soc. Amer., vol. 58, pp. 613–687.

STEBBING, T. R. R.

1888. Report on the Amphipoda collected by H. M. S. *Challenger* during the years 1873–1876. Rep. Sci. Res. Voyage of H.M.S. *Challenger*, Zool., vol. 29, pt. 67, xxiv + 1737 pp., 210 pls., 1 map.

Stepanova, V.

1937. Biologische Zeichnungen der Stromungen im Nordischen Teil des Bering und im Sudlichen Teil des Tschuktschen Meeres. Publ. Hydrol. Inst. Lenningrad, no. 5, pp. 176–216.

Stephensen, K.

1923. Crustacea Malacostraca V (Amphipoda I). The Danish *Ingolf* Exped., vol. 3, pt. 8, pp. 1–100, figs. 1–22.

1924. Hyperiidea—Amphipoda (pt. 2: Paraphronimidae, Hyperiidae, Dairellidae, Phronimidae, Anchylomeridae). Rep. Danish Oceanographic Exped. 1908–1910 to the Mediterranean and adjacent seas, vol. 2, D. 4, pp. 71–149.

1933. Amphipoda. The Godthaab Expedition 1928. Medd. Grønland, vol. 79, no. 7, pp. 1–88.

1944. Amphipoda. Zoology of East Greenland. Medd. om Grønland, vol. 121, no. 14, pp. 1–165.

1947. Tanaidacea, Isopoda. Amphipoda, and Pycnogonida. Sci. Res. Norwegian Antarctic Exped. 1927–1928 et seq., no. 27, pp. 1–90.

1949. The Amphipoda of Tristan da Cunha. Res. Norwegian Sci. Exped. to Tristan da Cunha 1937–1938, no. 19, pp. 1–61.

Stewart, Dorthy

1913. A report on the Extra-Antarctic Amphipoda Hyperiidea collected by the *Discovery*. Ann. Mag. Nat. Hist., ser. 8, vol. 12, pp. 245–265, pls. 4–7.

Sverdrup, H. U.; Johnson, Martin W.; and Fleming, Richard H.

1946. The oceans, their physics, chemistry, and general biology, x+1087 pp., 7 charts.

Tanaka, Otohiko

1953. The pelagic copepods of the Izu region. Rec. Oceanogr. Works Japan, n.s., vol. 1, no. 1, pp. 126–137.

Thorsteinson, Elsa D.

1941. New or noteworthy amphipods from the North Pacific coast. Univ. Washington Publ. Oceanogr., vol. 4, pp. 50–94.

Tokioka, Takasi

1940. The chaetognath fauna of the waters of western Japan. Rec. Oceanogr. Works Japan, vol. 12, no. 1, pp. 1–22, charts 1–3.

Uda, Mititaka

1934. Hydrographical studies based on simultaneous oceanographical surveys made in the Japan Sea and in its adjacent waters during May and June, 1932. Rec. Oceanogr. Works Japan, vol. 6, no. 1, pp. 19–107.

Vinogradov, M. E.

1956. Hyperiids (Amphipoda-Hyperiidea) of the western Bering Sea. Zool. Journ. Acad. Nauk SSSR, vol. 35, fasc. 2, pp. 194–218 (in Russian).

Wailes, G. H.

1929. Marine zoo-plankton of British Columbia. Museum and Art Notes, Vancouver, vol. 4, pp. 1–9.

Yamada, Tetuo

1933. Report on the distributions of the plankton in the neighboring seas of Tyosen in June, 1932. Ann. Rep. Hydrographical Observations, Fishery Experiment Station, Government General of Tyosen, no. 7, appendix (in Japanese).

U.S. GOVERNMENT PRINTING OFFICE: 1960

Proceedings of
the United States
National Museum

SMITHSONIAN INSTITUTION • WASHINGTON, D.C.

Volume 112 1960 Number 3440

ASSASSIN BUGS OF THE GENUS GHILIANELLA IN THE AMERICAS (HEMIPTERA, REDUVIIDAE, EMESINAE)

By J. Maldonado-Capriles[1]

This paper brings together and summarizes available data on the genus *Ghilianella* in the Americas. Descriptions of the genus and subgenera are given, as well as a checklist of the 88 known species. The keys differentiate the 80 species of which specimens were available for study; they are expansions of those published in 1925 by McAtee and Malloch (the fine work of these authors has aided me greatly in the completion of this paper). Among the species treated in the following pages, 15 are described as new, 1 is redescribed, and the "hypotypes" of 7 others are described. For 32 previously described species, notes are given on specimens examined, and the paper closes with notes on the 8 species not included in the keys. In the illustrations (see pp. 407–421) I have tried to keep together similar structures from the various species so that a comparison of them could be made.

In this paper, the term "hypotype" is used to refer to a specimen herein described and belonging to the opposite sex of the corresponding holotype described by another author. Additional specimens of the hypotype are called "parahypotypes." Thus, I have followed the terminology suggested by Frizzell (1933).

---

[1] College of Agriculture and Mechanic Arts, Mayagüez, Puerto Rico.

Thanks to the cooperation of the entomologists listed below, I was able to see many types and received many specimens for study and identification. To all I am greatly indebted:

Dr. J. Carayon, Museum National D'Histoire Naturelle (MNHN), Paris.

Dr. Mont. A. Cazier, American Museum of Natural History (AMNH), New York City.

Dr. P. J. Darlington, Museum of Comparative Zoology (MCZ), Harvard, Cambridge, Massachusetts.

Dr. Thomas H. Farr, Institute of Jamaica (IJ), Kingston, Jamaica, West Indies.

Dr. Theodore H. Hubbell, Museum of the University of Michigan (MUM), Ann Arbor, Michigan.

Dr. John Miller, Chicago Natural History Museum (CNHM).

Dr. Edward S. Ross, California Academy of Science (CAS), San Francisco.

Dr. Reece I. Sailer, U.S. Department of Agriculture, especially for loaning unidentified material and permitting me to examine the type material deposited in the U.S. National Museum (USNM), and for his detailed review of the manuscript of this paper.

Dr. George Wallace, Carnigie Museum (CM) at Pittsburgh, Pennyslvania.

Dr. Petr Wygodzinsky (PW), Instituto de Medicina Regional, Universidad Nacional, Tucumán, Argentina, especially for loaning me abundant material from his collection and other material under his temporary care, especially that from the Vienna Museum (VM).

Genus *Ghilianella* Spinola

Ghilianella Spinola, 1850, p. 102.

The following descriptions are abstracted from McAtee and Malloch (1925):

Genus *Ghilianella* Spinola: foretarsi without distinguishable segmentation under the highest power (even when cleared), consisting of but one heavily chitinized segment, with an unequal pair of claws, a single claw, or without distinct claws. Foretarsus with two longitudinal series of angularly deflected spines, which under high power appear like elongate knifelike teeth on its ventral surface. Head with a more or less pronounced spine or tubercle between bases of antenna, labrum closely adherent to base of rostrum, not projecting spine-like. Adults never winged. Head and thorax more or less granulate, the former with a profound constriction anterior of eyes. Mesothorax and metathorax each tricarinate or with a median carina and lateral rows of tubercles above and usually unicarinate below.

Abdomen more or less carinate or keeled below. Front tibia with a patch of short pale golden hairs on inner side apically and a tuft of longer ones at the apex inferiorly. Middle and hind legs and antenna much longer than body. When the legs have pale markings, they are almost invariably as follows: middle and hind femora with two postmedian bands and a subapical spot, and tibiae with a subbasal spot; in the pale species, dark markings tend to appear at these same places; frontal and femoral spines mostly pale.

Subgenus *Ghilianella* Spinola, 1850: claws of foretarsi two, the inner short, closely applied to the base of outer.

Subgenus *Ploeodonyx* McAtee and Malloch, 1925: claw of foretarsus single; claw separated from tarsus by a suture; forefemur rather slender as a whole, but notably thicker near base than at first strong spine.

Subgenus *Lissonyx* McAtee and Malloch, 1925: claw of foretarsus single; claw entirely fused with tarsus; forefemur rather stout, little if any thicker at base than at first strong spine.

Table I, below, is the checklist of the known species of *Ghilianella* in the Americas. Included are 88 species of which the males of 56 and the females of 60 are known. The origin of the holotype is also given. The keys to both sexes follow the table.

Table 1.—*Checklist of species of* Ghilianella, *origin of the holotype, and the sexes known*

Species [1]	*Known sexes*		*Origin of holotype*
	Male	*Female*	
aliena McAtee and Malloch, 1925		x	Venezuela
alterata McAtee and Malloch, 1925		x	Venezuela
alveola McAtee and Malloch, 1925		x	Grenada
amicula (*Ploeodonyx*) McAtee and Malloch, 1925		x	French Guiana
analis (Dohrn), 1860	x		Dutch Guiana
andersoni Brindley, 1931	x		British Guiana
angulata (*Lissonyx*) (Uhler), 1893	x	x	St. Vincent
annectens McAtee and Malloch, 1925		x	Panama
annulata (Dohrn), 1863	x		South America
apiculata McAtee and Malloch, 1925	x		Dominican Republic
approximata McAtee and Malloch, 1925	x	x	Bolivia
aracataca McAtee and Malloch, 1925	x	x	Colombia
assanutrix Bergroth, 1906	x	x	Venezuela
atabapo Maldonado, 1953		x	Venezuela
atriclava Bergroth, 1911	x		French Guiana
bethei Dohrn, 1863		x	Colombia
bicaudata McAtee and Malloch, 1925	x	x	Cuba
borincana, new species	x		Puerto Rico
brasiliensis (Dohrn), 1860		x	Brazil
brevicornis Brindley, 1931	x		British Guiana

See footnote at end of table.

TABLE 1.—*Checklist of species of* Ghilianella, *origin of the holotype, and the sexes known*—Continued

Species [1]	*Known sexes* *Male*	*Female*	*Origin of holotype*
bulbifera Champion, 1898	x		Panama
calva, new species		x	Colombia
calymmata, new species		x	Colombia
campulligaster, new species	x		Brazil
clavellata, new species		x	British Guiana
claviventris Bergroth, 1906	x		Venezuela
colona McAtee and Malloch, 1925	x		Colombia
cuneata McAtee and Malloch, 1925		x	Panama
fenestrata, new species	x		Costa Rica
filiventris Spinola, 1850	x	x	Brazil
galapagensis Heidemann, 1901		x	Galapagos
gerstaeckeri (Dohrn), 1860		x	Haiti
gibberosa Piza, Jr. (see Toledo Piza), 1939	x		Brazil
gibbiventris Champion, 1898	x	x	Panama
glabrata (*Ploeodonyx*) McAtee and Malloch, 1925		x	British Guiana
gladiator McAtee and Malloch, 1925	x	x	Trinidad
globifera Bergroth, 1906	x	x	Venezuela
globulata McAtee and Malloch, 1925	x	x	Guatemala
granulata Champion, 1898	?	?	British Honduras
grapta, new species	x	x	Venezuela
haitiana, new species	x	x	Haiti
ica McAtee and Malloch, 1925	x		Peru
ignorata Dohrn, 1860	x		Venezuela
imbecilla (Dohrn), 1860	?	?	Peru
insidiatrix (*Ploeodonyx*) Bergroth, 1922	x	x	French Guiana
lissa Maldonado, 1953	x		Venezuela
longula McAtee and Malloch, 1925	x	x	Cuba
maculata McAtee and Malloch, 1925	x		Cuba
mariae Wygodzinsky, 1953	x	x	Peru
megharpacta, new species	x		Peru
minimula McAtee and Malloch, 1925	x	x	Brazil
mirabilis McAtee and Malloch, 1925	x	x	Brazil
monense Maldonado, 1953	x	x	Mona Island
nanna, new species		x	Argentina
nebulosa (Dohrn), 1860	x		Bolivia
neivai Piza, Jr. (see Toledo Piza), 1939	x	x	Brazil
obesa, new species		x	Costa Rica
pachitea McAtee and Malloch, 1925	x		Peru
panamana, new species		x	Panama
pascoei Bergroth, 1906	x	x	Venezuela
patruela McAtee and Malloch, 1925		x	Costa Rica
pendula McAtee and Malloch, 1925		x	Panama
perigynium McAtee and Malloch, 1925	x	x	Peru
persimilis McAtee and Malloch, 1925	x	x	Cuba
personata McAtee and Malloch, 1925		x	Brazil
peruviana McAtee and Malloch, 1925		x	Peru

See footnote at end of table.

TABLE 1.—*Checklist of species of* Ghilianella, *origin of the holotype, and the sexes known*—Continued

Species[1]	*Known sexes* *Male*	*Female*	*Origin of holotype*
perversa McAtee and Malloch, 1925		x	Colombia
productilis Barber, 1914	x	x	Florida
puncticauda Maldonado, 1953	x	x	Venezuela
recondita McAtee and Malloch, 1925	x	x	Colombia
rhabdita, new species	x		Brazil
semipallida Bergroth, 1906		x	Venzuela
servillei (Spinola), 1837	x	x	Brazil
signata McAtee and Malloch, 1925	x	x	Colombia
signoreti (Dohrn), 1860	x	x	Jamaica
similata McAtee and Malloch, 1925		x	Venezuela
simillima McAtee and Malloch, 1925	x		Cuba
spinata, new species	x	x	Jamaica
spinicaudata, new species		x	Jamaica
sipinolae Dohrn, 1860			Brazil
stipitata McAtee and Malloch, 1925		x	Venezuela
strigata McAtee and Malloch, 1925	x		Costa Rica
subglobulata McAtee and Malloch, 1925	x	x	Venezuela
succincta McAtee and Malloch, 1925		x	Brazil
sulcata Maldonado, 1953	x		Venezuela
truncata McAtee and Malloch, 1925		x	Panama
uncinata McAtee and Malloch, 1925	x		Panama
varicornis (Dohrn), 1860	x	x	Puerto Rico

[1] Unless otherwise noted, all species are of the subgenus *Ghilianella*.

Keys to the Species of Ghilianella

MALES

1 Mesothorax distinctly longer than prothorax; shape of abdomen various 2

Mesothorax little if any longer than prothorax; abdomen usually gradually widening from base 29

2(1) Abdomen with an abrupt bulbous swelling behind middle 3

Abdomen without bulbous swelling 22

3(2) Interantennal spine well developed, acute; head and prothorax usually distinctly granulose; claspers of hypopygium with upper and lower margins in most species without a rounded notch above or below; metathorax usually much attenuated anteriorly . 4

Interantennal spine not developed, a mere wart, blunt; head and prothorax but little granulose; claspers of hypopygium long, obtriangular with at least the upper margin notched 19

4(3) Hypopygium with a large apical hooklike process which has an emargination or concavity on each side of hook, not entirely filled by claspers 17

Hypopygium with a small process visible only under high magnification; the upper margin of hypopygium but little concave; the claspers entirely filling the space between the margin and the process 5

5(4) Fifth tergum bearing a pair of strongly divergent long conical horns 6

Fifth tergum without such horns 7

6(5) Horns more vertical, width between tips of horns 5.0 mm . . **mirabilis**

Horns more flattened, width between tips of horns 2.5 mm. **brevicornis**

7(5) Seventh tergum short, sixth entirely incorporated into the bulbosity, which thus appears almost terminal 8

Seventh tergum long, sixth not wholly incorporated into bulbosity, which is distinctly subterminal 9

8(7) Sixth tergum more than half as long as fifth, provided with a smaller elevation similar in shape to that of fifth . . . . **filiventris**

Sixth tergum less than half as long as fifth, without elevations. **atriclava**

9(7) Widest part of bulbosity in fourth segment; top of abdomen with two distinct longitudinal lines of gray hairs (fig. 24) . . . . **globifera**

Widest part of bulbosity in fifth segment 10

10(9) Fifth tergum lacking subangulate ridged elevations; sixth trisinuate posteriorly . . . . **claviventris**

Fifth tergum with subangulate ridged elevations; sixth slightly convex posteriorly 11

11(10) Elevations of fifth tergum distinctly inside lateral margins of disk (fig. 45) . . . . **approximata**

Elevations of fifth tergum on lateral margins of disk, the margins passing over as carinae 12

12(11) Elevations of fifth tergum pointed, nearer to posterior margin; clasper long and slender, slightly upcurved apically; abdomen not spotted. 13

Elevations of fifth tergum more rounded or squared, at or close to middle; clasper of different shape 14

13(12) Sixth segment more involved in bulbosity; seventh tergum apiculate and surpassing claspers . . . . **recondita**

Sixth segment less involved in bulbosity; seventh tergum not apiculate and not surpassing claspers . . . . **bulbifera**

14(12) Seventh tergum surpassing hypopygium by more than length of claspers; abdomen unspotted . . . . **puncticauda**

Seventh tergum slightly or not surpassing apex of hypopygium, spotted 15

15(14) Abdomen with 12 large pilose spots; four of these on sixth segment (figs. 16, 100) . . . . **signata**

Abdomen with 10 or 14 pilose spots, none of these on sixth segment 16

16(15) With a total of 14 spots on abdomen; fifth sternum with two more extensive spots near anterior margin and four smaller on apical margin (figs. 17, 102) . . . . **grapta**

With a total of 10 spots on abdomen; fifth sternum with only two patches on posterior margin . . . . **ignorata**

17(4) Seventh tergum without longitudinal carina, tip of tergum projecting little if any beyond apex of hypopygium; apical hook of latter much curved at base standing well clear of sternum so that it is usually visible as a hook to the unaided eye . . . . **uncinata**

Seventh tergum with a longitudinal carina on apical half, tip of tergum projecting well beyond apex of hypopygium; apical central hook of latter relatively small, not much curved at base and not standing well clear of the sternum at base so that it is only visible as a hook under a moderate magnification 18

18(17) Sixth tergum not longer than wide at base (fig. 19) . . **subglobulata**

Sixth tergum distinctly longer than wide at base . . . . **globulata**

19(3) Prothorax with two long spines above near middle (fig. 85) . **spinata**

Prothorax without such spines 20

20(19) Upper margin of hypopygium with a large apical process, standing clear from base (fig. 25) . . . . **fenestrata**

Upper margin of hypopygium with a very small hidden apical process 21

21(20) Claspers each with a deep excavation on upper margin before apex, the lower margin entire; fifth sternum with regular microscopic striae which run from base to apex and are slightly outwardly directed . . . . **strigata**

Claspers each with a deep rounded excavation on upper margin before apex, and a deep incision about opposite on lower margin (fig. 27); fifth sternum lacking regular striae, granular, the granulations being partially grouped in irregular transverse rows . . **patruela**

22(2) Abdomen nearly as wide at hypopygium as at any point proximad to it 23

Abdomen notably widest at third or fourth segment; seventh tergum remarkably elongated and slender, projecting beyond apex of hypopygium by at least the length of the latter 28

23(22) Hypopygium almost annular, the terminal hook large, flanked each side by a space, which is not filled by the broadly triangular claspers; seventh tergum not especially narrowed subapically, apex a strong process projecting well beyond hypopygium . . **apiculata**

Hypopygium more elongate, hook small, seventh tergum different . 24

24(23) Hypopygium scarcely inflated and but little deeper than abdomen . 25

Hypopygium somewhat inflated, notably thicker vertically than adjacent part of abdomen 27

25(24) Apical process of hypopygium exposed, short, vertical (fig. 23). **borincana**

Apical process of hypopygium if developed bent cephalad and hidden by claspers 26

26(25) Claspers oblong, almost truncate apically, slightly beveled off at inferior angle . . . . **ica**

Claspers broader basally, rather pointed apically, superior angle sloped off with a long bevel . . . . **pachitea**

27(24) Seventh tergum longer, much narrowed and slightly transversely corrugated subapically, the apex pointed and slightly keeled (figs. 5, 30) . . . . **aracataca**

Seventh tergum shorter, but little narrowed and faintly transversely wrinkled subapically, the apex triangular, bluntly pointed (fig. 20) . . . . **colona**

28(22) Abdomen widest at fourth segment, each tergum with a pair of small round spots of pale yellow pile on hind margin; spiracles yellow . . . . **assanutrix**

Abdomen widest at fifth segment, terga lacking pilose spots; spiracles blackish . . . . **gladiator**

29(1) Abdomen with bulbous swelling, clavate, or decidedly widest at fourth, fifth, or sixth segment 30
Abdomen parallel sided, if some segment wider very slightly so . 33

30(29) Abdomen with subapical bulbosity; hypopygium with large apical process (figs. 21, 46) . . . . **gibbiventris**
Abdomen clavate or of different shape; apical process of hypopygium small 31

31(30) A spinelike process above behind each eye; seventh tergum triangular; eighth sternum partially hidden by seventh . . . . . . **mariae**
Without such spinelike processes 32

32(31) Abdomen widest across apex of fourth segment . . . . . **andersoni**
Abdomen widest across apex of fifth segment . . . . **angulata**

33(29) Apical process of hypopygium hooked and visible under subtriangular claspers, margin of hypopygium deeply concave above before apex (figs. 26, 38) . . . . **neivai**
Hypopygium on lateral aspect different 34

34(33) Apex of upper margin of hypopygium with long tapering process mostly hidden by broad rectangular claspers; hypopygium almost at right angle to rest of abdomen (fig. 13) . . . . **campulligaster**
Hypopygium different, in line with rest of abdomen or slightly bent upward 35

35(34) Apical angles of abdominal terga 2 to 6 produced laterally 36
Apical angles of abdominal terga 2 to 6 not produced laterally . . 38

36(35) Dense patches of golden short hairs on several places, very conspicuous on base of fourth, fifth, and sixth segments; forefemur thickened on basal half of the part basad of first ventral spine (fig. 74). **insidiatrix**
Without dense patches of golden hairs, forefemur gradually thickened to first ventral spine 37

37(36) Head and thorax densely granulate; hind margin of sixth tergum with backward sloping tubercle; 12 mm. long (fig. 1) . . . . **haitiana**
Head and thorax not granulate; sixth tergum without such tubercle; 15 mm. long . . . . **lissa**

38(35) Hind margin of sixth sternum almost straight; head and thorax copiously granulate; seventh tergum triangular apically, not keeled, extending little if any beyond hypopygium; upper margin of hypopygium convex . . . . **pascoei**
Hind margin of sixth sternum with a broad central rounded concavity and smaller lateral ones, the sternum longest at a point between the lateral margin and median line or with a different set of characters 39

39(38) Pronotum on hind margin with two short spines set on round elevations; middle and hind femora with raised bumps; sparsely granulose; overall body length 11.3 mm. . . . . **nebulosa**
Without spines on apex of pronotum and with other set of characters 40

40(39) Narrowed portion of seventh tergum distinctly longer than terminal expanded part . . . . **persimilis**
Narrowed portion of seventh tergum distinctly shorter than terminal expanded part if narrowed portion is present 41

41(40) Head and thorax conspicuously granulate 42
Head and thorax not granulate or very sparsely so 45

42(41) Claspers very large, subtriangular; frontal spine poorly developed; apical process of hypopygium large (fig. 4) . . . . **megharpacta**

Claspers small, oblong; frontal spine developed; apical process of hypopygium small 43

43(42) Short species 14 to 17 mm. long 44

Long species over 23 mm. long (fig. 6) . . . . **signoreti**

44(43) Head with a pair of divergent pointed tubercles just behind transverse sulcus; eighth sternum very short, nearly hidden by seventh; 15–17 mm. long . . . . **minimula**

Head without such tubercles; eighth sternum long, nearly half as long as seventh; 14 mm. long . . . . **rhabdita**

45(41) Eighth sternum with sides more or less concealed 46

Eighth sternum visible on its entire width, the spiracle moderately pedunculate 47

46(45) Clasper with longitudinal furrow on upper margin . . . . . **sulcata**

Clasper without such furrow (fig. 44) . . . . **maculata**

47(45) Abdomen nearly cylindrical; clasper very broadly triangular, width at apex equaling length (fig. 8) . . . . **personata**

Abdomen otherwise; claspers elongate not triangular 48

48(47) Seventh tergum without constriction, apex moderately pointed and not surpassing claspers; first tergum with well-developed conical elevation; length 24 mm. (fig. 60) . . . . **gibberosa**

Seventh tergum of different shape; first tergum without conical elevation 49

49(48) Apical process of hypopygium short, exposed, vertical, and with an apical U-shaped notch (fig. 42) . . . . **varicornis**

Apical process of hypopygium bent cephalad, hidden by claspers or of different shape 50

50(49) Claspers wide subbasally, much narrowed apically 51

Claspers of nearly same width throughout their length, rectangular or trapezoidal on lateral aspect 52

51(50) Seventh tergum with shallow lateral constriction; 25 mm. long. **simillima**

Seventh tergum without constriction; 29 mm. long . . . . . **longula**

52(50) Short species, 18 mm. long; seventh tergum surpassing hypopygium by a clasper length; yellowish brown (fig. 9). . . . . . **bicaudata**

Longer species, over 24 mm. long; seventh tergum slightly surpassing hypopygium; reddish brown or black 53

53(52) Claspers oblong; reddish brown and mottled with fuscous; apical process of hypopygium developed, tapering (fig. 22). . **productilis**

Clasper trapezoidal; abdominal segments black and banded basally with gray; apical process of hypopygium undeveloped. . **monenes**

FEMALES

1 Mesothorax on dorsal aspect longer than prothorax 2

Mesothorax not longer than prothorax. 26

2(1) Abdomen with a bulbous swelling beyond middle and prominent lateral elevations on either fifth or sixth tergum 3

Abdomen without bulbous swelling or lateral elevations on fifth or sixth tergum 18

3(2) Fourth tergum the widest (fig. 87). . . . . **globifera**

Fifth or sixth tergum the widest. 4

4(3) Fifth tergum the widest, sides before hind margin prominently elevated usually standing above connexivum. 5

Sixth tergum about as wide as or wider than fifth, bearing a large median tubercle. 17

5(4) Sixth tergum with a prominent median falcate tubercle on its hind margin (fig. 97) . . . . **bethei**

Sixth tergum without large median tubercle, though fifth or sixth may be more or less elevated at middle of hind margin. . . . 6

6(5) Fifth tergum with a pair of divergent, long conical horns, each nearly equal in length to width of tergum . . . . **mirabilis**

Fifth tergum without such horns 7

7(6) With long spines, one on each side, on: head behind eyes, middle of prothorax, mesothorax, and metathorax; other long spines on abdomen (fig. 69). . . . . **spinata**

Without such spines. 8

8(7) Elevations of fifth tergum distinctly inside lateral margin of disk. 9

Elevations of fifth tergum on lateral margins of disk. 10

9(8) Seventh tergum broader than long (fig. 107) . . . . **clavellata**

Seventh tergum longer than broad (fig. 99) . . . . . . **approximata**

10(8) Abdomen with one or more pairs of large pale pilose spots on dorsum and venter 11

Abdomen without such pale pilose spots 12

11(10) Yellow spots extensive; with spots on sixth segment. . . . . **signata**

Yellow spots small; without spots on sixth segment . . . . . **grapta**

12(10) Eighth tergum much shorter than wide. 13

Eighth tergum as long as or longer than wide. 15

13(12) Posterior angles of seventh tergum produced distinctly beyond middle of hind margin which is merely convex and not at all tuberculate; ninth tergum with lateral and shorter median ridges (figs. 109, 125). **subglobulata**

Posterior angles of seventh tergum produced no farther than median convexity of hind margin. 14

14(13) Hing margin of seventh tergum tuberculate; eighth nearly semicircular; ninth tergum with lateral margin elevated apically and with long median ridge (figs. 98, 136) . . . . **globulata**

Hind margin of seventh tergum not tuberculate; eighth trapezoidal; median elevation of ninth anchor shaped, the arms passing under lateral elevations (fig. 127) . . . . **puncticauda**

15(12) Posterior lateral angles of seventh tergum distinctly produced beyond middle of hind margin which is not tuberculate (figs. 96, 137). **gladiator**

Posterior lateral angles of seventh tergum produced no farther than median convexity of hind margin which is slightly tuberculate. 16

16(15) Seventh sternum about twice as long on median line as sixth, with a broad convex process apically which is slightly emarginate medianly. **perigynium**

Seventh sternum only a third longer than sixth, somewhat angulate apically . . . . **recondita**

17(4) Fifth tergum about equal in length to its width at hind margin (fig. 49). . . . . **pendula**

Fifth tergum about twice as long as its width at hind margin (fig. 57). **cuneata**

18(2) Eighth and ninth terga each with a prominent median longitudinal ridge; seventh sternum at least one and one-half times as long as sixth on median line, the latter with a very deep median concavity on hind margin (figs. 62, 106, 134) . . . . **aracataca**

With a different set of characters 19

19(18) Seventh tergum with posterior angles produced as divergent acute processes; other terga ornamented on their hind margins with a pair of spots of golden pubescense; abdomen boat shaped (fig. 118). **assanutrix**

Posterior angles of seventh tergum not so produced; abdomen not so ornamented 20

20(19) Sixth tergum with a prominent median elevation or tubercle on hind margin 21

Sixth tergum with or without a wartlike median elevation on hind margin 23

21(20) Elevation of sixth tergum very large and broad, hoodlike, with a small wartlike projection on its apical margin (fig. 56) . . . **calymmata**

Elevation of sixth tergum smaller, conical. 22

22(21) Ninth tergum with a long, broad, median ridge (fig. 120). **panamana**

Ninth tergum with a short, narrow median ridge (fig. 126) . . **obesa**

23(20) Seventh sternum distinctly produced at middle of hind margin . 24

Seventh sternum not produced at middle of hind margin 25

24(23) Seventh tergum much longer than wide; middle of hind margin conspicuously declivate, the lateral angles prominent acute; genital segments as in figure 119 . . . . **stipitata**

Seventh tergum little longer than wide, hind margin not declivate medianly, almost straight across, the lateral angles and median point very slightly produced . . . . **similata**

25(23) Abdomen clavate: eighth tergum semicircular: ninth tergum truncate cuneate . . . . **filiventris**

Abdomen parallel sided; eighth tergum hexagonal; ninth tergum with apex truncate (fig. 128) . . . . **atabapo**

26(1) Posterior angles of at least four terga more or less ampliate or produced, the outline of dorsum of abdomen on dorsal aspect not a continuous straight or curved line (fig. 89) 27

Posterior angles of terga, except sometimes fifth, sixth, or seventh, not produced, the outline or dorsum of abdomen a continuous straight or curved line 35

27(26) Forefemur notably thicker near base than at first strong spine (fig. 74) 28

Forefemur enlarging gradually from base to first strong spine . . 30

28(27) A strong tubercle on hind margin of sixth tergum 29

No obvious tubercle on hind margin of sixth tergum (fig. 54). **glabrata**

29(28) Eighth tergum with disk prominently elevated each side of a broad median sulcus; ninth tergum convex medianly, the margin elevated, very slightly corrugate . . . . **insidiatrix**

Eighth and ninth terga with disk depressed and margins elevated, each longitudinally carinate and transversely corrugate (fig. 112). **amicula**

30(27) Seventh tergum narrower basally than apically, posterolateral angles sharply produced, with a long spinelike median projection (fig. 89). **spinicaudata**

Seventh tergum differently shaped and without median long spine . 31

31(30) Angulations of terga less pronounced; apex of sixth tergum scarcely wider than that of seventh 32

Angulations of terga more pronounced; apex of sixth tergum notably wider than that of seventh 33

32(31) A strong tubercle on hind margin of sixth tergum; head and thorax strongly granulate; length over 21 mm. . . . . **peruviana**

Hind margin of sixth tergum without a tubercle; head and thorax not granulate; length under 15 mm. . . . . **calva**

33(31) Eighth tergum pentagonal; ninth tergum with lateral margins raised from middle and curving mesad on apex, with a median subcircular elevation near apex (fig. 123) . . . . **haitiana**

Eighth tergum broadly elliptical; ninth tergum different, with a median low ridge 34

34(33) Elevated margins of ninth tergum produced apically as distinct spines (fig. 142) . . . . **anneetens**

Elevated margins of ninth tergum not forming spines . . **truncata**

35(26) Basal spine of forefemur at less than its own length from base of femur; foretibia and tarsus combined three fourths as long as femur; interantennal spine a mere wart, abdomen racket shaped (figs. 55, 115) . . . . **galapagensis**

Basal spine of forefemur at slightly or distinctly more than its own length from base of femur; other characters not as above . . . 36

36(35) Seventh sternum distinctly or slightly produced on middle of hind margin 37

Seventh sternum not produced medianly 48

37(36) Hind margin of seventh tergum not tuberculate 38

Hind margin of seventh tergum more or less tuberculate 40

38(37) Hind margin of seventh tergum concave medianly; seventh sternum roundly produced medianly (fig. 8) . . . . **personata**

Hind margin of seventh tergum not concave medianly 39

39(38) Seventh tergum triangularly produced on hind margin; head and thorax copiously granulate; eighth tergum short and broad (fig. 116) . . . . **alterata**

Hind margin of seventh tergum straight; head and thorax sparsely granulate; eighth tergum semicircular . . . . **semipallida**

40(37) Median tubercle on hind margin of seventh tergum extending farther posteriorly than lateral angles; ninth tergum with three fingerlike ridges at apex . . . . **persimilis**

Median tubercle on hind margin of seventh tergum not extending as far posteriorly as lateral angles, if extending apex of ninth tergum without fingerlike longitudinal ridges 41

41(40) Apex of ninth tergum distinctly upcurved 42

Apex of ninth tergum not upcurved 43

42(41) Apex of ninth tergum emarginate medianly; projection of seventh sternum rectangular, longer than its basal width (figs. 61, 90). **monense**

Apex of ninth tergum straight; projection of seventh sternum rounded (fig. 132) . . . . **productilis**

43(41) Apex of ninth tergum decurved 44
Apex of ninth tergum straight 45

44(43) Apex of ninth tergum distinctly decurved, longitudinally strigate and with a strong median carina, the lateral margins depressed (fig. 144) . . . . **succinta**
Apex of ninth tergum slightly decurved, the lateral margins strongly elevated, depressed median area with a carina that extends from the upper transversely corrugated third of tergum (fig. 117) . **aliena**

45(43) Ninth tergum with strong posterolateral fingerlike elevation or projection (fig. 140) . . . . **signoreti**
Ninth tergum without projection on posterolateral angles 46

46(45) Short species, under 13.0 mm. long . . . . **nanna**
Long species, over 19.0 mm. long 47

47(46) Hind margin of seventh sternum concave and with a rectangular median projection; ninth tergum pointed apically; length 23 mm. **brasiliensis**
Hind margin of seventh sternum with a large median concavity and with a sharp short median projection inside; ninth tergum truncate apically; length 19.5 mm. . . . . **neivai**

48(36) Eighth sternum visible only as two small rounded laterally situated protuberances below apex of seventh tergum, not continued downward in center over base of ninth tergum. . . . . **alveola**
Eighth tergum covering base of ninth tergum 49

49(48) Sixth tergum with a prominent protuberance; seventh with a smaller median one on middle of hind margin 50
Sixth tergum without a prominent protuberance 51

50(49) Abdomen parallel sided, long and slender; ninth tergum with a short apical projection on either side (fig. 138) . . . . **varicornis**
Abdomen clavate; ninth tergum rounded apically, the depressed apex overlaid by two short tapering ridges . . . . **perversa**

51(49) Apex of ninth tergum with a strong bidentate tubercle on each side (fig. 143) . . . . **bicaudata**
Ninth tergum different 52

52(51) Abdomen clavate; posterolateral angles of fifth tergum laterally produced over margin; short species 11.5 mm. . . . . . **mariae**
Abdomen parallel sided; angles of fifth tergum not produced . . 53

53(52) Sixth sternum a third longer on sides than in middle . . . . **pascoei**
Sixth sternum not so deeply emarginate posteriorly 54

54(53) Apex of ninth tergum overlaid by two strong fingerlike processes; length over 30 mm. . . . . **longula**
Apex of ninth tergum with a low median carina; length less 20 mm. **minimula**

Ghilianella bicaudata McAtee and Malloch

FIGURES 9, 53, 143

Ghilianella bicaudata McAtee and Malloch, 1925, pp. 101–102 (female).—Wygodzinsky, 1953, p. 291.

MALE: Head, thorax, legs, and antenna yellowish brown, legs paler. Head laterally, mesothorax and metathorax laterally and ventrally brownish. Forefemur with two rows of blackish dots on upper surface;

Middle and hind femora each with irregular longitudinal rows of brownish spots. Middle and hind tibiae each with narrow subbasal blackish band. Abdominal segments yellowish brown, irregularly variegated with blackish brown, third to sixth sterna each with an elongate dot at each side of median line.

Body and legs with very scarce appressed silvery pilosity.

Head sparsely granulose; eyes small. Interantennal spine well developed, straight.

Thoracic segments sparsely granulate; lengths of segments: 2.5, 2.0, 1.7 mm. Armature of forefemur with inner row consisting of short setae arising from warts, a single preapical stout spine. Claws of foretarsi two, the inner very short and closely appressed to base of outer. First spine of forefemur at twice its length from tip of trochanter. Basal half of forefemur gradually thickened to first spine.

Abdomen on dorsal aspect parallel sided; apical angles of second to sixth terga not produced; hind margins of terga with small median blackish warts, straight. Seventh tergum slightly longer than sixth, surpassing claspers by a clasper length, medianly carinate to middle of segment, constriction inconspicuous or obsolete, very slightly longer than distance from end of constriction to apex of tergum. Hind margins of second to fourth sterna straight or very shallowly concave medianly; of fifth and sixth concave medianly and convex laterally; of seventh and eighth straight. Sixth sternum twice as long as seventh. Eighth sternum visible on its entire width, hind margin laterally concave. Hypopygium opening upwards, claspers relatively broad, twice as long as broad (fig. 9).

Overall body length 18.0 mm.

In the key this species is close to *productilis* and *monense*, but it can be easily separated from these by its small size. Figures 53 and 143 show the genital segments of the female.

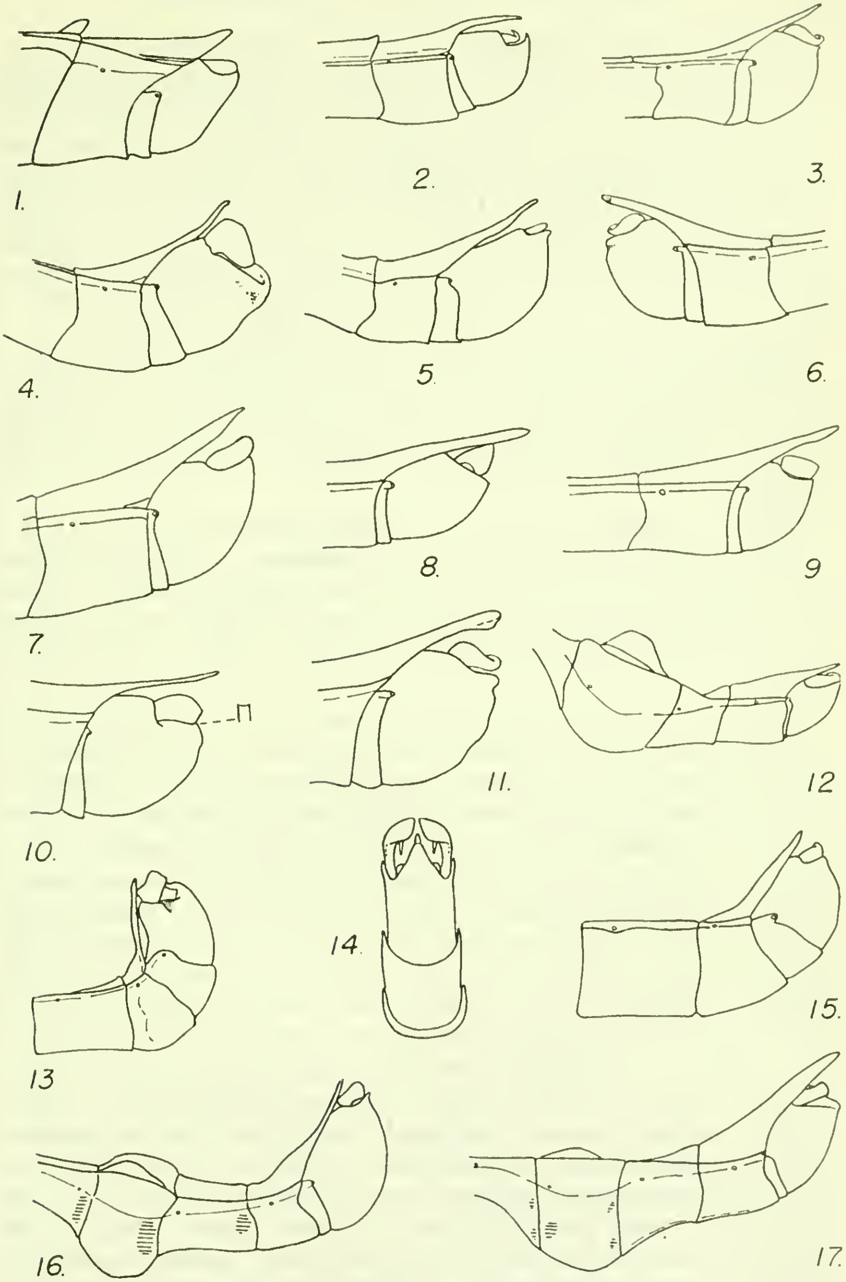
TYPES: Hypotype, male, Soledad, Cuba, February 11, 1925, J. G. Myers collector, MCZ 29467. Parahypotypes, two males, one with same data as hypotype, the other intercepted at New Orleans in pineapples from Cuba by Hadden and Pritchett (this specimen labeled *G. bicaudata* by H. G. Barber), in USNM. Females identified: two from Soledad, Cuba, one collected on August 1920 by Banks and the other on February 1925, by Myers, both in MCZ.

***Ghilianella borincana*, new species**

FIGURES 23, 36, 72, 108

Ghilianella longula, Barber, not McAtee and Malloch, 1939, p. 388.

MALE: Body and head blackish brown. Interantennal spine stramineous. Beak brown, first segment paler, second with paler



FIGURES 1–17.—1, *Ghilianella haitiana*, male, lateral view of last abdominal segments. 2, *G. varicornis*, same. 3, *G. longula*, same. 4, *G. megharpacta*, same. 5, *G. aracataca*, same. 6, *G. signoreti*, same. 7, *G. insidiatrix*, same. 8, *G. personata*, same. 9, *G. bicaudata*, same. 10, *G. minimula*, same. 11, *G. simillima*, same. 12, *G. approximata*, same. 13, *G. campulligaster*, same. 14, *G. campulligaster*, rear view, same. 15, *G. rhabdita*, lateral view, same. 16, *G. signata*, same. 17, *G. grapta*, same.

apical band, third with paler basal band. First antennal segment brown with four or five narrow yellowish annuli; second segment unbanded; third and fourth grayish on account of the pilosity. Forelegs and foretarsi blackish brown; coxa with inconspicuous reddish yellow spots basally; femur spotted with reddish yellow, spotting more conspicuous on apical half; tibia with two incomplete reddish-yellow annuli. Middle legs dark brown; femur with five reddish-yellow annuli; tibia with two basal annuli. Hindlegs dark brown; femur without annuli, with faint yellowish spots; tibia with five or six annuli. Thoracic segments with pale anterolateral areas.

Sparse, short, appressed pilosity over body, more concentrated at base of interantennal spine, on pale anterolateral spots of thorax; more erect and longer pilosity toward apices of middle and hind tibia.

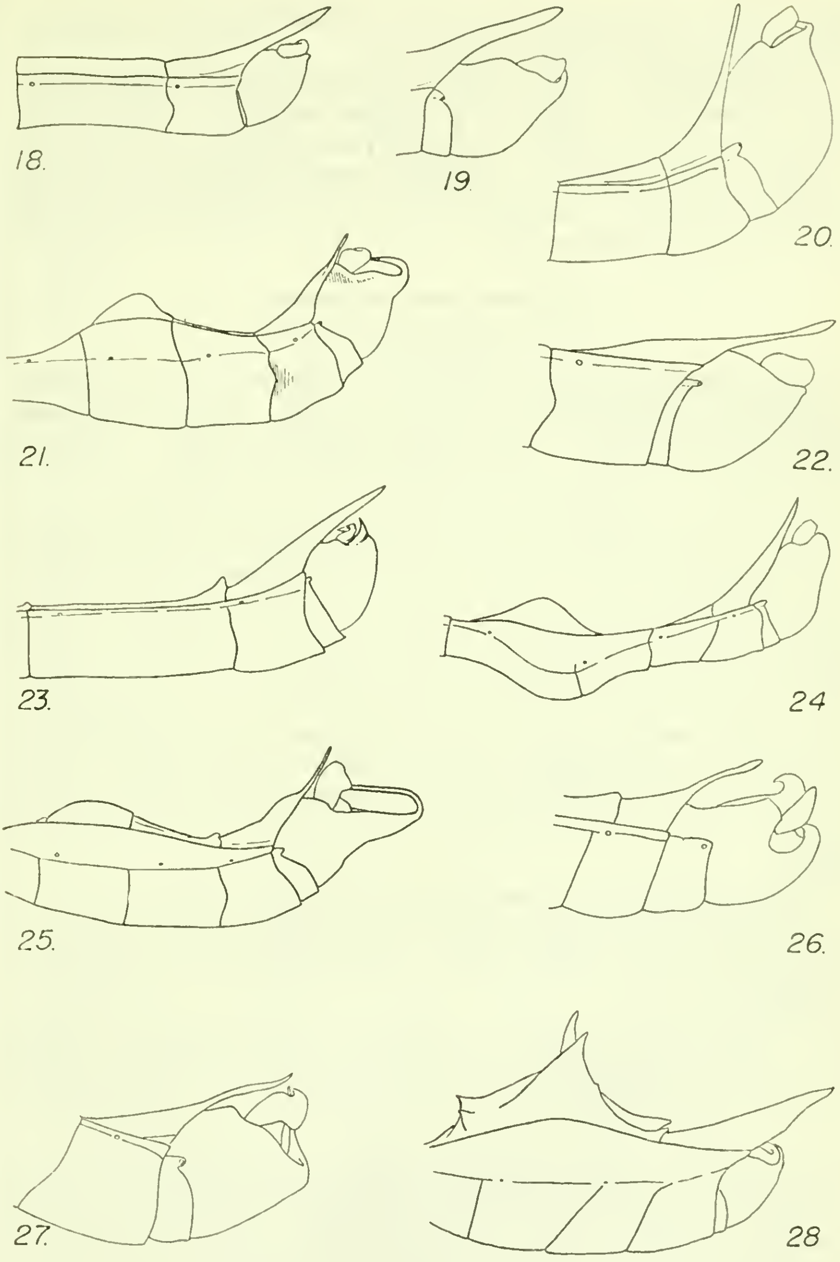
Head distinctly but sparsely granulose. Interantennal spine straight.

Thoracic segments sparsely granulate; lengths of segments: 4.6, 4.6, 3.0 mm. Claws of foretarsi two, inner one shorter. First spine of forefemur at nearly three times its length from tip of trochanter. Basal half of forefemur gradually thickened to first spine. Armature of forefemur with inner row consisting of long setae arising from wartlike bases.

Abdomen on dorsal aspect parallel sided from apex of third segment to middle of seventh. Apical angles of second to fourth terga not produced, last two very slightly produced laterally; hind margin of terga with small blackish wart, the last one more elevated. Second to sixth terga finely and transversely corrugated; hind margin of sixth slightly convex; seventh equal in length to sixth, surpassing claspers by twice their visible length, transversely corrugated, longitudinally ridged, apical fourth pointed (fig. 36). Hind margins of first to fifth sterna straight, slightly swollen at either side of median line; sixth sternum medianly concave behind and convex laterally; seventh sternum with V-shaped median notch; eighth slightly convex (fig. 72). Sixth sternum slightly over twice as long as seventh. Eighth sternum visible its entire width. Spiracle pedunculate. Hypopygium opening upward; not much thicker than rest of abdomen (fig. 23); apical process perpendicular, slightly receding from apical margin of hypopygium, exposed, short, constricted near base, and ending in a sharp point (fig. 108). Claspers short, fitting in concavity of upper lateral margin of hypopygium, leaving exposed the apical process of the hypopygium, slightly wider basally, apex pointed and turned cephalad.

Overall body length 30.0 mm.

This species, in general appearance, seems close to *productilis*, *monense*, and *varicornis;* however, the mesothorax being longer than



Figures 18–28.—18, *Ghilianella maculata*, male, lateral view of last abdominal segments. 19, *G. subglobulata*, same. 20, *G. colona*, same. 21, *G. gibbiventris*, same. 22, *G. productilis*, same. 23, *G. borincana*, same. 24, *G. globifera*, same. 25, *G. fenestrata*, same. 26, *G. neivai*, same. 27, *G. patruela*, same. 28, *G. spinata*, same.

the prothorax and the pointed, vertical, exposed apical process of the hypopygium separate it from them.

TYPES: Holotype, male, Doña Juana State Forest, Villalba, Puerto Rico, November 3, 1952, J. A. Ramos collector, USNM 63087. Paratype, male, from Aibonito, Puerto Rico, June 1–3, 1915, collector unknown, AMNH F3553. This is the specimen identified as *longula* by Barber (1939). I am inclined to believe that this latter species does not occur in Puerto Rico.

Ghilianella calva, new species

FIGURES 64, 77, 103, 121

FEMALE: Head reddish brown, paler along median line, darker laterally from antennal base to base of head. Antenna brownish. Beak yellowish brown. Thorax above yellowish brown. Prothorax on sides and below reddish brown, with two narrow longitudinal paler stripes above. Forelegs with yellowish brown coxa; femur reddish brown, with a preapical and central inconspicuous yellowish band; spines yellowish and black tipped; tibia with post basal yellowish band, tarsi darkening toward apex. Middle and hind femora each with three inconspicuous yellowish annuli on apical half. Middle and hind tibiae each with two brownish annuli on basal half. Abdomen blackish brown ventrally, irregularly spotted and lined with yellow and black along median line. Connexivial margin of second to seventh terga with two long blackish areas, the last one of these apical. Terga sort of checkered with blackish and yellowish brown; median ridge up to eighth tergum yellowish brown and bordered at either side with black.

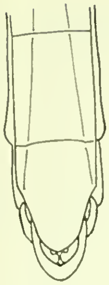
Very scarce short appressed pilosity over body and legs.

Head as in figure 77; not granulose; eyes small. Fourth antennal segment five times as long as third. Interantennal spine not produced, a mere wart.

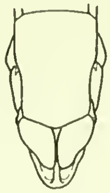
Thoracic segments not granulate; lengths of segments: 2.2, 1.4, 0.7 mm. Posterolateral angles of mesonotum and metanotum slightly produced. Claws of foretarsi two, the inner one short and appressed

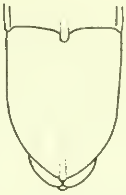
---

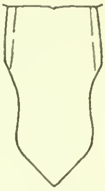
FIGURES 29–47.—29, *Ghilianella rhabdita*, male, dorsal view of last abdominal segment. 30, *G. aracataca*, male, dorsal view of apex of abdomen. 31, *G. megharpacta*, male, dorsal view of seventh tergum and exposed parts of hypopygium. 32, *G. haitiana*, male, seventh tergum. 33, *G. fenestrata*, same. 34, *G. grapta*, same. 35, *G. insidiatrix*, same. 36, *G. borincana*, same. 37, *G. varicornis*, same. 38, *G. neivai*, same. 39, *G. varicornis*, male, lateral view of clasper. 40, *G. campulligaster*, same, dorsal view. 41, *G. ica*, male, projection of apical angle of hypopygium. 42, *G. varicornis*, same. 43, *G. subglobulata*, male, dorsolateral view of clasper. 44, *G. maculata*, male, dorsal view of clasper. 45, *G. approximata*, male, dorsal view of last abdominal segments. 46, *G. gibbiventris*, same. 47, *G. spinata*, same.

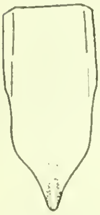

29.

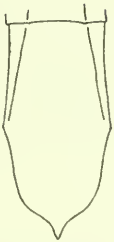

30.

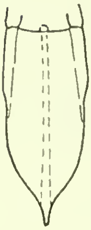

31.

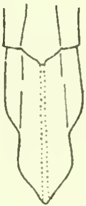

32.

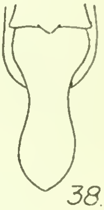

33.


34.

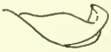

35.

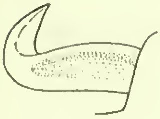

36.


37.


38.


42.

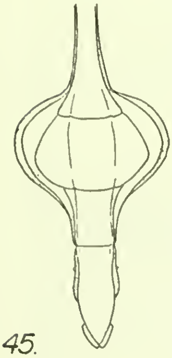

43.

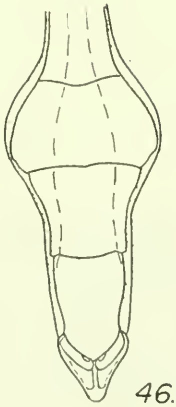

39.

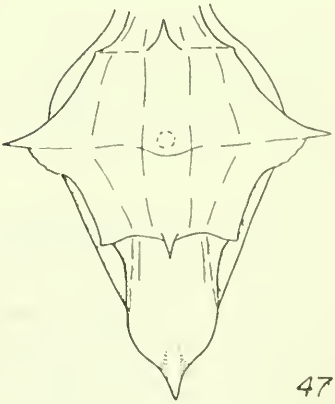

40.


41


44.


45.


46.


47

For explanation, see opposite page.

to base of outer. First spine of forefemur at twice its own length from tip of trochanter. Basal half of forefemur gradually thickened to first spine. Armature of forefemur with inner row consisting of short spines and between them longer fine hairs.

Abdomen without bulbous swelling; hind margins of terga straight, without median warts. Lateral angles of terga very slightly produced. Third to seventh terga with two to four squarish depressions between low median ridge and connexivium. Seventh tergum three-fourths as long as sixth, hind margin slightly convex, not tuberculate (fig. 103). Eighth tergum horizontal, triangular, with conspicuous median ridge. Ninth oblique, strongly convex longitudinally, gradually narrowing to apex, hind margin with V-shaped depression before apex, apical margin with small notch (figs. 64, 121). Hind margins of second to sixth sterna straight. Seventh sternum nearly one and one-third times as long as sixth medianly, hind margin with a broad nearly round, median projection.

Overall body length 15.0 mm.

This small species belongs in the group with the posterolateral angles of the terga produced. It can be easily separated from other similar species by the characters mentioned in the key and the peculiar shape and position of the eighth and ninth terga.

TYPES: Holotype, female, Posadas, Colombia, Biraben collector, November 12, 1948, USNM 63093.

***Ghilianella calymmata*, new species**

FIGURES 56, 94

FEMALE: Head and thorax brown. Femora each with three yellowish annuli on apical half, annuli broader on hind femur. Abdomen yellowish brown, irregularly mottled with blackish or brownish.

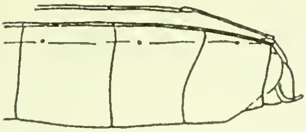
With sparse short appressed silvery or golden pilosity on body, more abundant posteriorly and anteriorly on sides of thoracic segments.

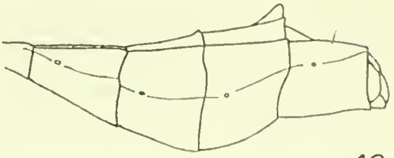
Head distinctly granulose. Interantennal spine long, slightly decurved.

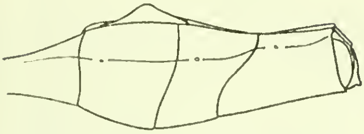
Thoracic segments granulate; lengths of segments: 3.9, 5.2, 2.6 mm. Claws of foretarsi, two, the inner short and closely appressed to base

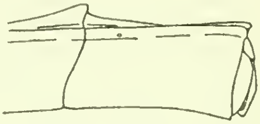
---

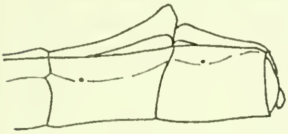
FIGURES 48–65.—48, *Ghilianella nanna*, female, lateral view of last abdominal segments. 49, *G. pendula*, same. 50, *G. clavellata*, same. 51, *G. varicornis*, female, lateral view of apex of abdomen. 52, *G. panamana*, female, lateral view of last abdominal segments. 53, *G. bicaudata*, female, lateral view of apex of abdomen. 54, *G. glabrata*, female, lateral view of last abdominal segments. 55, *G. galapagensis*, same. 56, *G. calymmata*, same. 57, *G. cuneata*, same. 58, *G. approximata*, female, lateral view of apex of abdomen. 59, *G. monense*, female, lateral view of last abdominal segments. 60, *G. gibberosa*, male, lateral view of seventh sternum, after de Toledo. 61, *G. monense*, female, hind margin of seventh sternum. 62, *G. aracataca*, female, lateral view of last abdominal segments. 63, *G. grapta*, same. 64, *G. calva*, same. 65, *G. succinta*, same.


48.

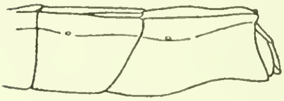

49.

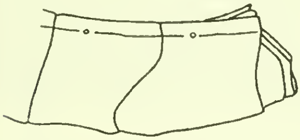

50.

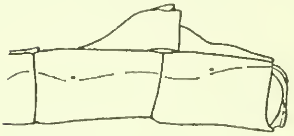

51.


52

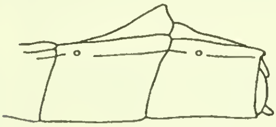

53

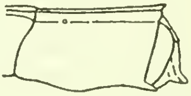

54.

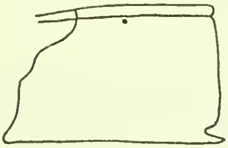

55.


56.

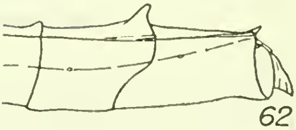

58.

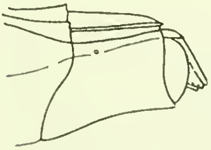

57

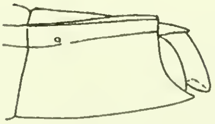

59.

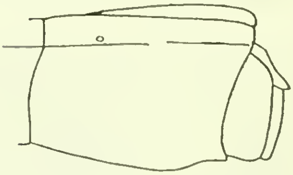

60.


61


62


63.


64.


65.

For explanation, see opposite page

of outer. Armature of forefemur with inner row consisting of alternating slightly longer setae and short spines, the setae arising from wartlike bases. First spine of forefemur at nearly two and one-half times its length from tip of trochanter; basal half of forefemur gradually thickened to first spine.

Abdomen on dorsal aspect widening to apex of third segment; fourth and fifth segments parallel sided, slightly wider at apex of sixth and at base of seventh segments (fig. 94). Hind margin of terga straight; margins of fourth and fifth terga with shallow concavities before lateral angles. Sixth tergum with large hoodlike elevation medianly before hind margin. Seventh tergum four-fifths as long as sixth, shorter than its basal width, trapezoidal; hind margin with broad but slightly produced apical angles and very short median projection; with four round depressions on disc; basal fourth raised cephalad but not reaching upper margin of elevation of sixth tergum (fig. 56). Eighth tergum narrow, apical margin semicircular, margins and median carina elevated; transversely corrugate. Ninth tergum with median line and margins elevated, transversely corrugate; apex rounded. Hind margin of second to sixth sterna shallowly and broadly concave; of seventh with small median projection. Seventh sternum slightly longer medianly than sixth.

Overall body length 27.0 mm.

The hoodlike elevation of the sixth tergum easily distinguishes this species from all others.

Types: Holotype, female, Puerto Barrio Antioquia, Colombia, August 15, 1938, C. H. Seevers collector, CNHM. Paratype, same collecting place, August 9, 1938, H. S. Dybas collector, author's collection.

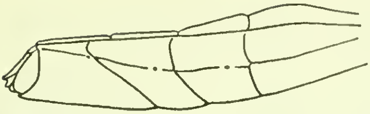
Ghilianella campulligaster, new species

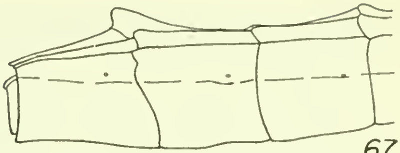
FIGURES 13, 14, 40

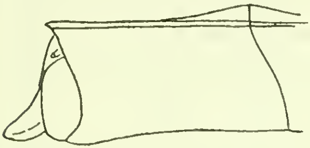
Male: Body uniformly blackish brown, interantennal spine yellowish. Legs, antenna, and beak somewhat lighter.

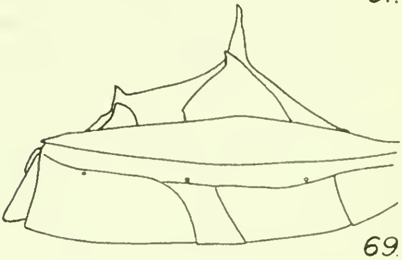
Body and legs with dense appressed short silvery pilosity.

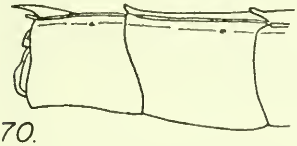
Figures 66–85.—66, *Ghilianella globifera*, female, lateral view of last abdominal segments. 67, *G. obesa*, same. 68, *G. productilis*, same. 69, *G. spinata*, same. 70, *G. spinicaudata*, same. 71, *G. nana*, female, seventh sternum. 72, *G. borincana*, male, seventh and eighth sterna. 73, *G. signoreti*, female, lateral view of last abdominal segments. 74, *G. insidiatrix*, male, foretibia and tarsi. 75, *G. varicornis*, male, apical margin of seventh and eighth sterna. 76, *G. spinicaudata*, female, lateral view of head. 77, *G. calva*, female, dorsal view of head. 78, *G. spinicaudata*, female, lateral view of prothorax. 79, *G. haitiana*, male, dorsal view of head. 80, *G. spinata*, male, lateral view of head. 81, *G. obesa*, female, lateral view of prothorax. 82, *G. fenestrata*, male, same. 83, *G. haitiana*, male, lateral view of head and prothorax. 84, *G. spinata*, male, lateral view of metathorax. 85, *G. spinata*, male, lateral view of prothorax.

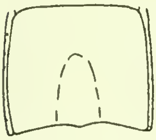

66.

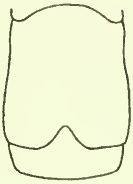

67.

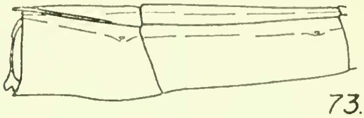

68.

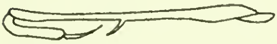

69.

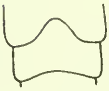

70.

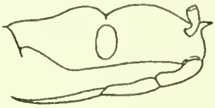

71.

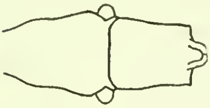

72.

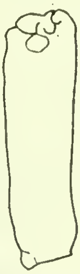

73.

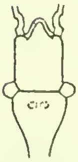

74.

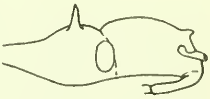

75.


76.


77.


78.

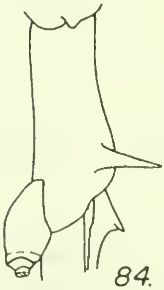

79.


80.


81.


82.


83.


84.


85.

For explanation, see opposite page.

Head conspicuously granulate; eyes small. Interantennal spine almost straight.

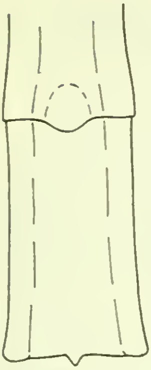
Thoracic segments conspicuously granulate; lengths of segments: 3.5, 2.9, 1.4 mm. Armature of forefemur with inner row consisting of short setae arising from small warts. Claws of foretarsi two, the inner very short, closely appressed to base of outer. First spine of forefemur at slightly over three times its length from tip of trochanter. Basal half of forefemur gradually thickened to first spine.

Abdomen without bulbous swelling, parallel sided. The lateral margins of terga shallowly concave. Sixth tergum three-fourths as long as fifth, narrower at midlength than fifth; this constriction makes the abdomen narrower at base of second segment and at middle of sixth. Sterna easily seen from above on each side of terga. Seventh tergum abruptly narrowed after basal fifth, thence parallel sided to broadly rounded apex, subequal in length to fifth. Hind margins of second to sixth sterna straight. Hind margin of seventh and eighth sterna shallowly concave medianly. Seventh sternum shorter than sixth and longer than eighth, swollen before hind margin on either side of median line (fig. 13). Eighth sternum visible on its entire width. Spiracle short. Hypopygium at right angle to rest of abdomen; with a quadrate projection on the outside of the upper margin, this projection reaching to about midlength of margin; basal half of margin raised and reaching to upper margin of clasper; clasper fitting between these two raised structures. Apical process of hypopygium developed into a long, broad at base, tapering point, most of it hidden by the broad claspers. Claspers large, rectangular in lateral aspect, upper margin shallowly concave about middle, apical half bent mesad; on inner surface near upper margin with a lanceolate appendix parallel to and pointing to the base of the clasper (figs. 14, 40).

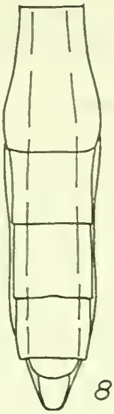
Length 20.0 mm. to apex of seventh sternum; 0.3 mm. from the latter to apex of hypopygium.

The vertical position of the hypopygium in this species is most striking and unique. On account of its unusual position the hypopygium, its apical process, and the caudal end of the claspers can be seen from a dorsal view of the insect. The shape of the hypopygial structures and specially the appendix of the clasper suffice to separate this species.

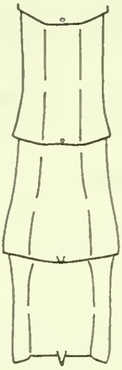
FIGURES 86–99.—86, *Ghilianella varicornis*, female, apical margin of sixth and seventh sterna. 87, *G. globifera*, female, dorsal view of last abdominal segments. 88, *G. haitiana*, same. 89, *G. spinicaudata*, same. 90, *G. monense*, same. 91, *G. nanna*, same. 92, *G. panamana*, same. 93, *G. obesa*, same. 94, *G. calymmata*, same. 95, *G. annectens*, same, lateral view. 96, *G. gladiator*, same, dorsal view. 97, *G. bethei*, same. 98, *G. globulata*, same. 99, *G. approximata*, same.



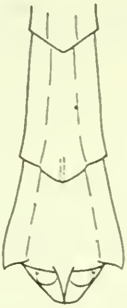
86.



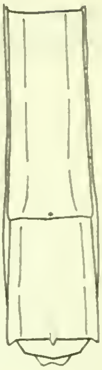
87.



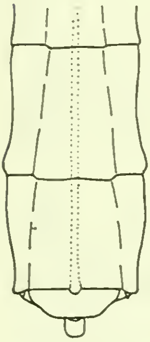
88.



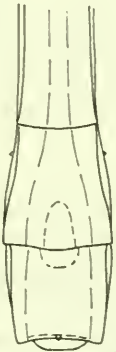
89.



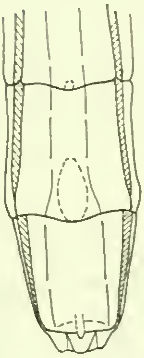
90.



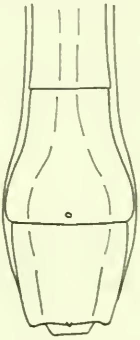
91.



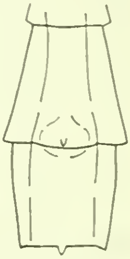
92.



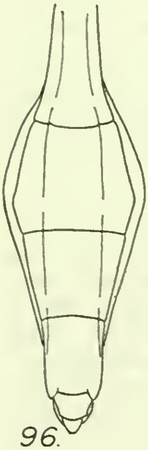
93.



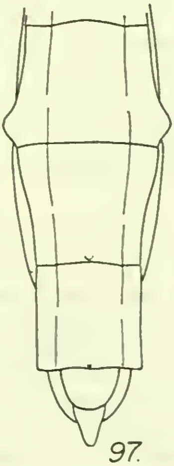
94.



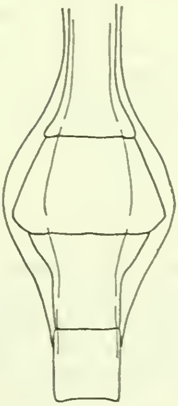
95.



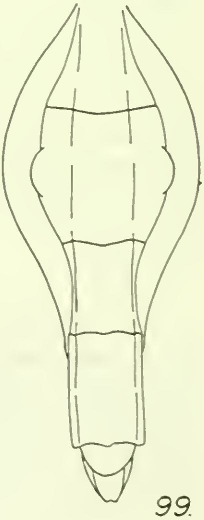
96.



97.



98.



99.

For explanation, see opposite page.

TYPES: Holotype, male, Espirito Santo, Brazil, collection of Fruhstorfer, USNM 63089. Paratype, same data, PW.

***Ghilianella clavellata*, new species**

FIGURES 50, 107, 124

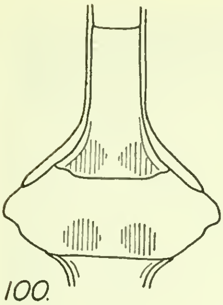
FEMALE: Head brownish to black. Thorax dark brown to black. Abdomen dorsally dark brown; connexivium to near apex of fourth tergum yellowish. Fifth to seventh terga each with two broad irregular longitudinal paler areas and connexivial margins yellowish. Eighth tergum with transverse elevation straw colored, median line and edges blackish brown. Ninth tergum with basal half pale brownish, apical half and lateral edges of basal half blackish brown. First three abdominal sterna brownish. Fourth to fifth sterna blackish; median ventral line from base of fourth to apex of seventh sternum straw colored. Fifth to seventh sterna blackish with pale brownish irregular areas about midway from median line to lateral edges and at lateral edges. Front legs brownish, femur with inconspicuous yellowish band near middle and at apical three-fourths; middle and hind femora brownish, a yellowish band at middle and at apical three-fourths.

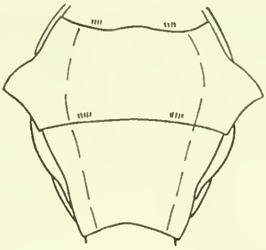
With short, appressed, very sparse silvery pilosity over body; slightly heavier on underside of head. Third antennal segment conspicuously covered with short hairs; fourth segment hairy on apical half.

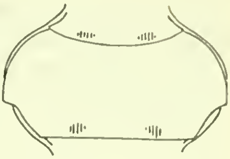
Head distinctly granulose. Interantennal spine short, straight. Fourth antennal segment twice as long as third.

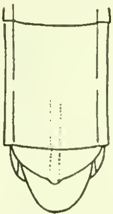
Thoracic segments granulate; lengths: 2.8, 5.0, 2.9 mm. Claws of foretarsi two; the inner short, closely appressed to base of outer. Armature of forefemur with inner row consisting of alternating slightly longer fine hairs and short spines, the hairs arising from wartlike bases. First spine of forefemur at two and one-half times its own length from tip of trochanter. Basal half of forefemur gradually thickened to first spine.

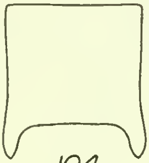
FIGURES 100–123.—100, *Ghilianella signata*, male, pilose spots on fourth and fifth terga. 101, *G. grapta*, female, same. 102, *G. grapta*, male, same. 103, *G. calva*, female, dorsal view of apex of abdomen. 104, *G. assanutrix*, female, seventh tergum. 105, *G. productilis*, female, apical margin of seventh tergum. 106, *G. aracataca*, female, dorsal view of last abdominal segments. 107, *G. clavellata*, same. 108, *G. borincana*, male, projection of apical angle of hypopygium. 109, *G. subglobulata*, female, hind margin of seventh tergum. 110, *G. succinta*, female, seventh tergum. 111, *G. nanna*, female, apex of abdomen from behind. 112, *G. amicula*, same. 113, *G. angulata*, same. 114, *G. spinicaudata*, same. 115, *G. galapagensis*, same. 116, *G. alterata*, same. 117, *G. aliena*, same. 118, *G. assanutrix*, same. 119, *G. stipitata*, same. 120, *G. panamana*, same. 121, *G. calva*, same. 122, *G. globifera*, same. 123, *G. haitiana*, same.


100.

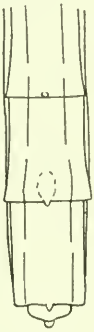

101.

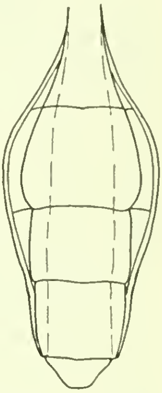

102.


103.


104

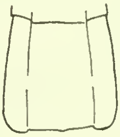

105.

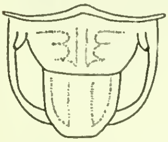

106

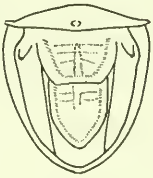

107.

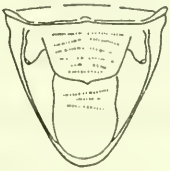

108.

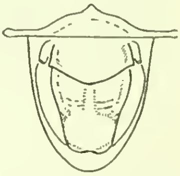

109

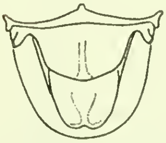

110

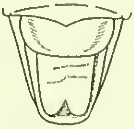

111

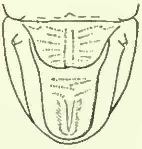

112.

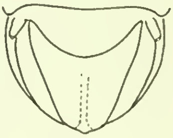

113.


114

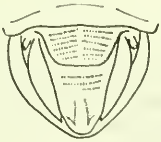

115.

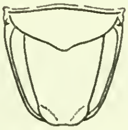

116.

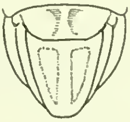

117

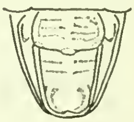

118.


119.


120.


121


122.


123.

For explanation, see opposite page.

Abdomen on dorsal aspect slender and almost parallel-sided to base of fourth segment. Fourth segment expanding apically, apical half forming part of bulbosity. Fifth segment the widest, with subangulate, ridged very slightly produced elevation on apical two-thirds close to lateral margins. Sixth segment forming part of bulbosity, slightly shorter than fifth, narrower apically. Seventh tergum slightly narrower apically than basally, slightly shorter than sixth, apical margin very shallowly concave, apical angles slightly rounded, with a small inconspicuous median projection (fig. 107). Eighth tergum basally slightly over twice as wide as long, one-half times as long as ninth, corrugated. Ninth tergum corrugated on basal half; apical half narrower, lateral margins depressed, making it more convex than basal half, shiny, apical margin concave (fig. 124). Hind margin of sixth sternum U-shaped, longer on lateral margins than medially. Seventh sternum slightly over twice as long as sixth, apical margin broadly produced medially (fig. 50).

Overall body length 25.0 mm.

This species is close to *approximata* but can be easily separated from it by the characters in the key and also by having the bulbosity longer than wide, while this character is shorter in *approximata*. *G. pendula* and *gladiator* also have the bulbosity longer than wide but otherwise they are very different from *clavellata*.

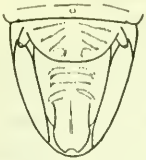
TYPES: Holotype, female, Kaieteur, British Guiana, July 28, 1911, AMNH. Paratypes, two females, same locality, collected August 10, and July 26, 1911, in author's collection and AMNH.

***Ghilianella fenestrata*, new species**

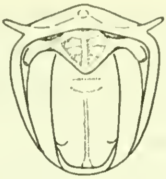
FIGURES 25, 33, 82

MALE: Head, thorax, and forelegs dark reddish brown. Beak and antenna reddish brown. Forefemur reddish brown, with three inconspicuous lighter spots on inner side, spines of armature of femur brownish, those of outer row fading to yellowish toward apex. Middle and hind femora reddish brown, each with two yellowish annuli on apical half. Middle and hind tibiae each with inconspicuous basal yellowish band. Abdomen blackish brown, irregularly mottled with yellowish brown.

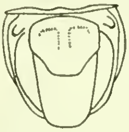
FIGURES 124–146.—124, *Ghilianella calvellata*, female, apex of abdomen from behind. 125, *G. subglobulata*, same. 126, *G. obesa*, same. 127, *G. puncticauda*, same. 128, *G. atabapo*, same. 129, *G. approximata*, same. 130, *G. glabrata*, same. 131, *G. cuneata*, same. 132, *G. productilis*, same. 133, *G. pendula*, same. 134, *G. aracataca*, same. 135, *G. minimula*, same. 136, *G. globulata*, same. 137, *G. gladiator*, same. 138, *G. varicornis*, same. 139, *G. monense*, same. 140, *G. signoreti*, same. 141, *G. grapta*, same. 142, *G. annectens*, same. 143, *G. bicaudata*, same. 144, *G. succinta*, same. 145, *G. personata*, same. 146, *G. bethei*, same.

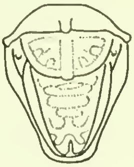

124.

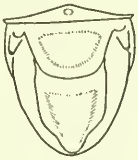

125.

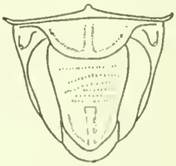

126.

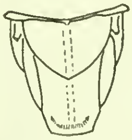

127.

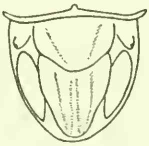

128.

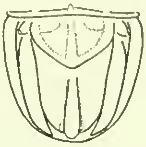

129.

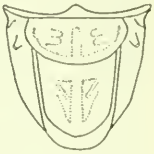

130.

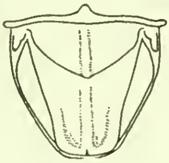

131.

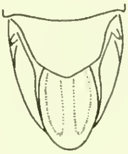

132

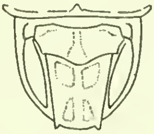

133.

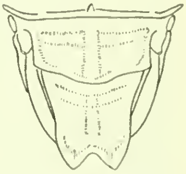

134.

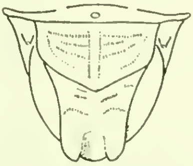

135.

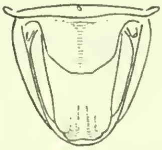

136.

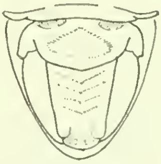

137.


138.

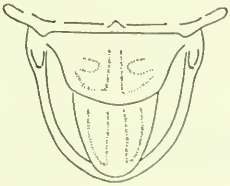

139.

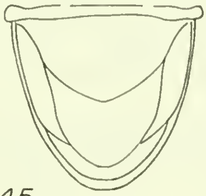

140.

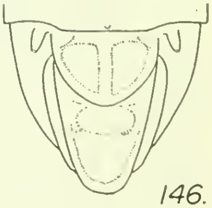

141.


142.


143.


144.


145.


146.

For explanation, see opposite page.

Body with very sparse, short, appressed yellowish pilosity.

Head not granulose. Interantennal spine not developed.

Thoracic segments not granulate; lengths of segments: 3.4, 4.2, 1.4 mm. Anterior half of prothorax distinctly stouter than posterior (fig. 82). Armature of forefemur with inner row consisting of short spines of nearly uniform length alternating with fine longer setae. Claws of foretarsi two, the inner short and closely appressed to base of outer. First spine of forefemur at two and one-half times its length from tip of trochanter. Basal half of forefemur thickened gradually to first spine.

Abdomen with bulbous swelling. Abdomen gradually widening to middle of fourth segment. Apical half of fourth segment widening and forming minor part of bulbosity. Fifth segment forming widest part of bulbosity, equal in length to sixth, tergum with angulate ridged elevations on lateral sides. Basal two-thirds of sixth segment forming part of bulbosity, lateral angles slightly projected laterally. Seventh tergum narrowing on basal third, narrowest portion parallel sided to over apical two-thirds, apical third tapering to a sharp point; apex not surpassing claspers, transversely corrugate (fig. 33). Terga each with wartlike elevation on hind margin. Hind margins of second to fifth sterna straight; of sixth shallowly concave medianly and convex on sides; of seventh and eighth sterna shallowly and broadly concave; eighth sternum visible its entire width. Hypopygium opening upwards; claspers longer than wide, on lateral aspect with an angular elevation near middle of upper margin, lower margin with an angular indentation near middle, upper margin as seen from behind with a U-shaped notch before apex. Upper apical margin of hypopygium with a very large hook; broad base of hook projecting caudad, the more slender apical half standing clear from the base, the apex hidden by the claspers, and with a shallow furrow above near apex (fig. 25).

Overall body length 23 mm.

The shape of the hook of the hypopygium of this species as well as the combination of characters separate this species from others with such a hook. The shape of the basal half of the hypopygial hook is slightly different in the paratype; in the paratype it is stouter and shorter than in the holotype; otherwise, the two specimens are quite similar.

Types: Holotype, male, Rio Reventazón, Costa Rica, April 30, 1908, V. Reimoser collector, Vienna Museum. Paratype, male, Costa Rica, no other data, author's collection.

Ghilianella gibbiventris Champion

Figures 21, 46

Ghilianella gibbiventris Champion, 1898, p. 172.

Some material at hand agree very closely with Champion's description. A redescription of the species follows:

Male: Blackish. Legs, beak, and antenna blackish brown. Legs inconspicuously annulate.

Body and legs with short, appressed, scarce yellowish pilosity.

Head sparsely but distinctly granulose; eyes moderately large. Interantennal spine long, decurved.

Thoracic segments sparsely but conspicuously granulate; lengths of segments: 3.0, 2.8, 1.5 mm. Armature of forefemur with inner row consisting of long and short spines and alternating longer fine setae, the setae arising from wartlike bases. Claws of foretarsi two, the inner very short and closely appressed to base of outer. First spine of forefemur at nearly twice its length from tip of trochanter. Basal half of forefemur gradually thickened to first spine.

Abdomen with bulbous swelling (fig. 46). Second and third abdominal segments relatively short, the bulbosity thus strikingly close to the thorax. Abdomen gradually widening to middle of fourth segment, apical half of fourth segment forming part of bulbosity. Fifth segment forming widest part of bulbosity, the margins of the tergum produced as lateral carinae and over margin of segment, the elevations nearer to posterior margin, gibbous above. Basal half of sixth segment forming part of bulbosity, equal in length to fifth. Seventh tergum bent upward, narrowed portion beginning at basal two-fifths, one and two-thirds times as long as sixth, apical half transversely corrugate, apex ending in a sharp point, slightly surpassing apex of claspers. Hind margins of second to fifth sterna straight, of sixth shallowly concave medianly and before lateral margin. Hind margin of seventh sternum with a broad V-shaped indentation and of eighth shallowly concave. Sixth sternum one and one-half times as long as seventh. Seventh sternum with conspicuous lateral basal depressions. Eighth sternum visible its entire width, shorter near spiracle. Clasper broad to near midlength and narrower apically, apical upper angle pointing cephalad. Upper lateral margin of hypopygium bisinuate; with a large apical hook standing clear of the sternum, its apex hidden under claspers (fig. 21).

Overall body length 20.0 mm.

The lateral aspect of the hypopygial portion of this species closely resembles *uncinata*. In *gibbiventris*, the mesothorax is shorter than the prothorax, the claspers are narrower apically, and the bulbous swelling is strikingly close to the thorax.

MATERIAL EXAMINED: One male, Barro Colorado Island, Panama Canal Zone, Nov. 22, 1944, K. E. Frick collector, CAS; one male, Corozal, Panama Canal Zone, June 6, 1937, author's collection.

Ghilianella globifera Bergroth

FIGURES 24, 66, 87, 122

Ghilianella globifera Bergroth, 1906, pp. 319–320 (Venezuela, male).—McAtee and Malloch, 1925, p. 110.

FEMALE: Head and thorax brown, interantennal spine straw colored or brown. Beak and antenna darkening to blackish toward apex. Middle and hind femora brownish with three broad yellowish annuli on apical half. Middle and hind tibiae straw colored or brownish. Tarsi dark brown. Abdomen brown, irregularly spotted with black small areas.

Body and legs with scarce and very short appressed yellowish pilosity.

Head granulate; eyes moderately small. Interantennal spine long and straight.

Thoracic segments granulate; lengths of segments: 2.9, 3.7, 2.3 mm. Claws of foretarsi two, the inner shorter and closely appressed to base of outer. First spine of forefemur at nearly three times its length from tip of trochanter; basal half of forefemur gradually thickened to base of first spine. The inner row of armature of forefemur consisting of setae arising from wartlike bases.

Abdomen with elongate bulbous swelling. Abdomen parallel sided to before apex of third segment, apex of third segment slightly widening and forming minor part of bulbosity; fourth widening to before apex and constituting widest part of bulbosity; from apex of fourth to apex of abdomen gradually narrowing. Hind margin of second to fourth tergum nearly straight; of fifth shallowly concave; the others as in figure 87. Third tergum the longest, each succeeding tergum shorter than the preceding. Seventh tergum slightly broader than long, hind margin very shallowly concave. Eighth tergum nearly horizontal, hexagonal or semicircular, with a median elevation that slightly widens toward apex, shallow depressions at either side of median elevation. Ninth tergum one and one-half times as long as eighth, tapering to a round apex, margins slightly elevated, with broad inconspicuous median elevation, irregularly transversely corrugated (fig. 122). Hind margins of second and third sterna straight; of fourth with a broadly shallow V-shaped indentation; of fifth and sixth very deeply emarginate; of seventh with a round median projection. Seventh sternum over twice as long as sixth (fig. 66).

Overall body length 22.0 mm.

G. globifera is the only species having the fourth tergum the widest part of the bulbosity. The genitalia of the other three females at hand show slight variations from the hypotype. In one the eighth tergum is nearly semicircular, but the details of its surface agree with those of the hypotype. In another the ninth tergum is relatively shorter and broader but otherwise is similar. In the third the ninth tergum has a small notch on either side before apex. The hypotype was collected in coitu with a specimen that agrees closely with McAtee and Malloch's description.

TYPES: Hypotype, female, Villavicencio, M.I., Colombia, July 23, 1938, H. S. Dybas collector, CNHM. Parahypotypes, three females: one collected by H. S. Dybas, July 13, 1938, CNHM; one collected by C. H. Seevers, author's collection; and one collected January 20, 1948, PW; all three from Caño Grande, Colombia. Six males of this species have been identified, one of them, as mentioned above, was collected in coitu with the female hypotype.

***Ghilianella grapta*, new species**

FIGURES 17, 34, 63, 101, 102, 141

MALE: Head, thorax, and legs brown. Abdomen blackish brown. Body covered with sparse decumbent yellowish hairs. Abdomen with 14 patches of yellowish white hairs as follows: 2 small patches on hind margin of fourth and fifth terga, 4 near hind margin of fourth sternum, 2 more extensive near anterior margin of fifth sternum, and 4 near posterior margin of fifth sternum.

Head conspicuously granulose, eyes moderately small. Long straight interantennal spine.

Thoracic segments conspicuously granulose; lengths of segments: 2.5, 3.5, 2.2 mm. Armature of forefemur with inner row consisting of alternate long and short spines and between them longer fine setae arising from wartlike bases. Claws of foretarsi two, the inner one shorter and appressed to base of first. First spine of forefemur at slightly less than three and one-half times its length from tip of trochanter. Basal half of forefemur gradually thickened to first spine.

Abdomen with bulbous swelling. Apical angles of second to fourth terga not produced. Abdomen gradually widened to apical three-fourths of fourth segment. Apical fourth of fourth segment forming minor part of bulbosity, its hind margin conspicuously convex. Fifth segment constituting major and widest part of bulbosity, the margins of the tergum produced over lateral margins of segment, the margins pointed on apical two-thirds (fig. 102). Basal third of sixth segment forming minor part of bulbosity. Seventh tergum as in figure 34, narrowed portion from basal third to apical two-thirds, apical third tapering to a point, medianly ridged; twice as long as sixth, surpassing claspers by nearly their own length; apical two-thirds of tergum transversely corrugate. Hind margins of sixth, seventh, and eighth sterna broadly and shallowly V-shaped. Sixth and seventh sterna conspicuously medianly carinate, others slightly so. Eighth sternum visible on its entire width, except stigma that is hidden (fig. 17). Upper lateral margin of hypopygium straight; apical process of hypopygium small, inclined cephalad, hidden by claspers except at its base (which is visible beyond end of claspers), slightly widening toward apex; apex truncate and produced above claspers. Claspers with lower margin straight, upper margin with an inconspicuous indentation before apex, shortly before apex bent mesad at 90°.

Overall body length 20 mm.

FEMALE: Head, thorax, and legs brown. Abdomen variegated with black and yellow.

Abdomen with same 14 patches of yellowish white hairs exhibited by male and in addition 2 small spots on hind margin of third tergum and sternum. Body covered with sparse decumbent yellowish hairs. Pilosity denser on sides of neck, anterior sides of mesothorax, and dorsally on base of metathorax.

Head as in male.

Thoracic segments conspicuously granulose; length of segments: 2.6, 3.8, 2.4 mm. Armature of forefemur with inner row and claws of foretarsi as in male. First spine of forefemur at slightly less than twice its length from tip of trochanter. Basal half of forefemur gradually thickened to first spine.

Abdomen with bulbous swelling. Apical angles of second to fourth terga not produced. Abdomen gradually widened to middle of fourth segment. Apical half of fourth segment forming part of bulbosity. Fifth segment constituting major and widest part of bulbosity, the margin of the tergum produced over lateral margins of segments, pointed beyond middle. Basal half of sixth segment forming part of bulbosity (fig. 101). Seventh tergum as long as wide at apex, slightly narrower basally than apically; hind margin shallowly convex, with inconspicuous median tubercle, lateral angles roundly pointed and extending beyond median tubercle. Eighth tergum nearly semicircular, slightly produced apically, on either side of median line slightly elevated. Ninth tergum medianly slightly longer than eighth, lateral margins conspicuously elevated on apical half, with narrow, median ridge on apical half, apical margin shallowly cuneate (fig. 141). Sterna medianly keeled. Hind margin of second to fifth sterna straight; of sixth sternum with broad median concavity, on sides slightly longer than medianly. Seventh sternum nearly one and one-half times as long as sixth medianly; hind margin slightly produced medianly (fig. 63).

Overall body length 21.0 mm.

G. grapta, signata, and *ignorata* are the only species with extensive pilose spots; they can be easily separated by the characters in the keys.

Types: Holotype, male, Mérida, Venezuela, no other data, PW. Allotype, female, Mérida, Venezuela, 1883, USNM. Paratypes, two males, Venezuela, Brunner collector, one in USNM and other in author's collection.

***Ghilianella haitiana*, new species**

Figures 1, 32, 79, 83, 88, 123

Male: Head brownish, with paler median longitudinal band. First antennal segment with seven yellowish annuli, remaining segments uniformly brownish, last two with short silvery pilosity. First and second segments of beak with brownish basal halves, apical halves yellowish white; third segment brownish. Thoracic segments brown. Prothorax with three longitudinal yellowish brown lines above. Forelegs, middle and hind femora brownish, irregular, and conspicuously marked with stramineous; tarsi brownish. Middle and hind tibiae brownish, each with two yellowish basal bands. Abdomen brown, darker ventrally; terga inconspicuously spotted with stramineous; posterolateral angles yellowish.

Very scarce and short silvery decumbent pilosity over body.

Head as in figures 79 and 83, heavily granulose, grains behind interocular depression raised into two very short horns; interantennal spine short, pointing upward. Fourth antennal segment three times as long as third.

Thoracic segments granulate; lengths of segments: 1.9, 1.0, 0.7 mm. Prothorax on lateral aspect as in figure 83. Armature of forefemur with inner row consisting of bristles arising from wartlike bases, a strong spine at end of row. Claws of foretarsi two, the inner very short and closely appressed to base of outer. First spine of forefemur at its own length from tip of trochanter. Basal half of forefemur gradually thickening to first spine.

Abdomen without bulbous swelling, parallel sided in dorsal aspect; as seen from side deepest at middle. Apical angles of terga slightly produced. Hind margin of terga with blackish wart. First tergum slightly elevated, with median longitudinal ridge. Sixth tergum three-fourths as long as seventh, hind margin with a backward sloping tubercle. Seventh tergum with apical half transversely corrugate and roundly tapering to a sharp point, apex not surpassing hypopygium, longitudinally carinate (fig. 32). Hind margins of second to sixth and eighth sterna straight; of seventh sternum concave laterally. Sixth sternum longer than seventh; eighth visible its entire width. Claspers parallel sided, not reaching apex of hypopygium (fig. 1).

Overall body length 12.0 mm.

FEMALE: Head brownish, darker ventrally, with inconspicuous longitudinal median yellowish stripe. First antennal segment with six or seven narrow yellowish bands; second, third, and fourth brownish, last one covered with long silvery pilosity. Thorax brownish; forelegs yellowish white, apices and bases of segments brownish; brownish areas among spines of armature of forefemur, spines yellowish white or stramineous with black points, hairs of armature brown; tarsi brownish. Middle and hind femora yellowish white, each with four or five broad brownish bands; middle and hind tibiae straw colored; middle tibia with brownish basal band; tarsi blackish brown. Abdomen brown, darker ventrally and toward apex, terga lighter medianly.

Body with very scarce silvery decumbent pilosity.

Head heavily granulose; eyes relatively small. Interantennal spine nearly straight. Fourth antennal segment four times as long as third.

Thoracic segments granulate; lengths of segments: 2.6, 1.5, 0.8 mm. Armature of forefemur with inner row consisting of setae arising from wartlike bases, a strong spine at end of row. Claws of foretarsi two; the inner very short, closely appressed to base of outer. First spine of forefemur at nearly its length from tip of trochanter. Basal half of forefemur gradually thickened to first spine.

Abdomen without bulbous swelling. Posterior angles of terga produced, lateral margins shallowly concave, hind margins with median blackish wart or small projections, as in figure 88; connexivium rugose or granulose. First tergum with well-developed median longitudinal elevation. Sixth tergum medianly longer than seventh, its apex wider than that of seventh, with a backward sloping tubercle on hind margin. Seventh tergum with posterior angles produced backward, hind margin with a well-developed median spine, with longitudinal carina. Eighth tergum transversely corrugate, lateral margin slightly elevated, hind margin medianly produced and shallowly concave at either side of center, lateral angles slightly elevated. Ninth tergum nearly twice as long as eighth, disc slightly elevated, lateral margins from about middle of segment to apex raised and then curving mesad, with an almost circular elevation between them (fig. 123). Hind margins of second to fifth sterna straight; of sixth broadly and shallowly concave. Seventh sternum concave on sides, and hind margin with a narrow small median emargination; laterally compressed near middle.

Overall body length 16.0 mm.

The backward sloping tubercle on the sixth tergum, the projecting posterolateral angles of the terga, and the heavily granulated body will separate this species from the other short ones; additional information is given in the discussion of *nanna* above. There is the possibility that the sexes of *haitiana* have been erroneously associated.

TYPES: Holotype, male, Kenscoff, near Port-au-Prince, Haiti, Darlington collector, October 13, 1934, 4–6,000 ft. elevation, MCZ 29465. Allotype, female, Kenscoff, Haiti, April 30, 1937, Chester Rays collector, MUM.

Ghilianella longula McAtee and Malloch

FIGURE 3

Ghilianella longula McAtee and Malloch, 1925, p. 104 (female).

MALE: Thorax and abdomen blackish brown. Head brown. Interantennal spine and beak paler. Antenna brown, last two segments silvery where pilose. Legs light brown, unmarked; forelegs slightly paler. Mesothorax and metathorax with anterolateral paler areas due to the concentration of pilosity.

Body covered with abundant short, appressed, silvery pilosity easily discernible against the dark background.

Head very sparsely granulose; eyes small. Interantennal spine long and straight.

Thoracic segments not granulose; lengths of segments: 3.7, 3.7, 3.1 mm. Claws of foretarsi two, the inner one short and appressed to the base of the outer. Armature of forefemur with inner row consisting of long setae arising from wartlike bases.

Abdomen on dorsal aspect parallel sided. Apical angles of terga not produced, hind margins of terga with small inconspicuous blackish warts. Hind margin of sixth tergum straight. Seventh tergum shorter than sixth, not surpassing claspers, without constriction on lateral margin, tapering from about middle to a sharp caudal point, transversely corrugate, with inconspicuous median ridge. Hind margins of second to fifth sterna straight, hind margin of sixth concave on median line and convex laterally; hind margins of seventh and eighth very shallowly concave medianly. Eighth sternum visible its entire width. Hypopygium opening upwards; claspers on lateral aspect elongate, broader basally, apex sharp and pointing cephalad (fig. 3). Upper lateral margin of hypopygium shallowly concave; apical process of hypopygium receding from apical margin, its base hidden by apices of claspers, sides slightly concave, apex somewhat expanded laterally.

Overall body length 29.0 mm.

This male specimen has been considered to be *longula* because the thoracic segments very closely agree with those of a female at hand identified by McAtee & Malloch as *longula*. This species is very close to *simillima* and to *signoreti*. *G. simillima* and *longula* can be separated by the characters given in the key; besides, the hind margin of the eighth sternum in *simillima* is undulated medianly while that of *longula* is straight. *G. signoreti* has the head and thoracic segments granulose instead of smooth as in *longula*. The females of these species can readily be separated by the shape of the seventh sternum.

TYPES: Hypotype, male, from Santiago de Cuba, no other data, AMNH; two parahypotypes, same data as hypotype, one in AMNH and other in author's collection.

***Ghilianella megharpacta*, new species**

FIGURES 4, 31

MALE: Head, thorax, and abdomen blackish brown. Legs brown. Middle and hind femora each with three incomplete annuli on apical half.

Body and legs with scarce short, appressed silvery pilosity. The setae on abdomen in small clusters and with clear areas between them.

Head heavily granulose. Interantennal spine not well developed, a mere wart. Third antennal segment two-thirds as long as fourth.

Thoracic segments heavily granulose; lengths of segments: 3.0, 2.9, 1.3 mm. Armature of forefemur with inner row consisting of alternating long and short spines and between them fine longer setae arising from wartlike bases. Claws of foretarsi two, the inner very short, closely appressed to base of outer. First spine of forefemur at one and one-half times its length from tip of trochanter. Basal half of forefemur gradually thickened to first spine.

Abdomen gradually widening to apex of fourth segment, thence parallel sided to middle of seventh. Seventh sternum slightly inflated laterally near apex and constituting widest part of abdomen. Apical angles of terga not produced laterally. Apical margin of terga straight, without median wart, with inconspicuous median ridge, with many subsquare depressions at either side of median ridge and on connexivium. Seventh tergum longer than sixth, transversely rugose, shallow constriction starting on basal third, apical third pointed and not expanded, not surpassing claspers (fig. 31). Hind margins of second to fifth sterna shallowly concave; of sixth more deeply concave medianly and convex on sides; of seventh shallowly concave; of eighth straight. Seventh sternum on lateral margins one-half as long as medianly, slightly shorter medianly than sixth. Eighth sternum visible its entire width. Hypopygium opening upwards. Claspers very large, subtriangular, hind-most margin longer than upper. Upper margin of hypopygium with small concavity above where basal angle of clasper fits, apical process with a large hook, slightly separated from the sternum, its apex hidden by the large claspers (fig. 4).

Overall body length 18.5 mm.

The huge subtriangular claspers easily separate this species from all others.

Type: Holotype, male, Tingo María, Perú, 670 meters elevation, September 1947, Weyrauch collector, USNM 63092.

Ghilianella monense Maldonado

Figures 59, 61, 90, 139

Ghilianella monense Maldonado, 1953, p. 195 (male).

Female: Brown, paler than the male. Interantennal spine straw colored. Legs somewhat paler than remaining parts of body, inconspicuously banded with yellow. Venter of abdomen irregularly variegated with blackish and brown.

Prothorax with scarce pilosity. Mesothorax caudally with slightly denser pilosity. Metathorax with heavier pilosity on sides and below. Second to fifth abdominal segments, above and on sides, with somewhat heavier pilosity on basal halves, giving the abdomen a faint banded appearance; banding difficult to see except in reflected light, less conspicuous than in the male.

Head sparsely granulate; eyes small. Long interantennal spine, slightly decurved. Fourth antennal segment twice as long as third.

Thoracic segments very sparsely granulate; lengths of segments: 3.1, 3.1, 2.6 mm. Claws of foretarsi two, the inner very short and closely appressed to outer. First spine of forefemur at three times its own length from tip of trochanter; basal half of forefemur gradually thickened to first spine. Armature of forefemur with inner row consisting of bristles arising from wartlike bases.

Abdomen almost parallel sided; posterior angles of terga not produced; terga each with low longitudinal median ridge. Hind margin of each terga straight, with small black median wart. Fifth tergum longer than sixth; sixth longer than seventh (2.9, 2.6, 1.5 mm.). Seventh tergum longer than wide, hind margin not declivate, with apical angles produced, with a median tubercle subequal to apical angles (fig. 90). Eighth tergum twice as broad as long, hind margin slightly produced medianly, corrugate, lateral margins raised, inconspicuous median ridge. Ninth tergum corrugate, apex distinctly upcurved, apical margin deeply emarginate (fig. 139). Seventh sternum shorter than sixth, inflated below near middle, hind margin produced, projection rectangular, longer than wide at base (figs. 59, 61).

Overall body length 27.0 mm.

This species is very close to *productilis*, but both sexes can be separated from *productilis* by the characters in the keys. Examination of additional males demonstrate the presence of small wartlike elevations on the hind margins of the abdominal terga. It should be added that the hind margins of the seventh and eighth sterna are convex and with a small median semicircular concavity. All the type material was collected from a very small extension of *Sporobolus virginicus* growing in the shade of white mangrove and Australian pine trees; this place is probably covered with water during the rainy season.

Types: Allotype, female, from Mona Island, Puerto Rico, J. Maldonado-Capriles collector, April 20, 1954, USNM 63091. Paratypes, five females, same data; two males, same data as allotype, one in PW and other in author's collection.

***Ghilianella nanna*, new species**

Figures 48, 71, 91, 111

Female: Head and thorax dark brown; antenna and legs brownish. Middle and hind femora with two incomplete yellowish preapical bands. Connexivial margins with apical half to just before posterior angle blackish; terga medianly much darker, with irregular pale brownish spotting, median ridge pale brown. Abdomen below blackish brown, slightly paler medianly.

Body and legs with very scarce and short appressed pilosity.

Head granulose; eyes small. Interantennal spine long, bent downward.

Thoracic segments granulate; lengths of segments: 2.0, 1.2, 0.7 mm. Claws of foretarsi two, the inner short and appressed to base of outer. First spine of forefemur at slightly over its own length from tip of trochanter. Armature of forefemur with inner row consisting of fine setae arising from wartlike bases. Basal half of forefemur gradually thickening to first spine.

Abdomen without bulbous swelling, parallel sided. Lateral margins of fifth and sixth terga shallowly concave. Apical angles of terga slightly produced; hind margins of terga without wartlike elevations. Seventh tergum slightly shorter than sixth, broader than long, hind margin concave at either side of short median projection (fig. 91). Eighth tergum over twice as broad as long, with a short median ridge, at either side of median ridge a narrow longitudinal depression not reaching hind margin. Ninth tergum with a broad median elevation, lateral margins raised (fig. 111). Hind margin of seventh sternum with a short median projection; with a median broad depression on apical half (figs. 48, 71).

Overall body length 13.0 mm.

The short projections of the posterolateral angles of the terga of *nanna* may pass unnoticed; otherwise, the characters in the key will easily separate it from *rhabdita, galapagensis, mariae, calva, haitiana,* and *nebulosa*—the other known species under or around 13.0 mm. long.

TYPE: Holotype, female, Misiones, Argentina, July 1948, Bernardo Irigoyen collector, USNM 63090.

Ghilianella obesa, new species

FIGURES 67, 81, 93, 126

FEMALE: Head, antenna, beak, and thorax brown. Abdomen yellowish brown, darker above. Middle and hind femora with two broad yellowish bands on apical half.

Body and legs with scarce, short, appressed grayish or yellowish pilosity.

Head not granulose. Fourth antennal segment two and one-half times as long as third. Interantennal spine not developed.

Thoracic segments not granulate; lengths: 3.1, 3.4, 1.8 mm. Prothorax on lateral aspect as in figure 81. Claws of foretarsi two, the inner short and appressed to base of outer. First spine at one and one-third times its length from tip of trochanter. Armature of forefemur with inner row consisting of short and long spines alternating with longer fine setae. Basal half of forefemur gradually thickened to first spine.

Abdomen conspicuously widening to apex of third segment, thence parallel sided to before apex of sixth and narrowing to apex of seventh (fig. 93). Apical angles of third to sixth terga projected laterally. Hind margin of second to fifth terga straight, with moderately large median warts. Wart on fourth tergum larger than that on third and fifth, smaller than that on sixth. Hind margin of sixth tergum angularly produced caudad, with large caudally produced median elevation, and constituting the widest part of the abdomen. Seventh tergum slightly shorter than sixth medially, notably narrower apically than basally; hind margin medially angularly produced, tuberculate, and longitudinally ridged. Connexivial areas on each tergum with several subsquare depressions. Eighth tergum notably reduced, hind margin produced, small areas of ninth tergum visible on its sides, margins strongly elevated. Ninth tergum slightly over twice as long as eighth, lateral margin with subapical elevation, with a median ridge on apical half (fig. 126). Hind margins of second to fifth sterna straight; of sixth deeply and broadly concave. Seventh sternum nearly one and one-half times as long as sixth, hind margin slightly produced medianly (fig. 67). Sterna medianly carinate. Stigma unusually separated from lateral margin.

Overall body length 21.0 mm.

In the key this species is close to *panamana*, but they can be easily separated by the mentioned characters.

TYPE: Holotype, female, Hamburg Farm, Costa Rica, March 1936, collector unknown, MCZ 29464.

***Ghilianella panamana*, new species**

FIGURES 52, 92, 120

FEMALE: Head and thorax reddish brown. Antenna brown, third and fourth segments each with apical two-thirds with whitish hairs. Forelegs brownish, upper side of femur yellowish brown. Middle and hind femora brown, each with three narrow incomplete annuli on apical half. Middle and hind tibiae brown, middle tibia with a basal yellowish annulus.

Body covered with short, appressed yellowish pilosity.

Head granulose; eyes moderately small; two short elevations behind interocular sulcus. Interantennal spine long, curved downward. Fourth antennal segment slightly over one and one-half times as long as third.

Thoracic segments moderately granulose; lengths of segments: 3.4, 4.5, 2.4 mm. Mesothorax with two small round elevations near posterior margin. Claws of foretarsi two, the inner short and appressed to base of outer. First spine of forefemur at nearly three times its length from tip of trochanter. Basal half of forefemur gradually thickened to first spine. Armature of forefemur with inner row consisting of short and long spines alternating and between them longer fine setae.

Abdomen widening to middle of fourth segment and thence parallel sided to fifth, sixth widening toward apex, and seventh slightly narrower apically; the widening of sixth segment not enough to form a bulbous swelling. Hind margins of second to fourth terga straight, with inconspicuous wartlike median elevations; lateral angles of terga not produced. Fifth tergum longer than sixth, with sides slightly concave, apical margin with small shallow concavity on connexivium. Sixth tergum slightly less than twice as long as wide at base; posterolateral angles produced, hind margin with a large conical median elevation. Seventh tergum shorter than sixth, slightly narrower apically than basally, basal margin with broad median elevation set against conical elevation of sixth; hind margin concave and declivate, with small median projection, shorter than projections of lateral angles (fig. 92). Eighth tergum narrow, leaving exposed narrow portions of ninth tergum at either side, depressed along median line, with fine transverse corrugations. Ninth tergum with broad longitudinal elevation on apical half; with a few transverse corrugations on basal half; apex narrow (fig. 120). Second to sixth sterna shallowly concave.

Seventh sternum longer medianly than sixth, longer medianly than on lateral margins, very slightly produced medianly, carinate on apical half (fig. 52).

Overall body length 24.5 mm.

Other females with similar elevation on the sixth tergum are *bulbifera, cuneata, pendula, bethei,* and *aracataca,* but otherwise these species are very different from *panamana.*

Types: Holotype, female, Barro Colorado, Panama Canal Zone, July 10, 1924, N. Banks collector, MCZ 29466. Paratype, same collection data, author's collection.

Ghilianella rhabdita, new species

FIGURES 15, 29

Male: Head, antenna, and thorax brownish. Forelegs yellowish brown, femur with two incomplete yellowish annuli. Middle and hind femora brownish, darker toward apex, with two preapical yellowish rings. Middle and hind tibiae brownish, with postbasal yellowish ring. Abdomen brownish, variegated with yellowish.

Inconspicuously covered with short, scarce, appressed pilosity.

Head granulose; eyes small. Interantennal spine long, decurved.

Thoracic segments granulate; lengths: 2.5, 1.6, 0.7 mm. Armature of forefemur with inner row consisting of long fine setae arising from wartlike bases. Claws of foretarsi two, the inner very short, and closely appressed to base of outer. First spine of forefemur at one and one-half times its length from tip of trochanter. Basal half of forefemur gradually thickened to first spine.

Abdomen on dorsal aspect nearly parallel sided to middle of seventh segment, thence narrower to apex. Terga with apical angles not produced or elevated and hind margins without median warts. Seventh tergum longer than sixth; the narrowed portion beginning before middle, thence parallel sided to before apex; apex roundly produced, apical half transversely corrugate (fig. 29). Hind margins of second to fifth sterna straight; of sixth medianly concave and slightly convex on sides, inside the lateral convexity with a circular elevation; of seventh straight; of eighth slightly acutely produced. Sixth and seventh sterna of same median length. Seventh sternum nearly half as long on lateral margins as medianly. Eighth sternum visible on its entire width, medianly as long as seventh laterally. Spiracle pedunculate. Hypopygium opening upwards; its upper lateral margin stepped, the claspers fitting in the concavity. Claspers on lateral aspect oblong, apex inwardly curved, pointed apically (fig. 15).

Overall body length 14.0 mm.

TYPES: Holotype, male, Espirito Santo, Rio São Jose, Brazil, Santos Soares collector, USNM 63086.

The straight margins of the abdominal terga easily separate this small species from others 14.0 mm. or less in length. The circular elevation on either side of the sixth and the unusual length of the eighth sterna identify it.

Ghilianella signata McAtee and Malloch

FIGURES 16, 100

Ghilianella signata McAtee and Malloch, 1925, p. 120 (female).

MALE: Brownish, last four abdominal segments blackish brown. Legs and antenna covered with short appressed scarce pilosity. Pilosity on body longer and in patches; more abundant on base of interantennal spine, frons, and sides of neck; prothorax anteriorly on sides around neck, mesothorax and metathorax anteriorly on sides; above and below abdominal segments in patches of 4 to 10 setae. Abdomen with a total of 12 extensive patches of whitish hairs and of nearly same extension as follows: 2 apically on fourth, fifth, and sixth terga; 2 apically on fourth, fifth, and sixth sterna.

Head not granulose, eyes moderately large. Interantennal spine long, slightly decurved. Fourth antennal segment slightly less than twice as long as third.

Thoracic segments not granulate; lengths of segments: 2.8, 3.7, 2.2 mm. Armature of forefemur with inner row consisting of alternate long and short spines and between them longer fine setae. Claws of foretarsi two; the inner one shorter, appressed to base of first. First spine of forefemur at four times its length from tip of trochanter. Basal half of forefemur gradually thickened to first spine.

Abdomen with bulbosity. Abdominal terga conspicuously convex. Abdomen in dorsal aspect parallel to apical three-fourths of fourth segment. Apical fourth of fourth segment much wider and forming base of bulbosity. Fifth segment constituting major and widest part of bulbosity, the margins of the tergum produced over lateral margins of segment, produced in a point at about midlength of segment (fig. 100). Base of sixth segment wider than remaining portion, thence parallel sided to apex, one-third longer than fifth. Seventh tergum bent upward, longer than sixth, narrowed portion beginning at basal two-fifths and longer than either basal or apical portions; apex very slightly surpassing claspers, transversely corrugated. Hind margin of second to fifth sterna straight; of sixth and seventh shallowly concave; of seventh shortly produced medianly. Sixth sternum less than twice as long as seventh; eighth visible on its entire width. Hypopygium opening cephalad, much deeper than abdomen at sixth segment;

claspers broad (fig. 16). Upper lateral margin of hypopygium stepped, claspers fitting in the concavity.

Overall body length 24.0 mm.

G. grapta and *ignorata* are the only two other species with such extensive yellowish pilose spots, but can be separated from *signata* by the characters in the key.

TYPES: Hypotype, male, Santa Marta Mountains, Mount San Lorenzo, Colombia, 3,500 ft. elevation, June 8, 1920, F. M. Gaiger collector, MUM. Parahypotypes, three males, Vista Bella, Colombia, F. W. Walker collector, one each in USNM, author's collection, and MUM.

Ghilianella signoreti (Dohrn)

FIGURES 6, 73, 140

Emesa signoreti Dohrn, 1860, p. 227, fig. 1 (Jamaica, female).

Ghilianella signoreti (Dohrn), McAtee and Malloch, 1925, p. 97.—Wygodzinsky, 1951, p. 225.

MALE: Uniformly blackish brown or yellowish brown.

Body well covered with short, appressed silvery pilosity that give the insect a grayish aspect. Pilosity slightly more abundant at base of interantennal spine and at metathorax. Pilosity on first two antennal segments and on legs scarce.

Head distinctly granulose; eyes small; fourth antennal segment slightly less than twice as long as third. Well-developed interantennal spine; slightly decurved.

Prothorax slightly granulose, mesothorax and metathorax inconspicuously granulose; lengths of segments: 3.0, 3.0, 2.5 mm. Armature of forefemur with inner row consisting of fine setae arising from wartlike bases. Claws of foretarsi two, the inner shorter than the outer. First spine of forefemur at three times its length from tip of trochanter. Basal half of forefemur gradually thickened to first spine.

Abdomen in dorsal aspect parallel sided. Terga with apical angles not produced; hind margin with small wart, straight. Seventh tergum very slightly shorter than sixth, constriction very shallow and somewhat long, apical half irregularly wrinkled. Hind margins of second to fifth sterna nearly straight; of sixth concave medianly and convex on sides; of seventh and eighth shallowly concave on sides and slightly convex medianly. Eighth sternum visible its entire width. Hypopygium opening upward; clasper wider near base, much narrower apically; apex curved mesad and pointing cephalad (fig. 6). Upper lateral margin of hypopygium angularly bent near middle, sides ledged; apical process of hypopygium developed, small, its apex reaching to slightly above apical upper margin of clasper, parallel sided to apex, apex very shallowly concave.

Overall body length 24 mm.

The lengths of the thoracic segments have been used to associate the male specimens with the females. This species is very close to *simillima* and *longula*; it can be distinguished from them by the shorter thoracic segments, the slightly greater length of the prothorax compared with the mesothorax, the granulation of the head and thorax, and the shape of the hind margin of the seventh and eighth sterna. The ninth tergum of the female (figs. 73, 140) has a close resemblance to that of *bicaudata*, but otherwise these two species are very different. This species seems to be very variable.

Types: Hypotype, male, Portland Ridge, Clarendon, Jamaica, July 22, 1955, T. H. Farr collector, IJ. Parahypotypes, seven males, from different localities in Jamaica, one in USNM and another in author's collection. Five females were also identified, all from Jamaica, one in author's collection. These females agree very closely with the description given by Wygodzinsky (1951).

Ghilianella spinata, new species

Figures 28, 47, 69, 80, 84, 85

Male: Overall color yellowish brown or brown. Head, forelegs, second and third abdominal segments, and apex of seventh tergum darker, brownish. Antenna stramineous to yellowish brown; first segment with four or six yellowish annuli; second segment darker, with four or five more or less equidistant broad yellow annuli; third and fourth segments brownish. Forefemur with many irregular small yellowish areas, spines of outer row of armature yellowish white and black tipped. Middle and hind femora each with basal half stramineous, apical half brownish with two broad yellow annuli. Middle tibia with three broad yellowish annuli, apical portion of segment paler than basal. Middle and hind tarsi blackish brown. Spiracles yellow. Body and legs with very scarce short appressed golden pilosity.

The male paratype has very striking longitudinal lines of yellow pilosity along the inner margin of the conexivium on the bulbosity. These lines may have been rubbed off in the holotype.

Head from side as in figure 80, granulose; eyes small; two well developed spines behind interocular depression. Interantennal spine poorly developed, a mere wart.

Prothorax granulose, mesothorax and metathorax sparsely granulate. Lengths of thoracic segments: 3.4, 4.4, 2.1 mm. Apical half of prothorax narrower than basal, dorsally with two long spines where segment begins to narrow, small elevation on anterior dorsal angle (fig. 85). Mesothorax twice as long as metathorax, with two long spines above at about their own length from caudal margin. Metathorax dorsally with two long spines closer to caudal margin (fig. 84).

Armature of forefemur with inner row consisting of spines with fine setae between them. Claws of foretarsi two, the inner very short and closely appressed to base of outer. First spine of forefemur at nearly twice its length from tip of trochanter. Basal half of forefemur gradually thickened to first spine.

Abdomen with bulbosity (fig. 47); gradually widening to basal half of fourth segment, apical half of segment forming minor part of bulbosity, lateral angles of hind margin slightly produced, with a long median spine bent cephalad. Apical margin of fifth tergum widest part of bulbosity, lateroposterior angles each produced into long spine that surpasses lateral margins of segment, with a long median vertical spine. Sixth tergum narrower apically, posterior angles produced caudad, with a median short, nearly horizontal spine. Seventh tergum twice as long as sixth, broader basally, suddenly narrowed before apex and then produced into a tapering stout spine, surpassing claspers by three times their length, transversely corrugate on apical half. Hind margin of second to fourth sterna straight; of fifth and sixth sterna broadly and shallowly concave; of seventh notched medianly, lateroposterior angles produced into long spines. Eighth sternum visible its entire width, hind margin straight. Upper margin of hypopgium sloping downward at 45°; clasper parallel sided; longer than wide, apex curved cephalad and slightly bent upward (fig. 28). Apical process of hypopygium slightly developed, its base exposed between the claspers.

Overall body length 24.5 mm.

Female: Head and thorax brown. Last four abdominal segments darker. The specimen is not well preserved and no further color details can be given.

Head as in male; granulose; eyes relatively small; two long spines after interocular depression. Interantennal spine slightly more developed than in the male.

Granulations and length of thoracic segments as in the male. Prothorax parallel sided to before middle, thence narrowed to apex; with four radiating spines above at end of broader portion, dorsolateral angle slightly raised, more so than in the male. Mesothorax and metathorax as in the male. Inner row of armature of forefemur and fortarsal claws as in male. First spine of forefemur a little less than twice its own length from tip of forefemur. Basal half of forefemur gradually thickened to first spine.

First abdominal tergum raised into a caudally bent spine. Second and third abdominal segments gradually widening; apical half of fourth tergum forming part of bulbosity, posterior margin straight. Caudal margin of fifth tergum forming widest part of bulbosity, lateroposterior angles produced into long spine surpassing lateral margins of segment, with a median vertical long spine. Sixth tergum narrower apically, posterior angles produced laterally into short broad spines with a median short vertical spine; apical half of lateral margin strongly depressed. Seventh tergum subequal to sixth, basal half slanting downward to horizontal apical half; caudal margin straight (fig. 69). Eighth tergum with basal margin roundly produced, apical margin with shallow median indentation, with longitudinal median depression, on either side of this depression roundly elevated, transversely corrugate. Basal half of ninth tergum transversely corrugate; apical half with lateral margins strongly elevated and with a shorter small median longitudinal ridge, area between these ridges smooth and shiny. Seventh sternum longer than sixth, with a small round median notch. Hind margins of remaining sterna straight.

Overall body length 24.0 mm.

This is the only species of *Ghilianella* with such long spines on the head, thorax, and abdomen.

TYPES: Holotype, male, St. Thomas Baths, Jamaica, March 29, 1937, collector Chester Rays, 500 ft. elevation, MUM. Allotype, female, St. Thomas Baths, Jamaica, collector Mrs. Swainson, IJ. Paratype, male, same data as holotype, author's collection. Paratype, male, St. Andrews, Jamaica, October 1955, collector T. H. Farr, USNM. One female paratype, St. Thomas, Jamaica, IJ.

***Ghilianella spinicaudata*, new species**

FIGURES 70, 76, 78, 89, 114

FEMALE: Head, thorax, and legs light reddish brown. Tibiae either without or each with two basal brownish bands. First antennal segment dark brown, with eight or nine narrow yellowish annuli, second segment dark brown, third and fourth grayish on account of the pilosity. Abdomen dark brown to blackish.

Body with very scarce short appressed pilosity.

Head as in figure 76; granulose, granulations small. Interantennal spine long, slightly pointing upward, straight.

Thoracic segments very sparsely granulate; lengths of segments: 3.8, 2.7, 1.3 mm. Prothorax as in figure 78. Claws of foretarsi two, the inner very short, closely appressed to base of outer. Armature of forefemur with inner row consisting of alternating fine setae and short spines, the setae arising from wartlike bases. Outer row of spines similarly arranged but with more spines; with five or six longer spines forming a third row more to the outside, and four still longer spines forming a fourth row on the outside. No other species has the spines of the armature of the forefemur arranged in four rows. First spine of forefemur slightly curved, at slightly over its own length from tip of trochanter; basal half of forefemur gradually thickened to first spine.

Abdomen noticeably thicker than wide; without bulbous swelling; parallel sided to middle of sixth tergum, thence widening to apex. First tergum with well developed caudally inclined projection. Posterolateral angles of third to sixth terga produced laterally; hind margin of terga angularly produced caudad and with median wart, each successive wart bigger than the preceding; surface of terga not smooth, somewhat verrucose or granulate. Seventh tergum at median length shorter than sixth, narrower basally than apically; posterolateral angles sharply produced, with a long median spinelike projection (fig. 89). Eighth tergum broader than long, quadrangular, caudal angles slightly produced. Ninth tergum short, narrower toward apex; basal half finely corrugate, with a narrow median elevation reaching to middle of segment; apical half roundly swollen (fig. 114). Seventh sternum four-fifths as long as sixth, apical and basal margin shallowly concave, longer medianly than on sides (fig. 70). Hind margin of remaining sterna straight. All sterna finely and transversely corrugate.

Overall body length 22 mm.

The armature of the foreleg is strikingly different from that of the other know species. No other species has the median spine of the hind margin of the seventh tergum so long and well developed.

TYPE: Holotype, female, Portland near Hardwar Gap, Jamaica, West Indies, March 14, 1954, T. H. Farr collector, IJ.

Ghilianella varicornis (Dohrn)

FIGURES 2, 37, 39, 42, 51, 75, 86, 138

E. [*mesa*] *varicornis* Dohrn, 1860, pp. 226–227 (Puerto Rico, female).
Ghilianella varicornis (Dohrn), Bergroth, 1906, p. 317.—McAtee and Malloch, 1925, p. 101.—Barber, 1939, p. 387.

MALE: Head and thorax blackish brown. Head with distinct stramineous median line from interocular depression backward; darker underside. Interantennal spine stramineous. First segment of beak stramineous, second brown with narrow stramineous apical annulus. First antennal segment brown, with eight narrow yellowish annuli, remaining antennal segments brownish. Forelegs dark brown, femur paler and with many yellowish spots above, spines of armature yellowish white and black tipped. Middle femur brownish with many broad and narrow complete and incomplete yellowish annuli; middle tibia dark brown, with five or six broad yellowish annuli; tarsi dark brown. Hind and middle femora similar, conspicuous yellowish annuli irregularly spaced; tibia and tarsi as in middle leg. Abdomen blackish brown, with many yellowish small areas above and below, these spots more concentrated and conspicuous on hypopygium.

Scarce short, appressed, silvery pilosity over body.

Head distinctly granulose. Fourth antennal segment twice as long as third. Interantennal spine, short, straight.

Thoracic segments very sparsely granulate; lengths of segments: 3.5, 2.8, 1.8 mm. Claws of foretarsi two, the inner very short, closely appressed to base of outer. First spine of forefemur at twice its length from tip of trochanter. Basal half of forefumur gradually thickened to first spine. Armature of forefemur with inner row consisting of long setae arising from wartlike bases, with a strong spine before apex.

Abdomen on dorsal aspect practically parallel sided from apex of third segment to seventh. Apical angles of terga very slightly produced, hind margin of terga with small blackish wart, wart on sixth larger. Hind margin of sixth tergum medianly produced caudad. Seventh tergum slightly shorter than sixth, not surpassing claspers, with constriction beginning at middle; constriction shorter than basal half, transversely corrugated on apical half, medianly ridged (fig. 37). Hind margins of second to fifth sterna straight; of sixth shallowly concave; of seventh deeply concave; of eighth very shallowly concave (fig. 75). Sixth sternum twice as long as seventh. Eighth sternum visible its entire width. Hypopygium opening upward; exposed part of clasper on lateral aspect short, longer than wide, apex sharp, pointing cephalad and rising above upper margin of clasper; with a shallow lateral longitudinal furrow (figs. 2, 39). Upper lateral margin of hypopygium stepped; apical process of hypopygium short, vertical, not receding from caudal margin, relatively broad, with a deep V-shaped apical notch (fig. 42).

Overall body length 23–24 mm.

The striking appearance of the apical process of the hypopygium easily separates the males of this species from all the others. Only *borincana* has a somewhat similar process. The similarity of the length of the thoracic segments to those of the female has been used to associate the sexes. Figures 51, 86, and 138 show three aspects of the end of the abdomen of the female of this species. The ninth tergum in profile can be as in figure 2 or straight to the apex.

TYPES: Hypotype, male, Mayagüez, Puerto Rico, September 29, 1947, collector J. A. Aguiló, USNM 63088. Parahypotypes, three males, same locality and date. Additional females studied and identified: three females, Ponce, Puerto Rico, collected from a mosquito animal bait trap, March 1948, collector J. Maldonado-Capriles; three females, two from Mayagüez, Puerto Rico, and one from Aguadilla; all in the collection of the College of Agriculture and Mechanical Arts, Mayagüez, Puerto Rico.

Additional Material Examined

***Ghilianella aliena* McAtee and Malloch**

Ghilianella aliena McAtee and Malloch, 1925, p. 106.

Figure 117 is of the female holotype in the Paris Museum.

***Ghilianella alterata* McAtee and Malloch**

Ghilianella alterata McAtee and Malloch, 1925, pp. 107–108.

Figure 116 is of the female holotype in MNHN. The first spine of the forefemur is distant three times its length from the tip of the trochanter.

***Ghilianella (Ploeodonyx) amicula* McAtee and Malloch**

Ghilianella (Ploeodonyx) amicula McAtee and Malloch, 1925, pp. 127–128.

Figure 112 is of the female holotype in MNHN. This species is very close to *insidiatrix*. Besides the characters given in the key and by the authors to separate these two species, it can be added that the abdomen of *amicula* is widest at the end of the sixth tergum. Material examined: one ♀, Marowyne River, September 1939, in the collection of PW.

***Ghilianella angulata* (Uhler)**

Ghilianella angulata Uhler, 1893, pp. 717–718.

Figure 113 is of a female deposited in USNM, from Balthazar, windward side, Grenada, West Indies. On page 129 of their revision, McAtee and Malloch mention that this female may well be a distinct species from the true *angulata* of St. Vincent.

***Ghilianella annectens* McAtee and Malloch**

Ghilianella annectens McAtee and Malloch, 1925, pp. 125–126.

Figures 95 and 142 are of the following material examined: two ♀. Barro Colorado Island, Panama, January 1934, Zetek collector, in USNM. One ♀, July 1938, Williams collector, in CNHM.

***Ghilianella approximata* McAtee and Malloch**

Ghilianella approximata McAtee and Malloch, 1925, p. 117.

Figures 12, 45, 58, 99, and 129 are of male and female paratypes in USNM. Additional material examined: 13 specimens all from Peru: one ♀ and one ♂, Valle Chanchamayo, 800 meters elevation, January 1939, Weyrauch collector; one ♀, Tingo María, December 1946, Kuschel collector; two ♂, Tingo María, 1,670 meters elevation, November 1947, Weyrauch collector; all in PW's collection. Three ♂, Tingo María, 2,200 ft. elevation, Pallister collector (Johnson donor), in AMNH. One ♂, from Río Pachitea, 1923, Standinger and Bang Haas collectors, in MUM. One ♀, Puerto Inca, Río Pachitea, Bloete collector, in PW collection. One ♀, 1,000 meters elevation, May 1906, Iconnicoff collector, in USNM. One ♂, Río Ucayali, November 1923, Bassler collector; one ♀, Pucalpa Loreto 660 ft. elevation, November 1946, Pallister collector; one ♀, Madre de Dios, Garlepp collector, all in AMNH.

Ghilianella aracataca McAtee and Malloch

Ghilianella aracataca McAtee and Malloch, 1925, pp. 112–113.

Figures 5, 30, 62, 106, 134 are of the following material examined: five ♂, and nine ♀, from Río Frío, Colombia, one ♂, collected by G. Salt, the rest labeled W. L. McAtee collection, 1942, all in USNM.

Ghilianella assanutrix Bergroth

Ghilianella assanutrix Bergroth, 1906, pp. 314–315.

Figures 104 and 118 are of CAS specimens. Additional material examined: one ♂, from Yaracey, Venezuela, determined by McAtee and Malloch, February 1920, J. and E. B. Williamson collectors, in MUM. Four ♀, San Esteban, Venezuela, April 1940, Anduze collector, in CAS.

Ghilianella bethei Dohrn

Ghilianella bethei Dohrn, 1863, pp. 68–70.

Figures 97 and 146 are of a specimen deposited in CM and determined by McAtee and Malloch. Additional material examined: one ♀, Costa Rica, Reinoser collector, deposited in the VM.

Ghilianella colona McAtee and Malloch

Ghilianella colona McAtee and Malloch, 1925, p. 112.

Figure 20 is of the male holotype in CM. Additional material examined: one ♂, Tela, Lancetilla Creek, Honduras, March 1923, Hubbell collector, in MUM.

Ghilianella cuneata McAtee and Malloch

Ghilianella cuneata McAtee and Malloch, 1925, pp. 113–114.

Figures 57 and 131 are of a female paratype in USNM.

Ghilianella filiventris Spinola

Ghilianella filiventris Spinola, 1850, p. 103.

Material examined: Brazil: three ♂, from Santarem, July 1927, Zerny collector, in VM. One ♂, Pará, June 1944, PW collection. Two ♀, Santarem, June 1919, Klages collector, USNM 6324. One ♀, Pará, Fordlandia, June 1931, Shannon collector, in USNM. Also one ♂, from Cumbase, Peru, in USNM.

Ghilianella galapagensis Heideman

Ghilianella galapagensis Heideman, 1901, pp. 367–368.

Figures 55 and 115 are of the female holotype in the USNM.

Ghilianella glabrata McAtee and Malloch

Ghilianella glabrata McAtee and Malloch, 1925, p. 128.

Figures 54 and 130 are of the female holotype in the USNM.

Ghilianella gladiator McAtee and Malloch

Ghilianella gladiator McAtee and Malloch, 1925, p. 115.

Figures 96 and 137 are of a female paratype in the USNM. Additional material examined: one ♀ examined, Trinidad, 1939, Mann collector, in USNM.

Ghilianella globulata McAtee and Malloch

Ghilianella globulata McAtee and Malloch, 1925, pp. 118–119.

Figures 98 and 136 are of a female paratype in the USNM. Additional material examined: three ♂ and three ♀, from Honduras, six different localities, collected by Hubbel, in MUM. One ♂, Honduras, San Antonio, June 1931, White collector, in PW. One ♀, intercepted in New Orleans in bananas from Mexico, July 1936, in USNM. One ♀, Yurimaguas, Peru, June 1930, Parish collector, in USNM. One ♀, Iquitos, Peru, February 1920, Parish collector, in USNM. Two ♀, Guatemala, intercepted one each in New Orleans and Mobile, 1936, in USNM. One ♂, St. Thomas Izabel, Guatemala, April 1934, Mandel collector, in author's collection.

Ghilianella ica McAtee and Malloch

Ghilianella ica McAtee and Malloch, 1925, p. 111.

Figure 41 is of the male holotype in MNHN.

Ghilianella ignorata Dohrn

Ghilianella ignorata Dohrn, 1860, pp. 238–239.

Material examined: one ♂, from Gamboa, Panama, Canal Zone, May 1937, Bliss collector, in author's collection, from PW. One ♂ from Nueva Granada, collected and determined by Signoret, in USNM.

Ghilianella insidiatrix Bergroth

Ghilianella insidiatrix Bergroth, 1922, pp. 219–220.

Figures 7, 35, and 74 are of a male determined by Wygodzinsky, from Paramaribo, Brazil, Leiskes collector, May 1938, in PW. Additional material examined: two ♂, Trindad, Cedros, October 1921, Busk collector, in USNM. One ♂, from Trindad, Caparo, Klages collector, in USNM. One ♀, determined as *longipes* by Signoret, in author's collection.

Ghilianella maculata McAtee and Malloch

Ghilianella maculata McAtee and Malloch, 1925, p. 108.

Figures 18 and 44 are of the male holotype in the USNM.

Ghilianella mariae Wygodzinsky

Ghilianella mariae Wygodzinsky, 1953, pp. 292–295.

Material examined: two ♀ from Peru in USNM.

Ghilianella minimula McAtee and Malloch

Ghilianella minimula McAtee and Malloch, 1925, p. 105.

Figures 10 and 135 are of the type material in CM. This species appears to be fairly common; 14 ♂ and 12 ♀ from PW collection and 2 ♀ from USNM were examined. All the specimens have different localities in Brazil. The projection of the posterior angle of the hypopygium is moderately developed, parallel sided, and with a shallow apical depression.

Ghilianella patruela McAtee and Malloch

Ghilianella patruela McAtee and Malloch, 1925, p. 119.

Material examined: two ♂, Nicaragua, in AMNH. Figure 27 is of one of these specimens. They differ from McAtee and Malloch's description in that the posterior margin of the hypopygium is not so markedly bisinuate, and the seventh sternum is shorter on the margins than medianly.

Ghilianella pendula McAtee and Malloch

Ghilianella pendula McAtee and Malloch, 1925, pp. 116–117.

Figures 49 and 133 are of a female paratype in the USNM.

Ghilianella personata McAtee and Malloch

Ghilianella personata McAtee and Malloch, 1925, pp. 108–109.

Figures 8 and 145 respectively are of a male paratype and the female allotype in CM.

Ghilianella productilis, Barber

Ghilianella productilis Barber, 1914, pp. 502–503.

Figures 22, 68, 105, 132 are of specimens identified by Barber and deposited in the USNM. Additional material examined: two ♂, from Nassau, Bahamas, in AMNH. One ♂ and one ♀, Big Pine, Florida, Barber collector; one ♂, Soledad, Cuba, Myers collector, in MCZ. One ♂, from Vinales, Cuba, August 1931, Vaurie collector, in AMNH. One ♂, Florida, 1920, Parrish collector, in USNM. One female from Haiti in USNM runs to this species in the key, but additional material should prove it to be a different species.

Ghilianella recondita McAtee and Malloch

Ghilianella recondita McAtee and Malloch, 1925, pp. 119–120.

Material examined: one ♂, from San José de Guilla, Venezuela, Vogl collector, in CNHM.

Ghilianella simillima McAtee and Malloch

Ghilianella simillima McAtee and Malloch, 1925, p. 102.

Figure 11 is of the male holotype in MNHN. Additional material examined: two ♂, Agua Azul, Lake Yojoa, Honduras, August 1948, Hubbell collector, in MUM. One ♂, Aguan River Valley, Malon Farm, Honduras, April 1923, Hubbel collector, determined by McAtee and Malloch, in MUM. One ♂, Sierra de los Organos, Cuba, May 1946, Acuña, USNM.

Ghilianella stipitata McAtee and Malloch

Ghilianella stipitata McAtee and Malloch, 1925, p. 116.

Figure 119 is of the female holotype in MNHN. The head and thoracic segments are granulose; the first spine of the forefemur is four times its length from the tip of the trochanter; the connexivium is lighter than the remaining parts of the terga.

Ghilianella subglobulata McAtee and Malloch

Ghilianella subglobulata McAtee and Malloch, 1925, pp. 121–122.

Figures 19, 43, 109, and 125 are of the holotype and allotype in MNHN. Additional material examined: one ♂, from Patanemo, Venezuela, March 1940, Anduze collector, in CAS.

Ghilianella succinta McAtee and Malloch

Ghilianella succinta McAtee and Malloch, 1925, p. 105.

Figures 65, 110, and 144 are of the female holotype in CM.

Ghilianella uncinata McAtee and Malloch

Ghilianella unicnata McAtee and Malloch, 1925, p. 122.

Material examined: two ♂, Panama, February 1936, Gertsch collector, in AMNH. One ♂, Panama, April 1929, Zetek collector, in USNM. One ♂, Barro Colorado Island, Panama Canal Zone, January 1947, Krauss collector, in USNM. One ♂, Barro Colorado Island, Panama Canal Zone, July 1924, in PW.

Previously Described Species Not Included in the Keys

Ghilianella analis (Dohrn)

Emesa analis Dohrn, 1860, pp. 229–230, fig. 5 (Surinam).
Ghilianella analis (Dohrn), McAtee and Malloch, 1925, p. 96.

This species runs to couplet 25 of the key to the males, as Dohrn's illustration shows that the hypopygium is not inflated. This condition places it close to *ica* and *pachitea*. The seventh tergum of these two species scarcely surpasses the hypopygium while in *analis*, the seventh tergum seems to surpass the claspers by twice their length.

Ghilianella angulata (Uhler)

Emesa angulata Uhler, 1893, pp. 717–718.
Ghilianella angulata (Uhler), McAtee and Malloch, 1925, pp. 128–129.

This species was not included in the key to females because one female deposited in USNM described as this species by McAtee and Malloch may well be another species. The specimen runs to couplet 29 of the key. These characters place it close to *insidiatrix* and *amicula*. Since these two species belong to the subgenus *Ploeodonyx*, they can be easily separated from *angulata*, which is in subgenus *Lissonyx*.

Ghilianella annulata (Dohrn)

Emesa annulata Dohrn, 1863, pp. 65–66 (South America ?).
Ghilianella annulata (Dohrn), McAtee and Malloch, 1925, p. 96.

McAtee and Malloch state: "Closely related to *analis*, 'last dorsal segment scarcely petiolate'. This indicates that the species is to be compared with *aracataca* and may possibly be identical."

Ghilianella gerstaeckeri (Dohrn)

Emesa gerstaeckeri Dohrn, 1860, pp. 223–224 (Haiti).
Ghilianella gerstaeckeri (Dohrn), McAtee and Malloch, 1925, p. 97.

McAtee and Malloch state: "The present species is said to have the sixth (that is seventh) segment bispinose apically."

Ghilianella granulata Champion

Ghilianella granulata Champion, 1898, pp. 171–172, pl. 10., fig. 19 (British Honduras).

As the terminal segments of the type are missing, this species is therefore unidentifiable.

Ghilianella imbecilla (Dohrn)

Emesa imbecilla Dohrn, 1860, pp. 228–229 (Para).
Ghilianella imbecilla (Dohrn), McAtee and Malloch, 1925, p. 97.

According to McAtee and Malloch, this species may not be identifiable. "Mid and hind femora each with three pale rings; described from a specimen with collapsed abdomen."

Ghilianella servillei (Spinola)

Emesa servillei Spinola, 1837, pp. 90–95.
Ghilianella servillei (Spinola), Wygodzinsky, 1949, p. 29.

According to Wygodzinsky, this species belongs to *Ghilianella*. The male described by Spinola is insufficiently characterized to be run in the key. The prothorax is the longest thoracic region, and the abdomen is parallel sided.

Ghilianella spinolae Dohrn

Ghilianella spinolae Dohrn, 1860, p. 238 (Amazon River).

According to McAtee and Malloch (1925, p. 97): "Abdominal segments 1–3 yellow and longer even than in *filiventris* indicates a species distinct from any here described."

Bibliography

Barber, H. G.
1914. Insects of Florida, II Hemiptera. Bull. Amer. Mus. Nat. Hist., vol. 33, pp. 485–535.
1939. Scientific survey of Puerto Rico and the Virgin Islands. New York Acad. Sci. Bull., vol. 14, No. 3, pp. 264–441, 36 figs.
Bergroth, E.
1906. Zur Kenntnis der Ploeariinen. Verh. Zool. Bot. Ges. Wien, vol. 56, pp. 305–321.
1911. New neotropical Ploeariinae. Psyche, vol. 18, pp. 15–20.
1922. Two new American Ploeariinae (Hemiptera, Reduviidae). Konowia, Wien, vol. 1, pp. 218–220.
Brindley Haviland, M. D.
1931. The Reduviidae of Kartabo, Bartica District, British Guiana. Zoologica, vol. 7, pp. 129–154, 2 pls.
Champion, G. C.
1897–1901. Insecta. Rhynchota. Hemiptera-Heteroptera, vol. 2, *in* Biologia Centrali Americana. London, xvi+416 pp., 22 pls.

DOHRN, A.
1860. Beitrage zu einer monographischen Bearbeitung der Familie der Emesina. Linnaea Ent., vol. 14, pp. 206–255, 1 pl.
1863. Beitrage zu einer monographischen Bearbeitung der Familie der Emesinae (Zweites Stueck) & Nachtrage. Linnaea Ent., vol. 15, pp. 42–76.
FRIZZELL, D. L.
1933. Terminology of types. Amer. Midl. Nat., vol. 14, No. 6, pp. 637–668.
HEIDEMANN, O. H.
1901. Papers from the Hopkins Stanford Galapagos Expedition, 1898–1899. I. Entomological results (1): Hemiptera. Proc. Washington Acad. Sci., vol. 3, pp. 363–370.
MALDONADO-CAPRILES, J.
1953. Five new Neotropical species of *Ghilianella* (Hemiptera, Reduviidae). Proc. Ent. Soc. Washington, vol. 55, No. 4, pp. 189–195, 18 figs.
MCATEE, W. L., and MALLOCH, J. R.
1925. Revision of the American bugs of the reduviid subfamily Ploiariinae. Proc. U.S. Nat. Mus., vol. 67, No. 1, pp. 1–152, 9 pls.
SPINOLA, M.
1837. Essai sur les genres d'insectes appartenant à l'ordre des hémiptères, Lin. ou Rhyngotes, Fab., et à la section des Hétéroptères, Dufur. Gênes, 383 pages.
1850. Tavola sinottica dei generi spettanti alla classe degli insetti arthrodignati Hemiptera Linn., Latr., Rhyngota Fabr., Rhynchota Burm. Modena, 138 pages.
TOLEDO PIZA, S., DE
1939. Dois novos ploiariideos do Brasil (Hemiptera). Rev. Ent. Rio de Janeiro, vol. 10, No. 3, pp. 619–622, 8 figs.
UHLER, P. R.
1893. A list of the Hemiptera-Heteroptera collected in the island of St. Vincent by Mr. Herbert H. Smith; with descriptions of new genera and species. Proc. Zool. Soc. London, pp. 705–719.
WYGODZINSKY, PETR
1948. Sôbre alguns Reduviidae da região Amazônica (Hemiptera). Rev. Ent. Rio de Janeiro, vol. 19, No. 3, pp. 557–564, 17 figs.
1949. Elenco sistemático de los reduviiformes americanos. Instituto Med. Regional, Univ. Nacional de Tucumán, Monografia No. 1.
1951. Sôbre algumas especies do gênero "Ghilianella" Spinola 1850 (Emesinae, Reduviidae, Hemiptera). Rev. Brasileira Biol., vol. 11, No. 2, pp. 223–226, 18 figs.
1953. Apuntes sobre Emesinae Americanas (Reduviidae, Hemiptera). Acta Zool. Lilloana, vol. 14, pp. 281–315, 73 figs.

U.S. GOVERNMENT PRINTING OFFICE: 1960

Proceedings of
the United States
National Museum

SMITHSONIAN INSTITUTION • WASHINGTON, D.C.

Volume 112 1960 Number 3441

WELCOME MOUND AND THE EFFIGY PIPES OF THE ADENA PEOPLE

By Frank M. Setzler

The expansion of the Columbia-Southern Chemical Corporation's Natrium Plant near New Martinsville, West Virginia, required removing two Adena Indian burial mounds on their property. The first, known as "Natrium Mound" (46Mr–2), was carefully excavated in 1948 by Ralph S. Solecki (Solecki, 1953); the second, "Welcome Mound" (named after the community "Welcome," 46Mr–3), was excavated by me in 1957.

Appreciating the need to preserve a detailed record of the contents of such prehistoric burial sites, Mr. C. E. Wolf, Plant Manager, notified the West Virginia Archeological Society and, through it, the Smithsonian Institution of the impending program of expansion. In addition, the Columbia-Southern Chemical Corporation, a subsidiary of the Pittsburgh Plate Glass Company, in 1948 and again in 1957 provided laborers, heavy and light machinery, and tools. The Smithsonian Institution provided the archeologists.

Adena People

Adena burial mounds are common in the Ohio River Valley region. It was not, however, until 1901 that the first Adena mound was excavated for historical purposes by William C. Mills of the Ohio State Museum (Mills, 1902). This mound was on the estate of Thomas Worthington (Governor of Ohio, 1814–18) in Ross County, a mile northwest of Chillicothe, Ohio. Governor Worthington gave the name "Adena" (probably from the Hebrew "Adinah") to his acreage on the west side of the Scioto River. Presumably he meant to imply "nothing lacking" or, freely translated, "paradise." The name "Adena" was adopted by archeologists to refer to the prehistoric Indians who built such mounds.

The middle section of the Ohio River flows through narrow, steep-sided valleys with hills rising 600 to 700 feet above the river. Level areas occur at various bends in the river, known as bottoms, one such being Grave Creek where one of the highest mounds in the United States is located, the famous Grave Creek Mound in the center of Moundsville, West Virginia.

The relatively wide, level areas periodically flooded by the Ohio River served as ideal village sites for these prehistoric people. The environment consisted of a river well-stocked with fish and mollusks, and with plenty of fresh water; heavily wooded hills that even now support deer, bear, and many other meat-producing animals; and sites for garden plots that were annually enriched by flood waters. Such an environment was probably an important factor in the transition of a nomadic group to a semisedentary one.

These ecological factors probably enabled a gathering, gardening, and hunting people to plant, cultivate, and store vegetables. They probably also depended on animals, fish, berries, and wild plants to supplement their diet. The large mounds that they built over the bodies of their dead are evidence that they remained in one place for a considerable time. It is not known how long it took them to build Welcome, Natrium, Cresap, or Grave Creek Mounds, which are all within a few miles of each other, for we do not know how many people worked on these mounds or what kinds of implements they used.

The prevalence of Adena mounds along the Ohio River and its tributaries in Kentucky, Ohio, West Virginia, Pennsylvania, and Maryland suggests that this area (fig. 1) became one of the favored locations of these people between 800 B.C. and A.D. 800. Here many family groups apparently found an environment conducive to settle in and built a compact social organization. The mounds that they built probably honored certain deceased members of their tribe and served as protection for their remains.

The bodies were usually interred extended on their backs with personal belongings and ceremonial and political paraphernalia, and were surrounded by log and bark structures. The ceremonial objects buried with the deceased individual were probably regarded as contributing to his welfare in after life.

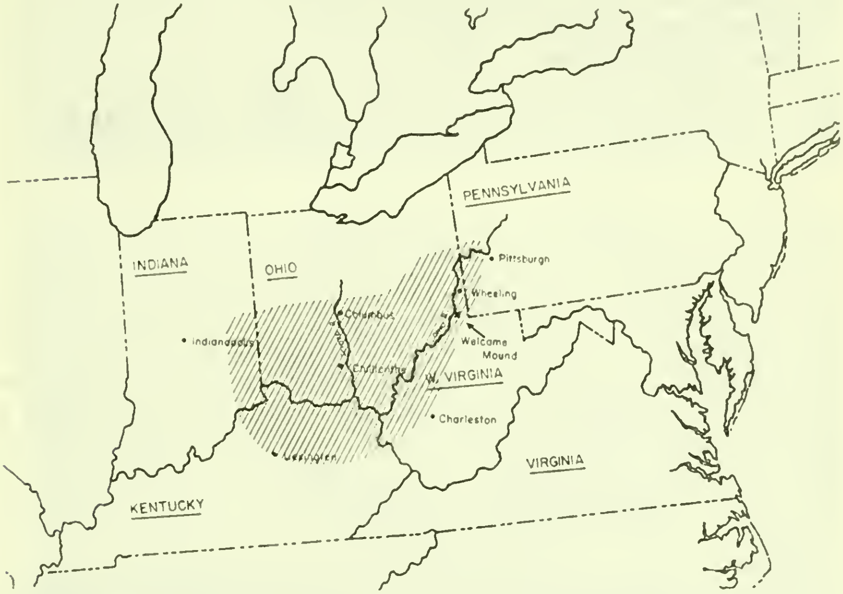


Figure 1—Map showing concentration of Adena sites in the Ohio River Valley region.

Welcome Mound

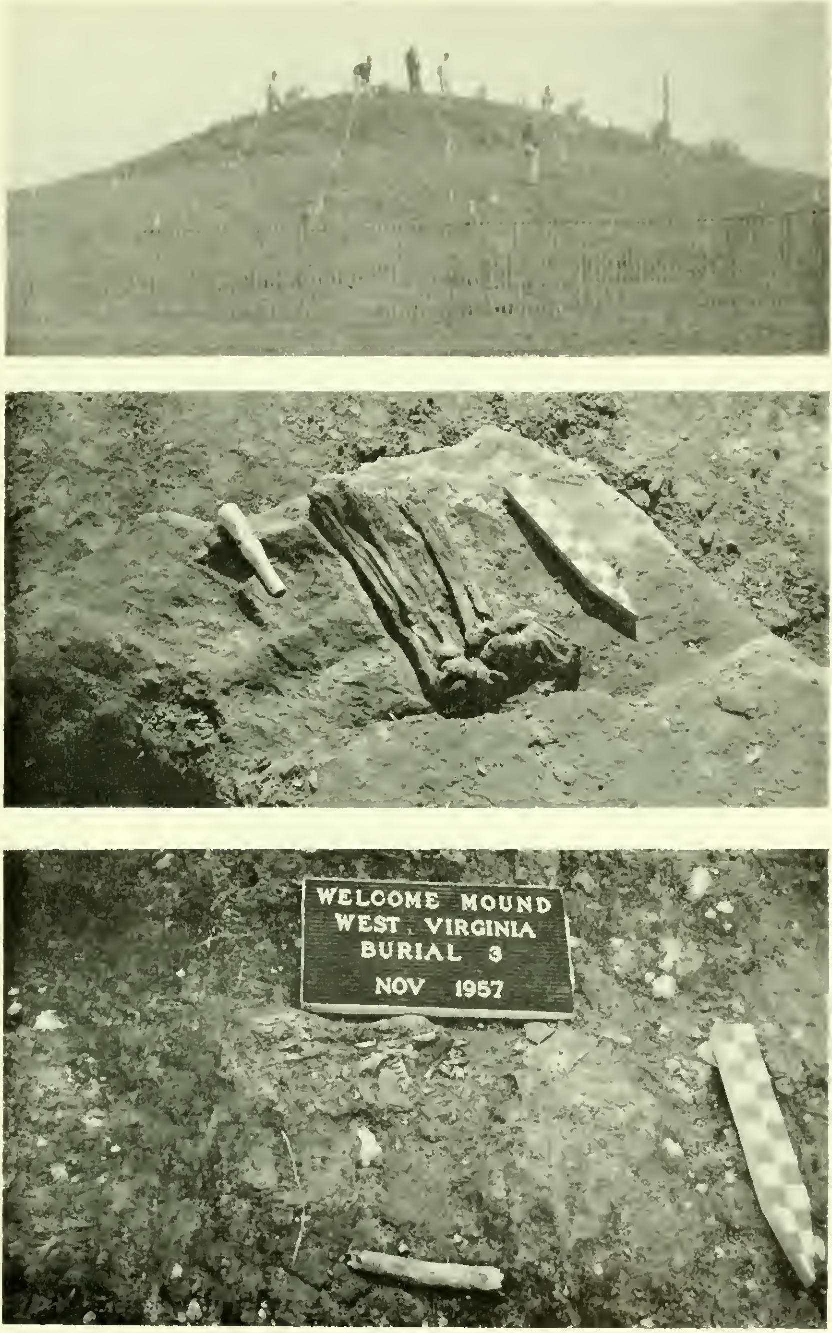
Erecting a tumulus as large as Welcome Mound was a considerable undertaking for these people. It measured about 110 feet in diameter and 14 feet at the highest point (plate 1). The hundreds of tons of dirt were composed of both the thin mantle of topsoil and surrounding humus and a loose gravelly soil, interspersed with water-worn pebbles ranging in size from a marble to elliptical biconvex pebbles 4 to 5 inches across. The composition was comparable to that found in the Natrium Mound, a mile to the south (Solecki, 1953, pp. 327, 382, 390). Such a mixture made it difficult for us to dig with shovels and trowels.

In contrast to some of the other large Adena mounds which contained the remains of many more bodies (Bache and Satterthwaite, 1930; Greenman, 1932; Webb and Snow, 1945; and Webb and Baby, 1957), Welcome Mound contained only three adult human skeletons. Two of the bodies were placed on the base near center. There were no pits or clay-lined tombs beneath the original surface of the ground as were found in the other mounds. The stratum of glacial gravels underlying the base probably discouraged such an operation by people limited to primitive tools of wood or stone. The badly decomposed skeletons were surrounded with the usual channels or molds, caused by decayed logs lying in various directions. Layers of bark and the residue of perishable things lay both beneath and over the skeletons.

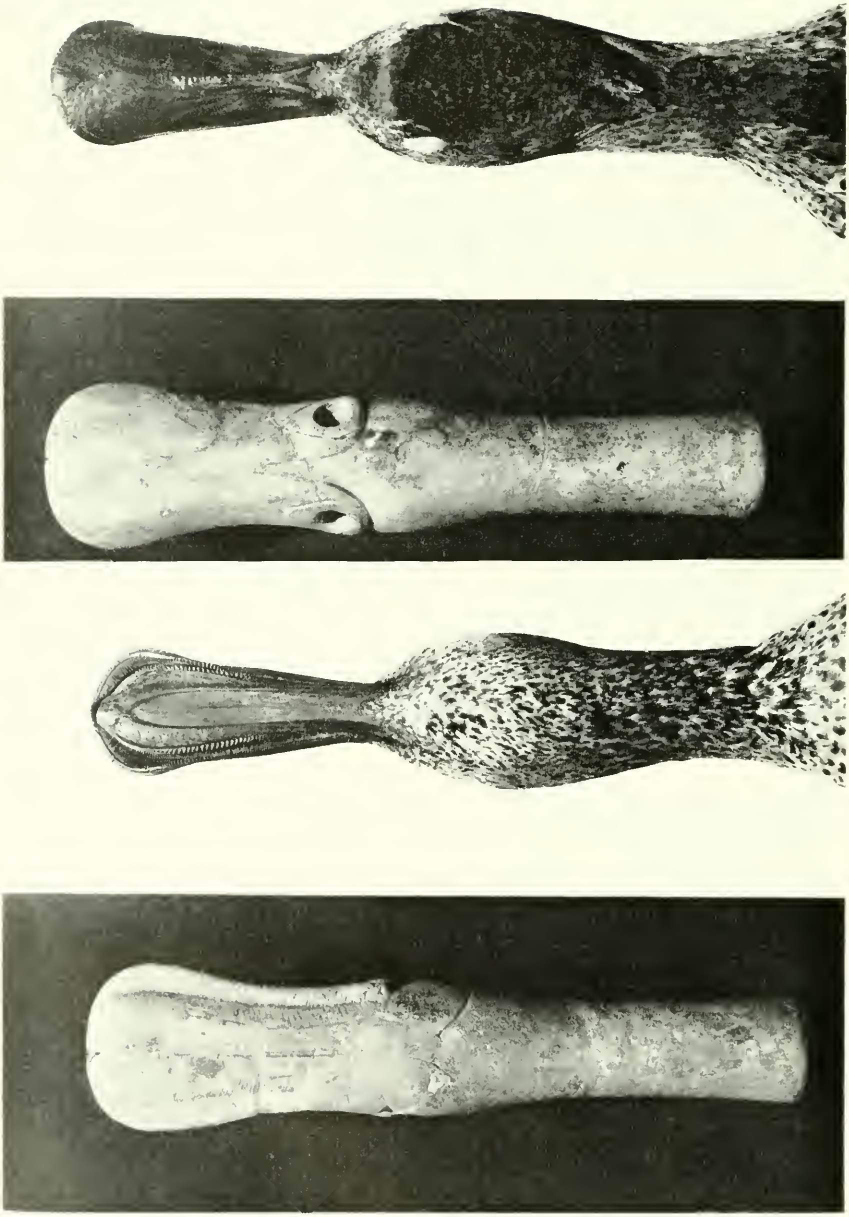
A mass of thick, coarse, grit-tempered potsherds and a handful of fresh-water mollusk shells were found on the same level within a few feet of the skeletons. After much effort to restore these hundreds of sherds, I was able to construct a large (over 1-foot high) barrel-shaped vessel with no neck or constriction and with a flat undecorated rim. The rim is ⁵⁄₁₆ inch thick, and the wall thickens down the side to ⅝ inch near the rounded base. The outside surface, especially near the top, gives the appearance of smoothed-out cord marks. In color, it varies from a dark brownish grey at the top, through a pinkish tinge, to an off-white base. It is tempered with relatively large and coarse water-worn gravelly pebbles. It is not as heavy and crude as earlier Adena Fayette Thick pottery, but is in no way comparable to the decorated pottery of the contemporaneous Hopewell Indians, whose burial mounds are in the same general area. I am inclined to place the pottery somewhere between Early and Middle Adena periods.

In the mouth of skeleton No. 3 was found a large tooth (plate 1), subsequently identified as the canine tooth of the mountain lion, or cougar, *Felis concolor.* The tooth in this position would seem to be of little significance, but this finding must be correlated with a previous discovery. W. S. Webb and R. S. Baby in 1949 (Webb and Baby, 1957, pp. 61–71) found the front portion of the upper jaw of a wolf, cut in the form of a spatula, associated with a human skull in the Ayres Mound near New Liberty, Kentucky. This jaw, together with the six other known associations of bear, cougar, and wolf teeth, establishes an important ceremonial trait among these Adena people. Thanks to the meticulous work of Webb and Baby, we now know that the Adena people had men who served their society in a capacity comparable to that of a shaman, medicine man, or witch doctor.

The mountain lion tooth in the mouth of skeleton No. 3 therefore supports the belief that this skeleton is the remains of an important religious leader. He was probably buried in a costume that included an animal mask. If the bark and other discolorations surrounding



Welcome Mound, remains of skeleton No. 1 and the duck effigy pipe in situ, and remains of skeleton No. 3 and the canine tooth of a mountain lion.



The duck effigy pipe from Welcome Mound compared with the bill, head, and neck of a shoveler duck.

Human effigy pipe from the Adena Mound.

Other Adena pipes: Duck effigy from Englewood Mound, aquatic bird effigy and wolf effigy from Sayler Park Mound, and the more common plain pipe.

this skeleton could be identified, we would have more specific evidence of the paraphernalia and garments—probably the skin of a cougar—worn by this intermediary between his people and the spirit world. Such an individual would be sufficiently important to justify the arduous task of constructing a 14-foot high mound.

Granulated pieces of charcoal found at the base of the mound and in association with burials 2 and 3 were tested for Carbon-14 by Michigan-Memorial Phoenix Project No. 6. Dr. James B. Griffin of the University of Michigan has relayed the results of sample M-903 as 2300 plus or minus 200 years before the present, or about 341 B.C.

Effigy Pipes

The most unusual object recovered during the excavation of Welcome Mound was the straight-tubular, duck-effigy pipe (USNM 417000). One can readily see (plate 2) that the prehistoric sculptor responsible for carving the duck effigy was gifted, as he reproduced almost to scale the head, neck, and bill of a shoveler duck, *Spatula clypeata* (Linnaeus). In using Ohio limestone, he had the advantage of its softness when freshly dug. After it is exposed to the air, it becomes hard and brittle. This peculiarity was noticed when I cleaned the dirt from around the pipe. The bristles of the whisk broom made slight scratches. I had to use a camel's hair brush instead. Several days later the limestone was much harder.

The pipe was found 5 inches from the right knee of skeleton No. 1 (plate 1), 6 feet beneath the crest of the mound and 8 feet directly above burial No. 3 in square N18–W1. The body had been buried in a north-south direction with feet pointing to the north. The bones being articulated indicated that the body was buried in the flesh on its back. It was surrounded by a greenish-grey oily clay, which was enclosed with heavy bark. The acidity of these bark coverings (oak or walnut) seems to have given the bones a reddish cast. On three sides were imprints or molds 18 inches in diameter left by the decomposed logs. The bones of the skeleton are heavy and are judged to be those of a middle-aged male.

The pipe measures 6⅝ inches in length. The tubular end is 1 inch in diameter on the outside, and the diameter of the drilled hole is ⅝ inch. The widest part of the bill is 1½ inches. Near the head back of the eyes, it is 1³⁄₁₆ inches wide. The narrowest part of the bill, directly in front of the eyes is 1³⁄₃₂ inches wide. The ³⁄₁₆ inch opening in the bill or mouthpiece is elliptical. The eye sockets are ⅜ inch in diameter and are 2½ inches from the end of the bill. The underside of the bill clearly suggests the lamellae characteristic of shoveler ducks (plate 2).

The pipe is thus basically tubular in shape and gracefully carved to represent the neck, head, and bill of a shoveler duck. The two countersunk holes, representing eye sockets, could have been filled with a perishable substance to represent the pupils. The relatively flat, expanded bill served as the mouthpiece. The circular bore runs to within ½ inch from the mouthpiece, where the hole is reduced from ⅝ inch to an elliptical opening of 3/16 inch.

Straight tubular effigy pipes have also been found in other Adena mounds. The most famous one is the human effigy pipe, found by Mills in 1901 in the Adena Mound on Governor Worthington's estate near Chillicothe, Ohio. This pipe is reproduced here (plate 3) through the kindness of Raymond S. Baby of the Ohio State Museum. It was carved from multicolored Ohio pipestone also in the form of a straight tube and represents the body of an achondroplastic (chondrodystrophic) dwarf, as is apparent from the short heavy-set muscular torso, stubby arms and legs, enlarged head, and swollen (goiter) neck. This pipe has been regarded by both archeologists and artists as one of the sculptured masterpieces of American Art. Until now, it was the only effigy pipe ever described from an Adena Mound.

Soon after the Welcome Mound pipe was discovered, a cast of a similar duck effigy pipe was located in the Division of Archeology of the Ohio State Museum. The original, now in the Dayton Museum of Natural History, was reported found in loose dirt while the Englewood Mound, near Dayton, Ohio, was being levelled by a bull-dozer during the building of a dam in the early 1930's. The pipe is illustrated here (plate 4) by permission of Mr. E. J. Koestner, Director of the Dayton Museum. The length is 6¼ inches, the diameter of the neck is ⅞ inch, and the widest part of the bill is 1¼ inches. The length from the end of the neck to the center of the eye socket is exactly 4 inches, the same length as the Welcome Mound pipe.

Two effigy pipes were uncovered in the excavation of a mound in Sayler Park, Cincinnati, Ohio, by the Cincinnati Museum of Natural History. One is a well-proportioned clay effigy of an aquatic bird and was found in association with one of the burials. The director of the Cincinnati Museum of Natural History, Mr. Ralph Dury, very kindly sent me photographs of this pipe, as well as of another that represents the head of a wolf. These pipes were excavated under the supervision of Dr. James Kellar and S. Frederick Starr and are reproduced here (plate 4) by permission of Mr. Dury. On the basis of these and other artifacts recovered, we must assume that Sayler Park Mound was also built over the interred bodies of Adena people.

Since straight-tubular effigy pipes were made exclusively by the Adena, they are a diagnostic culture trait of these people. The carving of objects as artistic as these pipes certainly represents an artistic talent beyond that of an ordinary member of a society. To what extent the making of pipes indicates specialized professions, however, is difficult to determine.

The duck effigy pipe from Welcome Mound appears to be related in some way to the person buried beside it and to a mortuary custom of the Adena people. Moreover, it may indicate some religious significance associated with a shoveler duck. The same reverence postulated here for the shoveler duck may be applied to the wolf and unidentified aquatic-bird effigy pipes from Saylor Mound.

The human effigy pipe from Adena Mound could well represent a particular individual. A person possessing the physical and pathological characteristics apparent in the effigy was likely regarded as unique and thereby deified; actual dwarf skeletons have been recovered in Adena mounds.

Among numerous primitive people, the smoking of tobacco or some herb was regarded as sacred or an important part of a ceremonial function. As we know from early European contacts with North American Indians, the smoking of a peace pipe attended all important political as well as religious or ceremonial functions. Possibly these effigy pipes and the more common plain pipe (plate 4) found in the mounds of the Adena represent the origin of such a ceremony. Our only evidence rests with similar forms used by historic Indians and reported by early Spanish, French, and English explorers and missionaries.

Several monographs have been published on this topic, e.g., G. A. West (1934) and H. C. Shetrone (1941). These men not only illustrate various other kinds of pipes, but quote from hundreds of sources describing the variety of uses that were made of the many forms of *Nicotiana*. When we consider the impact that tobacco had upon the countries of the world after 1492, it is understandable that the probable original users of this herb buried pipes—especially such well carved pipes—as offerings to their dead.

Summary

The burial methods, the type of pottery and restored vessel, the date from Carbon-14 tests, the effigy pipe, and the association of an animal tooth in the mouth cavity are sufficient evidence to establish Welcome Mound as an Adena burial site. The wearing of an animal mask indicates that such a person could have served as a shaman and as such would justify the building of Welcome Mound. The effigy pipes indicate a possible religious association between the prehistoric Adena and aquatic birds, animals, and dwarfs, while the artistry shows an advance over the common straight tubes of the earlier, archaic people and those of the Adena.

References

Bache, C., and Satterthwaite, L.

1930. The excavation of an Indian mound at Beech Bottom, West Virginia. Mus. Journ., Univ. Museum, Philadelphia, vol. 21, Nos. 3 and 4, pp. 132–187.

Douglas, L. H., and D'Harnoncourt, R.

1941. Indian art of the United States, The Museum of Modern Art, p. 72.

Dragoo, D. W.

1956. Excavations at the Watson Site, Hancock County, West Virginia, Pennsylvania Arch., vol. 26, No. 2, pp. 59–88.

Fetzer, E. W., and Mayer-Oakes, W. J.

1951. Excavation of an Adena burial mound at the Half-Moon Site. West Virginia Arch., No. 4, pp. 1–25.

Greenman, E. F.

1932. Excavation of the Coon Mound and an analysis of the Adena culture. Ohio Arch. and Hist. Quart., vol. 41, No. 3, pp. 366–523.

Mills, W. C.

1902. Excavations of the Adena Mound. Ohio Arch. and Hist. Quart., vol. 10, Nos. 4, figs. 28–30, pp. 452–479.

Ritchie, W. A., and Dragoo, D. C.

1959. The eastern dispersal of Adena. Amer. Antiquity, vol. 25, No. 1, pp. 43–50.

Setzler, F. M.

1931. The archeology of Randolph County and the Fudge Mound. Indiana Hist. Bull., vol. 9, No. 1, pp. 1–49.

1940. Archeological perspectives in the northern Mississippi Valley, Essays in historical anthropology of North America, Smithsonian Misc. Coll., vol. 100, pp. 253–290.

Shetrone, H. C.

1941. The Mound-Builders, Appleton-Century Co., New York, 508 pp.

Solecki, R. S.

1953. Exploration of an Adena mound at Natrium, West Virginia, Anthro. papers, No. 40, Bur. Amer. Ethnol. Bull. 151, pp. 313–395.

Spaulding, A. C.

1952. The origin of the Adena culture of the Ohio Valley. Southwestern Journ. Anthro., vol. 8, No. 3, pp. 260–268.

Starr, S. F.

1958. Excavation of an Indian mound in Sayler Park. Bull. Hist. Philos. Soc. of Ohio, vol. 16, No. 1, pp. 31–40.

Webb, W. S., and Baby, R. S.

1957. The Adena people No. 2, Ohio Hist. Soc., Columbus, 123 pp.

Webb, W. S., and Snow, C. E.

1945. The Adena people, Report Anthro. and Arch., Univ. Kentucky, vol. 6, pp. 369.

West, G. A.

1934. Tobacco, pipes and smoking customs of the American Indians. Bull. Public Mus., Milwaukee, vol. 17, pt. 1, pp. 1–477; pt. 2, pp. 478–994.

U.S. GOVERNMENT PRINTING OFFICE: 1960

Proceedings of
the United States
National Museum

SMITHSONIAN INSTITUTION • WASHINGTON, D.C.

Volume 112 1960 Number 3442

DESCRIPTIONS OF NEW BATS FROM PANAMA

By Charles O. Handley, Jr.

In its studies of tropical diseases, the Gorgas Memorial Laboratory of Panama is conducting a mammal survey of the Republic. The work in 1959 centered on the headwaters of the Río Pucro, near Cerro Tacarcuna, Province of Darién, eastern Panama.

Among the mammals collected on the Río Pucro were 43 species of bats, all caught in mist nets. Many of these species had not been taken previously in Central America. Three species and one subspecies herein described are new. Either there is a surprising amount of endemism in this region, which is continuous with the Choco of Colombia, or else there are a surprising number of undescribed widespread species of bats in the Neotropical fauna.

The Malaria Control and Survey Branch of the Office of the Chief Surgeon, U.S. Army Caribbean, has also been collecting bats in Panama. Included in its collections are several species not previously taken in the Republic and one of the new subspecies here described.

I am indebted to the personnel of the Gorgas Memorial Laboratory, particularly Carl Johnson, Pedro Galindo, and Rudolpho Hinds for their support and cooperation. Likewise, I thank Robert Altman, Marvin Keenan, and Vernon Tipton of the Malaria Control and Survey Branch for their assistance and for the opportunity to study their collections. I am also grateful to the authorities of the American

Museum of Natural History (AMNH), Academy of Natural Sciences of Philadelphia (ANSP), Chicago Natural History Museum (CNHM), and Harvard University Museum of Comparative Zoology (MCZ) for allowing me to study specimens under their care.

Capitalized color terms in the following descriptions are from Ridgway (Color Standards and Color Nomenclature, 1912). All measurements are in millimeters and are explained in Handley (1959, pp.98–99).

Mimon crenulatum keenani, new subspecies

Holotype: USNM 311951, adult male, skin and skull, collected August 25, 1959, by C. M. Keenan, Fort Gulick, Panama Canal Zone, original number 4127.

Distribution: Central Panama to northwestern Venezuela and western Ecuador. The Panamanian specimen was found in the daytime hanging on the outside of a decayed hollow stump in a sparsely wooded area. The Ecuadorean specimens likewise were taken in a hollow rotted tree stump in a wooded area (Tate, 1931, p. 250).

Description: Dorsum bright mahogany brown (between Carob Brown and Black); individual hairs monocolored from base to tip; prominent yellowish-white median stripe from forehead to base of tail; large prominent yellow-orange spots at posterior bases of ears. Underparts orangish, individual hairs fuscous at base. Membranes and ears blackish. Noseleaf hairy, slightly crenulated at base; wing membranes attached to metatarsus; calcar long. Rostrum relatively long, shallow, and dorsally flattened; sagittal crest relatively low; posterior extension of palate relatively long and broad; molariform teeth broad and massive.

Measurements: See table 1.

Comparisons: Brighter and more ornate than the contiguous races *crenulatum* and *longifolium*. Rostrum longer and slightly deeper, posterior palatal elongation longer and broader, teeth larger, and calcar longer than in *crenulatum*. Rostrum shallower and dorsally flatter than in *longifolium*.

Remarks: The nominal genera *Anthorhina* and *Mimon* are not distinguishable even as subgenera. The bats of *Anthorhina* differ from those of *Mimon* principally in having a smaller anterior upper premolar (P^1); shorter lower incisor; larger auditory bulla; stouter zygomatic arch; shorter, less woolly fur; smaller ears; and hairy noseleaf.

It is doubtful that either of the nominal genera contains more than a single species. Dalquest (1957, p. 45) cleared up some of the confusion surrounding the supposed species *M. bennettii* and *cozumelae*, presently known only by a few specimens from Brazil and Mexico, respectively. Dalquest failed, however, to note that his only specimen of *bennettii* was a juvenile, and that he distinguished it from his

TABLE 1.—*Measurements of* Mimon crenulatum.

Species and locality	Sex	Specimens	Total length	Tail vertebrae	Hind foot	Ear from notch	Forearm	Tibia	Calcar	Greatest length	Zygomatic breadth	Interorbital breadth	Braincase breadth	Braincase depth	Maxillary tooth row length	Postpalatal length	Palatal breadth outside of M^3	Rostral breadth behind canine
M. crenulatum, Santarém, Brazil	♂	MCZ 30285	79	24	13	------	48. 2	------	22. 0	21. 5	12. 2	4. 2	8. 7	7. 3	7. 7	8. 0	8. 4	5. 3
M. crenulatum, Santarém, Brazil	♀	MCZ 30284	85	23	12	------	49. 1	------	24. 0	21. 6	12. 1	4. 1	8. 6	7. 5	7. 8	7. 6	8. 4	5. 1
M. crenulatum, Port-of-Spain, Trinidad	♀	AMNH 175586	------	------	12	24	50. 1	19. 7	20. 4	20. 9	11. 7	4. 4	8. 2	7. 4	7. 8	7. 4	8. 0	5. 4
M. keenani, Rio Tocuyo, Venezuela	♂	AMNH 130687	82	24	12	------	49. 9	20. 1	18. 6	21. 8	12. 5	4. 0	8. 4	7. 4	7. 7	7. 5	8. 2	5. 2
M. keenani, Río Tocuyo, Venezuela	♀	AMNH 130688	78	24	11	------	50. 3	20. 3	18. 0	21. 1	11. 9	4. 3	8. 3	7. 7	7. 5	6. 9	8. 1	5. 1
M. keenani, (holotype) Fort Gulick, Panama Canal Zone.	♂	USNM 311951	------	------	12	24	51. 9	20. 9	25. 3	21. 9	12. 5	4. 3	8. 6	7. 6	8. 3	7. 4	9. 0	5. 3
M. keenani, Bahía de Caráquez, Ecuador	♂	AMNH 64541	82	23	12	------	50. 8	21. 2	21. 8	22. 2	12. 0	4. 1	8. 5	7. 5	7. 9	7. 5	8. 3	5. 3
M. longifolium, Santo Antonio, Brazil	♂	AMNH 92223	80	22	13	------	50. 1	------	24. 7	21. 4	12. 2	4. 3	8. 4	7. 7	7. 9	7. 8	8. 7	5. 2
M. longifolium, Santo Antonio, Brazil	♀	AMNH 92224	82	24	12	------	48. 9	------	23. 0	21. 3	12. 1	4. 0	8. 1	7. 4	8. 0	7. 3	8. 4	5. 3

adult *cozumelae* on the basis of its juvenile characters—smaller size; darker, less ornate coloration; and bulging braincase. Apparently *bennettii* and *cozumelae* are very similar, but until adult specimens of each are compared, their true relationship cannot be determined.

Four species have been named in *Anthorhina*, but all seem to have been based on distortions of preservation or individual, seasonal, or geographic variations of a single species. Crenulation and hairiness of the noseleaf are individually variable throughout. The wings apparently are always inserted on the distal portion of the metatarsus, but this feature may be obscured by labels tied to the ankle. The calcar varies individually and geographically, and often is difficult to measure accurately in preserved specimens. Coloration varies with age and season, as well as geographically. Coloration of the fresh adult pelage approximates black and white, but with age these colors became progressively obscured with yellow, orange, and reddish. Juveniles are duller, blacker, and have less prominent markings than adults. Crowding of the maxillary tooth row is individually variable. Size of the ears in dried specimens depends to some extent on the conditions of drying.

The genus *Mimon* includes the following:

Mimon bennettii Gray: Type locality Ipanema, São Paulo, Brazil; and *Mimon cozumelae* Goldman: Type locality Cozumel Island, Quintana Roo, Mexico. DIAGNOSIS: Body size large (forearm averages 55 mm.); coloration pale brownish, unmarked except for whitish postauricular patches; fur long and woolly; ears very large; noseleaf plain, naked; anterior upper premolar (P^1) about equal to inner upper incisor (I^1) in size; lower incisor longer than wide; auditory bullae small; zygomata fragile. SPECIMENS EXAMINED: *M. bennettii*: Brazil: Ipanema, São Paulo, 1, USNM. *M. cozumelae:* Mexico: Cozumel Island, Quintana Roo, 1, MCZ, 2 including type of *cozumelae*, USNM; Izamel, Yucatan, 2, USNM.

Mimon crenulatum crenulatum E. Geoffroy St. Hilaire: Type locality, Brazil.[1] DIAGNOSIS: body size small (forearm averages 50 mm.); dorsal coloration blackish-brown, marked with whitish postauricular patch and median dorsal stripe, both varying from fairly prominent to obscure; fur medium-long, lax; underparts whitish to rusty, bases of hairs grayish; ears large; noseleaf more or less crenulated on margins toward the base, fringed with long hairs; P^1 about equal to I^2 in size; lower incisor as wide as long; auditory bullae large; zygomata stout; rostrum

---

[1] Cabrera (1958, p. 66) further restricted the type locality to Bahia, but in view of the uncertainty of the distribution of variation in the species in eastern Brazil, the restriction appears premature and perhaps detrimental. Present indications are that the subspecies *crenulatum* occurs at least from eastern Venezuela and Trinidad to the lower Amazon.

relatively short, shallow, and posteriorly narrowed; posterior palatal extension short and narrow; sagittal crest relatively low; molariform teeth relatively small. SPECIMENS EXAMINED: Brazil: Santarém, Rio Tapajoz, 4, MCZ. Trinidad: Port-of-Spain, 1, AMNH.

Mimon crenulatum keenani Handley: Type locality, Fort Gulick, Panama Canal Zone. DIAGNOSIS: see description and comparisons above. Specimens from Río Tocuyo, Venezuela, show intergradation with *crenulatum*. These are as ornate as typical *keenani*, but are duller and have gray ventral hair bases. In shape of rostrum and shortness of calcar, they approach *crenulatum*. Specimens from Bahía de Caráquez, Ecuador, seem to show intergradation with *longifolium*. Colorwise they are close to *keenani*, but are slightly duller and have gray based ventral hairs. Skull is most like that of *longifolium*. SPECIMENS EXAMINED: Ecuador: Bahía de Caráquez, 5, AMNH. Panama Canal Zone: Fort Gulick, 1, USNM. Venezuela: Río Tocuyo, 500 meters, 16, AMNH.

Mimon crenulatum longifolium Wagner: Type locality, Villa Maria, Mato Grosso, Brazil (*peruanum* Thomas, type locality Río Pachitea, Huanuco, Peru, is a synonym). DIAGNOSIS: This is the least ornate subspecies. Dorsal coloration dull blackish brown; ventral hairs gray based; postauricular patches and median dorsal stripe usually reduced, often obscure, and occasionally absent; rostrum relatively long, deep, and not dorsally flattened; sagittal crest high; calcar long. SPECIMENS EXAMINED: Brazil: Cacao Pereira Igarapé, Rio Negro, 3, AMNH; Santo Antonio da Uayará, Rio Madeira, 4, AMNH. Colombia: Tahuapunto, Río Vaupes, 8, AMNH. Ecuador: Boca de Río Curaray, 1, AMNH. Peru: Montealegre ?, 2, AMNH. Venezuela: Mount Duida, 350 meters, 1, AMNH. No exact locality, 1, USNM.

Mimon crenulatum picatum Thomas: Type locality, Lamarão, 300 meters, Bahia, Brazil. DIAGNOSIS: Apparently similar to *crenulatum* in length of calcar and rostrum, but may be brighter and more ornate in coloration. *M. c. picatum* may be a synonym of *crenulatum*, or it may represent a bright-colored southeastern population. It is known only by Thomas' type specimen.

Anoura cultrata, new species

HOLOTYPE: USNM 309396, adult female, skin and skull, collected February 7, 1959, by Charles O. Handley, Jr., and B. R. Feinstein, Tacarcuna Village, 3,200 ft., Río Pucro, Darién, Panama, original number 4747.

DISTRIBUTION: Known only from the type locality, where in February and March 1959 eight specimens were caught in mist nets set over a stream in a mountain forest.

Description: Coloration shiny blackish (between Blackish Brown-3 and Black) throughout; individual hairs of dorsum pale grayish on basal two-thirds, those of underparts black to base. Pelage short and crisp; interfemoral membrane reduced to a narrow, densely furred band; tail present. Skull most like that of *Anoura geoffroyi*, but differing as follows: larger; braincase more tapering anteriorly; rostrum thickened; zygomata complete; posterior margin of palate more deeply incised beside posterior palatal extension; pterygoids inflated posteriorly so as to narrow the elongated mesopterygoid fossa. Symphysial region of mandibles shortened and trough between canines deepened and broadened (anterior end of mandible correspondingly depressed); coronoid process reduced in height; ventral edge of mandible with a low process just anterior to the angular process. Outer upper incisor (I^2) enlarged, bladelike; upper canine enlarged, roughly triangular in cross-section at base, with distinct anterointernal, anteroexternal, and posterior basal cusps; internal face anteroposteriorly concave, and anterior face flat, with prominent longitudinal sulcus from base of crown to near tip; P^3 and P^4 reduced in height and thickness and in prominence of cusps; M^2 and M^3 reduced in size; lower canine reduced in height, with distinct cingulum on anterior and internal faces, and with a posterointernal cingular cusp; anterior lower premolar (P_1) bladelike and enormously enlarged (lengthened and thickened), with its highest point in the posterior half of the tooth; P_3 and P_4 reduced in height and thickness and in prominence of cusps.

Measurements (holotype): Total length 94, tail vertebrae 6, hind foot 14, ear from notch 16, forearm 43.2, tibia 15.9, calcar 3.8. Greatest length of skull 26.3, zygomatic breadth 10.7, interorbital breadth 4.7, braincase breadth 10.3, braincase depth 8.0, maxillary tooth row length 9.0, postpalatal length 9.4, palate breadth outside of M^3 5.7, rostral breadth at base of canines 4.7.

Comparisons: Probably the closest relative of *cultrata* is *Anoura geoffroyi*, but as indicated in the description above it is strongly differentiated from this species in many characters.

Specimens examined: Panama: Tacarcuna Village, 3,200 ft., Río Pucro, Darién, 8, USNM.

Chiroderma gorgasi, new species

Holotype: USNM 309903, adult male (testis 6 x 3 mm.), skin and skull, collected March 6, 1959, by Charles O. Handley, Jr., and B. R. Feinstein, Tacarcuna Village, 3,200 ft., Río Pucro, Darién, Panama, original number 5436.

Distribution: Known only from the type locality in eastern Panama, where five individuals were caught in February and March 1959 in mist nets set over a stream in a mountain forest.

Description: Body size small (forearm 37.5–38.5 mm., greatest length of skull 20.2–20.9 mm.). Dorsal coloration yellowish brown, brown (between Sudan Brown and Prout's Brown in holotype), or grayish, paler anteriorly; a white median stripe extends from upper back to base of tail; prominent white stripes above and below eye, extending from noseleaf to crown at inner base of ear and from posterior part of upper lip to outer base of ear; area about eye a little darker than remainder of body; individual hairs of dorsum tricolored, dusky at base, buffy medially, and brown or gray at tip; underparts uniformly grayish or brownish gray, very slightly washed with whitish. Membranes blackish; tragus and basal portion and margins of ear yellow; tip of ear yellowish gray. Eye large; noseleaf broad, with simple tip; interfemoral membrane hairy at base but naked on posterior margin. Nasal aperture short, extending only to level of anterior edge of orbits; supraorbital region scarcely ridged, but lachrymal region sharply ridged; sagittal and lambdoidal crests poorly developed; inner upper incisors slender; canines and P_4 low, but anterior lower premolar (P_1) large and anterior cusp half or two-thirds the height of P_4.

Measurements: Male holotype of *gorgasi*, followed by female paratype (USNM 309902), and in parentheses the female holotype of *trinitatum:* total length 56, 57 (–); hind foot 10, 11 (12); ear from notch 17, 18 (15 in alcohol); forearm 38.5, 37.6 (41.0); tibia 12.4, 12.4 (15.2); calcar 4.9, 4.5 (4.5). Greatest length of skull 20.9, 20.7 (22.2); zygomatic breadth 12.8, 13.1 (13.9); interorbital breadth 5.4, 5.6 (5.6); braincase breadth 9.4, 9.6 (9.8); braincase depth 7.8, 7.9 (7.8); maxillary tooth row length 7.3, 7.3 (7.7); postpalatal length 5.4, 6.0 (5.8); palatal breadth outside of M^3 9.5, 9.4 (9.7); rostral breadth behind canines 4.8, 4.9 (5.1).

Comparisons: The closest relative of *gorgasi* appears to be *trinitatum* Goodwin, which is known only by the type specimen from Trinidad. Together these species stand well apart from all other known *Chiroderma*, and additional collecting may show them to be conspecific. *C. gorgasi* may be distinguished from *trinitatum* by smaller size; relatively broader skull; relatively deeper braincase and more bulging forehead; shorter rostrum; sharper lachrymal ridge; more rounded supraorbital region; heavier zygomata; larger outer upper incisors (I^2); shorter (anterior-posterior) M^1. Coloration of *trinitatum* is unknown.

The facial stripes, small size, low canines and P_4, large P_1, short nasal aperture, and lack of a supraorbital ridge are characters of *gorgasi* that distinguish it from the sympatric *villosum* Peters and *salvini* Dobson.

Remarks: *Chiroderma jesupi* J. A. Allen (1900), known only by the type specimen from northern Colombia, was described as a small species. The type is a juvenile with phalangeal epiphyses not ossified. It is the same as the bat subsequently described as *C. isthmicum* by Miller (1912), and it is conspecific with *Chiroderma villosum* Peters, type locality Brazil (not Venezuela as stated by Cabrera, 1958, p. 85). The valid species of the genus *Chiroderma* are thus as follows:

Chiroderma doriae Thomas: type locality, Minas Gerais, Brazil (*dorsale* Lund and *villosum* Dobson are synonyms).

Chiroderma gorgasi Handley: type locality, Tacarcuna Village, Darién, Panama.

Chiroderma salvini Dobson: type locality, Costa Rica.

Chiroderma trinitatum Goodwin: type locality, Cumaca, Trinidad.

Chiroderma villosum villosum Peters: type locality, Brazil.

Chiroderma villosum jesupi J. A. Allen: type locality, Cacagualito, Santa Marta, Colombia (*isthmicum* Miller is a synonym).

Specimens examined: *C. gorgasi:* Panama: Tacarcuna Village, Darién, 5, USNM. *C. salvini:* Costa Rica: Angostura, Cartago, 1, USNM; Cañas Gordas (Agua Buena), Puntarenas, 1, AMNH. Honduras: La Flor Archaga, 32, AMNH; San Marcos, 1, AMNH; Department of Yoro, 2,800 ft., 1, MCZ. Panama: Cana, Darién, 1, USNM; Cerro Azul, 2, USNM; Tacarcuna Village, Darién, 99, USNM. *C. trinitatum:* Trinidad: Cumaca, 1, type of *trinitatum*, AMNH. *C. villosum villosum:* Brazil: Calama, 1, AMNH. Trinidad: Diego Martin, 1, AMNH; Maracas Valley, 1, AMNH; Port-of-Spain, 2, MCZ. Venezuela: San Esteban, 1, AMNH. *C. v. jesupi:* Colombia: Cacagualito, 1, type of *jesupi*, AMNH. Panama: Barro Colorado Island, 6, USNM; Cabima, 2, including type of *isthmicum*, USNM; Cerro Azul, 1, USNM; Culebra, 1, USNM; Paya Village, Darién, 1, USNM; Río Cangandí, San Blas, 1, USNM; Tacarcuna Village, Darién, 7, USNM. Mexico: Presidio, Veracruz, 1, USNM.

***Myotis simus riparius*, new subspecies**

Holotype: USNM 310255, adult female (with one embryo, 7 mm. crown-rump), skin and skull, collected February 9, 1959, by Charles O. Handley, Jr., and B. R. Feinstein, Tacarcuna Village, 3,200 ft., Río Pucro, Darién, Panama, original number 4843.

Distribution: Eastern Panama.

Description: Fur short and woolly; dorsum buffy brown (between Warm Sepia and Bister); individual hairs slightly burnished at tip, slightly grayer toward base; underparts yellowish brown, individual hairs fuscous at base; lips, ears, membranes, and feet blackish. Calcar keeled; wing membrane attached to foot at base of toes. Body size large; zygomata heavy and wide spreading; braincase relatively narrow; sagittal and lambdoidal crests high and forming a triangular "helmet" at their juncture in the interparietal region; rostrum long and shallow; inner cutting edge of outer upper incisor (I^2) usually not crenulated; middle upper premolar (P^3) about two-thirds the size of P^1; M^1 and M^2 with protoconule, hypocone, metaloph, and cingulum fairly well developed.

Measurements: Holotype and a female paratype (USNM 310256) from the type locality, together with measurements, in parentheses, of two female topotypes of *simus* (AMNH 76244 and 76246): Total length 89, 86 (–, –); tail vertebrae 40, 36 (–, –); hind foot 8, 8 (9, 10); ear from notch 14, 13 (–, –); forearm 39.1, 35.7 (–, –); tibia 14.3, 13.5 (–, –); calcar 12.8, 13.2 (–, –). Greatest length of skull 13.9, 13.8 (14.0, 13.7); zygomatic breadth 8.8, 8.9 (9.4, –); interorbital breadth 3.5, 3.5 (3.9, 3.7); braincase breadth 6.4, 6.3 (7.0, 6.7); braincase depth 5.0, 5.0 (5.1, 4.9); maxillary tooth row length 5.3, 5.4 (5.1, 5.1); postpalatal length 4.5, 4.7 (4.7, 4.6); palatal breadth outside of M^3 5.5, 5.7 (5.7, 5.2); rostral breadth behind canines 3.7, 3.6 (4.0, 3.8).

Comparisons: Compared with Amazonian *simus*, the Panamanian specimens have the rostrum longer, shallower, and narrower at the tip; the braincase narrower, less inflated; the tooth row is longer and less crowded; the middle upper premolar (P^3) is larger (two-thirds the size of P^1 as opposed to one-fourth to one-third the size of P^1); the protoconule, hypocone, metaloph, and cingulum are better developed in M^1 and M^2; the inner cutting edge of the outer upper incisor (I^2) is entire in four of six specimens, rather than consistently crenulated; the sagittal crest is lower and expanded at the juncture with the lambdoidal crests in the interparietal region to form a triangular helmet not seen in the Amazonian specimens; the fur of the dorsum is slightly longer and more burnished (thus brighter).

Remarks: Coloration and length of fur are seasonally variable in *simus*. In a series of sixteen specimens from Boca de Río Curaráy, Ecuador, those collected in February and March have short (2–3 mm. on rump), orange-brown fur, with the individual hairs monocolored on all parts of the body. The remainder of the series, collected in October and December, are quite different in appearance. The fur is longer (3–4 mm. on rump), chocolate brown, with slightly burnished tips, and the individual hairs of the underparts are sharply bicolored. Several Brazilian and Peruvian specimens (*e.g.* AMNH 74378, 74380, 74105, 91889, 92702) show molt from short, orange, monocolored fur to the longer, brown, bicolored pelage.

Several characters ascribed to *simus* by Thomas (1901, p. 541) and subsequent authors cannot be substantiated in the specimens of *simus* that I have examined. Most important is the supposed insertion of the wing at the ankle. Possibly this feature had been distorted in Thomas' specimen by labels tied to the ankles, as in the two USNM specimens relaxed by Miller (1928, p. 206). Actually the wing is attached to the foot at the base of the toes in *simus* as in most other *Myotis*. The calcaral keel, described as practically absent, indeed is absent in a few specimens, but as a rule it is well developed. The width of the rostrum and crowding of the maxillary tooth row are geographically variable. Coloration and length of fur are seasonably variable.

Thus, *Myotis simus* is not so strikingly differentiated from other species of *Myotis* as Thomas and Miller supposed, and there is little basis for the subgeneric name *Hesperomyotis* proposed for it by Cabrera (1958, p. 103).

The Panamanian specimens were caught in mist nets set over streams in a lowland semideciduous forest and a mountain forest, and at the edge of a clearing in a mountain forest.

SPECIMENS EXAMINED: *M. s. riparius:* Panama: Boca de Paya, Darién, 1, USNM; Cerro Azul, 2,100 ft., 1, USNM; Tacarcuna Village, 3,200 ft., Río Pucro, Darién, 4, USNM. *M. s. simus:* Brazil: Auará Igarapé, Rio Madeira, 7, AMNH; Cacao Pereira Igarapé, Rio Negro, 8, AMNH; Igarapé Amorin, Rio Tapajoz, 3, AMNH; Rosarinho, Rio Madeira, 4, AMNH; Villa Bella Imperatriz, South bank of Rio Amazonas, 14, AMNH. Ecuador: Boca de Río Curaráy, 16, AMNH, 2, USNM. Peru: Apayacu, Río Amazonas, 4, AMNH; Orosa, Río Amazonas, 3, AMNH; Panya, Boca de Río Topaya, Ucayali, 1, AMNH; Río Pisqui, Ucayali, 1, AMNH; Sarayacu, Río Ucayali, 12, topotypes of *simus*, AMNH.

Lasiurus castaneus, new species

HOLOTYPE: USNM 310263, adult female (with 2 embryos, 13 mm. crown rump), skin and skull, collected March 6, 1959, by Charles O. Handley, Jr., and B. R. Feinstein, Tacarcuna Village, 3,200 ft., Río Pucro, Darién, Panama, original number 5445.

DISTRIBUTION: Known only from the type locality, where a single specimen was taken in a mist net over a stream in a mountain forest.

DESCRIPTION: Dorsum deep chestnut (between Morocco Red and Chestnut), shading on rump, interfemoral membrane, and feet to mahogany (between Maroon and Claret Brown); median band of individual dorsal hairs Cinnamon-Rufous; individual hairs tricolored, with individual bands (black-amber-chestnut) about equal in extent; face and muzzle entirely black; underparts blackish brown with only scattered buff-tipped hairs except on collar; throat not differentiated from remainder of underparts in color; hairs surrounding white humeral spot black tipped; ears, wings, membranes, and lips entirely blackish. Distal fourth of interfemoral membrane naked; auricle and antitragus relatively large. M^3 much reduced, second commissure shorter than first; hypocone much reduced on M^1 and M^2; P_4 double rooted. Rostrum broad and deep; lachrymal ridge not developed; braincase narrow, deep, and tilted up away from plane of palate. Otherwise similar to *Lasiurus borealis.*

MEASUREMENTS OF HOLOTYPE: Total length 112, tail vertebrae 48, hind foot 11, ear from notch 14, forearm 44.8, tibia 19.5, calcar 15.1. Greatest length of skull 13.0, zygomatic breadth 9.9, interorbital breadth 4.2, braincase breadth 7.6, braincase depth 6.2, maxillary tooth row length 4.7, postpalatal length 5.7, palatal breadth at M^3 6.7, rostral breadth at canine 5.7.

COMPARISONS: *Lasiurus castaneus* is a member of the *borealis* group. Its coloration is unique, and extreme tilting of the braincase rlativeto the palatal plane and reduction of parts of the upper molaers likewise set it apart from other species of the *borealis* group. In overall size and in size of auricle and antitragus it resembles the remote northern *borealis* and southern *varius*, but its wings are unusually long. Like *seminolus* it lacks development of a lachrymal ridge, has a black face, and has the median band of the dorsal hairs reduced. Like *varius* it has black ears and membranes and darkened face. It scarcely needs comparison with the sympatric *frantzii*, which is much smaller, paler and brighter colored, and plain faced and has a globose braincase and a shorter, narrower rostrum.

REMARKS: Variation in coloration is remarkably slight in the *borealis* group. Specimens from California (*teliotis*), Central America (*frantzii*), and Chile (*varius*) are scarcely distinguishable colorwise. Differentiation in coloration has occurred in the extreme northeast (*borealis*) and extreme southeast (*blossevillii*) along similar lines—overlay of the red mass effect with white (sort of a "frosting"). *Castaneus* in Central America, *seminolus* in the northeast, and perhaps *egregius* in Brazil, appear to be independent variables. Sexual dimorphism in size and coloration is marked in *borealis* and *seminolus* but is slight in western North America, Central America, and South America (see also table 2 on next page). Extension of fur onto the membranes varies with latitude and perhaps with altitude (more at higher latitudes, less at lower latitudes) and is of limited taxonomic value.

Bats of the mainland of North and South America that belong to the *Lasiurus borealis* group are:

Lasiurus borealis blossevillii Lesson and Garnot: Type locality, Montevideo, Uruguay (*bonariensis* Lesson, Buenos Aires, Argentina; *enslenii* Lima, São Lourenço, Rio Grande do Sul, Brazil; and *salinae* Thomas, Cruz del Eje, Cordoba, Argentina, are probably synonyms). DIAGNOSIS: slightly larger than *frantzii*, smaller than *varius* (larger toward the south); dorsum washed with whitish ("frosted"); reddish

TABLE 2.—*Selected measurements of adult specimens of the* Lasiurus borealis *group*

Part	Sex	Specimens	*L. b. varius*	*L. b. blossevillii*				*L. b. frantzii*						*L. b. teliotis*		*L. b. borealis*	*L. seminolus*	*L. castaneus*
			Chile	Argentina	Uruguay	Brazil	Paraguay	Peru	Venezuela	Colombia	Panama	Costa Rica	Honduras	Mexico	California	Virginia	Georgia	Panama
Forearm	♀	number	5	1	-------	1	3	-------	1	1	2	-------	-------	6	4	3	3	1
		minimum	41.2	41.0	-------	-------	37.9	-------	-------	-------	37.1	-------	-------	41.1	41.1	40.6	42.2	44.8
		maximum	43.4	-------	-------	39.0	41.0	-------	39.8	39.1	40.6	-------	-------	43.6	41.9	41.0	42.5	-------
	♂	number	3	1	1	-------	-------	1	1	-------	2	1	1	1	3	4	3	-------
		minimum	40.2	39.6	39.2	-------	-------	-------	-------	-------	38.5	-------	-------	38.4	38.1	38.1	39.3	-------
		maximum	41.4	-------	-------	-------	-------	39.9	38.3	-------	38.7	39.1	39.8	-------	39.9	39.0	39.8	-------
Greatest length of skull	♀	number	5	1	-------	2	3	-------	2	-------	2	-------	-------	6	4	3	3	1
		minimum	13.0	12.1	-------	12.0	11.7	-------	11.7	-------	11.3	-------	-------	12.0	12.5	13.0	13.1	13.0
		maximum	13.5	-------	-------	12.3	11.9	-------	11.9	-------	11.6	-------	-------	12.1	12.7	13.4	13.6	-------
	♂	number	3	1	1	-------	-------	1	1	-------	1	1	1	-------	3	4	3	-------
		minimum	12.8	11.6	11.6	-------	-------	-------	-------	-------	11.5	-------	-------	-------	11.7	12.2	12.6	-------
		maximum	13.1	-------	-------	-------	-------	11.7	11.7	-------	-------	11.5	11.8	-------	11.9	12.8	12.9	-------

Maxillary tooth row length	♀	number	5	1	--------	2	3	--------	2	2	2	--------	--------	1	4	3	3	1
		minimum	4.6	4.1	--------	4.0	3.9	--------	4.0	3.8	3.9	--------	--------	4.1	4.2	4.7	4.7	4.7
		maximum	4.9	--------	--------	4.0	4.0	--------	4.1	4.1	4.1	--------	--------	--------	4.4	4.8	4.7	--------
	♂	number	3	1	1	--------	--------	1	1	--------	1	1	1	1	3	4	3	--------
		minimum	4.4	3.9	3.8	--------	--------	--------	--------	--------	3.9	--------	4.0	--------	3.9	4.2	4.4	--------
		maximum	4.7	--------	--------	--------	--------	3.9	3.8	--------	--------	4.0	--------	3.9	4.0	4.7	4.7	--------

tips of dorsal hairs shading terminally to blackish (dominantly blackish in south, more reddish to north); buffy median band of dorsal hairs the dominant band; ears and membranes with reddish markings; females slightly larger and paler than males; lachrymal ridge developed. SPECIMENS EXAMINED: Argentina: Yuto, Jujuy, 2, AMNH. Brazil: Maracaju, Mato Grosso, 1, AMNH; São Sebastião, São Paulo, 1, USNM. Paraguay: Villa Rica, 3, USNM. Uruguay: Montevideo, 1, AMNH.

Lasiurus borealis borealis Müller: Type locality, New York. DIAGNOSIS: larger than *teliotis*; dorsum reddish, washed with whitish; buffy median band of dorsal hairs the dominant band; ears and membranes with reddish markings; females distinctly larger and paler than males; lachrymal ridge developed. SPECIMENS EXAMINED: many from southern Canada, eastern United States, and northeastern Mexico.

Lasiurus borealis frantzii Peters: Type locality, Costa Rica. DIAGNOSIS: smaller than contiguous races; dorsal color clear reddish without white wash; buffy median band of dorsal hairs the dominant band; ears and membranes with reddish markings; females scarcely differentiated from males in size and coloration; juveniles similar to adult *blossevillii* in coloration; lachrymal ridge developed. SPECIMENS EXAMINED: Colombia: Pacho, near Bogota, 1, AMNH; Villavicencio, Meta, 1, AMNH. Costa Rica: San Sebastián, San José, 1, AMNH. Honduras: La Flor Archaga, 1, AMNH. Panama: Boquete, 3,500 ft., Chiriquí, 1, USNM; Tacarcuna Village, 3,200 ft., Darién, 2, USNM; no exact locality, 1, USNM. Peru: Juliaca, 6,000 ft., 1, AMNH. Venezuela: Paya, 10 miles north of El Sombrero, Guárico, 1, AMNH; Macuto, 1, USNM; Merida, 1, AMNH.

Lasiurus borealis teliotis H. Allen; Type locality, unknown, probably California (*ornatus* Hall, Peñuela, near Cordoba, Veracruz, is a synonym). DIAGNOSIS: larger than *frantzii* but similar to it in coloration (slightly paler northward) and cranial characters. SPECIMENS EXAMINED: many from the western United States, Baja California, Jalisco, Michoacan, Oaxaca, and Veracruz.

Lasiurus borealis varius Poeppig: Type locality, Antuco, Bío-Bío, Chile (*poepingii* Lesson is a synonym). DIAGNOSIS: much larger than *frantzii*; similar to *frantzii* in color, except for darker face; ears and membranes entirely black; lachrymal ridge developed. SPECIMENS EXAMINED: Chile: Angol, 3 AMNH; Maquehue, Temuco, 1, AMNH, 2, USNM; Río Blanco, 4,900 ft., 4, USNM.

Lasiurus castaneus Handley: Type locality, Tacarcuna Village, 3,200 ft., Darién, Panama (see description above).

Lasiurus egregius Peters; type locality, Santa Catarina, Brazil. DIAGNOSIS: Similar to *castaneus* but larger (forearm 48 mm. in male type, the only known specimen); dorsum bright rufous, darkening almost to chestnut on interfemoral membrane; face noticeably more red tinged than crown and nape; underparts bright red; membranes black (this diagnosis is from notes that G. S. Miller, Jr., made at the Berlin Museum in the early 1900's).

Lasiurus seminolus Rhoads: Type locality, Tarpon Springs, Pinellas County, Florida. DIAGNOSIS: similar in size to *borealis;* dorsum mahogany, washed with whitish; black basal band of dorsal hairs the dominant band; face black; ears and membranes with reddish markings; females larger than males, but similar in coloration; juveniles darker; lachrymal ridge not developed. SPECIMENS EXAMINED: many from southeastern United States.

It should be noted that previous authors have followed Peters (1871) in aligning *egregius* with the genus *Dasypterus,* because it lacked the minute upper premolar (P^1), although in other characters it agreed with the *borealis* group of the genus *Lasiurus.* Absence of P^1 in a single specimen of *Lasiurus* (*egregius* apparently is still known only by the type specimen) is not significant, for although P^1 seems always to be absent in *Dasypterus,* it is also absent in one or both maxillae of about 10 percent of *Lasiurus.* Table 3, on page 475, lists some of the conspicuous differences between the species of *Lasiurus* and *Dasypterus.* More impressive are the following similarities linking these nominal genera and distinguishing them from other vespertilionids and in some cases from all other bats:

Four mammae and average of two or three young per litter.
Spiral effect in scale arrangement on hairs.
Reduction of sebaceous glandular tissue and location of the submaxillary salivary gland in the facial area.
Bright coloration.
Baculum short, J-shaped, with high base and narrow shaft.
Distally enlarged and spiny penis.
Furry interfemoral membrane.

It seems more reasonable to stress the important similarities of these bats and regard them as congeneric, rather than to stress the insignificant differences and regard them as representing distinct genera. I do not believe that *Dasypterus* is useful even as a subgenus.

Recent bats of the *ega* group may be arranged in the genus *Lasiurus* as follows:

Lasiurus ega argentinus Thomas: Type locality, Goya, Corrientes, Argentina (*caudatus* Tomes, Pernambuco, Brazil, is a synonym). DIAGNOSIS: dorsum pale whitish buff, washed lightly with black; orange hairs of interfemoral membrane contrasting with remainder of dorsum; face blackish; underparts dull whitish buff. Paler than *ega.* Body size small. SPECIMENS EXAMINED: Argentina: Tucuman, 1, CNHM, 1, USNM. Bolivia: Caiza, 1, USNM. Brazil: Ipiranga, São Paulo, 1, CNHM; Lago Hyanuary, Pernambuco, 2, MCZ; Salto Grande, Paraná, 1, USNM; São Marcello, Bahia, 1, CNHM; Villa Bella Imperatriz, south bank of Rio Amazonas, 2, AMNH. Paraguay: near Asuncion, 1, CNHM; Colonia Nueva Italia, Chaco, 1, CNHM; Villa Montes, Chaco, 1, CNHM; Villa Rica, 1, USNM. Uruguay: Salto, 2, CNHM.

Lasiurus ega ega Gervais: Type locality, Ega, Amazonas, Brazil. DIAGNOSIS: dorsum yellowish orange (darker than *argentinus*), with inconspicuous blackish wash; hairs of interfemoral membrane not contrasting with remainder of dorsum; face black; underparts paler. The Amazonian specimens become progressively darker upstream. Body size small. SPECIMENS EXAMINED: Bolivia: Buena Vista, Santa Cruz, 1, CNHM. Brazil: Baião, Rio Tocantins, 2, AMNH; Borba, Rio Madeira, 1, AMNH; Manaos, Rio Negro, 1, AMNH; Rosarinho, Rio Madeira, 1, AMNH; Santarém, Rio Tapajoz, 1, MCZ; Santo Antonio da Uayará, Rio Madeira, 1, AMNH. Peru: Pebas, Loreto, 1, ANSP; Sarayacu, Río Ucayali, 1, AMNH.

Lasiurus ega fuscatus Thomas: Type locality, Río Cauquete, Río Cauca, Colombia (*punensis* J. A. Allen, Puna Island, Ecuador, is a synonym). DIAGNOSIS: dorsum orange with heavy black wash (compared with *panamensis*, coloration is much darker and richer, broad subterminal band of dorsal hair orange rather than buff, and black tip longer and more dominant in mass effect); hairs of interfemoral membrane not contrasting with remainder of dorsum; entire head blackish; underparts dusky, becoming buffy posteriorly. Body size small. SPECIMENS EXAMINED: Colombia: Cali, 1, AMNH. Ecuador: Guayaquil, 1, MCZ; Puna Island, 5, including type of *punensis*, AMNH.

Lasiurus ega panamensis Thomas: Type locality, Bugaba, Chiriquí, Panama. DIAGNOSIS: dorsum dull sooty yellowish (paler than *fuscatus* and duller and more black washed than *ega*); hairs of interfemoral membrane not contrasting with remainder of dorsum; face black; underparts dull drabby buff, paler posteriorly. Body size small. SPECIMENS EXAMINED: Costa Rica: San José, 1, AMNH; Villa Quesada, Alajuela, 1, AMNH. Honduras: Tegucigalpa, 1, AMNH. Venezuela: Lagunillas, Zulia, 3, CNHM. Mexico: Achotal, Veracruz, CNHM; Yaxcach, Yucatan, 1, USNM.

Lasiurus ega xanthinus Thomas: Type locality, Sierra Laguna, Baja California, Mexico. DIAGNOSIS: dorsum pale yellowish, lightly washed with black (paler, more yellowish, and less mantled with black than *panamensis*); hair of interfemoral membrane bright yellow, contrasting with remainder of dorsum; face not blackened; underparts orangish, not becoming significantly paler posteriorly. Body size small. SPECIMENS EXAMINED: Mexico: Comondú, Baja California, 1, USNM; Miraflores, Baja California, 2, AMNH; Santa Anita, Baja California, 3, USNM; Sierra Laguna, Baja California, 1, USNM; Escuinapa, Sinaloa, 1, AMNH.

Lasiurus floridanus Miller: Type locality, Lake Kissimmee, Osceola County, Florida. DIAGNOSIS: dorsum buffy yellow, lightly washed with black (similar to *xanthinus;* paler, less orange and with more black than *intermedius*); hairs of interfemoral membrane not contrasting with remainder of dorsum; face blackish; underparts similar to dorsum in coloration. Body size large. SPECIMENS EXAMINED: a

TABLE 3.—*Differentiating characters of the species groups of the genus* Lasiurus

Red bats (*L. borealis*, etc.)	Hoary bats (*L. cinereus*, etc.)	Yellow bats (*L. ega*, etc.)
Size small (forearm 37–44 mm.)	Size large (forearm 46–57 mm.)	Size large (forearm 44–57 mm.)
Lateral wings of presternum equal to body of presternum in width	Lateral wings of presternum equal to body of presternum in width	Lateral wings of presternum considerably broader than body of presternum
Presternum about as long as wide	Presternum much longer than wide	Presternum about as long as wide
Auditory bullae not enlarged	Auditory bullae slightly enlarged	Auditory bullae not enlarged
Rostrum relatively short	Rostrum medium	Rostrum relatively long
Sagittal crest very weak	Sagittal crest weak	Sagittal crest strong
Coronoid process medium height	Coronoid process low	Coronoid process high
P^1 usually present	P^1 usually present	P^1 always absent
Hypocone slightly reduced on M^1 and M^2	Hypocone much reduced on M^1 and M^2	Hypocone slightly reduced on M^1 and M^2
M^3 very reduced	M^3 reduced	M^3 slightly reduced
P_4 double rooted	P_4 single rooted	P_4 double rooted
M_3 talonid reduced	M_3 talonid only slightly reduced	M_3 talonid much reduced

TABLE 4.—*Selected measurements of adult specimens of the* Lasiurus ega *group*

Parts	Sex	Specimens	*L. e. argentinus*				*L. e. ega*			*L. e. fuscatus*		*L. e. panamensis*			*L. e. xanthinus*		*L. intermedius*			*L. floridanus*		
			Argentina	Brazil	Paraguay	Bolivia	Brazil	Peru	Bolivia	Ecuador	Colombia	Venezuela	Costa Rica	Yucatan & Veracruz	Sinaloa	Baja California	Cuba	Southern Mexico	Lower Rio Grande	Louisiana	Georgia	Florida
Forearm	♀	number	-----	3	3	1	5	-----	-----	2	-----	3	-----	-----	1	3	juv. ♀(?)	3	10	2	2	3
		minimum	-----	46.9	47.1	-----	47.2	-----	-----	48.8	-----	46.5	-----	-----	-----	45.4	-----	55.0	53.6	48.6	50.2	49.3
		maximum	-----	49.5	48.6	49.7	50.7	-----	-----	52.2	-----	47.8	-----	-----	47.2	46.6	54.2	58.0	56.2	51.3	52.6	50.7
	♂	number	2	3	1	-----	-----	-----	1	-----	1	-----	2	2	-----	3	-----	1	5	1	12	7
		minimum	45.7	46.7	44.3	-----	-----	-----	43.8	-----	47.0	-----	44.4	42.7	-----	44.0	-----	-----	50.4	46.3	47.8	45.5
		maximum	46.5	47.3	-----	-----	-----	-----	-----	-----	-----	-----	45.7	44.0	-----	45.2	-----	56.5	54.6	-----	50.7	50.1
Greatest length of skull	♀	number	-----	3	3	1	5	1	-----	1	-----	3	-----	-----	1	3	-----	3	10	2	2	3
		minimum	-----	15.7	15.7	-----	15.4	-----	-----	-----	-----	15.6	-----	-----	-----	15.7	-----	18.5	17.8	17.6	17.9	17.7
		maximum	-----	16.1	16.1	16.0	15.6	16.2	-----	16.0	-----	16.3	-----	-----	16.1	16.2	-----	19.2	19.3	18.0	18.5	18.3
	♂	number	2	1	1	-----	1	1	1	-----	-----	-----	1	1	-----	3	-----	1	5	2	12	7
		minimum	15.8	14.9	14.8	-----	14.7	-----	14.8	-----	-----	-----	14.7	14.6	-----	14.8	-----	-----	17.2	17.4	16.9	16.8
		maximum	15.9	-----	-----	-----	-----	15.7	-----	-----	-----	-----	-----	-----	-----	15.0	-----	18.6	18.3	17.7	18.4	17.8

Maxillary tooth row length	♀	number	------	3	3	1	5	1	------	2	------	3	------	------	1	1	juv. ♀(?)	3	10	2	2	3
		minimum	------	5.3	5.5	------	5.4	------	------	5.9	------	5.7	------	------	------	5.7	------	6.6	6.6	6.1	6.6	6.5
		maximum	------	5.7	5.9	5.9	5.7	5.6	------	6.0	------	5.9	------	------	5.8	------	7.1	6.9	7.1	6.7	6.8	6.7
	♂	number	2	1	1	------	1	1	1	------	1	------	2	2	------	3	------	1	5	2	12	7
		minimum	5.4	5.1	5.3	------	5.0	5.7	5.4	------	5.3	------	5.3	5.1	------	5.2	------	6.6	6.4	6.4	6.0	6.0
		maximum	5.7	------	------	------	------	------	------	------	------	------	5.6	5.5	------	5.3	------	------	6.9	6.4	6.8	6.4

total of 47, including the type, from Florida, Georgia, Mississippi, and Louisiana.

Lasiurus intermedius H. Allen: Type locality, Matamoros, Tamaulipas, Mexico. DIAGNOSIS: dorsum clear yellowish orange with very fine blackish wash (brighter, clearer orange than *panamensis*, with which it is sympatric); hairs of interfemoral membrane not contrasting with remainder of dorsum; face slightly blackened; underparts colored like dorsum. Body size large. SPECIMENS EXAMINED: Cuba: San German, Oriente Province, 1, USNM. Honduras: Río Yeguare, between Tegucigalpa and Danli, 1, MCZ. Mexico: San Bartolomé, Chiapas, 1, USNM; Tehuantepec, Oaxaca, 1, AMNH; Izamal, Yucatan, 5, USNM; Tekom, Yucatan, 1, CNHM; Matamoros, Tamaulipas, 5, USNM. United States: Brownsville, Texas, 4, AMNH, 1, ANSP, 3, CNHM, 49, USNM; Cameron County, Texas, 6, USNM; Padre Island, Texas, 1, USNM.

Although geographic variation in coloration is considerable, geographic variation in body size is not apparent in the small samples of *ega* that I have examined (see table 4, pp. 476–477).

L. intermedius and *floridanus* must be closely related. Together they stand well apart from *ega* in larger body size, more massive skull, stronger rostrum, higher crests, and more widely spreading zygomata. Southern Texas and Latin American populations of *intermedius* average larger in body size than do specimens of *floridanus* from Louisiana, Georgia, and Florida, but they overlap. Neither this variation nor the variation in coloration appears to be clinal in *intermedius* and *floridanus*. However, similarity of the antorbital structure in specimens from Mexico, Texas, and Louisiana, in contrast to this structure in specimens from Georgia and Florida, suggests gene flow between *intermedius* and *floridanus*. I have not seen specimens from Texas north of the Río Grande Valley, where intergradation would be expected to occur if *floridanus* and *intermedius* are conspecific.

Literature Cited

Cabrera, Angel

1958. Catalogo de los mamiferos de America del Sur. I. Rev. Mus. Argentino Cienc. Nat. Bernardino Rivadavia, Cienc. Zool., vol. 4, pp. 1–308.

Dalquest, Walter W.

1957. American bats of the genus Mimon. Proc. Biol. Soc. Washington, vol. 70, pp. 45–47.

Handley, Charles O., Jr.

1959. A revision of American bats of the genera *Euderma* and *Plecotus*. Proc. U.S. Nat. Mus., vol. 110, pp. 95–246, 27 figs.

Miller, Gerrit S., Jr., and Allen, Glover M.

1928. The American bats of the genera *Myotis* and *Pizonyx*. U.S. Nat. Mus. Bull. 144, i–viii, 1–218 pp., 13 maps.

Peters, W.

1871. Eine Monographische übersicht der Chiropterengattungen *Nycteris* und *Atalapha*. Monatsb. Preuss. Akad. Wiss. Berlin, 1870, pp. 900–914, 1 pl.

Ridgway, Robert

1912. Color standards and color nomenclature, iv + 44 pp., 53 pls.

Tate, G. H. H.

1931. Random observations on habits of South American mammals. Journ. Mamm., vol. 12, pp. 248–256.

Thomas, Oldfield

1901. New *Myotis, Artibeus, Sylvilagus,* and *Metachirus* from Central and South America. Ann. Mag. Nat. Hist., ser. 7, vol. 7, pp. 541–545.

U.S GOVERNMENT PRINTING OFFICE: 1960

Proceedings of
the United States
National Museum

SMITHSONIAN INSTITUTION • WASHINGTON, D.C.

Volume 112 1960 Number 3443

CULTURAL SEQUENCES IN HOKKAIDO, JAPAN

By Lt. Col. Howard A. MacCord[1]

The present archeological field work was carried on during 1953–54 as a part-time project. I was assisted at times by Japanese friends and hired laborers. The work was necessarily limited to the area of Hokkaido lying between the Ishikari River on the north, and the south coast of the island through the narrow isthmus known as the Ishikari Plain (see the map, fig. 1). This area of the island is the most heavily populated and the most accessible by road and railroad from the capital, Sapporo, where I lived and worked. The collections made during these explorations have been given to the U.S. National Museum (Accession No. 209693). The 6-digit number that accompanies descriptions of artifacts is the Museum catalog number. Field notes and unpublished photographs have also been placed in the Museum.

The explorations consisted mainly of reconnaissance trips to locate new sites and to visit known archeological sites in the area. In this work I was advised by two able and willing friends: Doctor S. Kodama, head of the Medical Department of Hokkaido University and an authority on Ainu physical anthropology; and Father Gerhardt Huber, German missionary-teacher and long-time student of the

---

[1] Lt. Col. MacCord is a member of the U.S. Army Corps of Engineers.

Ainu people and Hokkaido in general. I take this opportunity to express again my deep appreciation to both these men for their many kindnesses and their valuable help.

Ever since the opening of Japan to Westerners in the mid-1800's, students have speculated about the identity and relationships of the Ainu people of northern Japan. Anthropologists who have studied them have arrived at no firm conclusions as to their nearest kin, their original home, or their prehistory. Among Japanese students the belief has long been current that the Ainu were the aborigines of Japan proper, and that they were forced northward to their present homes in Hokkaido, Sakhalin, and the Kuriles by the overwhelming power of the Japanese race—the Yamato people.

The teaching of State Shintoism during the years between the Restoration (1868) and the end of World War II stressed the divine descent of the Japanese from the mythical deities, Izanagi and

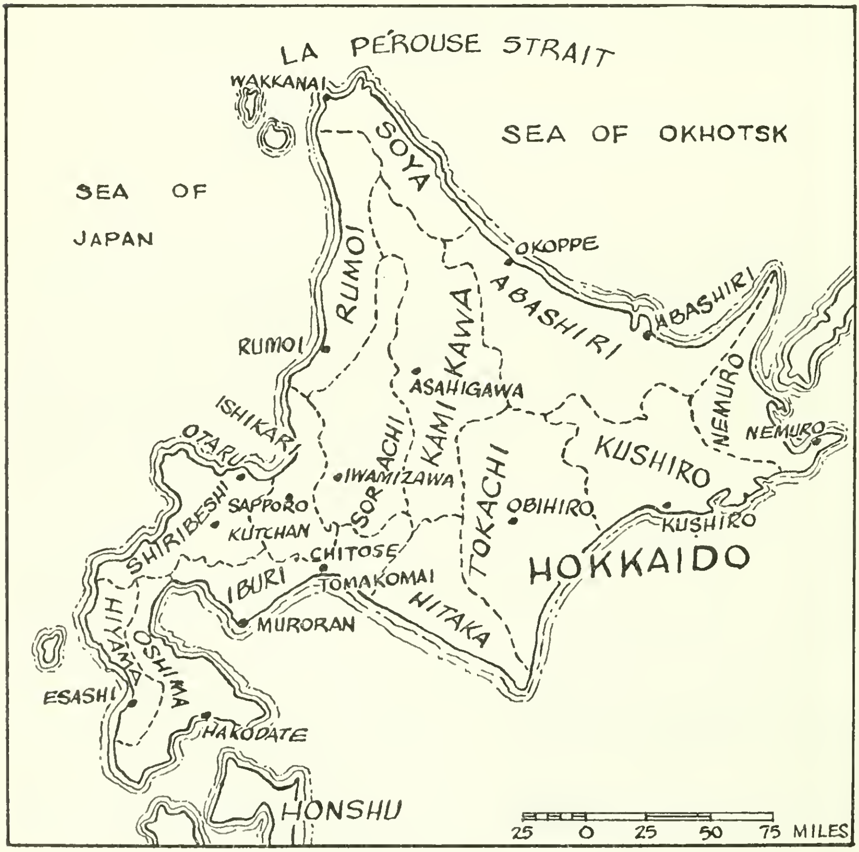


FIGURE 1.—Map of Hokkaido, Japan.

Izanami. Nothing could be published that conflicted with this myth. In such a repressive atmosphere, no Japanese dared undertake the necessary research to identify the people of the shell mounds or to establish once and for all the identity of the Ainu. Since 1945 archeological work by both Japanese and Westerners has begun to illuminate the problems and to hint at solutions.

Archeological work in Hokkaido has been greatly neglected, though sites attributable to prehistoric cultures and to historic Ainu and Yamato occupancy are numerous. These sites comprise shell mounds, caves, stone "circles," earthen-walled enclosures, quarry workshops, groups of still-visible housepits, and many sites yielding both ceramic and nonceramic artifacts in topsoil of varying depths. Surface collections indicate occupancy of these sites during the entire range of the Jomon Period, as well as during the protohistoric and historic eras. Dates for these periods are unknown, but the Jomon Period is Japan's Neolithic Period and occurred possibly from 3000 B.C. to A.D. 500, while the historic era begins about A.D. 1400. In addition, many sites yield only implements of flint and obsidian and may well be of preceramic age.

Taniguchi Site

The Taniguchi Site is on the left bank of the Ishikari River, 1 kilometer west of the town of Barato, 13 kilometers north of Sapporo. The site is at the northeastern tip of a sandy terrace that abuts on the river at this point, as well as at other points to the west. This sandy terrace is of uneven elevation and appears to have originated as beach dunes at some time in the geologic past, when the mouth of the Ishikari was near this point. The property is owned by Mr. Jinsaku Taniguchi, of Sapporo, who kindly consented to our making a limited excavation on the site. Since most of the site is occupied by houses, barns, and gardens of the Taniguchi homestead, no major excavation was made. A search of the fields and garden, however, revealed the extent of the refuse-strewn area to be about 2 acres. In a low swale adjacent to the houses the refuse appeared to be concentrated, and this area was selected as the site for a test excavation 5 meters square. The site map (fig. 2) shows the location of the tested area in relation to the houses.

Surface materials found on the site consist of numerous cord-marked (Jomon) sherds, plentiful chips of obsidian and flint, and occasional finished implements such as projectile points, knives, scrapers, celts, and hammerstones. No bones, shells, or other organic materials were found.

The excavations were begun on May 2, 1953, and completed on May 31, 1953. My assistants in this work were Messrs. Hatsuji

Takao, Yukie Kudo, Hichiro Ishibashi, and Isamu Shintani—all of Iwamizawa, Hokkaido. The area to be dug was staked in units of 1 square meter, and each square was dug to hardpan in units of 12½ centimeters (5 inches).

All material found in each layer and square was kept separate pending washing, sorting, and classifying. Hardpan under the black topsoil was a yellowish-brown sand, and any disturbances due to pits and postmolds were easily detected. Each square was carefully searched for such disturbances, and the few found were plotted on a sketch map of the excavation. Hardpan was usually reached at a depth of 80 centimeters, though two of the three pits reached depths of 130 centimeters. Pit outlines could not be discerned in the black topsoil, and we first became aware of the pits when hardpan was reached. Since the cultural material obtained in the excavation was practically uniform throughout, this failure to detect pit outlines at a higher level is not serious.

At two places (squares 15 and 63) we found the remains of recent burials of infants. No bones remained, but the decayed wood and the nails, cleats, and handles of the coffins were identifiable. In one grave we found a mass of carbonized straw, as if this material had been used for packing the coffin. Also found in each grave were broken china dishes that date back to about 1900 A.D. Neither

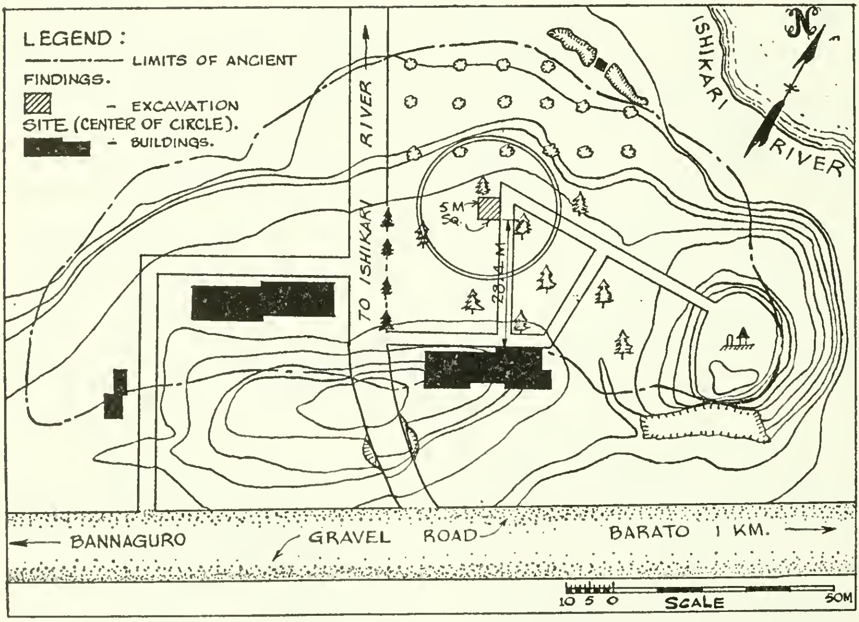


Figure 2.—Ground plan of the Taniguchi Site, Ishikari Province, Hokkaido.

TABLE 1.—*Pottery traits found at various depths in the Taniguchi site.*

		Layers					
Traits	*Topsoil*	*1*	*2*	*3*	*4*	*5*	*Totals*
Coarse cord, continuous pattern	100	121	157	187	185	134	884
Coarse cord, discontinuous pattern	12	45	20	17	15	17	126
Fine cord marked	4	6	8	0	5	3	26
Plain surface	3	13	6	3	3	7	35
Cord-marked bases	0	0	0	1	1	0	2
Plain bases	4	4	7	6	7	3	31
Obsidian tempering	5	8	14	14	28	20	89
Other grit tempering	110	171	173	199	182	137	972
Fiber tempering	3	6	10	5	11	10	45
"Support perforations"	1	2	1	0	0	2	6
Cord-marked inner rims	3	9	18	7	5	3	45
Added rim strips	8	6	13	12	14	15	68
Added fillet decorations	2	2	5	5	5	5	24
"Pseudocord" designs	0	12	5	10	17	7	51
"Chevron" cord marking	5	9	7	2	4	2	29
Straight rims	13	15	21	27	20	19	115
Everted rims	1	6	5	1	4	1	18
Notched rim tops	1	1	5	5	2	1	15
Punctate rim tops	1	0	0	3	2	3	9
Crenelated rims	3	1	3	2	2	2	13
Hollow drill punctate	3	5	3	4	2	3	25
Solid drill punctate	2	3	10	7	3	2	28
Incised over cord marks	17	22	20	18	24	21	122
Blunt stick incised	5	9	13	9	4	5	45
Pointed stick incised	3	5	4	6	3	4	25
Split reed incised	15	11	11	11	12	15	75
Total rim sherds	15	19	28	28	27	21	138
Total basal sherds	4	4	7	7	8	3	37
Total sherds	121	185	197	217	221	167	1,108

TABLE 2.—*Percentages of tempering used in the pottery found at various depths in the Taniguchi site.*

		Layers				
Tempering	*Topsoil*	*1*	*2*	*3*	*4*	*5*
Obsidian	4.2	4.3	7.1	6.4	12.7	11.9
Fiber	2.5	3.2	5.0	2.2	4.9	6.1
Other grits	93.3	92.5	87.9	91.4	82.4	82.0

grave exceeded a depth of 70 centimeters, and the tops of the coffins were just below the plowline. The finding of these graves, while having no bearing on the prehistoric nature of the site, is interesting archeological evidence of the disposal during recent times in Hokkaido of infant dead by burial as opposed to the more common cremation. An elderly local woman (possibly aged 70) witnessed the finding of the graves and claimed that she had not known previously of such graves in this garden.

Throughout the squares excavated we found many sherds, chips, stone implements, fire-cracked stones, and flecks of charcoal. No restorable vessels were found, though enough sherds were obtained to show shape and approximate size of the pottery. Typical rimsherds found of Yoichi type (Middle Jomon Period) pottery are illustrated in plates 1 and 2. Careful sorting and comparisons of the pottery from each layer reveal no differences between that from the topsoil and that from the deepest layer. It had been hoped that some indication of cultural change would be detectable in the material from such a deep site, but this hope did not materialize.

A tabulation of ceramic traits from seven squares (1, 2, 3, 4, 5, 13, and 14) that were least likely to have been disturbed by the pit excavations and by the recent graves is shown in table 1 above. The table reflects the strong cultural conservatism in the pottery, which is marked by the absence of change in surface treatment, design, shape, size, or firing. The only change noted is in the tempering material, which shows a gradual decrease in the use of fibers and pulverized obsidian from early to late and a corresponding increase in the use of grit other than obsidian (see table 2 above).

Artifacts found in the 26 square meters consisted of the following:

4000	sherds
204	scrapers
22	projectile points
18	celts and fragments
17	abrading stones
2	chisels with polished blades
1	perforated sherd, 3 cm. square
1	perforated pebble of chalcedony
1	partially perforated pendant?
5	tanged knives
4	drills, chipped, obsidian

The three pits found were of unknown use or purpose, and they contained no concentration of cultural materials. Their sizes and shapes are as follows:

Pit	*Cross-section*	*Maximum depth*	*Dimensions (at hardpan)*
1	hemispherical	130 cm.	2 ×2½ m.
2	subconoidal	130 cm.	1.2×0.6 m.
3	hemispherical	95 cm.	1.0×0.5 m.

Charcoal collected from the undisturbed portion of pit 1 below the hardpan level was given a Carbon–14 test by Dr. Meyer Rubin of the

Low Level Radiation Laboratory of the U.S. Geological Survey Radiocarbon Laboratory, and yielded an age of 3950 ± 200 years (W–372).

A comparison of the distribution of stone implements by depth shows no detectable differences in shape, size, or material used. Their types and distribution by depth are shown in table 3. They indicate an intense utilization of the locally available flints as well as obsidian brought from the valley of the Tokachi River, 100 miles to the east. Sandstone and pumice were used for abrasives, and several varieties of basaltic stones were employed in the manufacture of celts and chisels.

TABLE 3.—*Stone implements found at various depths in the Taniguchi site.*

		Layers								
Artifacts	*Topsoil*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*Totals*	*Pits*
Celts and fragments	4	2	5	3	4	0	0	0	18	0
Chisels	1	0	0	0	0	0	1	0	2	0
Abrasive, pumice	0	1	1	0	1	0	0	1	4	2
Abrasive, sandstone	3	1	1	0	3	0	1	1	10	1
Arrowpoints, stemmed	2	2	1	3	4	2	0	0	14	1
Arrowpoints, unidentified	1	2	0	1	1	0	1	0	6	1
Drills	2	0	0	1	0	0	0	0	3	1
Scrapers, flint	1	1	7	3	2	2	0	3	19	1
Scrapers, obsidian	25	20	22	36	41	12	13	6	175	9
Knives, tanged flint	4	0	0	0	1	0	0	0	5	0
Ornaments, perforated	0	0	1	0	0	0	0	0	1	2

The celts found are all flattish and are either rectangular or oval in cross-section. All are small, 7 to 15 centimeters long and 5 to 8 centimeters wide. A few celt "blanks" show that chipping usually preceded grinding in their manufacture. The chisels might be considered miniature celts, as their shape and materials are identical. The celts illustrated in plate 3*a–d* are typical.

Projectile points (plate 4*d–i*) are small, 18 to 60 millimeters in length. and were probably used to tip arrows. All are made of obsidian. The predominant shape has a long, pointed tang, sometimes longer than the main portion of the point.

Knives (plate 3*e–h*) and scrapers (plate 4*a–c*) were probably used interchangeably and are the most common tool at the site. Five of the knives are tanged, of which three are illustrated in plate 3*f–h*. Four of the flake scrapers seem to have been deliberately formed from large flakes (plate 4*a–c*), but the remainder are fortuitous flakes and spalls that show only slight secondary chipping. On a few is chipped a pointed tip for use as a graver or burin.

The abrasives are irregular lumps of pumice or sandstone, though a few are worn through use into thin slabs. Two of the pumice abraders show rounded, grooved slots, as if they had been used to smooth a round object. Others are flat and may have been used to sharpen celts. One large, flattened boulder of quartzite has a concave depression on each flat side and apparently was used as a whetstone for sharpening celts.

Two stones found may have been intended for use as pendants. One is a pebble of chalcedony (411611) having a natural perforation, though there is some evidence of chipping around the hole. The other specimen is a flat, oval piece of basalt showing a partially drilled hole near one end (411570). No effort had been expended on polishing or otherwise altering the pebbles.

The pottery from the Taniguchi Site seems to be entirely homogeneous ware of the Yoichi type, named after a small town some 30 kilometers west of the Taniguchi Site where identical ware was found. The vessels are cylindrical, with flat bases, and with straight or slightly everted rims. The entire outer surfaces are usually corded, and in many instances the inner surfaces are corded for the top 3 or 4 centimeters. Basal diameters range from 9 to 15 centimeters. Oral diameters are from 10 to 30 centimeters. The ware is usually from 5 to 12 millimeters thick and is generally black or brown, though occasionally a red, yellow, or buff sherd is observed. Designs are common on the rim portions of the vessels. These consist of thickened and overlapping rims, added fillets of clay in various patterns, and various combinations of incised, punctate, and pseudocord designs. The rims illustrated in plates 1 and 2 show typical designs and combinations.

Pottery of the Yoichi type is equated by Groot (1951, p. 54) with the wares of the Middle Jomon Period on Honshu. Similar pottery is found at numerous sites in Hokkaido.

Uenae Site

The Uenae Site is located on the right bank of the Bibi River, 9 miles south of Chitose. The site lies on a prominent headland truncated by the Chitose-Tomakomai highway just west of the road leading to the Uenae railroad station. The site was found exposed in the roadcut resulting from highway construction. Since the entire region is buried under nearly 3 feet of geologically recent volcanic ash, no indications of the site show on the surface. Nearby Mount Tarumae, still smoldering today, is undoubtedly the source of the ash.

The site appears to have been a small habitation area, since no extensive refuse is encountered, and the outcrop of cultural material is small. No bones or shells are present in the layers. A typical cross-section of the site is shown in figure 3. Since remains found in the lower part of layer 3 are identical with those of the upper part of layer 5, the occupants of the site were probably the same before and after the volcanic activity that produced layer 4. No concentrations of refuse or other indications of hasty abandonment of the site were noted at the line of contact between layers 5 and 4. It is presumed therefore that the site was not occupied at the time of the eruption, but how long it had been abandoned is, of course, problematical.

Due to the thickness of the overburden of ashes, no extensive excavation was undertaken. An area 5 feet by 15 feet was laid out

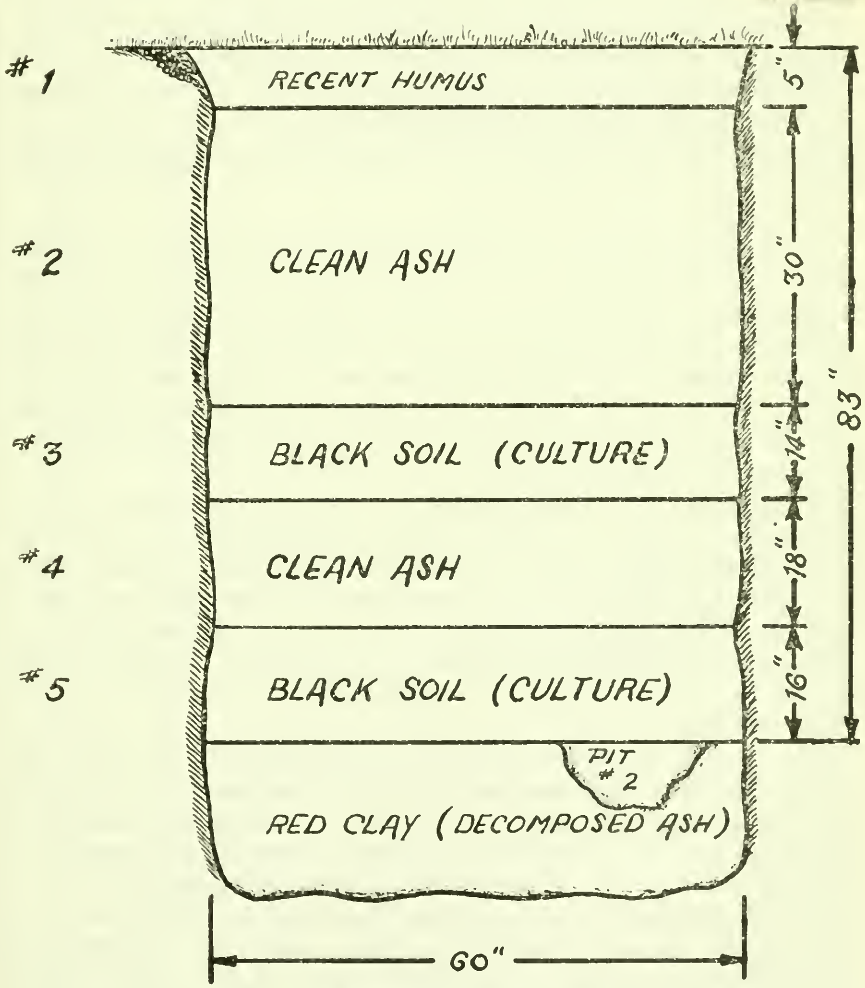


FIGURE 3.—Cross-section of the strata cut at the Uenae Site, Hokkaido.

parallel to the edge of the roadcut and uncovered layer by layer down to hardpan. Layer 5 was removed in two equal increments, and all material found was kept separate for statistical comparisons. The blackness of the soil in layer 5 precluded our finding pit outlines until hardpan was reached. Here two small pits were easily detected. Pit 1 was 12 inches in diameter and extended 14 inches into the subsoil. It contained fire-cracked stones and a few sherds of Nopporo type. Pit 2 was 17 inches in diameter and 12 inches deep. This pit contained pottery of two types (Yoichi and Nopporo), fire-cracked stones, two broken and incomplete celts, two chipped scrapers, and charcoal, a sample of which was collected for Carbon-14 dating. The test by Dr. Meyer Rubin of the Low Level Radiation Laboratory of the U.S. Geological Survey yielded an age of 3230±160 years (W–322).

The lower half of layer 5 yielded pottery of both Yoichi and Nopporo types, while the upper half yielded only Nopporo type sherds. No difference could be detected in the types of stone implements from the two zones. No postmolds were found in the excavated area, though they were carefully sought.

Artifacts found include sherds, chipped and polished stone implements, and one ornament made from a naturally perforated pebble of dark green material (plate 5*c*). The polished stone implements are limited to three broken and incomplete celts, one of which shows the scars of cutting on one side and illustrates the method used to detach the piece from a larger source. One lump of pumice has a groove on one side, the groove indicating use as a smoothing tool, possibly for dressing arrow shafts (plate 5*b*).

Chipped implements are arrowpoints, drills, scrapers, and knives. The material used is usually obsidian, though flint was also used. Arrowpoints (plate 5*e-f*) are small, either triangular, or with a small pointed tang. The drills and scrapers (plate 5*d*) are flakes and spalls, sometimes with only the slightest amount of secondary chipping. The knives are either large flakes with secondary chipping, or are specially made blades with a notched tang at one corner or on one end (plate 5*a*).

The pottery of Yoichi type (plate 6*a-b*) is similar to that from the Taniguchi Site. The examples found show oral diameters of from 8 to 15 inches, and wall thicknesses of from ⅜ to ¾ inches. Designs are limited to rim thickening and the addition of small lugs at rim level, but extend above the rim to form small crenelations (plate 6*c*).

The majority of the ware from the Uenae Site is the Nopporo type (plate 6, *c-e* and *g-h*), which Groot (1951, p. 62) calls "Nohoro" and equates with the Omori type of the Tokyo region. According to Groot (p. 65), the Nohoro type is the probable ancestor of the Kamegaoka type of the Final Jomon period in Hokkaido. The Nopporo ware found is thin-walled, ⅛ to ⅜ inches thick, and is uniformly of bowl shape. Bowls vary from 2 inches to over 12 inches in height. All are grit-tempered and flat-bottomed, and have slightly bulging sides and slightly incurved rims. No spouted bowls or other ornate forms were found.

All the sherds are impressed with a cord-wrapped stick, with the finer cords predominating. Designs are limited to the rim and neck areas and include lines of fingertip impressions, lines of short, vertical slashes filling the space between horizontal incised lines, incised lines paralleling the rim, pseudocord lines paralleling the rim, geometric incised patterns, notched rimtops, and in two instances small rimtop enlargements bearing incised or notched designs. One strap handle covered by closely spaced cord impressions was found. Bases found are either plain or are cord marked. Plate 6, *c-e* and *g-h*, illustrates rimsherds of Nopporo type. Two restorable bowls have the following characteristics:

Bowl 1 (411621) is 4½ inches high with a plain base 4 inches in diameter. The rim is incurved and is 6½ inches in diameter. The rimtop is round with thin, slanting incisions on the outer face of the rim. The sides of the bowl are finely cord marked, while design is limited to two incised lines parallel to and within ¼ inch of the rimtop. The bowl is brown on all surfaces but in a few places is soot incrusted.

Bowl 2 (411614) is identical in shape to bowl 1, but is only 3 inches high. The base is cord marked and is 4 inches in diameter. The rim is 7 inches across and is rounded and incurved. Design consists of three pseudocord lines parallel to the rim. The ware is brown with some soot incrustation. This bowl is illustrated in plate 6*c*.

During the years required for the accumulation of the 14 inches of humus comprising layer 3, the pottery underwent considerable change. In the upper part of layer 3 was one sherd of Ebetsu type, with smooth surfaces and with thin ribbons of clay bearing closely spaced notches covering most of the lower part of the vase. For an illustration of this type, see plate 8*a*. Also found in layer 3 was a small restorable vase (vessel 3, 411615) of smooth ware. This vase appears to be related to the Haji type of pottery of the Tanaka Site, described below, and of the Ogawara Pithouse Culture of northern Honshu, which is protohistoric. This vase is 2¾ inches high, with a basal diameter of 1¼ inches and an oral diameter of 3 inches. The sides expand from the base to the rim, which is slightly flaring. No design is found on this vase, and the base is smooth, concave, and slightly flanged. The vase is illustrated in plate 6*f*.

Tanaka Site

The Tanaka Site is located on the right bank of the Osatsu River, 2 miles southwest of its confluence with the Chitose River. The site lies on a small peninsula formed by the juncture of a small, unnamed creek with Osatsu River. Elevation is about 30 feet above sea level, and about 10 feet above the level of the marshland bordering the two watercourses. The peninsula is level, with gently sloping sides. The site is part of the farm of Mr. Sadaiichi Tanaka, whose house and barns cover portions of the occupied area. Mr. Tanaka reports finding sherds and stone tools in his excavations for potato cellars and other deep diggings. He cooperated wholeheartedly in the plan to excavate on his land and deferred cultivation of the field until our work was completed. For this great kindness, I again express my sincere appreciation.

Since the site had been covered with volcanic ash during relatively recent times, no artifacts were found on the surface. Four round, shallow depressions represent the locations of semisubterranean pit houses. The visible pits are about 30 feet in diameter, with a maximum depth in the center of about 1 foot. Six additional pits are in a wooded area about 30 yards southwest of the Tanaka homestead. In another wooded area, about 200 yards east of the Tanaka Site, on the south bank of Osatsu River, is another group of 10 housepit depressions in an excellent state of preservation. According to a local informant, Ainu graves containing glass beads, iron swords, and similar articles of recent origin had been found when the area was cleared of trees in about 1920. Since the area has been cultivated repeatedly no evidence of the graves is now visible, and testing yielded no indication of graves.

A test excavation 5 feet wide by 10 feet long was made in a portion of the Tanaka Site not showing a housepit, in order to determine normal soil conditions. This test revealed the layer of volcanic ash on the level surface to be 16 inches thick. Beneath this layer a stratum of black soil 20 inches thick was found overlying the brown clay subsoil resulting from the decomposition of earlier volcanic ash deposits.

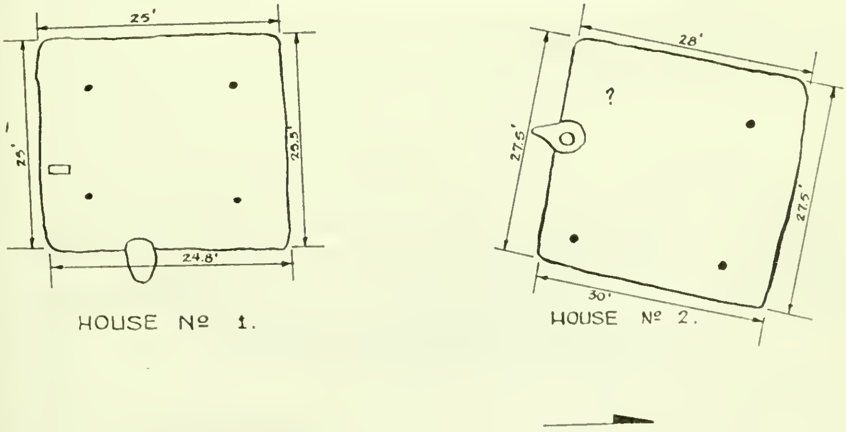
Throughout the black stratum were scattered sherds, obsidian chips, and occasional stone tools. The sherds (411627) were identifiable as representing several cultural periods: (1) Middle Jomon (Yoichi type pottery); (2) Later Jomon (Nopporo type); and (3) the Epi-Jomon with Ebetsu, Satsumon, and Haji-like wares, whose exact relationships have not yet been defined. Stone implements found are small triangular arrowpoints (411631), a broken celt (411630), and chipped flakes and spalls showing use as scrapers.

At the bottom of the black zone was a small oval hearth, 30 by 26 inches across, identified by the reddish condition of the clay subsoil. This reddening extended 3 inches into the clay. No concentrations of sherds or other remains were found on or near the hearth, and no postmolds were noted in the tested area.

One restorable vase of Haji type (411628) was found in the test trench. This vase is made of grit tempered clay, is brown, and is 4½ inches high. The base is 2 inches across and is plain and slightly concave. The ware is completely plain, though a line of vertical fingernail impressions parallels the rim ½ inch from the lip. The rim top is pointed and slightly everted.

A second vase (411629) found in the tested area is not restorable, but is a good example of a globular jar of the Ebetsu type. This jar is grit tempered and yellow. The rim diameter is 3 inches, while the base is 3½ inches across. The base is plain. The upper half of the vase is covered by six bands, each ½ inch wide, of horizontal cord impressions, while the lower half is covered by similar marks running vertically. No design is found adjacent to the rim, which is square and slightly everted. Maximum diameter of the globular part of the jar is 6½ inches. Overall height cannot be determined, due to the lack of essential parts, but it is in excess of 7 inches.

Since it was decided to excavate two of the visible housepits, a base line was staked near the two depressions. This line ran almost due north and south, with both housepits east of the base line. Figure 4 shows the shape, size, and relationships of the two excavated housepits.



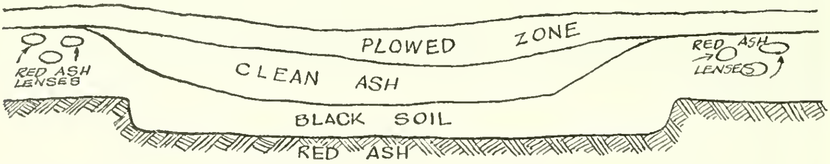
HOUSE Nº 1.

HOUSE Nº 2.

Figure 4.—Ground plan of houses 1 and 2 in the Tanaka Site, Hokkaido.

The southern housepit (No. 1) was excavated first. This pit was found to be nearly square, 25 by 25½ feet. The floor was 36 inches below the present ground level. Profiles of the north-south and east-west centerlines are shown in Figure 5. The partial filling of the pit with humus and the obliteration of the sides reveal that the housepit had been abandoned long before the ashfall now forming the surface of the ground. The ashfall was apparently wind driven, since the housepit received a thicker deposit than fell on the surrounding level surface. Cultivation of the surface of the ash has resulted in some intermixture of modern humus with the upper 1 foot of the ash. The cultivation of the field had also tended to level the housepit by dragging in ash and humus from surrounding elevations. A perfect, charred walnut found in the undisturbed ash layer indicates that the area was wooded when the ash fell, and the season of the year was probably fall or winter.

A 3-foot wide trench was dug completely around house 1, thereby outlining the walls formed by the undisturbed subsoil. No artifacts were found in the recent humus or in the volcanic ash. However, in the black humus layer were found hundreds of sherds of both Jomon and Haji provenience. Among these sherds were one complete cup, one restorable vase, and three nonrestorable vases, numbered 1 to 5 inclusive. Stone implements (411642) were few, but include 2 frag-



PROFILE ALONG E-W CENTER LINE
HOUSE # 1, TANAKA SITE, OSATSU

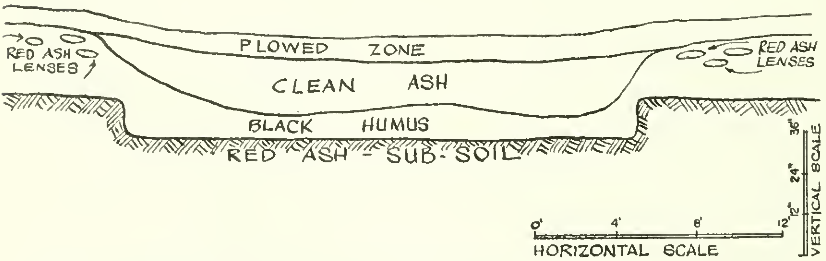


Figure 5.—Soil profile along N.-S. center line of house 1 in the Tanaka Site, Osatsu.

ments of celts, 2 projectile points (plate 7*d*), 2 drills or reamers (plate 7,*c*,*e*), and 17 chipped scrapers (plate 7*a–b*). The majority of the chipped implements are made of obsidian, though the presence of a few chips of flint show that this material was used. The celt fragments are small chips of polished diorite, too small to indicate the dimensions of the tool. One lump of sponge iron (411643, plate 7*f*) found in the humus seems to be contemporary with the housepit, but no other evidence of iron working was found in the excavation. Two postmolds found in the subsoil outside the housepit were vertical, and do not appear to have been part of the house structure.

Miscellaneous sherds from the trench outlining housepit 1 consist of the following:

Type	*Rims*	*Body*	*Basal*	*No. of vessels*
Yoichi	0	13	0	3
Nopporo (411633)	36	34	13	21
Ebetsu (411632)	12	13	0	2
Haji	3	15	0	2

Of the 13 bases, 12 are cordmarked and are 3 to 3½ inches in diameter. The remaining one is plain, 3 inches in diameter.

Vessel 1 (411637) is an incomplete, nonrestorable bowl made of sandy clay containing many fiber casts. The paste is yellow and buff. It is a straight-sided bowl with a rounded bottom. The vessel is cordmarked over the entire outer surface. Height of the bowl is in excess of 8 inches. Rim diameter is 9 inches, while the base is about 3 inches across. The rim is straight and pointed in cross-section. Short impressions of twisted cords are found on the inner edge of the rim. Perforations for repair are present on each side of a break in the side wall.

Vessel 2 (411635) is a small vase-shaped cup 1½ inches high. It is made of sandy clay and is unevenly fired. Basic color is a reddish orange, but black smoke clouding covers about one half of the surface. The base is subconoidal. Sides flare outward to a maximum diameter of 1¾ inches at a height of 1 inch. At the shoulder thus formed, the sides narrow abruptly to a nearly vertical neck ½ inch high. Rim diameter is 1 inch. The cup appears to have been molded over a fingertip. The outer surface is plain, though the neck is decorated with two parallel incised lines, which cut across a zigzag line to form equilateral triangles between the shoulder and the rim. The rim is straight and rounded in cross-section.

Vessel 3 (411638) is a restorable bowl 5 inches high bearing at least two crenelations 1 inch higher. The shape is that of a wide-mouthed bowl with a flat bottom and straight, sloping sides. The paste is a sandy clay of yellow and buff color. The entire outer surface is cordmarked, as is the base and the upper ½ inch of the inner surface. The rim is straight and pointed in cross-section. The one crenelation present bears five rounded gashes. Rim diameter is 8½ inches, and the base is 3 inches across. Perforations for repair are present.

Vessel 4 (411639) is an incomplete, nonrestorable vase at least 12 inches high. Sides are straight and are nearly vertical. The oral diameter is 15 inches while the base is 4 inches across. The entire outer surface including the base is cord marked. The rim is straight and pointed in cross-section. No design is found, but the rim bears an unknown number of small (½-inch high) plain crenelations. Perforations for repair are present.

Vessel 5 (411634) (plate 8*b*) is an incomplete, nonrestorable vase of the type known to Japanese archeologists as "Satsumon." Since the base is missing, the exact height and basal type cannot be determined. Oral diameter is 10¾ inches, and the height is in excess of 10 inches. The vase shows coil joints indicating the method of manufacture. The paste is sandy clay, well fired, and yellow, buff, and brown in color, with some soot encrustation. Outer surfaces are plain, but show marks of having been scraped vertically with a rough-edged scraper. Maximum body diameter is 7 inches, with a slight constriction to 6¾ inches in the neck. The rim flares outward and then upward to a vertical, rounded rim. Design is found in two areas: the shoulder and the outer edge of the rim. On the shoulder are two discontinuous incised lines ¼ inch apart. Immediately below the lower line is a row of ¼ inch long gashes impressed into the clay at an angle of about 30 degrees from vertical, sloping from lower left to upper right. The design at the rim is a 1-inch band of three incised lines, spaced ¼ inch apart with a row of gashes immediately below each line. The upper and lower gashes slope from lower left to upper right, while the center row slopes in opposite directions.

Upon completion of the trench outlining the house, the house proper was completely cleared of ash and humus. As no trace was found of a doorway, the house must have been entered through the roof. A small burned area of the floor on the east side at the wall was undoubtedly the hearth. It was connected with a collapsed structure of clay, which extended outside the housepit wall. The exact nature of this structure could not be determined, but it appears to have been either a smoke hole, or an air vent lined with clay. I found similar "chimneys" in house pits in the Anenuma-Ogawara area of Aomori Prefecture, Honshu (MacCord, 1955, pp. 150–151).

Midway along the south wall, and 1 foot inside the edge of the house was a small rectangular pit of unknown use. It measured 10 by 18 inches, was 6 inches deep, and was lined with small marsh reeds (Japanese-Yoshi), which had been converted into charcoal. No sherds were found in or near this small pit.

At many places around the sides of the house floor and at several places near the center were found charred wood representing fallen roof timbers. Four interior supporting posts for the roof were evidenced by the postmolds equally spaced in the four corners of the pit. These molds were from 18 to 20 inches deep and were rounded on the bottom. The postholes were about 1 foot in diameter, while the actual post mold was only 5 to 6 inches thick.

The location of the supporting posts and the orientation of the charred roof timbers indicate that the roof framing consisted of a square lintel connecting the tops of the four posts. The roof members were undoubtedly poles laid from the ground surface over the lintels and meeting in the center to form a four-sided pyramid. That this roof was covered with thatch is indicated by the presence of charred marsh reeds in quantity in the floor debris.

Since so much of the roof structure has been converted to charcoal, it seems that the roof must have been covered with earth that smothered the fire when the roof collapsed. The few Jomon Period sherds found in the pit fill could have come from the earth used on the roof. The earth had probably been scraped up from the immediate vicinity of the house. No trace of a prepared floor was found, nor were there any subfloor storage pits or additional hearths.

Cultural material found in the fill of the housepit was not plentiful. Stone implements (411646) consist of three retouched flakes of obsidian, apparently used as scrapers. Two basal halves of vessels of the Haji type (411644), and nine miscellaneous sherds (411645) of the same type indicate the occupants of the house. Eight Jomon Period sherds of the Nopporo type were found scattered through the fill dirt. The two fragmentary Haji vessels are flat-bottomed vases with flaring sides. One base is 3 inches and the other 3¾ inches in diameter. Both are marked with the impressions of a bamboo leaf, possibly *Sasa palmata* (identification by Dr. F. A. McClure, Department of Botany, U.S. National Museum).

Apparently in the manufacture of the vases, the molded base of moist clay was placed on a section of leaf, and as coils were added to build the sidewalls, the leaf was turned, thus serving as a turntable, and possibly in imitation of the potters' wheel. The clay of the two fragmentary vases is a pale yellow with occasional blotches of red or brown, apparently representing firing inequalities. Temper in both vases is quartz sand. Both vases are plain, though they show vertical marks of scraping of exterior surfaces and similar horizontal marks on inner surfaces.

A sample of the charcoal found on the floor of house 1 was collected for Carbon-14 dating. Dr. Meyer Rubin of the Low Level Radiation

Laboratory of the U.S. Geological Survey obtained the age of 1100 ±160 years (W–419).

A test trench 5 feet wide was dug from house 1 to house 2. This trench yielded no artifacts, but uncovering the subsoil revealed a shallow (24-inch deep) trench about halfway between the two houses, V-shaped in profile and running at right angles to the edge of the terrace. Due to insufficient time, this trench was not further explored, but it appears to have been a drainage ditch designed to receive and carry away water running off the roofs of the houses, and possibly to lower the water table in the vicinity of the pit dwellings.

The outlines of house 2 were traced by means of a trench similar to that around house 1. In the trench were found one triangular arrowpoint of obsidian (411649), six retouched flakes of obsidian, one of flint, and one of chalcedony (411650). Sherds found show the following distribution and varieties:

Type	*Rims*	*Body*	*Basal*	*No. of vessels*
Yoichi	—	3	2	2
Nopporo	3	6	1	3
Ebetsu	3	12	—	3
Satsumon	2	27	2	2
Haji	1	33	2	2

One of the Satsumon rimsherds shows a support perforation just below the rim made before the pot was fired.

House 2, like house 1, was roughly square but slightly larger. The sides measured 27.5, 28, 27.5, and 30 feet. The floor of the pit was 36 inches from the present surface. No trace of a prepared floor was found, and no entrance way was visible. The fireplace was located on the south side, just west of center, and a collapsed clay extension outside the housepit wall was probably the remains of either an air vent or a smokehole. Three postmolds were found in the corners, but the fourth, if it existed, was missed. These postmolds were about 1 foot in diameter and extended into the subsoil for 2 feet. No subfloor pits or similar features were found. As in house 1, large quantities of charred roof members were found on the floor, and the floor showed reddening by fire in several large irregular areas.

Artifacts found consisted of sherds and one obsidian flake scraper (411652). Sherds were found scattered throughout the fill, but one almost complete bowl was found at floor level only 2 feet from the hearth's edge. This bowl was found articulated, but was struck by a workman's shovel, and one piece was lost. Sherds of two other badly broken vessels were found concentrated in the southern half of the housepit, probably due to the proximity of the hearth.

The miscellaneous sherds found in the housepit show the following distribution and variety:

Type	*Rims*	*Body*	*Basal*	*No. of vessels*
Nopporo	1	25	3	3
Ebetsu	2	7	1	1
Satsumon	7	49	0	2

Vessel 1 from housepit 2 (411655) (plate 9) is an almost complete vase of Satsumon type. Since the base is missing, the exact height and base type cannot be determined. Overall height is in excess of 7 inches. The vase has expanding sides with a maximum diameter of 5½ inches, and a constricted neck having a diameter of 4 inches. The rim is strongly flared with an oral diameter of 5 inches. The paste is ellow clay containing a temper of fine quartz sand and minute flakes of obsidian. The exterior is plain except for vertical marks of scraping. No design is found on this vessel.

Vessel 2 (411654) (plate 10*a*) is a small, shallow bowl made on a potters' wheel. The characteristic spiral striations on the base (plate 10*b*) show the technique of severing with a cord the shaped bowl from the pedestal of clay from which the vessel was formed. The bowl is 2⅜ inches high and has a flat base and straight, expanding sides. Oral diameter is 4⅞ inches while the base is 1⅞ inches across. The clay is yellow and red. Tempering is primarily quartz sand. The use of a high-firing temperature is indicated by the glazed surface area roughly ¾ inch square on one side. Since other vessels at the site were made by the coiling method, the bowl is probably an importation, though from what source is not known.

Vessel 3 (411651) is an incomplete shallow bowl apparently hand-molded. Height is 1½ inches, oral diameter is 4 inches, and basal diameter is 1¾ inches. The clay is yellow with some areas of black clouding. The temper is quartz sand with some obsidian flakes.

Miscellaneous Sites

In addition to the excavations carried out at the Taniguchi, Uenae, and Tanaka Sites, surface collections were made at a number of other sites in the Ishikari Plain region of Hokkaido. These sites yielded materials representing most of the cultural periods of Hokkaido and supplementing the data obtained from the excavations. The following brief descriptions of the sites and the materials collected at each are arranged according to a cultural sequence based on the excavations and on presumably parallel cultural evolution in other parts of Japan.

Preceramic (?) Period

One mile east of the city of Iwamizawa at a place called Higashi-Tonebetsu is a hilltop on which hundreds of obsidian and flint chips were found, as well as occasional perfect or broken artifacts of stone. No pottery was found, either on the site or in its immediate vicinity. This lack of pottery indicates that the site is a preceramic horizon or that the site is a workshop without adjacent habitation sites. Collection from the site consists of:

Item	*USNM No.*	*Quantity*	*Plate No.*
Projectile, triangular, obsidian	411685	1	11*e*
Projectile, lanceolate, obsidian	411685	2	11*f*
Projectile, elongate, tanged obsidian	411685	2	11*d*
Projectile, stubby, tanged obsidian	411685	3	11*c*
Scraper knife, flint	411684	1	11*b*
Celts, broken and incomplete	411680	5	—
Chisels, polished	411683	3	11*a*

The celts and chisels are made from locally obtained boulders of glaucophane schist, or phyllite, both forms of metamorphosed shale (identified by Mr. James H. Benn, formerly of the U.S. National Museum). The obsidian is both of the speckled type and the plain type, which is translucent on thin edges.

Early Jomon Period

At Sunahama, located on the right bank of an abandoned channel of the Ishikari River, 1.8 miles west of Horomui, Ebetsu Township, is a small outcrop of cultural remains at a depth of 20 feet below the present surface of the flood plain. No excavations were undertaken, but a small collection consisting of sherds and two small triangular arrowpoints was made where these artifacts protruded from the deposit. The sherds appear to represent the cylindrical ware of the Early Jomon Period (Groot, 1951, p. 39). They are straight sided, flat bottomed, and cord marked over the entire outer surface. The paste is tempered with sand containing flakes of obsidian, and the ware is gritty to the touch. Designs occur only adjacent to the rim and consist of lines of pseudocord impressions parallel to and, rarely, at right angles to the lip. Rims are straight and rounded in cross-section, while six out of the seven rims show a notched rim top. Three sherds (411666) from this site are illustrated in plate 12*a–c*. The two arrowpoints found are of obsidian (411665).

Middle Jomon Period

One mile north of the town of Shimamatsu, on the road to Hiroshima, is a small site lying on a hill just north of an unnamed creek that flows into the Shimamatsu River. Surface indications of occupancy occur over a 10-acre tract and consist of chips, artifacts, and an occasional sherd. All sherds are of the Yoichi type attributable to the Middle Jomon Period. Fragments of grooved mullers are plentiful. Artifacts collected are:

Item	*USNM No.*	*Quantity*	*Plate No.*
Celts, pecked, unfinished	411657	2	–
Celts, polished	411657	2	–
Chisel, double-ended	411663	1	13*c*
Knives, tanged, flint	411661	11	13, *a–b, d*
Scrapers, flint flake	411660	1	–
Scrapers, obsidian flake	411660	1	–
Projectiles, lanceolate, obsidian	411658	2	–
Projectiles, stemmed, flint	411662	1	13*e*

On the property of Mr. Matsushima Saichi at the highest point of the hill mass just east of the town of Noboribetsu is a shellheap about 150 feet in diameter. According to Mr. Saichi, it is about 5 feet thick at the center and contains shells, bones, sherds, and earth mixed throughout. No excavation was undertaken, but a small surface collection was made. No sherds were collected, but the few seen appeared to be of the Middle Jomon Period. Stone artifacts collected are:

Item	*USNM No.*	*Quantity*	*Plate No.*
Muller, grooved	411671	1	14
Knives, tanged, flint	411667	2	–
Scraper, flint flake	411667	1	–
Projectile, stemmed, flint	411668	2	–
Abrader, sandstone	411670	1	–
Chisel, phyllite	411669	1	–

The chisel collected is 3¼ inches long, ¼ inch thick, and ⅞ inch wide.

At Tsuishikari, 1 mile west of the town of Ebetsu is a sandy hill bordering the Toyohira River just south of its confluence with the Ishikari River. This sandy emminence is probably part of an ancient sand-dune system. On this hill Japanese archeologists excavated many Ainu graves. These graves were not old, some being as recent as the middle of the 19th century. The graves yielded human bones in excellent condition, accompanied by iron swords and kettles, glass beads, brass wire ornaments, and other trinkets obtained by the Ainu from trade with the Japanese. In the topsoil between the graves and in some instances included in the backfill of the graves were found Jomon Period sherds and stone artifacts. During the present investigations, a 10-foot square test was dug to hardpan, but no graves or other features were met. In the topsoil of the test square and on the surface of the site were found the following:

Item	*USNM No.*	*Quantity*
Muller, grooved	411691	1
Celt, perfect	411689	1
Celts, broken	411689	3
Abrader, sandstone	411690	1
Scraper, flint	411688	1
Projectile, triangular, obsidian	411687	1
Sherd, base, Jomon Period	411686	1

Later Jomon Period

In the town of Hiroshima, east of Sapporo, is a rather large site on a hilltop north of the small stream that passes through the center of the town. In fields behind a large shrine and across from the town's primary school is a portion of a site containing hundreds of sherds and numerous stone artifacts and chips. Recent Ainu graves intrusive to the site yield glass beads, iron swords, etc., of Japanese origin. No excavation was made at this site, but surface collecting produced the following:

Item	*USNM No.*	*Quantity*	*Plate No*
Abrader, sandstone	411675	1	–
Hammerstone, jasper nodule	411676	1	–
Celt, broken	411674	1	–
Drill, T-shaped, flint	411679	1	–
Scraper, triangular, obsidian	411673	1	–
Arrowpoints, triangular, obsidian	411678	1	–
Arrowpoints, stemmed, obsidian	411678	1	–
Arrowpoints, stemmed, flint	411673	1	–
Sherds, rim, Nopporo type	411677	14	12*d–h*
Sherds, body, Nopporo type	411672	2	–
Sherds, basal, Nopporo type	411672	2	–

Summary

In summing up, I must first express the hope that the findings reported herein will stimulate and challenge others to enter the field of Japanese archeology. Additional research in this hitherto almost unexplored area will, no doubt, produce results that will contribute much to our knowledge of the prehistory of the entire Far East and north Pacific region, including the Bering Strait approaches to North America.

The stratigraphic evidence and the Carbon-14 dates from the three excavation sites demonstrate that Hokkaido has been the setting since at least 2000 B.C. for a sequence of cultures almost identical to that of Honshu. The many similarities in ceramics, stone implements, pit houses, and the hint of iron working at the Tanaka Site, as compared with the Ogawara Pit House Culture of northern Honshu, permit the conclusion that the people responsible for both sites were identical culturally and probably racially. Such a long time span with its numerous close parallels indicates frequent cultural contacts, if not actual migrations and intermarrying of the peoples of the two islands.

The indications of a nonceramic period in Hokkaido, while not conclusive, hint of a far longer occupation there by man before 2000 B.C. How much longer is unknown at this time. Recent finds on Honshu prove a preceramic occupation there, and more thorough search of Hokkaido may demonstrate a similar situation in the northern island.

The stemmed arrowpoint illustrated in plate 13*e* is identical to many found in America, and Japanese archeologists refer to it as the "American Indian type." Such stemmed points of flint are more frequent in collections of stone implements from Sakhalin than from Hokkaido, and they are almost never seen in Honshu collections. This distributional pattern indicates a probable dispersion from a source common both to America and Japan—probably northeastern Siberia. This problem must await further search on the mainland before it can be solved.

The identity of the people responsible for the Jomon Period materials and for the protohistoric Tanaka Site materials remains problematical at this time. I suspect that the people were of the same racial stock as the modern Japanese, but I cannot now prove this assumption.

The role of the modern Ainu and his ancestors in this archeological picture is also still too obscure for any positive statement. The Ainu graves at Ebetsu and Hiroshima and those adjoining the Tanaka Site reportedly have yielded intact skeletal material and grave goods of such recency that they can with certainty be dated within the past century or so.

During my explorations on Hokkaido I saw no archeological site that I could with certainty identify with prehistoric Ainu. Possibly the culture of the Ainu in early times was such that nothing but stone implements could survive. If so, this fact would account for the nonceramic sites on Hokkaido. We must, however, await more thorough stratigraphical explorations of the shell mounds, caves, and other sites on Hokkaido for answers to this puzzling problem.

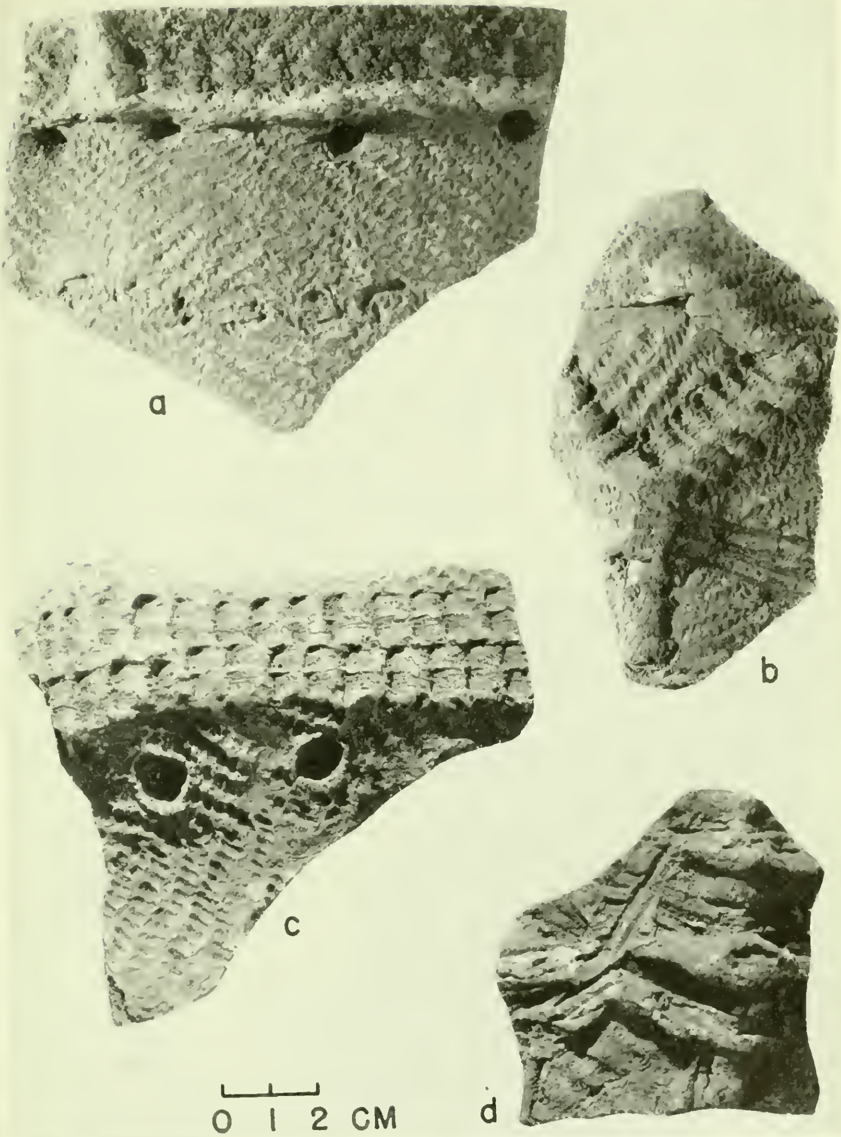
Literature Cited

Groot, Father Gerard
1951. The prehistory of Japan, Columbia University Press, New York, xvii+122 pp.

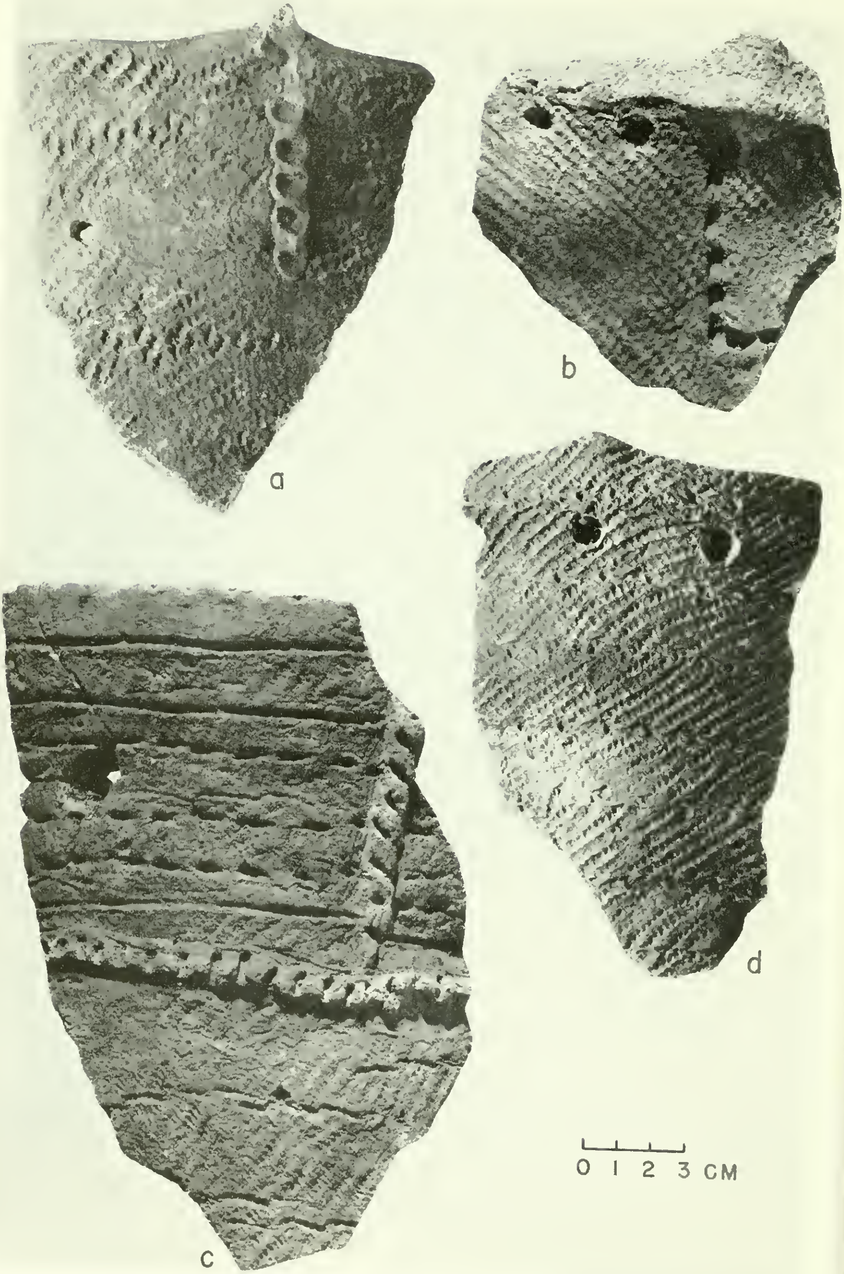
MacCord, Howard A.
1955. Contributions to the archeology of northern Honshu, Part II, Ogawara pit-house culture. American Antiquity, Salt Lake City, vol 21, No. 2, pp 149–61.

Rubin, Meyer; and Alexander, Corinne
1958. U.S. Geological Survey Radiocarbon Dates, IV. Science, vol 127, No. 3313, pp 1476–1487.

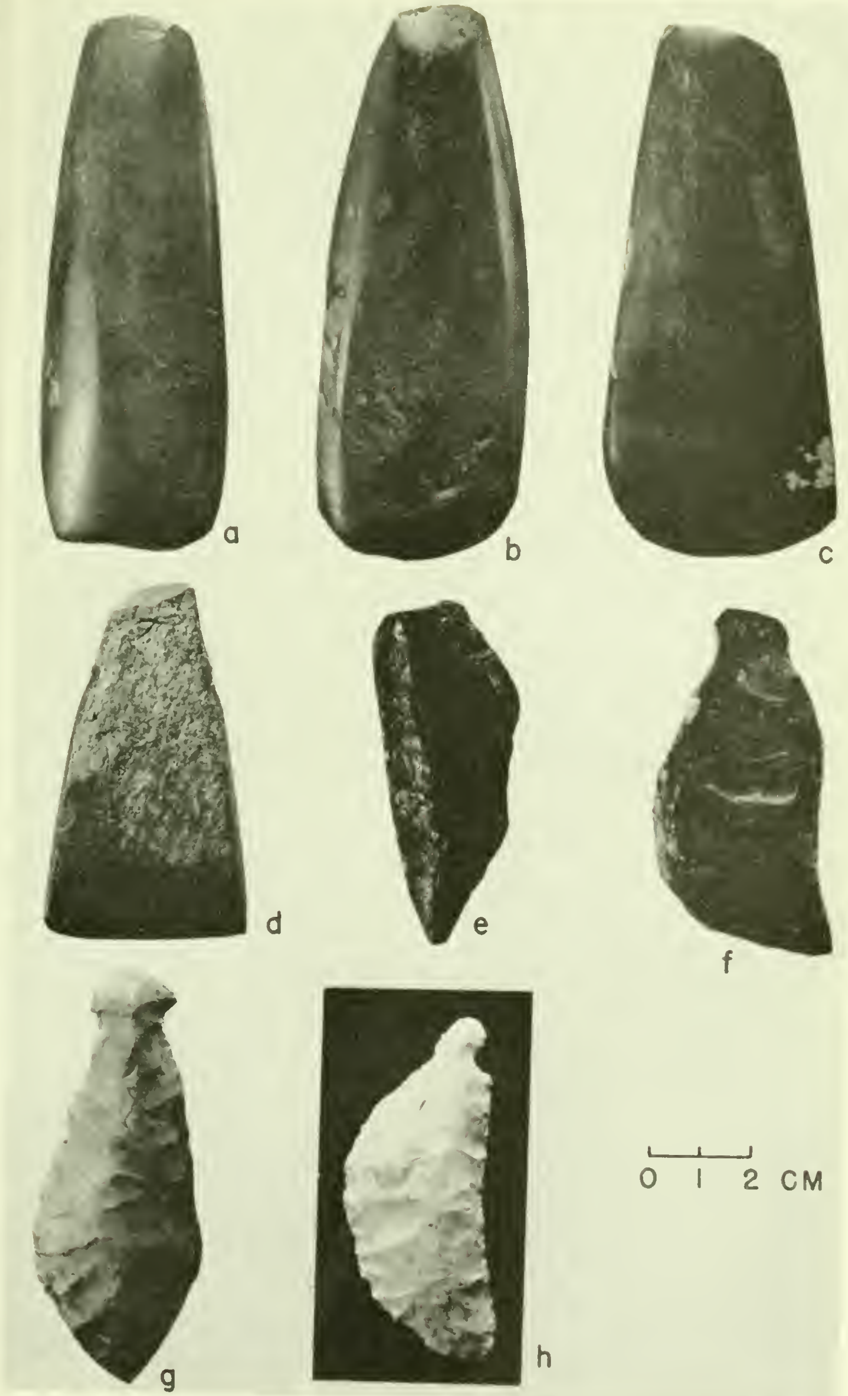
U. S. GOVERNMENT PRINTING OFFICE 1960



Rim sherds of Yoichi type (Middle Jomon Period) from Taniguchi Site. USNM Nos.: *a–b*, 411582; *c–d*, 411573.

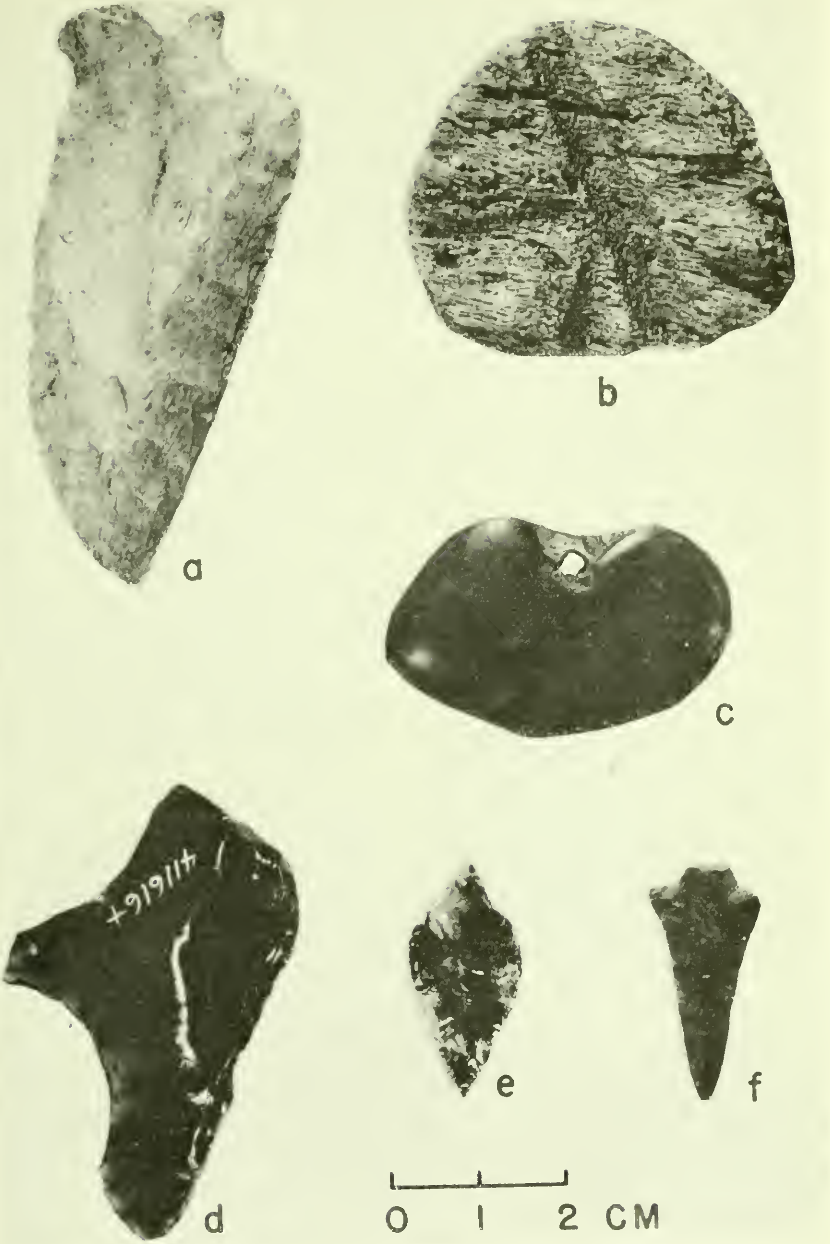


Rim sherds of Yoichi type (Middle Jomon Period) from Taniguchi Site. USNM Nos.: *a*, 411601; *b*, 411573; *c*, 411606; *d*, 411596.

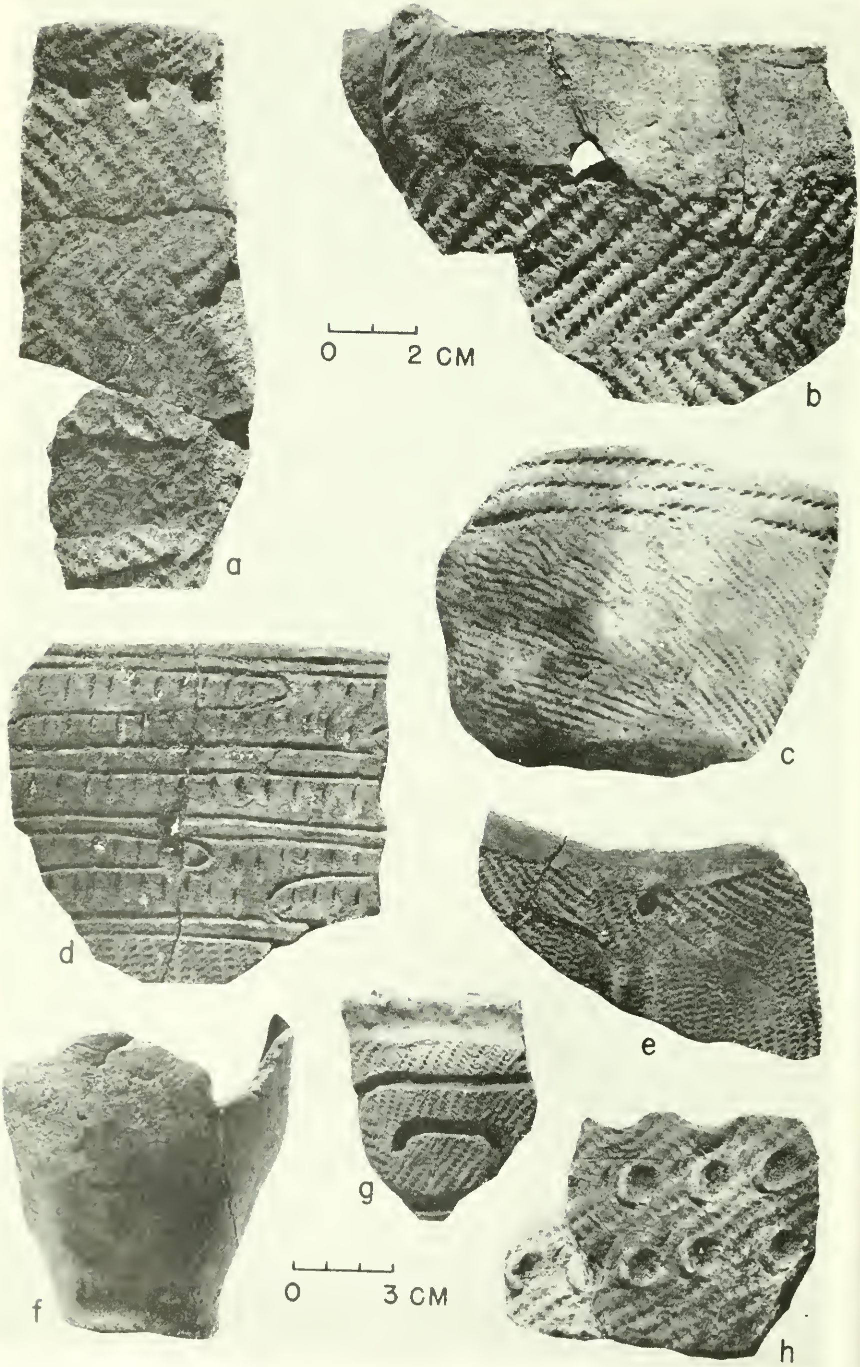


Stone artifacts from Taniguchi Site: *a–d*, celts; *e–h*, knives. USNM Nos.: *a*, *d*, 411571; *b*, 411589; *c*, *e–h*, 411549.

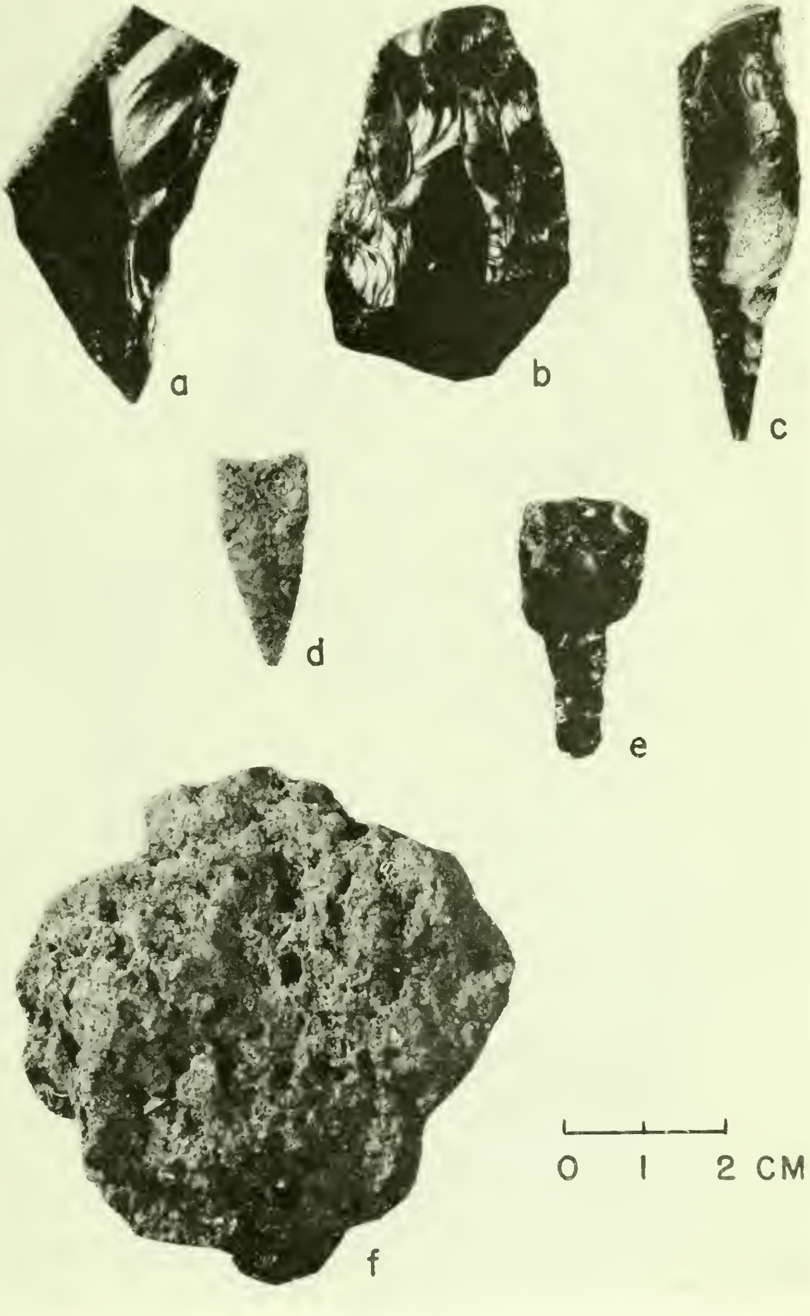
Obsidian artifacts from Taniguchi Site: *a–c*, chipped scrapers; *d–i*, projectile points. USNM Nos.: *a–c*, 411579; *d*, *f–g*, 411590; *e*, *i*, 411549; *h*, 411557.



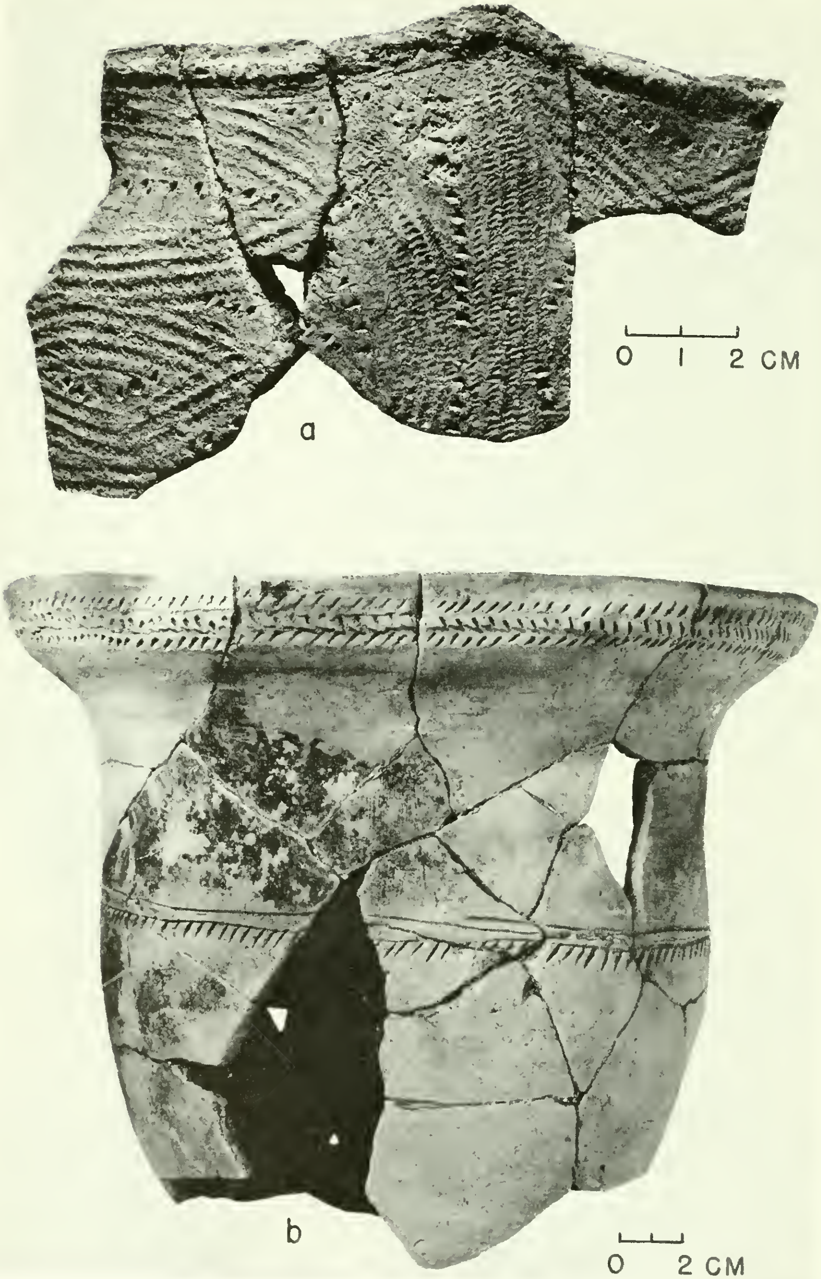
Stone artifacts from Uenae Site: *a*, notched tang blade; *b*, pumice "arrow-shaft" smoother; *c*, perforated pebble; *d*, obsidian scraper; *e–f*, obsidian projectile points. USNM No.: *a–f*, 411616.



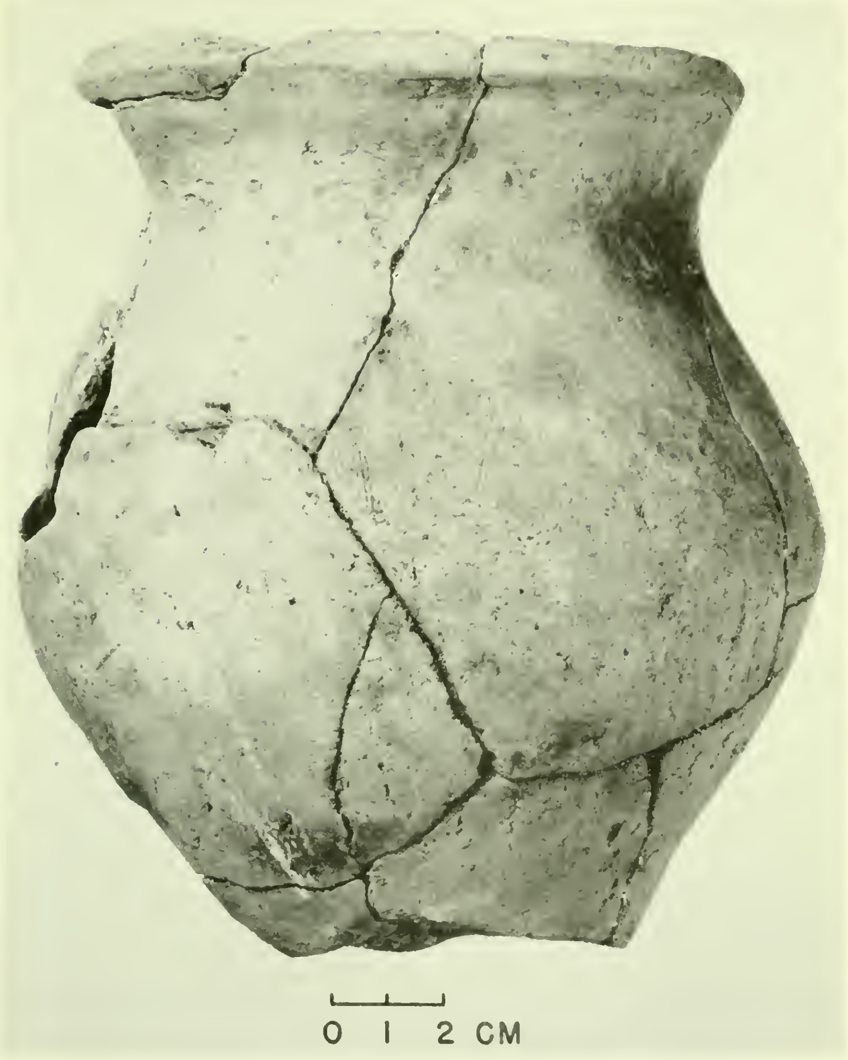
Pottery from Uenae Site: *a–b*, Yoichi type; *c–e* and *g–h*, Nopporo type; *f*, flat base related to Haji type. USNM Nos.: *a–b*, 411612; *c*, 411614; *d–e* and *g–h*, 411613; *f*, 411615.



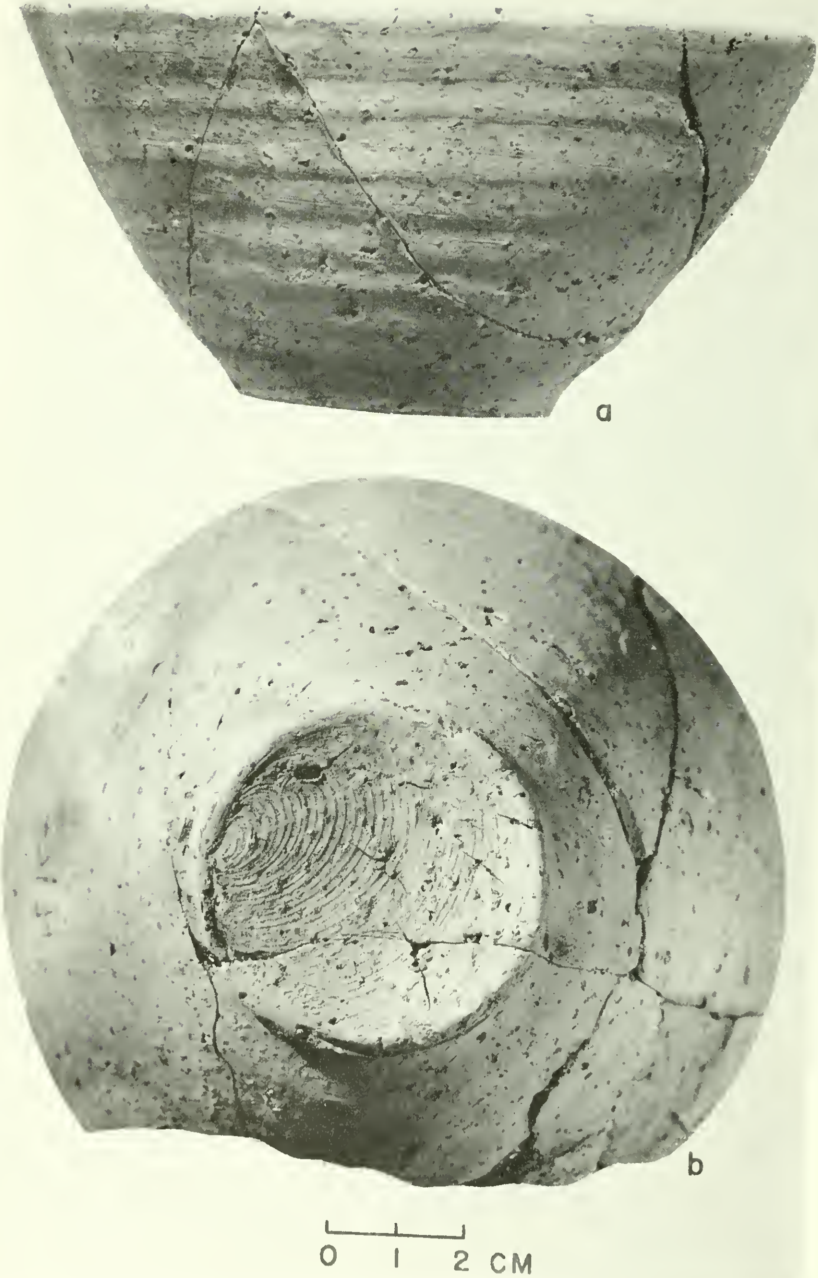
Stone artifacts and miscellaneous object from the Tanaka Site: *a–b*, chipped scrapers; *c* and *e*, drills or reamers; *d*, projectile point; *f*, lump of sponge iron. USNM Nos.: *a–e*, 411642; *f*, 411643.



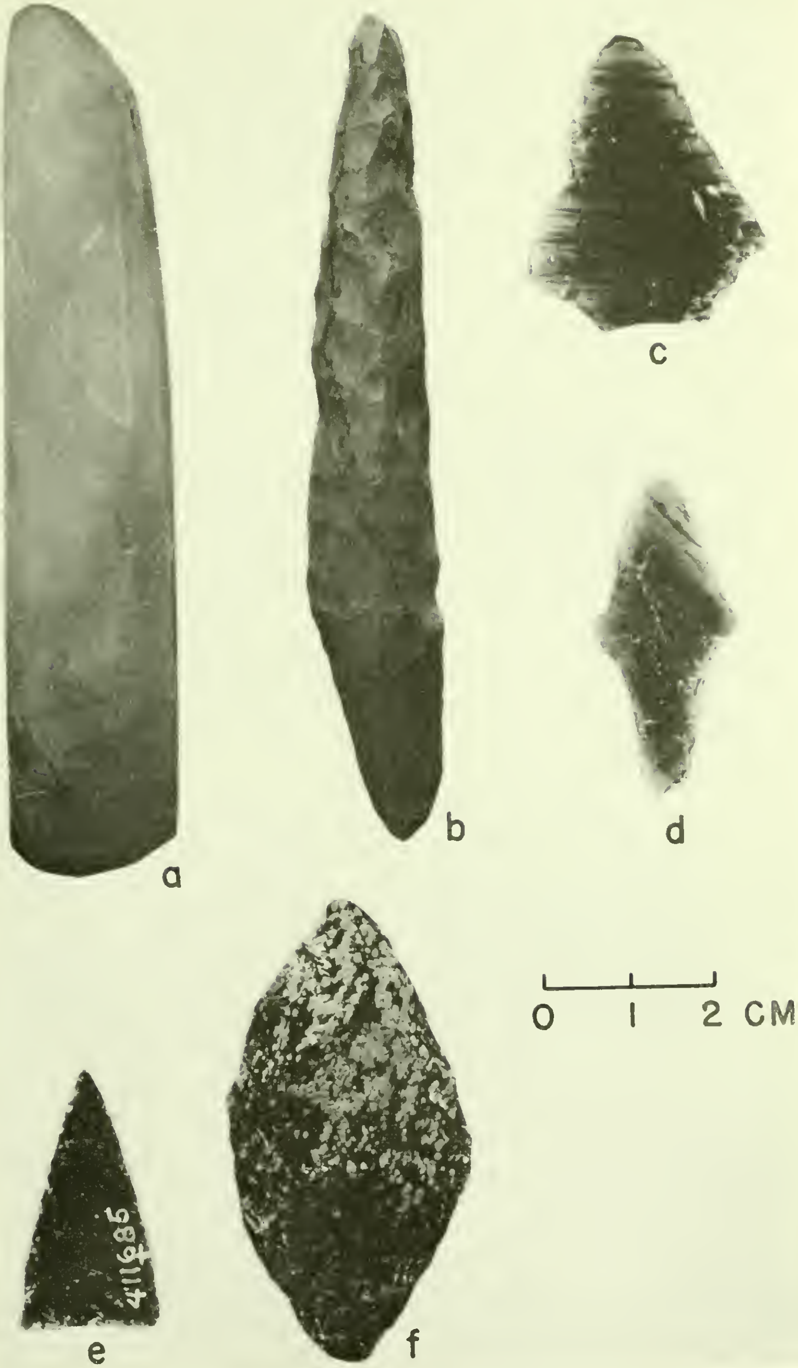
Pottery from house 1 of the Tanaka Site: *a*, Ebetsu type; *b*, Satsumon vessel. USNM Nos.: *a*, 411636; *b*, 411634.



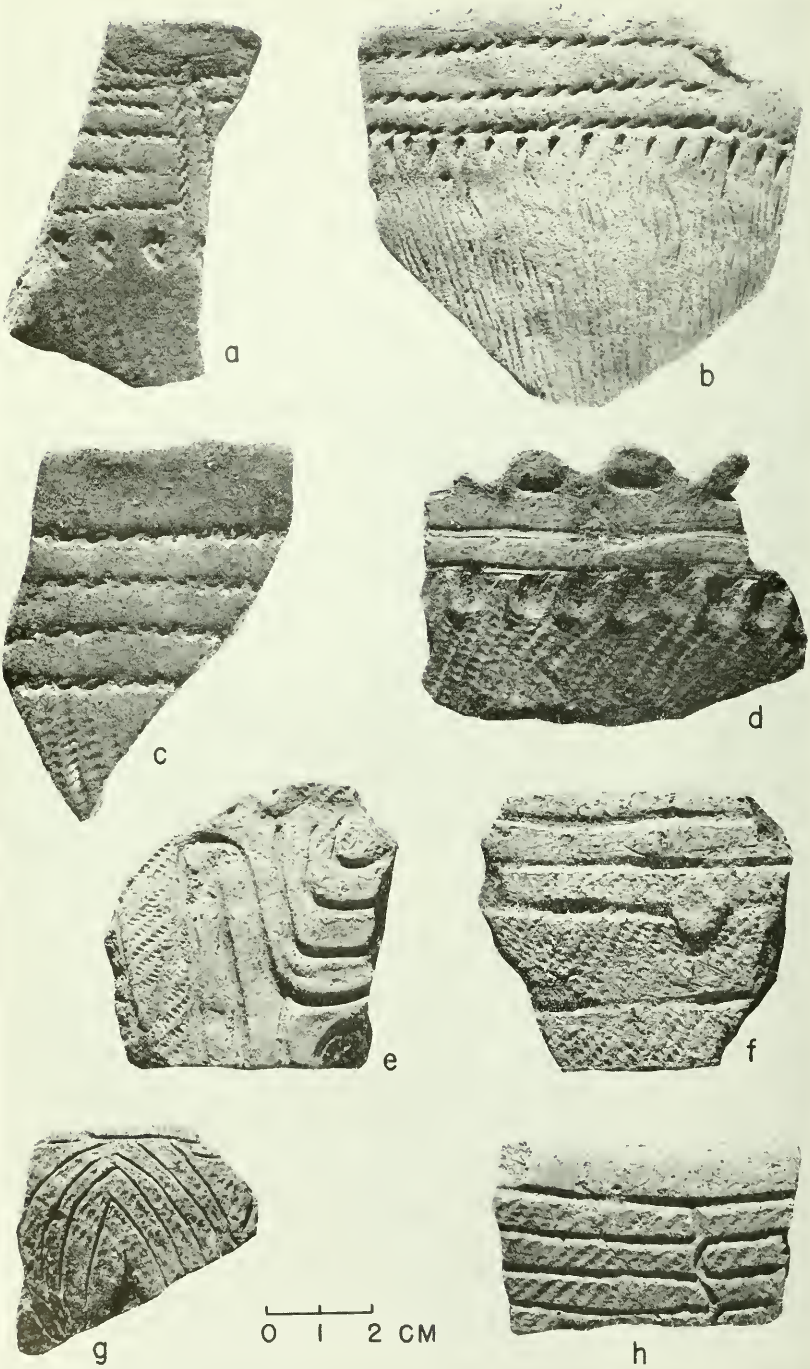
Satsumon vessel from house 2 of the Tanaka Site. USNM No. 411655.



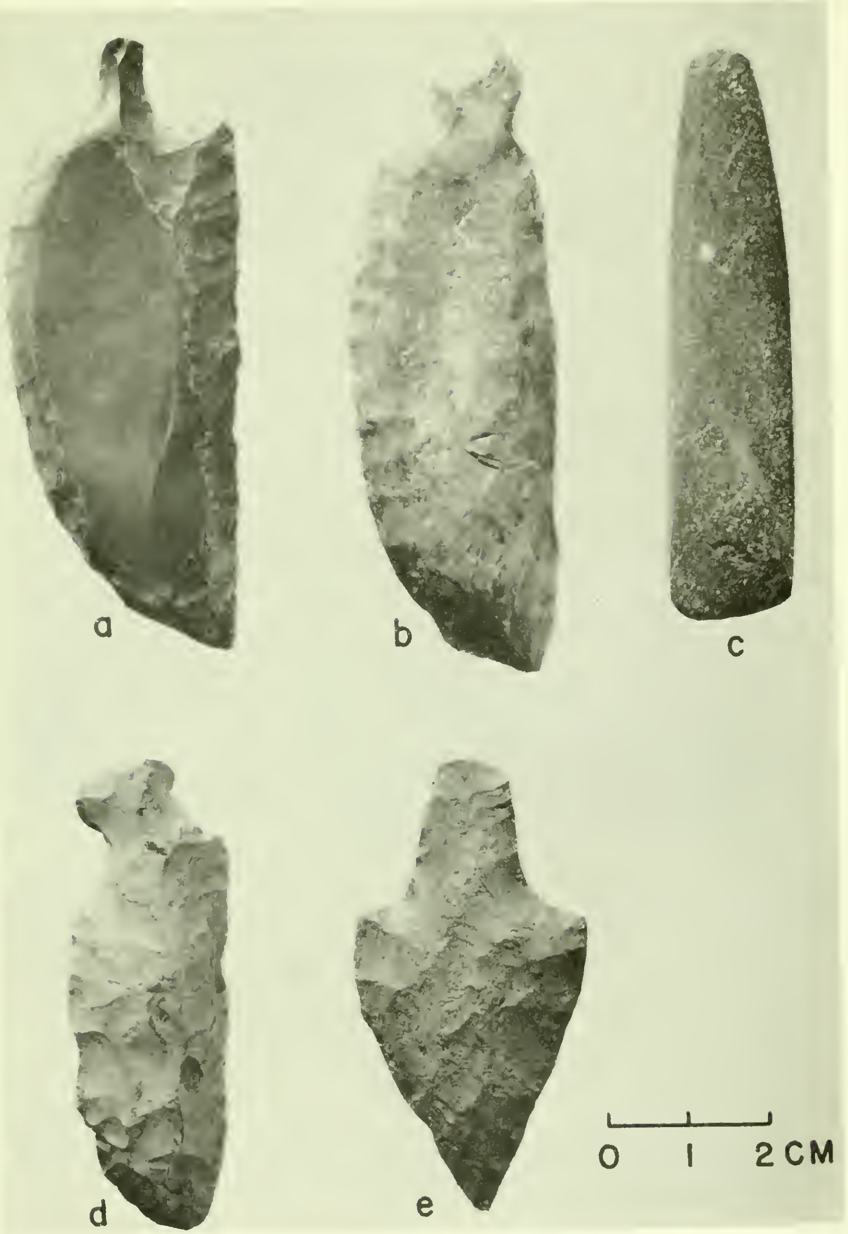
Pottery vessel made on potter's wheel from house 2 of the Tanaka Site: *a*, side view of vessel 2; *b*, base of vessel 2 showing the scar of severing from the pedestal of clay on the potter's wheel. USNM No.: *a-b*, 411655.



Stone artifacts from near Iwamizwa: *a*, polished chisel; *b*, flint scraper-knife; *c–f*, obsidian projectile points. USNM Nos.: *a*, 411683; *b*, 411684; *c–f*, 411685.



Sherds from near Sunahama and Hiroshima Site: *a–c*, Early Jomon Period sherds from Sunahama; *d–h*, Nopporo type sherds from Hiroshima Site. USNM Nos.: *a–c*, 411666; *d–h*, 411677.



Stone artifacts from Shimamatsu Site: *a–b* and *d*, tanged flint knives; *c*, polished double-ended chisel; *e*, stemmed flint projectile point. USNM Nos.: *a–b*, *d*, 411661; *c*, 411663; *e*, 411662.

Grooved muller from a shell mound near Noboribetsu, USNM No. 411671.

Proceedings of
the United States
National Museum

SMITHSONIAN INSTITUTION · WASHINGTON, D.C.

Volume 112 1960 Number 3444

NOCTUID MOTHS OF THE SCOPULEPES GROUP OF HEMEROPLANIS HÜBNER

By E. L. Todd[1]

Three distinct species of the American genus *Hemeroplanis* Hübner (family Noctuidae) have been confused in the literature and in collections for more than 50 years, the specimens being identified as *Hemeroplanis scopulepes* (Haworth) or as one or another of its synonyms. Specific differences exist, however, in the legs and genitalia of the males and in the maculation of the wings of the females. These differences are discussed and illustrated in this paper.

The three species—*H. scopulepes* (Haworth) (=*H. pyralis* Hübner, the only originally included species, and therefore the type of the genus), *H. aurora* (Walker), and *H. zayasi*, new species—are treated herein as the *scopulepes* group. The males of the species of this group have the tibiae of the hindlegs modified—each is decurved toward the apex and bears prominent dorsal hair tufts—while in the other species presently placed in the genus, the hindlegs are not so modified. In addition, in males of the *scopulepes* group (except males of the *geometralis* form of *scopulepes*) the coloration of the forewing basad of the postmedial line is some shade of yellow,[2] whereas in the other

---

[1] Entomology Research Division, Agricultural Research Service, U.S. Department of Agriculture.

[2] The author has seen specimens indicating that at least in some specimens this color may be some olivaceous shade, which fades after the specimens are killed.

species of *Hemeroplanis* the coloration of that portion of the forewing (or at least the median area of the wing) is some shade of brown or gray. Characters for group separation of the females, if existent, have not been recognized. Some of the females of the *scopulepes* group are colored as in the males, and may therefore be separated from females of other species of *Hemeroplanis*, but other females of this group are not so distinctly colored.

Nothing is known of the immature stages or the larval food plants of either the *scopulepes* group or the other species presently placed in *Hemeroplanis*.

A total of 127 specimens were available for study. Most were from the collections of the U.S. National Museum, but 25 specimens from the British Museum (Natural History) were sent by D. S. Fletcher, 1 specimen of *aurora* was loaned by J. G. Franclemont from the collection of the Department of Entomology, Cornell University, and 2 specimens were received from the private collection of Fernando de Zayas Muños of Havana, Cuba. Most of the line drawings were prepared by Arthur Cushman of the Entomology Research Division. The illustration of the genitalia of the type of *aurora* is presented through the courtesy of Mr. Fletcher. The adults illustrated on plate 1 were photographed by J. R. Foy, Photographic Service Section, Photograph Division, Office of Information, U.S. Department of Agriculture.

Key to the Species of the *scopulepes* Group

MALES

1. Middle tibia longer than basal segment of tarsus (fig. 3); a tuft of hairs present on lower surface of forewing in cell between bases of Cu_1 and Cu_2. **scopulepes**

Middle tibia modified, distinctly shorter than basal segment of tarsus (figs. 1 and 2); lower surface of forewing lacking tuft of hairs as above . . . 2

2. Inner (posterior) spur of middle tibia very long, as long as basal segment of tarsus (fig. 2); basal segment of tarsus not distinctly enlarged (fig. 2); apex of femur of hindleg not bearing a dark tuft of scales (fig. 2); uncus of genitalia short, stout, somewhat sickle shaped in lateral view (fig. 5*c*) . . . . **aurora**

Inner (posterior) spur of middle tibia shorter, about one-half as long as basal segment of tarsus (fig. 1); basal segment of tarsus enlarged, approximately as broad as tibia (fig. 1); apex of femur of hindleg with a dark tuft of scales (fig. 1); uncus of genitalia more elongate, nearly straight, but slightly cygnate apically (fig. 4*c*) . . . . **zayasi**

FEMALES [3]

1. Pale median line of postmedial band of upper surface of forewing bordered basally by a brown line or linear series of dark brown spots (plate 1, fig. 5); terminal black points usually present on upper surface of both the forewing and the hindwing (plate 1, fig. 5); lower surface of hindwing usually with three distinct transverse, serrate lines (plate 1, fig. 6). **scopulepes**

   Pale median line of postmedial band of upper surface of forewing usually not bordered basally by a brown line or linear series of dark brown spots (plate 1, figs. 2 and 8); dark terminal line or points of hindwing usually extremely vague or absent (plate 1, figs. 2 and 8); lower surface of hindwings usually with but two distinct transverse lines, the outer line (subterminal) vague or absent (plate 1, fig. 3) 2

2. Postmedial band of upper surface of hindwing only vaguely indicated (plate 1, fig. 8); fringe of lower surface of wings darker than ground color of wings . . . . **aurora**

   Postmedial band of upper surface of hindwing distinct (plate 1, fig. 2); fringe of lower surface of wings concolorous with ground color of wings . . . **zayasi**

Hemeroplanis scopulepes (Haworth)

FIGURES 3, 6; PLATE 1, FIGURES 4–6

Phytometra scopulepes Haworth, 1810, Lepidoptera britannica, pt. 2, p. 260.

Scopelopus scopulaepes (Haworth), Stephens, 1829, A systematic catalogue of British insects, pt. 2, p. 110; 1829 [1830 ?], Illustrations of British entomology, Haustellata, vol. 3, p. 124.

Hemeroplanis scopulaepes (Haworth), Barnes and McDunnough, 1918, Contributions to the natural history of the Lepidoptera of North America, vol. 4, No. 2, p. 122.—McDunnough, 1938, Check list of the Lepidoptera of Canada and the United States of America, pt. 1, Macrolepidoptera, Mem. Southern California Acad. Sci., vol. 1, p. 127.—Forbes, 1954, Lepidoptera of New York and neighboring States, pt. 3, Memoir 329, Cornell University Agric. Exp. Stat., p. 378.

[*Hemeroplanis* ?][4] *scopelopes* Seitz [1940–46 ?], Die Gross-Schmetterlinge der Erde, vol. 7, pl. 94, row *e*, 3rd fig. from right side.

Scopelopus inops Stephens, 1829 [1830 ?], Illustrations of British entomology, Haustellata, vol. 3, p. 124.

Hemeroplanis pyralis Hübner, 1818, Zuträge zur Sammlung exotischer Schmeittlinge [sic], Erste Hundert, p. 23, figs. 127–128.

Heliothis pyralis (Hübner), Walker, 1857, List of the specimens of lepidopterous insects in the collection of the British Museum, pt. 11, p. 687.

Pleonectyptera pyralis (Hübner), Grote, 1872, Trans. Amer. Ent. Soc., vol. 4, p. 23; 1874, Bull. Buffalo Soc. Nat. Sci., vol. 2, p. 44; 1876, Check list of the Noctuidae of America, north of Mexico, pt. 2, p. 42 [12]; 1880, Canadian Ent., vol. 12. p. 87.—Smith, 1891, List of the Lepidoptera of boreal America, p. 61; 1893, U.S. Nat. Mus. Bull. 44, p. 362.—Holland, 1903, Moth book, p. 246, pl. 29,

---

[3] The characters given will probably not separate all examples, but they are the best the author can offer at present. The characters utilized in the separation of *aurora* are based on a single female.

[4] As text is not available for the species illustrated on this plate and since specific names only are given for most of the species, it is presumed that *Hemeroplanis* probably would have been utilized. Plate 94 is one of several that were issued without text during or shortly after World War II. Seitz, the editor, is cited as author, since the individual or individuals responsible for the name *scopelopes* are unknown.

fig. 19.—Dyar, 1902, U.S. Nat. Mus. Bull. 52, p. 207.—Smith, 1907, Trans. Amer. Ent. Soc., vol. 33, p. 368, pl. 9, figs. 1–3; 1909, The insects of New Jersey, p. 472.—Grossbeck, 1917, Bull. Amer. Mus. Nat. Hist., vol. 37, p. 67.—Barnes and McDunnough, 1917, Check list of the Lepidoptera of boreal America, p. 88.

Hemeroplanis pyraloides Hübner, 1823, Verzeichniss bekannter Schmettlinge [sic], p. 259.—Druce, 1890, Biologia Centrali-Americana, Insecta, Lepidoptera, Heterocera, vol. 1, pt. 85, p. 412.

[*Hemeroplanis* ?][5] *pyraloides* Hübner, Seitz [1940–46 ?], Die Gross-Schmetterlinge der Erde, vol. 7, pl. 94, row *e*, last 2 figs. right side.

Poaphila irrecta Walker, 1865, List of the specimens of lepidopterous insects in the collection of the British Museum, pt. 33, p. 993.

Apicia denticulata Walker, 1866, List of the specimens of lepidopterous insects in the collection of the British Museum, pt. 35, p. 1544 [new synonymy].

Coptocnemia floccalis Zeller, 1872, Verh. Zool.-Bot. Ges. Wien, vol. 22, p. 476, tab. 2, figs. 10*a* and *b*.

Pleonectyptera geometralis Grote, 1872, Trans. Amer. Ent. Soc., vol. 4, p. 24; 1874, Bull. Buffalo Soc. Nat. Sci., vol. 2, p. 44; 1876, Check list of the Noctuidae of America, north of Mexico, pt. 2, p. 42 [12].—Smith, 1891, List of the Lepidoptera of boreal America, p. 61; 1893, U.S. Nat. Mus. Bull. 44, p. 362.—Dyar, 1902, U.S. Nat. Mus. Bull. 52, p. 207.—Smith, 1907, Trans. Amer. Ent. Soc., vol. 33, p. 370; 1909, The insects of New Jersey, p. 472.—Grossbeck, 1917, Bull. Amer. Mus. Nat. Hist., vol. 37, p. 67.

Pleonectyptera pyralis form *geometralis* Grote, Barnes and McDunnough, 1917, Check list of the Lepidoptera of boreal America, p. 88.

Hemeroplanis scopulaepes form *geometralis* (Grote), McDunnough, 1938, Check list of the Lepidoptera of Canada and the United States of America, pt. 1, Macrolepidoptera, Mem. Southern California Acad. Sci., vol. 1, p. 127.

Hemeroplanis scopulaepes var. *geometralis* (Grote), Forbes, 1954, Lepidoptera of New York and neighboring States, pt. 3, Memoir 329, Cornell University Agric. Exp. Stat., p. 378.

DISCUSSION: This species is extremely variable in maculation, so it is not surprising that the other two species, *H. aurora* (Walker) and *H. zayasi* new species, have been confused with it in collections. Typically the ground color of the basal and median parts of the wings is some shade of yellow while the terminal part is brown, but the ground color of the entire wing may be yellowish or some shade of brown.

The name *geometralis* Grote (=*Poaphila irrecta* Walker) has been applied commonly to those specimens in which the entire upper surfaces of the wings are more or less suffused with some shade of brown. For many years these dark specimens were treated as a distinct species, but more recently they have been considered to be but a form or variety (not geographical) of *scopulepes*. It would appear, judging from the dates on the labels of the specimens under examination, that the dark specimens represent the spring and/or winter (Florida) form. In the neotropical region this form appears to be uncommon, but it does occur occasionally.

---

[5] See footnote 4, p. 507.

Many of the specimens from the Antilles have the ground color entirely of some shade of yellow. There is no evidence at present, however, to indicate whether these pale specimens represent another seasonal form. If so, they probably should be named, but for the present I prefer to refer to them as "the pale form." Seitz [6] applied the name "*pyraloides*" to two figures of the pale form on plate 94, row e of volume 7, Die Gross-Schmetterlinge der Erde [1940–46 ?]. *H. pyraloides* Hübner should apply only to the typical form of *scopulepes*.

In addition to the characters indicated in the key, males of *scopulepes* may be recognized by the characteristic male genitalia (fig. 6).

Length of forewing: Male 11 to 16 mm.; female 12 to 16 mm.

TYPE: The present location of the type of *scopulepes* is unknown. It has probably been lost. Haworth described the species from a single specimen, obviously a male, in the collection of W. E. Leach via the Portland Museum. As the material from both the Haworth and Leach collections is now in the British Museum (Natural History), the type of this species should be in that institution, but Fletcher has been unable to locate it in that collection.

TYPE LOCALITY: Haworth listed the type as occurring in England, "Habitat in Anglia rarissime." But he obviously believed that it was not a native species because he states in the description: "Antennae, pedesque desunt in exemplario D. Leach; at in peregrino (forte ex Americae Georgiâ) pedes postici praesingulares, subtus hirsutissimi et exacte scopulaeformes" (Antennae and legs absent in the example of Mr. Leach; but in the exotic (probably from Georgia of America) the very remarkable posterior legs very hairy underneath and precisely scopuliform). Franclemont (1951, Proc. Ent. Soc. Washington, vol. 53, No. 2, p. 66) discusses other American species of moths that were described by Haworth and recorded as English species.

SYNONYMICAL NOTES: *Hemeroplanis pyralis* Hübner, 1818: Type locality "Georgien in Florida." The excellent illustrations (figs. 127–128) leave no doubt as to the proper application of this name. Barnes and McDunnough (1918) were the first to place the name in the synonymy of *scopulepes* and I concur in that placement. The present location of the type of *pyralis* is unknown. It may be in the Naturhistorisches Museum, Vienna, Austria.

Hemeroplanis pyraloides Hübner, 1823: Hübner proposed this name as a substitute for *pyralis* without explanation. The type is therefore ipso facto the type of *pyralis*.

Scopelopus inops Stephens, 1829: Proposed as a replacement name for *scopulaepes* without explanation. The type is ipso facto the type of *scopulepes*.

---

[6] See footnote 4, p. 507.

Poaphila irrecta Walker, 1865: Walker did not know the source or original locality of the specimen that he described under this name. Fletcher has examined the type in the British Museum (Natural History) and states in correspondence that it is a brown female of the form named *geometralis* by Grote. Therefore, if the brown form is to be recognized by the application of a form name, *irrecta* Walker would have priority. Smith (1893) treated this name as a synonym of *pyralis* Hübner.

Apicia denticulata Walker, 1866: Type locality "Georgia." Fletcher has also examined the type of this species, likewise in the British Museum (Natural History) and has informed me that is it also a female of the brown form. I therefore place this name in the synonomy of *scopulepes.*

Coptocnemia floccalis Zeller, 1872: Type locality "Texas." Described from a single male stated to be in the "Cambridger Museum" (Museum of Comparative Zoology at Harvard College, Cambridge, Mass.). It is clear from the original description and illustrations that his name is a synonym of *scopulepes*, and it was treated by Smith (1891) as a synonym of *H. pyralis* Hübner.

Pleonectyptera geometralis Grote, 1872: Described from a single female from Central Alabama in June. Grote compared it with specimens of *H. pyralis* Hübner taken at the same locality in July and stated that *geometralis* was "reddish fawn" to the postmedial lines. The type is in the collection of the Philadelphia Academy of Sciences.

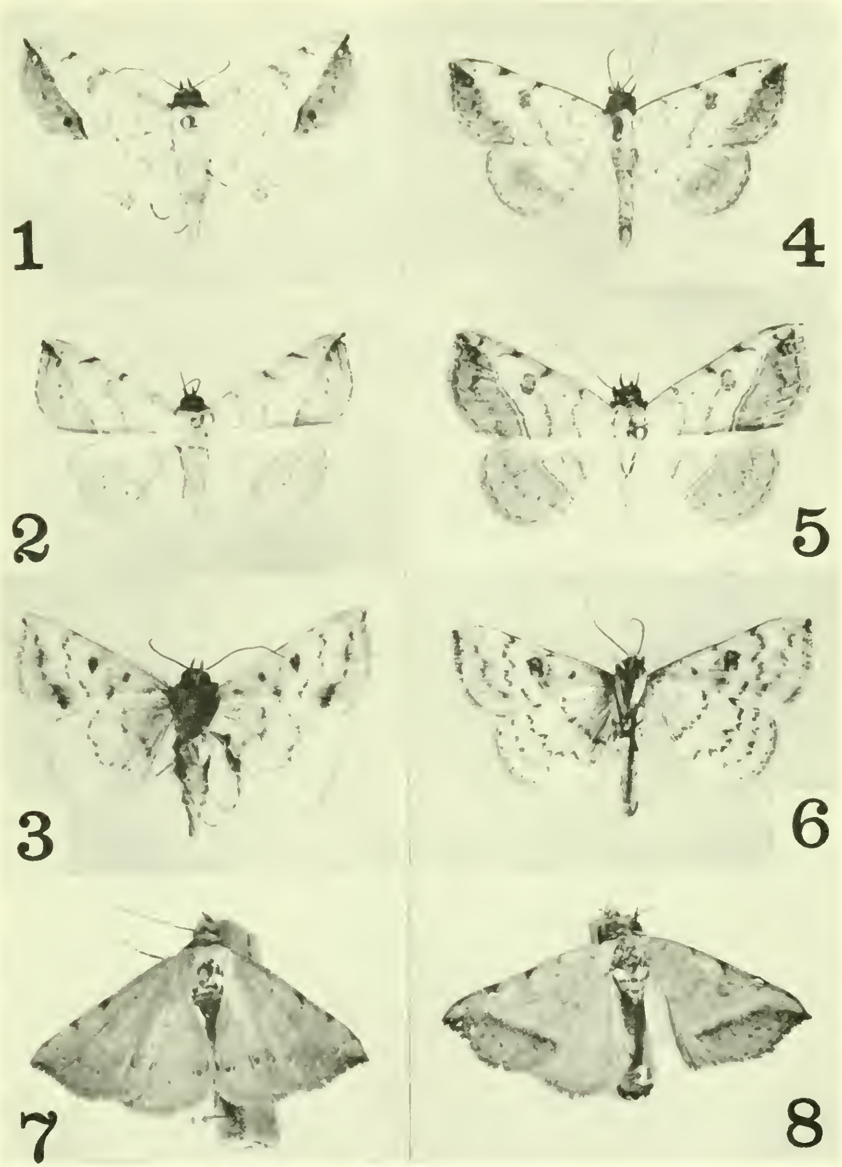
MISSPELLING: Stephens (1829) inserted an "a" after the "l" and thus made the name "scopulaepes" and has been followed in this action by all subsequent writers. He did not discuss the change, but in any event I follow the original spelling, "scopulepes." On plate 94 of Seitz (1940–46?) the specific name is spelled "scopelopes." Since the text referrable to this plate has not been published, the name, if an original proposal, has no status.

DISTRIBUTION: This species is known to occur from North Carolina (Raleigh) and Arkansas (Carrol County), through Central America, the Caribbean, and South America, to Argentina (Misionés), but it has not been reported from Puerto Rico. It was not present in a large collection of Noctuidae from that island recently studied by the author. The apparent absence of the species in Puerto Rico suggests that the species reached Cuba, Jamaica, and Hispaniola from the north and the Lesser Antilles from the south.

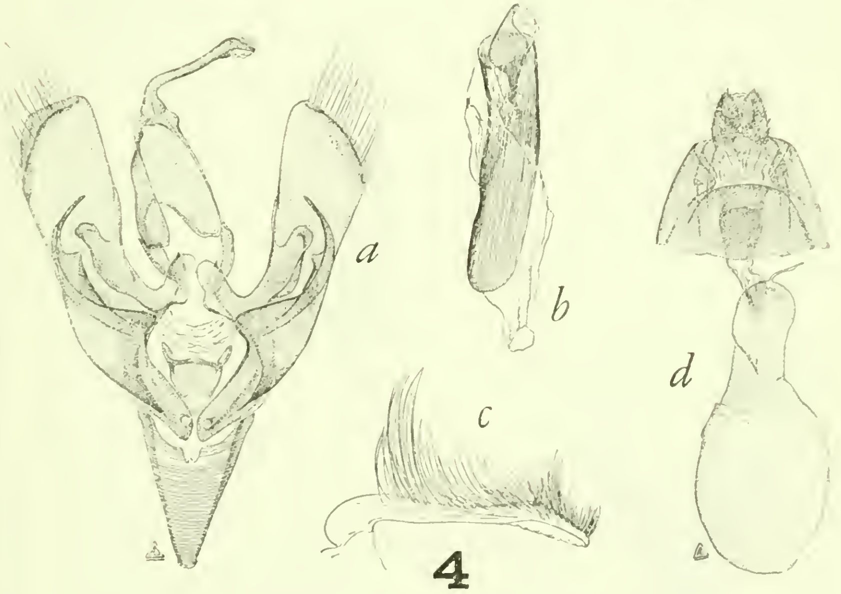
Hemeroplanis aurora (Walker)

FIGURES 2, 5; PLATE 1, FIGURES 7–8

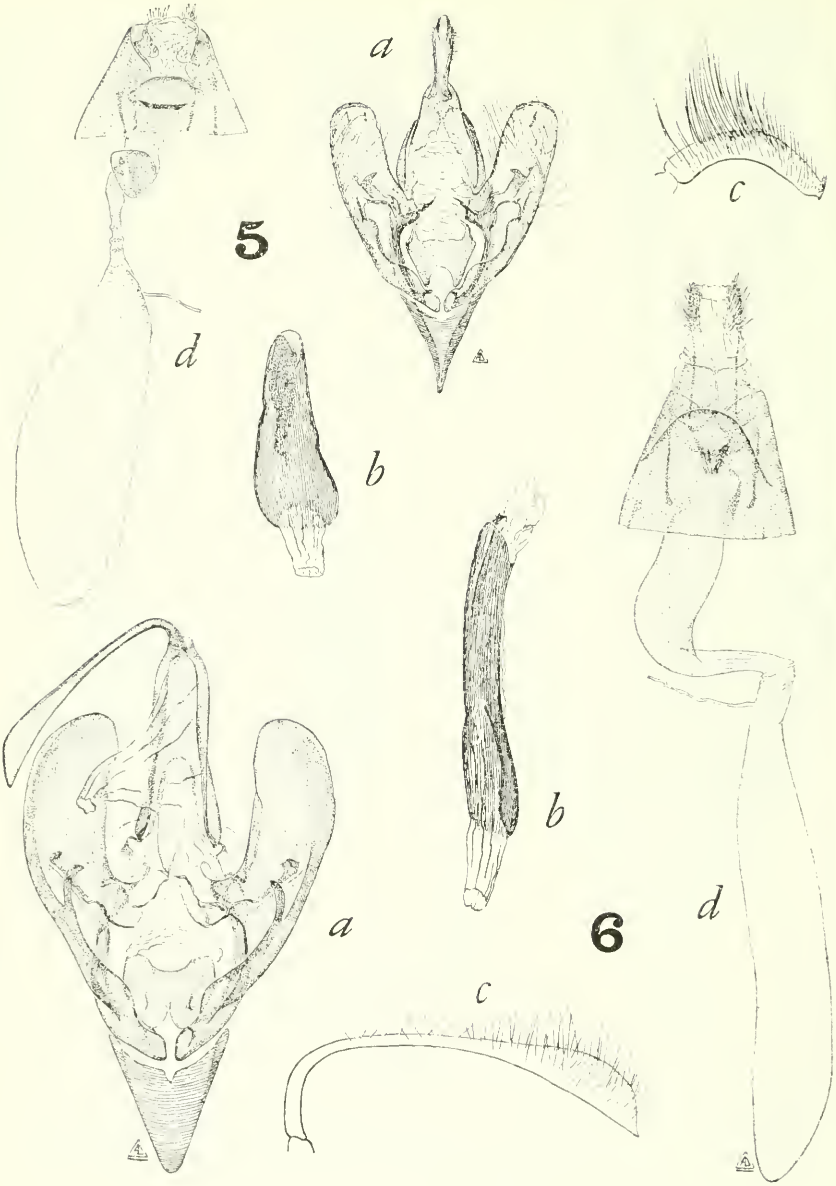
Thermesia aurora Walker, 1865, List of the specimens of lepidopterous insects in the collection of the British Museum, pt. 33, p. 1039.



Adults of species of the *scopulepes* group of *Hemeroplanis:* 1 and 3, dorsal and ventral views, holotype male of *zayasi*, Santiago, Cuba; 2, dorsal view, female of *zayasi*, Santiago, Cuba; 4 and 6, dorsal and ventral view, male, of *scopulepes*, Misantla, Mexico; 5, female of *scopulepes*, Matanzas, Cuba; 7 and 8, dorsal view, male and female of *aurora*, "St. Domingo."



Figures 1–4.—Hind and middle legs (figs. 1–3) and male and female genitalia (fig. 4): 1, *Hemeroplanis zayasi*, new species; 2, *H. aurora* (Walker); 3, *H. scopulepes* (Haworth); 4, *H. zayasi*, new species: *a*, male genitalia, aedeagus removed; *b*, aedeagus; *c*, enlarged lateral view of uncus of male; *d*, female genitalia.



Figures 5–6.—Male and female genitalia: 5, *Hemeroplanis aurora* (Walker); 6, *H. scopulepes* (Haworth). *a*, Male genitalia, aedeagus removed; *b*, aedeagus; *c*, lateral view of uncus of male, enlarged; *d*, female genitalia.

Discussion: *H. aurora* (Walker) superficially resembles *scopulepes*, but the tibia of the middle leg of the males of *aurora* are greatly reduced, and the undersurface of the forewing does not bear a tuft of hair as in *scopulepes*. Males of *zayasi* likewise differ in these two respects from *scopulepes*, but the basal tarsal segment of the middle leg is enlarged (nearly as wide as tibia) in *zayasi* and normal in *aurora*. The inner (posterior) spur of the middle leg is very long and slender (as long as basal tarsal segment) in *aurora* but only about half as long as basal tarsal segment in *zayasi*.

The three specimens of *aurora* that have been studied exhibit some differences in maculation of the wings from *scopulepes* and *zayasi*, but three specimens represent such a small sample that it is not known whether the differences are constant and accordingly characteristic of the species. In the males the dark terminal marking of the forewing is only slightly darker than the median part of the wing; the basal edge of the marking is diffuse and poorly defined. The subterminal series of dark points is well developed, the spots nearest the inner margin largest. The apical part of the hindwing distad of postmedial band is suffused with salmon pink and has a subterminal series of dark points present. The female appears to differ from females of the other two species in that the postmedial band of the hindwing is nearly obsolescent. In both sexes the reniform spot of the forewing is nearly obsolescent, while in the other species, especially *scopulepes*, it is usually well developed.

Length of forewing: Male 12 to 13 mm.; female 13 mm.

The characteristic male and female genitalia are illustrated (fig. 5).

Type: In the British Museum (Natural History), London, England.

Type locality: "St. Domingo."

Misidentification: This name was erroneously listed as a synonym of *Hemeroplanis pyraloides* Hübner, one of the synonyms of *H. scopulepes* (Haworth) by Druce (1890, Biologia Centrali-Americana, Insecta, Lepidoptera, Heterocera, vol. 1, pt. 85, p. 412).

Distribution: Only five specimens of this species are known in collections, and they are all from Hispaniola. In addition to the type, there are three other specimens in the British Museum (Natural History), all with labels identical to those of the type. It has been possible, through the courtesy of Fletcher and the authorities of the British Museum (Natural History), to study a pair of these specimens. The other specimen of *aurora*, a male, is from Pétionville, Haiti, May–June 1930, O. Fulda, and is from the collection of the Department of Entomology, Cornell University, Ithaca, New York.

Remarks: The specimens illustrated (plate 1, figs. 7–8) are not so dark as the photographs indicate. The ground color is not darker than most specimens of *scopulepes*, the apparent darker ground color being the result of different lighting and other photographic techniques. Because of space limitations, the underside of the wings of *aurora* have not been figured. In the single female the maculation of the underside is similar to that of *zayasi*, but the maculation of the underside of the hindwings in the males agrees more closely with that of *scopulepes* in regard to the development of the transverse lines.

***Hemeroplanis zayasi*, new species**

Figures 1, 4; Plate 1, Figures 1–3

Description: Head with front only slightly exceeding eyes; front narrow, about equal in width to eye. Eyes moderately large, globoid, naked. Ocelli present. Antennae filiform, weakly ciliate ventrally. Labial palpi slightly oblique, nearly porrect, reaching about to middle of front, clothed with small, appressed salmon pink and dull brown, pale-tipped scales.

Vestiture of front and patagia mostly of dull brown, pale-tipped scales, many bifid and hairlike. Vestiture of tegulae and thorax of yellow hairs over pale yellow scales. Abdomen yellow suffused with brown scaling. Large, white, lateral tufts of basal abdominal segment extending ventrad, covering abdominal sternites of basal segments.

Legs of male with femora and tibiae conspicuously tufted (fig. 1), tufts mostly salmon pink except distal tuft of hind femur black. Tibia of middle leg short. Basal tarsal segment enlarged, densely scaled (fig. 1).

Forewing about half again as long as wide (13:8); slightly falcate apically; termen weakly angulate at Cu_1; venation of quadrifid type, areole present in forewing. Maculation of wings as illustrated (pl. 1, figs. 1–3). Ground color of wings of male basad of postmedial band pale lemon yellow irrorated with brown, area distad of postmedial band rust brown. Ground color of wings of female variable, orangish-yellow, olivaceous or salmon brown, darker distally. Subterminal spot between Cu_2 and anal vein of forewing of male black; anal spot of hindwing of male salmon; elements of transverse band (when present) reniform and orbicular spots dull brown.

Underside colored about as upperside, except ordinary spots and lines darker brown, and terminal area paler.

Male and female genitalia specifically distinct (fig. 4). Uncus of male genitalia (fig. 4*c*) shorter and stouter than that of *scopulepes* but longer than that of *aurora;* apex of uncus membranous ventrally. Processes of inner face of valve larger and more heavily sclerotized in *zayasi* than in the other two species (see figs. 4*a*, 5*a*, and 6*a*). The aedeagus of *zayasi* shorter and stouter than that of *scopulepes*, longer than that of *aurora*, the vesical plate differently shaped in all three species (figs. 4*b*, 5*b*, and 6*b*). Female genitalia with ductus bursae shorter than in *scopulepes* and *aurora* and lacking a noticeable sclerotized area near the ostium (figs. 4*d*, 5*d*, and 6*d*).

Length of forewing: Male 12 to 14 mm.; female 13 to 15 mm.

Types. Holotype ♂, Santiago (Santiago de Cuba), Cuba, USNM 64634; 1 ♂ and 2 ♀ paratypes, same place, in USNM. 2 ♀ paratypes, Santiago (Santiago de Cuba), October 1902, W. Schaus; 1 ♂ paratype, Nassau, Bahamas, April 15, 1903, J. L. Bonhote; 2 ♂ paratypes, Mangrove Cay, Andros, Bahamas, January 11, 1902, J. L. Bonhote; 1 ♂ paratype, Bahamas (Nassau ?), April 15, 1903, L. Bonhote; 1 ♀ paratype, same place and collector, September 3, 1902, in the British Museum (Natural History), London, England. 1 ♂ paratype, La Breña, Moa.-Ote., Cuba, June, 1954, Zayas and Alayo; 1 ♀ paratype, Sierra de Cristal, Oriente, Cuba, June 1956, F. de Zayas in the collection of Ing. Fernando de Zayas Muños, Havana, Cuba.

Distribution: Presently known only from Cuba and the Bahama Islands.

Remarks: In addition to the characters presented in the key, the size and color of the subterminal spot between Cu_2 and anal vein in the forewing, the presence of the salmon-colored anal spot of the hindwing, and the more or less uniform ground color of the hindwing enable one to separate males of *zayasi* from males of the other known species of the *scopulepes* group.

U.S. GOVERNMENT PRINTING OFFICE: 1960

Proceedings of
the United States
National Museum

SMITHSONIAN INSTITUTION • WASHINGTON, D.C.

Volume 112 1960 Number 3445

LITHOGLYPTES SPINATUS, A BURROWING BARNACLE FROM JAMAICA

By JACK T. TOMLINSON *and* WILLIAM A. NEWMAN[1]

While in Jamaica in the spring of 1959, Stephen A. Wainwright of the Department of Zoology, University of California, collected specimens of the coral *Acropora palmata* containing the large burrowing barnacle, *Lithotrya*. At Berkeley we found associated with this barnacle a minute burrowing barnacle that has proved to be not only a new species, but a critical form in the taxonomic status of the families Chytraeidae and Berndtiidae of the order Acrothoracica. This Jamaican acrothoracican has given us grounds for uniting these families with an older family, the Lithoglyptidae.

The family Lithoglyptidae was established by Aurivillius in 1892 to accommodate three species of acrothoracicans: *Lithoglyptes indicus, ampulla*, and *bicornis*. Utinomi (1950b) established a family, the Chytraeidae, in which he placed *Lithoglyptes ampulla* and *bicornis* (under the genus *Chytraea*). This classification was made because an adhesive disc was not mentioned in Aurivillius' description of these two species, and Utinomi believed that they attached to their burrows by means of their apertural hooks and spines.

---

[1] The former is a member of the Department of Biology, San Francisco State College, San Francisco, California; the latter is a member of the Department of Zoology, University of California, Berkeley, California.

The species described here conforms to the diagnostic features of the family Lithoglyptidae, and except for certain specific differences it is very similar to "*Chytraea*" *ampulla.* This similarity extends to the details of the attachment area clearly illustrated by Aurivillius (1894) but disputed by Utinomi. The attachment disc in our form securely fastens the barnacle within its burrow.

We therefore believe that Aurivillius did not place two barnacles without attachment discs in a genus and family that he described as having a disc whose function is attachment. "*Chytraea*" *ampulla* and *bicornis* clearly belong to the family Lithoglyptidae and to the genus *Lithoglyptes* as originally described.

Utinomi (1950b) described the family Berndtiidae to accommodate a new species, *Berndtia purpurea* Utinomi (1950a). This barnacle is a burrower that attaches by an adhesive disc. The diagnostic features of the new family were such that it was necessary for him to include *Lithoglyptes indicus* in it. Since no particular diagnostic differences separate the Berndtiidae from the Lithoglyptidae and since the latter was described first, there is no justification for the family Berndtiidae. Thus, *Lithoglyptes indicus* and *Berndtia purpurea*, along with *Lithoglyptes ampulla*, *Lithoglyptes bicornis*, and the species described here, constitute the family Lithoglyptidae. *Weltneria spinosa* Berndt (1907) is placed incertae sedis in this family on the basis of its five pairs of terminal cirri. It appears to resemble *Berndtia;* however, the description is incomplete.

Family Lithoglyptidae Aurivillius (emend.)

Lithoglyptidae Aurivillius, 1892, p. 133.
Berndtiidae Utinomi, 1950b, p. 457.
Chytraeidae Utinomi, 1950b, p. 457.

Mouth cirri well developed, on a 2-jointed pedicle. Four to five pairs of terminal cirri, but if only four pairs, caudal appendage present (four pairs in original description). No gut teeth or gizzard in digestive tract. Adhesive disc on mantle. Lateral bar absent. Burrows in coral or mollusc hard parts.

Key to the Lithoglyptidae

1. Caudal appendages absent, five pairs of terminal cirri 2
   Caudal appendages present, four pairs of terminal cirri . . LITHOGLYPTES 3
2. Burrowing in coral . . . . **Berndtia purpurea** Utinomi, 1950a
   Burrowing in *Haliotis midae* . . . . **Weltneria spinosa** Berndt, 1907
3. Apertural hooks and spines absent, 6×4 mm.
   Lithoglyptes indicus Aurivillius, 1892
   Apertural spines or hooks and spines present 4
4. Apertural spines present (no hooks), 2.5×1.5 mm.
   Lithoglyptes bicornis Aurivillius, 1892
   Apertural hooks and spines present 5

5. Caudal appendage four articles, rami of mouth cirrus five and six articles, 4.5×2.5 mm., aperture one-fourth of mantle width.
Lithoglyptes ampulla Aurivillius, 1892
Caudal appendage two articles, rami of mouth cirrus four and five articles, 1.9×1.3 mm., aperture one-half of mantle width.
Lithoglyptes spinatus, new species

Genus *Lithoglyptes* Aurivillius

Lithoglyptes Aurivillius, 1892, p. 133 (emend.).

Four pairs of terminal cirri on a 2-jointed pedicle with oblique sutures at first joints. Caudal appendage present. Mouth cirrus with two rami of four to six articles (five to six articles in original description).

Lithoglyptes spinatus, new species

Figures 1–10

Diagnosis: Female (figs. 1–3 and 5–10): Aperture half greatest width of mantle, slightly arched, equipped with one pair of strong hooks and one pair of bristle-bearing spines. Anterior and posterior rami of mouth cirri with five and four articles, respectively. Caudal appendage with two distinct segments. Larvae retained until cyprid stage. Formalin-preserved specimens whitish with orange area surrounding aperture. Holotype 1.92 mm.×1.28 mm. About 40 barnacles associated with the thoracican *Lithotrya* in about 6 square inches of the dead algae-encrusted coral *Acropora palmata* from Salt Gut, Jamaica. The species is named for the presence of numerous spines and teeth around the mantle aperture.

Type specimens: Holotype, USNM 103729. Paratypes, California Academy of Sciences, San Francisco, California; Seto Marine Biological Station, Japan; Portobello Marine Station, New Zealand; Plymouth Laboratory, England; Muséum National d'Histoire Naturelle, Paris.

Description: Female: *Lithoglyptes spinatus* is obovate in lateral aspect (fig. 1). Twelve adults had an average height of 1.92 mm. (range 1.30 to 2.84 mm.) as measured from the basal end to the middle of the rounded apertural hooks. The average width of 1.28 mm. (range 0.94 to 1.86 mm.) was obtained by measurements from the muscle attachment knob to the opposite side of the mantle. The barnacles are flattened laterally and average about 0.28 mm. in thickness.

The mantle is provided with superficial bands of striated muscle radiating from the attachment knob, and from the basal area. There is no apparent musculature in the area of the aperture. Numerous small T-shaped teeth and short. stout spinules are scattered on the

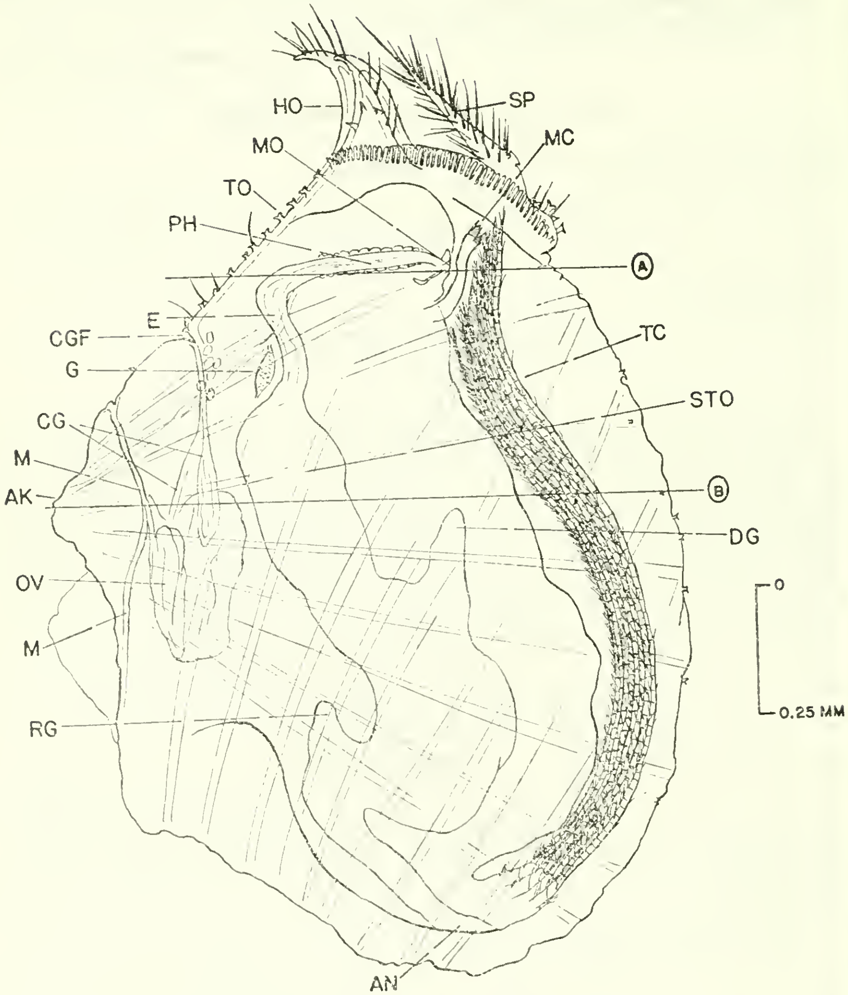
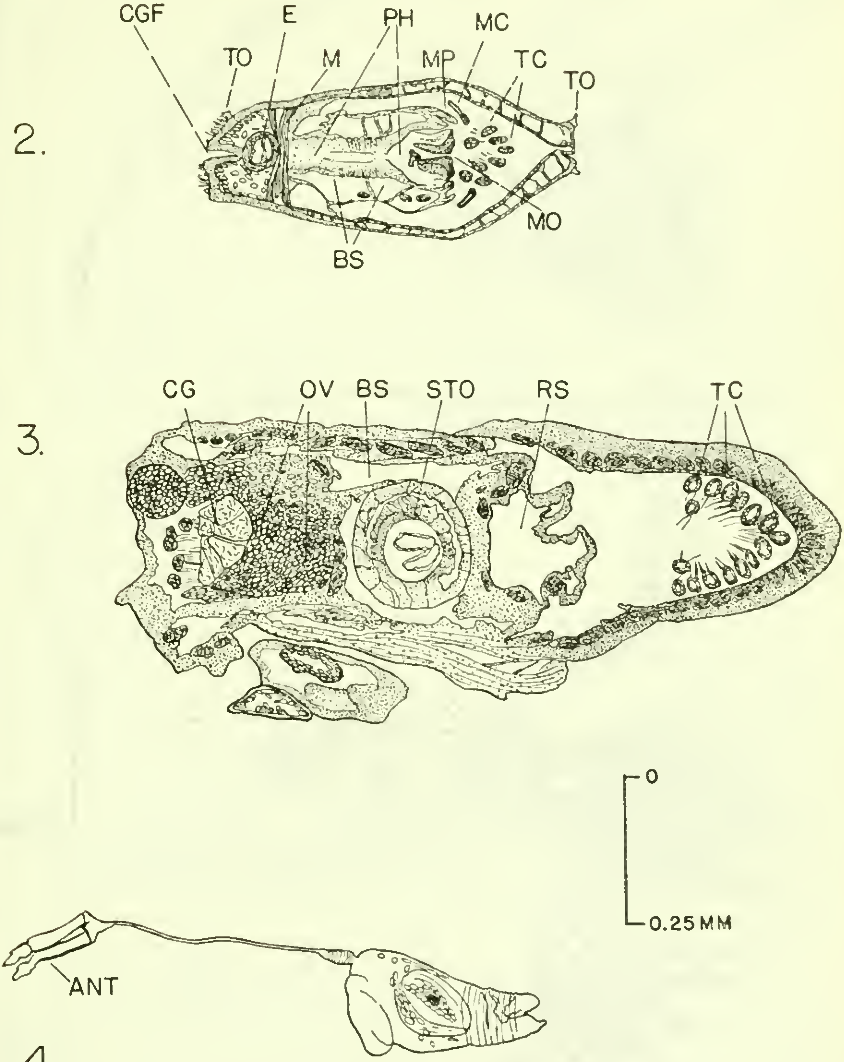
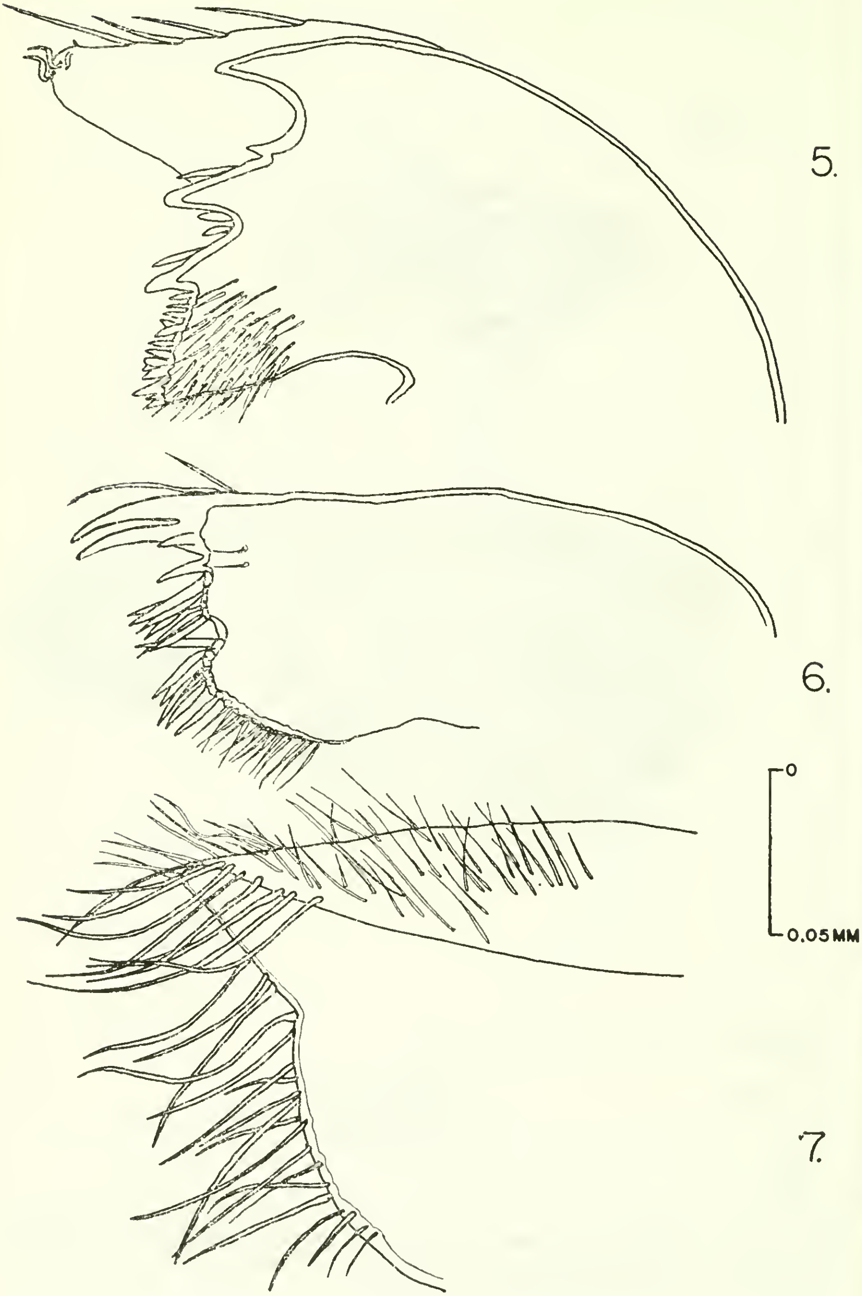


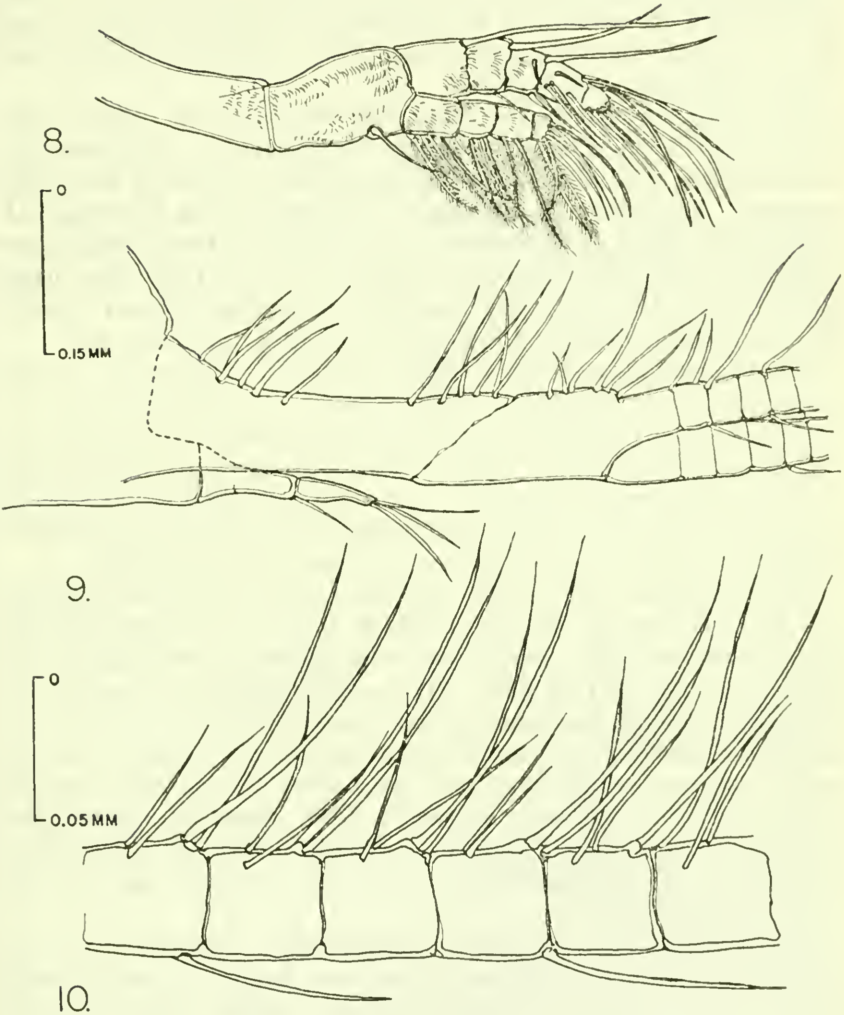
Figure 1.—*Lithoglyptes spinatus*, new species, holotype female, drawn from photographic enlargement and the specimen. Abbreviations: AK, attachment knob; AN, anus; ANT, antennule; BS, blood sinus; CG, cement gland; CGF, cement gland furrow; DG, digestive gland; E, esophagus; G, ganglion; HO, hook; M, muscle; MC, mouth cirrus; MO, mouth; MP, mouth parts; OV, ovary; PH, pharynx; RG, rectal gland; RS, renal space; SP, spine; STO, stomach; TC, terminal cirri; TO, tooth. Scale identical for figures 2–4, 5–7 and 8–9. Figures 2–10 made with the aid of a camera lucida.



Figures 2–4.—*Lithoglyptes spinatus:* 2, 3, cross-sections through female in regions indicated in figure 1 at levels A and B; figure 3 includes male in pocket on right side of female; 4, male. For meaning of abbreviations see figure 1.



Figures 5-7.—*Lithoglyptes spinatus:* 5, mandible and palp; 6, first maxilla; 7, second maxilla



Figures 8–10.—*Lithoglyptes spinatus:* 8, mouth cirrus; 9, fourth terminal cirrus and caudal appendage; 10, intermediate segments of outer ramus of fourth terminal cirrus.

surface of the mantle around the aperture and on the base of the hooks and spines. The remainder of the mantle is naked.

The attachment disc adheres strongly to the burrow, and the barnacles are not readily removed until the coral is decalcified. From the base of a groove formed by the heavily reinforced ridges between the disc and the aperture, a small duct opens to the exterior from what is believed to be a cement gland.

The average length of the slitlike aperture, based on 12 specimens, is 0.63 mm. Two large curved hooks are situated at the dorsal rim, and two large straight spines are situated near the ventral rim of the aperture. The hooks are essentially immovable while the spines, although not jointed along their length, have flexible basal attachments and can be opened outwardly in dead specimens from their usual position over the aperture. Comblike projections extend upward from both inside edges of the aperture and tend to occlude it.

The pharynx leads dorsally from the mouth. The gut then bends posteriorly as an esophagus which leads to the long stomach. A supraesophageal ganglion is situated just dorsal to the esophagus. A pair of round digestive glands arise from the ventral side of the stomach and project anteriorly. An unpaired, thick-walled pocket near the anus may represent a rectal gland. The elongate anus opens between the paired terminal cirri on the dorsal side of the body.

The mouth parts (figs. 5–7), composed of mandibles with palps and two pairs of maxillae, are typical for the genus. Each mandible has three strong, equally spaced teeth and numerous short spines and bristles on the cutting edge. The mandibular palp exceeds the mandible in length, and terminates in a tapering point; the edges bear a few long, soft bristles. Each first maxilla is armed with two strong teeth, numerous bristles and short teeth along the cutting edge, and is equipped with the usual apodeme. The second pair of maxillae are large and soft and have numerous flexible bristles distributed along their edges. These appendages are set close together and serve to cover the mouth field.

The mouth cirri (fig. 8) have a 2-jointed pedicle upon which the two bristle-bearing rami articulate. They arise below the mouth parts and can extend up to the aperture of the mantle. They normally curve with the tips directed outward from the body. The anterior ramus has five segments, and the posterior ramus has four segments. All segments of the rami are equipped with numerous bristles arising with no particular symmetry. Many of the posterior bristles are hairy or feathery.

There are four pairs of biramous, multisegmented terminal cirri. The articulations between the segments of the pedicles are slanted obliquely (fig. 9), a characteristic of the genus noted by Aurivillius (1892). The number of articles of the rami range from 30 to 50 (counts for one specimen), and increase in the posterior cirri. The rami are armed with long setae along their lesser curvature (fig. 10). The number and arrangement of these setae repeats itself on each article. A single seta occurs on every second to fifth articulation along the greater curvature of each terminal cirrus.

The posterior end of the body supports a pair of uniramous caudal appendages of two distinct segments each (fig. 9). The proximal segment bears a faint indentation suggesting a third articulation. The total length of the caudal appendage is about half the length of the pedicle of the posterior terminal cirrus.

Male (fig. 4): The degenerate male appears as a small simple sac with antennules for attachment. It is unique in that it possesses a stalk, often long and attenuated, between the antennules and the body proper. The stalk arises from a T-shaped connection with the two normal-appearing antennules and terminates in an annulated attachment to the body. The presence of a penis could not be confirmed. The male attached to the holotype female measured 0.91 mm. in overall length, and 0.34 mm. in body length. Usually one male was recovered in or near a pocket on the right side of the female (fig. 3) although two males attached to a single female were observed.

PHYLOGENY: Of the known forms of the Lithoglyptidae, *Lithoglyptes spinatus* from Jamaica is most closely related to *L. ampulla* from the Java Sea. Both of these forms are superficially similar and both inhabit corals. *L. spinatus* can be separated from *L. ampulla* by its proportionately larger aperture, its more numerous small hooks and spinules on the surface of the mantle, and by the lesser number of articles composing the rami of the mouth cirri and the caudal appendages. *L. ampulla* is twice as large as *L. spinatus*.

Armor in the form of large apertural hooks and spines would appear to be a primitive characteristic in the Acrothoracica. The arrangement of these structures occurs in a strikingly similar pattern in certain members of the Lithoglyptidae, Balanodytidae, and the Kochlorinidae. It is highly unlikely that such similar patterns could have arisen independently from the more naked members of these groups. Furthermore the most specialized (reduced) acrothoracicans have the most specialized habitats (e.g., *Trypetesa* within snail shells). The ability to attach by a disc and cement gland is also probably a primitive trait. The location and nature of this gland as seen in *Lithoglyptes spinatus* makes it highly probable that it is homologous to the cement gland and method of attachment seen in the thoracican Cirripedia. Acrothoracica without this gland should thus be considered as more highly modified forms.

It follows then that the Lithoglyptidae is the most primitive family of the Acrothoracica because of the heavy armament, the possession of cement glands, the large number of terminal cirri, and the caudal appendage seen in most species. In contrast to these primitive characters, members of the family Lithoglyptidae lack the specialized lateral bar, gizzard, and long labrum characteristic of the family Cryptophialidae and the degenerate uniramous terminal cirri of the family Trypetesidae.

Finally, it is interesting to note that *Lithoglyptes spinatus* from the Caribbean was found some 11,000 miles from other members of the family in the Indo-Pacific.

Literature Cited

AURIVILLIUS, C. W. S.

1892. Neue Cirripeden aus dem Atlantischen, Indischen, and Stillen Ocean. Öfv. Svenska Vet.-Akad. Förh., vol. 49, No. 3, pp. 133–134.

1894. Studien über Cirripeden. Svenska Vet. Akad. Handl., ser. 4, vol. 26, No. 7, pp. 1–107.

BERNDT, W.

1907. Über das System der Acrothoracica. Arch. Naturg., vol. 73, No. 1, pp. 287–289.

UTINOMI, H.

1950a. A new remarkable coral-boring acrothoracican cirriped. Mem. Coll. Sci., Univ. Kyoto, ser. B, vol. 19, No. 3, art. 18, pp. 1–8.

1950b. General account of Acrothoracica, *in* Professor Nakamura's Some problems of modern biology, Osaka (In Japanese).

U.S. GOVERNMENT PRINTING OFFICE: 1960

Proceedings of
the United States
National Museum

SMITHSONIAN INSTITUTION • WASHINGTON, D.C.

Volume 112 1960 Number 3446

NOTES ON MYSIDACEAN CRUSTACEANS OF THE GENUS LOPHOGASTER IN THE U.S. NATIONAL MUSEUM

By O. S. Tattersall, D. Sc.

The manuscript of U.S. National Museum Bulletin 201, "Review of the Mysidacea of the United States National Museum," by W. M. Tattersall, was completed in 1939 but, owing to wartime restrictions, was not published until Oct. 4, 1951. During the intervening 12 years, literature containing references relevant to Tattersall's work appeared and some systematic changes were introduced. The most important of these were contained in two beautiful "*Dana* Reports" (Nos. 19, 23) on the Lophogastrida collected by the *Dana* Expeditions (Fage, 1941; 1942). Of these two, only the second deals with the genus *Lophogaster.*

Interchange of literature at the time was impossible and, although Tattersall, who died in 1943, was aware that a 1940 publication by Fage contained preliminary diagnoses of certain new species of the genus *Lophogaster,* he never saw it or the subsequent *Dana* Reports.

When literature once more became available, it was evident that many amendments would have to be made to Tattersall's Bulletin 201 in order to bring it up to date with the time of its publication.

To this end Professor A. H. Banner (1954) of the University of Hawaii compiled a concise and very careful supplement enumerating additional records of known species and noting the foundation of new ones. Doubts concerning the systematics of any species arising as a result of these records were indicated, but their resolution was left until actual reexamination of the material could be carried out.

In the 1942 *Dana* Report, Fage established certain new criteria whereby species of the genus *Lophogaster* could be distinguished, and instituted a number of new species based on these specific characters. Tattersall had also founded new species in this genus but in his descriptions and figures had not mentioned the characters that Fage regarded as of specific significance.

As both workers dealt in some cases with material from the same localities, it seemed probable that some of the new species were synonymous. The question could only be answered by a reexamination of the material in the collections with which Tattersall had worked. This reexamination I was recently privileged to make at the U.S. National Museum of the Smithsonian Institution, in Washington, D.C. I wish to express my very great gratitude to Dr. Waldo L. Schmitt and to Dr. Fenner A. Chace, Jr., and his staff in the Division of Marine Invertebrates for all the help and kindness that they have given me during the course of this work and for all the facilities accorded me during my stay in Washington.

By the great kindness of Dr. Elisabeth Deichmann, of the Museum of Comparative Zoölogy, Cambridge, Mass., I have been allowed to examine paratypes of *Lophogaster longirostris* Faxon and have illustrated from them those characters set forward as specific by Fage. The illustrations supplement the original description of this species.

I am greatly indebted to Mr. Vernon E. Brock, Pacific Oceanic Fishery Investigations, for very kindly sending me material from Hawaiian waters for comparison with specimens in the collections of the U.S. National Museum. As a result, I am able to comment on Fage's species *Lophogaster schmidti* and to record it from the tropical central Pacific.

It has not been possible to obtain the types of *Lophogaster intermedius* Hansen, but I have examined specimens from the Mergui Archipelago, eastern Indian Ocean, which were referred to *intermedius* by Tattersall (1922), and have been able to compare them with the specimen from *Albatross* station 4944, referred doubtfully to this species by Tattersall (1951, p. 20).

Genus *Lophogaster* M. Sars

Lophogaster M. Sars, 1857, p. 160.
Ctenomysis Norman, 1862, p. 151.

Remarks: The genus *Lophogaster* is so homogenous and its generic characters so clearly defined that it can readily be distinguished from closely related genera of the suborder. On the other hand, the separation of its species has always presented great difficulty to the taxonomist because of the slight differences in their specific characters and of individual variation that may occur. As a result, there has been much confusion in the records of members of this genus in the past.

Differences between species lie not so much in the general form of the animals as in the degree of development of certain characters such as the length of the various spinous processes, the shape and relative length to breadth of the antennal scale and the number of denticles on its outer margin, the proportions and armature of the telson, and the amount of tuberculation or spinulation of the integument of the carapace.

Fage (1942, p. 5) noted that in most species of the genus, noticeable sexual differences occurred in some of these characters. Frequently the rostrum and sometimes other spinous processes became more elongated in larger females than in the males and young individuals. There is also a tendency for the number of spines arming the lateral margins of the telson to be greater in males than in females of the same species and for any tuberculation or spinulation of the carapace to be more pronounced in males.

Fage (1940, 1942), when reporting on the very rich collections of this genus made by the *Dana*, noted two characters which proved to be much more constant, and therefore much more useful as taxonomic guides, than those hitherto used. These characters were (1) the form of what he termed the "antennular scale" [1] (the lamellar prolongation from the inner region of the distal margin of the third segment of the antennular peduncle) and (2) the dorsal profile, in lateral view, of the wings of the carapace together with the size and direction of the posterolateral or alar spines, when these were present.

Specimens of *Lophogaster* have been recorded from various localities in all the tropical and warmer temperate waters of the world, including the Mediterranean and the Red Sea. Fage noted that animals showing a correspondence in the form of their spinous processes, and in his new characters, sufficient to justify placing them in separate

---

[1] As this platelike prolongation is in no way homologous with the antennal scale (which is the modified exopod of the antenna), it is perhaps confusing to call this structure a "scale." I have therefore used the word "lamina" for it throughout this work.

species were almost invariably confined within circumscribed and isolated geographical regions.

Investigation of the hydrography of these areas revealed that only very slight temperature variation occurred in them, and Fage suggested that this factor is the dominating one restricting the spread of the *Lophogaster* population. He advanced an interesting hypothesis to explain the sporadic distribution of the members of the genus and the restriction of each to its own isolated locality in the world today. He suggested that these isolated species represent the survivors from an ancestral form which in earlier epochs was widely spread throughout the world. Owing to an inability to tolerate changes of temperature, this early form died out in those regions in which, owing to geological changes, considerable variations in temperature occurred. Only in isolated areas where the temperature remained relatively stable did remnants of the old stock survive and in their enforced isolation evolve those combinations of small differences whereby they may be separated into species today.

There is much to commend this hypothesis. Certainly the geographical distribution is a most valuable guide for the identification of species, though one or two cases are known of more than one species occurring in the same area. The correlation of distribution with areas which have a small range of temperature is most striking. Where there is a horizontal spread in the range of a species, this spread is usually associated with the flow of warm or cooler ocean currents.

At the present time the genus includes 15 species, but the present research has convinced me that 2 of them are synonymous with 2 previously described species. The 13 remaining species are distributed as follows:

Atlantic and Western Indian Oceans

1. *L. typicus* M. Sars (1857): coastal waters of western Europe from southern Norway to the Bay of Biscay, west of Ireland; Mediterranean.
2. *L. subglaber* Hansen (1927): south of Spain off Cadiz and Gibraltar.
3. *L. spinosus* Ortmann (1906): tropical midsouth Atlantic and off Puerto Rico, the Bahamas, and between the Bahamas and the coasts of the Carolinas. These regions have the highest temperatures in the Atlantic of the Northern Hemisphere.
4. *L. longirostris* Faxon (1896, = *L. americanus* W. M. Tattersall, 1951): Gulf of Mexico, West Indies, and along the path of the Gulf Stream to the waters off Massachusetts.
5. *L. challengeri* Fage (1941): coastal waters off South Africa from Cape Town to Angola in the path of the Benguela Current.
6. *L. rotundatus* Illig (1930): off the Saya da Malha Bank, Central Arabian Sea; Straits of Zanzibar and off the coast of southeast Africa to Durban and Port Elizabeth along the path of the warm southward flowing Mozambique Current.
7. *L. affinis* Colosi (1930): Red Sea, northern and central region.
8. *L. erythraeus* Colosi (1930): south of the Red Sea near Bab el Mandeb.

Pacific Ocean

9. *L. pacificus* Fage (1940, = *L. japonicus* W. M. Tattersall, 1951): China Sea to north of Formosa and off the east and southeast coasts of Japan in the path of the warm Kuora-Shio Current, inhabiting higher levels as the current flows northward.
10. *L. hawaiensis* Fage (1940): around Hawaii.
11. *L. intermedius* Hansen (1910): off the Moluccas, southeast of Celebes, off New Guinea, Mergui Archipelago, eastern Bay of Bengal.
12. *L. multispinosus* Fage (1940): off Fiji and Samoa.
13. *L. schmidti* Fage (1940): north of New Guinea, north of the Maluccas, south of Amboine, east of Ras Hafun.

Lophogaster longirostris **Faxon**

Figure 1

Lophogaster longirostris Faxon, 1896, p. 164.—W. M. Tattersall, 1937, p. 1.—Fage, 1940, p. 327; 1942, p. 21.—W. M. Tattersall, 1951, p. 21.
Lophogaster typicus Ortmann, 1906, p. 23.
Lophogaster americanus W. M. Tattersall, 1951, p. 17.

Remarks: This species was founded by Faxon on 20 specimens captured by the U.S. Coast Survey Steamer *Blake* in the Gulf of Mexico at 119 fathoms. The description, which I quote in full, is very brief: "Similar to *L. typicus* Sars but different in the great length of the medium spine of the rostrum which far surpasses the antennular peduncle and almost attains the tips of the antennal scales. There are 6 teeth along the outer edge of the antennal scale. Length 27 mm." The figure of the telson given by Faxon shows seven lateral spines on each lateral margin in addition to the long apical spine.

Ortmann (1906), when reporting on collections of *Lophogaster* from nine stations in the western Atlantic (three from the Gulf of Mexico, three off Key West, and three from off the coasts of the Carolinas), commented on the length of the rostrum and the variation displayed in the number of teeth arming the outer margin of the antennal scale and of the spines on the lateral margins of the telson. Because of much individual variation in these characters, he decided that they had no specific value and referred all the specimens to *L. typicus*.

Tattersall (1951) separated the *Lophogaster* material of the western Atlantic into two species: (1) *longirostris*, for those specimens occurring in the Caribbean and the Gulf of Mexico, and (2) a new species, *americanus*, for those taken off Key West and along the path of the Gulf Stream as far as the southern part of Massachusetts. In describing his new species, he enumerated the characters distinguishing it from *L. typicus* and especially stressed the fact that the integument of the carapace was minutely spinulose, but he made no detailed comparison between it and *longirostris*.

In reexamining the considerable numbers of specimens at present referred to these two species in the collections of the U.S. National Museum, I have failed to find any really constant characters upon which they can be separated. The form of the antennular lamina is almost precisely the same in all (fig. 1,*a,f*); the spinulation of the carapace is extremely difficult to make out and in a few instances does not correspond with the geographical distribution of the species as laid down by Tattersall. For instance, specimens from station

FIGURE 1.—*a–b*, *Lophogaster longirostris* Faxon, type: *a*, antennular lamina; *b*, apex of telson. *c–e*, *Lophogaster longirostris*, paratypes: *c*, antennal scale; *d*, wing of carapace; *e*, telson. *f–h*, *Lophogaster "americanus"* from *Albatross* station 2403: *f*, antennular lamina; *g*, wing of carapace; *h*, apex of telson. (Identified by W. M. Tattersall.)

2403 (in the Gulf of Mexico) are spinulose; on the other hand, I have been unable to find any trace of spinules on the integument in specimens from station 2314 (between Charleston and Savannah) and station 2418 (between Cape Charles and Savannah).

This character is not very satisfactory for specific purposes, for not only is it very difficult to see, but it varies with the size and maturity of the individual, the variance being more pronounced in the smaller forms. At some stations where several animals were taken in a haul, I found some spinulose and others apparently quite smooth.

The variation in the armature of the telson throughout the collections was most noticeable. Faxon's type of *longirostris* has seven lateral spines including the subapical ones on each side. In the paratypes, I found usually four, but in two cases there was an additional notch that might indicate a fifth spine lost or in the process of development. Tattersall's type of *americanus* had five, but in material from other stations identified as *americanus* by Tattersall and as *typicus* by Ortmann there are almost invariably four on each side including the subapical one.

After close examination of all the available material, I am of the opinion that there are insufficient grounds for the separation of *americanus* and that it should be regarded as a synonym of *longirostris*, whose description should be amplified as follows:

Carapace, integument smooth or more or less sparsely beset with microscopic, forwardly directed spinules, especially in the dorsal anterior region; rostral plate broadly tridentate with the central spine produced into a long acute rostrum extending beyond the antennular peduncle (rarely slightly shorter) but not extending to the tips of the antennal scales; usually relatively longer in the female; posterolateral angles produced into rather short acute spines.

Antennular lamina well developed with inner margin usually straight, armed with a close row of long, very fine setae and terminating in a strong tooth which extends very slightly beyond the apex; apex rounded, armed with a regular row of small spinules (fig. 1,*a*,*f*).

Antennal scale of the rotundate type but less broad than in *typicus;* outer margin armed throughout its length with from 6–8 strong teeth; apex acutely pointed, straight or very slightly incurved (fig. 1*c*).

Tergal spines from the last abdominal somite long and acutely pointed; from one-ninth to one-seventh as long as the telson.

Telson with lateral margins armed with 4–7 slender spines including the subapical pair; apical spines very long (may be as much as one-fourth of the telson in length) flanking a small apical plate bearing 5–8 small spinules (fig. 1,*b*,*e*,*h*).

Lophogaster intermedius Hansen

Figure 2

Lophogaster intermedius Hansen, 1910, p. 14, figs.—W. M. Tattersall, 1922, p. 448 (not W. M. Tattersall, 1951,p. 20, as *L. intermedius* ?).

Remarks: This species was founded by Hansen on specimens captured by the *Siboga* Expedition in the waters of the Dutch East Indies. It has unfortunately not been possible to examine the types of the species. A number of specimens from the Mergui Archipelago referred to *L. intermedius* (Tattersall, 1922, p. 448), however, agree so closely with Hansen's description and figures of this species that there can be little doubt as to the correctness of their identification. For the purpose of comparison, a figure showing the salient features of these specimens is given herewith (fig. 2.)

Tattersall (1951, p. 20) doubtfully referred an adult ovigerous female from station 4944 off the south east of Japan to *L. intermedius* and pointed out at the same time its close resemblance to other specimens from Japanese waters. He added that it might be merely a variety of his new species *L. japonicus* (=*L. pacificus* Fage). With this suggestion I concur, and I discuss characters and individual differences below under *L. pacificus* (fig. 3). I have examined a single specimen from station 4101 off Kauai, Hawaiian Islands, and find that it conforms very closely with the description and figures of *L. hawaiensis* (especially in the form of the antennular lamina). I suggest that it should be referred to this species. If I am correct in my interpretation of the identity of these two specimens, it will mean that *L. intermedius* is not represented in the collections of the U.S. National Museum.

Lophogaster pacificus Fage

Figure 3

Lophogaster pacificus Fage, 1942, p. 29, figs.
Lophogaster typicus, Ortmann, 1906, p. 25 (Japanese specimens only).
Lophogaster japonicus W. M. Tattersall, 1951, p. 19, figs. 1*b*, 2*a*.
Lophogaster intermedius ? W. M. Tattersall, 1951, p. 20, fig. 1*c*.

Remarks: Fage (1942, p. 29) founded the species *L. pacificus* on two nearly adult female specimens captured by the *Dana* in the China Seas to the north of Formosa. He mentioned that specimens from Japanese waters referred by Ortmann (1906) to *L. typicus* agreed in all respects with this new species except that there were fewer teeth arming the outer margin of the antennal scale—only three compared with the five to six in his types of *pacificus*.

One of the most outstanding characters of both *pacificus* and *typicus* is the presence of thickly scattered coarse tubercles on the carapace. In addition there is in *typicus* a strong, very noticeable, forwardly

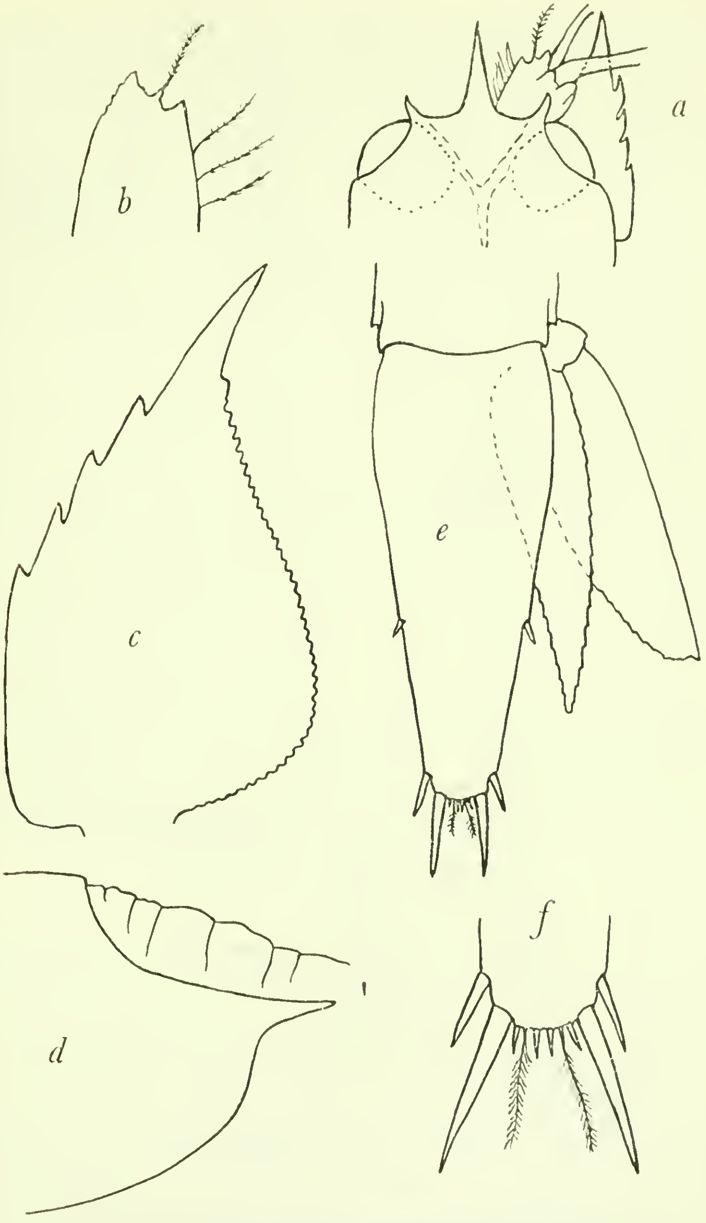


FIGURE 2.—*Lophogaster intermedius* Hansen, from Mergui Archipelago: *a*, anterior end in dorsal view; *b*, antennular lamina; *c*, antennal scale; *d*, wing of carapace; *e*, telson; *f*, apex of telson.

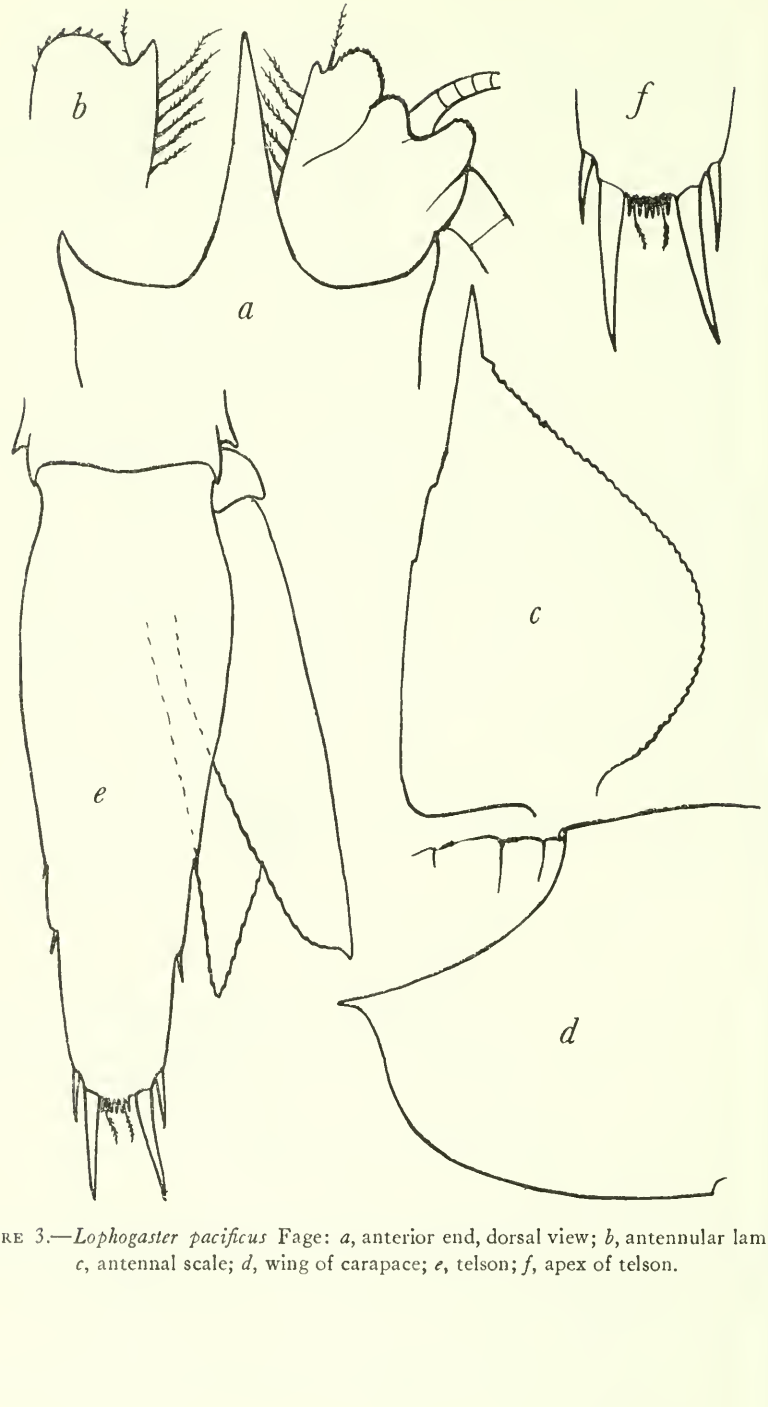


FIGURE 3.—*Lophogaster pacificus* Fage: *a*, anterior end, dorsal view; *b*, antennular lamina; *c*, antennal scale; *d*, wing of carapace; *e*, telson; *f*, apex of telson.

directed spine on each side posterior to the eye and just in front of the cervical sulcus. In *pacificus* this spine is replaced by a thick blunt protuberance.

Curiously, Ortmann made no reference to these characters when recording the Japanese specimens. A reexamination of his specimens reveals, however, that in these characters they agree precisely with *L. pacificus*, and Fage himself stated that they belong to this species.

Tattersall (1951) founded a new species, *L. japonicus*, on specimens captured by the *Albatross* in 1906 off the south of Japan and, at the same time, expressed the opinion that the Japanese specimens referred by Ortmann (1906) to *L. typicus* should be referred to it. The types of *japonicus* agree in every detail with Ortmann's material including the presence of only three teeth (or in one case only two) on the outer margin of the antennal scale.

After very close examination of all the material of *japonicus* in the collections of the U.S. National Museum—amounting to 13 ♂ and 7 ♀ (3 ovigerous)—I can find no other constant point of difference between these specimens from Japanese waters and the description and figures given by Fage of his types of *L. pacificus*. Since in other species of the genus the number of teeth arming the antennal scale is somewhat variable, I think that *L. japonicus* should be referred to the synonymy of *L. pacificus*.

In his description of *L. pacificus*, Fage did not mention any armature on the lobe from the anterior margin of the antennular peduncle. He simply stated, as one of the characters of the species, "écaile antennulaire largement déprimée au bord antérieur."

Lophogaster hawaiensis **Fage**

FIGURE 4

Lophogaster hawaiensis Fage, 1942, p. 30, figs.
Lophogaster typicus, Ortmann, 1905, p. 967; 1906, p. 23 (Hawaiian specimens only).

OCCURRENCE: *Albatross* stations 3847, 3857, 3858, 3884, and 4101 situated in coastal waters around the Hawaiian Islands; two specimens taken at 43 m. but the remainder around 250 m. in depth.

REMARKS: This species very closely resembles *L. intermedius* in the presence of minute scattered nodules or microscopic blunt spinules on the carapace, in the length and shape of the rostrum, and in the shape and armature of the telson. It can be distinguished from *intermedius* by its relatively broader antennal scale with its somewhat convex outer margin and much more convex inner margin, by the characteristic concave anterior margin of the antennular lamina, and, if the specimens from the Mergui Archipelago can be taken as true *intermedius*, by the shorter and stouter alar spines.

It differs sharply from *pacificus* in lacking coarse tubercles on the carapace and in the complete absence of any postorbital spines or blunt processes, in the relatively shorter rostrum, in the shape of the anterior margin of the antennular lamina (figs. 3*a* and 4*a*), in the smaller horizontal alar spines, and in the presence of only one pair of spines on the lateral margins of the telson in addition to the subapical and apical spines.

In *intermedius*, *pacificus*, and *hawaiensis* the tergal spines from the last abdominal somite are almost obsolete.

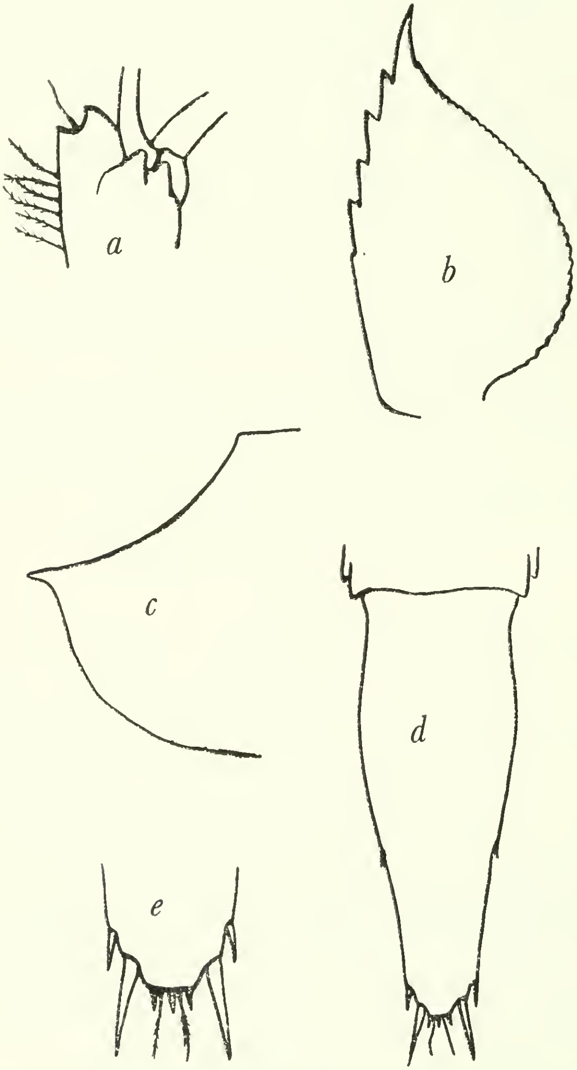


FIGURE 4.—*Lophogaster hawaiensis* Fage, from *Albatross* station 4101: *a*, antennular lamina; *b*, antennal scale; *c*, wing of carapace; *d*, telson; *e*, apex of telson.

A specimen in the collection from station 4101 and labelled *L. intermedius* resembles other specimens from this station so closely in all respects that it should be referred with them to *L. hawaiensis.* Most of the specimens in the collection are juvenile, but in those sufficiently mature for their sex to be ascertained, the rostrum is not invariably longer in the females than in the males. Possibly, this character develops only with maturity.

Lophogaster schmidti Fage

FIGURE 5

Lophogaster schmidti Fage, 1940, p. 324; 1942, p. 34, figs.—O. S. Tattersall, 1955 pp. 44–45, figs.

OCCURRENCE: Station 3: cruise 32 of U.S. Fish and Wildlife Research Vessel *Hugh M. Smith*, 21°0′ N., 157°54′ W., Feb. 2, 1956 (night); *Isaac-Kidd* trawl, oblique haul approximately 500 m., 1 immature ♀, 10 mm. Station 9: cruise 30 of R/V *Hugh M. Smith*, 26°09′ N., 167°17′ W., Aug. 19, 1955 (night); *Isaac-Kidd* trawl, oblique haul approximately 550 m., 2 adult ♂, 20–25 mm., 1 immature ♂, 18.5 mm (damaged), 1 ovigerous ♀, 15.5 mm., 2 immature ♀, 14 and 15 mm.

REMARKS: These specimens agree remarkably closely with the published descriptions and figures of *L. schmidti* as follows:

The integument is quite smooth with no trace of spinules.

The rostral plate is rather narrow with the central spine long and slender; it extends in the males beyond the anterior margin of the antennular lamina and in the females to the level of the distal tips of the antennal scale (fig. 5*a*).

The eyes are comparatively small and are almost covered by the rostral plate in dorsal view exactly as in Fage's figure (fig. 5*a*).

The antennal scale is exactly similar in shape and proportions, but on the whole there are fewer teeth on the outer margin. One adult male and the ovigerous female had three–three and three–four respectively; one male had four–four; two immature females had four–five; and the small female from station 3 had five on one scale and six on the other. This character is evidently variable (fig. 5*c*.)

The profile of the dorsal margins of the "wings" of the carapace is evenly concave; the alar spines are long and slender and only slightly, if at all, directed upward (fig. 5*d*).

The tergal spines of the last abdominal somite are unusually long (fig. 5*e*).

The telson is long and narrow, nearly five times as long as its greatest width. Each lateral margin bears three extremely small spines in addition to the subapical spines that are themselves very

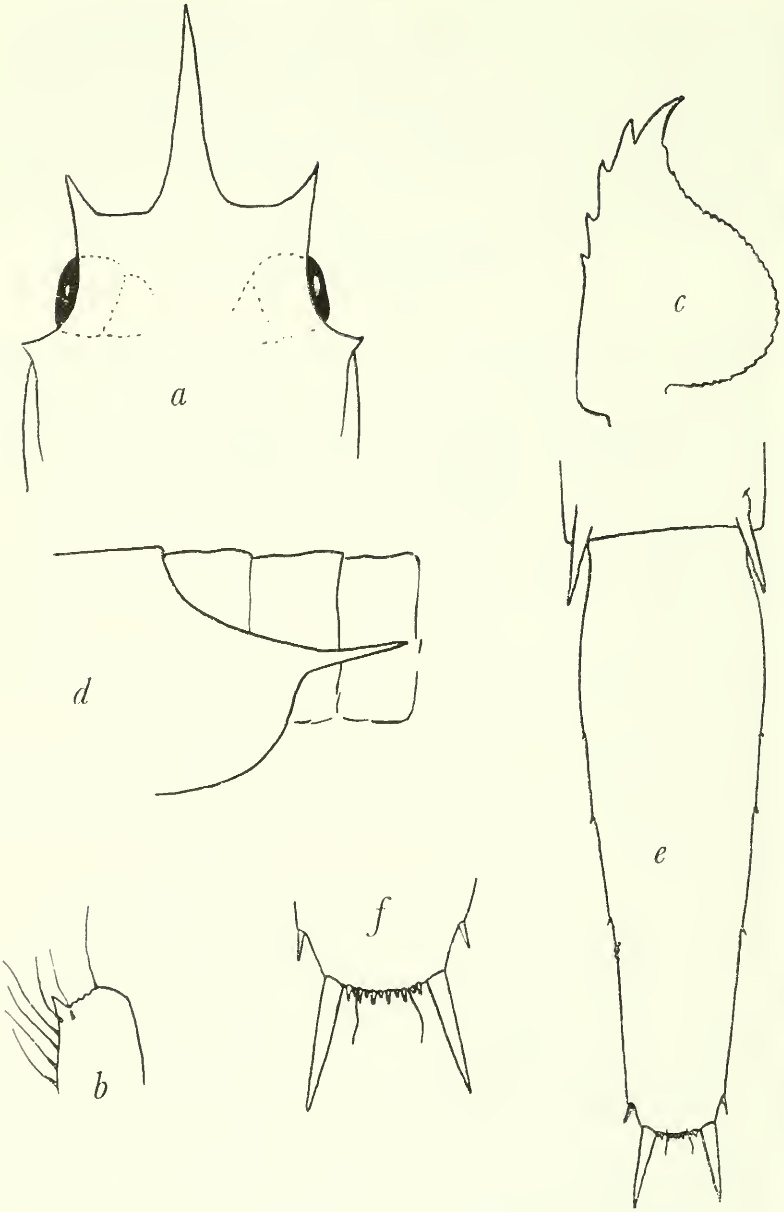


FIGURE 5.—*Lophogaster schmidti* Fage, from Hawaiian waters: *a*, dorsal view of rostral plate (adult female); *b*, antennular lamina; *c*, antennal scale; *d*, posterior region of carapace in lateral view; *e*, telson and posterior margin of last abdominal somite; *f*, apex of telson.

small and slender. Apical spines are long and strong. The apical plate is not produced at all and is armed with 9–13 spinules, which are usually uneven in size and consist of somewhat larger ones alternating with smaller ones in the spaces between them (fig. 5*f*).

In some of the specimens the proximal spine on each lateral margin is so small that only by the slight indentation of the margin at the point of its origin can one be led to see it. Fage mentioned a similar condition in his description of the types of *L. schmidti.*

These Hawaiian specimens are somewhat smaller than the types and paratypes collected by the *Dana*. The one ovigerous female in this collection was carrying advanced embryos, but it measures only 15 mm., whereas those of the *Dana* were from 17–20 mm. in length. Apart from this slight difference, the present specimens differ in only one character from the full description given by Fage (1942, p. 35)—the form of the lamina from the antennular peduncle. He made a strong point of the fact that in all his specimens the anterior margin of this lamina was evenly rounded and without teeth or spinules. The only armature he figured was a single slender simple seta in the middle of the apex. In all the Hawaiian specimens the inner margin ends in a strong tooth. The tooth is separated by a small concavity from the rounded apex, which extends only very slightly beyond it. From three to five very minute notches can be made out on the inner half of the apex, but the other half and the whole of the outer margin are completely smooth. In the immature specimens the inner margin and the inner half of the apex are adorned with a few regular very fine setae. It may be that the small notches seen on the margins of the older specimens indicate the positions from which setae had arisen and have subsequently been lost.

Fage considered that the form of the antennular laminae was of specific importance but, though differing in this particular character, the present specimens agree so very closely with *L. schmidti* in all other characters that they should be referred to this species. It may be that they represent a geographical race of *L. schmidti.*

If my diagnosis is correct, the geographical range of this species is considerably extended northward and eastward. The captures off Hawaii were made in precisely the same conditions as the captures from north and west of New Guinea (Fage) and the western Arabian Sea (O. S. Tattersall)—that is, the animals were pelagic in depths of not more than 550 m. from the surface over much greater depths. Possibly the species is widely distributed in similar conditions throughout the tropical Pacific.

The adult female described below as *Lophogaster* sp. B closely resembles *schmidti* in the form of the rostral plate, the length of the alar spines, and the armature of the lateral margins of the telson.

It differs in the armature of the antennular lamina, the shape of the antennal scale, the upward inclination of the alar spines, the fewer spinules arming the apex of the telson, and above all in the short poorly developed tergal spines from the last abdominal somite (fig. 7,*a*,*f*).

Lophogaster **sp. A**

FIGURE 6

Lophogaster sp. ? W. M. Tattersall, 1951, p. 20, fig. 1*d*.

OCCURRENCE: *Albatross* station 4891, Ose Saki Light, Eastern Seas, 32°27′ N., 128°34′ W., 1 ♂, 20 mm.

DESCRIPTION: Tattersall (1951, p. 20) gave a brief description with a figure of the antennal scale of a single male specimen of *Lophogaster* captured by the *Albatross* off the south of Japan. The following supplementary description can now be given:

Carapace with the three spines of the frontal plate equal in length, lateral ones slightly incurved; posterolateral angles produced into short acute spines (fig. 6*c*).

Antennular lamina well developed; extending forward almost to the level of the apex of the antennal scale; inner margin slightly convex, armed with fine plumose setae and terminating in a very small tooth; anterior margin rounded, extending noticeably beyond the level of the tooth; margin finely crenate (fig. 6,*a*,*b*).

Tergal spines of the last abdominal somite very long and acutely pointed; about one-eighth of the telson in length (fig. 6*d*).

Telson with lateral margins armed with four very small spines and a pair of long slender subapical spines. The tips of both apical spines are broken off, but from what is left it is evident that they must have been very long. Apical plate short and broad, armed with eight spinules of which the median pair are extremely minute; a fine plumose seta arises on each side between the outermost spinule and the next (figs. 6,*d*,*e*).

REMARKS: In the form of the frontal plate, the shape of the antennal scale and the armature of the telson, this specimen resembles *L. typicus* but can at once be distinguished from it by the absence of tubercles and postorbital spines on the carapace, by the form of the anterior margins of the antennular laminae, by the well developed alar spines, and by the very long acute spines of the last abdominal somite.

It differs from the other Pacific species, *pacificus*, *intermedius*, and *hawaiensis*, in the shortness of the rostrum, in the rounded crenate anterior margin of the antennular lamina, in the small alar spines, in the long acute tergal spines; in the larger number of spines arming the lateral margins of the telson, and in the form and arrangement of the apical spinules (fig. 6*e*).

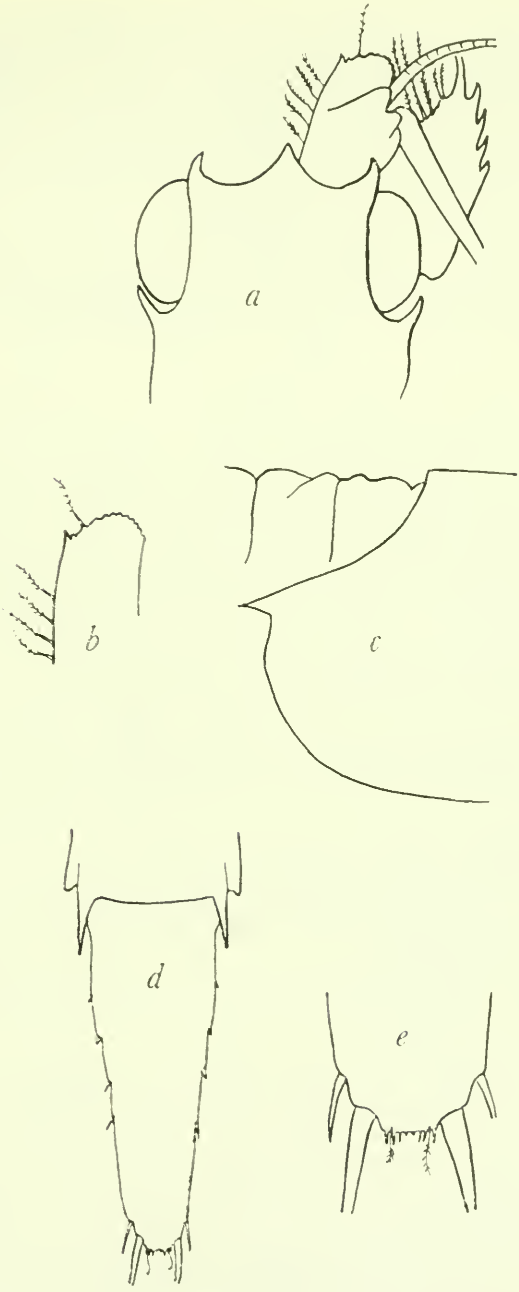


Figure 6.—*Lophogaster* sp. A from *Albatross* station 4891, south of Japan: *a*, anterior end in dorsal view; *b*, antennular lamina; *c*, wing of carapace in lateral view; *d*, telson; *e*, apex of telson.

The specimen shows some points of resemblance to *L. multispinosus* but differs in the somewhat shorter rostrum, in the rounded apex of the antennular lamina and, principally, in the relatively shorter and broader telson with the fewer lateral spines, and in the long slender subapical spines. Fage does not mention the form of the apical plate, but in his figure there are six spinules of equal size which are longer than any of those in the present specimen.

There seems to be no doubt that this specimen represents a new species; however, as it may not be fully mature and considerable changes may occur with growth, naming it would be unwise until more material is available.

Lophogaster sp. B

Figure 7

Occurrence: Albatross station 3965, vicinity of Laysan Island, Hawaii, 1 adult ♀ with fully developed but empty brood sac, 27 mm.

Description: Carapace with integument very sparsely beset with minute spinules; frontal plate rather broad; rostrum long, extending considerably beyond the antennular peduncle to the level of the tips of the antennal scales; wings with the ventral margin less convex than in other Pacific species; alar spines very long and acutely pointed, inclined obliquely upward in lateral view (fig. 7,*a*,*d*).

Antennular lamina with inner margin slightly convex, setose and terminating in a short, strong tooth; anterior margin convex, its apex barely extending beyond the tooth; armed with a regular row of minute spinules; apophyses from dorsal surface of peduncle unequal in size (fig. 7*b*).

Antennal scale twice as long as its greatest width, which occurs at about one-fifth of its length from its base and then tapers to a long acute apex; outer margin straight, armed with four teeth with a trace of a fifth (fig. 7*c*).

Tergal spines of the last abdominal somite small but well developed, acutely pointed (fig. 7*e*).

Telson less than three times as long as its greatest width; lateral margins armed with three small spines on each side in addition to the relatively small subapical spines; apical spines broken but appear from what remains to have been long and slender; apical plate not at all produced, armed with five regular spinules and two plumose setae (fig. 7,*e*,*f*).

Remarks: This specimen was referred by Ortmann (1905; 1906) to *L. typicus* in company with a number of specimens from five other stations around Hawaii (3847, 3857, 3858, 3884, and 4101). Fage (1940) founded a new species, *L. hawaiensis*, for these specimens, and W. M. Tattersall (1951, p. 252), not having access to Fage's paper, briefly referred all specimens from Hawaiian waters to Fage's species. He

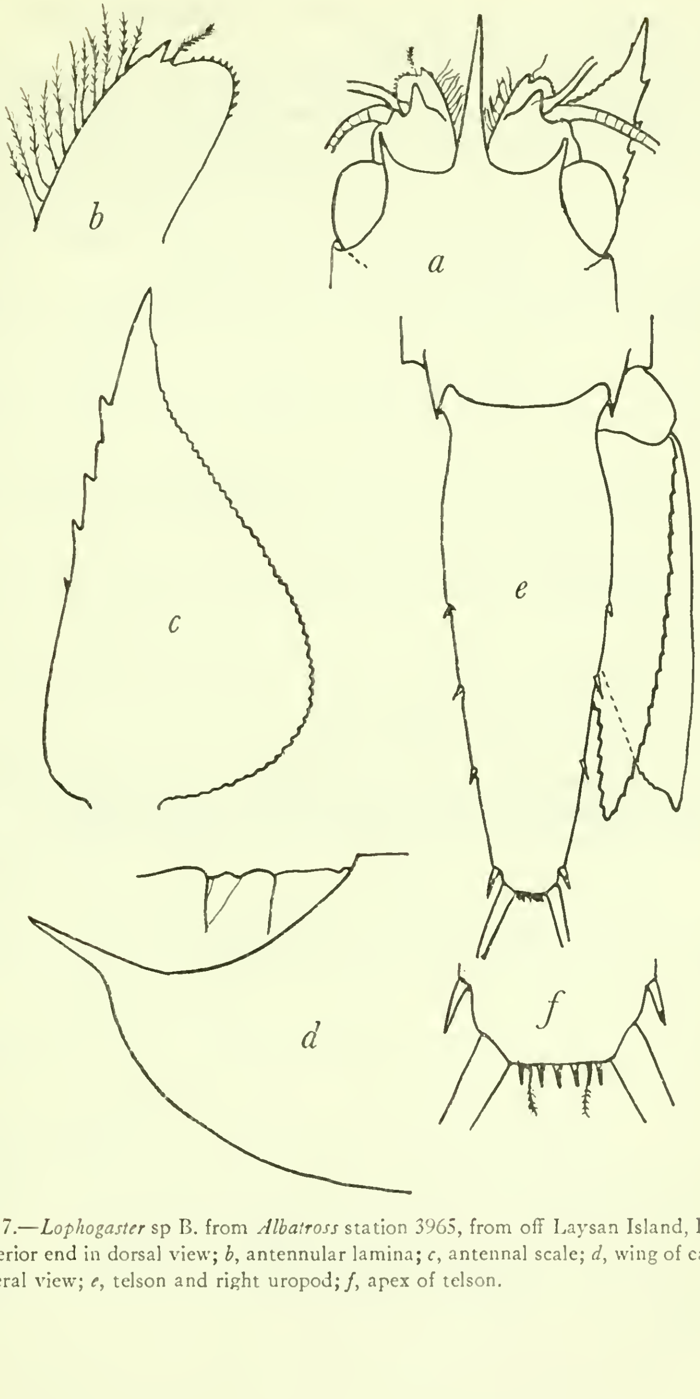


FIGURE 7.—*Lophogaster* sp B. from *Albatross* station 3965, from off Laysan Island, Hawaii: *a*, anterior end in dorsal view; *b*, antennular lamina; *c*, antennal scale; *d*, wing of carapace in lateral view; *e*, telson and right uropod; *f*, apex of telson.

noted that further examination of the material should be made when Fage's description became available.

Critical examination proves that all the specimens in the collections of the U.S. National Museum from Hawaiian waters, with the exception of the adult ♀ from station 3965, can without question be referred to *hawaiensis.* In every case the form of the antennular lamina and antennal scale, the shape and size of the alar spines, the almost complete absence of tergal processes from the last abdominal somite, and the armature of the telson are most consistent.

The specimen from station 3965, however, differs from *hawaiensis* as follows:

The rostrum is relatively much longer, the alar spines are very considerably longer, and the tergal spines (which are practically obsolete in *hawaiensis*) are well developed, though small.

The anterior margin of the antennular lamina has a tooth on its inner angle, separated by a small concavity from a rounded apex adorned with spinules, whereas in *hawaiensis* this margin is deeply concave and unadorned with spinules.

The antennal scale is longer and more slender and its outer margin is straight.

The telson is armed with three small spines on each side and a very short subapical spine, while in *hawaiensis* there is only one lateral spine in addition to the subapical one.

I am therefore unable to place this specimen into any of the known species and consider that in all probability it represents a new form, but since the genus exhibits so much individual variation, it would be unwise to found a new species on a single imperfect individual.

Literature Cited

Banner, A. H.

1954. A supplement to W. M. Tattersall's review of the Mysidacea of the United States National Museum. Proc. U.S. Nat. Mus., vol. 103, No. 3334, pp. 575–583.

Colosi, G.

1930. Lophogastridi nuovi. Bol. Zool., Anno 1, No. 4, pp. 119–125, 4 figs.

Fage, L.

1940. Diagnoses préliminaires de quelques espèces nouvelles du genre *Lophogaster*. Bull. Mus. Nat. Hist., ser. 2, vol. 12, pp. 323–328.

1941. Mysidacea. Lophogastrida—I. *Dana* Report, No. 19, 52 pp., 51 figs.

1942. Mysidacea. Lophogastrida—II. *Dana* Report, No. 23, 52 pp., 42 figs.

Faxon, W.

1896. Reports on dredging . . . Gulf of Mexico and Caribbean Sea . . . Supplementary notes on the Crustacea. Bull. Mus. Comp. Zool., vol. 30, pp. 153–166, 2 pls.

Hansen, H. J.

1910. The Schizopoda of the *Siboga* Expedition. *Siboga* Reports, vol. 37, pp. 1–123, 17 pls., 3 figs.

1927. Sergestides et schizopodes. Expéd. Sci. du *Travailleur* et du *Talisman*, 1880–1883, 26 pp., 1 pl.

Illig, G.

1930. Die Schizopoden der Deutschen Tiefsee Expedition. Wiss. Ergeb. Deutsch. Tiefsee Exped., vol. 22, pp. 400–625, 215 figs.

Norman, A. M.

1862. On the Crustacea, Echinodermata, and zoophytes obtained in deep-sea dredging off the Shetland Isles in 1861. Rep. British Assoc. Adv. Sci., vol. 31, 1861, pp. 151, 152.

Ortmann, A. E.

1905. Schizopods of the Hawaiian Islands collected by the *Albatross* in 1902. Bull. U.S. Fish Commission, 1903, pt. 3, pp. 961–973.

1906. Schizopod crustaceans in the U.S. National Museum. The families Lophogastridae and Eucopiidae. Proc. U.S. Nat. Mus., vol. 31, pp. 23–54, 2 pls.

Sars, Michael

1857. Omm 3 nye norske Krebsdyr. Forh. Skand. Naturf., vol. 7 (1856), pp. 160–175.

Tattersall, O. S.

1955. Mysidacea, *Discovery* Reports, vol. 28, pp. 1–190.

Tattersall, W. M.

1922. Indian Mysidacea. Rec. Indian Mus., vol. 24, pp. 445–504, 28 figs.

1937. New species of mysidacid crustaceans. Smithsonian Misc. Coll., vol. 91, No. 26, pp. 1–18, 10 figs.

1951. A review of the Mysidacea of the United States National Museum. U.S. Nat. Mus. Bull. 201, 292 pp., 103 figs.

U.S. GOVERNMENT PRINTING OFFICE: 1960

P

t

N

s

Proceedings of
the United States
National Museum

SMITHSONIAN INSTITUTION • WASHINGTON, D.C.

Volume 112 | 1960 | Number 3447

THE FAIRY SHRIMP BRANCHINECTA CAMPESTRIS FROM NORTHWESTERN UNITED STATES (CRUSTACEA: PHYLLOPODA)

By James E. Lynch[1]

The following description of a fairy shrimp belonging to the genus *Branchinecta* is the result of the study of 33 collections from 9 different localities, made between 1937 and 1958. The data contained in the specific diagnosis are based on observation and measurements of 20 mature specimens of each sex.

***Branchinecta campestris*, new species**

Figures 1–5

Specific diagnosis: Male: Length from front to end of cercopods 22.2 (15.9–28.5) mm. Ratio of length of head and thorax to that of genital segments, abdomen, and cercopods 1:1.3 (1:1.13–1:1.5). Antennule 2.3 (1.25–2.75) mm. long, length about 60 percent of that of basal article of antenna, with 3 setae and 9 to 12 aesthetases at the tip. Antenna biarticulate, 7.14 (5.25–9) mm. long. In straight, uncontracted specimens, the antennae, bent backwards, reach to thoracic segment 8, rarely to 7 or 9. Free part of proximal article of antenna 4 (2.75–4.75) mm. long, bearing an inconspicuous apophysis on its median side near its proximal end, distal to which is a file of from 7 to 15 small, conical sensory papillae 30–50 microns high, each with 1 or 2 sensory bristles. Distal article of antenna arcuate, its length across the arc 3.9 (2.75–4.75) mm.; nearly cylin-

---

[1] College of Fisheries, University of Washington.

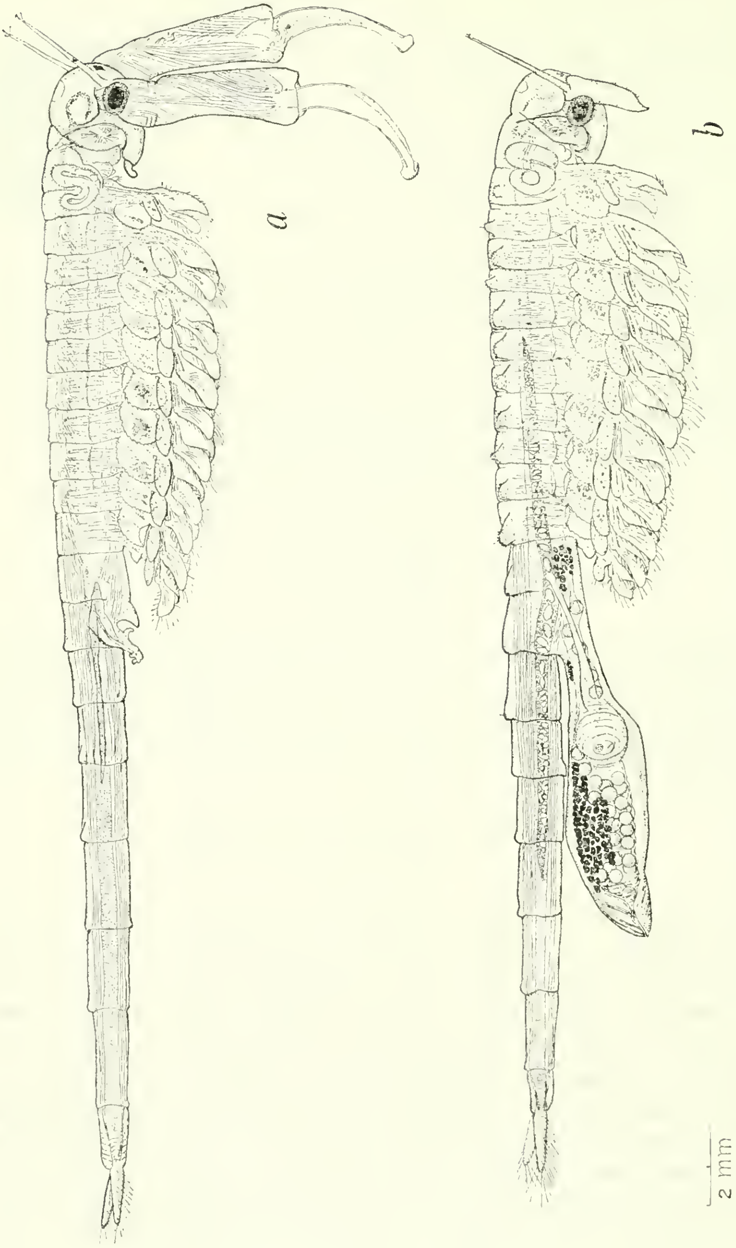


FIGURE 1.—*Branchinecta campestris*, new species: *a*, Male, × 5. *b*, Female, × 5.

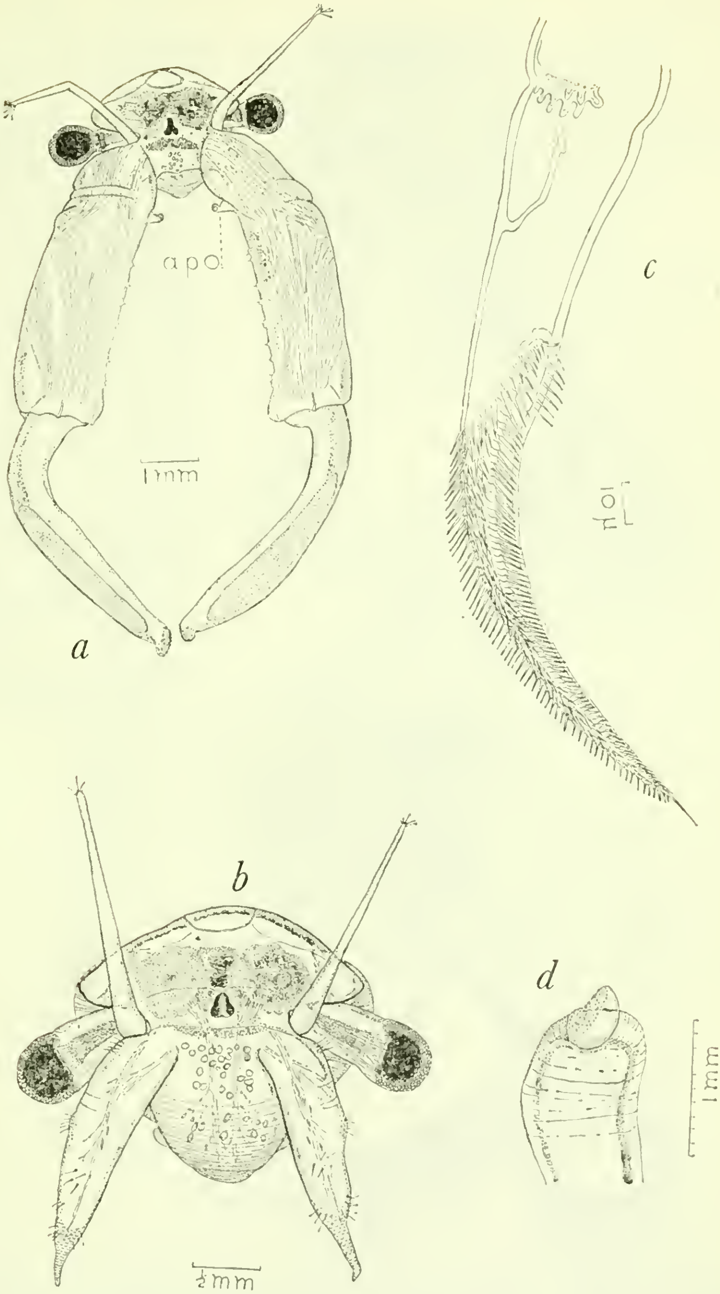


Figure 2.—*B. campestris: a*, Anterior view of head of male, × 7.5; *apo*, apophysis. *b*, Anterior view of head of female, × 17.5. *c*, Spine from distal median border of endopodite of sixth thoracic appendage of a male, × 540. *d*, End view of distal end of second antenna of a male to show the footlike expansion and its orientation, × 17.5. The concave lateral surface of the flattened part of the article is on the side opposite the observer.

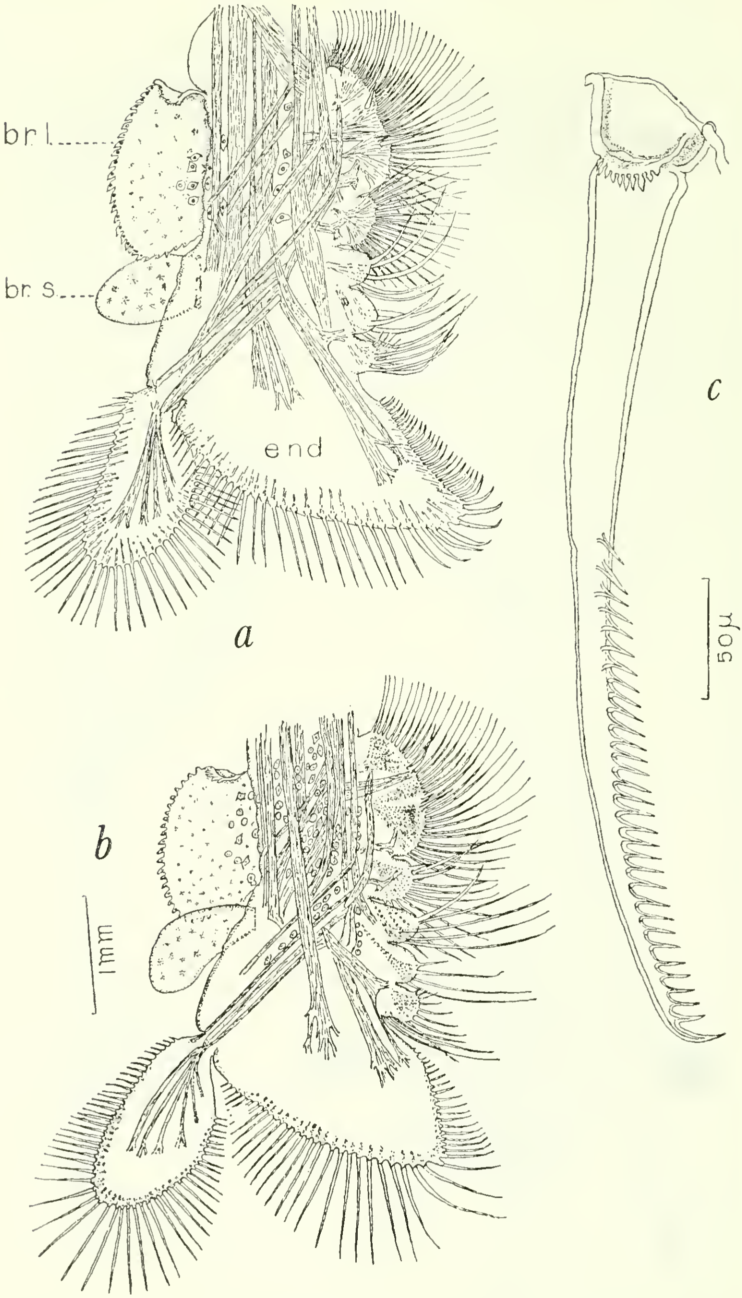


FIGURE 3.—*B. campestris: a,* Right sixth thoracic appendage of a male 26 mm. long, × 13.5. *br. l.,* branchial lamina; *br. s.,* branchial sac; *end.,* endopodite. Setules of the setae and spinules of the spines have been omitted. *b,* Right sixth thoracic appendage of a female 27 mm. long, × 13.5. *c,* Spine from distal median border of endopodite of sixth thoracic appendage of a female, × 280.

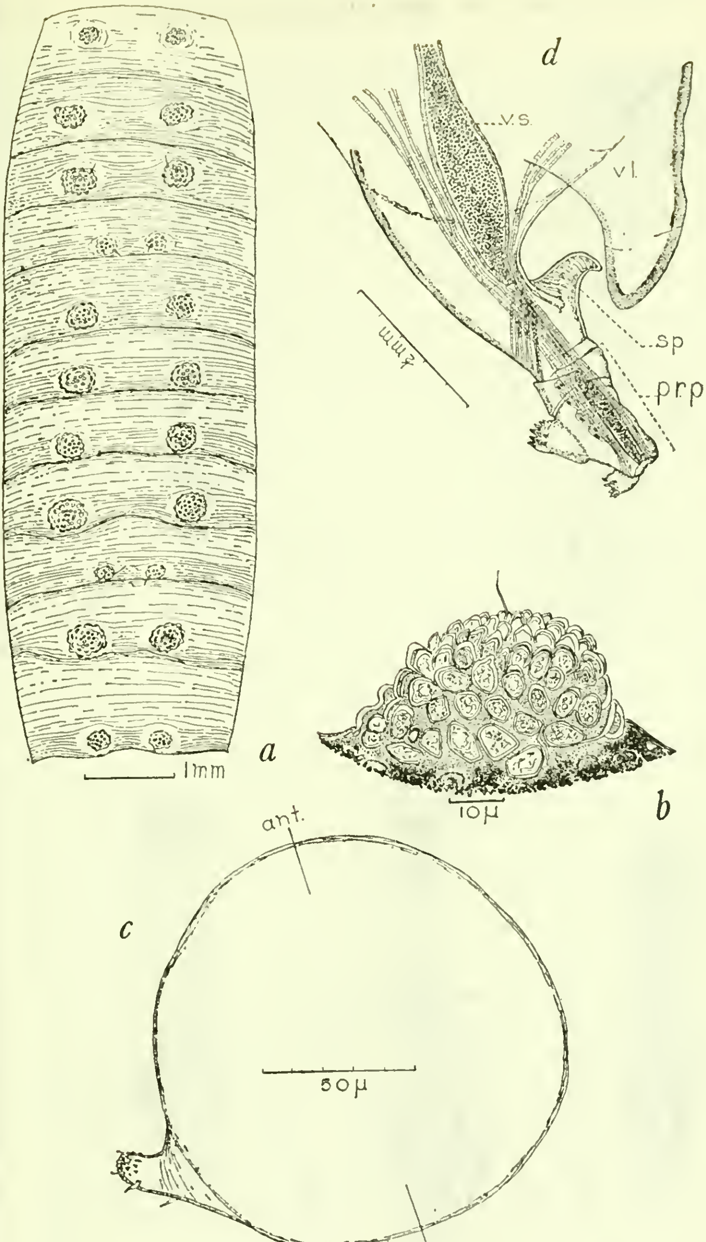


FIGURE 4.—*B. campestris: a*, Cuticle from dorsal side of thoracic segments of a female to show relative size and positions of thoracic bosses, × 12.5. *b*, Left bosse and sensory bristle from eighth thoracic segment of a female, lateral aspect, × 660. *c*, Outline of cross-section of basal article of right antenna of a male to show relative size of apophysis, × 30. *ant.* and *post.*, anteroposterior diameter of the article. *d*, Right penis and adjacent part of second genital segment of a male, × 44. *v. l.*, right ventral lobe of genital segments; *v.s.*, vesicula seminalis; *pr. p.*, retractile part of penis; *sp.*, chitinized spur on rigid part of penis.

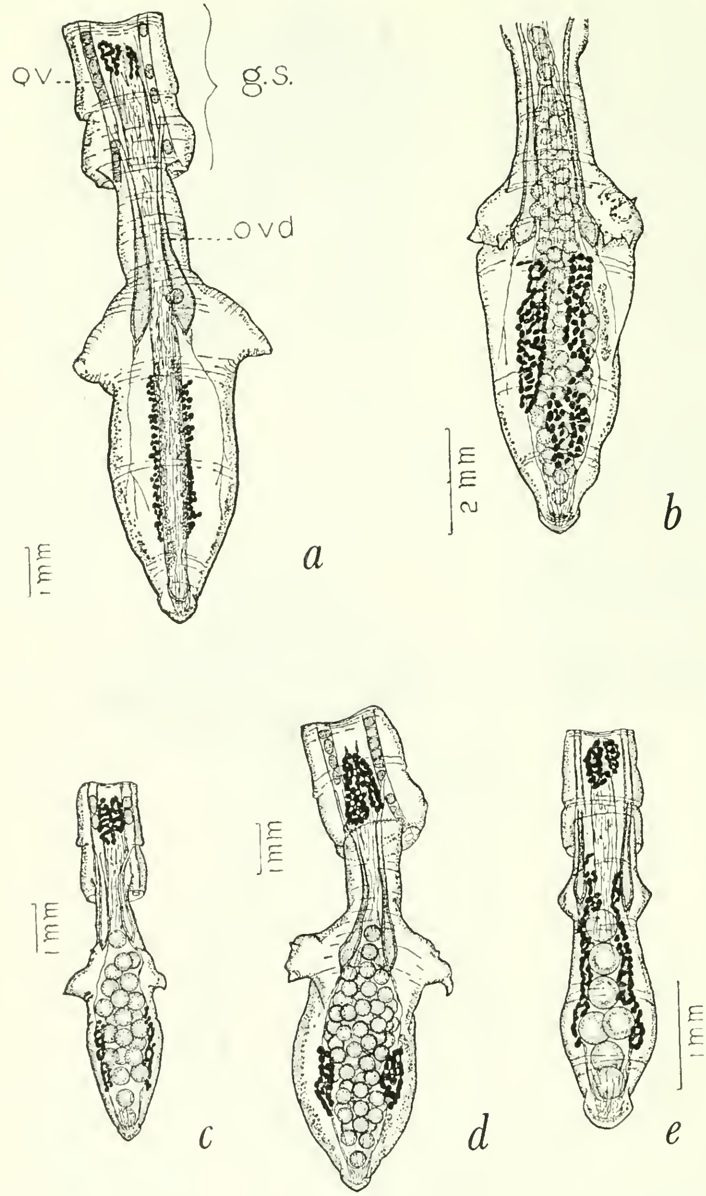


Figure 5.—Variations in development and conformation of the lateral outpocketings of the ovisac of female *B. campestris: a*, Ventral aspect of ovisac of a female 26 mm. long, × 6.6. *b*, Dorsal aspect of ovisac of a female 26 mm. long, × 6.6. *c*, Ventral aspect of ovisac of a female 20 mm. long, × 6.6. *d*, Ventral aspect of ovisac of a female 24 mm. long, × 6.6. *e*, Ventral aspect of ovisac of a female 14 mm. long, × 14.5. *g.s.*, genital segments; *o.v.*, ovary; *ovd.*, oviduct. Cement glands are depicted in solid black.

drical proximally, but expanding to a widened distal part which extends about 60 percent of its length, and which is approximately 4 times as wide as thick, slightly concave on its lateral side, with the narrower borders anterior and posterior. Near the apex the article contracts a little, then expands into a tip flattened nearly at right angles to the preceding part. In end view, the tip appears like a heel and toe, the more pointed toe being median. A rasplike area of low-flat-topped, chitinized papillae on the posterolateral side of the tip extends about halfway up the lateral border. Thoracic appendages typical of the genus; branchial lamina entire with serrated margin; the endopodite tapering to a slightly inturned end, with characteristic spines on its median border. Genital segments and copulatory appendages typical of the genus. Cercopods 1.5 (0.85–2.5) mm. long, distinctly articulated with the telson, with long, plumose setae on lateral and median borders.

Female: Length from front to end of cercopods 23 (18.75–30.0) mm. Ratio of length of head-thorax to that of genital segments, abdomen, and cercopods 1:1.33 (1:1.2–1:1.5). Antennule 1.9 (1.75–2.25) mm. long, about the same length as the antenna. Antenna 1.97 (1.4–3.5) mm. long, uniarticulate, the distal fifth narrowing to a tapering point. The 11 thoracic segments each bear a pair of dorsal verrucose bosses of conspicuous size, which may or may not bear sensory bristles; those of segments 4 and 9 nearer the middorsal line than the others. Thoracic appendages typical of the genus, the endopodite more obtuse than that of the male, with food-trapping spines of simpler spinulescence. Ovisac narrow anteriorly, expanding at the level of the second abdominal segment to from 2¼ to 4 times its anterior width to form right and left conical outpocketings, then contracting to about 65 percent of its maximum width to continue to a bluntly conical posterior end located under abdominal segment 4 or 5. Eggs of preserved specimens 295–345 microns in diameter. Cement glands composed of right and left, closely apposed, masses of large cells at the anterior end of the ovisac and on the dorsolateral sides of the posterior half of the uterus. Cercopods 1.36 (1.0–1.75) mm. long, with long, plumose setae on median and lateral borders.

The smallest mature female encountered was 12 mm. long, with 2 eggs in the ovisac, which extended only as far as the middle of the third abdominal segment.

Type data: One female holotype, USNM 104128, and 12 male and 12 female paratypes, USNM 104129, have been deposited in the U.S. National Museum. The type locality is an alkaline pond 12 miles south of the town of Moses Lake, Grant County, Washington.

Differentiating characters: The males are morphologically very close to *B. mackini* Dexter (1956). The most obvious differences are the conspicuously flattened distal article of the second antenna and the footlike expansion at the terminal end thereof in *B. campestris* (fig. 2,*a*,*d*).

Other noticeable differences are: (1) The antennule is relatively shorter than in *B. mackini.* It is about 60 percent of the length of the basal article of the antenna, whereas in *mackini* it averages 85 percent of the length of the basal article. (2) The apophysis is smaller and is about half the size of that of *mackini.* (3) The proximal article of the antenna of *mackini* presents on the median side of the distal one-fourth a small swollen area or projection bearing 3 to 7 sensory cones, whereas in *campestris* such an eminence is lacking. (4) The food-gathering spines on the median border of the endopodite in *mackini* are relatively shorter, with heavier spinules, than those of *campestris.* (5) The telson in both males and females of *campestris* is about one-half the length of abdominal segment 6; in *mackini* it is only about one-third as long.

The females differ from any species previously described in the lateral outpocketings of the ovisac (fig. 5, *a*, *e*), and in the large size of the dorsal bosses of the thorax (figs. 1*b*, 4*b*).

Linder (1941) called attention to the arrangement of the paired dorsal sensory bristles on the thoracic segments of *B. gaini* and *B. coloradensis*, where those of thoracic segments 4 and 9 are nearer the middorsal line than the others. This arrangement occurs also in *B. mackini* and in *B. campestris.* Linder also mentions "granulated knobs" and "bulges," mostly lateral to the sensory bristles.

In many species of *Branchinecta* a pair of delicate sensory bristles occurs on the dorsum of each segment from the first thoracic to the sixth abdominal. Each bristle is typically surrounded by a circular area of low cuticular granules or verrucae. The bosses of *B. campestris* correspond to these granular areas, which in this species are remarkably developed, more or less hemispherical, and covered with coarse cuticular verrucae. The conspicuousness of the bosses is augmented by their being placed, especially those of segments 6, 7, 8, 10, and 11, on a bulge or welt of the body wall. The sensory bristle persists in many; in some it appears to be absent, or at least is undemonstrable. Very rarely one of the anterior bosses is paired, but nothing corresponding to the more lateral and ventral thoracic lobes, such as are found in *B. packardi* or in *B. lindahli* has ever been found.

The thoracic bosses of the female of *B. mackini* have the same arrangement, but are much less conspicuous because they are relatively smaller and rise much less above the surface.

It is difficult to give brief and satisfactory measurements for the bosses, since they vary in size from segment to segment and from specimen to specimen, and since the height on each side is different (lateral side is usually highest) and the transverse diameter is usually greater than the anteroposterior diameter. On the largest bosses the verrucose part may be 450 microns high on the lateral side, and the entire eminence 530 microns high. Length and breadth are usually somewhat greater than the height. Less elevated above the surface, the bosses of the genital segments are large, but less prominent than those of the thorax. Equivalent structures occur on abdominal segments 1 to 6, but are small, scarcely rise above the surface, and are normally distinguishable only by the use of the compound microscope.

The females of *B. campestris* also differ from those of *B. mackini* in the following minor characteristics: (1) The spines on the distal median border of the endopodite of the female *B. campestris* are of the same type as those of *B. mackini*, but are relatively longer. In individuals of the same size, those of *campestris* are twice as long as those of *mackini*. (2) The antennule is usually from 85 percent to 100 percent of the length of the antenna, sometimes slightly longer. In *B. mackini* it is always longer than the antenna, averaging 185 percent as long. (3) In *B. campestris* 70 percent of the specimens have no connecting cells between the anterior and posterior groups of cement-gland cells, and the remainder have only a few, separated cells. In *B. mackini* 85 percent of the females have a continuous strand of juxtaposed cells on the dorsal side of the uterus connecting the anterior and posterior masses of cement-gland cells, and the remainder have scattered cells. (4) The ovisac is relatively shorter in *campestris*, where it terminates under abdominal segment 4 in 59 percent of the females and never extends posteriorly to segment 5. In *B. mackini*, the length of the ovisac is more variable but on the average is longer since it terminates under abdominal segment 5 in 69 percent and under segment 6 in 11.5 percent of the females.

Other American species in which the distal article of the antenna of the male is compressed and turned in at the tip can be distinguished from *B. campestris* by a number of features, of which the following are most easily recognized:

B. packardi Pearse, 1912: The males have both an apophysis and a large, proximally inclined protuberance on the median side of the proximal article of the antenna. The female has conspicuous conical lobes on the lateral side of the thorax, those of segments 9–11 and the first genital segment being the largest.

B. lindahli Packard, 1883, revised by Shantz 1905: The males have no apophysis or other protuberance on the median side of the basal article of the antenna. Full-grown females have lateral conical lobes on thoracic segments 4–11, those of segments 4–7 being the largest.

B. coloradensis Packard, 1874, revised by Shantz 1905. The male has a large, thick apopysis, plus a large swollen verrucose area near the middle of the proximal article of the antenna. Females usually have conical lobes on the lateral sides of the thoracic segments.

Color of living specimens: The males have no distinctive color pattern. To the unaided eye they usually appear a translucent white or yellowish white, rarely pinkish.

Under low magnification the head is usually colorless, except for the yellow hepatic caeca, which are visible through the integument, but in some it is suffused with a faint green or bluish tinge. The eyes are black. The antennule is colorless or faint yellow. The proximal article of the antenna is white or yellow, usually more intensely yellow on the median side; rarely it may be faint brown, blue green, or yellowish pink. The distal article of the antenna is faint yellow and becomes darker toward the tip and on the narrow borders. The ventral side of the head and labrum ranges from pale yellow to pale blue, with a faint stippling of minute green or blue dots. Internally, the labrum contains large orange or brownish cells, visible through the integument.

The thorax is typically colorless and lacking in colored cells or oil globules. The corm and endopodite of the thoracic appendages are dingy yellow, the other endites and exites colorless.

The abdomen and cercopods are colorless, except for the posterior half of the intestine, which appears as a greenish-brown or black streak because of food residues. The genital segments are colorless, except for the heavily chitinized spur and adjacent sinus on the median side of the penes, which are yellow (fig. 4*d*).

The females, to the unaided eye, appear nearly colorless except for the dark yellow eggs in the ovisac, the brownish spots of the cement glands, and the black intestine in the abdomen.

The antennule is colorless. The antenna is usually colorless, but sometimes is faintly yellow or orange on the anterior side. The head is usually colorless except for the internal hepatic caeca, although the dorsal side is sometimes a faint blue. The eyes are black. The labrum may have a greenish or blue wash, and contains large, brownish cells, discernible through the translucent integument.

The dorsal and lateral sides of the thorax are colorless, except for the dorsal bosses, which vary from yellow to brilliant orange. Internally, large blue cells may accompany the intestine for the length of the thorax, or may be present only in the posterior half. These cells also occur along the ventral portions of the intersegmental sutures of the thorax in some individuals. The thoracic appendages are nearly colorless, although the corm is often a faint yellow.

The wall of the ovisac is colorless or glassy, except for the lateral outpocketings and adjacent area, which range from yellow to orange, and in some individuals the colored areas merge on the ventral side of the ovisac. The cement glands vary from light yellow to dark brown but in most adult females are some shade of brown. The eggs within the uterus are usually an ochraceous yellow. The ovary, which extends from abdominal segment 4 or 3 to thoracic segment 8 to 4, often contains large oöcytes of white, greenish white, or pale blue-green tint.

The abdomen is colorless except for the intestine, which appears blackish regardless of food content since the dark blue cells mentioned above accompany the intestine along its dorsal side from some part of the thorax to the fourth or fifth abdominal segment and in some individuals completely encircle the abdominal intestine. The cercopods are colorless.

The females are unique among North American species of *Branchinecta* in the yellow or orange spots on the outpocketings of the ovisac, and in the similarly colored thoracic bosses.

Distribution and habitat. *B. campestris* has been collected in the State of Washington from the following localities: Three ephemeral ponds in the Lower Grand Coulee, Grant County, Washington, and five ponds scattered over an area of rough "scab land," 10 to 17 miles south of the town of Moses Lake, in southern Grant County and western Adams County. Most, or more likely all, of these ponds in Grant and Adams Counties have been destroyed in recent years by the construction of gigantic reservoirs filled with water from the Columbia River. These reservoirs have covered and annihilated some of the largest and most interesting "dry lakes" in North America. In addition, most of the ponds for miles below the dams have been converted, by continuous seepage, from ephemeral alkaline ponds into permanent fresh-water ponds in which none of the original unique and scarcely explored fauna of alkali-tolerant organisms has survived.

One collection came from a pond in Okanogan County, Washington, about 10 miles north of LaFleur. Dr. G. C. Anderson (1958) reported an unknown *Branchinecta* from Hot Lake, Okanogan County. Specimens that he kindly donated to the writer proved to be *B. campestris.* Two separate collections came from a pond situated at the eastern border of the town of Rawlins, Carbon County, Wyoming. The specimens from Rawlins differ slightly from those from Washington in that the females have somewhat smaller thoracic bosses, and the males have somewhat larger expansions at the tip of the antenna.

B. campestris has always been found in water of extremely alkaline reaction, or at least with a high content of dissolved salts. The pH of water carried back to Seattle and determined a day or two later by a Beckman pH Meter, Model G, has ranged from 9.5 to 10. On the two occasions when the density of the water was ascertained, it was 1.020 and 1.012 at 60° F. Usually, the new species has been found in clear water, as contrasted with *B. mackini* and *B. gigas*, common in the same area, which are usually in opaque water. The temperature of the water at the time that collections were made ranged from 48° to 69° F. All collections in the State of Washington were made from late March to mid-June. The collections from near Rawlins, Wyoming were made on August 5, 1937, and June 20, 1958.

The elevation above sea level of the ponds in which *B. campestris* has been found ranges from about 1,100 feet in Adams County, Washington, to 6,750 feet near Rawlins, Wyoming.

In 60 percent of the collections, *B. campestris* is the only phyllopod present. *Artemia salina* was, however, regularly present in three of the ponds in Grant County, and often the two species occurred simultaneously; at times only one or the other species was present. In three other ponds in Grant County, *B. mackini* in small numbers was associated with *B. campestris*.

In spite of the scanty data on physical conditions in the ponds, it seems evident that *B. campestris* is adapted to living in water with so high a content of dissolved salts that only *Artemia salina* can develop abundantly in the same habitat. This may account for its scarcity in Grant County, Washington (known from seven ponds) where, before the construction of enormous dams and the permanent inundation of approximately 67 square miles of land with water from the Columbia River, there were literally hundreds of ponds that annually produced teeming populations of *B. mackini*. This circumstance provoked the thought that *campestris* might be only a variety of *mackini* developing in water of greater alkalinity and density than its more usual habitat. This conjecture seems most unlikely, however, in view of the relatively large number of specific differences, and my failure to find unmistakable intergradations between the two species.

REMARKS. Including the subject of this paper there are now eight species of *Branchinecta* reported from western North America, and several undescribed species that await the attention of systematists. In addition, redescriptions of several species and a study of the variability of others are in order before an adequate revision of, and keys to, the species of the genus in North America can be made.

Literature Cited

ANDERSON, G. C.

1958. Some limnological features of a shallow meromictic lake. Limnol. and Oceanogr., vol. 3, pp. 259–270, 6 figs.

DEXTER, RALPH W.

1956. A new fairy shrimp from western United States, with notes on other North American species. Journ. Washington Acad. Sci., vol. 46, pp. 159–165, 6 figs.

LINDER, FOLKE

1941. Contributions to the morphology and taxonomy of the *Branchiopoda anostraca*. Zool. Bidrag Uppsala, vol. 20, pp. 101–302, pl. 1, 45 text figs.

PEARSE, A. S.

1912. Notes on phyllopod Crustacea. 14th Rep. Michigan Acad. Sci., pp. 191–197, pls. 1–3.

SHANTZ, H. L.

1905. Notes on North American species of *Branchinecta* and their habitats. Biol. Bull., vol. 9, pp. 249–259, pls. 10–12.

U.S. GOVERNMENT PRINTING OFFICE: 1960

Proceedings of
the United States
National Museum

SMITHSONIAN INSTITUTION • WASHINGTON, D.C.

Volume 112 1961 Number 3448

STARGAZER FISHES FROM THE WESTERN NORTH ATLANTIC (FAMILY URANOSCOPIDAE)

By Frederick H. Berry and William W. Anderson[1]

This review of the fishes of the family Uranoscopidae from the western North Atlantic is a consequence of our efforts to identify large series of various sizes of these fishes that have been taken in recent years by exploratory fishing in this area. It is based on all the uranoscopid specimens from this area in the collections of the U.S. National Museum, selected specimens from other institutions, and specimens at the U.S. Fish and Wildlife Service's Biological Laboratory at Brunswick, Georgia. Many of the specimens at Brunswick will subsequently be transferred to the U.S. National Museum.

Five species of stargazers have been recognized in our study of the family in the western North Atlantic. Illustrations, diagnostic characters, and known ranges are presented for these species. *Astroscopus y-graecum* Cuvier and *Astroscopus guttatus* Abbott are distinguished. *Execestides* Jordan and Thompson is synonymized with *Gnathagnus* Gill, and *E. egregius* Jordan and Thompson is included in

---

[1] United States Fish and Wildlife Service. This paper is Contribution No. 51 of the U. S. Fish and Wildlife Service, Bureau of Commercial Fisheries Biological Laboratory, Brunswick, Georgia.

the genus *Gnathagnus*. *Gnathagnus laticeps* (Longley and Hildebrand) is synonymized with *Gnathagnus egregius*. *Kathetostoma albigutta cubana* Barbour is distinguished as a species distinct from *Kathetostoma albigutta* Bean. *Uranoscopus occidentalis* Agassiz, described from Brazil, is included on the basis of the type description.

Astroscopus sexspinosus (Steindachner) was described from Argentina and Rio de Janeiro, Brazil, in the western South Atlantic (Steindachner, 1876) as *Uranoscopus* (*Upsulonophorus*) *sexspinosus*. It reportedly differs from *A. y-graecum* and *A. guttatus* in having a blackened border on the soft dorsal fin (Miranda Ribeiro, 1915), but specimens adequate for assessing its true relationship have not been available.

Data on dorsal and anal rays and data on pectoral rays are given in table 1, p. 566. A chart of distribution of *Kathetostoma albigutta*, *K. cubana*, and *Gnathagnus egregius* is shown in figure 1, next page.

Standard length (S.L.) was measured from the middle of the upper jaw (premaxillary symphysis) to the caudal base. Total length (T.L.) was measured from the most anterior part of the lower jaw to end of the caudal fin.

Dorsal and anal fin ray counts were made by counting the total number of rays (or ray bases), except in a minority of specimens that had the terminal soft ray in very close proximity to the next to the last soft ray. Dissection and clearing and staining showed that in certain specimens the terminal dorsal or anal soft ray was branched to its base and the two terminal elements were articulated beneath the body surface; it was therefore considered a branched ray and was counted as a single ray.

Pectoral and pelvic rays were counted on each side of the fish, and are recorded without respect to right or left sides. Bilateral variation may occur in the number of pectoral fin rays, but the side of a fish having the greater number is randomly right or left.

Terminology of the cranial bones follows Gregory (1933, figs. 244–248).

In the synonymies, a comma is used between the binomial and the author's name only in instances of emended or altered specific combinations; no comma is used in instances of original combinations.

The specimens examined are listed for each species by geographical location from north to south along the Atlantic coast of the United States to southern Florida, then northward, westward, and southward around the Gulf of Mexico into the Caribbean Sea. The following abbreviations are used: USNM, U.S. National Museum; CNHM, Chicago Natural History Museum; CM, Charleston Museum; CAS, California Academy of Sciences; UMML, University of Miami Marine

FIGURE 1.—Distribution of *Kathetostoma albigutta*, *Kathetostoma cubana*, and *Gnathagnus egregius*, including specimens examined and specimens reported by Springer and Bullis (1956, p. 97) and Hildebrand (1954, p. 318). A single specimen of *K. cubana* from east of Puerto Rico is not shown on this chart.

Laboratory; UF, University of Florida; TU, Tulane University; SU, Stanford University; MCZ Museum of Comparative Zoology; UNC, University of North Carolina; CHML, Cape Haze Marine Laboratory; GWM acct. No., G. W. Mead, U.S. Fish and Wildlife Service, Washington, D.C.; BLBG, U.S. Fish and Wildlife Service Biological Laboratory, Brunswick, Ga.

We owe special thanks for assistance in obtaining data on specimens to Leonard P. Schultz and Robert Kanazawa, U.S. National Museum; Myvanwy M. Dick, Museum of Comparative Zoology; G. Palmer, British Museum (Natural History); George S. Myers, Margaret Storey, and Stanley Weitzmann, Stanford University Natural History

TABLE 1.—*Frequencies of dorsal spines, dorsal and anal soft rays, and pectoral rays*

Species	Dorsal spines			Dorsal soft rays				Anal soft rays					
	III	IV	V	12	13	14	15	12	13	14	15	16	17
Astroscopus y-graecum	1	25	2	—	1	14	13	1	11	16	—	—	—
Astroscopus guttatus	—	4	6	—	1	4	4	—	4	5	—	—	—
Kathetostoma albigutta	—	—	—	—	4	14	5	12	10	—	1	—	—
Kathetostoma cubana	—	—	—	—	1	7	3	—	5	6	—	—	—
Gnathagnus egregius	—	—	—	2	19	1	—	—	—	—	—	18	4

Species	Numbers of pectoral rays (from each side of fish)																				
	13/14	14/14	14/15	15/15	15/16	16/16	16/17	17/17	17/18	18/18	18/19	19/19	19/20	20/20	20/21	21/21	21/22	22/22	22/23	23/23	23/24
Astroscopus y-graecum [a]	—	—	—	—	—	—	—	—	—	—	—	2	1	10	5	6	2	1	—	—	—
Astroscopus guttatus	—	—	—	—	—	—	—	—	—	—	—	1	2	3	2	1	—	—	—	—	—
Kathetostoma albigutta	1	—	3	15	2	7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Kathetostoma cubana	—	—	—	—	—	—	—	4	3	4	—	—	—	—	—	—	—	—	—	—	—
Gnathagnus egregius [b]	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	5	12	7	3	1	1

[a] One specimen with a stunted pectoral fin and counts of 14/20.

[b] One specimen with counts of 20/22.

Museum; James E. Böhlke, Academy of Natural Sciences of Philadelphia; Antenor Leiatão de Carvalho, Museo Nacional, Rio de Janeiro; Frank S. Cliff, Colgate University; Bruce B. Collette, Cornell University; and Donald P. deSylva, University of Delaware. For making specimens available, we are indebted to Winfield Brady, Florida's Gulfarium; Harvey R. Bullis, Jr., U.S. Fish and Wildlife Service, Pascagoula; E. Milby Burton, Charleston Museum; Eugenie Clark, Cape Haze Marine Laboratory; Earl E. Deubler, Jr., University of North Carolina; Myvanwy M. Dick, Museum of Comparative Zoology; W. I. Follett, California Academy of Sciences; John D. Kilby, University of Florida; Giles W. Mead, U.S. Fish and Wildlife Service, Washington, D.C.; George S. Myers, Stanford University; C. Richard Robins and Walter R. Courtenay, Jr., University of Miami Marine Laboratory; Leonard P. Schultz, U.S. National Museum; Royal D. Suttkus, Tulane University; and Loren P. Woods, Chicago Natural History Museum.

We appreciate suggestions concerning the manuscript from the following of the staff of the U.S. Fish and Wildlife Service Biological Laboratory, Brunswick, Georgia: Jack W. Gehringer, David K. Caldwell, and Hugh M. Fields. We are also indebted to Joseph E. King and Daniel M. Cohen for review of the manuscript, and to the latter for securing the illustration of *Uranoscopus occidentalis.*

Taxonomic Treatment

Key to Western North Atlantic Uranoscopidae

1*a*. Spinous dorsal fin present (3 to 5 spines).

2*a*. Top of head entirely covered by exposed cranial bones (apparently in all sizes); cleithral spines long, sharp pointed, and protruding through the skin. (*Uranoscopus* Linnaeus 1758; one species reported from Brazil.)
Uranoscopus occidentalis Agassiz

2*b*. Top of head partially covered by skin (plate 1) (in sizes over 34 mm. S.L. or 40 mm. T.L.); cleithral spines short, adpressed to body, bluntly pointed and covered with skin. (*Astroscopus* Brevoort 1860.)

3*a*. Posterior end of rear nostril groove much closer to eye (orbit) than to posterior margin of skin-covered area over electric organs; distance from eye to end of rear nostril groove (a in plate 1G) about 1.9 to 11.0 times into distance from end of rear nostril groove to posterior margin of skin-covered area (b in plate 1G), in sizes above 40 mm. S.L. Y-shaped process on head usually long and narrow (plate 1), least width of its base about 1.4 to 2.4 percent of standard length at sizes larger than 100 mm. S.L. Top of head and body with large, widely spaced white spots (plate 2B). (North Carolina to Brazil.)
Astroscopus y-graecum (Cuvier)

3*b*. Posterior end of rear nostril groove usually closer to posterior margin of skin-covered area over electric organs than to eye (orbit) or not much closer to eye; distance from eye to end of rear nostril groove (a in plate 1G)

about 0.5 to 1.6 times into distance from end of rear nostril groove to posterior margin of skin-covered area (b in plate 1G), in sizes above 40 mm. S.L. Y-shaped process on head usually short and broad (plate 1), least width of its base about 2.5 to 3.8 percent of standard length in sizes larger than 100 mm. S.L. Top of head and body with small, closely spaced, white spots (plate 2C). (North Carolina to New York.)
Astroscopus guttatus Abbott

1*b*. Spinous dorsal fin absent.

4*a*. Lower jaw with a pair of prominent converging bony ridges on anterior part, deeply notched between (plate 4D). Preopercle with lower edge developed as a long flattened wing-like appendage, without true spines. Body with embedded scales (readily apparent at 100 mm. S.L. and larger). Cleithral spine flattened and bluntly pointed. (*Gnathagnus* Gill 1861; one species in western North Atlantic, Georgia to Texas.)
Gnathagnus egregius(Jordan and Thompson)

4*b*. Lower jaw without a pair of prominent converging bony ridges on anterior part. Preopercle without winglike appendage but with three spines protruding from ventral margin. Body without scales. Cleithral spine long, conical, and sharply pointed. (*Kathetostoma* Günther 1860.)

5*a*. Pectoral rays 13 to 16. Dorsal fin with 2 or 3 distinct oblique black bars. Caudal fin with 2 to 5 horizontally elongated black spots. Upper part of body with distinct rounded or oblong white spots surrounded by dark margins. (North Carolina to Yucatan.)
Kathetostoma albigutta Bean

5*b*. Pectoral rays 17 or 18. Dorsal fin without distinct bars, but with a single, rounded, indistinct blotch. Caudal fin without horizontally elongate black spots, but with a dark broad stripe about middle of fin. Upper part of body without distinct white spots, but irregularly marbled. (Off the Bahamas, Puerto Rico, Cuba, and Honduras.)
Kathetostoma cubana Barbour

Genus *Uranoscopus* Linnaeus

Uranoscopus Linnaeus, Systema naturae, 1758, p. 250. Type species: *Uranoscopus scaber* Linnaeus, 1758, by monotypy.

Uranoscopus occidentalis Agassiz

PLATE 2A

Uranoscopus occidentalis Agassiz *in* Spix, 1831, p. 123, pl. LXXIII (type locality Atlantic Ocean, presumably on the coast of Brazil; type specimen presumably destroyed in the Munich Museum during World War II).—Valenciennes *in* Cuvier and Valenciennes, 1831, p. 492 (described after Agassiz, 1831).—Fowler, 1941, p. 178 (recorded after Agassiz, 1831).

Uranoscopus scaber (non Linnaeus), Kirsch, 1889, p. 261 (in part; reference to Agassiz, 1831; excluding reference to Günther's 1860 *U. occidentalis*).

Not *Uranoscopus occidentalis* Agassiz, Günther, 1860, p. 227 (specimens listed are from Mauritius, and Gulf of Guinea, West Africa).

SPECIMENS EXAMINED: No specimens seen by us.

SYNONOMY: Günther (1860, p. 227) listed as *Uranoscopus occidentalis* a stuffed adult specimen from the "West Indies" and two young specimens from the Gulf of Guinea, West Africa; Fowler (1936, p. 1033) included the reference of the young specimens in the synonomy of the Eastern Atlantic *Uranoscopus scaber* Linnaeus. G. Palmer of the British Museum (Natural History) in a communication of August 31, 1959, wrote regarding the adult specimen: "On checking the locality for the adult specimen, I find that the old register gives this as Mauritius and not the West Indies. It is part of a collection purchased by the Museum in 1841 from Stevens. The material was collected by Janvier, who certainly did work in the Mauritius area. I think the listing of the locality by Günther as the "West Indies" must be regarded as a *lapsus calami* on his part!" Agassiz's specimen may have been *Uranoscopus scaber* or some other species of *Uranoscopus*, but we record it as a distinct species because no other specimen of *Uranoscopus* has been reported from the American continents, and there is not sufficient evidence to warrant placing it in the synonymy of any other species.

DIAGNOSIS: Dorsal spines four. Dorsal soft rays 14. Anal soft rays 13 or 14. Pectoral rays 16. Lower jaw without a pair of prominent converging bony ridges. Top of head covered with exposed cranial bones. Cleithral spine long, sharp pointed, and protruding through the skin. Body scales present.

COLOR: Spinous dorsal fin black.

RANGE: Brazil (probably in the western South Atlantic), only the type specimen recorded.

Genus *Astroscopus* Brevoort

Astroscopus Brevoort *in* Gill, 1860, p. 20. Type species: *Uranoscopus anolopos* Valenciennes in Cuvier and Valenciennes, 1831, by monotypy.

Astroscopus y-graecum (Cuvier)

PLATES 1,A,C,E,G; 2B

Uranoscopus Y graecum Cuvier *in* Cuvier and Valenciennes, 1829, p. 308 (length quinze pouces; type locality unknown; type specimen deposition unknown).

Uranoscopus anoplos Valenciennes *in* Cuvier and Valenciennes, 1831, p. 493 (length deux pouces; type locality South Carolina from Mt. Le Conte; type specimen in Paris Museum ?).—DeKay, 1842, p. 37, pl. 22, fig. 65 (described; a 2.2-inch specimen from South Carolina collected by Le Conte; excluding reference to a sight record of a 6-inch specimen from New York Harbor).—Storer, 1846, p. 46 (reference after Cuvier and Valenciennes, 1831).

Agnus anoplus, Günther, 1860, p. 229 (reference after Cuvier and Valenciennes, 1831, and DeKay, 1842).

Uranoscopus y-graecum, Günther, 1860, p. 229 (described; an adult specimen from the "West Indies").—Gill, 1861b, p. 21 (referred to the genus *Astroscopus*).

Upselonphorus y-graecum, Gill, 1861a, p. 113 (reference).

Astroscopus anoplus, Gill, 1861a, p. 114 (reference, in part; excluding part of synonymy); 1861b, p. 43 (reference after Storer 1846).—Jordan and Gilbert, 1882, p. 629 (in part; excluding reference to Abbott, 1861, from synonymy).—Jordan, 1884, p. 139 (description; Key West, Fla.).

Astroscopus anolopos, Gill, 1861b, p. 21 (reference of this species to the new genus *Astroscopus* proposed by Brevoort through Gill).—Jordan and Evermann, 1898, p. 2308 (description of *A. anolopos* as a growth stage of *A. y-graecum*).

Astroscopus y-graecum, Bean, 1879, p. 58 (in part; described; St. Johns River, Matansas River Inlet, and Pensacola, Fla.; Charleston, S.C.; excluding record from Hampton Roads, Va.).—Jordan and Gilbert, 1882, pp. 628 and 941 (described); 1883, p. 610 (description; Charleston Harbor, S.C.).—Jordan and Evermann, 1898, p. 2307 (key; described; synonymy); 1900, p. 3301, pl. cccxxxiv, fig. 808 (Matanzas River Inlet, Fla.).—Evermann and Kendall, 1900, p. 92 (references, Fla.).—Smith, 1907, p. 371, fig. 170 (described; Bird Shoal, Beaufort Harbor, N.C.).—Weymouth, 1910, p. 140 (Cameron, La.).—White, 1918, p. 141 (development of electric organs; not distinguished from *A. guttatus*).—Meek and Hildebrand, 1928, p. 908 (small specimens from Atlantic coast of southern U.S. compared to small Pacific *A. zephyreus* Gilbert and Starks).—Hildebrand and Schroeder, 1928, p. 331, fig. 199 (compared with *A. guttatus;* Beaufort, N.C.).—Jordan, Evermann, and Clark, 1930, p. 454 ("South Atlantic Coast, from Cape Hatteras to the Caribbean Sea").—Fowler, 1941, p. 178 (Brazil, compiled); 1945, p. 152 (synonymy in part; Beaufort and New River Inlet, N.C.), p. 223 (Charleston Museum specimens from S.C.), p. 377 (Galveston, Tex.); 1953, p. 54 (Cartagena, Colombia).—Hildebrand, 1954, p. 348 (Texas Coast).—Springer and Bullis, 1956, p. 96 (*Oregon* station 82, 29°21.7′ N., 88°11′ W., 38 fathoms).—Anderson and Gehringer, 1957, p. 55 (34°38′ N., 76°33′ W., at Cape Lookout, N.C.).

Upsilonphorus y-graecum, Jordan, 1884, p. 140 (reference).

Astroscopus anolophus, Baird, 1884, p. 178 (Deal's Island, N.C.).

Anolophus V. graecum, Baird, 1884, p. 178 (reference).

Astroscopus anoplos, Kirsch, 1889, p. 262 (in part; length 1¼ inches, Key West, Fla.; excluding part of range).

Upsilonphorus Y-graecum, Kirsch, 1889, p. 263 (described; Pensacola, Fla., and Beaufort, N.C.).

Astroscopus guttatus (non Abbott), Weymouth, 1910, p. 140 (Cameron, La.).—Dahlgren, 1927, figs. 1 and 3 (these figures only; other references to *A. guttatus* apply or may apply to *A. guttatus*).

Astroscopus Y-graecum, Dahlgren, 1927, p. 364, fig. 11 (life history notes, possibly referable to this species; anatomy).

SPECIMENS EXAMINED

Off Cape Hatteras, N.C., 3 miles SSW of Diamond Shoals Lightship, Mar. 22–25, 1957 (1 specimen), 170 mm. S.L., UNC 2679. Cape Lookout Anchorage, N.C., *Gill* Cr. 4, Nov. 11–12, 1953 (1), 167 mm. SL , BLBG. Gallants Channel at Beaufort railroad bridge, N.C., Jan. 18, 1957 (1), 15.5 mm. S.L , UNC 924. Shackleford Banks, Beaufort, N.C., Sept. 4, 1925 (1), 135 mm. S.L., USNM 185681. Beaufort, N.C., collectors Gudger and Bean (1), 200 mm. S.L., USNM 51912. Beaufort, N.C., collector O. P. Jenkins (1), 84 mm. S.L., CAS (IU No. 6111). Bogue Sound near Swainsboro, N.C., July 17, 1956 (1), 187 mm. S.L., UNC 2370. West shore off Cape Fear River at Southport, N.C., Dec. 12, 1956 (2), 22.5–30 mm. S.L., UNC 866.

North Island at Wingate Bay, S.C., *Fish Hawk* (1), 33 mm. S.L., USNM 59055. Coosan River, S.C. (3), 26–41 mm. S.L., USNM 59083. Coosan River, S.C. (3), 26.5–41 mm. S.L., USNM 59091. South Carolina (2), 29–46.5 mm. S.L., USNM 59033.

Savannah, Ga., collector I. R. Tompkins (4), 32.5–38 mm. S. L., USNM 117198. Off Brunswick, Ga., Feb. 2, 1931, collector W. W. Anderson (1), 41 mm. S.L., USNM 111505. Commercial Trawling Area, Brunswick, Ga., Jan. 16, 1957 (2), 57.5–61 mm. S.L.; Mar. 25, 1959 (1), 59 mm. S.L.; July 13–14, 1959 (1), 120 mm. S.L.; July 14, 1959 (1), 117 mm. S.L.; Oct. 3, 1956 (2), 97.5–112 mm. S.L.; Oct. 20, 1955 (2), 113–127 mm. S.L.; Oct. 22, 1955 (1), 142 mm. S.L.; Nov. 22, 1955 (1), 145 mm. S.L., BLBG. Jekyll Island Causeway, Ga., Nov. 28, 1958 (1), 18 mm. S.L., BLBG. East Beach, St. Simons Island, Ga., Feb. 15, 1956 (1), 18.5 mm. S.L.; Mar. 5, 1957 (1), 25.5 mm. S.L.; Mar. 12, 1959 (1), 28 mm. S.L.; Apr. 13, 1956 (1), 42.5 mm. S.L.; Apr. 16, 1957 (3), 36.5–49.5 mm. S.L.; Apr. 27, 1956 (4), 31.5–47.5 mm. S.L.; May 14, 1956 (3), 44–62 mm. S.L.; May 28, 1956 (4), 41–58 mm. S.L.; July 15, 1957 (1), 81 mm. S.L.; Dec. 19, 1955 (1), 18 mm. S.L.; BLBG. King and Prince Beach, St. Simons Island, Ga., Jan. 15, 1954 (1), 24.5 mm. S.L.; Jan. 16, 1956 (1), 22.4 mm. S.L.; Jan. 27, 1959 (3), 14.5–50 mm. S.L.; Feb. 11, 1959 (1), 19.5 mm. S.L.; Feb. 15, 1956 (1), 25.5 mm. S.L.; Feb. 26, 1959 (1), 19.5 mm. S.L.; Feb. 29, 1956 (1), 48.5 mm. S.L.; Mar. 5, 1957 (10), 42.5–66.5 mm. S.L.; Mar. 15, 1956 (1), 33.5 mm. S.L.; Mar. 18, 1957 (6), 23.5–63.5 mm. S.L.; Apr. 3, 1957 (1), 55 mm. S.L.; Apr. 8, 1955 (1), 24.5 mm. S.L.; Apr. 25, 1955 (1), 30.5 mm. S.L.; May 2, 1957 (2), 60–60.5 mm. S.L.; May 14, 1956 (2), 17–39 mm. S.L.; May 16, 1957 (5), 48.5–68.5 mm. S.L.; May 25, 1959 (1), 22 mm. S.L.; May 31, 1957 (2), 51–71 mm. S.L.; June 14, 1957 (1), 69 mm. S L.; Sept. 11, 1957 (1), 124 mm. S.L.; Sept. 16, 1958 (1), 119 mm. S.L.; Nov. 28, 1958 (1), 40 mm. S.L.; Dec. 2, 1955 (1), 49 mm. S.L.; Dec. 4, 1956 (2), 12.5–21.5 mm. S.L.; Dec. 19, 1956 (2), 14.5–39.5 mm. S.L.; Dec. 19, 1955 (2), 12–19 mm. S.L.; BLBG. St. Simons Island, Ga., Nov. 21, 1930 (1), 36 mm. S.L., USNM 119233. Brickhill Creek, Camden County, Ga., Jan. 1931 (13), 33.5–43.5 mm. S.L., USNM 126065.

St. Johns River, Fla., collector S. F. Baird (1), 118 mm. S.L., USNM 18044. West of North Key, Florida Keys, 2.5 fathoms, Mar. 25, 1957 (1), 182 mm. S.L., UF. Key West, Fla. (1), 25 mm. S.L., CAS (IU No. 6344). Key West, Fla., collector D. S. Jordan (1), 24.5 mm. S.L., USNM 35002. Lemon Bay, Fla., summer 1953 (1), 105 mm. S.L., CHML. Lemon Bay at Grove City, Fla., Jan. 28, 1955 (1), 41.5 mm. S.L., CHML. South Englewood Beach, Fla., May 25, 1955 (1), 83 mm. S.L., CHML. Vicinity of Ft. Walton, Fla., summer 1959, collector The Gulfarium (1), 323 mm. S.L., BLBG. Pensacola, Fla., Feb. 9, 1885 (4), 21.3–39 mm. S.L., USNM 132272. Pensacola, Fla., collector Harrison (1), 140 mm. S.L., USNM 44870. Pensacola, Fla., collector Jordan and Stearns (1), 38 mm. S.L., USNM 30851. Florida, collector J. C. Willetts (1), 230 mm. S.L., USNM 18029. 30°12′ N., 88°40′ W., *Silver Bay* Station 167, 4 fathoms, Aug. 28, 1957 (1), 186 mm. S.L., USNM 159669.

Four Bayou Pass, La., Feb. 18, 1933 (1), 42.5 mm. S.L., USNM 185647. Louisiana, Nov. 28, 1931 (5), 23.8–90 mm. S.L., USNM 185669. Off Louisiana coast, 1932 (1), 39 mm. S.L., USNM 156863.

Galveston, Tex., 1941 (1), 120 mm. S.L., USNM 120039. Galveston, Tex., collector D. S. Jordan (1), 50.5 mm. S.L., USNM 30898. Aransas Pass, Corpus Christi, Tex., Nov. 5, 1926 (9), 11.1–17.1 mm. S.L., USNM 185650. Aransas Pass, Tex., Apr. 5, 1927 (1), 144 mm. S.L., USNM 185682. Texas (2), 20–32 mm. S.L., USNM 185675.

Port of Fortaleza, Macuripe, Brazil, Mar. 1945 (1), 48 mm. S.L., SU 52345.

SYNONYMY: *Astroscopus y-graecum* and *A. guttatus* have frequently been confused, due partly to the failure to recognize growth changes in head sculpture in the two species. In earlier years it was due also to the recognition of a third nominal species of this group, *Astroscopus anolopos*, apparently based on a small specimen of *A. y-graecum* that still had the larval character of the head covered by the exposed cranial bones. We have not examined larval specimens of *A. guttatus* and therefore cannot distinguish them from larval *A. y-graecum* other than by distribution. Larval specimens of *Astroscopus* from the North Carolina coast, where the ranges of the two species are known to overlap, are identified only to genus; specific identifications of larvae from north and south of North Carolina are presumptive. In a publication containing many life history notes and theories, Dahlgren (1927) discussed both *Astroscopus y-graecum* and *A. guttatus* and stated (p. 364): "Where they overlap in the neighborhood of Cape Hatteras it seems practically certain that they interbreed, and great variation is found." Dahlgren did not, however, record his criteria for separation of the two species, and we are convinced that he misidentified some of his specimens (see synonymies).

Diagnosis: Dorsal spines III to V. Dorsal soft rays 13 to 15. Anal soft rays 12 to 14. Pectoral rays 19 to 22. Pelvic rays I, 5. Pelvic girdle without exposed anteriorly directed spines. Top of head covered by exposed cranial bones to about 31 mm. S.L.; in larger sizes the frontal bones exposed posteriorly on the head, with their medial processes forming an exposed Y-shaped process that extends anteriorly between the eyes, and with the area within the fork of the Y and lateral to it covered by skin; with growth the basal arm of the Y becomes long and narrow and the fleshy area becomes comparatively large; least width of the basal arm of the Y about 1.4 to 2.4 percent of standard length at sizes larger than 100 mm. S.L. Posterior nostrils each in a fringed groove curving around behind the eye; posterior end of nostril groove much closer to back of eye than to posterior margin of skin-covered area over electric organs; distance from eye to end of rear nostril groove (a in plate 1G) into distance from end of rear nostril groove to posterior margin of skin-covered area (b in plate 1G) about 1.9 to 11.0 times (in sizes above 40 mm. S.L.). Lower jaw without a pair of prominent converging bony ridges.

Preoperculum and operculum without spines or processes above about 35 mm. S.L. (in smaller sizes the preoperculum has a blunt angle spine, and a bluntly pointed spine is present at the upper anterior margin of the operculum). Cleithral spine small, laterally compressed, covered by skin and adpressed to body. Scales present on body and extending onto fleshy part of caudal fin; scales absent on head, an area posterior to the pectoral fin bases, the throat and abdomen, between the lateral lines and the dorsal fin, and a narrow area along the anal fin base. Lateral lines on each side of body extending from head along back close to dorsal fin, bending down through central part of caudal base onto fleshy part of caudal fin, then bending anteroventrally to unite at bottom of caudal base.

Color: Body and head generally dark above and light below; tip of lower jaw and upper part of head and body to end of dorsal base with large, irregular, widely spaced white spots having narrow dark margins (these spots not formed on specimens less than about 47 mm. standard length); a dark stripe extending along middle of caudal peduncle; a large elongated black blotch on each side of chin. Spinous dorsal fin black. Soft dorsal fin with from one to three oblique black bars (one bar present between about 50 and 70 mm. standard length, two bars between about 55 and 130 mm., three bars above about 120 mm.). Anal fin with an elongated black stripe extending across most of the softrays (formed between about 53 and 60 mm. standard length). Pectoral fins dusky over most of fin, tending to become black near tip, with a narrow light margin (pigment becoming pronounced at about 50 mm. standard length). Pelvics with an elongated dusky or blackish spot near the distal end of the inner rays (forming at about 110 mm. standard length). Caudal fin with one or three black stripes (one stripe formed at about 40 mm. standard length, three stripes formed at about 55 mm.).

Size: Largest specimen examined, 323 mm. S.L. (440 mm. or 17.5 inches total length). Smallest specimen examined, 12 mm. S.L.

Range: From Cape Hatteras, North Carolina, southward along the United States Atlantic and Gulf coasts and the coast of Central and South America to Santos, Brazil. From recorded specimens this species appears to be an inshore, relatively shallow water inhabitant. Springer and Bullis (1956, p. 96) recorded the species from one *Oregon* station at 38 fathoms from off Alabama—apparently the greatest depth to be recorded.

Astroscopus guttatus Abbott

Plates 1b,d,f; 2c

Astroscopus guttatus Abbott, 1861, p. 365, pl. 7 (type locality Cape May, New Jersey, Beesley's Point ?); type specimen in Academy of Natural Sciences of Philadelphia, No. 22722, about 118 mm. S.L; not *Uranoscopus guttatus* Cuvier 1829, a *Uranoscopus* described from the coast of Pondicherry, India).—Gill, 1861b, p. 43 (reference after Abbott 1861).—Jordan and Evermann, 1898, p. 2307 (key), p. 2310 (description; distinguished from *Astroscopus y-graecum*).—Shufeldt, 1901, pl. vii (photograph).—Fowler, 1906, p. 399 (key), p. 401 (redescription of type specimen from Cape May, 6.5 inches in length).—Evermann and Hildebrand, 1910, p. 163 (Gloucester Point, Va.).—Fowler, 1916, p. 42 (Sandy Hook, N.J.).—White, 1918, p. 141 (development of electric organs; not distinguished from *A. y-graecum*).—Fowler, 1925, p. 45 (Young's Pier, Atlantic City, N.J.); 1926, p. 150 (Longport, N.J.).—Dahlgren, 1927, p. 361, figs. 2, 4–5 (in part; life history notes, possibly referable to this species; excluding figs. 1 and 3 which are *A. y-graecum*).—Nichols and Breder, 1927, p. 156, fig. 228 (accidental distribution in the fall in New York).—Hildebrand and Schroeder, 1928, p. 330, fig. 200 (described; compared with *A. y-graecum;* Lewisetta, Buckroe Beach, Lynnhaven Roads, and Ocean View, Va.).—Jordan, Evermann, and Clark, 1930, p. 454 ("Atlantic coast of the United States, from Long Island to Virginia; not known south of Cape Hatteras").—Pearson, 1941, p. 99, figs. 24–25 (larvae illustrated; Chesapeake Bay, Va.).—Fowler, 1945, p. 72 (synonymy in part; Little Assawoman Bay, Worcester County, Md.).—O'Brien, 1955, p. 90 (photographs).

Upselonphorus guttatus, Gill, 1861a, p. 113 (reference, in part, range incorrect).

Astroscopus anoplus (non Valenciennes), Uhler and Lugger, 1876, p. 83 (synonymy in part; "Occurs occasionally in the southern part of Chesapeake Bay").—Bean, 1879, p. 60 (described; Tompkinsville, N.Y., and Norfolk, Va.).—Jordan and Gilbert, 1882, p. 629 (in part; reference to Abbott, 1861, only), p. 941 (described).

Astroscopus y-graecum (non Cuvier), Bean, 1879, p. 58 (in part; record from Hampton Roads, Va., only).—Fowler, 1906, p. 399, pl. 91 (key to growth stages of *A. guttatus;* description; Atlantic City, N.J., 14-inch specimen).

Upsilonphorus guttatus, Jordan, 1884, p. 140 (reference).—Kirsch, 1889, p. 264 (reference).

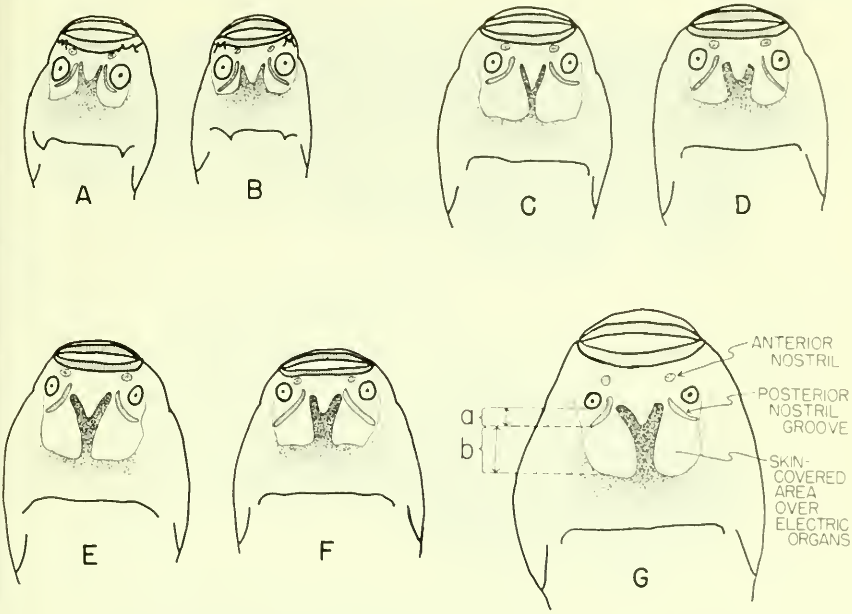
SPECIMENS EXAMINED

Astroscopus guttatus: Rockaway, Long Island, N.Y., collector Blackford (1), 37 mm. S.L., USNM 34628. Tompkinsville, N.Y., collector Charles Copley (1), 80 mm. S.L., USNM 10761. Longport, N.J., Aug. 26, 1887, collector T. H. Bean (1), 48.5 mm. S.L., USNM 45112. Barnegat Bay, N.J., Sept. 19, 1928, collector R. G. Collins (1), 71.5 mm. S.L., USNM 89062. Chesapeake Bay, collector Otto Lugger (3), 43–65.5 mm. S.L., USNM 39347.

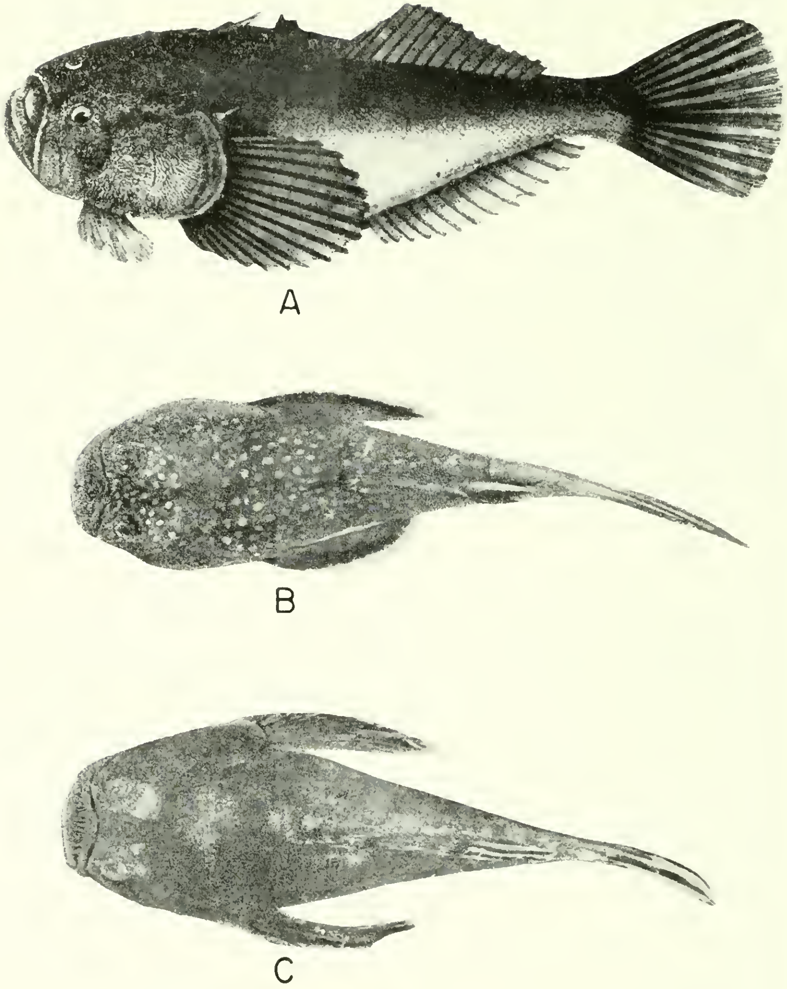
Old Point, Va., Apr. 10, 1922 (1), 70 mm. S.L., USNM 91208. Old Point Comfort, Va., Sept. 11, 1908 (2), 150–155 mm. S.L., USNM 73517. Gloucester Point, York River, Va., *Fish Hawk*, Apr. 3, 1892 (1), 54 mm. S.L., USNM 67917. Buckroe Beach, Va., Oct. 5, 1921 (2), 45–80 mm. S.L., USNM 91209. Off Buckroe Beach, Chesapeake Bay, Va., Apr. 3, 1930 (1), 91.5 mm. S.L., USNM 185668. Fortress Monroe, Va., *Grampus*, June 28, 1892 (1), 95 mm. S.L., USNM 125018. Ocean View, Norfolk, Va., Oct. 16–18, 1922, collector W. C. Schroeder (1), 98 mm. S.L., USNM 91207. Ocean View, Norfolk, Va., Oct. 10–13, 1922 (7), 69.5–105 mm. S.L., USNM 91206. Ocean View, Norfolk, Va., Sept. 5 to Oct. 7, 1922 (7), 58.5–104 mm. S.L., USNM 185683. Norfolk, Va., collector U. Dahlgren (1), 187 mm. S.L., USNM 57830. Norfolk, Va. (1), 207 mm. S.L., USNM 4622. The Cape, N.C., collector M. Corbel (1), 215 mm. S.L., USNM 32754. Off Cape Hatteras, N.C., 10–20 fathoms, Dec. 5, 1930 (1), 197 mm. S.L., USNM 185684. Cape Lookout, N.C., collector Coles (1), 119 mm. S.L., USNM 74308.

Astroscopus sp.: 35°25′30″ N., 75°25′00″ W., *Albatross* station 2286, Oct. 19, 1884 (1), 34 mm. S.L., USNM 131500. 35°22′50″ N., 75°25′00″ W., *Albatross* station 2289 (1), 22.8 mm. S.L., USNM 148208. Mouth of canal, Beaufort, N.C., Feb. 13, 1930 (1), 25.2 mm. S.L., USNM 153674. Mouth of canal, Beaufort, N.C., Mar. 13, 1931 (1), 24.2 mm. S.L., USNM 153675. Newport River, Beaufort, N.C., Jan. 2, 1930 (1), 23.7 mm. S.L., USNM 153676.

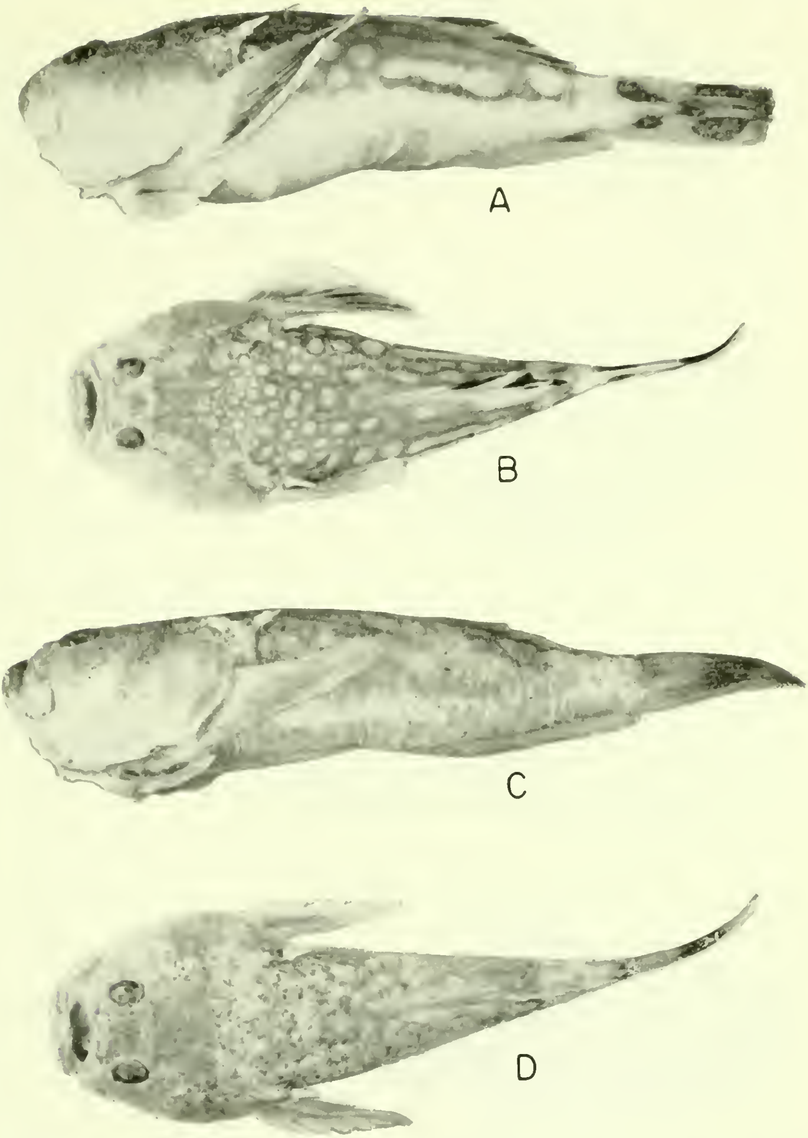
DIAGNOSIS: Dorsal spines IV or V. Dorsal soft rays 13 to 15. Anal soft rays 13 or 14. Pectoral rays 19 to 21. Pelvic rays I, 5. Pelvic girdle without exposed anteriorly directed spines. Top of head covered by exposed cranial bones at small sizes (at 23 mm. T.L., fide



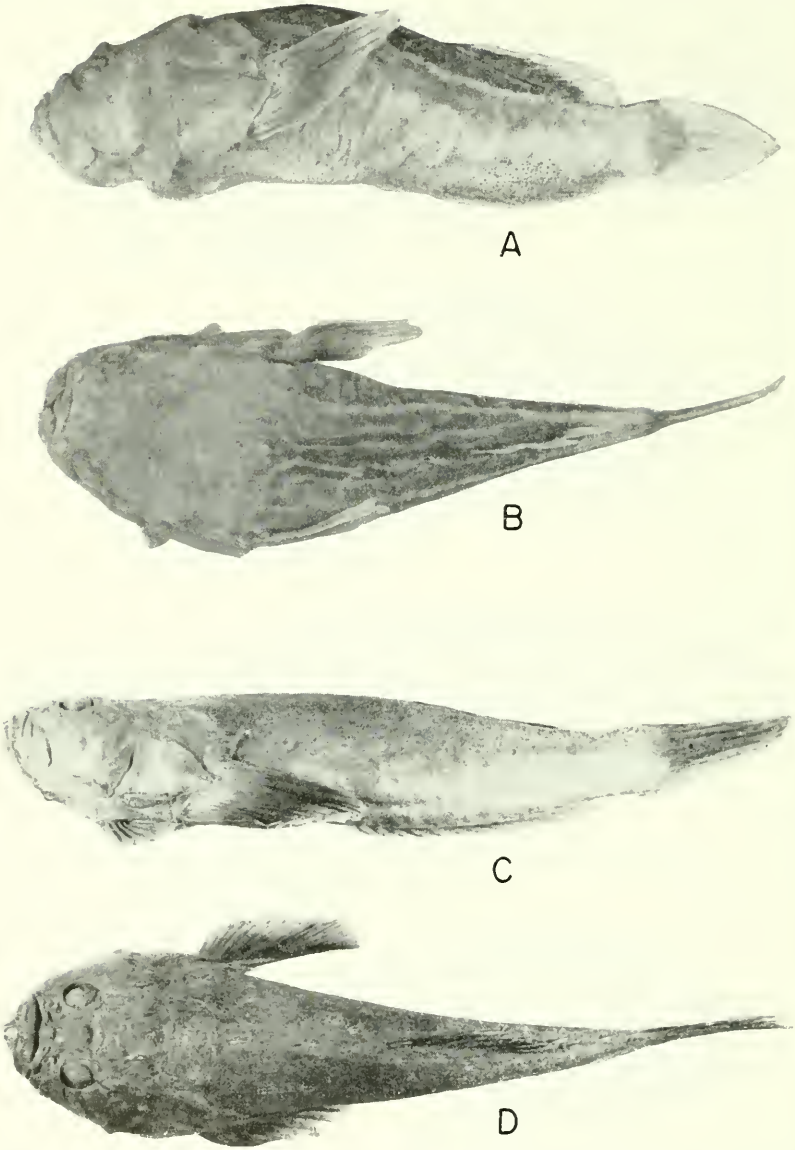
Diagrammatic dorsal view of heads of *Astroscopus y-graecum* and *Astroscopus guttatus* illustrating growth changes in shape or relative position of the Y-shaped processes of the frontal bones, the posterior nostril groove and the area of skin covering the electric organs. *Astroscopus y-graecum:* A, 45 mm. S.L.; C, 112 mm. S.L.; E, 14 inches total length; G, 323 mm. S.L. (17.5 inches total length). *Astroscopus guttatus:* B, 45 mm. S.L.; D, 98 mm. S.L.; F, 12 inches total length. E and F modified from Dahlgren (1927, figs. 4 and 11). The measurements shown in G are: a, distance from eye to rear end of posterior nostril groove; b, distance from rear and of posterior nostril groove to posterior margin of skin-covered area.



A, *Uranoscopus occidentalis*, drawing of the type, after Agassiz *in* Spix (1831, pl. LXXIII). B, *Astroscopus y-graecum*, 100 mm. S.L., Brunswick, Ga., BLBG. C, *Astroscopus guttatus*, 98 mm. S.L., Norfolk, Va., USNM 91207.



A and B, *Kathetostoma albigutta*, 113 mm. S.L., *Combat* station 454, 25°13′ N., 80°10′ W., BLBG. C and D, *Kathetostoma cubana*, 119 mm. S.L., *Silver Bay* station 441, 27°39′ N., 79°15′ W., BLBG.



Gnathagnus egregius: A and B, 76 mm. S.L., *Oregon* station 265, 29°20′ N., 87°42′ W., CNHM 46649. C and D, 243 mm. S.L., *Oregon* stations 472 through 478, Gulf of Mexico off Mississippi Delta, CNHM 46651.

Pearson 1941, p. 98, fig. 25); in larger sizes (at least by 43 mm. S.L.) the frontal bones exposed posteriorly on the head, with their medial processes forming an exposed Y-shaped process that extends anteriorly to between or just behind the eyes, and with the area within the fork of the Y and lateral to it covered by skin; in large specimens the basal arm of the Y short and broad and the skin-covered area only moderately enlarged; least width of the basal arm of the Y about 2.5 to 3.8 percent of standard length in sizes larger than 100 mm. S.L. Posterior nostrils each in a fringed groove curving around behind the eye; posterior end of nostril groove usually closer to posterior margin of skin-covered area over electric organs than to eye or not much closer to eye; distance from eye to end of rear nostril groove (a in plate 1G) into distance from end of rear nostril groove to posterior margin of skin-covered area (b in plate 1G) about 0.5 to 1.6 times (at sizes above 40 mm. S.L.). Lower jaw without a pair of prominent converging bony ridges.

Preoperculum and operculum without spines or processes. Cleithral spine small, laterally compressed, covered by skin and adpressed to body. Scales present on body and extending onto fleshy part of caudal fin; scales absent on head, an area posterior to the pectoral fin bases, the throat and abdomen, between the lateral lines and the dorsal fin, and a narrow area along the anal fin base. Lateral lines on each side of body extending from head along back close to dorsal fin, bending down through central part of caudal base onto fleshy part of caudal fin, then bending anterioventrally to unite at bottom of caudal base.

Color: Body and head generally dusky above and light below; tip of lower jaw and upper part of head and body to end of dorsal base with many small and irregular white spots; a dark stripe extending along middle of caudal peduncle; a large elongated black blotch on each side of chin. Spinous dorsal fin black. Soft dorsal fin with about 4 oblique black bars. Anal fin with an elongated blackish stripe extending across most of the soft rays. Pectoral fins dusky over most of fin, tending to become black near tip, and with a narrow light margin. Pelvic fins mostly clear with a dusky or dark spot between distal ends of last two rays. Caudal fin with about three black stripes.

Size: Largest specimen reported, 12¼ inches total length (about 220 mm. S.L.), from Chesapeake Bay (Hildebrand and Schroeder, 1927, p. 331). Smallest specimens reported, 2.5 to 5 mm. T.L. and 23 mm. T.L. (Pearson, 1941, p. 98, figs. 24–25). Largest specimen examined 215 mm. S.L. Smallest specimen examined 37 mm. S.L. Dahlgren (1927, p. 358) reported specimens as *Astroscopus* (presumably this species) from several miles off the Virginia coast that were up to 22 inches in total length and weighed up to 15 or 20 pounds.

RANGE: From Long Island, New York, to Cape Lookout, North Carolina. This species primarily inhabits inshore, shallow, sandy areas. Dahlgren (1927, p. 362) speculated that larger individuals spawned at depths of 30 to 200 feet.

Genus *Kathetostoma* Günther

Kathetostoma Günther, 1860, p. 231. Type species: *Uranoscopus laevis* Bloch and Schneider, 1801, by monotypy.

Kathetostoma albigutta Bean

PLATE 3A-B

Cathetostoma albigutta Bean, 1892, p. 121 (type specimens in U.S. National Museum. Type locality *Albatross* station 2403, 28°42′30″ N., 85°29′00″ W., 88 fathoms, USNM 39304, holotype 119 mm. S.L. and one paratype 115 mm. S.L. Paratypes from *Albatross* station 2404, 28°44′ N., 85°16′ W., 60 fathoms, USNM 39305 (2), 85 and 113 mm. S.L.; *Albatross* station 2410, 26°47′30″ N., 83°25′15″ W., 28 fathoms, USNM 39306 (1), 95 mm. S.L.; and *Albatross* station 2411, 26°33′30″ N., 83°15′30″ W., 27 fathoms, USNM 39307 (1), 27.5 mm. S.L.).

Kathetostoma albigutta, Jordan and Evermann, 1898, p. 2311 (key), p. 2312 (described; incorrectly stated that only one specimen known; dorsal and anal ray counts incorrect); 1900, p. 3301, pl. CCCXXXIV, figs. 809, 809a (type specimen illustrated).—Longley and Hildebrand, 1940, p. 267 (reference).—Barbour, 1941, p. 1 (reference to holotype).—Longley and Hildebrand, 1941, p. 245 (described; off Tortugas, Fla., 67 to 88 fathoms).—Hildebrand, 1954, p. 317 (off Gulf coast of Texas and northern Mexico).—Springer and Bullis, 1956, p. 97 (*Oregon* stations in the Gulf of Mexico).

Kathetostoma albiguttum, Evermann and Kendall, 1900, p. 92 (reference to type specimen localities).

SPECIMENS EXAMINED

34°52′ N., 75°27′ W., *Silver Bay* station 1283, 98 fathoms, Sept. 17, 1959 (1), 115 mm. S.L., BLBG. 34°48′ N., 75°33′ W. to 34°45.5′ N., 75°28′ W., *Albatross* III station 35, tow 1, 42–48 fathoms, June 3, 1945 (1), 80 mm. S.L., USNM 151918. 34°32′ N., 75°58′ W. to 34°34′ N., 75°58′ W., *Albatross* III Cr. 21, station 5, tow 1, 23–25 fathoms, June 8, 1949 (2), 120–121 mm. S.L., USNM 151923. 34°23′ N., 76°03′ W., *Combat* station 408, 30 fathoms, June 22, 1957 (1), 105 mm. S.L., USNM 159644. 34°17′ N., 76°01′ W., *Combat* station 406, 45 fathoms, June 21, 1957 (1), 36 mm. S.L., BLBG. 34°17′ N., 76°01′ W., *Combat* station 406 (1), 117 mm. S.L., USNM 159646. 34°11′ N., 76°18′ W., *Pelican* station 187–2, 22 fathoms, Feb. 27, 1940 (1), 90.5 mm. S.L., USNM 185649. 33°55.5′ N., 76°23′ W., to 33°59′ N., 76°20′ W., *Albatross* III Cr. 31–A, station 1, tow 4, 78 fathoms, Jan. 18, 1950 (2), 116–126 mm. S.L., USNM 151935.

Southeast of North Edisto River sea buoy, S.C., 20 fathoms, Feb. 24, 1958 (1), 105 mm. S.L., CM 58.2.19. 32°34′ N., 78°46′ W., *Combat* station 424, 24 fathoms, June 24, 1957 (1), 104 mm. S.L., TU 17087. 32°26′ N., 79°03′ W., *Combat* station 167, 23 fathoms, Nov. 1, 1956 (1), 106 mm. S.L., UF 7229. 32°05′ N., 79°40′ W., *Combat* station 514, 22–25 fathoms, Oct. 7, 1957 (1), 110 mm. S.L., USNM 159645. 31°55′ N., 79°35′ W., *Combat* station 518, 38–43 fathoms, Oct. 8, 1957 (1), 162 mm. S.L., TU 17552. 31°49′ N., 79°31′ W., *Combat* station 519, 45 fathoms, Oct. 8, 1957 (1), 88 mm. S.L., TU 17561. 31°38′ N., 79°40′ W., *Combat* station

526, 41–45 fathoms, Oct. 8, 1957 (1), 82 mm. S.L., TU 17600. 31°29′ N., 79°33′ W., *Combat* station 512, 60 fathoms, Oct. 3, 1958 (1), 115 mm. S.L., USNM 159097. 31°18′ N., 79°45′ W., *Combat* station 528, 100 fathoms, Oct. 9, 1957 (2), 118–157 mm. S.L., TU 17556. 31°00.5′ N., 80°01.5′ W., *Pelican* station 198–1, 40 fathoms, Mar. 15, 1940 (1), 29 mm. S.L., USNM 185666.

20 to 50 fathom contour from point north of Jacksonville, Fla., to a point south of Brunswick, Ga., *Bowers*, Jan. 1956, collector James D. Regan (1), 121 mm. S.L., UMML 5. 30°13′ N., 80°23′ W., *Combat* station 497, 25 fathoms, Aug. 20, 1957 (1), 94.5 mm. S.L., BLBG. 29°30′ N., 80°13′ W., *Combat* station 488, 50 fathoms, Aug. 19, 1957 (3), 99–107 mm. S.L., BLBG. 29°15′ N., 80°13′ W., *Combat* station 334, 30 fathoms, June 1, 1957 (1), 85 mm. S.L., BLBG. 29°03′ N., 80°13′ W., *Combat* station 335, 28 fathoms, June 1, 1957 (1), 147 mm. S.L., USNM 159389. 28°58′ N., 80°13′ W., *Combat* station 333, 30 fathoms, June 1, 1957 (3), 102–144 mm. S.L., BLBG. 25°13′ N., 80°10′ W., *Combat* station 454, 85 fathoms, July 26, 1957 (6), 87.5–142 mm. S.L., BLBG. South of Tortugas, Fla., collector W. H. Longley (6), 72.5–113 mm. S.L., USNM 92057.

Tortugas, Fla., collector W. H. Longley (4), 80–101 mm. S.L., USNM 117281. 24°47′ N., 83°13′ W., *Oregon* station 1020, 35 fathoms, Apr. 19, 1954 (1), 96 mm. S.L., USNM 185648. 26°33′30″ N., 83°15′30″ W., *Albatross* station 2411, 27 fathoms (1 paratype), 27.5 mm. S.L., USNM 39307. 24°25′ N., 83°22′ W., *Oregon* station 1548, 210 fathoms, June 17, 1956 (1), 90 mm. S.L., TU 12683. 26°47′30″ N., 83°25′15″ W., *Albatross* station 2410, 28 fathoms (1 paratype), 95 mm. S.L., USNM 39306. 27°30′ N., 84°14′ W., *Oregon* station 937, 38 fathoms, Mar. 18, 1954 (1), 105 mm. S.L., UF 3708. 28°44′ N., 85°16′ W., *Albatross* station 2404, 60 fathoms (2 paratypes), 85–113 mm. S L., USNM 39305. 28°47′ N., 85°19′ W., *Oregon* station 895, 64 fathoms, Mar. 7, 1956 (3), 88.5–111 mm. S.L., TU 12959. 28°42′30″ N., 85°29′ W., *Albatross* station 2403, 88 fathoms (holotype and 1 paratype), 119–115 mm. S.L., USNM 39304. 29°07.5′ N., 85°40.5 W., *Pelican* station 154–3, 50 fathoms, Mar. 10, 1939 (1), 72 mm. S.L., USNM 185646.

29°36′ N., 85°54′ W., *Silver Bay* station 160, 21–22 fathoms, Aug. 23, 1957 (1), 136 mm. S.L., USNM 159658. 29°32′ N., 86°04′ W., *Silver Bay* station 158, 40 fathoms, Aug. 23, 1957 (3), 110–122 mm. S.L., USNM 159660. 29°47′ N., 86°28.5′ W., *Pelican* station 143–3, 60 fathoms, Mar. 5, 1939 (1), 113 mm. S.L., USNM 185680. 29°50′ N., 86°35′ W., *Silver Bay* station 316, 60–75 fathoms, Mar. 16, 1958 (1), 108 mm. S.L., BLBG. 30°03′ N., 86°50′ W., *Silver Bay* station 312, 55 fathoms, Mar. 16, 1958 (1), 101 mm. S.L., BLBG. 30°03′ N., 86°50′ W., *Silver Bay* station 312 (1), 204 mm. S.L., TU 17561. 30°03′ N., 86°56′ W., *Oregon* station 331, 60 fathoms, May 4, 1951 (1), 98.5 mm. S.L., USNM 186170. 28°11′ N., 91°24.5′ W., *Pelican* station 85–4, 47 fathoms, July 12, 1938 (1), 96.5 mm. S.L., USNM 185671. 28°09′ N., 91°32′ W., *Pelican* station 85–2, 49 fathoms, July 12, 1938 (1), 111 mm. S.L., USNM 185670.

27°45′ N., 96°13′ W., *Pelican* station 108–10, 39 fathoms, Jan. 23, 1939 (2), 84.5–92 mm. S.L., USNM 185673. 27°24.5′ N., 96°13′ W., *Pelican* station 40, 90 fathoms, Apr. 21, 1938 (1), 108 mm. S.L., USNM 185672. 27°29′ N., 96°16′ W., *Oregon* station 159, 58 fathoms, Nov. 27, 1950 (1), 85 mm. S.L., TU 2674. 27°27′ N., 96° 17′ W., *Oregon* station 158, 65 fathoms, Nov. 27, 1950 (4), 102–145 mm. S.L., USNM 185685. 27°17.5′ N., 96°25′ W., *Pelican* station 111–4, 75 fathoms, Jan. 30, 1939 (2), 78–92.5 mm. S.L., USNM 185667. 26°10′ N., 96°40′ W., *Oregon* station 1087, 29 fathoms, June 3, 1954 (1), 86 mm. S.L., UF 7228. 26°10′ N., 96°40′ W., *Oregon* station 1087 (1), 136 mm. S.L., TU 10643. Brownsville, Texas (1), 119 mm. S.L., USNM 171762. 23°36′ N., 87°54′ W., *Silver Bay* station 438, 68 fathoms, May 18, 1958 (3), 109–141 mm. S.L., BLBG.

Diagnosis: No spinous dorsal fin. Dorsal soft rays 13 to 15. Anal soft rays 12 to 15. Pectoral rays 14 to 16. Pelvic rays I, 5, the spine obscured by skin. Pelvic girdle with paired anterior processes of conical spines protruding through the skin. Top of head covered by exposed cranial bones; a shallow anterior recess of the frontal bones between the eyes. Posterior nostrils not in fringed grooves. Lower jaw without a pair of prominent converging bony ridges. Preoperculum with three spines extending from ventral margin; operculum without a spine. Cleithral spine prominent, conical, sharply pointed, and extending posterodorsally. No scales present (scalelike structures present in lateral line). Lateral lines on each side of body extending from head along back close to dorsal fin, bending down to middle of caudal base, and ending between and nearly at ends of central caudal rays.

Color: Lower half of body whitish. Upper half of body with rounded white spots on brownish background, margins of the spots of darker brown, the spots confined mainly to predorsal area on small specimens, on large specimens the posterior spots larger and elongate. Pectoral fins with brownish black pigment across the fins. Pelvics clear. Anal fin with small area of pigment at posterior base. Dorsal fin with two to five and caudal fin with three or more blackish elongated spots, the spots more numerous in larger specimens.

Size: Largest specimen examined 204 mm. S.L. (about 10.2 inches T.L.). Smallest specimen examined 29 mm. S.L. A 21-mm. S.L. specimen is identified only to genus, because it lacks distinctive pigmentation and the pectoral fins are damaged.

Range: From Cape Lookout, N.C., to the Florida Keys and around the Gulf of Mexico to Campeche Bank off Yucatan. Depth records of all but one of the known specimens range from 22 to 100 fathoms, with the majority of these records between 30 and 60 fathoms. One specimen was recorded from 210 fathoms south of the Florida Keys where the Continental Shelf is very steep.

Kathetostoma cubana **Barbour**

Plate 3c-d

Kathetostoma albigutta cubana Barbour, 1941, p. 2 (type locality *Atlantis* station 3421 off the northern coast of Cuba. Holotype and 13 paratypes in Museum of Comparative Zoology, Nos. 35506, 35508, 35510, 35511, 35512, 35513, and 35514; 2 paratypes in U.S. National Museum, No. 153586; 2 paratypes sent to Museo Poey, Havana).

SPECIMENS EXAMINED

Kathetostoma cubana: 27°39′ N., 79°15′ W., *Silver Bay* station 441, 275–300 fathoms, June 9, 1958 (2), 67.5–119 mm. S.L., BLBG. 24°04′ N., 79°15′ W., *Combat* station 448, 250 fathoms, July 24, 1957 (1), 54.5 mm. S.L., BLBG. 24°04′ N., 79°15′ W., *Combat* station 448, 250 fathoms, July 24, 1957 (1), 55 mm.

S.L., USNM 159650. 22°50′ N., 79°08′ W., *Oregon* station 1344, 200–225 fathoms, July 16, 1955 (1), 66 mm. S.L., USNM 157986. 22°48′ N., 79°09′ W., *Atlantis* station 3422, 235 fathoms, Apr. 30, 1939 (3 paratypes), 86.5–118 mm. S.L., MCZ 35513. 22°50′ N., 78°55′ W., *Atlantis* station 3416, 200 fathoms, Apr. 30, 1939 (2 paratypes), 70.5–75 mm. S.L., USNM 153586. 16°39′ N., 81°43′ W., *Oregon* station 1878, 125 fathoms, Aug. 22, 1957 (1), 98 mm. S.L., UMML 4793. 16°39′ N., 82°29′ W., *Oregon* station 1870, 225 fathoms, Aug. 21, 1957 (1), 128 mm. S.L., TU 18848. 18°30′ N., 65°59′ W., *Oregon* station 2603, 230 fathoms, Sept. 25, 1959 (1), 85 mm. SL., USNM 195569.

Kathetostoma sp.: 27°49′ N., 84°12′ W., *Oregon* station 939, 35 fathoms, Mar. 18, 1934 (1), 21 mm. S.L., USNM 185674.

SYNONYMY: Barbour (1941, p. 1), apparently noting only color differences, described *K. cubana* as a subspecies of *K. albigutta*. Because of the consistent and discrete color differences, differences in pectoral ray counts and geographical and depth distribution, and differences in modal numbers of anal soft rays, we evaluate *K. cubana* as a distinct species.

DIAGNOSIS: No spinous dorsal fin. Dorsal soft rays 13 to 15. Anal soft rays 13 or 14. Pectoral rays 17 or 18. Pelvic rays I, 5, the spine obscured by skin. Pelvic girdle with paired anterior processes of conical spines protruding through the skin. Top of head covered by exposed cranial bones; a shallow anterior recess of the frontal bones between the eyes. Posterior nostrils not in fringed grooves. Lower jaw without a pair of prominent converging bony ridges. Preoperculum with three spines extending from ventral margin; operculum without a spine. Cleithral spine prominent, conical, sharply pointed, and extending posterodorsally. No scales present (scalelike structures present in lateral line). Lateral lines on each side of body extending from head along back close to dorsal fin, bending down to middle of caudal base, and ending between and nearly at ends of central caudal rays. Barbour (1941, p. 2) recorded fin counts as "usually with D. 11 and A. 11," but we have examined five paratypes and six other specimens in which the counts are consistently higher.

COLOR: Ventral part of body unpigmented, sides of body and head with faint pigment, dorsal surface of body and head mottled with irregular dull brown spots. Pelvic and anal fins unpigmented. Pectoral fins faintly pigmented. Dorsal fin faintly pigmented along the rays. Caudal fin with faintly pigmented spot on upper part of base and a broad darker blackish stripe located about middle of fin.

SIZE: Largest specimen reported about 146 mm. S.L. (7.75 inches T.L.). Smallest specimen examined 54.5 mm. S.L.

RANGE: Off the Little Bahama Banks, the Grand Bahama Banks, the northern coast of Cuba, off eastern Puerto Rico, and in the Caribbean off eastern Honduras. All the known specimens but one have been taken between depths of 180 and 300 fathoms; the other record was from 125 fathoms off Honduras. The type localities for *K. cubana* have not been published, and are furnished through the courtesy of Myvanwy M. Dick of the Museum of Comparative Zoology. They are all from off the north central coast of Cuba: *Atlantis* station 3392, 22°35′ N., 78°16′ W., 225 fathoms; *Atlantis* station 3396, 22°34′ N., 78°15′ W., 180 fathoms; *Atlantis* station 3414, 22°50′30″ N., 78°52′ W., 230 fathoms; *Atlantis* station 3416, 22°50′ N., 78°55′ W., 200 fathoms; *Atlantis* station 3421, 22°49′ N., 79°07′ W., 235 fathoms; *Atlantis* station 3422, 22°48′ N., 79°09′ W., 235 fathoms; *Atlantis* station 3423, 22°50′ N., 79°08′ W., 245 fathoms; *Atlantis* station 3437, 23°05′ N., 78°16′ W., 260 fathoms.

Genus *Gnathagnus* Gill

Gnathagnus Gill, 1861, p. 115. Type species: *Uranoscopus elongatus* Temminck and Schlegel, 1844, by monotypy.

Gnathagnus egregius (Jordan and Thompson)

Plate 4

Execestides egregius Jordan and Thompson, 1905, p. 253, figs. 5–6 (type locality reef at Garden Key, Tortugas, Fla. Type specimen in Stanford University Natural History Museum, SU 8411).—Longley and Hildebrand, 1940, P. 267 (reference), 1941, p. 244 (described after Jordan and Thompson, 1905).—Hildebrand, 1954, p. 318 ("24–10 grounds" off northern Gulf coast of Mexico, between 21 and 31 fathoms, specimen 87 mm. long).

Benthoscopus laticeps Longley and Hildebrand, 1940, p. 264, figs. 20–21 (type locality off Tortugas, Fla., between 90 and 175 fathoms; type specimen in U.S. National Museum, USNM 108879); 1941, p. 244 (reference).—Springer and Bullis, 1956, p. 97 (*Oregon* stations in the Gulf of Mexico).

Gnathagnus laticeps, Myers, 1946, p. 42 (generic relationship).

SPECIMENS EXAMINED

31°50′ N., 79°14′ W., *Combat* station 304, 180 fathoms, Apr. 22, 1957 (1), 197 mm. S.L., BLBG. 29°46′ N., 80°13′ W., *Combat* station 9, 200 fathoms, July 29, 1956 (1), 197 mm. S.L., GWM acct. Dinner Key, Biscayne Bay, Dade County, Fla., Mar. 1956, collector Fiefield (1), 57.5 mm. S.L., UMML 747. Off Tortugas, Fla., between 90 and 175 fathoms, collector Longley (holotype of *Benthoscopus laticeps*), 200 mm. S.L., USNM 108879. 24°20′ N., 83°20′ W., *Oregon* station 1005, 190 fathoms, Apr. 13, 1954 (2), 119–186 mm. S.L., GWM acct. 24°28′ N., 83°25′ W., *Oregon* station 1011, 200 fathoms, April 14, 1954 (1), 193 mm. S.L., CNHM 61325. 24°29′ N., 83°32′ W., *Oregon* station 1938, 200 fathoms, June 15, 1956 (1), 145 mm. S.L., TU 12716. 29°16′ N., 86°10′ W., *Oregon* station 1383, 125 fathoms, Sept. 7, 1955 (1), 113 mm. S.L., USNM 158823. 29°57′ N., 86°57.5′ W., *Oregon* station 326, 82 fathoms, Apr. 30, 1951 (1), 87 mm. S.L., GWM acct. No. 190888. 29°38′ N., 87°16.5′ W., *Oregon* station 281, 112 fathoms, Feb. 25, 1951 (1), 71.5 mm. S.L., CNHM 46648.

29°38′ N., 87°16.5′ W., *Oregon* station 281, 112 fathoms, Feb. 25, 1951 (1), 131 mm. S.L., GWM acct. No. 188434. 29°38′ N., 87°16.5′ W., *Oregon* station 281, 112 fathoms, Feb. 25, 1951 (1), 79 mm. S.L., USNM acct. No. 187053, GWM acct. No. 188434. 29°23′ N., 87°25′ W., *Oregon* station 270, 220 fathoms, Feb. 17, 1951 (1), 226 mm. S.L., GWM acct. No. 188434. 29°20′ N., 87°42′ W., *Oregon* station 265, 101 fathoms, Feb. 16, 1951 (1), 117 mm. S.L., CNHM 46650. 29°20′ N., 87°42′ W., *Oregon* station 265, 101 fathoms, Feb. 16, 1951 (1), 76 mm. S.L., CNHM 46649. 29°20′ N., 87°42′ W., *Oregon* station 265, 101 fathoms, Feb. 16, 1951 (1), 78.5 mm. S.L., GWM acct. No. 188434. 29°15.5′ N., 87°53′ W., *Oregon* station 314, 175 fathoms, Apr. 27, 1951 (1), 200 mm. S.L., GWM acct. No. 190888. 29°12′ N., 88°05′ W., *Oregon* station 637, 195 fathoms, Sept. 18, 1952 (1), 175 mm. S.L., TU 6834.

29°13.5′ N., 88°12′ W., *Oregon* station 2203, 125 fathoms, June 26, 1958 (5), 111–127 mm. S.L., BLBG. 29°03′ N., 88°25′ W., *Oregon* station 1107, 210–235 fathoms, June 15, 1954 (1), 175 mm. S.L., TU 12868. 28°57′ N., 88°40.5′ W., *Oregon* station 481, 210 fathoms, Sept. 7, 1951 (2), 211–229 mm. S.L., GWM acct. No. 190888. Between 29°05′ N., 88°31′ W., and 28°56.5′ N., 88°40′ W., *Oregon* stations 472 to 484, between 185 and 240 fathoms, Sept. 6–7, 1951 (2), 166–243 mm. S.L., CNHM 46651. 29°00′ N., 88°48′ W., *Oregon* station 93, 122 fathoms, Aug. 24, 1950 (1), 138 mm. S.L., GWM acct. No. 185983. 27°38′ N., 95°35′ W., *Oregon* station 1509, 225 fathoms, May 7, 1956 (1), 122 mm. S.L., TU 12807. 27°15′ N., 96°24′ W., *Pelican* station 112–1, 80 fathoms, Jan. 30, 1939 (1), 76.5 mm. S.L., GWM *Pelican* acct. No. 186572.

SYNONYMY: We adhere to Myers' (1946, p. 42) decision in placing *Benthoscopus laticeps* in the genus *Gnathagnus* Gill. We include *Execestides* Jordan and Thompson in the synonymy of *Gnathagnus.* The major recorded difference between *G. laticeps* and *Execestides egregius* was that the former had scales, the latter was scaleless. Our specimens of *Gnathagnus*, ranging from 243 mm. S.L. down to 57.5 mm. S.L., showed a pronounced structural ontogeny, and the presence of scales on all of these confirmed their identification as *G. laticeps.* George S. Myers, Margaret Storey, and Stanley H. Weitzman of the Stanford University Natural History Museum cooperated in furnishing us with information on the small type specimen of *E. egregius*, reported to lack scales. A portion of mucous scraped from the side near the peduncle of the type was stained with alizarin and a small scale was found to be present in the scrapings, presumptive evidence that the type specimen has small, hidden scales and supporting our placing *G. laticeps* in the synonymy of *E. egregius* in the genus *Gnathagnus.*

DIAGNOSIS: No spinous dorsal fin. Dorsal soft rays 12 to 14. Anal soft rays 16 or 17. Pectoral rays 20 to 24. Pelvic rays I, 5. Pelvic girdle without exposed anteriorly directed spines. Top of head covered by exposed cranial bones; a shallow anterior recess of the frontal bones between the eyes. Posterior nostrils not in fringed grooves. Lower jaw with the dentary bones forming a pair of prominent converging bony ridges on the anterior part, deeply notched between. Preoperculum with a flattened process, usually bluntly pointed, extending posteriolaterally from across angle of the bone, diminishing with growth; operculum striated and ridged and ending in a spine which diminishes with growth. Cleithral spine prominent, laterally compressed, and curved posteriodorsally. Scales present on body and extending onto fleshy part of caudal fin; scales absent on head, an area posterior to pectoral fin bases, the throat and abdomen, a small area posterior to the bones on top of the head, and a narrow area along the anal fin base; the scales small and deeply embedded in smaller specimens (the largest scale found on a 57.5-mm. specimen had a maximum diameter of 0.19 mm.). Lateral lines on each side of body extending from head along back close to dorsal fin, bending down to middle of caudal base, and ending between and nearly at ends of central caudal rays.

Color: At about 47 mm. S.L. (holotype description), body color blackish, fins pale with a blackish area at base of each, a pale streak along lateral line and one across base of dorsal. From 57.5 to 71.5 mm. S.L., head and dorsal half of body with irregular dark blotches tending to form broken stripes on back, scattered small pigment spots on rest of body, pelvics with spots at bases, other fins dark near bases. By 76 mm. S.L., head no longer dark spotted. By 87 mm. S.L., about the proximal three-fourths of the pectoral, dorsal, anal, and caudal fins are darkened, and the body has taken on a brownish cast. By 113 mm. S.L., the coloration of the upper half of the body consists of numerous small pigment spots, on some specimens these coalesce in some areas to form short lines.

Size: Largest specimen examined, 13 inches T.L. (243 mm. S.L.). Smallest specimen reported, 2⅓ inches total length (the holotype, about 47 mm. S.L.).

Range: All known specimens have been taken from off the coast of the United States: From off northern Georgia, eastern Florida, Tortugas and northwestern Florida, Alabama, Mississippi, and southern Texas. Of the specimens we examined, those larger than 100 mm. S.L. were taken from between about 101 and 240 fathoms; those from 71.5 to 100 mm. S.L. were taken from between 80 and 112 fathoms; and a 57.5-mm. S.L. specimen was taken at Dinner Key in Biscayne Bay, Florida. An 87-mm. T.L. specimen was reported from between 21 and 31 fathoms (Hildebrand, 1954, p. 318), and the 2⅓ inch holotype was taken "on the reef at Garden Key" (Jordan and Thompson, 1905, p. 254).

Literature Cited

Abbott, Charles C.

1861. Description of a new species of *Astroscopus*, Brev., in the Museum of the Academy of Natural Sciences of Philadelphia. Proc. Acad. Nat. Sci. Philadelphia, vol. 12 (1860), p. 365, pl. 7 [pp. 361 et seq. published in 1861, fide ANSP Index].

Anderson, William W., and Gehringer, Jack W.

1957. Physical oceanographic, biological, and chemical data, south Atlantic coast of the United States, M/V *Theodore N. Gill* Cruise 4. U.S. Dep. Int., Fish Wildl. Serv., Spec. Sci. Rep., Fish., No. 234, pp. 192, figs. 19.

Baird, Spencer F.

1884. On the specimens received by the Smithsonian Institution from the United States Life-Saving Service. Bull. U.S. Fish Comm., vol. 4, pp. 177–178.

Barbour, Thomas

1941. A new Cuban star-gazer. Proc. New England Zool. Club, vol. 19, pp. 1–2.

Bean, Tarleton H.

1879. On the species of *Astroscopus* of the eastern United States. Proc. U.S. Nat. Mus., vol. 2, pp. 57–63.

1892. Description of a new species of star-gazer (*Cathetostoma albigutta*), from the Gulf of Mexico. Proc. U.S. Nat. Mus., vol. 15, pp. 121–122.

Bloch, M.E., and Schneider, J. Gottlob

1801. Systema ichthyologiae iconibus ex illustratum . . . . Berolini, pp. ix+584, pls. 110.

Cuvier, Georges, and Valenciennes, Achille

1829. Histoire naturelle des poissons, Paris, F. G. Levrault, vol. 3, pp. xxviii+500, pls. 41–71.

1831. Histoire naturelle des poissons, Paris, F. G. Levrault, vol. 8, pp. xix+509, pls. 209–245.

Dahlgren, Ulric

1927. The life history of the fish *Astroscopus* (the "stargazer"). Scientific Monthly, vol. 24, April, pp. 348–365, figs. 1–11.

DeKay, James E.

1842. Zoology of New-York or the New York fauna, Albany, White and Visscher, pt. 1, Zool., pt. 4, Fishes, pp. xiv+415, pls. 79.

Evermann, Barton W., and Hildebrand, Samuel F.

1910. On a collection of fishes from the Lower Potomac, the entrance of Chesapeake Bay, and from streams flowing into these waters. Proc. Biol. Soc. Washington, vol. 23, pp. 157–164.

Evermann, Barton W., and Kendall, William C.

1900. Check-list of the fishes of Florida. Rep. U.S. Comm. Fish and Fish. (1899), pt. 25, pp. 35–103.

Fowler, Henry W.

1906. The fishes of New Jersey. Ann. Rep. New Jersey State Mus. (1905), pt. 2, pp. 35–477, text-figs., pls. 1–103.

1916. Records of northern New Jersey fishes. Copeia, No. 31, pp. 41–42.

1925. Records of fishes in New Jersey 1924. Copeia, No. 143, pp. 42–46.

1926. Records of fishes in New Jersey 1925. Copeia, No. 156, pp. 146–150.

1936. The marine fishes of West Africa. Bull. Amer. Mus. Nat. Hist., vol. 70, pt. 2, pp. 607–1493, figs. 276–567.

1941. A list of the fishes known from the coast of Brazil. Arq. Zool. Est. São Paulo, vol. 3, pp. 115–184.

1945. A study of the fishes of the southern Piedmont and coastal plain, Monogr. Acad. Nat. Sci. Philadelphia, No. 7, pp. 408.

1953. The shore fishes of the Colombian Caribbean. Caldasia, vol. 6, pp. 43–73.

GILL, THEODORE

1860. Notes on the nomenclature of North American fishes. Proc. Acad. Nat. Sci. Philadelphia, vol. 12, pp. 19–21.

1861a. Synopsis of the uranoscopids. Proc. Acad. Nat. Sci. Philadelphia, vol. 13 (1862), pp. 108–117.

1861b. Catalogue of the fishes of the eastern coast of North America, from Greenland to Georgia. Proc. Acad. Nat. Sci. Philadelphia, vol. 13 (1862), Appendix, pp. 63.

GREGORY, WILLIAM K.

1933. Fish skulls. A study of the evolution of natural mechanisms. Trans. Amer. Philos. Soc., vol. 23, pt. 2, pp. 75–481.

GÜNTHER, ALBERT

1860. Catalogue of the acanthopterygian fishes in the collection of the British Museum, London, Taylor and Francis, vol. 2, pp. xxi+548.

HILDEBRAND, HENRY H.

1954. A study of the fauna of the brown shrimp (*Penaeus aztecus* Ives) grounds in the western Gulf of Mexico. Pub. Inst. Mar. Sci., vol. 3, pp. 231–366, figs. 1–7.

HILDEBRAND, SAMUEL F., and SCHROEDER, WILLIAM C.

1928. Fishes of Chesapeake Bay. Bull. Bur. Fish., vol. 43 (1927), pt. 1, doc. 1024, pp. 366, figs. 211.

JORDAN, DAVID S.

1884. List of fishes collected at Key West, Florida, with notes and descriptions. Proc. U.S. Nat. Mus., vol. 7 (1885), pp. 103–150.

JORDAN, DAVID S., and EVERMANN, BARTON W.

1898–1900. 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. U.S. Nat. Mus. Bull. 47, pt. 3, pp. xxiv+2183a–3136, 1898; pt. 4, pp. ci+3137–3313, pls. I–CCCXCII, 1900.

JORDAN, DAVID S., and GILBERT, CHARLES H.

1882. Synopsis of the fishes of North America. U.S. Nat. Mus. Bull. 16, pp. lvi+1018.

1883. Notes on a collection of fishes from Charleston, South Carolina, with descriptions of three new species. Proc. U.S. Nat. Mus., vol. 5, pp. 580–620.

JORDAN, DAVID S., and THOMPSON, JOSEPH C.

1905. The fish fauna of the Tortugas Archipelago. Bull. Bur. Fish., vol. 24 (1904), pp. 229–256, figs. 1–6.

JORDAN, DAVID S.; EVERMANN, BARTON W.; and CLARK, HOWARD W.

1930. Checklist of the fishes and fishlike vertebrates of North and Middle America north of the northern boundary of Venezuela and Colombia. Rep. U.S. Comm. Fish. (1928), Appendix 10, pp. 670.

KIRSCH, PHILIP H.
1889. A review of the European and American Uranoscopidae or stargazers. Proc. Acad. Nat. Sci. Philadelphia, vol. 41, pp. 258–266.
LONGLEY, WILLIAM H., and HILDEBRAND, SAMUEL F.
1940. New genera and species of fishes from Tortugas, Florida. Carnegie Inst. Washington, Pub. 517, Pap. Tortugas Lab., vol. 32, pp. 223–285, figs. 28, pl. 1.
1941. Systematic catalogue of the fishes of Tortugas, Florida. Carnegie Inst. Washington, Pub. 535, Pap. Tortugas Lab., vol. 34, pp. xii+331, pls. 34.
MEEK, SETH E., and HILDEBRAND, SAMUEL F.
1928. The marine fishes of Panama. Field Mus. Nat. Hist., zool. ser., vol. 15, pt. 3, pp. xxv–xxxi+709–1045, pls. LXXII–CII.
MIRANDA RIBEIRO, ALIPIO DE.
1915. Fauna brasiliense. Peixes. V. [Eleutherobranchios aspirophoros] Physoclisti. Arch. Mus. Nac. Rio de Janeiro, vol. 17, 777 pp., illustrated [pages and plates not numbered consecutively].
MYERS, GEORGE S.
1946. Occurrence of uranoscopid fishes of the western Pacific genus *Gnathagnus* in the American Atlantic fauna. Copeia, No. 1, p. 42.
NICHOLS, J. T., and BREDER, C. M., JR.
1927. The marine fishes of New York and southern New England. Zoologica, vol. 9, pp. 192, figs. 261.
O'BRIEN, A. J.
1955. The stargazer. Nat. Hist., New York, vol. 64, pp. 90–93, illustrated.
PEARSON, JOHN C.
1941. The young of some marine fishes taken in lower Chesapeake Bay, Virginia, with special reference to the gray sea trout, *Cynoscion regalis* (Bloch). Fish. Bull. Fish Wildl. Serv., vol. 50, pp. 79–102, figs. 1–26.
SHUFELDT, R. W.
1901. Experiments in photography of live fishes. Bull. U.S. Fish Comm., vol. 19, pp. 1–5, pls. I–IX.
SMITH, HUGH M.
1907. The fishes of North Carolina. North Carolina Geol. and Econ. Surv., vol. 2, pp. xi+453, figs. 186, pls. 19.
SPIX, JOHANN B.
1831. Selecta genera et species piscium quos in itinere per brasiliam . . . Monachii, pp. 83–138, pls. XLIX–CI [publication date fide Dean, 1917, Bibl. Fish., vol. 2, p. 474].
SPRINGER, STEWART, and BULLIS, HARVEY R., JR.
1956. Collections by the *Oregon* in the Gulf of Mexico. U.S. Dep. Int., Fish Wildl. Serv., Spec. Sci. Rep., Fish., No. 196, pp. 134.
STEINDACHNER, F.
1876. Ichthyologishe beitrage. V. Sitzungsber. Akad. Wiss. Wien, vol. 74 (1877), 1 Abth., pp. 49–240, 15 pls. [not seen].
STORER, DAVID H.
1846. A synopsis of the fishes of North America. Mem. Amer. Acad., No. 7, pp. 298.
TEMMINCK, C., and SCHLEGEL, H.
1884. Pisces, *in* P. F. Siebold, Fauna Japonica, Tokyo, pp. 345, pls. 142 [1934 reprint].

UHLER, P. R., and LUGGER, OTTO
1876. List of fishes of Maryland. Rep. Comm. Fish. Maryland, pp. 67–176.

WEYMOUTH, FRANK W.
1910. Notes on a collection of fishes from Cameron, Louisiana. Proc. U.S. Nat. Mus., vol. 38, pp. 135–145, figs. 1–2.

WHITE, E. GRACE
1918. The origin of the electric organs in *Astroscopus guttatus.* Carnegie Inst. Washington, Pub. 252, Pap. Dep. Mar. Biol., vol. 12, pp. 139–172, fig. 1, pls. 1–7.

U.S. GOVERNMENT PRINTING OFFICE: 1961

Proceedings of
the United States
National Museum

SMITHSONIAN INSTITUTION · WASHINGTON, D.C.

Volume 112 | 1961 | Number 3449

REVISION OF THE MARINE SILVER HATCHETFISHES (FAMILY STERNOPTYCHIDAE)

By Leonard P. Schultz

This revision of the marine silver hatchetfishes, family Sternoptychidae, is based on specimens in the collections of the following institutions:

Academy of Natural Sciences of Philadelphia (ANSP)
Binghman Oceanographic Collections, Yale University (BOC)
British Museum (Natural History) (BM)
Chicago Natural History Museum (CNHM)
Institut Royal des Sciences Naturelles de Belgique (IRSNB)
Koninklijk Museum voor Midden-Afrika (=Musée Royal du Congo Belge) (KMMA)
Museum of Comparative Zoology, Harvard University (MCZ)
Scripps Institution of Oceanography (SIO)
Stanford Natural History Museum (SNHM)
Tulane University (TU)
University of California at Los Angeles (UCLA)
University of Miami, Marine Laboratory (UMML)
U.S. Fish and Wildlife Service (USFWS)
U.S. National Museum (USNM)
Woods Hole Oceanographic Institution (WHOI)

To the authorities of these institutions the author is grateful for loaning specimens and furnishing photographs and other data.

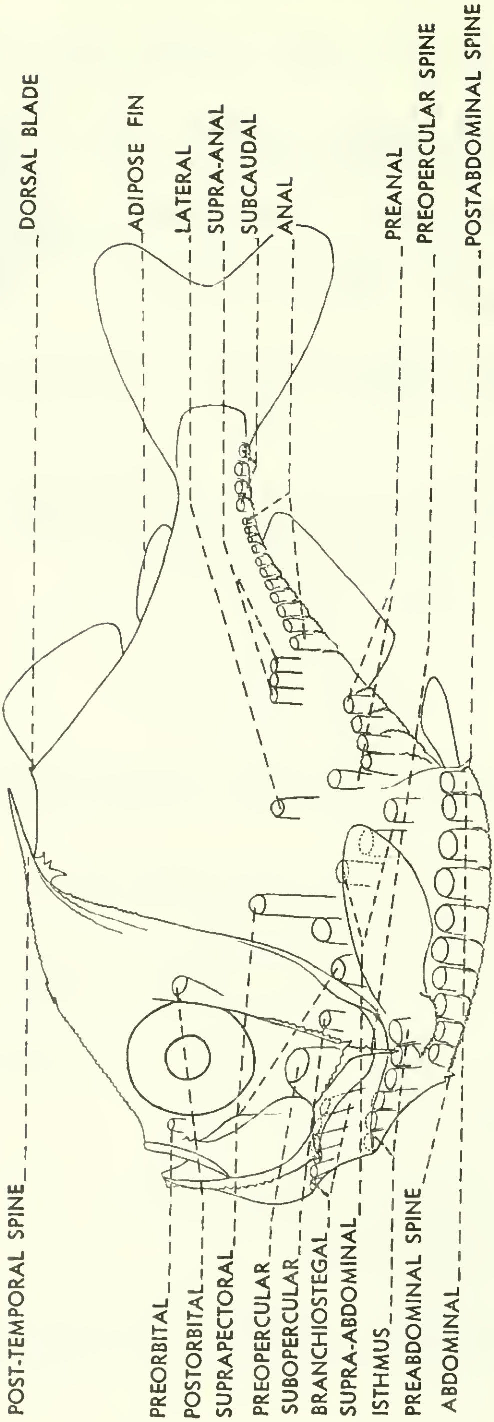


Figure 1.—Terminology used for the family Sternoptychidae. Drawing of *Polyipnus tridentifer* McCulloch, by Dorothea B. Schultz.

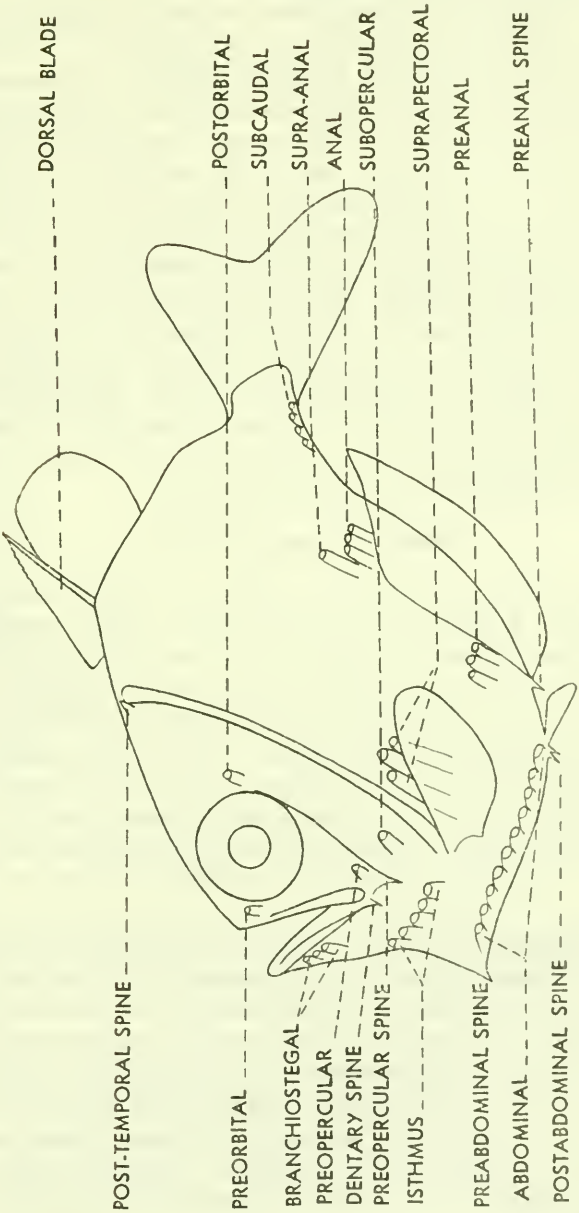


Figure 2.—Terminology used for the family Sternoptychidae. Drawing of *Sternoptyx diaphana* Hermann, by Dorothea B. Schultz.

The terminology used for the groups of photophores is presented in figures 1 and 2, on pages 588–589.

Each fin ray that has a separate base was counted, and all rudiments of gill rakers were counted on the first gill arch.

Radiographs were expertly made by Robert H. Kanazawa and T. John Leppi for the various genera and species of this family, and from those films the number of vertebrae are recorded in table 1, p. 591.

Gill (Proc. U.S. Nat. Mus., vol. 7, pp. 349–351, 1884) gives the relationships among the genera and a list of the family and subfamily synonymy. Gregory and Conrad (Copeia, No. 1, p. 27, 1936) discuss the relationships of the family Sternoptychidae with other forms. Wilimovsky (Copeia, No. 3, pp. 247–248, 1951) corrects the spelling of the family name. Hubbs (Copeia, No. 2, p. 97, 1953) thinks, as did earlier authors, that the family Sternoptychidae should be expanded to include Gonostomatinae and the Maurolicinae. Not having studied all the fishes in those relationships, I tentatively assign to the Sternoptychidae those genera with a dorsal blade, externally visible and in front of the soft dorsal fin.

Family Sternoptychidae

The marine silver hatchetfishes, family Sternoptychidae, may be distinguished as a group by the dorsal blade, which represents the highly specialized dorsal pterygiophores, externally evident in front of the dorsal fin. These pterygiophores may be fused into a thin plate as in *Argyropelecus*, a small pair of bony keels as in *Polyipnus*, or a single elongate spine as in *Sternoptyx*. Body thin, compressed, its depth very great; abdominal vertebrae 11, caudal vertebrae 17 to 29; branched caudal rays 9 + 8; scales probably present, very thin. The scales are usually lost in preservation, so that they are seldom seen, and thus from museum specimens no evaluation of their significance is possible.

The sternoptychids are deep-sea fishes with groups of characteristically arranged photophores for each genus, as are illustrated in the figures beginning on p. 623. They are caught in the open sea in plankton nets, trawls, and other gear in all temperate and tropical seas from the surface to considerable depths. Records from the Pacific indicate depths of 16,200 feet and from the Atlantic 12,704 feet. Such depths, however, are inadequately documented because closing nets were seldom used in oceanographic exploration. The fish could have been caught somewhere between the surface and the deepest point reached by the equipment.

The present study recognizes 9 species and 3 subspecies for *Argyropelecus*, 1 species for *Sternoptyx*, and 12 species and 2 subspecies for *Polyipnus*.

Table 1.—*Counts of vertebrae recorded for the Sternoptychidae.*

Genera, species, and subspecies	Number of Vertebrae												
	28	29	30	31	32	33	34	35	36	37	38	39	40
Argyropelecus													
affinis	—	—	—	—	—	—	—	—	—	—	2	3	1
pacificus	—	—	—	—	—	—	—	—	—	—	5	3	1
gigas	—	—	—	—	—	—	—	—	—	—	3	—	—
hemigymnus	—	—	—	—	—	—	—	—	—	15	9	—	—
intermedius	—	—	—	—	—	—	—	1	1	3	2	—	—
amabilis	—	—	—	—	—	—	—	12	2	—	—	—	—
aculeatus	—	—	—	—	—	—	5	14	5	—	—	—	—
olfersi	—	—	—	—	—	—	—	—	1	9	1	—	—
lynchus													
lynchus	—	—	—	—	—	—	—	3	8	3	—	—	—
sladeni	—	—	—	—	—	—	—	1	3	1	—	—	—
hawaiensis	—	—	—	—	—	—	—	—	6	1	—	—	—
Sternoptyx													
diaphana	1	11	2	1	—	—	—	—	—	—	—	—	—
Polyipnus													
polli	—	—	—	—	4	—	—	—	—	—	—	—	—
laternatus	—	—	—	—	3	1	—	—	—	—	—	—	—
triphanos	—	—	—	—	—	3	—	—	—	—	—	—	—
asteroides	—	—	—	—	13	12	1	—	—	—	—	—	—
matsubarai	—	—	—	—	—	5	—	—	—	—	—	—	—
fraseri	—	—	—	—	1	—	—	—	—	—	—	—	—
unispinus	—	—	—	—	—	—	—	1	9	—	—	—	—
nuttingi	—	—	—	—	—	24	3	—	—	—	—	—	—
indicus	—	—	—	—	1	2	—	—	—	—	—	—	—
tridentifer													
Western Australia	—	—	—	—	2	3	6	—	—	—	—	—	—
Philippines	—	—	—	—	—	4	40	2	—	—	—	—	—
spinosus													
spinosus	—	—	—	—	1	8	1	—	—	—	—	—	—
stereope	—	—	—	—	—	3	—	—	—	—	—	—	—

Key to the Genera of Sternoptychidae

1a. Abdominal photophores 12 and supra-abdominal 6; suprapectoral photophores 2; no supra-anal or lateral photophores, see figure 1, p. 588. Dorsal blade present and well developed in front of dorsal fin; on maxillary the anterior teeth point posteriorly, and posteriorly located ones point anteriorly . . . . **Argyropelecus** Cocco

1b. Abdominal photophores 10 and supra-abdimonal none to 3; suprapectoral photophores 3, dorsal blade present but very small and scarcely evident externally; none of the maxillary teeth point forward.

2a. Dorsal blade present represented externally by a long spine; photophores as follows: anal 3; branchiostegal 3; isthmus 5; preanal 3; supra-abdominal none; supra-anal 1; lateral none . . . **Sternoptyx** Hermann

2b. Dorsal blade evident externally as a short, low paired keel just in front of dorsal fin; photophores as follows: anal 4 to 15; branchiostegal 6; isthmus 6; preanal 5; supra-abdominal 3; supra-anal none to 3; lateral 1. **Polyipnus** Günther

TABLE 2.—*Counts recorded for certain species and subspecies of* Argyropelecus

Species and subspecies	Teeth pointing anteriorly on maxillary																			Teeth pointing posteriorly on maxillary												
	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	1	2	3	4	5	6	7	8	9	10	11	12	13
affinis	—	—	—	1	1	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—	1	—	1	—	—
pacificus	—	—	—	—	3	2	1	2	1	—	1	—	—	—	—	—	—	—	—	—	—	—	—	2	3	3	1	—	—	1	—	—
gigas	—	—	—	1	—	1	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	2	—	—	—	—	—
hemigymus	—	—	—	—	1	—	2	—	1	4	—	1	1	—	—	—	1	—	1	—	3	1	3	2	—	2	—	—	1	—	—	—
intermedius	—	—	1	2	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	2	1	1	—	1	—	—	—	—	—	—	—	—
aculeatus	—	3	3	9	5	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	2	8	2	7	1	—	—	—	—
olfersi	3	6	4	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	6	3	3	—	—	2	—	1
lynchus																																
lynchus	—	—	2	5	10	4	6	2	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	6	8	8	6	—	—	—	—
sladeni	—	—	2	3	3	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3	1	1	2	—	1	1	—	—	—
hawaiensis	—	—	—	—	—	1	2	4	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	1	4	1	—	—

Species and subspecies	Number of fin rays												Number of gill rakers on first gill arch																							
	Dorsal			Pectoral				Anal					Above angle					Below angle							Total gill rakers										
	8	9	10	9	10	11	12	6	7	8	+5	6	7	8	9	10	11	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
affinis	—	4	—	—	2	1	—	2	2	—	3	1	—	2	—	—	—	—	—	—	2	—	—	—	—	—	—	—	2	—	—	—	—	—	—
pacificus	—	11	—	—	1	13	2	—	11	—	11	—	—	3	8	—	—	—	—	—	—	3	7	1	—	—	—	—	—	1	3	7	—	—	—
gigas	—	3	1	—	2	1	—	—	4	—	1	3	—	3	—	—	—	—	—	1	1	1	—	—	—	—	—	1	1	1	—	—	—	—	—
hemigymus	18	—	—	1	9	13	—	16	—	—	18	—	—	—	12	13	2	—	—	2	4	11	9	1	—	—	—	—	1	5	5	7	6	1	1
intermedius	6	3	—	—	5	3	—	7	—	—	7	—	1	3	2	1	—	—	—	—	3	4	—	—	—	—	—	1	2	1	2	1	—	—	—
amabilis	—	10	—	—	7	1	—	—	9	1	10	—	5	4	—	—	—	1	7	1	—	—	—	—	—	6	2	1	—	—	—	—	—	—	—
aculeatus	—	15	—	2	12	1	—	—	14	—	14	—	6	7	—	—	—	—	12	1	—	—	—	—	—	4	8	—	—	—	—	—	—	—	—
olfersi	—	13	—	—	6	6	—	—	12	—	12	—	5	6	—	—	—	4	7	—	—	—	—	—	1	7	3	—	—	—	—	—	—	—	—
lynchus																																			
lynchus	—	33	—	—	6	23	—	3	30	—	32	1	1	31	1	—	—	—	3	26	4	—	—	—	—	—	4	24	5	—	—	—	—	—	—
sladeni	—	10	1	—	7	2	—	—	10	—	10	—	—	6	4	1	—	—	—	3	7	1	—	—	—	—	—	3	3	4	—	1	—	—	—
hawaiensis	—	8	—	—	2	7	—	—	5	3	8	—	—	6	1	1	—	—	—	—	4	4	—	—	—	—	—	—	3	4	1	—	—	—	—

Table 3.—*Measurements made on species and subspecies of* Argyropelecus, *expressed in thousandths of standard length*

Characters	*affinis*	*pacificus*	*gigas*	*hemigymnus*	*intermedius*	*amabilis*	*aculeatus*	*olfersi*	*lynchus lynchus*	*lynchus sladeni*	*lynchus hawaiensis*
Greatest depth (pigmented area) of body	414–455	502–528	524–526	531–643	530–561	742–820	749–886	660–820	646–700	552–682	584–612
Least depth of caudal peduncle	76–110	103–111	107–121	81–106	75–81	122–134	127–148	109–144	107–121	112–127	103–115
Length of snout	76–83	65–84	83–97	91–99	—	87–94	84–94	—	73–94	81–90	83–92
Diameter of eye	117–121	121–141	94–119	123–150	—	125–139	126–160	—	138–156	125–150	112–138
Length of maxillaries	246–290	254–263	223–244	274–298	—	297–333	297–332	—	313–345	277–307	272–292
Greatest height of dorsal blade	33–51	33–47	76–78	74–161	78–113	130–182	136–187	77–144	78–109	63–135	33–46
Length of groups of photophores:											
anal	202–235	224–255	210–223	98–123	107–131	122–151	116–164	133–159	145–161	122–173	176–183
preanal	102–134	106–115	103–116	85–108	88–99	111–123	110–136	108–124	103–117	92–148	113–121
subcaudal	121–148	129–134	129–146	43–64	42–53	65–75	68–74	64–81	81–100	69–100	83–86
Distance between groups of photophores:											
preanal to anal	8–19	7–14	6–12	56–81	45–58	24–41	20–36	26–42	21–35	14–29	23–27
anal to subcaudal	18–37	22–28	13–25	145–180	155–183	[a] 70–83	72–108	54–76	55–78	52–120	48–53
last abdominal (upper tip) to first preanal (upper tip)	60–94	106–113	112–114	172–220	155–179	255–285	258–300	198–264	195–220	150–188	150–164
Distance from orbit to upper preopercular spine	152–159	161–172	143–163	150–192	152–168	225–252	216–264	228–248	231–252	182–227	194–203
Postorbital length of body	803–857	806–830	818–820	767–823	807–863	755–832	772–848	806–842	788–831	780–836	800–856
Number of specimens	5	4	3	11	3	5	6	7	7	7	4

[a] 111 on a small specimen

Genus *Argyropelecus* Cocco

Argyropelecus Cocco, Giorn. Sci. Lett. Arti Sicilia, vol. 26, No. 77, p. 46, 1829 (type species *Argyropelecus hemigymnus* Cocco).

Sternoptychides Ogilby, Proc. Linn. Soc. New South Wales, ser. 2, vol. 3, p. 1313, 1888 (type species *Sternoptychides amabilis* Ogilby).

Pleurothyris Lowe, A history of the fishes of Madeira . . . , vol. 1, p. 64, 1843 (type species *Sternoptyx olfersi* Cuvier).

I consider the following unidentifiable:

> *Argyropelecus bocagei* Osorio, Mem. Mus. Bocage, Lisbon, fasc. 1, p. 27, pl. 2, fig. 3, 1909 (type locality near Setúbal).—Seabra, Bull. Soc. Portugaise Sci. Nat., vol. 5, fasc. 3, p. 176, 1911 (Setúbal).—Nobre, Fauna marinha de Portugal, vertebrados, vol. 1, pt. 3, Peixes de Portugal, p. 350, 1935 (Setúbal).
>
> *Argyropelecus elongatus* Esmark, Forh. Vid. Selsk. Christiana 1870, p. 489, 1871.

Species referable to the genus *Argyropelecus* have the following characters in common:

Abdominal vertebrae 11; caudal vertebrae 23 to 29; branched caudal fin rays 9+8; pectoral rays 9 to 12; dorsal 8 to 10; anal 6 to 8+5 or 6; gill rakers on first gill arch 7 to 11+8 to 14 totaling 15 to 25.

The number of organs in groups of photophores are as follows:

Abdominal 12; anal 6; branchiostegal 6; isthmus 6; preanal 4; preopercular 1; preorbital 1; postorbital 1; subcaudal 4; subopercular 1; supra-abdominal 6; suprapectoral 2; for location of groups of photophores see figure 1, p. 588. On the maxillary the dentition is characteristic because on the anterior part of that bone the teeth point posteriorly, and on its posterior part the teeth point anteriorly. The number of teeth pointing forward and aft is variable (see table 2, p. 592), the number appearing to increase slightly with increase in size.

Certain species, such as *aculeatus*, when sexual maturity is reached, develop spines around the subcaudal photophores and in front of them, between the divided anal fin, around the anus, on the dorsal blade, and on the ridges of the head. Both males and females may develop these spines.

The various species may be distinguished on the basis of counts of fins rays, gill rakers, and vertebrae and distribution and location of groups of photophores. In addition, the characteristics of the post-abdominal and preopercular spines are of utmost importance in the recognition of species and groups of species.

An important feature of the genus is the dorsal blade, which consists not of dorsal spines or rays but of more or less fused pterygiophores, the dorsal rays having been lost. Radiographs show seven or eight of these pterygiophores, the last two somewhat fused together externally, but all forming a bony blade.

Another pecularity of the genus is the lack of anal pterygiophores opposite two or three vertebrae, usually beteeen the 9th to 12th caudal vertebrae. The pterygiophores that normally occur opposite these vertebrae are displaced anteriorly and posteriorly, where they are crowded between adjoining vertebrae.

In certain groups of photophores the organs in the postlarvae increase in number with increase in length up to a certain size, after which the full complement of light organs are formed. For example in *Argyropelecus hemigymnus*, the relationship of number of organs to standard length is:

Standard length in millimeters	*Number of organs in certain groups of photophores*		
	Preanal	*Anal*	*Subcaudal*
5. 7	3	2	3
7. 0	2	3	3
7. 0	2	3	3
7. 0	3	3	4
7. 5	2	3	4
7. 8	2	3	4
8. 0	4	4	4
8. 8	4	4	4
10. 0	4	5	4
10. 0	4	6	4
10. 0	4	6	4
10. 5	4	6	4
12. 0	4	6	4
12. 8	4	6	4
14. 5	4	6	4

These data indicate for *A. hemigymnus* that the full complement of photophores for the preanal, anal, and subcaudal groups is not reached until a standard length of about 10 mm. is attained. In *A. aculeatus* the anal photophores reach six in number at about 12 mm. in length.

Tables 1–3 give the counts and measurements that were made for certain species and subspecies of *Argyropelecus*.

Key to Species of *Argyropelecus*

1a. Supra-abdominal, preanal, anal, and subcaudal groups of photophores nearly in a straight and almost continuous line; 2 short postabdominal spines (occasionally lacking) about equal length, the acute angle between them about 10 to 15 degrees; lower preopercular spine directed downward and curving outward and forward; upper preopercular spine hooked outward and usually forward, not extending to bony edge of preopercle.

2a. No postorbital spine; dorsal blade short, length of exposed part of last spine above pigmented area contained about 2.2 to 3.3 times in base of soft dorsal; origin of base of soft dorsal on same level as pigmented base of dorsal blade; palatine teeth present, moderately strong.

3a. Lower edge of pectoral shield smooth or with only a few weak spines or scallops; greatest depth of pigmented body contained 2.1 to 2.4 times in standard length. (Atlantic Ocean and ? Indian Ocean.) **affinis** Garman

3b. Lower edge of pectoral shield with spines or sharply pointed scallops; greatest depth of body contained 1.9 to 2.1 times in standard length. (East Pacific and Hawaiian Islands.) . . . . **pacificus,** new species

2b. One or two postorbital spines (usually two on adults); dorsal blade high, length of exposed part of last spine contained 1.5 to 1.9 times in base of soft dorsal; palatines toothless or with only a few feeble teeth; origin of base of soft dorsal notably above level of pigmented base of dorsal blade; greatest depth of pigmented part of body 1.9 to 2.0 times in standard length. Ventral edge of pectoral shield with sharp-pointed scallops. (Atlantic.) . . . . **gigas** Norman

1b. Supra-abdominal, preanal, anal, and subcaudal groups of photophores not in a straight or continuous line.

4a. A single postabdominal spine.

5a. Postabdominal spine with both edges serrated, directed backward and a little ventrally with a minute spinule on dorsoposterior base; lower preopercular spine nearly straight, directed almost straight downward; upper preopercular spine, rather long, curved a little dorsally, notably extending past rear bony edge of preopercle; preanal, anal, and subcaudal groups of photophores notably separated by wide spaces, the distance between the anal and subcaudal groups greater than the overall width of the group of anal photophores.

6a. Tip of longest spine in dorsal blade with one to three hooks or points; ventral edge of bony pectoral shield smooth. (Atlantic and Mediterranean.) . . . . **hemigymnus** Cocco

6b. Tip of longest spine in dorsal blade smooth, without hooks; ventral edge of bony pectoral shield with a few minute points, these are strongest in small specimens (15 mm. and shorter in standard length). (Central and Western Pacific and Indian Oceans.) **intermedius** Clarke

5b. Postabdominal spine smooth edged, directed ventrally, and curved somewhat anteriorly; preopercle at lower angle with a spine pointing straight downward and curved a little outward, the upper preopercular spine small, pointing outward, its tip not extending past rear margin of bony edge of preopercle. (Atlantic Ocean and Lord Howe Island in the Pacific Ocean) . . . . **amabilis** (Ogilby)

4b. A pair of smooth postabdominal spines.

7a. Upper preopercular spine short, directed a little outward, not reaching or scarcely reaching past bony posterior edge of preopercle; lower preopercular spine directed downward and slightly curved forward and outward.

8a. Posterior postabdominal spine longer and heavier than anterior one, directed posteroventrally and sometimes with 1 or more spinlets on the ventral edge; angle between postabdominal spines 70 to 100 degrees; anterior postabdominal spine directed ventrally and curving forward, its length as long as or longer than lower preopercular spine; greatest depth of pigmented part of body 1.0 to 1.1, and length of dorsal blade 4.5 to 6.5 times, both in postorbital length of body. (Atlantic, Western and Eastern Pacific, and Indian Oceans.) . . . **aculeatus** Cuvier and Valenciennes

8b. Both postabdominal spines of about equal length and size; anterior postabdominal spine hooked anteroventrally, rear one usually shorter than anterior spine, without spinlets, and directed posteroventrally, angle between them about 60 degrees; greatest depth of pigmented part of body 1.2 to 1.4, and length of dorsal blade 7.5 to 9.5 times, both in postorbital length of body. (Atlantic, Western Pacific, and Indian Oceans.) . . . . . . **olfersi** (Cuvier)

7b. Upper preopercular spine long, reaching past posterior bony edge of preopercle; lower preopercular spine directed straight downward, sometimes curved a little forward and outward; the postabdominal spines diverge at an angle of about 50 to 65 degrees.

9a. Length of exposed part of longest spine of dorsal blade 1.0 to 2.2 times in base of soft dorsal fin.

10a. Total number of gill rakers on first gill arch 17 to 19, see table 2, p.592; teeth on maxillary pointing anteriorly 7 to 11, see table 2, p.592. (Eastern Pacific and Atlantic.) **lynchus lynchus** Garman

10b. Total gill rakers 18 to 22; teeth on maxillary pointing anteriorly 6 to 10. (Western Pacific and Indian Oceans.) **lynchus sladeni** Regan

9b. Length of exposed part of longest spine of dorsal blade 2.6 to 3.0 in base of soft dorsal fin; gill rakers total 20 or 21; teeth in maxillary pointing anteriorly 9 to 13. (Hawaiian Islands.) **lynchus hawaiensis,** new subspecies

Argyropelecus affinis Garman

FIGURE 3

Argyropelecus affinis Garman, Mem. Mus. Comp. Zool., vol. 24, p. 237, 1899 (type locality, *Albatross* station 2117, lat. 15°24′40″ N., long. 63°31′30″ W., depth 683 fathoms; holotype USNM 44593).—Brauer, Sitz. Gesellsch. Beförd. Ges. Naturw. Marburg, p. 120, fig. 1, 1901 (anatomy).—Brauer, Wissenschaftliche Ergebnisse der Deutschen Tiefsee-Expedition auf dem Dampfer *Valdivia*, 1898–1899 . . . , vol. 15, pt. 1, p. 103, figs. 43–44, pl. 7, fig. 1, 1906 (Atlantic and ? Indian Oceans, depths 1,000 to 3,396 meters); pp. 197–204, figs. 9–11, pl. 37, 1908 (anatomy eye).—? Regan, Trans. Linn. Soc. London, ser. 2, Zool., vol. 12, pt. 3, p. 218, 1908 (Farquhar Atoll, 750 to 1,000 fathoms).—Murray and Hjort, The depths of the ocean . . . , p. 612, pl. 2, 1912 (Atlantic).—Jespersen, Report on the Danish oceanographical expeditions to the Mediterranean, 1908–1910, vol. 2, No. 3, pt. A2, p. 6, 1915 (Eastern Atlantic).—Barnard, Ann. South African Mus., vol. 21, pt. 1, p. 152, pl. 8, fig. 1, 1925 (lat. 31° S., long. 8° E., depth 1,000 fathoms).—Jordan, Evermann, and Clark, Report U.S. Comm. Fish. 1928, pt. 2, p. 74, 1930 (name only).—Norman, *Discovery* reports, vol. 2, p. 301, fig. 9, 1930 (Eastern North Atlantic, 400–450 meters).—Beebe, Bull. Inst. Oceanogr. Monaco, No. 629, p. 4, 1933 (off Bermuda, 400 fathoms).—Roule and Angel, Resultats des campagnes scientifiques accomplies par le Albert I, Monaco, fasc. 86, p. 46, 1933 (Azores and Madeira Islands).—Jespersen *in* Joubin, Faune ichthyologique de l'Atlantique nord, No. 15, fig., 1934 (North Atlantic).—Fowler, Bull. Amer. Mus. Nat. Hist., vol. 70, pt. 1, p. 246, fig. 115, pt. 2, p. 1208, 1936 (after Brauer).—Beebe, Zoologica, New York, vol. 22, pt. 3, p. 201, 1937 (Bermuda).—Parr, Bull. Bingham Oceanogr. Coll., vol. 3, art. 7, p. 49, 1937.—Schultz, Smithsonian Misc. Coll., vol. 91, No.

27, p. 4, 1937 (detailed measurements); Proc. U.S. Nat. Mus., vol. 86, p. 147, 1938 (Western North Atlantic).—? Norman, John Murray Expedition, 1933–34, Scientific reports, vol. 7, No. 1, p. 20, 1939 (Indian Ocean, depths 400 to 3,872 meters).—Nybelin, Göteborgs Vet. Vitterh. Samh. Handl., ser. B., vol. 5, No. 16, p. 23, 1948 (Eastern North Atlantic).— ? Smith, The sea fishes of southern Africa, p. 107, 1949 (off the "Cape" in 1,000 fathoms).—Marshall, Aspects of deep sea biology, New York, p. 278, figs. XI, 6–7, 1954.— ? Fowler, Fishes of the Red Sea and southern Arabia, Jerusalem, vol. 1, p. 86, 1956 (Red Sea).— ? Guenther and Deckert, Creatures of the deep sea, New York, p. 119, fig. 79, 1956 (all oceans).

Argyropelecus hemigymnus, Goode and Bean, Oceanic ichthyology . . . , U.S. Nat. Mus. Spec. Bull., No. 2, p. 126, pl. 39, fig. 147, 1895 (figure of holotype of *A. affinis*, USNM 44593 and USNM 31709).—Griffini, Ittiologia italiana . . . ed. Hoepli, p. 261, fig. 141, 1903 (Mediterranean).

Argyropelecus olfersi, Barnard, A pictorial guide to South African fishes, marine and fresh water, p. 48, pl. 6, fig. 14, 1947 (South Africa).

Argyropelecus, Beebe, The *Arcturus* adventure, New York, pp. 65, 390, pl. 8 in color, 1926 (lat. 26°43′ N., long. 48°52′ W.).

STUDY MATERIAL: MCZ, *Atlantis* station 2994, lat. 23°24′ N., long. 80°50′ W., depth 565–585 fathoms, February 15, 1938, 1 specimen, 48 mm. USNM 44593, holotype of *A. affinis*, *Albatross* station 2117, lat. 15°24′40″ N., long. 63°31′30″ W., depth 683 fathoms, standard length 31.5 mm. USNM 31709, *Albatross*, August 18, 1882, lat. 39°56′ N., long. 70°35′ W., depth 245 fathoms, 1 specimen, 22.5 mm. USNM 102776, Johnson-Smithsonian Expedition, February 9, 1933, off Puerto Rico, 180 to 360 fathoms, 1 specimen, 39 mm. USNM 102778, off Puerto Rico, Johnson-Smithsonian Expedition, February 1933, depth 250 to 320 fathoms, 1 specimen, 25 mm. USNM 185536, *Pelican* station 31, April 10, 1956, lat. 29°36′ N., long. 80°06′ W., depth 180 to 210 fathoms, 1 specimen, 43.5 mm. CNHM 64367, *Oregon* station 1955, September 17, 1957, lat. 16°48′ N., long. 82°33′ W., depth 550 fathoms, 1 specimen, 59 mm. CNHM, *Combat* station 304, lat. 31°50′ N., long. 79°14′ W., 180 fathoms, 5 specimens, 48 to 64 mm. CNHM, *Combat* station 301, lat. 32°15′ N., long. 78°49′ W., 215 fathoms, 1 specimen, 64 mm.

DISTINCTIVE CHARACTERS: Three species of *Argyropelecus* form what may be called the *affinis*, *gigas*, and *pacificus* complex, characterized by the supra-abdominal, preanal, anal and subcaudal photophores almost forming a continuous series and the dorsal tips of the photophores being nearly in a straight line. Lower preopercular spine points downward and curves outward and forward; upper preopercular spine short, pointing outward, and usually curving forward, never extending posteriorly; two posterior abdominal spines, both short and directed downward, forming an acute angle between them of about 10° to 15°; space between anal group and subcaudal group of photophores very narrow, about equal to width of last anal photophore. In these three species the dorsal blade is low, as is indicated in the key on p. 595.

Description: Counts made are given in table 1, p. 591, and table 2, p. 592; the measurements made are given in table 3, p. 593. The photophores are arranged as shown in figure 3, p. 623.

Greatest depth of body 2.1 to 2.4 in standard length; exposed part of longest spine in dorsal blade 2.2 to 2.9 times in length of base of soft dorsal; no postorbital spine; ventral edge of pectoral shield without sharp points although edge is somewhat scalloped.

Color: The color pattern is shown in figure 3, p. 623.

Range: This pelagic species lives in considerable depths of the ocean. It probably is confined to the Atlantic Ocean and is replaced in the Pacific Ocean by *A. pacificus*, which is a very close relative. I have not been able to check the specimens reported from the Indian Ocean. I studied 12 lots from the Atlantic Ocean as follows: 1 specimen from off Delaware, 5 off Georgia; 3 off Florida, 2 from the Carribean, 1 from off Jamaica; 2 off Puerto Rico, 1 from Lesser Antilles, and 1 from Gulf of Mexico. It has been taken as far south as lat. 31° S. (Barnard, 1925) and as far north as lat. 39°56′ N. (USNM 31709); Norman (1939) reports depths of capture to 3,872 meters, but since closing nets were not used this depth is uncertain. The usual depths are less than 1,000 fathoms.

***Argyropelecus pacificus*, new species**

Figure 4

Argyropelecus affinis, Townsend and Nichols, Bull. Amer. Mus. Nat. Hist., vol. 52, p. 11, 1925 (off Lower California in 868 to 930 fathoms).—Ulrey, Journ. Pan-Pacific Res. Inst., Honolulu, vol. 4, No. 4, p. 3, 1929 (off California).—Terron, Anal. Inst. Biol. Univ. Nac. Mexico, p. 76, 1932 (on Ulrey).—Haig, Pacific Sci., vol. 9, p. 321, 1955 (off Mauna Loa lava flow, Hawaii).

Holotype: USNM 164000, Mauna Loa lava flow, Kona, Hawaii, June 6, 1950, collected by Gosline, Hays, and Keen, standard length 56.5 mm.

Paratypes: USNM 87563, *Albatross* station 5686, April 22, 1911, lat. 26°14′ N., long. 114° W., depth 930 fathoms, 1 specimen, 40 mm. USNM 177930, Mauna Loa lava flow, Kona, Hawaii, June 6, 1950, 1 specimen, 57 mm. collected by Y. Yamaguchi. SIO S10–54–83A, California off San Diego, lat. 32°51.5′ N., long. 117°45′ W., to lat. 33°05.5′ N. and long. 117°58′ W., November 4, 1954, no depth given, 5 specimens, 33 to 58 mm. SIO S10–55–258, Southwest of Galápagos Islands, lat. 2°0′–3′ S., long. 90°33′–54′ W., depth zero to 925 fathoms, June 26, 1956, 9 specimens, 8 to 67 mm.

The following paratypes are in the collections of the Stanford Natural History Museum (all SNHM numbers): 46542, lat. 0°0′ N., long. 91°53′ W., June 13, 1925, 1 specimen, 15 mm; 46533, lat. 3°52′ N., long. 86°43′ W., 600 fathoms, 1 specimen, 21 mm.; 46525, lat. 0°17′ N., long. 90°02′ W., depth 500 fathoms, April 11, 1925, 2 specimens, 9 to 13 mm.; 46591, *Arcturus* station 5912 74–Pt–3, 60 miles south of Cocos Island at lat. 4°50′ N., long. 87°00′ W., depth 620 fathoms, May 25, 1925, 1 specimen, 41 mm.; 46617, *Arcturus* station 5866B, lat. 4°50′ N., long. 87°00′ W., depth 600 fathoms, May 25, 1925, 1 specimen, 25 mm.; 46619 *Arcturus* station 5917, lat. 4°50′ N., long. 87°00′ W., depth 450 fathoms, 1 specimen, 10 mm.

DESCRIPTION: Five specimens were measured in detail and these data, expressed in thousandths of the standard length, are recorded, respectively, for the holotype then the paratypes; standard lengths in mm. are 56, 45, 46.4, 46, and 58. Greatest depth of pigmented area of body 455, 528, 502, 506, and 516; least depth of caudal peduncle 98, 111, 110, 109, 83; greatest height of dorsal blade 36, 38, 47, 33, and 36; postorbital length of body 839, 806, 830, 815, and 827. Length of groups of photophores: Anal 213, 255, 224, 228, and 229; preanal 116, 109, 106, 109, and 115; subcaudal 139, 129, 134, 133, and 131. Distance between preanal and anal groups of photophores 11, 7, 9, 11, and 14. Distance between anal and subcaudal groups of photophores 18, 27, 22, 28, and 26. Distance from upper edge of last abdominal photophore to upper edge of first preanal photophore 88, 109, 106, 113, and 110. Distance from orbit to base of upper preopercular spine 152, 162, 168, 161, and 172. Distance from tip of snout to rear edge of maxillary 250, 262, 263, 254, and 259.

Counts made on the types are given in table 1, p. 591, and table 2, p. 592; measurements made are given in table 3, p. 593.

COLOR: The color pattern is shown in figure 4, p. 623.

RANGE: This species occurs in the eastern Pacific westward to the Hawaiian Islands. It has been taken to a depth of 930 fathoms (USNM 87563).

REMARKS: This species differs from its closest relatives, *A. affinis* and *A. gigas*, as indicated in the key on p. 595.

***Argyropelecus gigas*, Norman**

FIGURES 5, 26*a*

Argyropelecus gigas Norman, *Discovery* reports, vol. 2, p. 302, fig. 10, 1930 (type locality, Eastern Atlantic Ocean).—Fowler, Bull. Amer. Mus. Nat. Hist., vol. 70, pt. 2, p. 1208, 1936 (after Norman).—Parr, Bull. Bingham Oceanogr. Coll., vol. 3, art. 7, p. 49, 1937 (after Norman).—Schultz, Proc. U.S. Nat. Mus., vol. 86, p. 147, 1938 (on Norman).—Noronha and Sarmento, Vertebrados da Madeira, ed. 2, Peixes, vol. 2, p. 141, 1948 (Maderia).—Maul, Lísta sistemática dos peixes assinalados nos mares da Madeira e índice alphabetica, p. 13, 1949 (Madeira); Bol. Mus. Mun. Funchal, No. 4, art. 9, p. 17, fig. 6, 1949 (Madeira).—Marshall, Aspects of deep sea biology, New York, p. 111, fig. V, 15, 1954.

Argyropelecus affinis, Jespersen *in* Joubin, Faune ichthyologique de l'Atlantique nord, No. 15, fig., 1934 (Cape Verde Islands).

Study material: MCZ 37641 *Captain Bill II* station 92, July 25, 1952, lat. 42°39′ N., long. 63°41′ W., depth 340 to 350 fathoms, 1 specimen, 44 mm. MCZ 37422, *Captain Bill II* station 48, June 26, 1952, lat. 39°56′ N., long. 69°37′ W., depth 360 to 445 fathoms, 1 specimen, 57 mm. CNHM 45943, *Oregon* station 841, November 6, 1953, lat. 28°58′ N., long. 88°0′ W., depth 830 to 930 fathoms, 1 specimen, 90 mm. UMML 925, *Pelican* station 57, June 10, 1956, lat. 29°59′ N., long. 80°07′ W., depth 165–169 fathoms, 1 specimen, 79 mm. CNHM 64457, Gulf of Mexico, *Oregon* station 1302, May 26, 1955, lat. 28°53′ N., long. 87°58′ W., depth 890 fathoms, 1 specimen, 87 mm.

Distinctive characters: The body deep, greatest depth contained about 1.9 to 2.0 times in standard length; dorsal blade high, height of last spine above pigmented area contained 1.5 to 1.9 times in length of base of soft dorsal; one or two small spines behind orbit.

Dr. N. B. Marshall, British Museum (Natural History) has examined the three types and finds that the postabdominal spines are the same as in *affinis*, as is shown in figure 26*a*, p. 634. The sketch of these spines sent with his letter of January 21, 1958, is greatly appreciated.

Description: The arrangement of photophores and other details of this species are represented in figure 5, p. 624. Counts made are given in table 1, p. 591, and table 2, p. 592; measurements made are given in table 3, p. 593.

Color: The color pattern is shown is figure 5, p. 624.

Range: So far this species has been found only in the Atlantic Ocean.

Argyropelecus hemigymnus Cocco

Figure 6

Argyropelecus emigymnus Cocco, Giorn. Sci. Lett. Arti Sicilia, vol. 26, No. 77, p. 146, 1829 (type locality, seas around Messina. The Italian spelling of "emi," meaning half, was corrected to "hemi" in later publications and has consistently been used by all authors since 1829. Therefore, through long usage I continue to use *hemigymnus*).

Argyropelecus hemigymnus Cocco, Isis (Oken), vol. 24, pt. 12, p. 1342, 1831 (type locality, "seas around Messina").—Bonaparte, Iconografia della fauna Italica . . . vol. 3, Pesci, fasc. 28, pl. 121, fig. 3, 1840 (Mediterranean Sea); Catalogo metodico dei pesci Europei, Napoli, p. 37, 1846 (Mediterranean).—Cuvier and Valenciennes, Histoire naturelle des poissons, vol. 22, p. 398, 1849 (Mediterranean).—Lowe, Proc. Zool. Soc. London, pt. 18, p. 248, 1850 (Madeira).—Günther, Catalogue of the fishes in the British Museum, vol. 5, p. 385, 1864 (Mediterranean and Atlantic Ocean).—Canestrini, Fauna d'Italia, vol. 3, Pesci marini, pt. 2, p. 119, 1872.—Doderlein, Atti Accad.

Sci. Lett. Arti Palermo, new ser., vol. 6, p. 54, 1879 (Sicilia).—Moreau, Histoire naturelle des poissons de la France, Paris, vol. 3, p. 498, 1881 (Mediterranean).—Leydig, Die augenähnlichen Organe der Fische, Bonn, p. 26, pl. 2, figs. 13–14; pl. 3, figs. 19–20; pl. 4, figs. 22–27; pl. 5, figs 28–31; pl. 6, fig. 35, 1881 (anatomy).—Giglioli, Soc. Geogr. Italiana, Terzo Congresso Geogr. Internaz., vol. 2, pp. 195, 199, 207, 1881 (Mediterranean).—Facciola, Natur. Siciliano Giorn. Sci. Nat. 1882–83, p. 206, 1883 (Straits of Messina).—Goode and Bean, Bull. Mus. Comp. Zool., vol. 10, No. 5, pp. 186, 189, 220, 1883 (*Blake* station 315, lat. 32°18′40″ N., long. 78°43′ W., 225 fathoms, specimens not seen).—Vinciguerra, Ann. Mus. Civ. Stor. Nat. Genova, ser. 2a, vol. 2, p. 469, 1885 (Gulfo di Genova).—Günther, Report of the scientific results of the voyage of H.M.S. *Challenger* during 1873–76, vol. 22, p. 167, 1887 (between Shetland and Faröe Islands).—Jordan, Report U.S. Comm. Fish and Fisheries 1885, vol. 13, p. 833, 1887 (name only).—Vaillant, Expédition scientifiques du *Travailleur* et du *Talisman* pendant les années 1880–1883, Poissons, p. 103, 1888 (Eastern Atlantic).—Lütken, Vid. Medd. Naturhist. For. Kjøbenhavn 1891, p. 211, 1892 (North Atlantic).—Carus, Prodromus faunae Mediterraneae . . ., vol. 2, p. 568, 1893 (Mediterranean).—Damiani, Atti Soc. Lig. Sci. Nat. Geogr. Genova, vol. 7, p. 100, 1896 (Gulfo di Genova).—Jordan and Evermann, U.S. Nat. Mus. Bull. 47, pt. 1, p. 604, 1896.—Parona, Atti Soc. Lig. Sci. Nat. Geogr. Genova, vol. 9, p. 367, 1898 (name only).—Handrick, Zoologica, Stuttgart, vol. 13, pt. 32, pp. 1–68, pls. 1–6, 1901 (anatomy of nervous systems and light organs).—Collett, Forh. Vid. Selsk. Christiania 1903, No. 9, p. 110, 1903 (Norway).—Lo Bianco, Mitth. Zool. Stat. Neapel, vol. 16, pp. 126–161, 1903 (Mediterranean).—Brauer, Wissenschaftliche Ergebnisse der Deutschen Tiefsee-Expedition auf dem Dampfer *Valdivia*, 1898–1899 . . ., vol. 15, pt. 1, p. 106, fig. 45, 1906 (Atlantic); pp. 197–204, figs. 9–11, pl. 37, 1908 (eye anatomy).—Ehrenbaum, Eier und Larven von Fishen. Teil 2. Nordisches Plankton, 10th lief., p. 357, 1909 (North Atlantic).—Zugmayer, Resultats des campagnes scientifiques accomplies par le Prince Albert I, Monaco, fasc. 35, p. 51, 1911 (Atlantic).—Murray and Hjort, The depths of the ocean . . ., p. 612, 1912 (Atlantic).—Holt and Byren, Fish. Ireland Sci. Invest. 1912, No. 1, p. 21, fig. 7b, 1913 (off Ireland).—Gilchrist, Mar. Biol. Report Union South Africa, vol. 1, p. 66, 1913 (South Africa).—Hoek, Conseil Perm. Inter. Expl. Mer. Pub. Circonst., No. 12, p. 53, 1914 (North Sea).—Pappenheim, Die Fische der deutschen Südpolar-Expedition 1901–1903, vol. 15, pt. 2, p. 182, 1914 (North and South Atlantic to a depth of 3,000 meters).—Pietschmann, Sitz. Akad. Wiss. Wien, vol. 123, pt. 4, p. 433, pl. 3, figs. 1–3, 1914 ("Najade" Adriatic Sea).—Jespersen, Report on the Danish oceanographical expeditions to the Mediterranean, 1908–1910, vol. 2, No. 3, pt. 2A, p. 7, 1915 (Atlantic and Mediterranean).—Jespersen and Taning, Vid. Medd. Naturhist., Kjøbenhavn, vol. 70, p. 220, 1919 (larvae).—Roule, Resultats des campagnes scientifiques accomplies par le Prince Albert I, Monaco, fasc. 52, p. 25, 1919 (Atlantic).—Nushbaum-Hilarowicz, Resultats des campagnes scientifiques accomplies par le Prince Albert 1st Monaco, fasc. 65, p. 10, pl. 2, figs. 1–13, 17–19; pl. 3, fig. 2, 1923 (histology, anatomy).—Jespersen and Taning, Report on the Danish oceanographical expeditions to the Mediterranean, 1908–1910, vol. 2, A12, p. 48, figs. 29–30, 1926 (Mediterranean).—Sanzo, Comit. Talassogr. Italiano Monogr. 2, pp. 1–60, pls. 1–7, 1928 (larvae and adults).—Beebe, Zoologica, New York, vol. 12, No. 1, p. 14, 1929 (Hudson Gorge, 164 to 1,000 fathoms).—

Jordan, Evermann and Clark, Report U.S. Comm. Fish. 1928, pt. 2, p. 74, 1930 (name only).—Norman, *Discovery* Reports, vol. 2, p. 303, pl. 2, fig. 4, 1930 (South Atlantic, surface to 2,500 meters).—Roule and Angel, Resultats des campagnes scientifiques accomplies par le Prince Albert I, Monaco, fasc. 79, p. 29, pl. 2, figs. 29–38, 1930 (larvae).—Sparta, Comit. Talassogr. Italiano Mem. No. 172, pp. 1–22, pl., 1930 (anatomy).—Sanzo, Fauna e flora del Golfo di Napoli. Pub. Staz. Zool. Napoli. Monog. 38, p. 44, pl. 4, figs. 1–4, 1931 (larvae).—Beebe, Bull. Inst. Oceanogr. Monaco, No. 629, p. 4, 1933 (off Bermuda, 300 to 400 fathoms).—Roule and Angel, Resultats des campagnes scientifiques accomplies par le Prince Albert I, Monaco, pt. 86, p. 80, 1933 (East Atlantic).—Jespersen *in* Joubin, Faune ichthyologique de l'Atlantique nord, No. 15, figs. 1, 2, 1934 (Mediterranean and North Atlantic).—Parr, Bull. Bingham Oceanogr. Coll., vol. 6, art. 6, p. 5, 1934 (lat. 25°39′ N., long. 77°18′ W.).—Nobre, Fauna marinha de Portugal, vertebrados, vol. 1, pt. 3, Peixes de Portugal p. 351, 1935 (Madeira).—Fowler, Bull. Amer. Mus. Nat. Hist., vol. 70, pt. 1, p. 245, pt. 2, p. 1207, 1936 (off Italy).—Sanzo, Soc. Italiana Progr. Sci., Roma, vol. 14, p. 9, 1936 (larvae).—Beebe, Zoologica, New York, vol. 22, pt. 3, p. 202, 1937 (Bermuda).—Parr, Bull. Bingham Oceanogr. Coll., vol. 3, art. 7, p. 53, fig. 18, 1937 (North Atlantic).—Schultz, Smithsonian Misc. Coll., vol. 91, No. 27, p. 4, 1937 (detailed measurements); Proc. U.S. Nat. Mus. vol. 86, p. 148, 1938 (western North Atlantic, Bermuda).—Rey, Mem. Real Acad. Cien. Exact. Fis. Madrid., vol. 11, p. 249, figs. 81a, 82, 1947 (Atlantic).—Trotti, Ann. Mus. Civ. Stor. Nat. Genova, vol. 63, p. 22, 1947 (Mediterranean).—Noronha and Sarmento, Vertebrados da Madeira, ed. 2, Peixes, vol. 2, pp. 115, 141, 1948 (Madeira).—Nybelin, Göteborgs Vet. Vitterh. Samh. Handl., ser. B, vol. 5, No. 16, p. 23, 1948 (eastern North Atlantic).—Maul, Lista sistemática dos peixes assinalados nos mares da Madeira e indice alphabetica, p. 13, 1949 (Madeira).—Tortonese and Trotti, Atti Accad. Lig. Sci. Lett. Genova, vol. 6, No. 1, p. 37, 1949 (Mediterranean).—Harvey, Bioluminescence, New York, p. 541, fig. 187, 1952.—Karvolac, Inst. Oceanogr. Ribarstvo Split. Jugoslavija, Rep., vol. 5, No. 2B, p. 16, 1953 (Adriatic Sea).—Zahl, Nat. Geog. Mag., vol. 104, p. 597, color plates, 1953 (Mediterranean).—Dieuzeide, Novelle, and Roland, Catalogue des poissons des côtes Algeriennes, vol. 2, p. 50, fig., 1954 (Mediterranean).—Zahl, Nat. Geogr. Mag., vol. 113, No. 5, p. 713, pl., 1958 (Mediterranean).

Sternoptix mediterranea Cocco, Giorn. Faro, Messina, vol. 4, anno. 6, p. 7, figs. 1, 2a–b, 1838 (Mediterranean).

Argyropelecus d'urvilli Cuvier and Valenciennes, Histoire naturelle des poissons, vol. 22, p. 405, 1849 (Mediterranean).—Goode and Bean, Oceanic ichthyology . . . , U.S. Nat. Mus. Spec. Bull. No. 2., p. 127, 1895 (mid-Atlantic).

Argyropelecus heathii Harvey, Bioluminescence, New York, p. 541, fig. 184, 1952.

STUDY MATERIAL: Since so many specimens were studied, they are summarized below; the numbers of specimens are given in parentheses:

ANSP 67703(1) and 67704(1).

BOC 2958(1), 2962(1), 2965(1), 2971(3), 2986–2998(49), 3001–3007(24).

CNHM (taken at Bermuda by the *Caryn*) 49789(1), 49793(2), 49792(1), 49787(1), 49795(2), 49799(2), 49797(1), 49796(1), 49798(1), 49790(1), 49791(2), 49788(2), 49784(7), 49802(2), 49811(1), 49805(2), 49800(2), 49803(1), 49808(1), 49813(1), 49801(1), 49806(1), 49812(1), 49809(1), 49810(1), 49804(1), 49807(1).

MCZ 6600(8), 25882(1), 26389(4), 32293(1), 34990(3), 34993(6), 35151(3), and *Atlantis* station 2959(1).

USNM 10143(2), 40053(2), 100341(1), 100526(1), 100542(1), 102779(5), 102780(8), 102781(3), 102782(8), 102783(1), 102784(2), 102785(2), 102786(6), 163362(1), 164296(3).

WHOI RHB454(13), RHB456(3), RHB483(2), RHB569(3), RHB572(7).

Distinctive characters: *A. hemigymnus* and *A. intermedius* form what may be called the *hemigymnus* complex. The former appears to be confined to the Atlantic and Mediterranean Sea, and *A. intermedius* to the Pacific and Indian Oceans. My opinion is based on the specimens available. In each of these vast regions there may be populations or even subspecies that could be distinguished, but this possibility requires verification through special studies of hundreds of specimens from each of numerous localities.

The following characters are possessed by both species: Lower preopercular spine almost straight and directed nearly straight downward; upper preopercular spine rather long, curved a little upward and outward, notably extending past rear margin of bony edge of preopercle; a single serrated postabdominal spine directed posteriorly, the lower margin of spine almost in line with lower edge of abdomen, usually a minute spinule dorsally on posterior basal part of postabdominal spine.

Description: Counts made are given in table 1, p. 591, and table 2, p. 592, measurements made are given in table 3, p. 593. This species is notable for its slender body behind the preanal group of photophores, the compact nature of the anal and subcaudal groups of photophores, and the wide spaces separating preanal, anal, and especially the subcaudal group of photophores from the anal group. A white bar occurs between preanal and anal and another between anal and subcaudal groups of photophores. These white bars are separated by a dark bar.

Range: This species appears to be replaced in the Pacific and Indian Oceans by *A. intermedius*. *A. hemigymnus* is the only species of this genus that has so far been reported from the Mediterranean Sea. Numerous specimens were available for study in over 85 lots from the following general localities: Mediterranean Sea (54); Azores (9); off Iceland (4); vicinity of Bermuda (60); off New York (18); off South Carolina (1); off Georgia (1); Bahamas and West Indies (110); Caribbean Sea (1). I have not seen any specimen of *A. hemigymnus* from the Gulf of Mexico. The farthest north from which I have seen a specimen was lat. 42°56′ N., long. 30°19′ W. (MCZ 34990) and to a depth of 3,000 meters (Pappenheim, 1914). It also occurs in the South Atlantic.

Argyropelecus intermedius Clarke

Figure 7

Argyropelecus intermedius Clarke, Trans. Proc. New Zealand Inst. 1877, vol. 10, p. 244, pl. 6, figs., 1878 (type locality, Hokitika, New Zealand).

Argyropelecus heathi Gilbert, Bull. U.S. Fish Comm. 1903, vol. 23, pt. 2, p. 601, pl. 72, fig. 1, 1905 (type locality, Kaiwi Channel between Oahu and Molokai; holotype USNM 51632).—Jordan and Seale, Bull. U.S. Fish Comm. 1905, vol. 25, p. 190, 1906 (Hawaiian Islands).—Jordan and Jordan, Mem. Carnegie Mus., vol. 10, No. 1, p. 9, 1922 (Kaiwi Channel).—Fowler, Mem. Bernice Pauahl Bishop Mus., vol. 10, p. 35, 1928 (Hawaiian Islands); Acad. Nat. Sci. Philadelphia, monog. 2, p. 265, 1938 (Hawaiian Islands).—Haig, Pacific Sci., vol. 9, p. 321, 1955 (Mauna Loa lava flow, Hawaii).

Argyropelecus hemigymnus, Alcock, Journ, Asiatic Soc. Bengal, vol. 65, pt. 2, p. 331, 1896 (Bay of Bengal, 1803 fathoms); A descriptive catalogue of the Indian deep-sea fishes collected by the Royal Indian Museum . . . , Calcutta, p. 135, 1899 (Bay of Bengal, 1803 fathoms).—Brauer, Wissenschaftliche Ergebnisse der Deutschen Tiefsee-Expedition auf dem Dampfer *Valdivia*, 1898–1899 . . . , vol. 15, pt. 1, p. 106, 1906 (Pacific and Indian Oceans).—Gilchrist, Mar. Biol. Rep. Union South Africa, No. 1, p. 66, 1913 (South Africa).—Barnard, Ann. South African Mus., vol. 21, pt. 1, p. 153, 1925 (off Cape Point, South Africa, depth 156 to 630 fathoms).—Norman, British, Australian, and New Zealand Antarctic Research Expedition, 1929–1931, vol. 1, No. 2, Fishes, p. 82, 1937 (Pacific, off southwestern Australia).—? Smith, The sea fishes of Southern Africa, p. 107, fig. 160, 1949 (off the "Cape" in 600 fathoms).—Fowler, Mem. Bernice Pauahl Bishop Mus., vol. 12, p. 42, 1949 (Hawaiian Islands).—Munro, Handbook of Australian fishes, No. 7, p. 32, fig. 223, 1957 (off southwestern Australia).

Study material: Univ. Hawaii, Mauna Loa lava flow, Kona, Hawaii, June 6, 1950, 2 specimens, 19 to 25 mm. USNM 51632, holotype of *Argyropelecus heathi* Gilbert, *Albatross* station 4107, standard length 24.5 mm. UCLA H51–358, lat. 40°35′ N., long. 147°55′ W., August 10, 1951, depth 350 to 600 meters, 4 specimens, 12 to 30.5 mm. USNM 164004, off Kona, Hawaii, June 6, 1950, Y. Yamaguchi collector, 1 specimen, standard length, 19 mm. USNM 103022, *Albatross* station 5184, Philippine Islands, lat. 10°18′20″ N., long. 122°23′30″ E., depth 565 fathoms, 1 specimen, 15 mm. (another specimen in bad condition). USNM 103023, *Albatross* station 5120, Philippine Islands, lat. 10°18′30″ N., long. 122°23′30″ E., depth 393 fathoms, January 19, 1908, 1 specimen, 13.5 mm.

Distinctive characters: *A. intermedius* differs from *A. hemigymnus* in having the tips of spines of dorsal blade smooth, and in the ventral edge of the bony pectoral shield having a few minute points on the scalloped edges instead of the reverse as occurs in *hemigymnus*.

Description: Counts made are given in table 1, p. 591, and table 2, p. 592; measurements made are given in table 3, p. 593.

Color: The color pattern is shown in figure 7, p. 625.

RANGE: Although I have not seen any specimens from the Indian Ocean, this species probably replaces *hemigymnus* in the Central and Western Pacific and Indian Oceans. It occurs as far north as lat. 40°35′ N. and as deep as 565 fathoms in the Northwestern Pacific. Alcock (1896) had specimens from the Bay of Bengal from a depth of 1803 fathoms.

***Argyropelecus amabilis* (Ogilby)**

FIGURE 8

Sternoptychides amabilis Ogilby, Proc. Linn. Soc. New South Wales, ser. 2, vol. 3, p. 1313, 1888 (type locality, Lord Howe Island).—Goode and Bean, Oceanic ichthyology . . . U.S. Nat. Mus. Spec. Bull. No. 2, pp. 127, 128, 1895.

Argyropelecus amabilis McCulloch, Rec. Australian Mus., vol. 14, No. 2, p. 118, pl. 14, fig. 3, 1923 (Lord Howe Island).—Parr, Bull. Bingham Oceanogr. Coll, vol. 3, art. 3, p. 49, fig. 21, 1937.

Argyropelecus amabilis, Schultz, Proc. U.S. Nat. Mus., vol. 86, p. 150, 1938 (Western North Atlantic). Longley and Hildebrand, Pap. Tortugas Lab. Carnegie Inst. Washington, No. 535, p. 16, 1941 (Florida).

Argyropelecus micracanthus Parr, Bull. Bingham Oceanogr. Coll., vol. 3, art. 7, p. 52, figs. 18, 21, 1937 (type locality, lat. 23°49′ N., long. 76°58′ W., depth 7,000 feet of wire out; holotype BOC 3768 examined by me).

Argyropelecus antrorsospinus Schultz, Smithsonian Misc. Coll., vol. 91, No. 27, pp. 1–5, fig. 1, 1937 (type locality, Western North Atlantic).

Argyropelecus olfersi, Goode and Bean (in part), Oceanic ichthyology . . ., U.S. Nat. Mus. Spec. Bull. No. 2, p. 126, pl. 39, fig. 148a, 1895 (USNM 33296; 33393; 35561; 43855; 102987).—Jordan and Evermann, U.S. Nat. Mus. Bull. 47, pt. 1, p. 604, pt. 4, fig. 261, 1896.—Roule and Angel, Resultats des campagnes scientifiques accomplies par le Prince Albert I, Monaco, fasc. 86, p. 48, (? p.80), pl. 2, figs. 24, 24a, 1933 (Azores, Gulf of Gasconge).—Vladykov and McKenzie, Proc. Nova Scotian Inst. Sci., vol. 19, pt. 1, p. 60, fig., 1935 (on Goode and Bean).

STUDY MATERIAL: USNM 102989 (holotype of *A. antrorsospinus*), off Calebra Island, lat. 18°32′54″ N., long. 65°23′42″ W., to lat. 18°32′15″ N., long. 65°18′45″ W., February 26, 1933, depth 250 to 320 fathoms, standard length 33 mm. USNM 102987 (paratype of *A. antrorsospinus*), *Albatross* station 2208, lat. 39°33′ N., long. 71°16′15″ W., August 21, 1884, 1 specimen, 34.5 mm. USNM 35561 (paratype of *A. antrorsospinus*), *Albatross* station 2209, lat. 39°34′45″ N., long. 71°21′30″ W., August 21, 1884, 1 specimen, 33 mm. USNM 33393 (paratype of *A. antrorsospinus*), *Albatross* station 2075, lat. 41°40′30″ N., long. 66°35′00″ W., September 3, 1883, 1 specimen, 34 mm. USNM 43855 (paratype of *A. antrorsospinus*), *Albatross* station 2717, lat. 38°24′ N., long. 71°13′ W., September 18, 1886, 1 specimen in bad condition. USNM 33296, *Albatross*, lat. 39° N., long. 68° W., 1 specimen, 54 mm. MCZ 35815, *Atlantis* station 3457, lat. 23°23′ N., long. 80°36′ W., May 3, 1938, 550 fathoms, 1 specimen, 37 mm. WHOI, *Blue Dolphin* haul No. RHB 481, August 25, 1953, lat. 39°44′

N., long. 70°39′ W., to lat. 39°48′ N., long. 70°28′ W., 2 specimens, 13.5 to 18 mm. BOC 3768 (holotype of *Argyropelecus micracanthus* Parr).

DISTINCTIVE CHARACTERS: Lower preopercular spine directed straight downward and curved a little outward; upper preopercular spine short, pointing outward, its tip not extending past rear margin of bony edge of preopercle; a single postabdominal spine directed downward and curved a little forward; space between anal group and subcaudal group of photophores about equal to width of last two anal photophores; supra-abdominal, preanal, and anal photophores not in a straight line; caudal peduncle crossed with a white or pale bar between anal and subcaudal groups of photophores.

DESCRIPTION: Counts made are given in table 1, p. 591, and table 2, p. 592; measurements made are given in table 3, p. 593. This deep bodied species, when it reaches a standard length of over 35 mm., develops spines along the ventral edge of the caudal peduncle, around the anus, and the ventral bony edge of the abdominal ridge becomes serrated; also three flat bonylike spines develop between the two parts of the anal fin; the space between anal and subcaudal groups of photophores is much greater in small specimens than in the adults.

COLOR: The color pattern is shown in figure 8, p. 625.

RANGE: This species occurs in the Atlantic Ocean and at Lord Howe Island in the Pacific Ocean to a depth of at least 550 fathoms and perhaps over 1,000 fathoms (Parr 1937).

REMARKS: *H. aculeatus* may be confused with *H. amabilis* when the posterior abdominal spine of *aculeatus* is damaged and only the anterior one remains.

***Argyropelecus aculeatus* Cuvier and Valenciennes**

FIGURE 9

Argyropelecus aculeatus Cuvier and Valenciennes, Histoire naturelle des poissons, vol. 22, p. 406, 1849 (type locality, off the Azores).—Günther, Catalog of the fishes in the British Museum, vol. 5, p. 386, 1864 (Azores).—Sauvage, Histoire physique naturelle et politique de Madagascar, 1887–91, Paris, vol. 16 (Poissons), p. 483, pl. 48, fig. 5, 1875 (Reunion Island)—Goode and Bean, Oceanic ichthyology . . ., U.S. Nat. Mus. Spec. Bull. No. 2., p. 127, 1895 (mid-Atlantic).—Collett, Forh. Vid. Selsk. Christiania 1903, No. 9, p. 108, 1903 (off Norwegian coast); Zool. Anz., vol. 28, No. 21–22, p. 726, 1905 (on Collett, 1897).—Brauer, Wissenschaftliche Ergebnisse der Deutschen Tiefsee-Expedition auf dem Dempfer *Valdivia,* 1898–1899 . . ., vol. 15, pt. 1, p. 110, fig. 47, 1906 (Atlantic and Indian Oceans).—Murray and Hjort, The depths of the ocean . . ., p. 642, 1912 (Atlantic).—Hock, Conseil Perm. Intern. Expl. Mer. Pub. Circonst., No. 12, p. 53, 1914 (North Sea).—Jespersen, Report on the Danish oceanographical expeditions to the Mediterranean, 1908–1910, vol. 2, No. 3, pt. 2A, p. 27, 1915 (Atlantic).—Norman, *Discovery* reports, vol. 2, p. 303, fig. 11, 1930 (South Atlantic, surface to 1,000 meters).—Borodin, Bull.

Mus. Comp. Zool., vol. 72, No. 3, p. 68, 1931 (MCZ 31631).—Beebe, Bull. Inst. Oceanogr. Monaco, No. 629, p. 4, 1933 (off Bermuda from zero to 400 fathoms).—Roule and Angel, Resultats des campagnes scientifiques accomplies par le Prince Albert I, Monaco, pt. 86, p. 79, 1933 (East Atlantic).—Jespersen *in* Joubin, Faune ichthyologique de l'Atlantique nord., No. 15, fig., 1934 (North Atlantic).—Beebe, Zoologicia, New York, vol. 22, pt. 3, p. 201, 1937 (Bermuda).—Parr, Bull. Bingham Oceanogr. Coll., vol. 3, art. 7, p. 53, fig. 18, 1937 (North Atlantic).—Schultz, Smithsonian Misc. Coll., vol. 91, No. 27, p. 4, 1937 (detailed measurements); Proc. U.S. Nat. Mus., vol. 86, p. 151, 1938 (Gulf of Mexico, western North Atlantic).—Bertin, Bull. Mus. Nat. Hist. Nat. Paris, vol. 12, No. 6, p. 314, 1940 (holotype of *Argyropelecus aculeatus* Cuvier and Valenciennes, Azores).—Maul, Bol. Mus. Mun. Funchal, No. 4, art. 9, p. 17, fig. 5, 1949 (Maderia).—Marshall, Aspects of deep sea biology, New York, p. 278, fig. XI, 6, 1954.

Argyropelecus caninus Garman, Mem. Mus. Comp. Zool., vol. 24, p. 235, 1899 (type locality, Indian Ocean. The type of *A. caninus* Garman, was photographed by Harvard University through the kindness of Mrs. M. M. Dick, and the prints show the holotype to be badly damaged; preopercular spines are lacking, as is the rear postabdominal spine, the base of which has a ragged edge, indicating that it was broken off. There is little doubt that *A. caninus* is a synonym of *A. aculeatus*).

Argyropelecus acanthurus Fowler, Bull. Amer. Mus. Nat. Hist., vol 70, pt. 1, p. 246, pt. 2, p. 1207, 1936 (after Cuvier and Valenciennes).—Rey, Mem. Real. Acad. Cienc. Nat. Madrid, vol. 11, p. 254, figs. 81c, 84, 1947 (Atlantic).—Noronha and Sarmento, Vertebrados da Madeira, ed. 2, Peixes, vol. 2, p. 141, 1948 (Madeira).—Maul, Lista sistemática dos peixes assinalados nos mares da Madeira e indice alphabetica, p. 13, 1949 (Madeira).

Argyropelecus olfersi, Goode and Bean (in part), Oceanic ichthyology . . ., U.S. Nat. Mus. Spec. Bull., No. 2, p. 126, 1895 (USNM 35534, 35467, 38116, 38211, 74336).—Collett, Arch Math. Naturv. Christiana, vol. 19, No. 7, p. 14, 1897 (Azores).

Argyropelecus (*Sternoptychides*) *amabilis*, Whitley, Australian Zool., vol. 9, pt. 4, p. 404, fig. 12, 1940 (near Port Hacking, New South Wales).

Study material: Since many specimens were studied, they are summarized below; the numbers of specimens are given in parentheses:

CNHM 49187(1), 49785(2), 49786(1), 49828–49834(10), 49836(1), 64352(3), 64356(1), 64363–64366(9).

MCZ 28262(1), 31631(1), 32293(1), 34950(1), 34993(1); *Atlantis* station 2952(1), 2961B(1), 2962C(1).

SIO H53–356(1).

SNHM 43373(1), 44011(1), 44023(2), 44030–44031(12), 44034(1), 44037(1), 44065(1), 44073(1), 44075(1), 46026(1), 46524(1), 46527(15).

UMML 2322(1), 2324(1), 2336(1), 2746–2749(4).

USNM 35467(1), 35534(1), 38116(1), 38211(1), 74336(1), 86124(2), 102777(2), 103024(1); *Silver Bay* station 442(1), 443(2), 449(1); *Combat* station 291(1) and 444(1).

WHOI RHB 414(1), RHB 454(1), RHB 459(3) RHB 462(1), RHB471(2), RHB 475–476(52), RHB 478(3), RHB 555(1), RHB 569(1), RHB 588(3), RHB 593(1).

Distinctive characters: Lower preopercular spine directed downward and slightly curved outward; upper preopercular spine short, directed a little outward and posteriorly but not extending beyond bony edge of preopercle; 2 postabdominal spines, the anterior one directed ventrally and curving a little forward, the rear spine much longer and stronger, directed posteriorly and curving ventrally; posterior spine sometimes with 1 or 2 spinelets on the ventral side; the angle between postabdominal spines about 70° to 100°; space between anal group and subcaudal group of photophores rather narrow, about equal to width of last 3 anal photophores; supra-abdominal, preanal, and anal photophores not in a straight line; caudal peduncle crossed with a white or pale bar between anal and subcaudal groups of photophores; translucent part of abdominal keel notably wider than width of middle two anal photophores.

Description: Counts made are given in table 1, p. 591, and table 2, p. 592; measurements made are given in table 3, p. 593. Greatest depth of pigmented part of body 1.0 to 1.1 and length of dorsal blade 4.5 to 6.5 times, both in postorbital length of body. When it reaches a standard length greater than 25 mm., this deep bodied species develops a series of spines under the subcaudal photophores, a double series in front of subcaudal photophores, and a double group around the anus and 3 flat bonylike spines between the 2 parts of the anal fin; the bony ridges on head and dorsal blade also develop series of bony serrae; these occur on both males and females.

The four subcaudal photophores of equal size are in a straight line, whereas the first and last two anal photophores are notably larger than the middle three and dorsal edges are not in a straight line.

In alcohol there is a white bar across caudal peduncle between anal and subcaudal group of photophores up to a length of about 50 mm., after which it darkens like rest of body; base of lower lobe of caudal fin with a blackish posterior extension at least one-fourth the length of lower caudal fin rays.

Some specimens are difficult to distinguish from *olfersi* if the postabdominal spines are damaged. However, *aculeatus* has a deeper body; the depth is less than 1.1 in postorbital length, whereas in *olfersi* it is 1.2 or greater.

Range: This species occurs in abundance in the Atlantic and Pacific Oceans and is also found in the Indian Ocean. Specimens were examined from the following localities: Pacific localities: Japan (1), Philippines (1), Galápagos (15), in Pacific off Colombia (1). Atlantic localities: Grand Banks (5), off New York (51), off Deleware (10), middle North Atlantic (2), off North Carolina (2), off South Carolina (1), vicinity of Florida (9), Gulf of Mexico (3), Bahamas (1), Cuba and West Indies (9), Burmuda (43), Caribbean (16), off Azores (2).

The farthest north locality in the Atlantic is lat. 48°10′ N. (MCZ 34950); and it has been taken at a depth of 855 fathoms.

Argyropelecus olfersi (Cuvier)

Figure 10

Sternoptyx olfersii Cuvier, Le régne animal . . . , ed. 2, vol. 2, p. 316, 1829 (type locality, Atlantic Ocean).—Rüben and Koren, Vetensk. Akad. Handl. Stockholm 1844, p. 80, pl. 3, fig. 6, 1846 (Helgoland).

Argyropelecus hemigymnus, Borodin, Bull. Mus. Comp. Zool., vol. 72, No. 3, p. 68, 1931 (MCZ 31634).

Argyropelecus olfersi Cuvier and Valenciennes, Histoire naturelle des poissons, vol. 22, p. 408, 1849 (off Cape of Good Hope, Western Atlantic).—Lowe, Proc. Zool. Soc. London, pt. 18, p. 247, 1850 (Madeira).—Günther, Catalog of the fishes in the British Museum, vol. 5, p. 386, 1864 (Atlantic).—Collett, Forh. Vid. Selsk. Christiana, No. 1, p. 84, 1880 (off Norway).—Collett, Nyt Mag. Naturv., vol. 29, p. 102, 1884 (off Norway).—Jordan, Report U.S. Comm. Fish and Fisheries 1885, vol. 13, p. 833, 1887 (name only).—Günther, Report of the scientific results of the voyage of H.M.S. *Challenger* during 1873–76, vol. 22, p. 167, 1887 (off Cape Finisterre).—Vaillant, Expeditions scientifiques du *Travailleur* et du *Talisman* pendant les années 1880–1883, Poissons, p. 104, 1888 (off Portugal).—Lilljeborg, Sveriges och Norges fiskar, Upsala, vol. 3, p. 3, 1891 (off Norway).—Lütken, Spolia Atlantica, p. 283, 1892 (North Atlantic).—Vinciguerra, Atti Soc. Italiana Sci. Nat. Milano, 1893, vol. 34, p. 331, 1893 (Canary Islands).—Smitt, A history of Scandinavian fishes, Stockholm, pt. 2, p. 925, fig. 233, 1895 (Atlantic, also 2nd edition).—Collett, Resultats des campagnes scientifiques accomplies par le Prince Albert I, Monaco, fasc. 10, p. 127, pt. 3, fig. 14, 1896 (off Azores).—Jordan and Evermann, U.S. Nat. Mus. Bull. 47, pt. 1, p. 604, pt. 4, fig. 261A, 1896.—Collett, Forh. Vid. Selsk. Christiania, No. 9, p. 105, 1903 (off Norwegian coasts).—Brauer, Wissenschaftliche Ergebnisse der Deutschen Tiefsee-Expedition auf dem Dampfer *Valdivia*, 1898–1989 . . . , vol. 15, pt. 1, p. 108, fig. 46, 1906 (Atlantic, Pacific and Indian Oceans).—Zugmayer, Resultats des campagnes scientifiques accomplies par le Prince Albert I, Monaco, fasc. 35, p. 52, 1911 (Atlantic).—Murry and Hjort, The depths of the ocean . . . , p. 612, 1912 (Atlantic).—Halkett, Checklist of the fishes of the Dominion of Canada and Newfoundland, Ottawa, p. 56, 1913 (off Canada in Atlantic).—Holt and Byrne, Fish. Ireland Sci. Invest. 1912, No. 1, p. 20. fig. 7a, 1913 (off Ireland).—Weber, Die Fische der Siboga Expedition, Leiden, vol. 57, p. 21, 1913 (Banda Sea, 2,798 meters).—Weber and Beaufort, The fishes of the Indo-Australian archipelago, vol. 2, p. 134, fig. 49, 1913 (Banda Sea).—Hoek, Conseil Perm. Intern. Expl. Mer. Pub. Circonst., No. 12, p. 53, 1914 (North Sea).—Jespersen, Report on the Danish oceanographical expeditions to the Mediterranean, 1908–1910, vol. 2, No. 3, pt. 2A, p. 23, 1915 (Atlantic).—Thompson, Mar. Biol. Rep. South Africa, No. 3, p. 72, 1916 (Cape Province).—Roule, Bull. Inst. Oceanogr. Monaco, No. 348, p. 4, 1918 (stomach contents tuna).—Roule, Resultats des campagnes scientifiques accomplies par le Prince Albert I, Monaco, fasc. 52, p. 25, 1919 (Atlantic).—Barnard, Ann. South African Mus., vol. 21, pt. 1, p. 153, 1925 (off Cape Point, South Africa, depth 460 fathoms).—Beebe, Zoologica, New York vol. 12, No. 1, p. 14, 1929 (Hudson Gorge, 1,000 fathoms).—Kyle and Ehrenbaum *in* Dunker, et al., Die Fische der Nord- und

Ostsee, p. X11f54, fig. 32, 1929 (North Sea).—Jordan, Evermann, and Clark, Report U.S. Comm. Fish, pt. 2, p. 74, 1930 (name only).—Norman, *Discovery* reports, vol. 2, p. 304, fig. 12, 1930 (Atlantic Ocean).—Jespersen *in* Joubin, Faune ichthyologique de l'Atlantique nord, No. 15, fig., 1934 (North Atlantic).—Rivero, Mem. Soc. Cubana Hist. Nat., vol. 8, No. 1, p. 31, 1934 (off Cuba).—Fowler, Bull. Amer. Mus. Nat. Hist., vol. 70, pt. 1, p. 243, fig. 114, pt. 2, p. 1207, 1936 (after Weber and Beaufort).—Howell-Rivero, Proc. Boston Soc. Nat. Hist., vol. 41, No. 4, p. 56, 1936 (Cuba).—Parr, Bull. Bingham Oceanogr. Coll., vol. 3, art. 7, p. 50, fig. 18, 1937.—Schultz, Smithsonian Misc. Coll., vol. 91, No. 27, p. 4, 1937 (detailed measurements); Proc. U.S. Nat. Mus., vol. 86, p. 152, 1938 (western North Atlantic).—Bertin, Bull. Mus. Nat. Hist. Nat. Paris, vol. 12, No. 6, p. 313, 1940 (holotype of *Sternoptyx olfersi* Cuvier from Cape Good Hope).—Fowler, Proc. Amer. Philos. Soc., vol. 82, No. 5, p. 749, 1940 (lat. 33°40′ N., long. 62°10′ W. from drawing).—Nybelin, Fauna och flora, Upsala, vol. 5, pp. 206–209, fig., 1947 (off Sweden).—Rey, Mem. Real Acad. Cien. Nat. Madrid, vol. 11, p. 252, figs. 81b, 83, 1947 (Atlantic).—Noronha and Sarmento, Vertebrados da Madeira, ed. 2, Peixes, vol. 2, pp. 114, 141, 1948 (Madeira).—Nybelin, Göteborgs Vet. Vitterh. Handl., ser. B, vol. 5, No. 16, p. 24, 1948 (eastern North Atlantic).—Bertelsen and Grøntved, Vid. Medd. Dansk Naturh. For., vol. 111, pp. 164–167, figs. 1–2, 1949 (photographed photophores from their own light from lat. 52°20′ N., long. 27°30′ W.).—Maul, Lísta sistemática dos peixes assinalados nos mares da Madeira e índice alphabetica, p. 13, 1949 (Madeira).—Smith, The sea fishes of southern Africa, p. 107, 1949 (off the "Cape" in 500 fathoms).—Holgersen, Stavenger Mus. Årbok 1949, vol. 59, p. 87, fig., 1950 (off Norway).—Harvey, Bioluminescence, New York, p. 550, fig. 186, 1952.—Koumans, Biological results of the *Snellius* expedition, pt. 16, p. 186, 1953 (East Indies).—Koumans, Temminckia, Leiden, vol. 9, p. 186, 1953 (Central Pacific).—Marshall, Aspects of deep sea biology, New York, p. 278, fig. XI, 6, 1954.

Study material: USNM 164295, South of Iceland, collected by Schaeffer and Starr, 1 specimen, 43 mm. MCZ 34981, *Atlantis* station 1021, August 1, 1931, lat. 42°56′ N., long. 30°19′ W., haul B16, depth tub. 4, 1 specimen, 70 mm.. MCZ 34991, *Atlantis* station 1021, August 1, 1931, lat. 42°56′ N., long. 30°19 W., haul B14, depth tub. 2, 3 specimens, 28 to 50 mm. MCZ 34992, *Atlantis* station 1008, July 28, 1931, lat. 49°33′ N., long. 30° W., haul B4, 2 specimens, 28 to 30 mm. MCZ 34951, *Atlantis* station 1011, July 29 to August 1, 1931, lat. 48°10′ N., long. 30°03′ W., 2 specimens, 34 and 37 mm. MCZ 35002, *Atlantis* station 1011, July 29, 1931, lat. 48°10′ N., long. 30°03′W., haul B7, depth tub. 3, 1 specimen, 36 mm. MCZ 31634, *Iselin* station 322, 1928, lat. 33° N., long. 64° W., 1 specimen, 36 mm.

Distinctive characters: Lower preopercular spine directed downward and curved forward and outward; upper preopercular spine short, directed outward, not extending past rear edge preopercular bone; 2 postabdominal spines, the anterior one hooked anteroventrally, the rear spine usually shorter and directed posteroventrally, the angle between them about 60°; space between anal group and subcaudal group of photophores rather narrow, about equal to width of last 2½ to 3 anal photophores; supra-abdominal photophores not in line with preanal and anal groups; ventral line of abdominal keel usually with a concave notch just in front of anterior postabdominal spine.

DESCRIPTION: Counts made are given in table 1, p. 591, and table 2, p. 592, the measurements made are given in table 3, p. 593. Greatest depth of pigmented part of body 1.2 to 1.4 and height of dorsal blade 7.5 to 9.5 times, both in postorbital length of body.

RANGE: This species is distributed in the Atlantic, Pacific, and Indian Oceans and occurs at depths of 1,000 fathoms (Beebe, 1929) and as far north in the Atlantic as lat. 52°20′ N., (Bertelsen and Grøntved, 1949).

Argyropelecus lynchus lynchus Garman

FIGURE 11

Argyropelecus lynchus Garman, Mem. Mus. Comp. Zool, vol. 24, p. 234, pl. J, figs. 1, 1b, 1899 (type locality, East Pacific, Panama Bay; lectotype USNM 57885).—Ledenfeld, Mem. Mus. Comp. Zool., vol. 30, No. 2, p. 170, pl. 6, figs. 24, 25, 1905 (anatomy light organs).—Vanderbilt, To Galápagos on the *Ara*, p. 132, pl. 5 (in color), 1927 (off Panama in Pacific, 300 fathoms).—Parr, Bull. Bingham Oceanogr. Coll., vol. 2, art. 4, p. 17, fig. 5, 1931 (Atlantic).

Argyropelecus sladeni, Norman, *Discovery* reports, vol. 2, p. 305, fig. 13, 1930 (Atlantic Ocean).—Jordan, Evermann and Clark, Report U.S. Comm. Fish 1928, pt. 2, p. 74, 1930 (name only).—Beebe, Bull. Inst. Oceanogr. Monaco, No. 629, p. 4, 1933 (off Bermuda, 200 to 400 fathoms).—Fowler, Bull. Amer. Mus. Nat. Hist., vol. 70, pt. 2, p.1207, 1936 (after Norman).—Parr, Bull. Bingham Oceanogr. Coll., vol. 3, art. 7, pp. 46–51, figs. 18–20, 1937 (no locality given).—Schultz (in part), Proc. U.S. Nat. Mus., vol. 86, p. 153, 1938 (East Pacific).—Marr, Copeia, No. 2, p. 140, 1948 (lat. 32°12′ N., long. 118°37′ W., depth 190 to 210 meters).

Argyropelecus lichnus Ulrey, Journ. Pan.-Pacific Res. Inst., vol. 4, No. 4, p. 3, 1929 (error for *lynchus;* off California).—Terron, Ann. Inst. Biol. Univ. Nac. Mexico, p. 76, 1932 (on Ulrey).

Argyropelecus d'urvillei, Bertin, Bull. Mus. Nat. Hist. Nat. Paris, vol. 12, No. 6, p. 314, 1940 (holotype *A. d'urvillei* Cuvier and Valenciennes, from Atlantic).

Argyropelacus lynchnus (misspelled), Nichols and Murphy, Bull. Amer. Mus. Nat. Hist., vol. 83, p. 235, 1944 (lat. 4°01′ N., long. 80°26′ W.).

Argyropelecus olfersi, Clemens and Wilby, Fishes of the Pacific Coast of Canada, Fish. Res. Board Canada, Bull, No. 67, p. 106, fig. 54, 1949 (British Columbia).

STUDY MATERIAL: The following type specimens were examined: USNM 57885, lectotype, *Albatross* station 3360, lat. 6°17′ N., long. 82°5′ W., depth 1,672 fathoms, standard length 46 mm. USNM 120239, paratype, *Albatross* station 3410, lat. 0°19′ N., long. 90°34′ W., depth 331 fathoms, standard length 21 mm. USNM 120240, paratype, *Albatross* station 3383, lat. 7°21′ N., long. 79°2′ W., depth 1,832 fathoms, standard length 30 mm. USNM 120241, paratype, *Albatross* station 3395, lat. 7°30′36″ N., long. 78°39′ W., 730 fathoms, 32 mm. USNM 170966, paratype, *Albatross* station 3392, lat. 7°5′30″

N., long. 79°40′ W., depth 1,270 fathoms, standard length 26 mm. MCZ 28528, paratype, *Albatross* station 3414, lat. 10°14′ N., long. 96°28′ W., depth 2,232 fathoms (but a note in jar states "surface to 200 fathoms"), 3 specimens, 40 to 47 mm. MCZ 35193, paratype, *Albatross* hydrographic station 2619, lat. 7°31′00″ N., long. 78°42′ 30″ W., note in jar states "surface to 300 fathoms," 1 specimen, 19 mm. MCZ 35147, paratype, data same as MCZ 35193, 1 specimen, 26 mm.

Besides the types, the following lots were studied (the numbers of specimens are given in parentheses): USNM 148232(5), 150259(2), 164295(1). MCZ 34948(4). SIO H52–419(7) and S10–54–96(1). WHOI RHB569(2), RHB475(1). BOC 2708(4), 3006(1), *Atlantis* station 1355(6); also uncatalogued at BOC are five lots from off Peru, totaling 46 specimens.

DISTINCTIVE CHARACTERS: Lower preopercular spine directed downward and sometimes curved a little forward; upper preopercular spine rather long, curved outward and sometimes upward, notably rather long and reaching past rear of bony edge of preopercle; 2 postabdominal spines, directed ventrally, anterior one curved or hooked forward or directed straight downward, the angle between these spines varying from 50° to 70°; preanal, anal, and subcaudal groups of photophores compact, the distance between anal and subcaudal groups less than width of last 2 anal photophores; length of exposed part of longest spine of dorsal blade 1.0 to 2.2 times in base of soft dorsal fin.

The *lynchus* complex of subspecies (*lynchus*, *sladeni*, and *hawaiensis*) differs from *olfersi* mostly in the upper preopercular spine, which is short and stubby and does not extend past the bony preopercular edge in *olfersi*, whereas in the *lynchus* complex the spine is long, hooked outward, sometimes a little dorsally, and reaches past the bony preopercular edge.

Although I am recognizing three subspecies of *lynchus* in the Indo-Pacific, I do so with some uncertainty. The character of the height of dorsal blade may not be a sound one, as it appears to become proportionately shorter on large specimens than on small ones of the same subspecies. Unfortunately, I lack enough specimens of *hawaiensis* for a fuller study of this problem.

The *lynchus-sladeni* populations also need a detailed study, but the number of specimens available to me are not sufficient for an analysis of variability.

Data indicate that three subspecies might be recognized on the basis of number of gill rakers (see table 4, p. 614) and height of dorsal blade. These are *lynchus lynchus* of the Eastern Pacific and Atlantic Oceans, *lynchus hawaiensis* of the Central Pacific, and *lynchus sladeni* of the Western Pacific and Indian Oceans. However, the problem of where these so-called subspecies meet in the areas where

TABLE 4.—*Number of gill rakers on first gill arch*

Subspecies and localities	Above angle			Below angle				Total rakers					
	8	9	10	9	10	11	12	17	18	19	20	21	22
lynchus lynchus													
East Pacific	27	1	—	2	23	3	—	2	22	4	—	—	—
West Atlantic	6	—	—	—	6	—	—	—	6	—	—	—	—
South Atlantic	4	—	—	—	2	2	—	—	2	2	—	—	—
lynchus sladeni													
Indian Ocean and West Pacific	1	5	1	—	1	5	1	—	—	2	4	—	1
lynchus hawaiensis	6	1	1	—	—	4	4	—	—	3	4	1	—

I have not seen specimens is unsolved, and all subspecies of the *lynchus* complex of populations may disappear into groups of more or less overlapping populations.

Although the height of the dorsal blade varies considerably from specimen to specimen of *lynchus lynchus*, six measured from the Western Atlantic had a shorter blade (1.8 to 2.2 times in base of soft dorsal) than those from the Eastern Pacific and South Atlantic (1.1 to 1.9 times in base of soft dorsal), but other differences were not observed.

DESCRIPTION: Counts made are given in table 1, p. 591, and table 2, p. 592; measurements made are given in table 3, p. 593.

RANGE: This subspecies occurs in the Eastern Pacific and Atlantic Ocean. I have studied material from: Pacific: Off Panama, 10 specimens; Galápagos, 9 specimens; off Northern Peru, 49 specimens; off Cocos Island, 5 specimens; off Clipperton Island, 7 specimens; off Costa Rica, 3 specimens. Atlantic: Off Delaware, 1 specimen; Iceland, 1 specimen; Bahamas, 1 specimen; Caribbean Sea, 6 specimens; Azores, 4 specimens; northwest of Cape Verde Islands, 1 specimen.

Depths range down to 2,222 fathoms (USNM 150259).

Argyropelecus lynchus sladeni Regan

Argyropelecus sladeni Regan, Trans. Linn. Soc. Zool., vol. 12, p 218, 1908 (type locality, Chagos Archipelago, Indian Ocean, depth 400 to 500 fathoms).—Jespersen *in* Joubin, Faune ichthyologique de l'Atlantique nord., No 15, figs., 1934 (? North Atlantic).—Schultz, Smithsonian Misc. Coll., vol. 91, No. 27, p. 4, 1937 (detailed measurements); (in part) Proc. U.S. Nat. Mus., vol. 86, p. 153, 1938 (Philippine Islands).—Norman, John Murray Expedition, 1933–34, Scientific reports, vol. 7, No. 1, p. 20, 1939 (Indian Ocean, depth 200 to 2,926 meters).—Fowler, Fishes of the Red Sea and southern Arabia, Jerusalem, vol. 1, p. 86, 1956 (Red Sea).

STUDY MATERIAL: USNM 103015, *Albatross* station 5368, lat. 13°35′30″ N., long, 121°48′ E., depth 181 fathoms, February 23, 1909, 2 specimens, 27 and 34 mm. USNM 103016, *Albatross* station 5387, lat. 12°54′40″ N., long. 123°20′30″ E., depth 209 fathoms, March 11, 1909, 1 specimen, 27 mm. USNM 103017, *Albatross* station 5447, lat. 13°28′ N., long. 123°46′18″ E., depth 310 fathoms, June 4, 1909, 1 specimen in bad condition. USNM 103018, *Albatross* station 5497, lat. 9°7′15″ N., long. 124°59′30″ E., depth 960 fathoms, August 3, 1909, 4 specimens, 14 to 19 mm. USNM 103020, *Albatross* station 5525, lat. 9°12′30″ N., long. 123°44′7″ E., depth 805 fathoms, August 11, 1909, 1 specimen, 35 mm. USNM 103021, *Albatross* station 5530, lat. 9°26′45″ N., long. 123°38′30″ E., no depth given, August 11, 1909, 1 specimen in poor condition. USNM 102787, *Albatross* station 4913, lat. 31°39′10″ N., long. 129°22′30′ E., depth 391 fathoms, August 12, 1906, 1 specimen, 39 mm., off Japan.

Distinctive characters: See *A. lynchus lynchus* and the discussion concerning the *lynchus* complex on p. 613.

Description: Counts made are given in table 1, p. 591, and table 2, p. 592; the measurements made are given in table 3, p. 593.

Range: This subspecies occurs in the Western Pacific and Indian Ocean. I have seen 10 specimens from the Philippines and 1 from off southern Japan.

Argyropelecus lynchus hawaiensis, new subspecies

Figure 12

Argyropelecus sladeni, Haig, Pacific Sci., vol. 9, p. 322, 1955 (off Mauna Loa lava flow, Hawaii).

Holotype: USNM 177931, Mauna Loa lava flow, Kona, Hawaii, June 6, 1950, Y. Yamaguchi, standard length 58 mm.

Paratypes: USNM 164003, same data as holotype, 2 specimens, standard lengths 55.5 and 60 mm. USNM 164001, Mauna Loa lava flow, Kona, Hawaii, June 2, 1950, Hayes and Burke, 1 specimen, standard length 62.3 mm. SIO H53–372, North Pacific Ocean, lat. 36°58′ N., long. 164°30′ E., November 4, 1953, 1 specimen, standard length 52 mm.

The University of Hawaii has 3 paratypes (no catalog numbers) taken with the holotype and bearing the same data, standard lengths 46 to 61.5 mm.

Description: Four specimens were measured in detail and these data, expressed in thousandths of the standard length, are recorded, respectively, for the holotype then the paratypes. Standard lengths in mm. are 58, 55.5, 60, and 62.3. Greatest depth of pigmented area of body 598, 612, 584, and 594; least depth caudal peduncle 103, 112, 115, and 108; greatest height of dorsal blade above pigmented part of body 46, 43, 33, and 35; postorbital length of body 831, 824, 800, and

856. Length of groups of photophores: Anal 176, 180, 183, and 178; preanal 121, 115, 113, and 117; subcaudal 86, 85, 83, and 83. Distance between preanal and anal groups of photophores 26, 27, 23, and 27; distance between anal and subcaudal groups of photophores 48, 49, 50, and 53; distance from upper edge of last abdominal photophore to upper edge of first preanal photophore 164, 150, 158, and 159; distance from tip of snout to rear edge of maxillary 278, 272, 292, and 287; distance from orbit to base of upper preopercular spine 198, 195, 203, and 194; length of snout 86, 83, 92 and 91; diameter of eye 129, 112, 137, and 138. The counts made on the types are given in table 1, p. 591, and table 2, p. 592; measurements made are given in table 3, p. 593.

COLOR: The color pattern is shown in figure 12, p. 627.

RANGE: This subspecies is known from 7 specimens collected in the Hawaiian Islands and 1 from the North Pacific at lat. 36°58′ N., long. 164°30′ E.

REMARKS: This subspecies differs from *lynchus* and *sladeni,* its closest relatives, as is indicated in the key on p. 597.

Genus *Sternoptyx* Hermann

Sternoptyx Hermann, Naturforscher, vol. 16, p. 33, 1781 (type species *Sternoptyx diaphana* Hermann).

The genus *Sternoptyx* has the following characters: Abdominal vertebrae 11; caudal vertebrae 17 to 20; branched caudal rays 9 + 8; pectoral rays 10 or 11; dorsal 9 to 11; anal 13 to 15; gill rakers on first gill arch 4 to 7 + 2 to 4 + 5 to 7 totaling 12 to 16.

The number of organs in groups of photophores are as follows: Abdominal 10, anal 3, branchiostegals 3, isthmus 5, preanal 3, preopercular 1, preorbital 1, postorbital 1, subcaudal 4, subopercular 1, supra-abdominal none, supra-anal 1, suprapectoral 3.

The dorsal blade consists of a single enlarged pterygiophore; there are no anal pterygiophores between the haemal spines on four of the abdominal vertebrae, usually numbers 5 to 8 or 6 to 9, the anal pterygiophores being displaced forward. Teeth on edge of maxillary directed outward; at origin of anal fin a pair of short spines, two pairs of short postabdominal spines in front of pelvic bases; a pair of preabdominal spines; preopercular spine single, directed downward; short spine at lower posterior angle of dentary; postemporal ending in a short spine; anterior edge of dorsal blade denticulate.

Although I have made numerous counts and measurements on specimens from the various seas, nothing could be found that indicated more than a single species for the world. Counts made are given in table 1, p. 591, and table 5, next page.

TABLE 5.—*Counts recorded for* Sternoptyx diaphana

Locality	Fin rays						Number of gill rakers on first arch														
	Anal			Dorsal			Upper arch				Lower arch						Total rakers				
											Normal			Rudimentary							
	13	14	15	9	10	11	4	5	6	7	2	3	4	5	6	7	12	13	14	15	16
Atlantic	1	14	10	—	14	8	13	8	—	—	1	20	—	—	11	10	—	9	7	7	—
West Pacific	3	10	—	6	7	—	10	2	—	—	—	10	2	3	9	—	2	7	3	—	—
East Pacific	2	14	1	1	14	2	3	4	5	2	2	9	2	—	11	3	1	1	1	7	4

Sternoptyx diaphana Hermann

FIGURE 2

Sternoptyx diaphana Hermann, Naturforscher, vol. 16, p. 33, 1781 (type locality, America, ? Jamaica).—Cuvier, The animal kingdom (Griffith's ed.), vol. 10, p. 435, 1834; Le règne animal (Diciple's ed.), vol. 4, p. 271, 1836–1849.—Cuvier and Valenciennes, Histoire naturelle des poissons, vol. 22, p. 415, 1849 (Eastern Atlantic).—Günther, Catalogue fishes British Museum, vol. 5, p. 387, 1864 (Atlantic).—Goode and Bean, Bull. Mus. Com. Zool. vol. 10, No. 5, pp. 186, 189, 220, 1882 (Western Atlantic north to lat. 33°19′ N.).—Günther, Report of the scientific results of the voyage of H.M.S. *Challenger* during 1873–76, vol. 22, p. 169, pl. 45, fig. D, D′, 1887 (Atlantic and Pacific to a depth of ? 2,500 fathoms).—Jordan, Report U.S. Comm. Fish and Fisheries 1885, vol. 13, p. 833, 1887 (Atlantic).—Vaillant, Expéditions scientifiques du *Travailleur* et du *Talisman* pendant les années 1880–1883, Poissons, p. 102, 1888 (Coast of Maroc, Azores).—Lütken, Mem. Acad. Sci. Lett. Danemark, ser. 6, vol. 7, p. 283, 1892 (North Atlantic).—Collett, Resultats des campagnes scientifiques accomplies par le Prince Albert I, Monaco, vol. 10, p. 125, 1896 (Eastern Atlantic).—Gilbert, Report U.S. Comm. Fish. and Fisheries 1893, p. 465, 1896 (off California).—Jordan and Evermann, U.S. Nat. Mus. Bull. 47, pt. 1, p. 603, 1896 (Atlantic).—Gilbert and Cramer, Proc. U.S. Nat. Mus., vol. 19, p. 416, 1897 (Hawaiian Islands).—Alcock, A descriptive catalogue of the Indian deep-sea fishes in the Indian Museum . . ., Calcutta, p. 136, 1899 (off Malabar Coast in 912 to 931 fathoms).—Jordan and Snyder, Proc. U.S. Nat. Mus., vol. 23, p. 350, 1900 (off Hokkaido).—Jordan and Seale, Bull. U.S. Bur. Fish. 1905, vol. 25, p. 180, 1906 (Hawaii).—Brauer, Wissenschaftliche Ergebnisse der Deutschen Tiefsee-Expedition auf dem Dampfer *Valdivia*, 1898–1899 . . ., vol. 15, pt. 1, p. 115, figs. 56–63, 1906; pt. 2, p. 175, pl. 36, figs. 1–3, 1908 (Anatomy).—Richard, Bull.Inst. Oceanogr. Monaco, No. 162, p. 149, 1910 (from tuna stomach).—Zugmayer, Resultats des campagnes scientifiques accomplies par le Prince Albert I, Monaco, fasc. 35, p. 54, pl. 2, fig. 5, 1911 (North Atlantic).—Murry and Hjort, The depths of the ocean . . ., p. 612, 1912 (Atlantic.—Halkett, Checklist of the fishes of the Dominion of Canada and Newfoundland, Ottawa, pp. 16, 56, 1913 (off Newfoundland).—Holt and Byrne, Fish. Ireland Sci. Invest., No. 1, p. 23, fig. 9, 1913 (off Ireland, depth 600–900 fathoms).—Jordan, Tanaka, and Snyder, Journ. College Sci. Imper. Univ. Tokyo, vol. 33, art. 1, p. 52, 1913 (off Hokkaido).—Weber, Die Fische der Siboga Expedition, Leiden, vol. 57, p. 22, 1913 (East Indies, depth 828 to 2,477 meters).—Hoek, Cons. Perm. Internat. Expl. Mer. Pub. Circonst., No. 12, p. 53, 1914 (North of Europe).—Pappenheim, Die Fische der Deutschen Südpolar-Expedition 1901–1903, vol. 15, pt. 2, p. 183, 1914 (South Atlantic to lat. 23°33′ S.).—Weber and de Beaufort, The fishes of the Indo-Australian archipelago, vol. 2, p. 132, fig. 48, 1914 (East Indies).—Jespersen, Report on the Danish oceanographical expeditions to the Mediterrenean, 1908–1910, vol. 2, p. 28, 1915 (Central North Atlantic to lat. 42° N.).—Roule, Resultats des campagnes scientifiques accomplies par le Prince Albert I, Monaco, vol. 52, p. 24, 1919 (Azores).—Vaillant, Resultats des campagnes scientifiques accomplies par le Prince Albert I, Monaco, vol. 52, pp. 129, 144, 147, 149, 155, 1919 (Eastern Atlantic).—Jordan and Jordan, Mem. Carnegie Mus., vol. 10, No. 1, p. 9, 1922 (Hawaiian Islands).—Barnard, Ann. South African Mus., vol. 21, p. 154, 1925 (off Cape Point, South Africa).—Fowler, Mem. Bernice Pauahl Bishop Mus., vol. 10, p. 35, 1928 (Hawaiian Islands).—Beebe, Zoologica, New York, vol. 12, No. 1, pp. 4, 14, 1929 (Hudson Gorge off New York).—Roule and Angel, Resultats des campagnes scientifiques accomplies par le Prince Albert I, Monaco, fasc. 79, p. 34, pl. 2, figs. 39–48, 1930 (larvae, adults, Eastern Atlantic).—Borodin, Bull. Mus. Comp. Zool., vol. 72, No. 3, p. 68, 1931 (Central North Atlantic).—Roule and Angel, Resultats des campagnes scientifiques accomplies par le Prince Albert I, Monaco, fasc. 86, p. 80, 1933 (Atlantic).—Beebe, Bull. Inst. Oceanogr. Monaco, No. 629, pp. 4, 13, 14, 1933 (off Bermuda).—Roxas, Philippine Journ. Sci., vol. 55, No. 3, p. 287, 1934 (Philippines).—Fowler, Bull. Amer. Mus. Nat. Hist., vol. 70, pt. 1, p. 241, fig. 113, pt. 2, p. 1207, 1936.—Beebe, Zoologica, New York, vol. 22, pt. 3, p. 202, 1937 (off Bermuda, depth zero to 1,000 fathoms).—Norman, British, Australian, and New Zealand Antarctic Research Expedition, 1929–1931, vol. 1, No. 2, p. 83, 1937 (South Pacific to lat. 41°59′ S.).—Parr, Bull. Bingham Oceangr. Coll., vol. 3, No. 7, p. 57, 1937 (Western Atlantic north to lat. 32°24′ N.).—Fowler, Acad. Nat. Sci. Philadelphia, monogr. 2, p. 265, 1938 (off Hawaiian Islands).—Norman, John Murray Expedition, 1933–34, Scientific reports, vol. 7, No. 1, p. 20, 1939 (Arabian Sea, Zanzibar, Maldives).—Longley and Hildebrand, Pap. Tortugas Lab. Carnegie Inst. Washington, vol. 34, No. 535, p. 16, 1941 (off Tortugas).—Rey, Mem. Real Acad. Cienc. Exact. Fis. Nat. Madrid, vol. 11, p. 242, fig. 80, 1947 (Atlantic).—Noronha and Sarmento, Vertebrados da Madeira, ed. 2, Peixes, vol. 2, p. 141, 1948 (Madeira).—Nybelin, Göteborgs Vet. Vitterh. Samh. Handl., ser. B, vol. 5, No. 16, p. 25, 1948 (Eastern North Atlantic).—Maul, Lísta sistemática dos peixes assinalados nos mares da Madeira e indice alphabetica, p. 13, 1949; Mus. Mun. Funchal, No. 4, art. 9, p. 17, fig. 4, 1949 (Madeira).—Wilimovsky, Copeia, No. 3, p. 247, 1951 (correct spelling of generic name).—Koumans, Temminckia, Leiden, vol. 9, p. 186, 1953 (East Indies).—Mead and Taylor, Journ. Fish. Res. Board Canada, vol. 10, No. 8, p. 570, fig. 5, 1953 (off Iwate Prefecture, Japan).—Haig, Pacific Sci., vol. 9, p. 319, 1955 (off Hawaii).—Fowler, Fishes of the Red Sea and southern Arabia, Jerusalem, vol. 1, p. 86, 1956 (Arabian Sea).—Guenther and Deckert, Creatures of the deep sea, New York, pp. 29, 119, fig. 9, 1956 (off Bermuda).—Grey, Fieldiana, Zool., vol. 39, No. 29, p. 326, 1959 (Gulf of Mexico).

Sternoptyx obscura Carman, Mem. Mus. Comp. Zool., vol. 24, p. 232, pl. 53, fig. 1, 1899 (type locality, Eastern Pacific, lat. 0°36′ S. to 7°31′ N., long. 78°42′30″ to 89°3′30″ W., from 134 to 1,832 fathoms, lectotype USNM 177888; lectoparatypes USNM 120294, 177889, and 177933).—Lendenfeld, Mem. Mus. Comp. Zool., vol. 30, No. 2, p. 175, pl. 6, figs. 26–27, 1905 (light organs).—Beebe, The *Arcturus* adventure, New York, p. 396, frontispiece, fig. B, 1926 (off Galápagos).—Belanski *in* Vanderbilt, To Galápagos on the *Ara*, p. 131, 1927 (off Panama in Pacific).—Borodin, Bull. Vanderbilt Oceanogr. Mar. Mus., vol. 1, art. 1, p. 11, 1928 (lat. 10°14′ N., long. 90° W., Eastern Pacific Ocean).—Follett, Proc. California Acad. Sci., vol. 27, No. 16, p. 409, 1952 (off Pt. Reyes, California).—Harvey, Bioluminescence, New York, pp. 540, 541, fig. 184 (1) 1952.

STUDY MATERIAL: I have studied 1,229 specimens from the Eastern Pacific, 47 from the mid-Pacific, 14 from the Western Pacific, and 311 from the Western Atlantic. The largest specimen in the Atlantic measured was 46.5 mm from tip of snout to caudal fin base, taken at *Atlantis* station 2852, lat. 27°01′ N., long. 94°22′ W. at a depth of 1,152 meters. In the Pacific, one specimen (SIO55–249) taken at lat. 4°6′ N., long. 78°43′ W., at a depth from 0 to 730 fathoms, measured 42 mm.

Since so many specimens were studied, they are summarized below; the numbers of specimens are given in parentheses:

ANSP 71332(1).

BOC 2704(38), 2775(8), 2776(1), 2777(22), 2778(4), 2779(7), 2780(1), 2781(1), 2782(16), 2783(6), 2784(4), 2785(6), 2793(27), 2794(39); *Atlantis* stations (uncataloged) 1355(1), 1935(2), and 2852(2).

CNHM 45341(2), 45942(11), 46278(2), 59968–59970(3), 64349(1).

MCZ 25880, 2588A(2), 28122(1), 28124(1), 28533(4), 31632(2), 32294–32296(12), 35175(1), 35192(2), 37528(1), 37662(1), 38040(1), 38066(1), 39478(3), 39482(1); *Blake* station 306(1); *Atlantis* station 2947(6), 2996(1), 3308(1), 3473(1).

SIO 56–83(4), 57–43(3), 57–88(2), 55–221(60), 57–46(3), 57–207(5), 54–95(4), 55–246(58), 55–258(28), 54–123(3), 56–127(15), 56–133(22), 55–249(52), 54–83(2); H53–371(1), H52–309(1), H51–161(1), H53–307(1), H52–355(11), H51–399(5), H52–419(2), H51–397(2), H51–377(8), H53–356(1), H52–320(7), H50–277(4), H52–384(7), H52–82(1), H53–305A(2), H51–375(7), H51–161(4), H52–409(8), H52–404(4), H52–338(3).

SNHM 18476(8), 46437(9), 46526(2), 46528–46529(9), 46532(3), 46535–46541(183), 46543(6), 46549–46551(30), 46560(1), 46565–46568(35), 46570–46572(75), 46574–46578(51), 46580–46583(72), 46585–46586(17), 46588–46589(7), 46591–46592(12), 46594(3), 46596–46610(84), 46612(2), 46614(29), 46616(18), 46618(11), 46620(3), 46622(13), 46624(9), 46626(2), 46628(4), 46633–46639(49), 46643(129).

UMML 2484(1), 2750(3), 2752(1), 2753(1).

USFWS (Brunswick, Georgia) *Silver Bay* station 443(3); *Combat* station 290(1), 295–296(4), 301–303(21), 304–305(9), 312–313(12), 323–324(10).

USNM 26235(1), 32659(1), 33471(2), 33563(2), 44590(1), 53052(2), 57884(1), 84497(1), 89912(6), 100531(1), 103071(1), 103075(1), 104206(2), 104207(1), 117221(1), 120294(1), 131297(1), 131307(1), 135647(1), 135665(1), 135672(1), 135690(1), 148789(4), 148848(1), 150040(3), 150306(1), 150416(1), 150441(1), 151395(1), 158168(9), 161392(2), 161394–161396(3), 163492(1), 177888(1), 177889(1), 177933(1); *Albatross* station 2553(1), 3402(1), 4650(2); *Combat* station 452(3); *Oregon* station 1073(2), 1168(4), 1273(2), 1370(11), 1440(3); *Pelican* station 53(1), 58(1).

Description: Counts made are given in table 1, p. 591, and table 5, p. 617.

Range: The species is commonly taken at depths of from 100 to 1,000 fathoms in the Pacific, Atlantic, and Indian Oceans, but many records exceed 1,000 fathoms. Of SIO numbers H53–371, taken at lat. 32°8′ N., long. 142°4′ E., over the Japan Trench, one specimen was taken between the surface and 4,455 fathoms; of SIO H53–307 taken at lat. 39°34′–23′ N., long. 142°29.5′–51′ W., one specimen was taken between 2,500 and 2,700 fathoms, the latter record being also the most northerly latitude for the species in the Pacific. In the Atlantic the deepest records are for *Oregon* station 1273 at 1,600 fathoms and *Albatross* station 2101 (USNM 33563) at 1,686 fathoms. The most northerly record for the Atlantic is MCZ 37662 taken at lat. 42°46′ N., long. 63°22′ W.

Genus *Polyipnus* Günther

Polyipnus Günther, Report of the scientific results of the voyage of H.M.S. *Challenger* during 1873–76, vol. 22, p. 170, 1887 (type species *Polyipnus spinosus* Günther).—Haneda, Pacific Sci., vol. 6, No. 1, pp. 13–16, 1952 (light organs).

Acanthopolyipnus Fowler, Proc. Acad. Nat. Sci. Philadelphia, vol. 85, p. 257, 1934 (type species *Polyipnus fraseri* Fowler).

Species referable to the genus *Polyipnus* have the following characters in common: Abdominal vertebrae 11; caudal vertebrae 21 to 25; branched caudal fin rays 9+8; pectoral rays ii,10–ii,15; dorsal rays 11 to 17; anal rays 13 to 19; gill rakers on first gill arch 4 to 10+6 to 18.

The number of organs in groups of photophores are as follows: Abdominal 10, anal 4 to 17, branchiostegal 6, isthmus 6, lateral 1, preanal 5, preopercular 1, preorbital 1, postorbital 1, subcaudal 4, subopercular 1, supra-anal 3 when present, supra-abdominal 3, suprapectoral 3. For the location of the groups of photophores see figure 1, p. 588.

Premaxillary and maxillary finely denticulate teeth pointing outward and backward; dentition in both jaws in two or three rows; dorsal blade represented by a pair of small diverging bony keels ending in spines at front base of dorsal fin; posttemporal with one or more spines projecting posteriorly, and dorsal ridge of posttemporal may bear spines; bony preopercular edge may be spiny and a long or short spine occurs at posteroventral corner of preopercle; ventral edge of abdomen may be denticulate. In adults spiny ridges may develop around anal region and on ventral edge of caudal peduncle; a pair of diverging spines at pelvic bases; pectoral shield usually with ventral edge denticulate; teeth present on vomer and present or absent on palatines; the dorsal blade is reduced in this genus to five or six dorsal pterygiophores, the last one, just in front of dorsal fin base, projects as a paired spine. These pterygiophores are not fused into a projecting plate in this genus.

The various species of *Polyipnus* may be distinguished on the basis of counts of fin rays, gill rakers, and vertebrae and distribution and location of groups of photophores. Especially important are the posttemporal and preopercular spines, which have unique shapes and lengths for nearly every species in the genus.

Counts made for available species of *Polyipnus* are given in table 1, p. 591, and table 6, p. 636; measurements made are given in table 7, p. 638. An examination of the frequency distributions of the various counts indicate significant differences in numbers of vertebrae, gill rakers, and fin rays.

Four new species of *Polyipnus* are described as a result of borrowing specimens, one each from the Eastern Atlantic and Indian Oceans and two from Japan. By means of the key below, all known species of *Polyipnus* may be distinguished.

A. Fraser-Brunner (Ann. Mag. Nat. Hist., vol. 8, ser. 10, p. 218, 1931) recorded *Polyipnus laternatus* from the Atlantic, but he was not able to locate the three specimens on which he based his identification. They are probably actually *P. polli* (see p. 635).

Key to the Species of *Polyipnus*

1a. At anterior end of anal series of photophores occur three supraanal photophores located much above general line of anal organs; minute teeth present on vomer and palatines; posttemporal spine simple, smooth, and shorter than diameter of pupil.
  2a. Anal photophores 6 or 7; total dorsal rays 15. (Eastern Atlantic Ocean.) . . . . **polli**, new species
  2b. Anal photophores 8 to 13.
    3a. Anal photophores 10 to 13, rarely 10; posttemporal spine equal in length to width of last 4 to 7 anal photophores. (Western Atlantic Ocean.) . . . . **laternatus** Garman
    3b. Anal photophores 8 to 10.
      4a. Gill rakers on lower part of first arch 9 to 12, and total rakers 14 to 19; anal photophores 8 or 9; dorsal rays 11 or 12; anal rays 17 to 19. (Philippine Islands in the Pacific Ocean.). **triphanos** Schultz
      4b. Gill rakers total 19 to 24.
        5a. Dorsal rays 14 to 17; a broad wedge-shaped dark bar anterodorsally on body does not reach ventrally to midlengthwise axis of body; no white bar behind dark bar. (Western Atlantic Ocean and the Gulf of Mexico.) . . . . **asteroides** Schultz
        5b. Dorsal rays 12 or 13; a narrow wedge-shaped dark bar anterodorsally on body (behind head) that reaches to midlengthwise axis of body; a narrow white bar behind dark bar that reaches to middorsal line. (Japan, in the Western Pacific Ocean.) **matsubarai**, new species

1b. At anterior end of anal series of photophores, no light organ is located high above the general line of other organs as in 1a.; minute teeth present on vomer but absent on palatines.
  6a. Anal photophores four.
    7a. Posttemporal spine, long, strong and with two strong spines basally; posterior bony edges of both supracleithrum and preopercle serrated. (Philippine Islands, in the Pacific Ocean.) . . . . **fraseri** Fowler
    7b. Posttemporal spine, simple and very short; posterior bony edges of supracleithrum and preopercle smooth. (Japan, in the Pacific Ocean.) . . . . **japonicus,** new species
  6b. Anal photophores 10 to 17.
    8a. Gill rakers on first arch 4 or 5 + 6 to 8 totaling 10 to 12; posttemporal spine, long, slender, simple, its length greater than diameter of pupil; greatest depth of body about twice in standard length; space between anal and subcaudal groups of photophores shorter than width of 3 subcaudal organs. (Philippine Islands, in the Pacific Ocean.) . . . . **unispinus** Schultz
    8b. Number of gill rakers on first gill arch 6 to 10 + 12 to 18 totaling 18 to 28.
      9a. Posttemporal spine very short, strong, its length shorter than diameter of pupil.
        10a. Number of gill rakers on first arch total 21 to 24; width of subcaudal group of photophores into the distance between anal and subcaudal groups 1.0 to 1.5 times. (Hawaiian Islands, in the Pacific Ocean.) . . . . . **nuttingi** Gilbert
        10b. Number of gill rakers on first arch total 20; width of subcaudal group of photophores into the distance between anal and subcaudal groups 0.6 to 0.8 times. (Western Indian Ocean.) . . . . **indicus,** new species
      9b. Posttemporal spine long, slender, with one or two curved basal spines, the dorsal one the longest, always longer than diameter of pupil.
        11a. Anal photophores 13 to 17, rarely 13; anal rays 15 to 18; pectoral rays 12 to 15; length of posttemporal spine 5.0 to 6.9 times in greatest depth of body; number of caudal vertebrae usually 24, occasionally 23 and 25; caudal peduncle long and slender. (Western Pacific and Indian Oceans.) . . . . **tridentifer** McCulloch
        11b. Anal photophores 12 to 14, rarely 14; anal rays 14 to 17; pectoral rays 13 to 16; length of posttemporal spine 7.0 to 16.0 times in greatest depth of body; caudal vertebrae usually 23, occasionally 22 and 24; caudal peduncle short and deep. . . . . **spinosus** Günther
          12a. Total gill rakers on first arch 18 to 20. (Philippine Islands and Celebes Sea, Pacific Ocean.)
          spinosus spinosus Günther
          12b. Total gill rakers on first arch 22 to 28. (Japan, in the Pacific Ocean.) . **spinosus sterope** Jordan and Starks

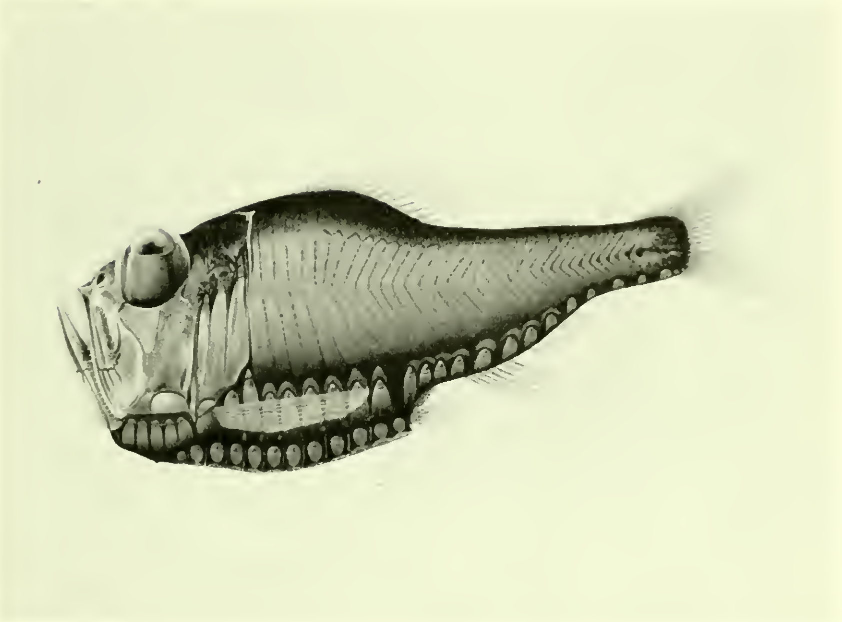


FIGURE 3.—*Argyropelecus affinis* Garman. After Brauer, 1906.

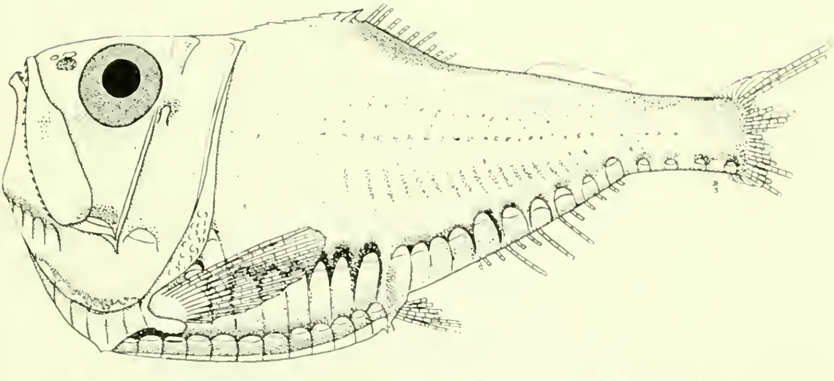


FIGURE 4.—*Argyropelecus pacificus*, new species. Holotype USNM 164000. Drawn by Dorothea B. Schultz.

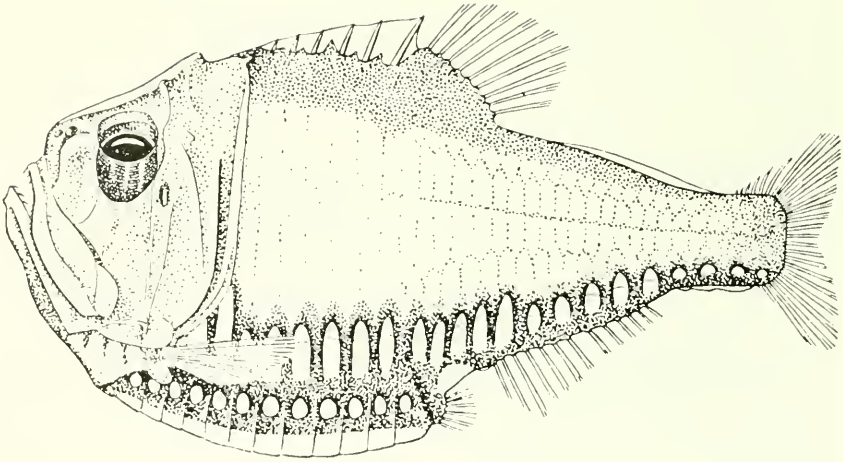


FIGURE 5.—*Argyropelecus gigas* Norman. After Norman, 1930.

FIGURE 6.—*Argyropelecus hemigymnus* Cocco. Drawn by Craig Phillips.

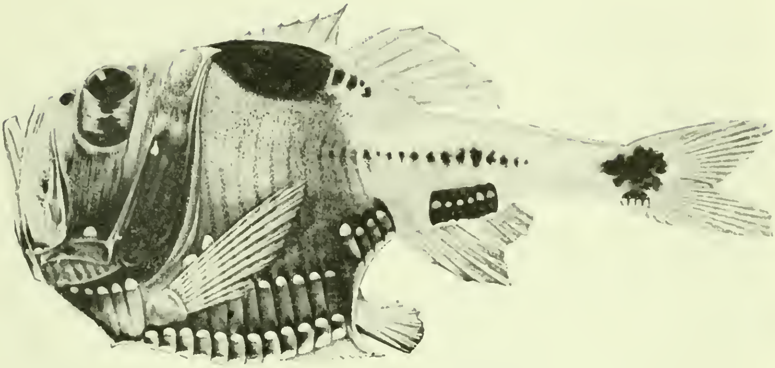


Figure 7.—*Argyropelecus intermedius* Clarke. After Gilbert, 1905, pl. 72.

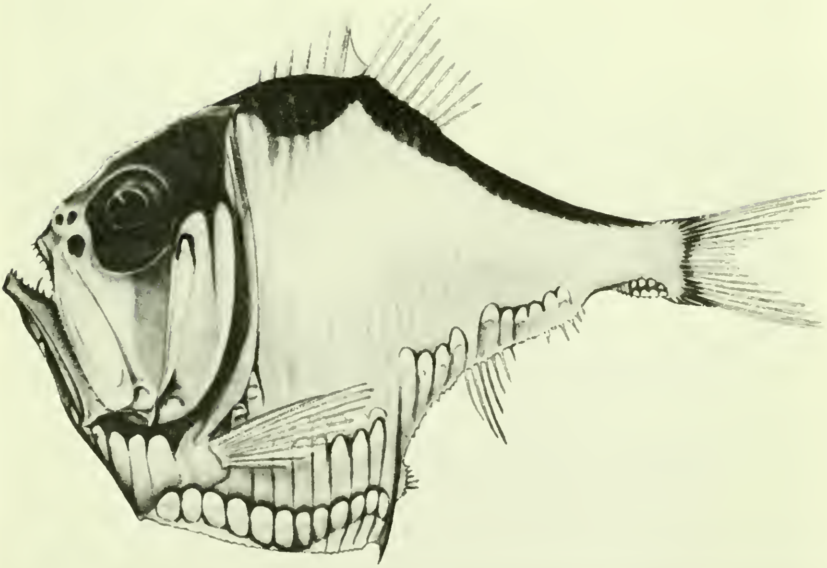


Figure 8.—*Argyropelecus amabilis* (Ogilby). After McCulloch, 1923.

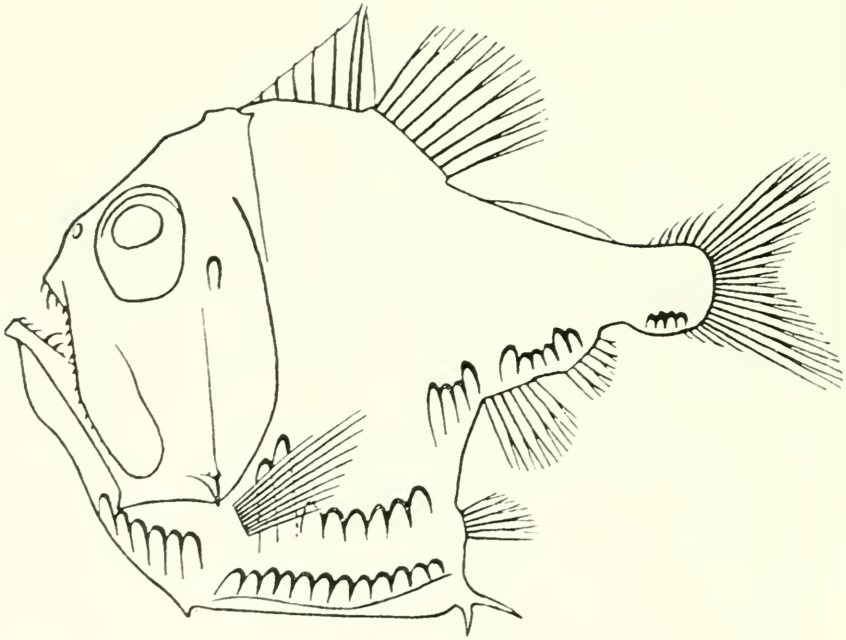


FIGURE 9.—*Argyropelecus aculeatus* Cuvier and Valenciennes. After Norman, 1930.

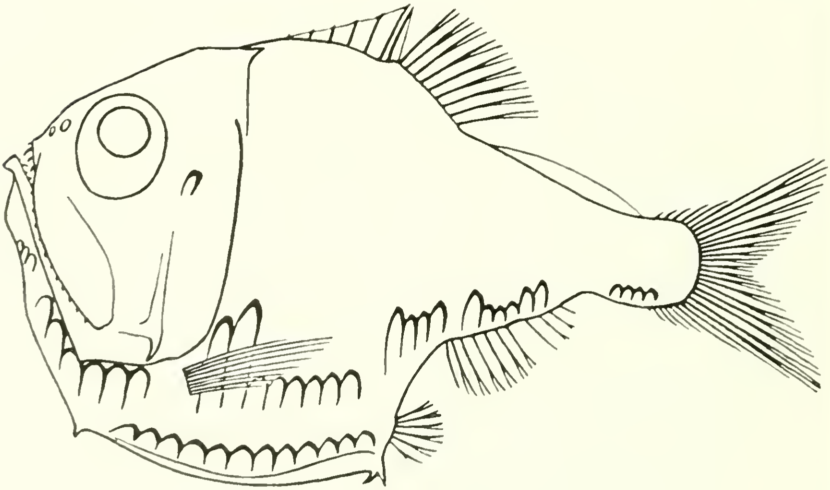


FIGURE 10.—*Argyropelecus olfersi* Cuvier. After Norman, 1930.

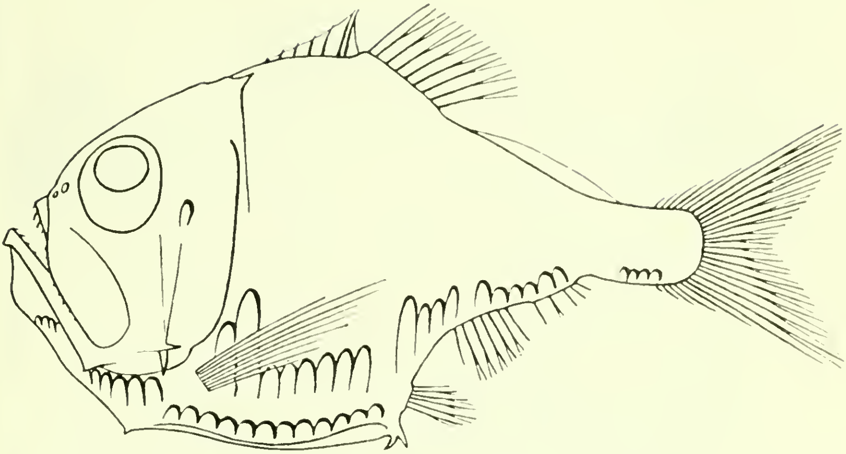


FIGURE 11.—*Argyropelecus lynchus lynchus* Garman. After Norman, 1930.

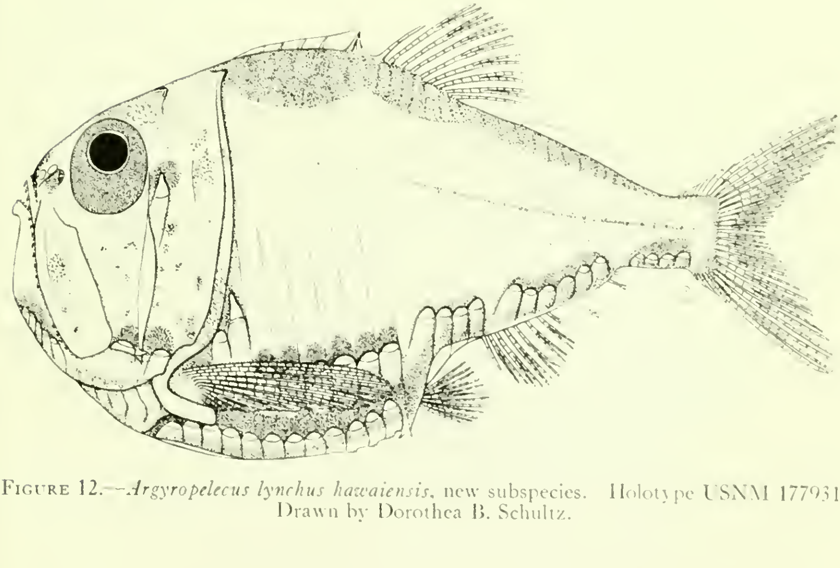


FIGURE 12.—*Argyropelecus lynchus hawaiensis*, new subspecies. Holotype USNM 177931. Drawn by Dorothea B. Schultz.

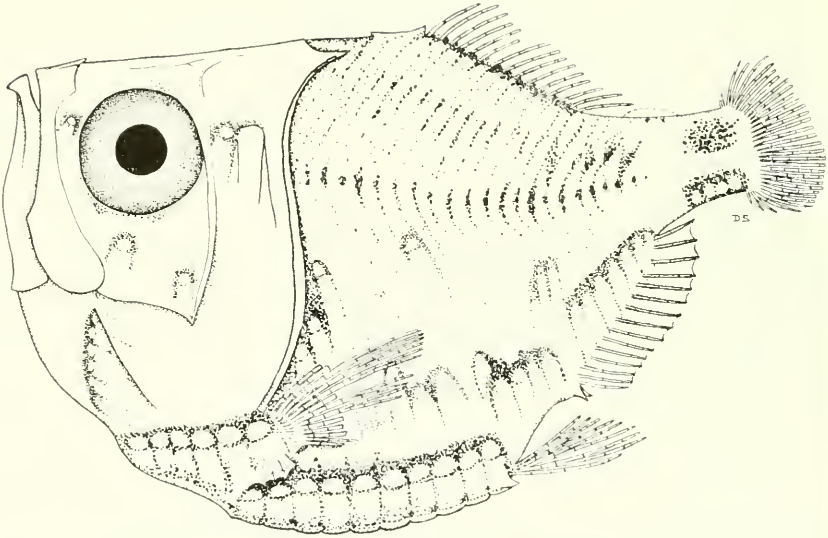


FIGURE 13.—*Polyipnus polli*, new species. Holotype KMMA 95092. Drawn by Dorothea B. Schultz.

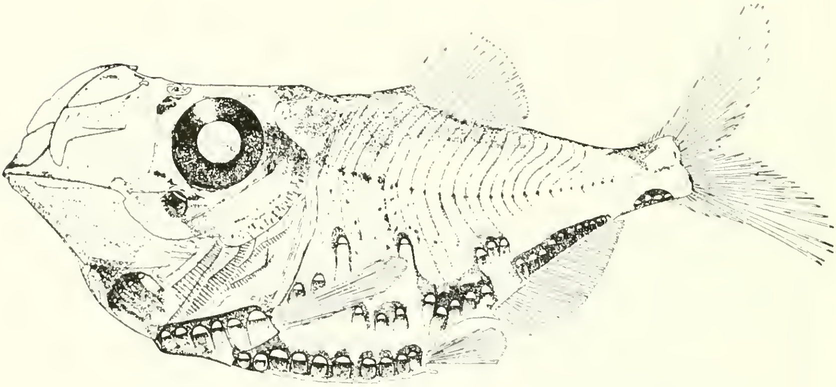


FIGURE 14.—*Polyipnus laternatus* Garman. After Parr, 1937.

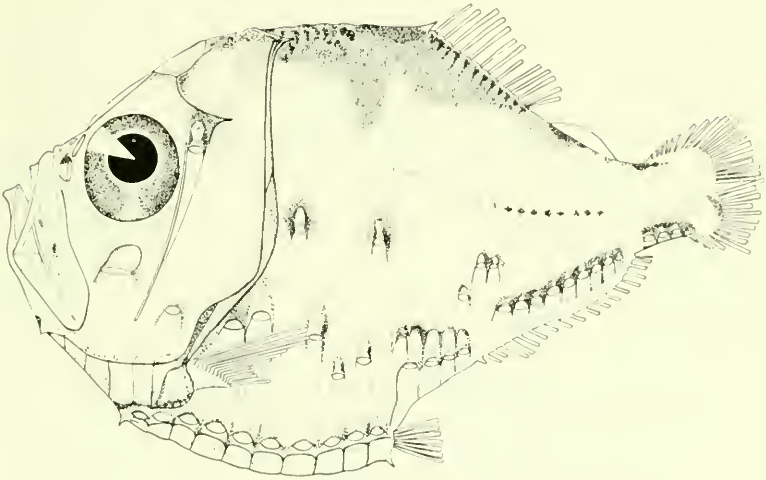


Figure 15.—*Polyipnus triphanos* Schultz. After Schultz, 1938.

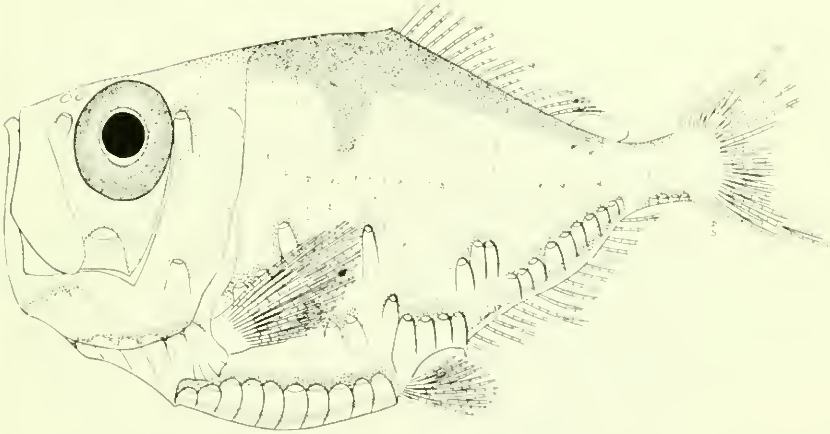


Figure 16.—*Polyipnus asteroides* Schultz. USNM 186020. Drawn by Dorothea B. Schultz.

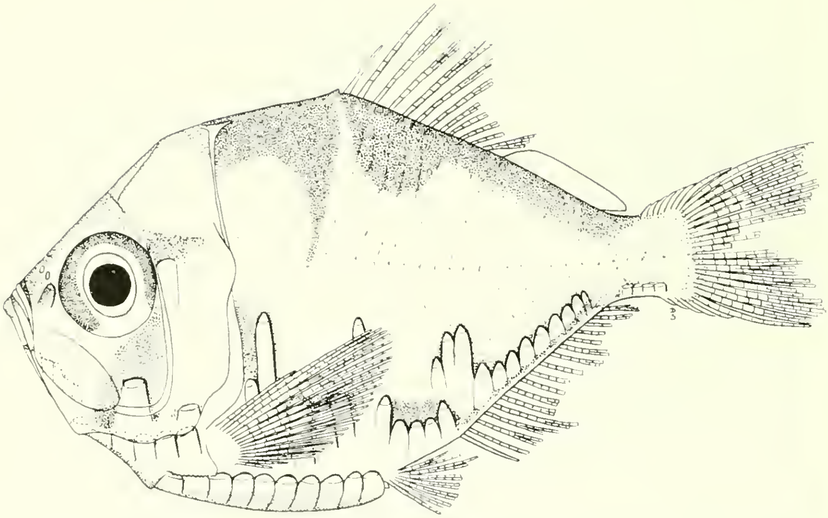


FIGURE 17.—*Polyipnus matsubarai*, new species. Holotype, USNM 179793. Drawn by Dorothea B. Schultz.

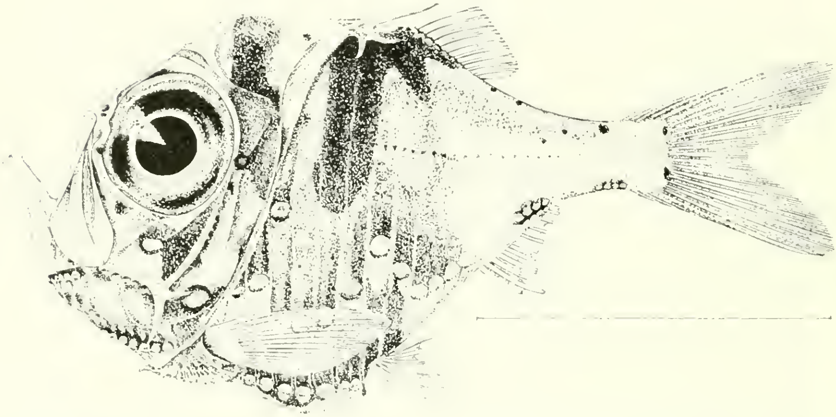


FIGURE 18.—*Polyipnus fraseri* Fowler. Retouched from holotype USNM 92324 by Dorothea B. Schultz.

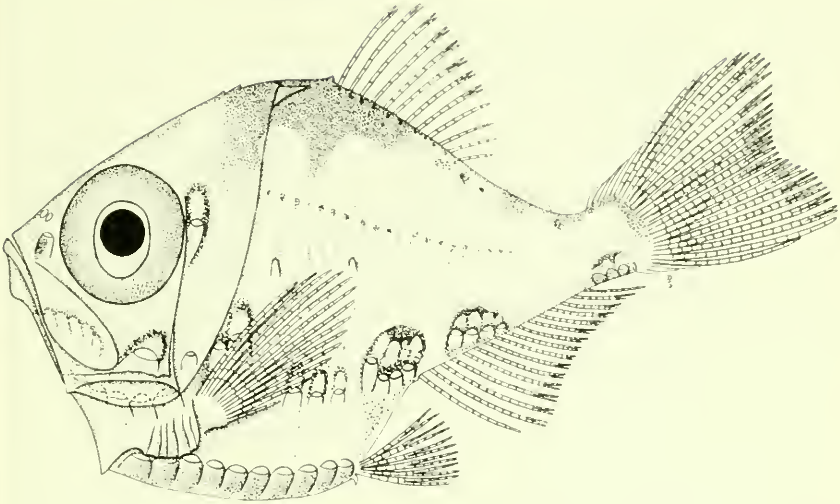


FIGURE 19.—*Polyipnus japonicus*, new species. Holotype, SIO H53-367. Drawn by Dorothea B. Schultz.

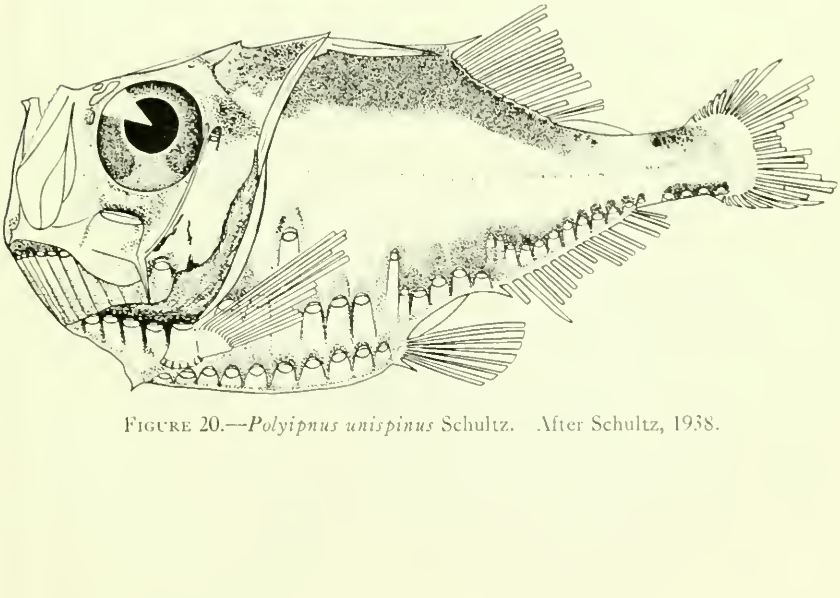


FIGURE 20.—*Polyipnus unispinus* Schultz. After Schultz, 1938.

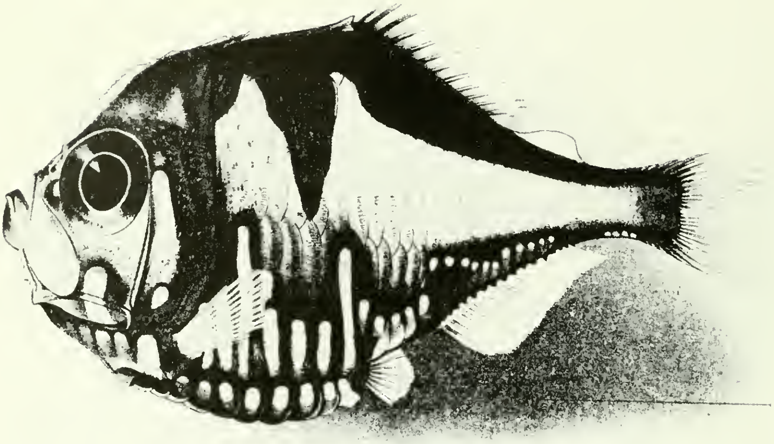


FIGURE 21.—*Polyipnus nuttingi* Gilbert. After Gilbert, 1905.

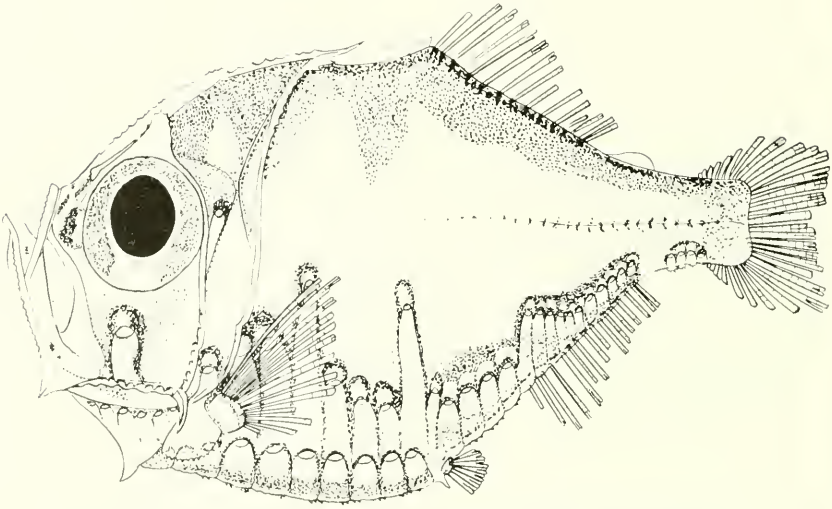


FIGURE 22.—*Polyipnus indicus*, new species. Holotype, BMNH 1939.5.24.403. Drawn by Craig Phillips.

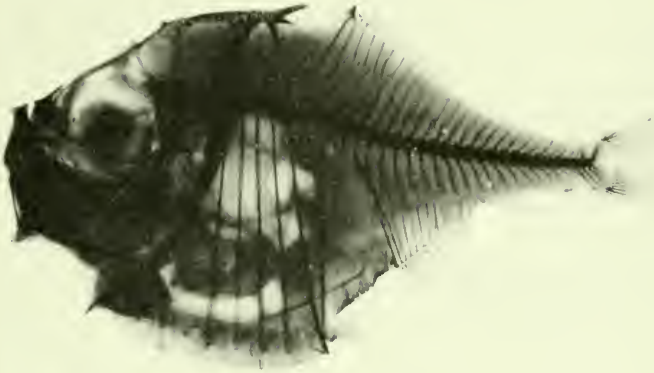


FIGURE 23.—*Polyipnus tridentifer* McCulloch. Radiograph of paratype No. E3543, of the Australian Museum

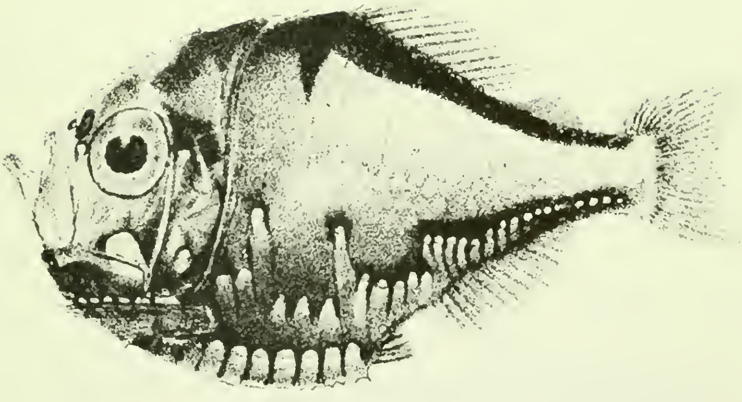


FIGURE 24.—*Polyipnus spinosus spinosus* Günther. After Günther, 1887.

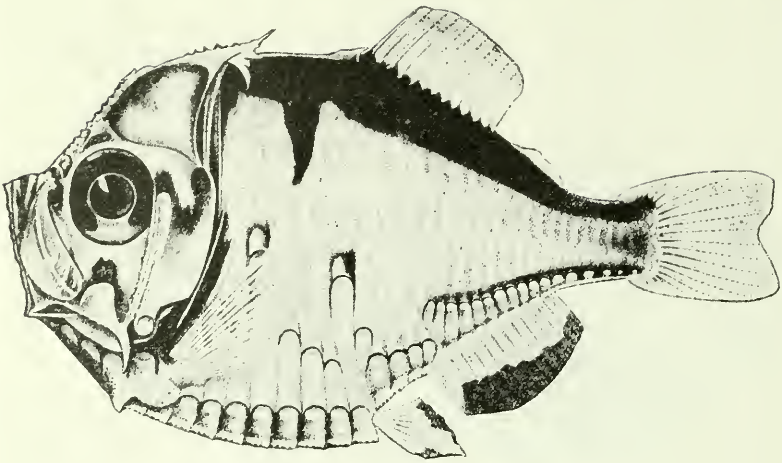


FIGURE 25.—*Polyipnus spinosus sterope* Jordan and Starks. After Jordan, Tanaka, and Snyder, 1913.

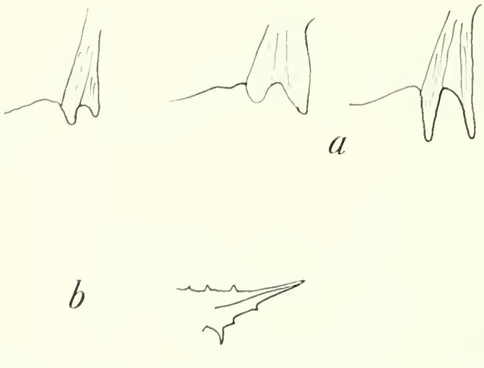


FIGURE 26.—*a*, Postabdominal spines of *Argyropelecus gigas* Norman, from sketch of Dr. N. B. Marshall of holotype and paratypes, in letter, January 21, 1958; *b*, posttemporal spine of holotype of *Polyipnus spinosus* Günther, from sketch of J. R. Norman, in letter, April 15, 1937.

Polyipnus polli, new species

FIGURE 13

Polyipnus laternatus (non Garman), Poll, Expédition océanographique Belge dans les eaux côtières Africaines de l'Altantique sud, 1948–1949, Resultats scientifiques, vol. 4, fasc. 2, Poissons, pt. 3, p. 65, fig. 27, 1953 (eastern South Atlantic off Angola).—Norman, *Discovery* reports, vol. 2, p. 305, ? fig. 14, 1930 (lat. 5°54′ N., long. 11°19′ E.; lat. 13°25′ N., long. 18°22′ W.).

HOLOTYPE: KMMA 95092, Eastern Atlantic Ocean, lat. 6°8′ S., long. 11°24′ E., depth 350 to 380 meters, standard length 22 mm.

PARATYPES: KMMA 95091, Eastern Atlantic Ocean. lat. 5°53′ S., long. 11°28′ E., depth 310 to 360 meters, 1 specimen, standard length 22.5 mm. USNM 179878, lat. 11°53′ S., long. 15°26′ E., depth 480 to 510 meters, Dec. 18, 1948, 1 specimen, 26 mm. IRSNB 8675, lat. 5°15′ S., long. 11°29′ E., depth 225 to 240 meters, 1 specimen about 17 mm., in poor condition. IRSNB 8687, lat. 8°28′ S., long. 12°54′ E., depth 310 meters, 1 specimen, about 21 mm., in very bad condition. IRSNB 8671, lat. 5°53′ S., long. 11°28′ E., depth 310 to 360 meters, 1 specimen, 17.7 mm.

DESCRIPTION: Measurements made on the holotype and paratype are given in table 7, p. 638; counts made are given in table 1, p. 591, and table 6, p. 636.

COLOR: The color pattern is shown in figure 13, p. 628.

RANGE: This species is known from the eastern South Atlantic off Anglo, Africa, at a depth of 225 to 510 meters.

REMARKS: This species is most closely related to *asteroides* and *laternatus*, both known from the Atlantic Ocean. It differs from them in having only seven anal photophores, a deeper body, and a deeper caudal peduncle, as is shown in the following tabulation:

	polli	*laternatus*	*asteroides*	*matsubarai*
Greatest depth of body in length of body without head	0. 9 to 1. 0	1. 1 to 1. 4	1. 1 to 1. 4	1. 1 to 1. 2
Width of group of anal photophores in greatest depth of body	4	3	3	2. 4 to 2. 8
Least depth of caudal peduncle in length of body without head	5. 3 to 6. 4	6. 5 to 7	6. 5 to 7	5. 8 to 6. 5

This species is distinguished in the key on p. 621 from all other known species in the genus. It is named *polli* in honor of my esteemed colleague, Dr. Max Poll, who loaned the specimens to me for study.

TABLE 6.—*Counts recorded for species and subspecies of* Polyipnus

Species and subspecies	Number of anal photophores														Total number of fin rays																		
															Dorsal							Anal							Pectoral				
	4	5	6	7	8	9	10	11	12	13	14	15	16	17	11	12	13	14	15	16	17	13	14	15	16	17	18	19	12	13	14	15	16
polli	—	—	2	4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5	—	—	—	—	1	3	—	—	—	—	3	2	—	—
laternatus	—	—	—	—	—	—	1	10	4	1	—	—	—	—	—	—	2	8	1	—	—	—	—	—	5	7	—	—	—	—	4	—	—
triphanos	—	—	—	—	1	3	—	—	—	—	—	—	—	—	2	2	—	—	—	—	—	—	—	—	—	2	1	1	—	2	2	—	—
asteroides	—	—	—	—	9	58	7	—	—	—	—	—	—	—	—	—	—	5	20	6	1	—	—	2	16	14	3	—	3	7	9	3	—
matsubarai	—	—	—	—	—	5	—	—	—	—	—	—	—	—	—	4	1	—	—	—	—	—	—	—	—	5	—	—	1	4	—	—	—
fraseri	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	1?	—	—	—	—	—	—	1	—	—
japonicus	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	1	—	—	—	—	1	—	—	—
unispinus	—	—	—	—	—	—	—	4	1	2	—	4	—	—	—	4	4	1	—	—	—	3	4	2	—	—	—	—	5	3	—	—	—
nuttingi	—	—	—	—	—	—	1	17	5	—	—	—	—	—	—	1	16	4	—	—	—	—	—	10	10	1	—	—	1	8	1	—	—
indicus	—	—	—	—	—	—	—	2	1	—	—	—	—	—	—	—	1	2	—	—	—	—	—	2	1	—	—	—	—	2	1	—	—
tridentifer																																	
Australia (cotypes)	—	—	—	—	—	—	—	—	—	—	1	4	2	3	—	—	7	3	—	—	—	—	—	—	4	4	2	—	2	4	2	—	—
Philippines	—	—	—	—	—	—	—	—	—	2	12	21	5	—	—	—	16	2	—	—	—	—	—	2	19	4	—	—	1	7	—	—	—
Japan	—	—	—	—	—	—	—	—	—	—	3	1	—	—	—	1	2	1	—	—	—	—	—	1	2	1	—	—	9	74	18	1	—
spinosus																																	
spinosus	—	—	—	—	—	—	—	—	3	14	2	—	—	—	—	1	15	4	1	—	—	—	2	11	5	4	—	—	—	6	5	1	—
sterope	—	—	—	—	—	—	—	—	1	3	—	—	—	—	—	—	4	—	—	—	—	—	—	2	2	—	—	—	—	6	14	14	1

Species and subspecies	Number of gill rakers on first arch																																						
	Above angle							Below angle													Total																		
	4	5	6	7	8	9	10	6	7	8	9	10	11	12	13	14	15	16	17	18	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
polli	—	—	—	2	2	—	—	—	—	—	—	—	—	—		3	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	1	1	—	—	—	—	—
laternatus	—	1	8	5	—	—	—	—	—	—	—	—	—	—	6	4	5	—	—	—	—	—	—	—	—	—	—	—	1	4	1	2	1	—	—	—	—	—	—
triphanos	—	5	—	1	—	—	—	—	—	—	1	1	3	1	—	—	—	—	—	—	—	—	—	—	1	1	4	—	—	1	—	—	—	—	—	—	—	—	—
asteroides	—	4	5	19	2	—	—	—	—	—	—	—	—	—	7	15	8	—	—	—	—	—	—	—	—	—	—	—	—	1	9	14	4	4	2	—	—	—	—
matsubarai	—	—	—	1	3	1	—	—	—	—	—	—	—	—		1	3	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	1	2	—	—	—	—
fraseri	—	—	—	1	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—
japonicus	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—
unispinus	7	1	—	—	—	—	—	1	5	2	—	—	—	—	—	—	—	—	—	—	1	4	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
nuttingi	—	—	—	16	8	—	—	—	—	—	—	—	—	—	—	4	16	4	—	—	—	—	—	—	—	—	—	—	—	—	—	2	8	11	3	—	—	—	—
indicus	—	—	—	3	—	—	—	—	—	—	—	—	—	—	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3	—	—	—	—	—	—	—	—
tridentifer																																							
Australia (co-types)	—	—	1	6	3	—	—	—	—	—	—	—	—	—	—	3	3	3	1	—	—	—	—	—	—	—	—	—	—	—	—	4	1	2	2	1	—	—	—
Philippines	—	—	—	11	1	—	—	—	—	—	—	—	—	3	3	1	2	—	—	—	—	—	—	—	—	—	—	—	—	1	3	1	1	1	—	—	—	—	—
Japan	—	—	—	—	4	—	—	—	—	—	—	—	—	—	—	—	1	2	1	—	—	—	—	—	—	—	—	—	—	—	2	18	36	31	12	1	—	—	—
spinosus																																							
spinosus	—	—	7	8	—	—	—	—	—	—	—	—	—	9	6	—	—	—	—	—	—	—	—	—	—	—	—	—	4	8	3	—	—	—	—	—	—	—	—
sterope [a]	—	—	—	—	—	4	2	—	—	—	—	—	—	—	—	—	—	2	2	2	—	—	—	—	—	—	—	—	—	—	—	—	1	6	8	11	5	6	3

[a] Some counts taken from literature.

Table 7.—*Measurements recorded for certain species of* Polyipnus, *expressed in thousandths of standard length*

Characters	*polli*		*matsubarai*					*japonicus*	*indicus*		
	Holotype	Paratype	Holotype	Paratypes				Holotype	Holotype	Paratypes	
Standard length in millimeters	22	22. 5	64	59	45	54	51. 5	12. 5	47	38. 2	46. 2
Greatest depth of body	659	644	610	576	600	580	611	664	630	618	639
Least depth of caudal peduncle	123	102	117	108	107	96	113	102	115	110	106
Length of caudal peduncle	127	107	131	136	156	135	169	168	138	160	145
Postorbital length of head	95	107	141	136	129	130	140	96	87	99	97
Length of posttemporal spine	45	41	30	41	36	28	39	16	75	94	87
Length of preopercular spine	23	31	19	17	16	13	27	40	43	42	43
Head	345	356	328	317	322	309	349	360	338	341	368
Snout	91	—	70	76	82	72	74	56	74	71	74
Eye	182	178	160	151	145	137	153	200	177	170	184
Tip of snout to rear of maxillary	318	—	241	227	222	222	237	240	255	257	282
Bony interorbital space	68	58	75	75	76	70	70	120	60	50	54
Tip of snout to dorsal origin	554	609	562	542	566	519	552	560	618	624	624
Length of dorsal fin base	232	240	227	254	225	235	240	192	234	238	249
Length of anal fin base	273	289	289	288	300	287	310	256	232	257	221
Occiput to dorsal origin	213	236	263	268	276	245	252	200	349	342	335
Distance between anal and subcaudal groups of photophores	59	62	47	54	71	56	62	152	51	37	39
Width of subcaudal group of photophores	55	49	58	68	82	61	70	80	62	58	63

Polyipnus laternatus **Garman**

Figure 14

Polyipnus laternatus Garman, Mem. Mus. Comp. Zool., vol. 24, pp. 238, 399, 1899 (off Barbados).—Parr, Bull. Bingham Oceanogr. Coll., vol. 3, art. 7, p. 55, fig. 22, 1937 (West Indies).—Schultz, Proc. U.S. Nat. Mus., vol. 86, pp. 142–143, 1938 (West Indies).

Polyipnus spinosus Brauer (in part), Wissenschaftliche Ergebnisse der Deutschen Tiefsee-Expedition auf dem Dampfer *Valdivia*, vol. 15, pt. 1, p. 121, 1906 (Atlantic Ocean).—Rivero, Proc. Boston Soc. Nat. Hist., vol. 41, No. 4, p. 56, 1936 (off Cuba).

Study material: Because of the large number of lots examined, they are summarized as follows:

Caribbean Sea 8 lots with 17 specimens; off Panama in Atlantic 1 lot, 2 specimens; off Hispaniola in Atlantic Ocean 2 lots, 2 specimens; Straits of Florida, off Cuba 10 lots, 17 specimens; off Puerto Rico 1 lot, 6 specimens; off Northern Florida in Atlantic Ocean 1 lot, 1 specimen; Western Atlantic Ocean 10 lots, 17 specimens.

Catalog numbers and number of specimens in parentheses are as follows:

BOC 3755(1) and 3756(1).

CNHM 64353(1), 64354(2), 64355(2), 64359(5), 64360(2), 64361(6), and 64362(2).

MCZ (*Atlantis* stations) 2956(1), 2960(1), 2981C(1), 2981D(2), 2985(1), 3387(1), 3404(2), 3405(3), 3425(4), and 3434(1).

UMML 2751(1).

USFWS (Brunswick, Georgia) *Combat* station 450(1).

USNM 157836(4).

Distinctive characters: This species is close to *asteroides*, both having three supra-anal photophores; however, *laternatus* has 10 to 13 anal photophores instead of 8 to 10, as *asteroides* has, and the posttemporal spine is longer in *laternatus*, its length equal to the width of the last 4 to 7 anal photophores. The last few anal photophores of *laternatus* are smaller than are those of *asteroides*.

Description: Counts made are given in table 1, p. 591, and table 6, p. 636.

Color: The color pattern is shown in figure 14, p. 628.

Range: This species has been taken in the western Atlantic Ocean in the West Indies, Caribbean Sea, off Barbados, Cuba, and the north coast of Hispaniola at depths of from 240 to 1,200 fathoms. I have not seen it from the Gulf of Mexico. Specimens observed were between 18 and 40 mm. in standard length.

Remarks: Records in the literature referring to *spinosus* from the Atlantic actually refer to *laternatus*, as I am unable to find authentic specimens of *spinosus* from the Atlantic.

Polyipnus triphanos Schultz

Figure 15

Polyipnus triphanos Schultz, Proc. U.S. Nat. Mus., vol. 86, p. 140, fig. 45, 1938 (Phillippines, holotype USNM 103027, and 2 paratypes 103028).

Study material: USNM 135519, Philippines, off Pescador Island, 295 fathoms, *Albatross* station 5190, April 1, 1908, 1 specimen, 33 mm. The three type specimens were examined.

Distinctive characters: Little, except number of vertebrae, can be added to my 1938 description of this species as only one additional specimen is available. It is distinguished by having 11 or 12 dorsal rays and 9 to 12 gill rakers on lower part of first arch, fewer than occur in other species with 3 supra-anal photophores.

Description: Counts made are given in table 1, p. 591, and table 6, p. 636.

Color: The color pattern is shown in figure 15, p. 629.

Range: Philippine Islands to a depth of 295 fathoms.

Polyipnus asteroides Schultz

Figure 16

Polyipnus asteriodes Schultz, Proc. U.S. Nat. Mus., vol. 86, p. 138, fig. 44, 1938 (West Indies and Gulf of Mexico).

Polyipnus laternatus Nichols and Breder, Proc. Biol. Soc. Washington, vol. 37, p. 21, 1924 (Gulf of Mexico).—Jespersen *in* Joubin, Faune ichthyologique de l'Atlantique nord, Paris, No. 15, fig., 1934 (on Norman, Atlantic).—Fowler, Bull. Amer. Mus. Nat. Hist., vol. 70, No. 2, p. 1206, 1936 (Atlantic).—Marshall, Aspects of deep-sea biology, New York, pp. 111, 277, middle fig. V, 15, 1954 (Atlantic).

Study material: Because of the large number of lots examined, they are summarized as follows:

Gulf of Mexico, 21 lots totaling 83 specimens; Caribbean Sea, 4 lots, 5 specimens; off Northern Florida in Atlantic Ocean, 2 lots, 3 specimens; Straits of Florida off Cuba, 3 lots, 18 specimens; off Puerto Rico, 4 lots, 25 specimens; Virgin Islands east of St. Croix, 1 lot, 2 specimens; off mouth of Orinoco River, 1 lot, 1 specimen; off British Guiana, 1 lot, 2 specimens; and Western Atlantic, 3 lots, 18 specimens.

Catalogue numbers and number of specimens in parentheses are as follows:

CNHM 45737(5), 46276(7), 46277(2), 64350(18), 64351(1), 64357(1), 64358(1), and 64368(3).

MCZ (*Atlantis* stations) 2981(1), 2982(2), and 3424(16).

UMML 1399(1), 1906(1), 2325(1), and 2331(2).

USFWS (Brunswick, Ga.) 3 lots, 4 specimens.

USNM 86131(1), 102978(4), 157901(15), 158080(2), 186016(5), 186017(3), 186018(1), 186019(4), 186020(4), 186022(5), 186023(1), 186024(1), 186025(2).

Distinctive characters: This species is best distinguished by having 3 supra-anal photophores in combination with 14 to 17 dorsal rays, 8 to 10 anal photophores, and a very short posttemporal spine, its length equal to width of only 1 or 2 anal photophores.

Description: Counts made are given in table 1, p. 591, and table 6, p. 636.

Color: The color pattern is shown in figure 16, p. 629.

Range: This species is known from the Western Atlantic Ocean, off the eastern coast of Florida, Gulf of Mexico, Caribbean Sea, off Nicaragua, off Costa Rica, off Puerto Rico, off British Guiana and Trinidad at depths of 200 to 600 fathoms. Specimens observed are from 19 to 71 mm. in standard length.

Remarks: Matsubara (Suisan Kenkiu-Shi, Japan, vol. 36, No. 1, p. 2, 1941; Japanese Journ. Ichthy., vol. 1, No. 3, p. 192, fig. 3, 1950) reported *P. asteroides* from Japan, but when I examined his specimens, collected at a later date, I found them to differ from *P. asteroides* of the Western Atlantic; therefore, the Japanese specimens represent a distinct species, described immediately below.

***Polyipnus matsubarai*, new species**

Figure 17

Polyipnus asteroides, Matsubara, Suisan Kenkiu-Shi, Japan, vol. 36, No. 1, p. 2, 1941 (near Kambara, Numazu Sizuoka Prefecture, Japan); Japanese Journ. Ichthy., vol. 1, No. 3, p. 192, figs. 3, 4B, 5B, 6, 1950 (Kambara, near Numazu).

Polyipnus stereope, Kuroda, Botany and Zoology, vol. 3, No. 4, p. 831, 1935 (Suruga Bay, Japan).—Oshima, Hattore Hôkokai Kenkiu Shôroku, No. 5, p. 283, 1938 (Sagami Bay).

Holotype: USNM 179793 collected by K. Suzuki at Kumanonada, Japan, standard length 64 mm.

Paratypes: Collected with holotype and bearing same data, 3 specimens, standard lengths 45 to 59 mm., deposited at Kyoto University, Maizuru, Japan. USNM 179794 collected with the holotype, standard length 51.5 mm.

Description: Measurements made on the holotype and four paratypes are given in table 7, p. 638; the counts made are given in table 1, p. 591, and table 6, p. 636.

Color: The color pattern is shown in figure 17, p. 630.

Range: This species has been found only in Japanese waters.

Remarks: This species is most closely related to *P. asteroides* in having about the same number of anal photophores, anal rays, and gill rakers, but differs in having only 12 or 13 total dorsal rays instead of the 14 to 17 that occur in *P. asteroides*. In addition the color pattern of *P. matsubarai* differs from that of *P. asteroides* in the wedge shaped dark bar a little behind the head being narrow and reaching ventrally to the midlengthwise axis of body, whereas in *P. asteroides* this wedge shaped bar is broad and reaches only halfway to the midlengthwise axis of body. Behind this dark bar a light or white inter-space reaches to the middorsal line on *P. matsubarai* but is absent on *P. asteroides.*

From the other related species *matsubarai* may be distinguished by use of the key to the species of *Polyipnus* on p. 621.

Dr. Tamotsu Iwai writes that all of the specimens used in Matsubara's 1941 and 1950 reports were destroyed by fire.

Since the accounts of Kuroda and of Oshima are in Japanese, Dr. Matsubara has kindly translated them for me, as follows:

Kuroda, N., 1935: On rare fishes contained in Suruga-Wan Marine Biological Laboratory. Botony and Zoology 3(4): 830–831.

Polyipnus stereope Jordan and Starks

Honen-eso (Japanese name) Sternoptychidae.

This is the famous luminous fish and the body is roundish in outline. It also is called Honen-uo. Several specimens.

Oshima, M., 1938: Preliminary report on the results of investigation of deep-sea fishes obtained from Suruga Bay. Hattori Hôkokai Kenkiu Shôroku, (5): 281–285.

Family Sternoptychidae

Polyipnus sterope Jordan and Starks, Honen-eso

Locality. Off Yaizu, Shizuoka, Pref., depth 100–200 m. The present species has been ascertained as the new species by Jordan and Starks based upon three specimens obtained from deep water of Sagami Bay. This species is very rare and generally is considered difficult to obtain. Only single specimens have been obtained together with luminous shrimps, but this is the new record from Suruga Bay.

Oshima misspelled *P. stereope* Jordan and Starks.

This new species is named *matsubarai* in honor of my esteemed colleague, Dr. Kiyomatsu Matsubara, who loaned the specimens for study.

Polyipnus fraseri **Fowler**

FIGURE 18

Polyipnus fraseri Fowler, Proc. Acad. Nat. Sci. Philadelphia, vol. 85, p. 257, fig. 19, 1934 (holotype USNM 92324, lat. 12°56′24″ N., long. 124°25′24″ E., *Albatross* station 5476, and not as published by Fowler).—Schultz, Proc. U.S. Nat. Mus., vol. 86, pp. 142, 145, 1938 (Philippines).

STUDY MATERIAL: Only known from the holotype.

DISTINCTIVE CHARACTERS: This species, along with *japonicus*, has only four anal photophores, fewer than occur in any other species in the genus. The posttemporal spine is long and strong, with two shorter but strong spines arising basally, and the posterior bony edges of both supracleithrum and preopercle are serrated.

DESCRIPTION: Counts made are given in table 1, p. 591, and table 6, p. 636.

COLOR: The color pattern is shown in figure 18, p. 630.

RANGE: This species is known from the Philippine Islands.

***Polyipnus japonicus*, new species**

FIGURE 19

HOLOTYPE: SIO H53-367, Kii Strait, Japan, Oct. 23–24, 1953, midwater trawl by *S. F. Baird*, standard length 12.5 mm.

DESCRIPTION: Measurements made on the holotype, the only known specimen, are given in table 7, p. 638; the counts made are given in table 6, p. 636.

COLOR: The color pattern is shown in figure 19, p. 631.

RANGE: This species is known only from Japan.

REMARKS: This species along with *P. fraseri* is characterized by having only four anal photophores, fewer than any other species of *Polyipnus*. *P. japonicus* is most closely related to *P. fraseri* but differs from that species as follows:

The posttemporal spine in *P. japonicus* is simple, very small, and without spines arising from its side or the base whereas the posttemporal spine in *fraseri* is long, strong, and has two strong basal spines; the posterior edge of both the supracleithrum and bony preopecle are serrated in *fraseri* whereas they are smooth in *japonicus*; the lower bony edge in both species is serrated. Although there are a few minor differences in body proportions between the two species, these might result from the great differences in size. The length of the posttemporal spine, however, is usually proportionately longer in small specimens of *Polyipnus* than in the larger specimens of the same species; hence, I conclude that the spine of *japonicus*, only 16 thousandths of the standard length, is significantly shorter than that of *fraseri*, which is 160 thousandths.

The first two pair of abdominal photophores in *fraseri* are out of line with the others, whereas in *japonicus* all abdominal photophores are in line, as is usual in *Polyipnus*. I presume the unusual arrangement of abdominal photophores in *fraseri* may be an abnormality.

Radiographs of this species did not show vertebrae clearly to enable me to make a count; therefore, this species is not included in table 1.

The species is named *japonicus* in reference to the region where the holotype was collected.

***Polyipnus unispinus* Schultz**

FIGURE 20

Polyipnus unispinus Schultz, Proc. U.S. Nat. Mus., vol. 86, p. 137, fig. 43, 1938 (Philippines).

STUDY MATERIAL: Holotype, USNM 103153, *Albatross* station 5451, lat. 13°22′22″ N., long. 124°00′48″ E., depth 380 fathoms, June 5, 1909, 20.5 mm. standard length. Paratypes, USNM 103029, same data as holotype, 5 specimens, 16 to 19 mm. Nontypes, USNM 135517, *Albatross* station 5287, lat. 13°37′40″ N., long. 120°39′ E., depth 379 fathoms, July 20, 1908, 5 specimens, 26 to 31 mm.

Distinctive characters: This species, without the group of supra-anal photophores but with 11 to 15 anal ones, has an unusually small number of gill rakers (a total of only 10 to 12 on the first arch); the posttemporal spine is long, slender, and simple and its length is always greater than the diameter of the pupil. The greatest depth is twice the standard length.

Description: Counts made are given in table 1, p. 591, and table 6, p. 636.

Color: The color pattern is shown in figure 20, p. 631.

Range: This species is known from the Philippines at a depth of about 380 fathoms.

***Polyipnus nuttingi* Gilbert**

Figure 21

Polyipnus nuttingi Gilbert *in* Jordan and Starks, Bull. U.S. Fish Comm. 1902, vol. 22, p. 581, 1904 (Hawaiian Islands).—Gilbert, Bull. U.S. Fish. Comm. 1903, vol. 23, pt. 2, p. 609, pl. 73, 1905 (Holotype USNM 51599, Hawaiian Islands).—Jordan and Seale, Bull. U.S. Bur. Fish. 1905, vol. 25, p. 180, 1906 (Hawaii).—Jordan, Proc. U.S. Nat. Mus., vol. 59, p. 646, 1921) Hilo, Hawaii).—Jordan and Jordan, Mem. Carnegie Mus., vol. 10, No. 1, p. 9, 1922 (Hawaiian Islands).—Fowler, Mem. Bernice Pauahl Bishop Mus., vol. 10, p. 35, 1928 (Hawaiian Islands); Acad. Nat. Sci. Philadelphia, monogr. No. 2, p. 265, 1938 (Hawaiian Islands).—Schultz, Proc. U.S. Nat. Mus., vol. 86, p. 145, 1938 (USNM 51693 not 51593 as published, see remarks below).—Fowler, Mem. Bernice Pauahl Bishop Mus., vol. 12, No. 2, p. 42, 1949 (Hawaiian Islands).—Böhlke, Stanford Ichthy. Bull., vol. 5, p. 17, 1953 (list of paratypes).—Haig, Pacific Sci., vol. 9, p. 319, 1955 (Hawaiian Islands).

Polyipnus spinosus (non Günther), Gilbert and Cramer, Proc. U.S. Nat. Mus., vol. 19, p. 416, 1897 (USNM 47720, Hawaii).

Study material: USNM 51599, Hawaiian Islands, Pailolo Channel between Molokai and Maui, 297 to 306 fathoms, *Albatross* station 4088. USNM 47720, Hawaiian Islands, lat. 21°09′ N., long. 157°53′ W., depth 298 fathoms, standard length 41 mm. USNM 177912, Hawaiian Islands, *Albatross* station 1902, 2 specimens, 58 and 60 mm. SNHM 8518 (paratypes), Hawaiian Islands, *Albatross* stations 3867, 4077, 4090, and 4121, 6 specimens, 37 to 71 mm.

Distinctive characters: This species lacks the group of supra-anal photophores and has a very short but strong posttemporal spine, its length shorter than the diameter of the pupil; the gill rakers on the first arch total 21 to 24, usually 22 or 23; anal photopores total 10 to 12, usually 11.

Description: Counts made are given in table 1, p. 591, and table 6, p. 636.

Color: The color pattern is shown in figure 21, p. 632.

Range: This species is known from the Hawaiian Islands; records in the literature from other areas are probably for other species.

Remarks: In 1938 I published USNM 51593 with *Albatross* station No. 4102, an error as far as *P. nuttingi* is concerned because futher investigation of USNM 51593 shows that this number belongs to a specimen of *Antigonia eos* and that the correct USNM number is actually 51693; this lot is labeled as cotypes of *P. nuttingi* in Gilbert's handwriting in the jar. No *Albatross* station number, however, was found in the jar, and now it appears that when the cotypes were returned from Stanford University, those from *Albatross* stations 3867, 3920, 4089, 4090, 4091, 4097, 4121, and 4134 were all placed in one package. To each specimen is attached a small paper tag with a number, perhaps corresponding to Gilbert's notes, which I have not seen. Later, 2 specimens from this lot were received from the University of Iowa, and 6 were sent on exchange to the Chicago Natural History Museum, a total of 29 specimens now being left.

***Polyipnus indicus*, new species**

Figure 22

Polyipnus nuttingi (non Gilbert), Norman, John Murray Expedition, 1933–34, Scientific reports, vol. 7, No. 1, p. 20, 1939 (Zanzibar Area).

Holotype: BMNH 1939.5.24.403, station 115, John Murray Expedition Zanzibar Area, depth 640 to 658 meters, standard length 47 mm.

Paratypes: BMNH 1939.5.24.404, same data as holotype, 1 specimen, 38.2. USNM 179897, same data as holotype, 1 specimen, 46.2 mm.

Description: Measurements made on the holotype and two paratypes are given in table 7, p. 638; counts made are given in table 1, p. 591, and table 6, p. 636.

Color: The color pattern is shown in figure 22, p. 632.

Range: This species is known only from the area off Zanzibar.

Remarks: This species is most closely related to *P. nuttingi* of the Hawaiian Islands region. It differs in having only 20 gill rakers, whereas *nuttingi* has from 21 to 24, usually 22 or 23. Furthermore, the distance between the anal and subcaudal groups of photophores is notably greater than the width of the subcaudal photophores in *nuttingi* but shorter in *indicus*, as is indicated in the following tabulation:

Width of subcaudal group of photophores divided into the distance between anal and subcaudal groups

	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5
nuttingi	—	—	—	—	1	1	—	4	—	2
indicus	2	—	1	—	—	—	—	—	—	—

Other differences may have significance too. The caudal peduncle is longer and more slender in *nuttingi*; its length is 160 to 213 thousandths of standard length, whereas in *indicus*, it ranges from 138 to 160. The posttemporal spine of *nuttingi* is shorter, 49 to 74 thousandths, whereas in *indicus* it is 75 to 94 thousandths. The distance from occiput to dorsal fin origin in *nuttingi* is 262 to 300 thousandths of standard length, whereas in *indicus* it is 335 to 349.

Polyipnus tridentifer McCulloch

FIGURES 1, 23

Polyipnus tridentifer McCulloch, Zoological (-biological) results of the fishing experiments carried out by the F.I.S. *Endeavour*, 1909–1910, vol. 2., pt. 3. pp. 78, 87–89, fig. 4, pt. 5, pl. 16, 1914 (Great Australian Bight, long. 129°28′ E., 350–450 fathoms).—Waite, The fishes of South Australia, Adelaide, p. 64, fig., 1923 (Great Australian Bight).—Barnard, Ann. South African Mus., vol. 21, pt. 1, p. 155, pl. 8, fig. 2, 1925 (Cape Morgan and Natal Coast, South Africa).—Whitley, A list of the fishes of Western Australia, Fisheries Dep., Western Australia, Fisheries Bull. No. 2, p. 11, 1948 (Australia).—Munro, Handbook of Australian fishes, No. 7, p. 31, fig. 220, 1957 (on McCulloch).

Polyipnus spinosus, Brauer (in part), Wissenschaftliche Ergebnisse der Deutschen Tiefsee-Expedition auf dem Dampfer *Valdivia*, 1898–1899 . . ., vol. 1, pt. 1, p. 121, figs. 64–66, 1906 (between Borneo and Philippines, Andaman Sea, Sumatra); pt. 2, p. 30, pl. 24, figs. 9–15, 1908 (anatomy).—Fowler, Bull. Amer. Mus. Hist., vol. 70, pt. 1, p. 240, fig. 112, 1934 (on Brauer and on Weber and Beaufort).—Schultz (in part), Proc. U.S. Nat. Mus., vol. 86, pp. 143–144, 1938 (Philippines, Moluccas, Celebes Sea, China Sea, Japan).—Matsubara, Suisan Kenkiu-Shi, Japan, vol. 36, No. 1, p. 2, 1941 (Japan); Japanese Journ. Ichthy. vol. 1, No. 3, p. 188, fig. 2, 1950 (Japan).—Okada and Suzuki, Pacific Sci., vol. 10, pp. 296–302, figs. 1–7, 1956 (Japan).

STUDY MATERIAL: The following specimens (all USNM catalog numbers with the number of specimens given in parentheses) were examined:

Andaman Sea: 44429(1).
Celebes Sea: 103041(1), 103055(1), 103056(2), 103057(1).
China Sea: 135523(4) and 135526(17).
Japan: 102980(2), 102982(2), and 149520(1).
Moluccas: 135537(17).
Philippine Islands: 103033(1), 103034(1), 103035(1), 103036(2), 103039(1), 103040(1), 103042(1), 103043(11), 103044(1), 103045(1), 103046(3), 103047(1), 103048(1), 103049(1), 103050(1), 103051(3), 103054(1), 135514(4), 135515(17), 135518(1), 135521(3), 135524(5), 135525(1), 135527(4), 135528(11), 135529(81), 135530(75), 135531(17), 135532(6), 135533(1), 135534(8), 135535(38), 135536(18).

Through the courtesy of Dr. Gilbert Whitley and J. W. Evans, The Australian Museum, Sydney, I have examined 10 of the cotypes of *Polyipnus tridentifer* McCulloch, Australian Museum No. E.3543, one of which is 72 mm. standard length and is selected as the lectotype. Although these cotypes differ slightly from specimens taken in the

Philippines and Japan, the differences observed do not appear great enough to consider them as more than somewhat distinct populations. This problem needs more material before a detailed study can be undertaken.

DISTINCTIVE CHARACTERS: This species lacks the group of supra-anal photophores; the posttemporal spine is long and slender and has 1 or 2 curved smaller basal spines; the dorsally located spine is always longer than diameter of the pupil; the anal photophores total 13 to 17, rarely 13; and the caudal vertebrae usually total 24.

DESCRIPTION: Detailed measurements were made on 10 of the cotypes of *P. tridentifer*, kindly sent for my examination by the Australian Museum. The minimum and maximum range of these data are expressed in thousandths of the standard length. Standard lengths range from 40.3 to 73 mm.; greatest depth 592 to 682; least depth caudal peduncle 89 to 104; length of caudal peduncle between vertical lines through rear of anal base and base of midcaudal fin rays 159 to 191; length of postorbital spine 80 to 174 (this spine proportionately longer in small specimens than in larger ones); length of preopercular spine 46 to 84; length of head 318 to 362; diameter of eye 161 to 183; length from snout tip to rear of maxillary 236 to 268; width of bony interorbital 70 to 83; snout tip to dorsal origin 550 to 600; occiput to dorsal origin 277 to 320; length of dorsal fin base 164 to 239; length of anal fin base 233 to 283; distance between anal and caudal groups of photophores 4 to 10; width of group of caudal photophores.

Counts made are given in table 1, p. 591, and table 6, p. 636.

RANGE: This species has been recorded from the Great Australian Bight, Moluccas, Andaman Sea, Celebes Sea, Philippines, China Sea, Japan and off Cape Morgan and Natal, and South Africa at depths of from 37 to 450 fathoms; however, it has been taken most frequently at depths of from about 100 to 300 fathoms.

Polyipnus spinosus spinosus Günther

FIGURES 24, 26*b*

Polyipnus spinosus Günther, Report of the scientific results of the voyage of H.M.S. *Challenger* during 1873–76, vol. 22, p. 170, pl. 51B, 1887 (type locality, between Philippine Islands and Borneo, station 200, depth 250 fathoms).—Alcock, Ann. Mag. Nat. Hist. ser. 6, vol. 4, p. 398, 1889 (Bay of Bengal, on Günther).—Wood-Mason and Alcock, Ann. Mag. Nat. Hist. ser. 6, vol. 8, p. 126, 1891 (Bay of Bengal).—Alcock, Journ. Asiatic Soc. Bengal vol. 65, pt. 2, p. 331, 1896 (off Andaman Islands); A descriptive catalogue of the Indian deep-sea fishes in the Indian Museum . . . , Calcutta, p. 138, 1889 (on Günther).—Weber, Die Fische der Siboga-Expedition, Lieden, vol. 57, p. 21, 1913 (East Indies).—Weber and Beaufort, The fishes of the Indo-Australian archipelago, vol. 2, p. 130, fig. 47, 1913 (East Indies).

—Roxas, Philippine Jour. Sci., vol. 55, No. 3, p. 286, 1934 (on Günther). —Schultz (in part), Proc. U.S. Nat. Mus., vol. 86, pp. 142–144, 1938 (Philippines and Celebes Sea).—Smith, The sea fishes of southern Africa, p. 106, fig. 159, 1949 (Natal to the Cape).—Harvey, Bioluminescence, New York, pp. 512, 540, 542, 1952 (light organs).—Koumans, Temminckia, Lieden, vol. 9, p. 185, 1953 (lat. 8°39′ S., 130°35′ E.).

Study material: The following specimens (all in USNM) were examined:

Flores Sea: 103059(1).
Moluccas: 103058(2) and 135522(2).
Philippine Islands: 103037(1), 103038(1), 103052(2), 103053(1), 135516(1), 135520(3), 177892(1), 177893(2), 177894(1).

Description: Counts made are given in table 1, p. 591, and table 6, p. 636.

Color: The color pattern is shown in figure 24, p. 633.

Range: This species is known from the Philippines, Celebes Sea, Flores Sea, Moluccas, East Indies, Andaman Islands, Bay of Bengal, and off Natal to Cape of Good Hope at a depth of from 100 to 303 fathoms.

Remarks: There has been much confusion concerning the actual speciation and nomenclature of the *Polyipnus spinosus* complex (Schultz, 1938; pp. 141–145; and Okada and Suzuki, Pacific Sci., vol. 10, pp. 296–302, 1956). The latter authors have presented a clear case that two distinct species of *Polyipnus* occur in Japanese waters. These two species may be distinguished by one having a more robust body behind dorsal fin and a deeper caudal peduncle, more gill rakers, and more pectoral fin rays. This species is called by them *P. stereope*, whereas the other is referred to as *P. spinosus*.

In the U.S. National Museum I have studied this complex of species again and now have a much larger series and more experience to call on than in 1938. I find that Okada and Suzuki are correct in that two species do occur in Japanese waters, but they have incorrectly applied the nomenclature. A study of Günther's drawing of the holotype of *P. spinosus* indicates a species with a robust caudal peduncle and only 13 anal photophores. These two characters are present in all specimens from the Philippines having a short posttemporal spine like that illustrated for the type of *P. spinosus* by the late J. R. Norman and sent to me in a letter dated April 15, 1937, and herein reproduced as figure 26*b*, p. 634.

In studying the types of *P. stereope* Jordan and Starks, however, I find they too have a robust body, robust caudal peduncle, and only 13 anal photophores, along with a relatively short posttemporal spine. Thus, *P. stereope* and *P. spinosus* form a species complex and, by means of data presented by Okada and Suzuki along with additional data from specimens in the U.S. National Museum, I am able to distinguish two subspecies: *P. spinosus spinosus* of the Philippines and Celebes Sea and *P. spinosus stereope* of Japan; see also table 6, p. 636, which gives counts for these two subspecies.

This leaves the other species in the complex, the one with a slender caudal peduncle and longer, more slender posttemporal spine, which was thought to be *P. spinosus* by Okada and Suzuki, but which is not that species.

McCulloch (Zoological (-biological) results of the fishing experiments carried out by the F.I.S. *Endeavour*, 1909–1910, vol. 2, pt. 3, pp. 78, 87–89, fig. 4, pt. 5, pl. 16, 1914) described *P. tridentifer* from off southern Australia. That species has a more slender caudal peduncle, 13 to 17 anal photophores, 15 to 18 anal rays, and 12 to 15 pectoral rays. These characters are close to those of our large series of specimens from the Philippines and Celebes Sea and must be considered as the *P. tridentifer* complex. In table 6, the specimens from Japan and the Philippines appear not to differ from the Australian *tridentifer* sufficiently to indicate subspecific populations.

The characters recorded by Okada and Suzuki (Pacific Sci., vol. 10, pp. 298–301, 1956) for their nominal species *P. spinosus*, such as 20 to 25 gill rakers, 12 to 14 pectoral rays, a more slender caudal peduncle, a long slender posttemporal spine, definitely are characters that identify their *P. spinosus* as actually *P. tridentifer*.

Polyipnus spinosus stereope Jordan and Starks

FIGURE 25

Polyipnus stereope Jordan and Starks, Bull. U.S. Fish Comm. 1902, vol. 22, p. 581, 1904 (Sagami Bay, Japan, holotype USNM 51451, and paratype 177895).—Jordan, Tanaka and, Snyder, Journ. College Sci. Imp. Univ. Tokyo, vol. 23, art. 1, p. 52, fig. 30, 1913 (Sagami Sea).—Haneda, Pacific Sci., vol. 6, No. 1, pp. 13–16, 1952 (Japan).—Okada and Suzuki, Pacific Sci., vol. 10, pp. 296–302, figs. 1–7, 1956 (Japan).

Polyipnus spinosus, Schultz (in part), Proc. U.S. Nat. Mus., vol. 86, pp. 143–144, 1938 (Japan).—Kamohara, Reports Kochi Univ. Nat. Sci., No. 3, p. 17, 1952 (Tosa Providence, Japan).

STUDY MATERIAL: USNM 51451 (holotype), off Manazuru Zaki, Honshu Island, Japan, *Albatross* station 3698, depth 153 fathoms. USNM 102981, *Albatross* station 4913, lat. 31°39′10″ N., long. 129°22′30″ E., off Japan, 2 specimens, 37 and 43 mm. SNHM 8392, 1 specimen, 42 mm.

DISTINCTIVE CHARACTERS: This subspecies is distinguished from *spinosus spinosus* in the discussion of the latter beginning on p. 648.

COLOR: The color pattern is shown in figure 25, p. 634.

DESCRIPTION: Counts made are given in table 1, p. 591, and table 6, p. 636.

RANGE: This species is known from Japan between depths of from 153 to 391 fathoms.

U. S. GOVERNMENT PRINTING OFFICE: 1961

INDEX

(New genera, species, etc., are printed in *italics*. Page numbers of principal entries also in *italics*.)