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Frank A. Taylor
Director, United States National Museum

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Proceedings of the United States National Museum

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REVIEW OF SOUTH AMERICAN CHARACID FISHES OF SUBTRIBE NANNOSTOMINA [1]

By Stanley H. Weitzman
Associate Curator, Division of Fishes

Introduction

Fishes of the subtribe Nannostomina, family Characidae, form a clearly definable group of about nine small South American freshwater fishes. No member is known over 44.5 mm. in standard length. They appear restricted in habitat to shaded forest brooks, seepages, and ponds, and are apparently confined to the Guianas, Río Orinoco in Venezuela, and the Amazon Basin of Brazil, Peru, Colombia, and Bolivia. All of the known species have been imported into Europe or North America as aquarium fishes. In the aquarium trade they are known as pencil fishes.

The osteology and relationships of these fishes have been treated elsewhere (Weitzman 1964), and their intercharacid relationships will be but briefly mentioned here. They are members of the characid subfamily Lebiasininae, which consists of two tribes, the Lebiasinini and the Pyrrhulinini. The Pyrrhulinini comprises two subtribes, the Pyrrhulinina and the Nannostomina. The Nannostomina appears to be the most specialized group within the Lebiasininae.

[1] This paper is the third and final of three parts based on a Ph. D. dissertation submitted at Stanford University, Calif. See Weitzman (1962, 1964) for the two preceding parts.

The Lebiasinini and Pyrrhulinina are small to moderate-sized, predaceous characids with moderate-sized mouths. The tiny mouths of members of the Nannostomina, however, are adapted for feeding on very small organisms. They apparently feed primarily on animals that occur on plants, rocks, and other objects and also to some extent on slowly moving, free-swimming organisms.

Wickler (1957) has described the breeding behavior of certain of these fishes in a preliminary fashion, and there is a very large amount of literature on this subject published by aquarists. However, even though they are excellent aquarium subjects, no detailed behavioral study has been published about them. A breeding pair enters a group of fine-leaved plants or a clump of roots, the male presses its body against that of the female, curves its anal fin around the female's vent, and the female sheds one to a very few eggs. The structure of the male's anal fin in several species is modified for aiding fertilization by guiding sperm over the female's vent. At this time the male sheds an undetermined number of sperm and fertilizes the eggs. The eggs are very slightly adhesive and may become attached to plants or fall to the bottom. All the species that I have seen alive (all but *Nannostomus digrammus* and *Nannostomus bifasciatus*) lay eggs of about 0.6 to 0.7 mm. The young mature in 8 to 10 weeks and specimens may live for as long as 4 years. Their lifespan in aquaria is usually 2 or 3 years.

Since most of Nannostomina can be bred with relative ease, they would make fine subjects for comparative ethological studies. It would be interesting to compare the taxonomic implications of such studies with those derived from the morphological investigation presented here.

The spotty locality records of the Nannostomina, the frequent damaged condition of the specimens, and the paucity of specimens from many localities have precluded satisfactory use of statistical procedures in analyzing geographical population differences or in recording changes in body proportions correlated with growth. Collectors frequently have packed these small, delicate fishes with specimens of other, larger species with the result that the nannostominans have been squashed out of shape, making valid measurements impossible. Only specimens in reasonably good condition were measured. For this reason, counts should be considered more reliable than measurements in the data presented below. The data available indicate in several instances that many geographically distinct populations of these fishes probably exist. Some of these differences are pointed out in the discussion under each species. It would be foolish to designate these different population samples as subspecies in view of the inadequate number of specimens and data at hand. The primary function served by this paper is to point out our present state of knowledge concerning these fishes and to indicate problems for future study.

Counts and measurements were taken from the left side of each specimen. In the descriptions the initial values are the arithmetical means, and the values included in parentheses are the extremes of all specimens cited in the material examined. Measurements were taken from adult specimens only.

The following straight-line measurements were made from the anteriormost part of the fleshy tip of the upper jaw to some point posterior on the body surface. Standard length (SL) was measured to the posterior end of the hypural fan. Predorsal length was measured to the anterior base of the first dorsal fin ray. Preanal length was taken to the anterior base of the most anterior, visible anal fin ray. Head length was measured to the most posterior border of the opercular bone, not the fleshy flap which was often damaged.

Eye length is the greatest distance between the posterior border of the first infraorbital and the anterior border of the fifth infraorbital bone. Depth was measured from the anterior dorsal fin base vertically to the median profile of the belly. Least depth of caudal peduncle was measured vertically. Length of caudal peduncle was measured from the posterior base of the last anal fin ray to the posterior end of the hypural fan. Interorbital width is the least width between the lateral supraorbital borders of the frontal bones.

Vertebral counts were taken from radiographs and include the vertebrae forming the pars sustentaculum of the Weberian apparatus and the ultimate vertebra with its urostyle.

Fin counts: The ultimate (posterior) ray of the dorsal and anal fins was counted as one when one ray was associated with the last pterygiophore and as two when there were two entirely separate rays associated with the last pterygiophore. Counts were least variable when this method was employed. All anterior rudiments of fin rays were counted. Unbranched rays (except the most posterior ray of the dorsal, anal, pectoral, or pelvic fins) are designated by lowercase roman and branched rays by Arabic numerals. The principal caudal fin ray count includes all rays associated with the hypural elements and may be taken without recourse to examining the hypural fan by counting all branched rays and adding two. The count of the upper lobe is given first, followed by a bar (/) and then the count of the rays of the lower caudal lobe.

Gill-raker counts in these small fishes can be made most accurately on alizarin-stained specimens and all such counts were confined to such specimens. The counts are of the bony supports of gill rakers. Scale counts in a lateral series refer to all scales in a median lateral series extending to the posterior midbase of the hypural fan. Vertical scale rows are counted between the anterior parts of the dorsal and anal fin bases.

Although the Nannostomina as a whole are easily definable and the species readily separable, their segregation into generic groups having a clear phylogenetic basis has not proven easy. However, some indication of their possible phylogenetic history is provided by their morphology, and morphological definitions of two generic groups is possible. Of the characters that seem to have generic and specific significance, the following appear to be most important.

Anal fin: The anal fin of males of this subtribe is used as an accessory sexual organ to guide the sperm toward the female's vent. During the spawning act, the anterior, posterior, and distal parts of the fin are cupped to form a bowl that partially covers the female's vent, apparently directing the sperm toward the eggs as they are laid. Correlated with this function is a previously overlooked morphological fact. The individual anal fin rays of the males of several species are widened in the sagittal plane (figs. 4 and 6). This modification is also found to a certain extent in some members of the subtribe Pyrrhulinina, the closest living relatives of the Nannostomina. This feature seems to have more significance at the specific than at the generic level.

Infraorbital bones: The usefulness of these structures also has been overlooked by previous authors. There are two types of infraorbital bone arrangement in the subtribe. In one they are more elongate, and both the first and second elements have a bony infraorbital canal. In the other type, the first two infraorbitals are short and the second is without a bony canal. The closest relatives of the Nannostomina, the Pyrrhulinina, have a canal in both the first and second infraorbital bones; its absence in the second infraorbital of some Nannostomina is possibly a neotenic specialization. This character is considered here to have generic significance because it is consistent and correlated with a definite difference in snout and head shape.

Color: The melanophore patterns occurring in this subtribe can be separated conveniently into three categories.

The first of these consists of long, dark, horizontal stripes present in almost all species. The term stripe is restricted in this account to the elongate pigmented areas that extend in a horizontal direction on the sides of these fishes. There are several of these stripes as follows: Primary stripe, the main midside stripe usually extending from the snout to the eye, across the operculum to the lower part of the caudal peduncle and onto the caudal fin. Secondary stripe, the dark stripe above the primary stripe. It usually extends from the nape or the top of the head to the upper portion of the caudal peduncle.

It often blends with the darkly pigmented back. Tertiary stripe, the lowermost stripe often extending from the lower jaw, across the lower part of the operculum, below the base of the pectoral fin to the origin of the anal fin. Additional stripes occur on some species, such as *Poecilobrycon eques*. Live specimens suddenly illuminated at night may show the stripes only faintly or almost not at all. During the day these same stripes are darkly pigmented.

The second category consists of oblique bands. The anterior of these lies along the sides a short distance anterior to the dorsal fin, while the posterior lies along the midside a short distance posterior to the dorsal fin. These oblique bands are usually absent or extremely pale in living specimens during the daylight hours; however, in the absence of light the oblique bands become very dark. Females of *Nannostomus beckfordi* while spawning often will show faintly the oblique bands. The oblique bands appear in some species, such as *N. beckfordi*, to be mostly areas of the primary horizontal stripe which fail to become pale under the influence of darkness. However, even in this species these bands are a little more than this because some of the area of the oblique band occurs above the primary horizontal stripe. In such species as *Poecilobrycon eques*, much of the area of the oblique bands is above the primary horizontal stripe.

The oblique bands have been called "night paint" by Hoedeman (1950) because they are usually present only at night. Specimens of *N. beckfordi* preserved at night in ten percent formalin retain their "night pigment" pattern. In these specimens the oblique bands are quite dark and their horizontal stripes are faded and sometimes indistinct.

In specimens preserved in daylight, oblique bands are present often but are usually very pale. Horizontal stripes are almost always present and distinct except on faded specimens or specimens preserved at night. Care should be used in determining the presence or absence of oblique bands from preserved specimens because if, as is usually the case, the specimens were preserved during daylight hours, the pigment of the melanophores of the oblique bands may be so contracted that the bands do not show.

Permanent blotches constitute the third category. These are present in only one species, *Nannostomus espei*, and differ in position and quality from all other dark markings seen in the other species. They are permanent, not disappearing in daylight or darkness, although as with other pigment, they may fade slightly at night. The borders of the blotches are darker than the rest of the blotch. This is not true of the oblique bands. There are five such permanent blotches along the midsides on *N. espei*, the first above the pectoral fin, the second below the origin of the dorsal fin, the third midway between the origin of the pelvic fin and the anal fin, the fourth above the anal fin origin, and the fifth in the lower half of the caudal fin root.

Caudal fin rays and body swimming position: The normal principal caudal ray count is 10/9 in characids, and this is true of all Nannostomina examined by me. However, in two species, two of the rays normally in the upper lobe of the caudal fin have their distal ends in the lower lobe. The proximal ends of these two rays retain the normal position on the hypural fan and thus originate in the upper lobe. The two species having this arrangement swim at an inclined angle, head up. Steindachner (1876) first noticed that the lower caudal fin lobe is larger in some Nannostomina, and Hoedeman (1950) noted that these unequal lobes are correlated with the swimming position. Hoedeman did not describe accurately the morphological arrangement of the caudal fin rays. He stated that there is a difference in the shape of the swim bladder correlated with the swimming position. This is possibly true, but investigation of this feature has been postponed pending a histological examination of the swim bladder and its musculature. A comparative histological examination of the semicircular canals and associated structures probably would show also interesting morphological differences associated with the oblique swimming position. Braemer and Braemer (1958) have begun to investigate some of the morphological differences in the arrangement of statoliths in characids, including that in *Poecilobrycon eques*, one of the oblique swimmers.

Other characters have been reported to have generic significance in Nannostomina. For example, Eigenmann (1909) based *Poecilobrycon* mainly on the presence of an adipose fin in the type species, *P. harrisoni*. However, additional specimens have shown that members of this species may or may not have an adipose fin, and the character is of no generic significance in this group. Steindachner (1876) noted that the adipose fin is variably present in *Poecilobrycon eques*. Hoedeman (1950) attempted to use the shape of the teeth as a generic character, but their shape often varies from individual to individual as well as among different geographical populations of the same species.

The characters most useful in separating species are color pattern, scale counts, gill-raker counts, numbers of vertebrae and teeth, and body proportions. Preliminary observations of living specimens in aquaria indicate that behavior also may be of considerable aid in understanding specific and generic relationships.

The synonymy used here is selected, and no attempt has been made to include all references to these fishes that have appeared in the very extensive aquarium literature. Many references to the aquarium literature concerning these fishes can be obtained from Hoedeman (1950).

The following abbreviations are used:

AM	Zoological Museum, Amsterdam
ANSP	Academy of Natural Sciences, Philadelphia
CAS	California Academy of Sciences
CAS (IUM)	Specimens formerly at the Indiana University Museum and now at the California Academy of Sciences but still bearing Indiana University Museum numbers
CNHM	Chicago Natural History Museum
MCZ	Museum of Comparative Zoology, Harvard
USNM	United States National Museum

For loan of specimens I am indebted to Dr. George S. Myers of Stanford University, W. I. Follett of the California Academy of Sciences, Loren P. Woods of the Chicago Natural History Museum, Dr. Giles Mead of the Museum of Comparative Zoology, Harvard University and Dr. James Böhlke of the Academy of Natural Sciences of Philadelphia. I am indebted greatly to Dr. George S. Myers for numerous discussions and for critically reading the original manuscript. In addition the following people have read the manuscript at various stages, all offering useful advice and aid: Drs. Paul Erlich, Myra Keen and Warren Freihofer of Stanford University, Mrs. Lillian Dempster of the California Academy of Sciences, and Drs. Robert H. Gibbs, Jr., and Victor G. Springer of the U.S. National Museum.

I am indebted also to Gen. Thomas D. White for forwarding living specimens of *Nannostomus marginatus* from eastern Colombia so that I could record their life colors. All drawings are by the author with the exception of figure 6, the anal fin of a male *Nannostomus digrammus* prepared by Dr. Margaret Bradbury.

The work was begun and largely completed at the Department of Biological Sciences, Stanford University. Additional work was done at the Department of Anatomy, Stanford University, and the U.S. National Museum, Smithsonian Institution.

Note on figures: Figures 1, 2, 4, 5, 7, 8, 9, 11, and 12 show male specimens with the antorbital and first three orbital bones and the third set (counting from the anterior end of the jaw base) of upper (premaxillary) and lower (maxillary) teeth. The enlarged scale (or scales) is from the third longitudinal scale row of the left side, just below the dorsal fin except where noted in the text. These parts are all drawn from alizarin specimens.

Key to Genera and Species of Subtribe Nannostomina

1. Second infraorbital bone without bony canal passing in its substance. Genus **Nannostomus.** 2

   Second infraorbital bone with well-developed bony infraorbital canal passing in its substance . . . . Genus **Poecilobrycon.** 7

2. Very indistinct primary horizontal stripe present. Secondary or tertiary horizontal stripes absent. Five dark permanent blotches along sides (in life these blotches not fading during exposure of fish to daylight). **Nannostomus espei** (p. 9)

   Primary horizontal stripe present, very well developed. Some species with secondary and tertiary horizontal stripes present. One or two pale oblique bands on sides (in life these bands ordinarily present only when fish kept in dark). Permanent blotches absent 3

3. Primary horizontal stripe present, secondary stripe present or absent, tertiary horizontal stripe absent. Teeth in single row on premaxillary, 5 to d (usually 6). Anal fin rays of males slightly to greatly modified, flattene6 in sagittal plane. 4

   Primary, secondary, and tertiary horizontal stripes well developed. Teeth in one row on premaxillary, 7 to 8 (usually 8). Anal fin rays of males completely unmodified in appearance 6

4. Perforated scales in lateral line 2 to 4. Adipose fin absent. Anal fin rays iii,9. Anal fin rays of males relatively little modified, not greatly flattened and expanded in sagittal plane 5

   No perforated lateral line scales. Adipose fin present. Anal fin rays iii,8. Anal fin rays of males greatly modified, flattened, and expanded in sagittal plane . . . . **Nannostomus digrammus** (p. 22)

5. Secondary horizontal stripe absent. Gill rakers 9 to 10+17 to 18. **Nannostomus bifasciatus** (p. 19)

   Secondary horizontal stripe present. Gill rakers 8+14. **Nannostomus beckfordi** (p. 12)

6. Scales 26 to 27 in lateral series. Total vertebrae (including those of Weberian apparatus) 35 to 36. Adipose fin present, either well developed or rudimentary. About 11 teeth in second tooth row of dentary. Snout in eye 1.0. Least depth of caudal peduncle in standard length 10.0 to 10.4. **Nannostomus trifasciatus** (p. 29)

   Scales 21 to 23 in lateral series. Total vertebrae 31 to 33. Adipose fin absent. Teeth in the second row of dentary 6 to 7. Snout in eye 1.3 to 1.4. Least depth of caudal peduncle in standard length 7.8 to 8.5. **Nannostomus marginatus** (p. 32)

7. Principal caudal fin rays 10/9, their distribution in lower and upper caudal lobes normal, 10 ending in upper lobe, 9 ending in lower lobe. Total vertebrae 38 to 39. Length of caudal peduncle in standard length 5.3 to 6.1 . . . (Subgenus *Poecilobrycon*). **Poecilobrycon harrisoni** (p. 38)

   Principal caudal fin rays 10/9, but 8 rays end in upper lobe and 11 in lower lobe of caudal fin. Total vertebrae 33 to 34. Length of caudal peduncle in standard length 6.0 to 7.5 . . . . (Subgenus *Nannobrycon*). 8

8. Scales 28 to 30 in lateral series. Perforated scales in lateral line 2 to 5. Adipose fin present. Gill rakers 9+14. Inner tooth row of dentary absent; teeth in outer dentary tooth row 6 to 7. **Poecilobrycon unifasciatus** (p. 42)

Scales 24 to 25 in lateral series. No perforated lateral line scales. Adipose fin present or absent. Gill rakers 16+24. Teeth in inner dentary row 12; teeth in outer dentary row 9 . . . . **Poecilobrycon eques** (p. 47)

Genus *Nannostomus* Günther

Nannostomus Günther, 1872, p. 146 (type species: *Nannostomus beckfordi* Günther, 1872, by monotypy).

Diagnosis.—Among the Lebiasininae the following character appears unique for this genus: Second infraorbital bone without bony canal for infraorbital branch of laterosensory canal; in addition, snout short, 1.0 to 1.4 in eye diameter. Correlated with the short snout, *Nannostomus* has a shorter, broader ethmoid and vomer, a shorter antorbital and infraorbital, and a shorter mesopterygoid and nasal bone than *Poecilobrycon*. An adipose fin may be either present or absent. Either the primary or tertiary, or both primary and tertiary horizontal stripes may be present or absent. The anal fin rays of the males may be greatly modified or scarcely modified as an accessory organ. The body is short to fairly elongate, the depth being 3.5 to 5.0 in the standard length.

The name *Nannostomus* is derived from the Greek *νανοσ*, meaning little or dwarf, and *στομα*, meaning mouth.

Nannostomus espei (Meinken)

Figure 1

Poecilobrycon espei Meinken, 1956, p. 31 (original description; no type locality; types in collection of Meinken and at Stanford University, lectotype SU 51593).

Nannostomus espei—Böhlke, 1956, p. 2 (description; unnamed creek emptying into the Paruma River, a tributary of the Kamarang River, which empties into the Mazaruni River, British Guiana).—Sterba and Tucker, 1962, p. 213 (description and aquarium notes).

Diagnosis.—Secondary and tertiary horizontal stripes absent; primary horizontal stripe poorly developed; permanent blotches on sides of living specimens (blotches do not disappear during daytime); scales (fig. 1) very much in outline like scales of members of subtribe Pyrrhulinina (see description on page 12). *Nannostomus espei* differs from all members of subtribe Nannostomina except *Nannostomus marginatus* by having fewer than 23 scales in lateral series.

Description.—Body elongate, sides flattened, and body compressed posteriorly. Greatest depth between posterior tip of appressed pectorals and anterior part of base of dorsal fin. Standard length of largest specimen examined, 28.1 mm. Greatest body depth 4.3 in all specimens; least depth of caudal peduncle 9.6 (9.4 to 10.0); length of caudal peduncle of both sexes 6.4 (6.1 to 7.0); snout tip to origin of dorsal 1.9 (1.9 to 2.0); snout tip to origin of anal 1.3 in all specimens.

Head elongate, snout obtuse in vertical and horizontal profiles. Top of head very slightly convex between eyes. Head 3.6 (3.5 to 3.7); eye in head 3.0 (2.9 to 3.0); snout in eye about 1.0 in all specimens examined; least width of bony interorbital in greatest eye diameter 1.0 or very slightly less in all specimens examined.

Premaxillary with 7 teeth. Each tooth except posterior 1 or 2 with 5 cusps. Posterior 2 teeth usually quadricuspid. Sometimes most anteromedial premaxillary tooth with only 4 cusps. Usually with largest cusp just medial to farthest posterolateral cusp. Maxillary with single, uni- to quadricuspid tooth. Teeth in anterior row of each dentary 7 to 8. Anterior 5 or 6 teeth hexacuspid, third from anteromedial cusp largest. Posteriormost dentary tooth usually tricuspid. Second dentary tooth row with 8 to 11 unicuspid teeth. Gill rakers 10+17 on each first gill arch in one alizarin preparation, SU 50252.

Dorsal fin rays ii,8; anal iii,9; pectoral i,10; pelvics ii,7, in all specimens examined. Adipose fin present, well developed in all specimens. Caudal fin with principal rays 10/9; distal tips of all ray elements of first (upper) 10 principal rays within upper caudal lobe; remaining 9 principal rays end in lower lobe.

Male's anal fin modified (fig. 1); rays somewhat expanded and more similar to highly modified anal rays of *Nannostomus digrammus* than any other species of Nannostomina.

Radial grooves of scales in third horizontal scale series below dorsal fin shown in figure 1. Posterior field of each scale with 2 to 3 radial grooves; dorsal and ventral fields each with 1 radial groove; anterior field with 2 to 4 radial grooves. Dorsal and ventral anterior corners of scales in this species more acute than in any other species of Nannostomina. Acute corners very similar to those found in subtribe Pyrrhulinina. Scales in lateral series 22 in all specimens examined. Perforated lateral-line scales on each side 1 or 2. Scales in median predorsal series 10 in all specimens examined. Total number of vertebrae 33 (18 precaudals and 15 caudals) in all specimens.

Color in alcohol.—Preserved specimens (SU 50214) have the following color: Top of head light to dark brown. Primary horizontal stripe from tip of snout across maxillary and first obrital bones onto anterior part of iris of eye; then from posterior part of iris to edge of opercular bone. Posterior to eye, primary horizontal stripe somewhat diffuse and hard to distinguish. Primary horizontal stripe behind operculum represented as very diffuse, slightly darkened area extending posteriorly to caudal peduncle, through third and fourth longitudinal scale rows. (In live specimens kept in an aquarium with dark brown peatmoss bottom and subdued light, horizontal stripe became much darker but remained diffuse.) Large permanent blotches

5 on sides with slightly irregular margins as shown in figure 1. Borders of blotches (very different from oblique bands described in other species) slightly darker than their centers. Very pale stripe above blotches and above very light and diffuse primary horizontal stripe. Dorsum brown above pale stripe. Network of dark lines that follow scale edges superimposed on entire body pigment pattern. Belly white, all fins hyaline.

Color in life.—Life colors of an aquarium specimen as follows: Five large permanent blotches dark brown to almost black. Body color very light brown with slight greenish cast. This ground color darker on back. Abdominal region silvery. Light green, somewhat iridescent stripe extending along sides just above dorsal borders of permanent blotches. This stripe reflecting pale gold. Fins translucent except for few dark spots on anal fin.

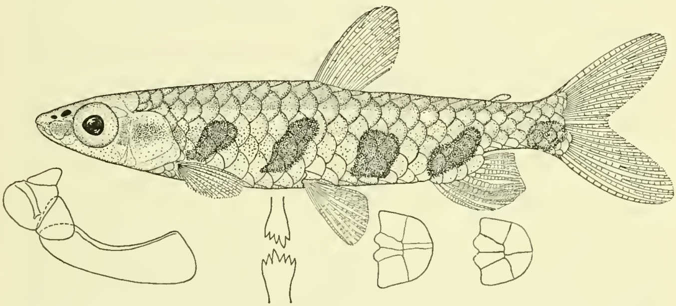

Figure 1.—*Nannostomus espei*, male, SL 27.6 mm., SU 50214 (see text for discussion of scales).

Remarks.—The original description of this species was inadequate, and no types were designated. Also because the type locality was unknown, none was cited. Böhlke (1956) has located and published data on the collecting site of the original aquarium importation of this species, but did not designate a restricted locality—this is done here. The "restricted locality" is that given by Böhlke (1956, p. 1). This locality, along the Paruma River, is apparently in the vicinity of lat. 5°50′ to 55′ N., long. 61°05′ to 10′ W. At my request, Herr Meinken has sent to me three of the specimens used in his original description. One of these (SU 51593), an adult female 26.5 in SL, is here designated as the lectotype. The two other specimens, paralectotypes, one an adult female 28.5 mm. and one subadult female 21.0 mm. in SL, now bear the number SU 51592.

The color pattern of *Nannostomus espei* greatly resembles that of *Pyrrhulina vittata* Regan and *Pyrrhulina spilota* Weitzman. Many of the scales of *Nannostomus espei* are more like those in the genera *Pyrrhulina, Copeina,* and *Copella* than those of other species of *Nannostomus* or *Poecilobrycon.* In figure 1, the scale to the left is from the third longitudinal scale row, just below the dorsal fin. It is typically pyrrhulininan in outline. That to the right is from the second longitudinal row near the adipose fin and is typically nannostominan in outline. The phylogenetic significance of these facts is not understood, especially since this species has the typical osteology of *Nannostomus.* It seems possible that this species has retained a few primitive features that were present in its presumably somewhat more *Pyrrhulina*-like ancestors. This species also has a body form which suggests that of the subtribe Pyrrhulinina more than the body form of any other species of *Nannostomus* or *Poecilobrycon.* The body form of *Nannostomus* and *Poecilobrycon* is usually more or less smoothly fusiform, whereas that of *Pyrrhulina* is not, the profile showing a slight notch behind the dorsal fin and the belly being slightly flat. *Nannostomus espei* has the dorsal notch of *Pyrrhulina.* This body shape in *espei* is subtle and considerable experience with live and preserved specimens was necessary before it was detected.

Specimens examined.—Five (one alizarin preparation), ANSP 73873, SL 21.5–28.1 mm., British Guiana, an unnamed creek, tributary to the Paruma River, a tributary of the Mazaruni River via the Kamarang River, Pakaraima Mountain region of western British Guiana, lat. 5°50′–55′ N., long. 61°05′–10′ W., 1955, Louis Chung.—One alizarin preparation, SU 50252, SL 25.0 mm., aquarium specimens, locality unknown but probably British Guiana.—Seven, SU 50214, SL 25.5–27.0 mm., aquarium specimens, locality unknown but probably British Guiana.—One, SU 51593 (lectotype) and two, SU 51592, paralectotypes, for locality see discussion on page 11.

Nannostomus beckfordi Günther

Figures 2, 3, 4

Nannostomus beckfordi Günther, 1872, p. 146 (original description; type locality: Goedverwating, a plantation on the coast of Demerara, British Guiana; holotype in British Museum [Natural History]).—Eigenmann and Eigenmann, 1891, p. 49 (listed).—Eigenmann, 1912, p. 281 (copied description).—Hoedeman, 1950, p. 16 (description; no specimens listed).—Boeseman, 1954, p. 18 (Surinam).

Nannostomus anomalus Steindachner, 1876, p. 129 (original description; type locality: mouth of Rio Negro, Brazil; types in Vienna Museum).—Eigenmann and Eigenmann, 1891, p. 49 (listed).—Eigenmann, 1910, p. 427 (listed).—Meinken, 1931, p. 554 (description from life; figure).—Innes, 1935 and later editions, p. 153 (description from life; photograph).—Puyo, 1949, p. 117 (description; Cayenne Island, French Guiana).—Boeseman, 1952, p. 184 (Surinam); 1953, p. 16 (Surinam).—Axelrod and Schultz, 1955, p. 239 (description and aquarium notes).

Nannostomus minimus Eigenmann, 1909, p. 42 (original description; type locality: Erukin, British Guiana; holotype in Chicago Natural History Museum); 1910, p. 427 (listed); 1912, p. 282, pl. 36, fig. 5 (description).

Nannostomus simplex Eigenmann, 1909, p. 42 (original description; type locality: Lama Stop-Off, British Guiana; holotype in Chicago Natural History Museum); 1910, p. 427 (listed); 1912, p. 283, pl. 36, fig. 6 (description).

Nannostomus beckfordii.—Eigenmann, 1910, p. 427 (listed, name emended).

Nannostomus beckfordi surinami Hoedeman, 1954a, p. 84 (original description; type locality: Berg en Dal at Surinam River, Surinam; holotype in Zoological Museum of Amsterdam).

Nannostomus aripirangensis Meinken, 1931, p. 553 (original description; figure; type locality: Brazil, State of Pará, Aripiranga Island NE. of Belém do Pará; types destroyed during World War II, Meinken in litt.).—Axelrod and Schultz, 1955, p. 240 (copied description and aquarium notes).—Sterba and Tucker, 1962, p. 210 (description and aquarium notes).

Nannostomus beckfordi aripirangensis.—Hoedeman, 1950, p. 18 (copied description); 1954a, p. 84 (listed).

Nannostomus beckfordi anomalus.—Sterba and Tucker, 1962, p. 210 (description and aquarium notes).

Diagnosis.—This species possesses few characters not found in at least some of the other members of the genus *Nannostomus* and is therefore difficult to diagnose by any single characteristic. Perhaps the best single diagnostic character complex is the pattern of horizontal stripes.

Secondary and tertiary horizontal stripes absent; well-developed primary horizontal stripe present; few (2–6) perforated lateral line scales present; 9 to 10+17 to 18 gill rakers; iii,9 anal fin rays; and 23 to 26 scales in a lateral series.

Description.—Body slender, cylindrical except in region of moderately compressed caudal peduncle. Greatest body depth slightly anterior to dorsal fin origin. Standard length of largest specimen 29.6 mm. Greatest body depth 4.3 [3.5 in egg-filled females] to 5.0 [in apparently starving specimens]; least depth of caudal peduncle 9.9 (8.8–10.8); length of caudal peduncle of population sample from Obidos (CM 19648) 5.2 (4.9–5.6), of population from Uruará Brook (SU 50257) 6.0 (5.5–6.3); length of caudal peduncle of all specimens measured 5.8 [a rather meaningless figure since the measurements are biased toward a large number of specimens from Uruará Brook, SU 50257] (4.9–6.3); snout tip to origin of dorsal fin 1.85 (1.62–1.99); snout tip to origin of anal fin 1.30 (1.24–1.35).

Head conic; snout blunt, obtuse in vertical and horizontal profile. Head 3.8 (3.5–4.0); eye in head 2.8 (2.5–3.2); snout in eye 1.24 (1.05–1.39); least width of bony interorbit in greatest eye diameter 1.1 (1.04–1.19).

Premaxillary with 6 teeth; anterior teeth quinquecuspid, lateral teeth quinque- to septemcuspid. [There is some geographical variation in the prominence of the individual cusps; for example specimens from Baduel, French Guiana, SU 50259, and specimens from Uruará Brook, SU 50257, have all the cusps of the premaxillary teeth about equal (fig. 2). Specimens from Obidos have the second cusp from posterolateral side much enlarged, quite similar to the upper left tooth shown in the figure of *Poecilobrycon eques* (fig. 12)]. Maxillary with single uni- to octocuspid compressed tooth, cusps subequal. Dentary with 5 to 6 teeth (almost always 6 in all population samples examined). Teeth in anterior dentary tooth row quinque- to sexcuspid (usually sexcuspid). Specimens from Uruará Brook with subequal cusps; however, specimens from Obidos with centralmost cusp enlarged in anterior 4 to 5 teeth of dentary. Teeth 2 to 6 in inner tooth row of dentary (seen in alizarin preparations only). Gill rakers 9 to 10+17 to 18 (seen in alizarin specimens only).

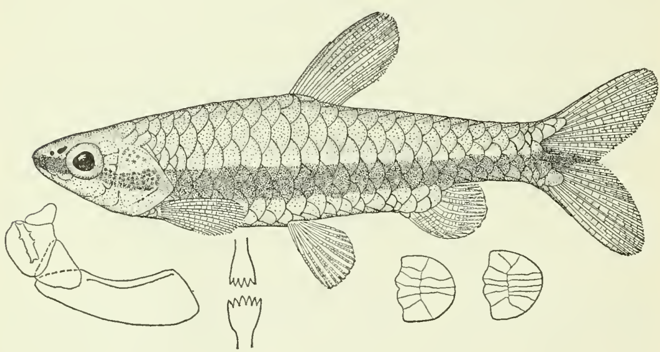

FIGURE 2.—*Nannostomus beckfordi*, male, SL 30.0 mm., SU 50261 (both scales are from third longitudinal row, below dorsal fin).

Dorsal fin ii,8; anal fin iii,9; pectoral i,10 to i,12; pelvic fin ii,7. Adipose fin absent in all specimens examined. Principal caudal fin rays 10/9; distal tips of all elements of first 10 rays contained in upper caudal lobe, distal tips of remaining 9 principal rays in lower lobe. Male with anal fin (figs. 2 and 4) somewhat modified in same manner as extremely modified anal fin of *N. digrammus*. Anal fin of female (fig. 3) unmodified. [Observation of living male *beckfordi* shows that while courting and spawning, the male often cups the fin into a spoon-shaped bowl and that, while spawning, the male places his fin partially over the female's vent.]

For radial grooves of scales in median scale row below dorsal fin, see figure 2. Posterior field with 2 to 6 radial grooves; dorsal and ventral fields with 1 or 2 radial grooves; and anterior field with 3 to

7 radial grooves. Scales in lateral series 24 (23–26); perforated lateral line scales 2 to 6 (usually 4 in population from Uruará Brook). Specimens often damaged so heavily that scales impossible to count accurately. In all instances, intact specimens from other localities with only 4 to 6 perforated scales. Scales in median series anterior to dorsal fin 10–11. Specimens from Uruará Brook with following total vertebral counts: 6 specimens with 34; 19 with 35 vertebrae. Specimens from Obidos: 3 specimens with 33, 31 specimens with 34 vertebrae, 8 specimens with 35 and 2 specimens with 36 vertebrae. Most specimens from other localities with 35 vertebrae. Usually 18 to 20 precaudal vertebrae and 15 to 16 caudal vertebrae, always in combination to produce total of 33 to 36 vertebrae. Counts of vertebrae undoubtedly will prove useful in distinguishing and determining subspecies.

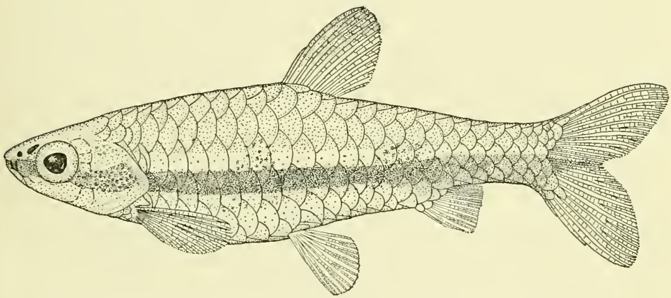

FIGURE 3.—*Nannostomus beckfordi*, female, SL 29.5 mm., SU 50261.

COLOR IN ALCOHOL.—Preserved specimens from Belém, State of Pará, Brazil (figs. 2 and 3) have the following color: Top of head light to dark brown. Primary horizontal stripe extending from tip of snout and tip of lower jaw across maxillary and first orbital bone onto eye. Posterior to eye, primary stripe continuing to posterior edge of opercular bone, but absent or extremely pale on fleshy opercular flap. Beginning on cleithrum and underneath opercular flap, primary horizontal stripe continuing posteriorly over lower midsides onto caudal fin, its course reaching posterior root of anal fin, covering entire lower half of caudal peduncle and continuing onto caudal fin as a wedge with its apex at posterior junction of upper and lower caudal fin lobes. In mature males primary horizontal stripe covering entire fourth horizontal scale row and adjacent parts of third and fifth scale rows. In mature females and immature specimens of both sexes lower portion of third scale row often only partly pigmented. No evidence of secondary or tertiary horizontal stripes.

Very pale stripe extending above primary horizontal stripe from eye to end of third scale row; this stripe often obscured by light brown color extending ventrally from dorsum. Females, and sometimes males, with scatterings of melanophores forming oblique bands in area of sixth to eighth vertical scale rows and over thirteenth to fifteenth vertical scale rows. Sides pale below primary horizontal stripe, shading to white on belly. Pectoral and pelvic fins translucent but pelvic fins sometimes with scattering of brownish melanophores giving entire fin light brown appearance. Dorsal fin translucent except for fairly dense accumulation of melanophores along anteriodistal portion. Anal fin hyaline except for some accumulation of melanophores in distal region of posteriormost rays.

Color in life.—(The color recorded here is from breeding male aquarium specimens from an unknown locality. These specimens appeared, when preserved, exactly like the specimens described above from Belém.) Dorsal fin, pectoral fins, and pelvic fins mostly hyaline without red except for small amount at base of pelvic fins. Primary horizontal stripe dark bluish black. Narrow silvery blue to golden stripe above primary horizontal stripe, beginning at posterior border of eye and extending to posterior end of caudal peduncle. Above this, beginning between third to sixth vertical scale row, with narrow red stripe, varying in intensity from deep crimson red to pale rose. This red stripe usually absent in nonbreeding males. Intense crimson spot above and below primary horizontal stripe at base of each caudal lobe. Intense red stripe often spreading completely over anal fin below primary horizontal stripe, and usually extending from sixth or seventh vertical scale row posteriorly to above anal fin in breeding males. Nonbreeding males often without red. Distal one-quarter to one-third of pelvic fins intense silvery blue. Some specimens with this color on distal tips of third, fourth, and fifth anal fin rays. Mature females and immature specimens of both sexes often with small amount of silvery blue at distalmost tips of pelvic rays. Dorsum pale brown above silvery and red stripes with each exposed scale edge outlined in darker brown. Lateral surface of snout above primary horizontal stripe pale brown. Top of head brown. Bright metallic-red spot frequently present near anterior narial opening. Iris silvery with reddish suffusion dorsally. Belly and throat regions white.

Remarks.—Hoedeman (1950, pp. 16–18) seems to have been correct in assuming *Nannostomus anomalus* Steindachner to be a synonym of *Nannostomus beckfordi*, a polymorphic species. Hoedeman pointed out that the only difference between *beckfordi* and *anomalus* recorded in the literature is that *beckfordi* has a black spot on the lower half of the gill cover. Hoedeman noted that at night there is a dark spot on the lower half of the gill cover of living specimens of a fish, apparently without known locality. He considered this fish to be *beckfordi*. These specimens apparently also fit the description of *anomalus*. I have been unable to confirm the presence of such a spot in living specimens available to me. The live specimens I have seen are without locality but are like specimens known to have come from near Belém, Pará, Brazil. Professor George S. Myers kindly examined the holotype of *beckfordi* in the British Museum and noted that the black spot on the lower half of the gill cover is a dirty black smudge, does not consist of melanophores, and occurs on the left side only. Since the spot appears to be an artifact, *anomalus* is here considered a synonym of *beckfordi*.

Meinken (1931) described *Nannostomus aripirangensis* from Aripiranga Island near Belém, Pará, Brazil. Herr Meinken (in litt.) has stated that the types of *aripirangensis* were destroyed during World War II, and no one reexamined them subsequent to Meinken's original account. Hoedeman (1950, p. 118) was possibly correct in assuming *aripirangensis* to be a subspecies of *beckfordi*. I have examined two specimens of *Nannostomus* from Aripiranga Island that were sent to Dr. George S. Myers prior to 1934 by Arthur Rachow, a prominent German aquarist. These specimens are said to be representatives of *aripirangensis* and are identical to specimens of *beckfordi* from around Belém. However, Meinken (1954, and in personal communications) has insisted that *aripirangensis* represents a distinct species. I have seen many living aquarium specimens of *Nannostomus* without locality data which I consider to be color variants (possibly geographical races or subspecies) of *beckfordi*. In appearance, one of these groups of specimens was like specimens of *beckfordi* collected at Belém, Pará, and Aripiranga Island and had, when breeding, some colors suggesting those described for *aripirangensis* by Meinken. Aripiranga Island, the type locality of *aripirangensis*, is just a few miles from the city of Belém, Pará.

Meinken showed in his drawings a small tertiary horizontal stripe, a stripe which I have never seen in any specimens that I could refer to *beckfordi*. Meinken's dorsal fin count of 11 rays should be considered with caution and some doubt, for all *Nannostomus* and *Poecilobrycon* so far examined by me have had a dorsal fin ray count of ii,8 or a total of 10 rays, not 11. Meinken's count may have been taken from an abnormal or rare variant specimen. Meinken has stated in a personal communication that *anomalus* (here *beckfordi*) and *aripirangensis* have interbred in aquaria and that in this manner the living stock of *aripirangensis* has been lost in Germany. This indicates at least a close genetic relationship. Recently Vorderwinkler

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(1957), in an aquarium publication, has recorded and published photographs of two forms of *Nannostomus*, one of which is stated to be *anomalus*, the other *aripirangensis;* both of these photographs appear to be of *beckfordi*, showing two of its several geographical color variants. Neither has a color pattern exactly like that described for the original *aripirangensis*.

Until thorough collections of *Nannostomus* can be made on the Island of Aripiranga, the problem of the distinctness of *aripirangensis* cannot be settled; however, I tentatively prefer to consider *aripirangensis* one of the several geographically distinct populations of *beckfordi*.

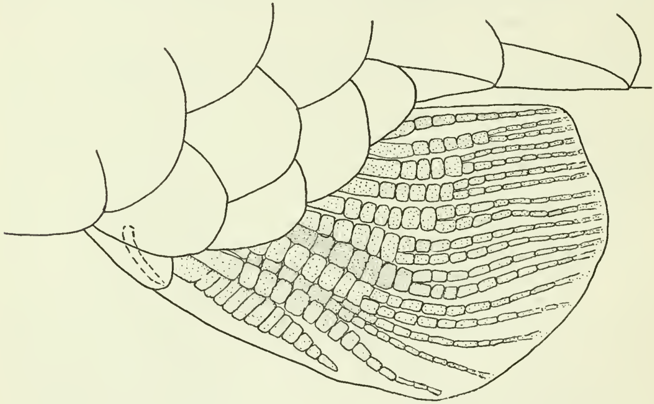

FIGURE 4.—Anal fin of male *Nannostomus beckfordi*, SL 31.0 mm., SU 50261.

Nannostomus beckfordi appears to be a polytypic species with a wide geographical range, known from the Guianas and for a considerable distance (about 700 or more air miles) up the Amazon River. Adequate collections and studies will undoubtedly show that this species consists of several distinct populations, some of which may prove to be subspecies. Studies of color variation, variation in certain body proportions (especially head depth compared to body length and caudal peduncle length), vertebral counts, and arrangement of tooth cusps will probably be of great value in studying subspecific population differences.

SPECIMENS EXAMINED.—Three, SU 50256, SL 22.0–22.7 mm., Brazil, State of Pará, Belém, May 18, 1924, Carl Ternetz.—Four, SU 50262, SL 22.5–27.5 mm., Brazil, State of Pará, brook into Tápajos near Santarém, Aug. 2, 1924, Carl Ternetz.—Forty-four, SU 50257, SL 16.0–29.0 mm., Brazil, State of Pará, south bank of Rio Amazonas, Rio Uruará, about lat. 1°54′ S. and long. 53°27′ W., June 26, 1924, Carl Ternetz.—Six, SU 50258, SL 22.0–26.5 mm., alizarin preparations, Brazil, State of Pará, south bank of Rio Amazonas, Rio Uruará about lat. 1°54′ S. and long. 53°27′ W., June 26, 1924, Carl Ternetz (from SU 50257).—Five, SU 50261, SL 20.5–29.6 mm., Brazil, State of Pará, Belém (Utinga Forest Reserve), September 1944, George S. Myers.—Two, SU 18469, SL 20.5–22.5 mm., no locality, aquarium specimens sent to Dr. George S. Myers as specimens of *Nannostomus aripirangensis*.—Two, USNM 94207, SL 30.0–31.0 mm., Brazil, state of Pará, Aripiranga Island, sent to Dr. George S. Myers prior to 1934 by Arthur Rachow.—Four, SU 50269, SL 19.0–25.0 mm., Brazil, State of Pará, Igarapé Uruará, tributary of Furo Maicá, about 10 miles southeast of Santarém, about lat. 2°30–55′ S. and long. 54°35–41′ W., June 23, 1924, Carl Ternetz.—Two, SU 50260, SL 25.0 mm. (both specimens), Brazil, State of Pará, Lagôa do Maicá, at the junction of the Igarapé Maicá and the Furo do Ituquí, about lat. 2°27′ S. and long. 54°40′ W., Apr. 2, 1924, Carl Ternetz.—Three, SU 50255, SL 22.0–24.0 mm., Brazil, State of Pará, Santarém, brook into Rio Tápajos, June 30, 1924, Carl Ternetz.—Nine, SU 50259, SL 21.0–25.4 mm., French Guiana, Baduel, on the Île de Cayenne, July 26, 1947.—Forty-three, CM 19648, SL 20.0–27.0 mm., Brazil, State of Pará, Obidos, 1856, Col. Bentos, Thayer Expedition.—One, CAS (IUM) 11692, SL 20.3 mm., paratype of *Nannostomus simplex*, British Guiana, Lama Stop-Off, Mahaica River, 1908, Carl H. Eigenmann.

Nannostomus bifasciatus Hoedeman

Nannostomus bifasciatus Hoedeman, 1953, p. x30.11.311 (original description, in Dutch; type locality: Berg en Dal at Surinam River, Surinam; holotype in Amsterdam Museum); 1954a, p. 85 (description in English); 1954b, p. 77 (description from life).—Sterba and Tucker, 1962, p. 211 (description and aquarium notes).

Diagnosis.—At least a few perforated lateral-line scales present; about 8+14 gill rakers; iii,9 anal fin rays, secondary horizontal stripe present, scales in a lateral series about 25.

Note.—This species is known from only four specimens and the original author has kindly sent three of them for examination. The fish was an aquarium import from Surinam to the Netherlands and the three available specimens are in poor condition, two having been dried at one time and all with torn, broken fins and broken jaws with missing teeth. Unfortunately the original description was inadequate and inaccurate, and it is impossible completely and competently to describe or illustrate the fish from the specimens at hand.

Description.—Body elongate; sides somewhat flattened and body compressed posteriorly. Greatest depth just anterior to origin of dorsal fin. Standard length of longest specimen examined 28.3 mm. Greatest body depth 5.4 (5.3–5.6) [females with ripe eggs not at hand but undoubtedly deeper bodied (see illustrations of live specimens in Hoedeman 1954a and Nieuwenhuizen 1954)]; least depth of caudal peduncle 11.6 (11.4–11.9); length of caudal peduncle 5.6 (5.5–5.6) in females, male damaged. Snout tip to origin of dorsal fin 1.9 (1.9–1.9); snout tip to origin of anal fin 1.3 (1.3–1.3).

Head conic and snout obtuse in both vertical and horizontal profiles, top of head gently convex between eyes. Head 3.8 (3.8–3.8); eye in head 3.1 (3.0–3.2); snout in eye 1.3 (1.2–1.3); least width of long interorbital in greatest eye diameter 1.3 (1.3–1.3).

Premaxillary with 7 teeth; anterior and lateral teeth septemcuspid, third from anterior or median cusp largest. Maxillary with 1 quadricuspid tooth. Dentary with 6 teeth, each usually with 7 cusps. Third cusp from medial or anterior end of tooth largest; sometimes central cusp largest. Inner row of teeth damaged in all specimens but appears to be over 10 simple conic teeth. Gill rakers 8+14 (one alizarin, specimen).

Dorsal fin ii,8; anal fin iii,9. Adipose fin absent. Caudal fin with principal rays 10/9.

Anal fin of male in good condition, somewhat modified. First ray small and completely hidden by a basal scale. Second ray enlarged and its anterior edge expanded and carinate. Entire fin larger than that of females and individual rays thickened laterally and somewhat enlarged in an anterior and posterior plane. In folded position, rays take an alternate position to each other with regard to median plane. However, anal fin not nearly as modified as that of *Nannostomus digrammus*.

Radial grooves of scales belonging to that part of third horizontal scale row below dorsal fin having posterior field with 1 to 3, usually 2 radial grooves; dorsal and ventral fields with 1 and anterior field with 3 to usually 4 radial grooves. Scales in lateral series 25 in single countable specimen. This specimen also with 3 perforated lateral-line scales in single row behind cleithrum. Scales in a median series before dorsal fin 10 in 2 female specimens. Total number of vertebrae 36 (19 precaudal and 17 caudal).

Color in alcohol.—Top of head and back light brown. Dorsum at base of dorsal fin dark brown. Primary horizontal stripe dark brown, extending from snout tip and lower jaw onto anterior surface of eye, across lower border of fifth orbital bone and upper border of fourth orbital bone to over upper limb of preopercle, finally terminating at posterior border of bony opercle. On body, primary horizontal stripe beginning anteriorly underneath fleshy opercular flap and extending through middle of fourth scale row, covering lower and upper exposed portions of third and fifth scale rows respectively. Primary stripe widening posteriorly until over anal fin covering entire fourth scale row and upper half of fifth scale row. Primary horizontal stripe covering entire lower half of caudal peduncle and entering lower lobe of caudal fin. Its pattern over lower lobe of caudal fin could not be determined due to damage. Below primary horizontal stripe, sides and belly pale brown (probably silvery in well-preserved specimens) with few irregularly scattered melanophores. No evidence of tertiary stripe. Single broad pale brown stripe (probably silvery in well-preserved specimens) above primary horizontal stripe extending from eye to caudal fin base. Two areas of large scattered melanophores occurring on pale stripe, forming oblique bands; anterior band covering 4 scales anterior to a point below anterior origin of dorsal fin, posterior band covering another 4 scales and center of this area located at a point dorsal to vent. Just dorsal to pale stripe a narrow secondary stripe arising a short distance above termination of upper opercular opening and extending posteriorly through center of second scale row to below dorsal fin, here becoming wider, denser, and rising to top of second scale row, there merging with dark pigment of dorsum behind dorsal fin and above pale stripe on caudal peduncle. Dorsum anterior to dorsal fin pale brown, lighter than secondary stripe. Top of head and snout with scattered large and small melanophores forming an area darker than dorsum just anterior to dorsal fin. All fins colorless except for a few scattered melanophores and dark pigment on lower caudal lobe. Pelvic fins appear artificially stained gray.

Color in life.—Life colors are taken from the original English description. Primary horizontal stripe "brilliant" black, extending onto caudal fin rays and onto lower caudal lobe. Typical wedge-shape distribution of pigment on lower caudal fin lobe apparently not present but precise distribution of black pigment not stated. Dorsal and ventral region dusky, back darker. Faint "reddish flush" on base of caudal and anal fins. Pelvic tipped with "ice blue," especially in males. Sides above and below primary horizontal stripe white except for narrow "golden-red streak" above primary stripe. (Hoedeman stated that this streak is diffuse at times except on snout. From this I would assume that there is probably a golden or red metallic spot at the anterior narial openings as in so many other nannostominans.) Secondary horizontal stripe present but tertiary stripe absent.

Remarks.—Concerning his new species, *N. bifasciatus*, Hoedeman (1954a) stated: "Phylogenetically the new species seems close to the stem of the tribe [i.e., his tribe Nannostomidi], near the presumed Pre-Nannostomid, taking an intermediate position between *Nannostomus beckfordi* and *Nannobrycon eques*." Hoedeman's opinion was apparently based on the following observation: "The oblique swimming position of *Nannobrycon* though less pronounced is sometimes observed in the present species [*bifasciatus*] also, especially while nipping planktonic food from the plants." He also mentioned that the black pigment of the caudal fin extends on the lower caudal fin lobe somewhat as in *Poecilobrycon eques* and remarked that the adipose fin of *bifasciatus* is placed more like that of members of *Nannostomus* than that of *Poecilobrycon harrisoni*, which has the adipose fin posterior to the anal fin, not over it as in *Nannostomus*. Hoedeman remarked that *bifasciatus* has a vestigal adipose fin; however, I find no trace of one in his 3 specimens. In addition I fail to find any generic significance in the placement of the adipose fin in nannostominans. It is somewhat more posterior in *Nannostomus trifasciatus* and *Poecilobrycon harrisoni* but more anteriorly placed in all other species of nannostominans which possess this fin. Concerning the swimming position, I can make little comment because I have not seen living specimens of *bifasciatus*. However, it should be remarked that *Poecilobrycon harrisoni* normally swims horizontally like all living species of *Nannostomus* that I have seen and that all species of *Nannostomus* will occasionally swim slightly obliquely when feeding. The color claimed for the caudal fin may be like that of *Poecilobrycon eques*, but I cannot determine this from the specimens at hand. The precise significance of this color pattern if present would be difficult to determine. From the key in the present paper it would seem that *bifasciatus* is closest to *beckfordi* in several characters and in fact may be rather closely related to it. I fail to find that Hoedeman presented sufficient evidence to indicate either that *bifasciatus* is a relatively primitive nannostominan or that it is intermediate between *Nannostomus* and *Nannobrycon*. The osteology of *bifasciatus* is typically that of *Nannostomus*. Weitzman (1964) noted that pyrrhulininans and nannostominans undoubtedly had a common ancestor. Presumably a relatively primitive nannostominan would have some characters suggesting pyrrhulininans. The only nannostominan that does this is *Nannostomus espei*, and even in this species the few such characters are difficult to evaluate.

Specimens examined.—Three, paratypes, AM 100513, SL 27.2–28.3 mm. (only 2 specimens could be measured as snout of 1 damaged), Surinam, Berg en Dal at Surinam River.

Nannostomus digrammus Fowler

Figures 5, 6

Nannostomus digrammus Fowler, 1913, p. 525 (original description; type locality: Rio Madeira, about 200 miles east of long. 62°20′ W., Brazil;[2] holotype in Academy of Natural Sciences of Philadelphia), 1950, p. 261 (listed).

Poecilobrycon diagrammus.—Hoedeman, 1954a, p. 84 (copied description).

Poecilobrycon digrammus.—Hoedeman, 1954b, p. 71 (listed).

Nannostomus beckfordi beckfordi.—Sterba and Tucker (not Günther), 1962, p. 209, (aquarium description of "gold anomalus" but counts from Günther's original description of *beckfordi;* see remarks below).

[2] Bohlke (1955, pp. 8–12) doubts the quoted locality and presents reasons why it may be considered as being 20 miles east of long. 62°20′ W.

DIAGNOSIS.—This species may be distinguished from all other known species of *Nannostomus* and *Poecilobrycon* by the greatly modified anal fin of the males (fig. 6) and an anal fin count of iii,8 in both sexes. In addition, the following combination of characters will distinguish this species from all others: Primary and secondary horizontal stripes well developed; tertiary horizontal stripe absent or only weakly developed; no perforated lateral-line scales; and adipose fin present.

DESCRIPTION.—Body elongate, rather cylindrical in its anterior half but compressed posteriorly. Greatest depth a short distance anterior to origin of dorsal fin. Standard length of largest specimen with locality data 25.0 mm. (an aquarium specimen measured, SU 18471, SL 27.6 mm.). Greatest body depth 4.7 (4.5–5.0); least depth of caudal peduncle 11.1 (10.3–11.5); length of caudal peduncle, males 5.9 (5.6–6.3), females 5.1 (4.9–5.4); snout tip to origin of dorsal fin 1.8 (1.7–1.9); snout tip to origin of anal fin 1.3 (1.29–1.34).

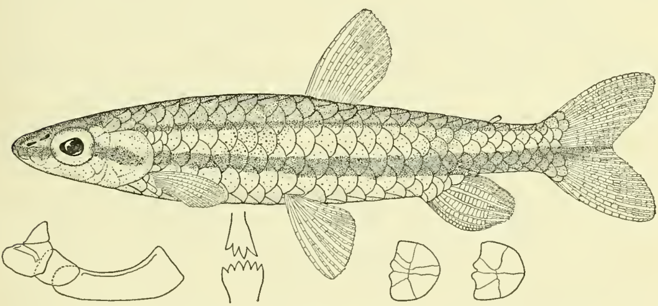

FIGURE 5.—*Nannostomus digrammus,* male, SL 24.5 mm., SU 50248.

Head conic but somewhat flattened dorsoventrally; snout obtuse in vertical and horizontal profiles. Top of head between eyes rather convex. Head 3.7 (3.5–3.8); eye in head 2.8 (2.5–3.0); snout in eye 1.2 (1.1–1.3); least width of bony interorbital in greatest eye diameter 1.2 (1.05–1.26).

Premaxillary with 6 teeth in anterior row, all quadricuspid; posterior 1 or 2 teeth of this row quinque- to sexcuspid, cusps being subequal. Central cusps of each tooth largest and longest. Maxillary with 1 quinque- to sexcuspid tooth. Dentary with 5 to 6 (usually 6) teeth in outer row, anterior 4 teeth with 6 cusps, posterior 2 teeth with 4 to 5 cusps, cusps subequal. Teeth in inner or second tooth row of dentary 1 to 4 in the alizarin specimens. Gill rakers 7+14 (alizarin specimens).

Dorsal fin ii,8; anal fin iii,8; pectoral i,8 to i,10; pelvics ii,7. Adipose fin present on all specimens, its base above scale row that runs diagonally to posterior base of anal fin. Caudal fin with principal rays 10/9. Distal tips of all elements of first 10 rays contained in upper caudal lobe. Lower lobe containing all distal tips of remaining 9 principal rays.

Highly modified anal fin of male *Nannostomus digrammus* (fig. 6) with an interesting structure. Unbranched anterior rays 3, followed by 7 once dichotomus branched rays; terminal or last ray unbranched. Last ray not divided to its base and with its own separate pterygiophore, or radial series. Except for anteriormost small ray hidden below scale at anterior base of anal fin, each of first 6 rays greatly expanded anteriorly and posteriorly. These rays arranged as follows in collapsed fin: Second ray (first large ray of anal fin) partially enclosed by anterior edges of ray halves of third anal ray. Thus appressed posterior borders of ray halves of second ray enclosed by 2 diverging anterior borders of third anal fin ray. Anterior edge of fourth anal ray (including both ray halves) lying to left of posterior border of third anal ray. Anterior border of fifth anal ray lying to right of posterior border of third anal ray and to right of entire middle region of fourth anal ray. Sixth anal ray lying to left of posterior border of fifth ray and will even slip to left of posterior border of fourth ray. Anterior edge of seventh anal ray lying to right of posterior half of sixth anal ray and posterior border of seventh ray lying to right of anterior border of eighth ray. Anterior border of ninth ray lying to right of posterior border of eighth ray, but tenth and eleventh rays with usual position in being just posterior to rays anterior to them. Fourth ray with its left lateral face convex, its right lateral face concave. Fifth ray, converse of fourth, and sixth ray with convex and concave faces facing same sides as fourth ray. This alternation continuing to eighth ray. Ninth through eleventh anal rays with little if any convexity or concavity.

Inclinator muscles extending bilaterally ventrally far beyond base of anal fin rays and inserting on lepidotrichs to about one-half length of tenth and eleventh anal fin rays. Similarly inclinator muscle extending ventrally beyond scales and inserting along basal one-fifth of second anal fin ray (fig. 6).

Many male nannostominans and some male pyrrhulininans have anal fins that are modified in a manner similar to that noted here for *Nannostomus digrammus*. However, none have their anal fin rays modified as greatly as those of *digrammus*. Species of nannostominans and pyrrhulininans that I have seen breeding in aquaria all have been capable, to a greater or lesser degree, of twisting the anal fin into a cup-shaped organ that is placed with the concave side almost over the female's vent during the act of laying an egg. Wickler (1957) has recorded some of the behavior of various species of nannostominans but has not noted the precise use of the anal fins. Although I have not seen the anal fin of the male *Nannostomus digrammus* in use, its morphology indicates that it undoubtedly changes greatly in shape during the spawning act.

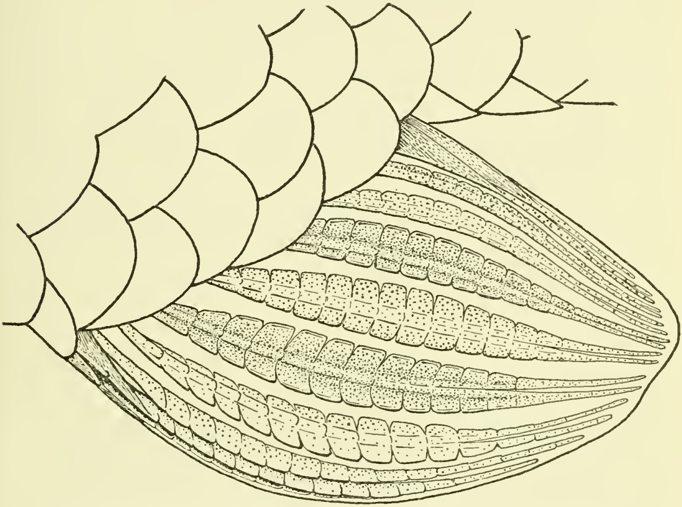

FIGURE 6.—Anal fin of male *Nannostomus digrammus*, SL 19.6 mm., SU 50251.

Radial grooves of scales belonging to third horizontal scale series and lying below dorsal fin shown in figure 5. Posterior field with 1 or 2 radial grooves; dorsal and ventral fields each with 1 and anterior field with 3 or 4 radial grooves. Scales in lateral series 25 to 26; no perforated lateral-line scales; scales in median series anterior to dorsal fin 10 to 11. Total number of vertebrae 34 to 35, 18 to 19 precaudals and 15 to 16 caudals, but always in a combination to produce a total count of 34 to 35 vertebrae.

COLOR IN ALCOHOL.—Top of head black. Primary horizontal stripe black, extending from snout tip and lower jaw onto anterior surface of eye, then from posterior surface of eye across lower border of fifth orbital bone and upper border of fourth orbital, then continuing over upper arm of preopercle onto opercle ending at about posterior bony border of opercle. On body, primary horizontal stripe begins anteriorly underneath fleshy opercular flap and extends through approximately lower half of fourth scale row and upper third of fifth scale row. Primary stripe widening posteriorly until, over anal fin, there covering entire fourth, and one-half of fifth scale rows. Posterior to this, primary horizontal stripe covering almost entire lower half of caudal peduncle and continuing as an acute wedge posteriorly over caudal fin, ending at base of caudal fork. Below primary horizontal stripe, sides and belly silvery with few irregularly scattered melanophores. Broad silvery stirpe extending from eye to caudal base above primary horizontal stripe. Silvery stripe with oblique band, about 3 scales long, located just anterior to dorsal fin. This area spotted with large, dark melanophores. Few small melanophores scattered over entire silvery stripe. Narrow, dark secondary horizontal stripe just dorsal to silvery lateral stripe, beginning at upper posterior edge of operculum and ending on upper part of caudal peduncle posterior to adipose fin. Dorsum pale brown above secondary horizontal stripe. Areas of head and eye not covered by dense black pigment, silvery with few scattered melanophores. Dorsal, pelvic, pectoral, and anal fins colorless. Caudal fin, in addition to having narrow wedge of primary horizontal stripe, with fairly dense aggregation of melanophores along first 3 upper principal rays of upper lobe. Some melanophores scattered over entire fin. Color in life not known with certainty.

Remarks.—*Nannostomus digrammus* was known previously only from the four specimens reported in the original description. However, this species has been imported as an aquarium fish. Several years ago a prominent aquarist, Mr. Frederick Stoye, sent a specimen of a nannostominan to Dr. George S. Myers at Stanford University. This specimen, labeled as the "gold anomalus," proved to be a large male *digrammus*.

All the specimens belonging to the original type lot of *digrammus* were females, and the holotype illustrated by Fowler shows the anal fin of a female.

Sterba and Tucker (1963, p. 209) believed the so-called "gold anomalus" to be Günther's original *Nannostomus beckfordi*. However Stoye's specimen mentioned above would seem to show that the "gold anomalus" of aquarists is *N. digrammus*. Aquarists' records of this fish cited by Sterba and Tucker (1963) are difficult to compare. Perhaps more than one species of fish is involved. However, live specimens of *Nannostomus beckfordi* from British Guiana are comparatively pale in color, never exhibiting the colors described for the "gold anomalus."

Specimens examined.—Two, paratypes, ANSP 39190 and 39191 SL 18.0–19.0 mm., Brazil, State of Amazonas, Rio Madiera, about 200 miles east of long.

62°20′ W., September 1912, Edgar A. Smith.—Eleven, MCA 19797, plus 2 alizarin specimens SU 50249, SL 16.3–19.4 mm., Brazil, State of Amazonas, Manáos, 1865, Louis Agassiz.—Two (male figured), SU 50248, SL 24.1–24.5 mm., Brazil, Pará, Igarapé do Sapucuá into Lagôa Sapucuá (This lake drains into the Rio Trombetas. The Trombetas flows into the Amazon from the north about 25 miles west of Obidos.), June 7, 1924, Carl Ternetz.—Fifteen, SU 50250, three alizarin preparations SU 50251, SL 18.0–22.8 mm., Brazil, State of Amazonas, Igrapé do Mãi Joana, a tributary of the Rio Negro near Manáos, Dec. 25, 1924, Carl Ternetz.—One, SU 18471, SL 27.6 mm., (a large adult male), an aquarium specimen sent to Dr. George S. Myers by Mr. Frederick Stoye.—Eight, SU 51024, SL 14.8–16.0 mm., British Guiana, Rupununi District, Nappi River, Rio Branco drainage, about lat. 30°30′ N., long. 59°32′ W., Sept. 29, 1957, Rosemary Lowe (McConnell).—One, SU 51025, SL 15.5 mm., British Guiana, Manawarin River, a tributary of the Moruka River about lat. 7°30′ N., long. 59°11′ W., July 16, 1957, Rosemary Lowe (McConnell).—One, SU 51026, SL 16.0 mm., British Guiana, Kumarow Creek pool into the Rupununi River, a tributary of the Essequibo River, Dec. 10, 1957, Rosemary Lowe (McConnell).—One, SU 50448, SL 17.2 mm., British Guiana, pool near Takatu River, Rio Branco drainage, Emprensa, Rupununi District, Dec. 8, 1957, Rosemary Lowe (McConnell).—One, SU 50450, SL 19.5 mm., British Guiana, Kumarow Creek Pool which flows into the Rupununi River in southern savannas of the Essequibo River Drainage, Dec. 10, 1957, Rosemary Lowe (McConnell).

Nannostomus trifasciatus Steindachner

Figure 7

Nannostomus trifasciatus Steindachner, 1876, p. 123, pl. 9, fig. 2 (original description; localities: backwaters and quiet tributaries of the Amazon close to mouth of the Rio Negro, Brazil; also Amazon at Tabatinga; types in Vienna museum).—Eigenmann and Eigenmann, 1891, p. 49 (listed).—Eigenmann, 1910, p. 427 (listed).—Innes, 1935, p. 155 (description from life and photograph) and later editions.—Hoedeman, 1950, p. 18 (description).—Axelrod and Schultz, 1955, p. 248 (description, aquarium notes).—Sterba and Tucker, 1962, p. 212 (description and aquarium notes).

?*Cyprinodon amazona* Eigenmann, 1894, p. 627 (in part; original description; type locality: Lower Amazonas; types apparently lost).—Garman, 1895, p. 28 (in part; copied description).—Hubbs, 1926, p. 16 (in part; discussion of identity).—Fowler, 1954, p. 216 (in part; listed).

Poecilobrycon erythrurus Eigenmann, 1909, p. 44 (original description; type locality: Rockstone, British Guiana; holotype in Chicago Natural History Museum).—Eigenmann, 1910, p. 427 (listed).—Eigenmann, 1912, p. 285, pl. 37, fig. 3 (description).

?*Cyprinodon amazonus* Eigenmann, 1910, p. 456 (in part; listed).

Poecilobrycon vittatus Ahl, 1933, p. 84, fig. (original description; type locality: "Pará"; type presumably in Berlin Museum); 1934, p. 124 (a longer, more useful description; no figure).

Nannostomus trilineatus (lapsus for *trifasciatus*) Innes, 1933, p. 142 (description from life).—Ladiges, 1948, p. 30 (description from life).

Nomenclatural note—The identity of *Cyprinodon amazona* is in doubt, but it seems most likely the fish is a synonym of either *Nannostomus trifasciatus* or *Nannostomus marginatus*. Eigenmann described the fish from 18 specimens collected by Frederick C. Hartt somewhere along the "Lower Amazon." Hubbs (1926), after examining the specimens, reported that the fish belongs to the genus *Nannostomus* and at that time Eigenmann, in personal communication with Hubbs, concurred in this referral. Neither Hubbs, Eigenmann, nor anyone else has tried to identify Eigenmann's syntypes of *amazona* with any known species of *Nannostomus.* Unfortunately, a check of various American museums and with Dr. Hubbs has not located the type specimens. From examination of Eigenmann's original description it seems probable that two species, *Nannostomus marginatus* and *N. trifasciatus,* were among the original specimens. Measurements and counts include the range of both species, and the color description could be of either species. It seems likely that the male mentioned by Eigenmann is *N. marginatus* but that some of the other specimens are most probably *N. trifasciatus.* The name *trifasciatus* Steindachner 1876 predates *amazona* Eigenmann 1894; however, *amazona* predates *marginatus* Eigenmann 1909; *Nannostomus marginatus* is a well-established name, especially in the aquarium literature, where it is used frequently. It would serve no useful purpose to substitute the name *amazonus* for *marginatus,* especially since some of the syntypes at least appear to have been *trifasciatus.* If the types of *amazona* are ever found and some of them prove to be *trifasciatus,* one of these should be selected as the lectotype and *Cyprinodon amazona* placed in the synonymy of *Nannostomus trifasciatus.*

Diagnosis.—This species, like *Nannostomus beckfordi,* lacks obvious unique characters, but it may be readily diagnosed by the following combination of characters: Anal fin rays completely unmodified; gill rakers 9+13; scales in a lateral series 26–27; perforated lateral-line scales 3 to 5; one maxillary tooth present; primary, secondary, and tertiary horizontal stripes present; 11 teeth in second tooth row of dentary.

Description.—Body elongate, somewhat cylindrical through anterior half, but sides flattened and body compressed posteriorly. Greatest depth lying between posterior tip of appressed pectorals and origin of dorsal fin. Standard length of largest specimen 28.2 mm. (a larger aquarium specimen, a male, measured at 32.5 mm.). Greatest body depth 4.6 (4.5–4.7); least depth of caudal peduncle 10.2 (10.0–10.4); length of caudal peduncle (including both sexes) 5.8 (5.6–6.1); snout tip to origin of dorsal 1.9 (1.8–2.0); snout tip to origin of anal 1.28 (1.27–1.30).

Head elongate, rather depressed, especially in snout region; top of head only slightly convex between eyes. Snout obtuse, especially so in dorsal profile. Head 3.6 (3.4–3.9) [Peruvian specimens 3.7–3.9, British Guiana specimens 3.4–3.6]; eye in head 3.0 (2.9–3.1); snout in eye 1.0 in all specimens examined; least width of bony interorbital in greatest eye diameter 1.0 in all specimens.

Premaxillary with 7 quinquecuspid teeth, lateroposterior cusp largest. Maxillary having 1 tooth with 4 or 5 cusps. Dentary with 8 sexcuspid teeth, cusps subequal and central cusps longest; 11 teeth in second row of dentary in alizarin specimens. Gill rakers 9+13.

Dorsal fin rays ii,8; anal iii,9; pectoral i,9 to i,10; pelvics iii,7. Adipose fin present in all specimens examined but reduced in size in some. Caudal fin with principal rays 10/9; distal tips of all elements of first 10 principal rays in upper caudal lobe. Lower caudal lobe with all elements of remaining 9 principal rays.

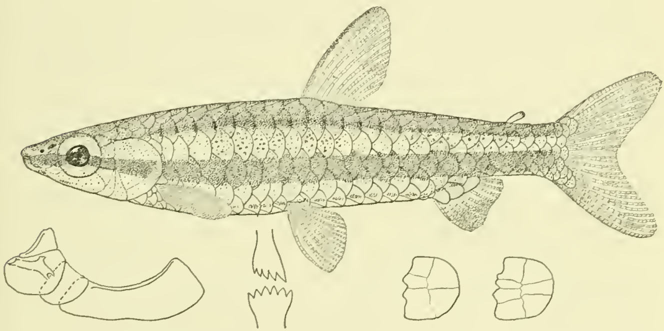

FIGURE 7.—*Nannostomus trifasciatus*, male, SL 27.5 mm., SU 36899.

Anal fins of male and female appear alike in this species; rays of male's anal fin not modified. Inclinator muscles appear slightly, if at all, more developed in male than in female.

Radial grooves of scales belonging to third horizontal scale series and lying below dorsal fin are shown in figure 7. Posterior field with 1 or 2 radial grooves. Dorsal and ventral fields each with 1 radial groove and anterior field with 2 to 4 radial grooves. Scales in a lateral series 26 to 27; 3 to 5 lateral-line scales and 10 scales in median series anterior to dorsal fin. Total number of vertebrae 35 to 36, 19 precaudal and 16 or 17 caudal vertebrae.

COLOR IN ALCOHOL.—Top of head light to dark brown. Primary horizontal stripe extending on head from snout tip and lower jaw posteriorly over first orbital bone across eye and operculum, terminating at posterior border of operculum. On body, primary horizontal stripe extending from under fleshy flap of opercle through fourth scale row and partially on adjoining third and fifth scale rows; expanding over anal fin to include one-half of third scale row and on caudal peduncle extending downward to all but the lowermost vertical scale row. Primary horizontal stripe ending on caudal peduncle in Peruvian specimens but extending posteriorly onto caudal fin as a very narrow wedge on most specimens from British Guiana.

Above primary horizontal stripe, pale stripe extending from eye to caudal peduncle. Melanophores scattered over entire surface of this stripe being thicker and heavier in region of fifth through eleventh and sixteenth to twentieth vertical scale rows. These areas constitute oblique bands. Secondary horizontal stripe dorsal to silvery lateral stripe, and extending from posterior upper end of gill cover through second row of scales onto caudal peduncle. Secondary horizontal stripe darker and wider at posterior margin of each scale in second row. Back above secondary horizontal stripe dark, rather densely covered with melanophores. Sides below primary horizontal stripe lightcolored with few scattered melanophores. On sixth scale row tertiary horizontal stripe extending from below operculum along sides of belly, where extending over or interrupted by pelvic fins, and then continuing to posterior end of base of anal fin. Tertiary horizontal stripe narrow and sometimes absent or restricted to region behind pelvic fins. Portion of tertiary horizontal stripe on head along surface of third orbital bone. Pectoral and pelvic fins without dense aggregations of melanophores. Sometimes rather weak aggregation of melanophores present along uppermost and lowermost principal caudal fin rays. Dorsal fin dusky on its anterior distal portion and first and second unbranched rays frequently dark. Anal fin of male and sometimes female dusky along its distal and anterior regions. Sometimes this duskiness not evident.

Color in life.—The color description given below agrees well with that given by Eigenmann (1909, p. 45) for live specimens of *Poecilobrycon erythrurus* from British Guiana. The specimens used here were collected in British Guiana by Louis Chung in 1955 or 1956 but are without definite locality. Midanterior region of dorsal fin with single bright red spot. Red spots on base of upper and lower lobes of caudal fins and bright red spots on anterior base of anal fin and proximal region of pelvic fin. In some specimens these red spots almost absent. Location of these spots well shown in color photograph by Innes (1953, p. 192). Photograph in Axelrod and Schultz (1955, p. 248) shows color of this species well. Primary horizontal stripe metallic pale green-gold. Caudal fin posterior to metallic pale green-gold stripe with few streaks of white pigment. Thin red line extending lengthwise through center of metallic pale green-gold stripe. Frequently this red line broken into series of streaks, reduced in length or absent. Laterodorsal and anterior surface of snout anterior to nostrils bright red. Also single red line in upper part of iris. Remainder of iris pale gold except where primary horizontal stripe extends through eye. Distal region of pelvics silvery blue, especially in male. In some specimens this color almost absent. Belly and region below primary horizontal stripe silvery white.

REMARKS.—*Poecilobrycon vittatus* of Ahl (1933) was described very poorly and the type locality is indefinite. Ahl, following Eigenmann, seemed confused about the identity of Steindachner's *trifasciatus* and *eques*, even though, for their time, Steindachner's figures and descriptions of these two species were excellent. Ahl believed his *vittatus* was related to Eigenmann's *erythrurus*, a form which perhaps could be recognized at most as a subspecies of *trifasciatus*. For the most part, Ahl's description of *vittatus* seems to fit the characters listed here for *trifasciatus*, and I concur with Hoedeman (1954) in considering *vittatus* a synonym of *trifasciatus*.

Eigenmann (1909, pp. 44–45) described *Poecilobrycon erythrurus* and noted that it was most closely allied to his own *P. marginatus* (now considered to be *Nannostomus marginatus*) and Steindachner's *P. trifasciatus*. Later Eigenmann (1912, p. 284) considered *Poecilobrycon auratus* to be synonymous with Steindachner's *Nannostomus trifasciatus*. He apparently had mentally transposed Steindachner's *trifasciatus* and *eques*. This probably caused Eigenmann to consider that his *erythrurus* (at most a subspecies of *trifasciatus*) was not *trifasciatus* and therefore that it was a distinct species. In any event, examination of some of Eigenmann's specimens of *erythrurus* and of specimens of *trifasciatus* from near the type locality of the latter indicates that the two forms are closely related and can be considered members of a widespread, somewhat polymorphic species. Adequate study of many samples from populations throughout the range of the species probably will show that there are several distinct races, some of which undoubtedly will be considered as subspecies. Schultz in Axelrod and Schultz (1955, p. 248) considered *Poecilobrycon auratus* Eigenmann a synonym of *Nannostomus trifasciatus*. Examination of type specimens of *auratus* shows it to be a synonym of *Poecilobrycon eques* (Steindachner) (p. 50).

SPECIMENS EXAMINED.—Three, SU 36900 (SL 24.5 mm.), SU 36999 (SL 27.0 mm.), SU 50221 (SL 27.0 mm.), Peru, Shansho Cano, Pévas [Pébas] District, July 28, Oct. 20, 1936 (date for third specimen unknown), W. G. Scherer.—One, SU 50222, SL 33.0 mm., Peru, Río Ampiyacu, Pévas [Pébas] District, July 23, 1944, W. G. Scherer.—Two (paratypes of *Poecilobrycon erythrurus* Eigenmann), CNHM 52974, SL 26.5–28.2 mm., British Guiana, Rockstone River, 1908, Carl H. Eigenmann.—Two (paratypes of *P. erythrurus*), CAS(IUM) 11693, SL 23.0–28.6 mm., British Guiana, Rockstone sandbank, Essequibo River, 1908, Carl H. Eigenmann.—One (paratype of *P. erythrurus*), CAS(IUM) 11694, SL 24.0 mm., British

Guiana, Gluck Island, Essequibo River, 1908, Carl H. Eigenmann.—One (paratype of *P. erythrurus*), CAS(IUM) 11695, SL 25.5 mm., British Guiana, Rupununi River, Twoca Pan, 1908, Carl H. Eigenmann.—One, CNHM 50162, SL 27.0 mm., British Guiana, Rockstone, Essequibo River, Mar. 1937, E. R. Blake.—Five, SU 50223 (one alizarin preparation), SL 25.0–30.0 mm., British Guiana, no other data.—Two, SU 18472 (one alizarin preparation), SL 31.5–32.0 mm., aquarium specimens said to be from "the Amazon," sent to Dr. G. S. Myers by Frederick Stoye, no other data.—Seven, SU 50220, SL 29.5–32.5 mm., aquarium specimens probably from British Guiana, 1955.—Two, SU 50434, SL 21.0–22.1 mm., British Guiana, Moreby Creek, Rupununi River near Karanambo, Essequibo drainage, Sept. 17, 1957, Rosemary Lowe (McConnell).—Two, SU 50437, SL 23.2–24.8 mm., British Guiana, Karanambo, "Grass Pond," Rupununi River, Essequibo drainage, Sept. 14, 1957, Rosemary Lowe (McConnell).—Two, SU 50432, SL 24.0–26.0 mm., British Guiana, "Crane Pond Creek," Karanambo Rupununi River, Essequibo drainage, Sept. 14, 1957, Rosemary Lowe (McConnell).—Two, SU 50440, SL 19.0–27.0 mm., British Guiana, Rupununi District, Nappi River and other Tocatú drainage creeks, Rio Branco drainage, Sept. 20, 1957, Rosemary Lowe (McConnell).

***Nannostomus marginatus* Eigenmann**

Figure 8

?*Cyprinodon amazona* Eigenmann, 1894, p. 627 (in part; original description; type locality: Lower Amazonas; types apparently lost).—Garman, 1895, p. 28 (in part; copied description).—Hubbs, 1926, p. 16 (in part; discussion of identity).—Fowler, 1954, p. 216 (in part; listed).

Nannostomus marginatus Eigenmann, 1909, p. 41 (original description; type locality: British Guiana, Maduni Creek, Mahaica River; holotype in Chicago Natural History Museum).—Eigenmann, 1910, p. 427 (listed); 1912, p. 281, pl. 37, fig. 4 (description).—Innes, 1935, p. 154 (description from life and photograph; see also later editions).—Hoedeman, 1950, p. 20 (description; figures).—Boeseman, 1952, p. 184 (Surinam); 1953, p. 16 (Surinam); 1954, p. 18 (Surinam).—Axelrod and Schultz, 1955, p. 241 (description and aquarium notes).—Sterba and Tucker, 1963, p. 211 (description and aquarium notes).

?*Cyprinodon amazonus* Eigenmann, 1910, p. 456 (in part; listed).

Nannostomus marginatus picturatus Hoedeman, 1954a, p. 87 (original description; type locality: "A ditch near Zonderij II, Surinam"; types in Amsterdam Museum).

Diagnosis.—This species is the deepest bodied of all nannostominans; only egg-filled females of *Nannostomus beckfordi* were found to have a body depth as great as the most slender specimens of *marginatus*. The body depth of *marginatus* is 3.5 to 4.0. Their caudal peduncle is the deepest of all nannostominans, 7.5 to 8.5 in standard length. In addition, *marginatus* may be distinguished from all other nannostominans by the following combination of characters: Primary, secondary, and tertiary horizontal stripes all present; maxillary tooth rarely present; 21 to 23 scales in a lateral series; 7+12 gill rakers; 31 to 33 vertebrae; male anal fin with unmodified fin rays.

Description.—Body elongate, robust; sides flattened and body compressed posteriorly. Greatest depth between posterior tip of appressed pectorals and anterior base of dorsal fin. Standard length of largest specimen examined 25.5 mm. Greatest body depth 3.8 (3.5–4.0); least depth of caudal peduncle 8.0 (7.5–8.5); length of caudal peduncle (including both sexes) 5.7 (5.3–6.2); snout tip to origin of dorsal fin 1.8 (1.8–1.9); snout tip to origin of anal 1.3 (1.2–1.3).

Head and snout obtuse in vertical and horizontal profiles, top of head convex between eyes. Head 3.4 (3.2–3.6); eye in head 2.8 (2.7–2.9); snout in eye 1.3 (1.3–1.4); least width of bony interorbital in greatest eye diameter 1.0 (1.0–1.1).

Premaxillary with 6 to 7 teeth, each quinque- to tricuspid, sometimes most anterior tooth with only 4 cusps; lateral cusps largest. In large specimens, largest cusp just medial to lateralmost cusp; cusps subequal in some specimens. Only 1 specimen, SU 50219 from Brazil, with any maxillary teeth; this specimen with 1 conical tooth on 1 side only. Dentary with 7 to 8 quinque- or sexcuspid teeth in first outer row. Most posterior tooth in dentary conical, bicuspid, or tricuspid. Specimens from Brazil (except specimens from Obidos) having dentary with quinquecuspid teeth, central cusp being largest. Specimens from British Guiana with lower jaw teeth having either 6 subequal cusps or 5 cusps with a large central cusp. Smallest Brazilian specimen with lower jaw teeth having almost subequal cusps, while some of largest specimens from British Guiana with very large central cusps on quinquecuspid teeth. Specimens from Obidos with 6 subequal cusps on lower jaw teeth and 5 subequal cusps on upper jaw teeth. Teeth 6 to 7 in second tooth row of dentary. Gill rakers 7+12 in all alizarin preparations.

Dorsal fin rays ii,8; anal iii,9; pectoral i,10 to i,13; pelvics ii,7. Adipose fin absent in all specimens examined. Caudal fin with principal rays 10/9; distal tips of all ray elements of first 10 principal rays in upper caudal lobe. Lower caudal lobe containing all elements of remaining 9 principal rays.

Anal fin of male and female alike. Rays of male's anal fin not modified. Inclinator muscle appears slightly, if at all, more developed in male than in female.

Radial grooves of scales in third horizontal scale series lying below dorsal fin shown in figure 8. Posterior field with 1 to 3 radial grooves. Dorsal and ventral fields each with 1 radial groove and anterior field with 2 to 4 radial grooves. Scales 21 to 23 in lateral series in all specimens examined and 3 to 5 lateral-line scales (usually 4); 10 scales in median predorsal series. Total number of vertebrae 31 to 33. Of 35 specimens from localities in Brazil, 32 with 32 vertebrae, 2 with 31 vertebrae and 1 with 33 vertebrae. Of 15 specimens from localities in British Guiana 9 specimens with 31 vertebrae, 1 with 33 vertebrae and 5 with 32 vertebrae. Precaudal vertebrae 17 to 19 and caudal vertebrae 13 to 14, never in a combination over 33 or under 31 total vertebrae.

Color in alcohol.—(Specimens from British Guiana). Dorsum of head light to dark brown. Primarily horizontal stripe beginning on lower part of snout tip and tip of lower jaw, extending to pupil of eye, then passing over posterior part of iris, across fourth and fifth orbitals to posterior edge of operculum. Primary horizontal stripe then continuing from under fleshy opercular flap posteriorly over lower portion of third scale row and upper half of fourth scale row to terminate as narrow black wedge on caudal fin. On caudal peduncle, primary horizontal stripe expanding downward to cover all but lowermost ventral scale row.

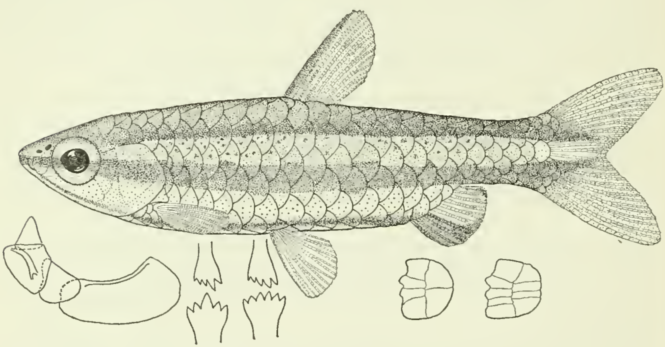

Figure 8.—*Nannostomus marginatus*, male, SL 19.5 mm., CAS(IUM) 11700 (see text for discussion of teeth).

Pale silvery stripe extending from eye onto caudal fin above primary horizontal stripe. Melanophores scattered over entire surface of this silvery stripe, thickest and heaviest in region of third through about eighth and thirteenth or fourteenth to sixteenth vertical scale rows. These darker areas representing oblique bands, one anterior, one posterior to dorsal fin. Silvery band most pale over hypural fan and on caudal fin between wedge-shaped portions of primary and secondary horizontal stripes. Secondary horizontal stripe dorsal to pale lateral stripe. Secondary stripe extending above opercular bone through upper part of second lateral scale row onto caudal fin, terminating on this fin as an acute wedge. Dorsum dark above secondary horizontal stripe, rather densely covered with melanophores, especially behind dorsal fin. Below primary horizontal stripe, sides white to very pale brown with few scattered melanophores. Tertiary horizontal stripe extending along sides of belly through sixth lateral scale row and across head over preopercle and third orbital bone to angle of jaw. Sometimes this stripe reduced in region of pectoral fins. Pectoral fin translucent; pelvic fin same except for thin line of melanophores along anterior 2 rays in some specimens. Dorsal fin dusky at its anterior base, its first two unbranched rays dark. Almost entire lower half of anal fin dark brown to black; its distal edge and upper edges also dark.

Color in life.—The color of aquarium specimens which are from an unknown locality, but which agree with Eigenmann's (1909, p. 42) brief color description of his material from British Guiana, is as follows: Midanterior region of dorsal fin with one red spot, ventral region of anal fin red; medial half of pelvic fins red. Color photo in Axelrod and Schultz (1955, p. 241) shows position of this red pigment well. A short red stripe along midupper border of primary horizontal stripe (which is black in life); half of this stripe on primary horizontal stripe and half on pale golden stripe above black horizontal stripe. This red stripe extending from about sixth to ninth vertical scale rows. A few streaks of white pigment at posterior end of pale gold band above primary horizontal stripe. This white pigment mostly confined to caudal fin rays between wedges of primary and secondary horizontal stripes. Lateral surface of the snout pale gold. Iris pale gold where melanin absent. Belly and region below primary horizontal stripe silvery white. Distal anterior parts of pelvics white.

Aquarium specimens which agree well with specimens recorded below from the lower Amazon have the following color: Red of fins almost absent except on dorsal fin. Red stripe on side of body absent. Secondary and tertiary horizontal stripes somewhat broader and more sharply delineated. Stripe above primary horizontal stripe not as golden as in presumed British Guiana specimens. Belly and area below primary horizontal stripe brownish white. White spot on caudal fin between wedges of primary and secondary horizontal stripes more intense.

Living specimens collected by White, Reynolds, and Wulff (see list of specimens below) from Colombia near Tres Esquinas have the following color: Proximal two-thirds and often entire length of fourth to sixth dorsal fin rays bright orange red. First 3 dorsal rays black, seventh to tenth rays and adjoining tissue hyaline. Middle rays of caudal fin red between dark caudal wedges (this region occupied by intense white in living specimens presumably from lower Amazon). Pelvic fins red except for anterior black border. Anal fin from its middle and posterior base out to one-third or three-quarters of its distal surface varying from silvery to golden yellow. Anterior base of pelvic fin and distal portion of its anterior 4 to 5 rays bright red. Distal tips of second to about fourth pelvic rays black. Belly silvery; area below primary horizontal stripe bright gold. Entire length above primary horizontal stripe with narrow iridescent gold or sometimes silvery-red stripe. Above this with a greenish dark-brown area, same color as top of head and dorsum. Primary, secondary, and horizontal stripes black. Iridescent golden to pale reddish spot near anterior nostril.

REMARKS.—*Nannostomus marginatus* has been reported only from the Guianas. It now appears to be a widespread polymorphic species found in the Guianas and in at least several widely separated areas in the Amazon Basin. Hoedeman's subspecies *picturatus* from Surinam is described very inadequately and some of the description appears to be in error. For example he reported a difference in caudal fin ray counts between the British Guiana and Surinam populations. He stated the caudal rays to be 10+10 in specimens from British Guiana and 8 to 9+9 to 8 in specimens from Surinam. All specimens of nannostominans and indeed all characids that I have examined, except for a few obviously abnormal specimens of the genera *Hyphessobrycon* and *Moenkausia*, have had a principal caudal fin ray count of 10/9 (equals 10+9). I am not sure whether Hoedeman counted principal caudal fin rays or only unbranched rays. However, he reported the wrong count for either method. It should be noted that in counting the principal caudal rays of two of Hoedeman's types of *N. bifasciatus*, the typical count of 10/9 was found. Hoedeman (1954a) reported 8(7)+8(7). Despite the probable errors in some of Hoedeman's counts, and possibly also his measurements, probably it will be found eventually that his subspecies *picturatus* is valid. Also the populations noted here from lower and upper Amazon Basin very probably will, when adequate material becomes available, prove to be sufficiently different to merit subspecific recognition. An example of the difference in teeth of different populations can be seen in figure 8. The two opposing teeth to the right are from British Guiana specimens [CAS (IUM) 11700] while those to the left are from Lagôa Grande, Brazil (SU 50219).

SPECIMENS EXAMINED.—Four, paratypes, CNHM 52776, SL 17.0–18.5 mm., Brutish Guiana, Maduni Creek, Mahaica River, 1908, Carl H. Eigenmann.—Two, CNHM 54932, SL 19.4–20.3 mm., British Guiana, Hubabu Creek, Demerara River, Oct. 1, 1910, Max Ellis.—One, paratype, SU 21941, SL 17.6 mm., British Guiana, Cane Grove Corner, Mahaica River, 1908, Carl H. Eigenmann.—Two, paratypes, CAS(IUM) 11697, SL 16.0–16.4 mm., British Guiana, Lama Stop-Off, Mahaica River, 1908, Carl H. Eigenmann.—One, paratype, CAS(IUM) 11698, SL (damaged), British Guiana, Crab Falls, Essequibo River, 1908, Carl H. Eigenmann.—One, paratype, CAS(IUM) 11699, SL 19.5 mm., British Guiana, Rockstone sandbank, Essequibo River, 1908, Carl H. Eigenmann.—Two, paratypes, CAS(IUM) 11700, SL 19.5–21.8 mm., British Guiana, Gluck Island, Essequibo River, 1908, Eigenmann.—One, paratype, CAS(IUM) 11701, SL (damaged), British Guiana, Christianburg Canal, Demerara River, 1908, Eigenmann.—Five, paratypes, CAS(IUM) 11702 (one alizarin preparation), SL 17.5–18.0 mm., British Guiana, Cane Grove Corner, Mahaica River, 1908, Eigenmann.—Thirty-two, SU 50219 (three alizarin preparations), SL 15.0–22.8 mm., Brazil, State of Pará, Lagôa Grande, Igrapé do Meritysál (probably Lagôa Grande do Javafy about 34 miles northwest of Santarém), Aug. 20, 1924, Carl Ternetz.—Four, SU 50218, SL 16.4–19.5 mm., Brazil, State of Pará, Igrapé Uruará, tributary of the Furo Maica about 10 miles southeast of Santarém, June 26, 1924, Carl Ternetz.—Two, MCZ 19645, SL 23.5–25.4 mm., Brazil, State of Pará, Obidos, 1865, Col. Bentos, Thayer Expedition.—Two, SU 50217, SL 20.0–22.0 mm., Brazil, State of Pará, Lagôa Grande (probably Lagôa Grande do Javafy about 34 miles northwest of Santarém), a stream into Ajamurí beach, July 17, 1924, Carl Ternetz.—One, SU 50555, SL 18.0 mm., Colombia, Caquetá Province, swampy pond about one-fourth mile inland from Río Orteguaza, across the river and slightly below Tres Esquinas, lat. 0°54′ N. and long. 75°15′ W., Feb. 8, 1958, 8–10 a.m., Gen. T. D. White, Col. J. N. Reynolds, Lee Wulff, and Dr. George S. Myers.—One, SU 50669, SL 16.5 mm., Colombia, Caquetá Province, small stream across Rio Orteguaza from Tres Esquinas, lat. 0°45′ N., long. 75°15′ W., Feb. 13, 1958, Gen. T. D. White, Col. J. N. Reynolds, Lee Wulff and Dr. George S. Myers.—Twenty-six, SU 50628, SL 16.0–22.1 mm., Colombia, Caquetá Province, small forest tributaries of Río Orteguaza on road from Tres Esquinas to Solano, lat. 0°45′ N., long. 75°15′ W., Feb. 12, 1958, Gen. T. D. White, Col. J. N. Reynolds and Lee Wulff.—Six, SU 50457, SL 18.0–18.4 mm., British Guiana, Ishalton, southern Rupununi District, Rupununi River drainage, tributary of Essequibo River, Dec. 12, 1957, Rosemary Lowe (McConnell).—Two, SU 50445, SL 17.5–19.6 mm., British Guiana, Atkinson Field Creek, near Hyde Park, tributary of Demerara River, Nov. 11, 1957, Rosemary Lowe (McConnell).—Eight, SU 50451, SL 16.0–17.0 mm., British Guiana, Kumarow Creek pool, tributary of Rupununi River in southern savannas, Essequibo River drainage, Dec. 10, 1957, Rosemary Lowe (McConnell).—Twenty-six, SU 50452, SL 16.2–18.7 mm., British Guiana, creek approximately 5 mi. south of Lumidpau, southern Rupununi savannas (flows into Rupununi River), Essequibo drainage, Dec. 11, 1957, Rosemary Lowe (McConnell).—Twenty-five, SU 50441, SL 15.7–19.5 mm., British Guiana, Rupununi District, Nappi River and other Tacatú drainage creeks, Rio Branco drainage, Sept. 20, 1957, Rosemary Lowe (McConnell).—Five, SU 50428, SL 16.5–19.0 mm., British Guiana, Manawarin River, tributary of the Moruka River about lat. 7°30′ N. and long. 59°00′ W., July 16, 1957, Rosemary Lowe (McConnell).

Genus *Poecilobrycon* Eigenmann

Poecilobrycon Eigenmann, 1909, p. 43 (type species *Poecilobrycon harrisoni* Eigenmann, 1909, by original designation).

Archicheir Eigenmann, 1909, p. 46 (type species *Archicheir minutus* Eigenmann, 1909, by monotypy).

Nannobrycon Hoedeman, 1950, p. 22 (type species *Nannostomus eques* Steindachner, 1876, by original designation).

Diagnosis.—The following two characters appear unique for this genus: Second infraorbital bone with a bony canal for infraorbital branch of latersensory canal. In addition, snout long, 0.8 to 1.2

in eye diameter. The members of this genus have, correlated with the long snout, a longer, narrower ethmoid and prevomer, a longer antorbital and infraorbital, and a longer mesopterygoid and nasal bone than do members of the genus *Nannostomus*. Primary and secondary horizontal stripes are present in all species, but a tertiary horizontal stripe is absent in 2 species. The anal fin rays may or may not be modified in males. The body is elongate in all species, the depth being 4.5 to 5.7 in standard length.

The name *Poecilobrycon* is derived from the generic names *Poecilia* and *Brycon*, the implied meaning being a *Poecilia*-like *Brycon*, i.e., a *Brycon*-like fish or characid with characters of the poeciliid fishes. This name probably occurred to Eigenmann because of the small mouth and numerous tooth cusps in *Poecilobrycon*. However, in detail, the mouth of nannostominans bears little resemblance to that of any poeciliid fish.

Subgenus *Poecilobrycon* Eigenmann

Diagnosis.—As in all members of *Nannostomus*, 10 principal rays of upper 4 hypural bones all enter upper caudal lobe. Lower lobe of caudal fin with dark pigment only at its base. Normal resting and swimming position horizontal. See under the subgenus *Nannobrycon* for a discussion of this character.

Poecilobrycon harrisoni Eigenmann

Figures 9, 10

Poecilobrycon harrisoni Eigenmann, 1909, p. 43 (original description; type locality: British Guiana, Canal at Christianburg, Demerara River; holotype in Chicago Natural History Museum); 1910, p. 427 (listed); 1912, p. 284, pl. 37, fig. 1 (description; British Guiana).—Hoedeman, 1950, p. 22 (copied description); 1954b, p. 89 (description; British Guiana).—Weitzman, 1964, p. 136 (osteology and relationships).

Archicheir minutus Eigenmann, 1909, p. 46 (original description; type locality: British Guiana, Canal at Christianburg, Demerara River; holotype in Chicago Natural History Museum); 1910, p. 427 (listed); 1912, p. 287, pl. 37, fig. 5 (description; British Guiana).

?*Nannostomus kumuni* Ladiges, 1948, p. 30 (name only listed, nomen nudum).

?*Nannostomus cumuni* Arnold, 1950, p. 63 (original description, from life, no type specimens).

Diagnosis.—This species may be distinguished from all other nannostominans by its greater number of vertebrae, 38 to 39, contrasted to 31 to 36. It may be recognized further by the following combination of characters: Second tooth row of dentary with 12 to 15 teeth; 7+13 gill rakers; iii,9 anal fin rays; 27 to 30 scales in lateral series; maxillary tooth present; fairly long caudal peduncle, 5.3–6.1 in standard length.

Description.—Body elongate, slender, sides only slightly flattened anteriorly and caudal peduncle compressed. Greatest depth lying just anterior to anterior base of dorsal and anal fins. Standard length of largest specimen 44.5 mm. One old aquarium specimen reached a standard length of 44.0 mm. after living 2½ years. Greatest body depth 5.4 (4.9–5.7); least depth of caudal peduncle 10.9 (10.4–12.1); length of caudal peduncle (including both sexes) 5.7 (5.3–6.1); snout tip to origin of dorsal fin about 1.9 in all adult specimens; snout tip to origin of anal fin about 1.3 in all adult specimens.

Head elongate and somewhat depressed. Top of head very slightly convex between eyes. Snout rounded in horizontal and vertical profiles. Head 4.0 (3.8–4.1); eye in head 3.2 (3.0–3.2); snout in eye 0.9 (0.8–1.0); least width of bony interorbital in greatest eye diameter 1.1 (1.0–1.2).

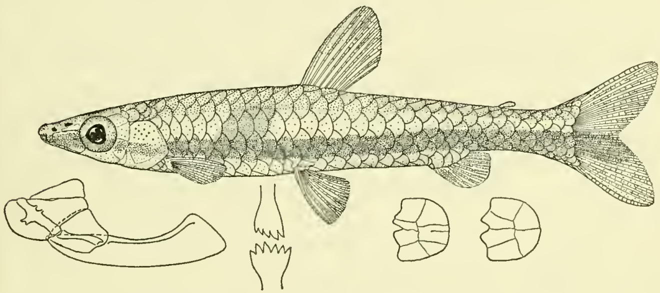

Figure 9.—*Poecilobrycon harrisoni* male, SL 38.5 mm., SU 50243.

Premaxillary with 7 quadri- to septemcuspid teeth. Most with 5 or 6 cusps; cusps subequal or posterolateral cusps most prominent. Maxillary with 1 conical, bicuspid, or tricuspid tooth. Dentary with 7 to 8 (usually 8) teeth in first row. Posterior 2 teeth with 3 to 5 subequal cusps, remainder of teeth in first row with 6 subequal cusps. Second dentary tooth row of about 12 to 15 small conical teeth. Gill rakers 7+13 in alizarin preparations.

Dorsal fin rays ii,8; anal iii,9; pectoral i,10 to i,11; pelvic fin rays ii,7. Adipose fin varying from well developed to rudimentary or absent. Caudal fin with principal rays 10/9; distal tips of all ray elements of first 10 principal rays included in upper lobe. Lower caudal lobe with all elements of remaining 9 principal rays.

Radial grooves of scales in median series below dorsal fin shown in figure 9. Posterior field with 1 to 4, dorsal and ventral fields 1, and anterior field 2 to 5 or 6 radial grooves. Scales in a lateral series 27 to 30 (usually 29). Lateral-line scales 3 to 5, usually 4. Scales in a median series in front of dorsal fin 11 to 13, usually 12. Total number of vertebrae 38 to 39 with 21 precaudal and 17 to 18 caudal vertebrae.

Color in alcohol.—Specimens from British Guiana, SU 50446, have the following colors: (The paratypes are coated rather heavily, apparently with lead oxide from a metal number tag, but agree well with the description below.) Top of head light to dark brown. Primary horizontal stripe extending from snout tip and lower jaw posteriorly over maxillary, first and second orbitals, and onto eye. From posterior part of eye, primary horizontal stripe extending to posterior edge of opercular bone. On body, primary horizontal stripe continuing from under fleshy opercular flap posteriorly through fourth scale row and part of fifth to caudal peduncle and caudal fin; on caudal peduncle extending over ventral body surface. On caudal fin, primary horizontal stripe not taking form of a narrow wedge but expanding to cover upper part of lower caudal lobe.

Above primary horizontal stripe a pale stripe extending from snout tip to caudal base. Dark area on sixth through eight vertical scale rows. Aggregation of melanophores on pale stripe vertically above anal fin. Secondary horizontal stripe apparently absent; entire dorsum above middle of second horizontal scale row light brown. Belly silvery, but posterior to pelvic fins in males becoming dusky. Pectoral fins translucent. Dorsal fin slightly dusky anterodistally but otherwise translucent and pelvics clear except for dusky distal band. Upper lobe of caudal fin slightly dusky. Anal fin translucent; in some specimens last ray black.

Color in life.—The colors of aquarium specimens, SU 50246, from Demerara River, British Guiana, are as follows: Dorsal and pectoral fins hyaline. Pelvic fin of male with proximal one-third to three-fourths of fourth to ninth pelvic rays orange red. These fins hyaline in female. Distal one-third of third through fourth pelvic rays and adjacent membrane silvery blue in both sexes. Anal fin of female hyaline with occasionally one spot of silvery blue on distal one-fourth of fourth anal fin ray. Male also with silvery blue disposed in same manner but proximal one-third to one-half of all anal fin rays bright red. Proximal portions of caudal fin lobes red above and below extension of primary horizontal stripe on fin rays. These areas silvery yellow with faint indications of red in females. Primary horizontal stripe black. Above this stripe a narrow silvery band and above this body shades to light or sometimes brown on dorsum. Metallic-red spot near anterior narial opening. Belly and sides below primary horizontal stripe white.

Remarks.—So far as is known *Poecilobrycon harrisoni* is restricted to British Guiana. All the aquarium specimens that I have seen over the past 10 years have had approximately the same color pattern. Thus it appears that aquarium fish collectors are collecting all their specimens from the same general area. Very probably this is from the vicinity of Georgetown in tributaries of the Demerara River, British Guiana, where the fishes are known to occur and where collectors are known to have been active in the last several years. In many respects, the color and breeding habits of *Poecilobrycon harrisoni* are like those of *Nannostomus beckfordi* suggesting that the two may have been derived from a common ancestor and may be related more closely than their morphology indicates.

The type of *Archicheir minutus* is the young of *Poecilobrycon harrisoni*. The type was studied at the Chicago Natural History Museum and found identical with young specimens of *harrisoni* spawned and raised in the author's aquarium.

Specimens examined.—Two, paratypes, CAS(IUM) 11709, SL 36.5–41.5 mm., British Guiana, Canal at Christianburg, Demerara River, 1908, C. H. Eigenmann.—Four, SU 50243, SL 34.0–38.0 mm., British Guiana, Georgetown.—Twelve, SU 50245 (one alizarin preparation), SL 31.0–37.5 mm., British Guiana, no other data.—Three, SU 50244, SL 13.3–44.5 mm., aquarium specimens, Aug. 21, 1956, S. H. Weitzman.—Eight, SU 50246, SL 9.5–37.5 mm., aquarium specimens from Demerara River, British Guiana, and their young aquarium spawned and raised, S. H. Weitzman.—Seven, SU 50446, SL 17.0–44.5 mm., British Guiana, Atkinson Field Creek, near Hyde Park, tributary of the Demerara River, Nov. 11, 1957, Rosemary Lowe (McConnell).

Subgenus *Nannobrycon* Hoedeman

Diagnosis.—Rays of caudal fin arranged unlike those of all other nannostominans; 10 rays of upper 4 hypural plates not all entering upper caudal lobe. Lowermost 2 of these rays enter lower caudal lobe, giving that lobe greater depth than upper lobe. Lower caudal lobe usually with dark pigment extending well onto fin, sometimes over its entire surface. Normal resting position of living members of this subgenus oblique, snout upwards. Angle of this oblique position is from about 45° to about 75° or 80°.

Remarks.—Hoedeman (1950) proposed *Nannobrycon* as a generic name for *Poecilobrycon eques* (Steindachner). In it he included only this species, believing *P. unifasciatus* to be a synonym of *P. eques*. Both species of this subgenus have the same peculiar caudal fin structure and behavior mentioned above. Hoedeman (1950) noted that the shape of the swim bladder of the members of this subgenus is different from those of all other nannostominans that he examined. However, he did not examine the swim bladder of *Poecilobrycon harrisoni*, as he had no specimens. The swim bladder differences that Hoedeman noted were crudely presented and are not suitable to distinguish *harrisoni* from *eques* and *unifasciatus*. However, the normal resting position of members of the subgenus *Nannobrycon* is so different from that of the single known member of the subgenus *Poecilobrycon*, and indeed from all other known nannostominans, that there is undoubtedly a difference in shape correlated with this swimming position. Critical morphological examination of the organs of equilibrium, the swim bladder, and musculature of the caudal fin of all nannostominans will possibly show sufficient differences for *Nannobrycon* to be retained as a full genus. Braemer and Braemer (1958) have started a project studying the behavior and position of the utricular statolith with reference to *Poecilobrycon eques* and other characids.

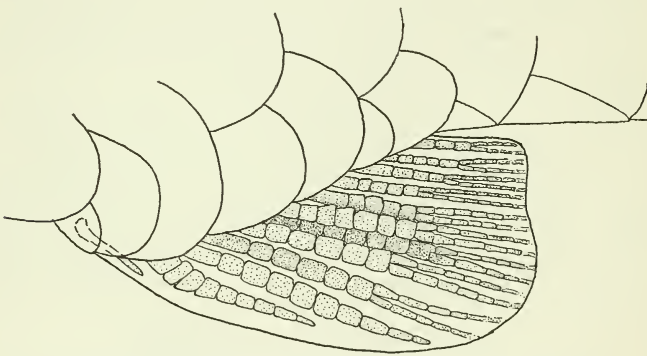

FIGURE 10.—Anal fin of *Poecilobrycon harrisoni*, SL 38.5 mm., SU 50243.

Poecilobrycon unifasciatus (Steindachner)

FIGURE 11

Nannostomus unifasciatus Steindachner, 1876, p. 127, pl. 9 (original description; localities: Mouth of the Rio Negro and Teffé on the Solimoens; types in Vienna Museum).—Eigenmann and Eigenmann, 1891, p. 49 (listed); 1910, p. 427 (listed).—Sterba and Tucker, 1962, p. 214 (description and aquarium notes; photographs are of *P. harrisoni;* also part of color description seems to refer to this species).

Poecilobrycon ocellatus Eigenmann, 1909, p. 45 (original description; type locality: British Guiana, Wismar, Demerara River, holotype in Chicago Natural History Museum); 1910, p. 427 (listed); 1912, p. 286, pl. 37, fig. 4 (description).

Poecilobrycon unifasciatus—Innes, 1935, p. 158 (description from life and photograph).—Axelrod and Schultz, 1955, p. 249 (description and aquarium notes).

Poecilobrycon eques (in part).—Hoedeman, 1950, p. 23.

Nannostomus ocellatus—Sterba and Tucker, 1962, p. 214 (description and aquarium notes).

DIAGNOSIS.—This species may be distinguished from all other nannostominans examined by the complete absence of a second row of teeth in the dentary; in addition, it may be distinguished by the following combination of characters: Adipose fin present; 33 to 34 vertebrae; 2 to 5 perforated scales in the lateral line; iii,9 anal fin rays; 9+14 gill rakers and 28 to 30 scales in a lateral series.

Description.—Body elongate, slender, and somewhat cylindrical anteriorly, but sides somewhat flattened; compressed posteriorly. Greatest depth anterior to dorsal fin and posterior to distal tips of appressed pectoral fins. Standard length of largest specimen 38.3 mm. Greatest body depth 5.0 (4.7–5.3); least depth of caudal peduncle 10.4 (10.0–11.2); length of caudal peduncle (including both sexes) in specimens listed below from Brazil 6.9 (6.7–7.5) and from British Guiana 6.2 (6.0–6.6); snout tip to origin of dorsal fin 1.9 (1.8–1.9); snout tip to origin of anal fin 1.2 (1.2–1.3).

Head elongate, somewhat depressed, especially over snout. Top of head slightly convex between eyes. Snout rounded in horizontal profile. Head 3.9 (3.9–4.0); eye in head, Brazilian specimens 3.0 (2.8–3.2), British Guiana specimens 3.4 (3.2–3.4); snout in eye 1.0 (0.9–1.2); least width of bony interorbital in greatest eye diameter 1.1 in all specimens from Brazil and 1.0 in all specimens from British Guiana.

Premaxillary with 6 to 7 quinquecuspid teeth. Posteriomost lateral tooth sometimes with only 3 to 4 cusps. Each maxillary with 1 quadricuspid tooth. Dentary with 6 or 7 quinque- or sexcuspid teeth, cusps subequal. Second row of dentary absent in all alizarin specimens. Gill rakers 9+14.

Dorsal fin rays ii,8; anal iii,9; pectoral i,9 to i,11; pelvics ii,7. Adipose fin present in all specimens examined. Caudal fin with principal rays 10/9. Distal tips of 8 principal rays in upper lobe and 11 in lower lobe.

Anal fin of males slightly modified. Male specimens examined from Venezuela and Brazil with anal fin shape as shown in insert in figure 11. This shape approaches that of anal fin of *Poecilobrycon eques* but fin of *P. unifasciatus* not as large. Second undivided ray expanded anteriorly and posteriorly, giving this ray a flattened appearance. Posterior margin of this ray fits into recess formed by 2 ray halves of expanded and flattened third unbranched ray behind. First branched ray with slight recess for the enlarged third ray. Inclinator muscle only slightly developed and beyond basal scales attached to ninth ray only. Specimens from British Guiana with anal fin of male less developed than specimens from Brazil and Venezuela. Anal fin of specimen from British Guiana resembles that of entire specimen in figure 11. Second and third unbranched and first and second branched rays only slightly enlarged. Anal fin of female from British Guiana, Brazil, and Venezuela with rays not at all enlarged. Male specimens from Brazil and Venezuela shorter than about 24 mm. in standard length with anal fins much like those of males from British Guiana. Possibly anal fin develops its pointed posterior border only in males longer than about 29 mm. in standard length.

Radial grooves of scales in that part of third horizontal scale series below dorsal fin rather variable but frequently resemble scales in figure 11. Posterior field with 1 to 3 (most frequently 2) radial grooves, dorsal and ventral fields with 1 and anterior embedded field with 2 to 6 radial grooves. Scales in a lateral series 28 to 30 (usually 29) and 2 to 5 (usually 4) scales in lateral line. Scales in a median series before the dorsal fin 11. Total number of vertebrae 33 to 34 with 21 precaudal and 12 to 13 caudal vertebrae. British Guiana

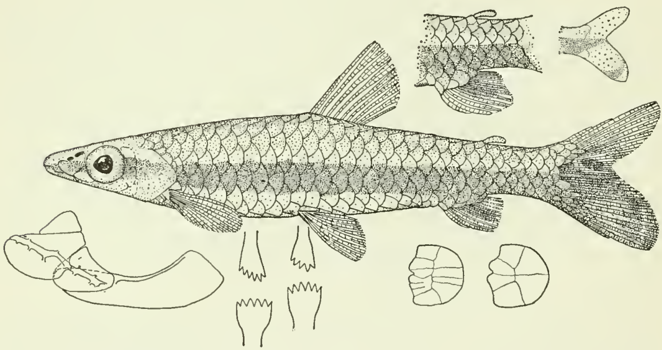

FIGURE 11.—*Poecilobrycon unifasciatus*, male, SL 33.4 mm., CAS(IUM) 11703 (see discussion for remarks on insert drawings of anal and caudal fins).

specimens all with 34 vertebrae and all specimens recorded below from Igarapé do Mãi Joana, near Manáos, with 33 vertebrae. Of specimens examined from Teffé, both with 33 vertebrae.

COLOR IN ALCOHOL.—(Specimens from British Guiana) Dorsum of head light brown. Primary horizontal stripe beginning on snout and lower jaw, extending posteriorly over maxillary and first orbital bone onto eye. Posteriorly from iris this stripe continuing across part of fourth and fifth orbitals to across opercular bone, not present on fleshy opercular flap and extending through fourth scale row to end of caudal peduncle as shown in figure 11. On caudal peduncle primary horizontal stripe expanding ventrally to include entire ventral area. On caudal fin primary horizontal stripe covering entire lower lobe except for crescent near lower posterior margin and central clear area as shown in figure 11. Upper lobe dusky near its basal, lower portion, and this dusky region with dark spot (ocellus) with a translucent area around it. Secondary horizontal stripe appearing absent and entire back light brown. Belly bright silvery with a dark spot in front of vent and a very small dark spot in front of pelvic fin base. Head below primary horizontal stripe bright silver. Pectoral, dorsal, and anal fins translucent. Anal fin with single dark spot in its basal and central regions. Preserved specimens from Brazil and Venezuela not differing in color except in caudal fin. Specimens from these areas lack an ocellus, except one from Venezuela with an imperfect ocellus. Also markings on lower lobe of caudal fin somewhat different. These well shown in figure accompanying Steindachner's original description. Preserved specimens from Igarapé do Mãi Joana at Manáos, with primary horizontal stripe extending onto caudal fin as a narrow wedge, and distal region of caudal fin dusky to dark (see upper right insert in fig. 11). Steindachner's figure shows primary horizontal stripe extending onto caudal fin as slightly widening band. However, all specimens that I have examined from Brazil and Venezuela with a caudal fin color pattern about as that shown in the upper right insert in figure 11.

Color in life.—Aquarium specimens from an unknown locality (but agreeing well with color of preserved specimens from British Guiana) had the following color pattern: Dorsal and pectoral fins hyaline; pelvic fin also hyaline except for second and longest ray, which is silvery blue on distal one-third to one-half of its length. Anal fin hyaline except for central black blotch and silvery white distal tips of fourth to seventh rays. Caudal fin variously colored, the upper lobe hyaline; area dorsal to black ocellus white, and below it creamy yellow to rich orange. Nonmelanistic areas on the lower caudal fin lobe creamy white to yellow suffused with varying shades of orange. Belly and throat regions white. Area below primary horizontal stripe white. Silvery white stripe especially distinct behind dorsal fin above black primary horizontal stripe. Above silvery stripe, dorsum and top of head light to medium brown. Bright metallic-orange spot near the anterior narial opening.

Remarks.—*Poecilobrycon unifasciatus* was known previously only from the mouth of the Rio Negro and Teffé and (under the name *Poecilobrycon ocellatus*) from British Guiana. The records listed below considerably enlarge its known range up the Rio Negro to the headwaters of the Río Orinoco in Venezuela. Hoedeman (1950) apparently did not have specimens of the true *unifasciatus*, or if he did, he confused them with *P. eques*. Hoedeman stated that some of the young from parents with the typical color pattern of *eques* look like typical *unifasciatus*. *Poecilobrycon eques* have spawned in my aquaria and I have raised the resulting young. Also I have seen young of *eques* raised by other aquarists. In none of these have I seen any specimens that look like *unifasciatus*. The description of *eques* given by Hoedeman is hard to follow and seems somewhat confused and inconsistent. However, his main thesis seems to be that the differences noted by Steindachner between *eques* and *unifasciatus* are those of age and sex. In any event, the descriptions given here should serve to distinguish *eques* and *unifasciatus* and put an end to further confusion. From the key and descriptions, it can be seen that the species are quite distinct in their morphology.

Specimens examined.—Thirteen, SU 50263 (three alizarin preparations, SU 50264), SL 27.0–34.8 mm., Brazil, State of Amazonas, Igarapé do Māi Joana into Rio Negro near Manáos, Dec. 24, 1924, Carl Ternetz.—One, MCZ 19769, SL 31.5 mm., Brazil, State of Amazonas, Lake Hyanuary, near Manáos, 1865–1866, Thayer Expedition, Mr. Navez.—One, MCZ 19935, SL 28.0 mm., Brazil, Jutahý, 1865–1866, Thayer Expedition, James, Thayer and Tailisman.—Two, MCZ 19787, SL 29.0–38.3 mm., Brazil, Lake José Assú, 1865–1866, Thayer Expedition, Louis Agassiz.—Fifteen, MCZ 19591, SL 25.0–33.0 mm., Brazil, State of Amazonas, Teffé, 1865–1866, Thayer Expedition, Louis Agassiz.—Two, SU 50266, SL 23.0–27.2 mm., Venezuela, Río Orinoco, Caño de Quiribana, opposite Pan de Azúcar, near Caicara, May 7, 1925, Carl Ternetz.—Five, SU 50265, SL 26.0–33.0 mm., Venezuela, Río Orinoco, creeks at high water into Laguna San Raphael, Caicara, Apr. 28, 1925, Carl Ternetz.—Two (paratypes of *P. ocellatus* Eigenmann), CAS(IUM) 11703, SL 31.2–32.8 mm., British Guiana, Demerara River, Wismar, 1908, Carl H. Eigenmann.—Ten (paratypes of *P. ocellatus* Eigenmann), CAS(IUM) 11704 (one specimen as alizarin preparation), SL 29.6–34.0 mm., British Guiana, Rockstone sandbank, Essequibo River, 1908, C. H. Eigenmann.—Two (paratypes of *P. ocellatus* Eigenmann), SU 21963, SL 31.8–33.5 mm., British Guiana, Rockstone, Essequibo River, 1908, Carl H. Eigenmann.—Three (paratypes of *P. ocellatus* Eigenmann), CAS(IUM) 11705, SL 29.2–37.1 mm. and three (paratypes of *P. ocellatus* Eigenmann) CNHM 52782, SL 32.0–34.0 mm., British Guiana, Gluck Island, Essequibo River, 1908, Carl H. Eigenmann.—Three (paratypes of *P. ocellatus* Eigenmann), CAS(IUM) 11706, SL 28.2–29.2 mm., British Guiana, Rupununi, Essequibo drainage, 1908, C. H. Eigenmann.—One (paratype of *P. ocellatus* Eigenmann), CAS(IUM) 11708, SL 30.0–33.5 mm., British Guiana, Konawaruk, Potaro River, 1908, C. H. Eigenmann.—Two, SU 19049, SL 31.0–34.4 mm., British Guiana, no other data.—Three, SU 19048, SL 27.0–28.0 mm., British Guiana, no other data.—One, SU 25613, SL 29.5 mm., aquarium specimen, no other data.—Two, SU 50267, SL 30.1–30.5 mm., aquarium specimens, no other data.—Two, SU 50268, SL 27.8–30.4 mm., alizarin preparations, aquarium specimens, no other data.—One, SU 50438, SL 30.6 mm., British Guiana, Karanambo, "Grass Pond," Rupununi River, Essequibo drainage, Sept. 19, 1957, Rosemary Lowe (McConnell).—Three, SU 50435, SL 23.2–31.4 mm., British Guiana, Moreby Creek, Rupununi River near Karanambo, Essequibo drainage, Sept. 17, 1957, Rosemary Lowe (McConnell).

Poecilobrycon eques **(Steindachner)**

FIGURE 12

Nannostomus eques Steindachner, 1876, p. 126, pl. 9, fig. 3 (original description; type locality: Peruvian Amazon above Tabatinga; types in Vienna Museum).—Eigenmann and Eigenmann, 1891, p. 49 (listed).—Sterba and Tucker, 1962, p. 215 (description and aquarium notes).

Poecilobrycon auratus Eigenmann, 1909, p. 43 (original description; type locality: British Guiana, canal at Christianburg; holotype in Chicago Natural History Museum); 1910, p. 427 (listed).—Innes, 1935, p. 156 (description from life and photograph).

Poecilobrycon trifasciatus.—(not Steindachner) Eigenmann, 1912, p. 284, pl. 37, fig. 2 (description).

Poecilobrycon eques.—Eigenmann, 1910, p. 427 (listed).—Eigenmann and Allen, 1942, p. 288 (listed).

Nannobrycon eques.—(in part) Hoedeman, 1950, p. 23 (description; photograph); 1954b, p. 82 (description; photograph); 1954b, p. 82 (description; photograph).

Diagnosis.—The unique feature of this species is its five lateral horizontal stripes. In addition it may be distinguished from all other nannostominans by the following combination of characters: No perforated lateral-line scales; 24 to 25 scales in lateral series; 33 to 34 vertebrae; iii,9 anal fin rays; 16+24 gill rakers; 12 teeth in the second tooth row of dentary.

Description.—Body elongate, somewhat cylindrical through anterior half, but sides flattened and compressed posteriorly. Greatest depth occurs between posterior tip of appressed pectorals and anterior base of dorsal fin. SL of largest specimen 35.0 mm. (largest aquarium specimen examined, a female, with SL of 37.0 mm.). Greatest body depth 4.5 (4.0–5.1); least depth of caudal peduncle 10.0 (10.0–11.0); length of caudal peduncle (including both sexes) 6.7 (6.0–7.1); snout tip to origin of dorsal fin 1.7 (1.7–1.8); snout tip to origin of anal fin about 1.3 in all specimens examined.

Head elongate, rather acute in vertical profile with tip of snout obtuse. Snout region somewhat depressed. Top of head very slightly convex between eyes. Head 3.5 (3.5–3.7); eye in head 3.3 (3.0–3.5); snout in eye 0.9 (0.8–1.0); least width of bony interorbital in greatest eye diameter 1.0 (0.9–1.0).

Premaxillary with 8 to 9 teeth, each quadri- to quinquecuspid, cusp next to posterolateral one largest. Maxillary with 1 quadri- or quinquescuspid tooth, cusps subequal. Dentary with 7 to 9 quinque- to sexcuspid teeth. Posterior 1 or 2 teeth usually with 3 cusps. Either central cusp or 2 posterolateral cusps largest (fig. 12). About 12 teeth in second dentary tooth row. Gill rakers 16+24.

Dorsal fin rays ii,8; anal iii,9; pectoral i,9 to i,11; pelvics ii,7. Adipose fin present or absent, seemingly not correlated with geographical origin. Caudal fin with principal rays 10/9; distal tips of 8 principal rays in upper lobe and 11 in lower lobe.

Anal fin of males enlarged and modified, but not as greatly as in *Nannostomus digrammus*. Second undivided ray expanded anteriorly and posteriorly, giving this ray a flattened appearance. Posterior margin of this ray fits into recess formed by 2 ray halves of expanded and flattened third unbranched ray behind. First, second, and third branched rays slightly flattened and expanded, first to greatest extent. These rays slightly ribbed. Rest of anal fin rays almost normal, being only slightly heavier than usual type of characid fin ray. Inclinator muscle attached to ninth ray only.

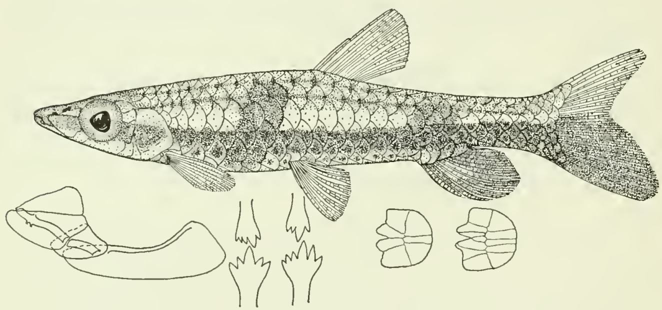

FIGURE 12.—*Poecilobrycon eques*, male, SL 29.0 mm., SU 50299.

Radial grooves of scales in third horizontal scale series below dorsal fin quite variable but general pattern shown in figure 12. Posterior field may have 1 to 4 radial grooves, anterior field 2 to 6 radial grooves and dorsal and ventral fields one radial groove each. Scales in a lateral series 24 to 25, no lateral-line scales and 11 or 12 predorsal scales. Total number of vertebrae 33 to 34, usually 18 to 19 precaudal and 15 caudal vertebrae.

COLOR IN ALCOHOL.—Top of head light brown. Nape, areas immediately above nares and eyes, central parts of frontals, and tip of snout, dark brown. Primary horizontal stripe beginning at tip of snout and lower jaw, extending posteriorly over first infraorbital to pupil of eye. Then extending from posterior edge of pupil to posterior edge of opercular bone. On opercle width of this stripe somewhat variable. On body, primary horizontal stripe beginning under fleshy opercular flap and extending posteriorly through entire fourth and fifth scale rows. In some specimens upper two-thirds of fourth scale row free of heavy pigment. Over anal fin primary horizontal stripe extending dorsally to cover lower half of third scale row. On caudal peduncle primary horizontal stripe extending ventrally to cover entire lower half of caudal peduncle and then posteriorly to include entire lower lobe of caudal fin. On fifth row of scales primary horizontal stripe frequently confined to center of each scale, producing spotted appearance. In some specimens this shows well, in others pigment expanded and covering entire fifth row of scales, making primary horizontal stripe appear solid. Above primary horizontal stripe a broad pale-yellowish stripe covering lower two-thirds of horizontal scale row. This stripe beginning on snout above primary horizontal stripe and extending posteriorly through caudal peduncle to caudal fin. Weak scattering of melanophores over this band. Region of posterior part of sixth to posterior edge of eighth vertical scale rows with a dense aggregation of melanophores extending from middle of first to middle of sixth horizontal scale rows. These are oblique bands, and they appear faintly to strongly in all preserved specimens examined. A dense aggregation of melanophores occurs over anal fin. Entire dorsum light brown and secondary horizontal stripe consists of dense aggregation of melanophores through center of each scale in second horizontal scale row. Fourth narrow horizontal stripe extending through first horizontal scale row. Third horizontal stripe present as a series of dark spots along sixth horizontal scale row, each dot being in center of scale. Belly and upper parts of head clear yellowish white. In some specimens third horizontal stripe present on head as a thin dark stripe on third infraorbital bone. Adipose fin, when present, frequently black. Dorsal, pectoral, and pelvic fins hyaline. Anal fin almost entirely black except for clear area in its midbasal region. Second undivided ray also hyaline.

Color in life.—Aquarium specimens from an unknown locality had the following color pattern: Pectoral, dorsal, and upper lobe of caudal fins hyaline. Anal fin dark brown or black except for clear area mentioned above; this area bright orange red. Large second ray of anal fin silvery blue for about one-third its proximal length. Pelvic fins hyaline except for small amount of silvery blue pigment along large second fin ray. Lower lobe of caudal fin dark brown or black, variously and sparsely mottled with pale gold or orange. Some specimens with slight suggestion of an ocellus as in specimens of *unifasciatus* from British Guiana. Bright pale-gold blotch in region of caudal fin between two caudal lobes. Bright silvery stripe extending from snout tip to caudal peduncle above primary horizontal stripe. Dorsum light to medium brown except where covered by darker stripes described above. Pale orange or yellow metallic spot in region of nares. Belly and throat white.

REMARKS.—As noted above under *Poecilobrycon unifasciatus*, Hoedeman (1950) confused *unifasciatus* and *eques*. However, as the two descriptions presented here show, these two names are applied to quite distinct species. As noted on page 28, under the remarks about *Nannostomus trifasciatus*, Eigenmann (1909 and 1912) was apparently confused in regard to the identity of Steindachner's *trifasciatus* and *eques*. This probably led to the description of *auratus*, a synonym of *eques*. In any event, comparisons of specimens of *eques* (including those described as *auratus*) from British Guiana, widely separated parts of the Amazon and Rio Negro Basins, and from the headwaters of the Rio Orinoco, show that this species is remarkably constant in its color pattern throughout its range, more so than any other widely distributed nannostominan.

SPECIMENS EXAMINED.—One, SU 36898, SL 31.0 mm., Peru, Pévas [Pébas] District, Shansho Caño, Sept. 20, 1936, W. G. Scherer.—Two, SU 50236, SL 23.0–33.5 mm., Peru, Río Ampiyacu, near Pévas [Pébas], Aug. 16, 1940, W. G. Scherer.—Four, SU 50237, SL 21.8–27.0 mm., Peru, Pévas [Pébas], 1940, W. G. Scherer.—Two, SU 50226, SL 26.2 mm., Peru, Yaguasyacú, July 7, 1941, W. G. Scherer.—Five, SU 50229, plus two alizarin preparations SU 50247, SL 28.4–30.5 mm., Brazil, State of Amazonas, São Gabriel, Rio Negro, rock pools below rapids, Feb. 1, 1925, Carl Ternetz.—One, SU 50227, SL 29.2 mm., Venezuela, mouth of the Casiquiare, Feb. 24, 1925, Carl Ternetz.—Two, SU 50228, SL 31.5–32.9 mm., Venezuela, Caño de Quiribana, near Caicara, May 2, 1925, Carl Ternetz.—One, SU 50233, SL 31.4 mm., Brazil, State of Pará, Igarapé do Sapucúa into Lagôa Sapucúa (this lake drains into the Rio Trombetas, a tributary of the Amazon River), June 7, 1924, Carl Ternetz.—Three, SU 50230, SL 25.4–25.7 mm., Brazil, State of Pará, Cabeceira Maturaca into Lagôa Grande, Nov. 1924, Carl Ternetz.—Four, SU 50231, SL 24.3–25.0 mm., Brazil, State of Amazonas, Igarapé do Mãi Joana, into Rio Negro near Manáos, Dec. 25, 1924, Carl Ternetz.—Three, SU 50232, SL 26.5–26.6 mm., Brazil, "Pará, Juntil lago Jará," Apr. 4, 1924, Carl Ternetz.—Six, MCZ 6312, SL 23.5–27.5 mm., Brazil, State of Amazonas, Lake Hyanuary, near Manáos, Oct. 28, 1865, Thayer Expedition, Louis Agassiz.—Three, MCZ 19473, SL 21.5–24.4 mm., Brazil, State of Amazonas, Villa Bella, 1865–1866, Thayer Expedition, Louis Agassiz.—Two, MCZ 19594, SL 24.0–24.5 mm., Brazil, State of Amazonas, region of Tabatinga, Sept. 20 to Oct. 20, 1865, Thayer, Expedition, Bourget.—Four, MCZ 19714, SL 24.6–28.5 mm., Brazil, State of Amazonas, Lagôa, Saracá, Silves, near Serpa (Itacutiara), 1865–1866, Thayer Expedition, Stephen Van Renssalaer.—Two, MCZ 19861, SL 21.0–21.5 mm., Brazil, State of Pará, Santarém, 1865–1866, Thayer Expedition, Bourget.—Seven, MCZ, 19646, SL 17.5–27.4 mm., Brazil, State of Pará, Obidos, 1865–1866, Thayer Expedition, Col. Bentos.—One, MCZ 19765, SL 27.4 mm., Brazil, State of Amazonas, Lake Hyanuary, near Manáos, 1865–1866, Thayer Expedition, M. Navez.—Thirteen, MCZ 19965, SL 24.0–27.5 mm., Brazil, State of Amazonas, Codajáz, 1865–1866, Thayer Expedition, Bourget.—Four, MCZ 19978, SL 25.4–30.5 mm., Brazil, Juturana, 1865–1866, Thayer Expedition.—Two, MCZ 19998, SL 25.7–27.0 mm., Brazil, Curupira, 1865 or 1866, Thayer Expedition, Major Coutinho.—One, SU 21964, SL 24.4 mm., and four CAS(IUM) 11688, SL 21.6–25.5 mm., British Guiana, Konawaruk, Essequibo River, 1908, Carl H. Eigenmann.—Three, CAS(IUM) 11690, SL 24.9–27.0 mm., British Guiana, Essequibo River at Rockstone, 1908, C. H. Eigenmann.—Five, CAS(IUM) 11690, SL 19.5–23.7 mm., British Guiana, Essequibo River at Gluck Island, Sept. 30, 1908, C. H. Eigenmann.—Two, SU 50234, SL 25.0–27.0 mm., British Guiana, no other data.—Four, SU 50225, SL 29.4–35.4 mm., aquarium specimens, no other data.—Three, SU 50224, SL 25.8–32.5 mm., aquarium specimens, alizarin preparations, no other data.

Discussion

In the course of this study three major problems have become apparent. The first of these is that of generic allocation; the second and really inseparable one is the relationships among the species; and the third and largest problem, left largely unworked by this study, is geographical variation and subspeciation. To untangle the nomenclatural mixup and mistaken identifications of past authors has presented some minor difficulties, and the conclusions reached are presented in the synonymies above.

Generic designation has proved difficult; indeed, I have believed at times that perhaps it would be best to place all generic and subgeneric taxa treated here under *Nannostomus*, following Sterba and Tucker (1962). However, it seems that to do this would obscure valid differences and relationships. It appears that the only valid difference between *Nannostomus* and *Poecilobrycon* is the presence or absence of a sensory tube in the second orbital bone. This difference seems small, but it proved to be remarkably constant in all specimens examined. The only other character found to correlate with this was a tendency for a longer snout in *Poecilobrycon* than in *Nannostomus*. However, measurements show an overlap in snout lengths even though individual bones of the snout region always seemed broader and relatively shorter in *Nannostomus* than *Poecilobrycon*. Both *Poecilobrycon eques* and *Poecilobrycon unifasciatus* are obviously closely related because of their caudal fin structure and swimming habits. Their tendency toward long snouts and their possession of tubed second infraorbital bones indicate a relationship with *Poecilobrycon harrisoni*. Indeed, the living color pattern of *unifasciatus* suggests relationships both with *harrisoni* and *eques*. These facts made it seem desirable to place these fishes under the genus *Poecilobrycon* with *Nannobrycon* as a subgenus for *unifsaciatus* and *eques*. The color pattern of *P. harrisoni* suggests relationships with *Nannostomus beckfordi*, and it is possible that they had a common ancestor. It thus seems that *Poecilobrycon* is most closely related to that section of the *Nannostomus* containing *beckfordi*.

A few groupings can be determined in *Nannostomus* itself. *Nannostomus trifasciatus* and *marginatus* are obviously closely related in color pattern and anal fin structure; indeed, a separate subgenus could be erected for their reception but I do not believe it advisable. *Nannostomus espei* appears apart from all other members of this genus in having the shape of certain scales and the color pattern similar to those of pyrrhulininans. However, a generic or subgeneric name does not seem advisable for this species. Whether these pyrrhulinian-like characters of *espei* indicate an archaic nature is problematical. I am inclined to believe that they are, especially when one considers that the body shape of this species is more like that of pyrrhulininans than any other nannostominan. On the other hand, it lacks the tube in the second orbital bone that is present in *Poecilobrycon* and the pyrrhulininans. Presumably the presence of this tube is a primitive character for nannostominans. It is possible that the loss of the tube in *espei* was independent of its loss in other species of *Nannostomus* and that my association of *espei* with species of *Nannostomus* rather than with *Poecilobrycon* is artificial. The problem cannot be settled with the morphological data at hand.

Nannostomus digrammus is likewise apart from other species of *Nannostomus* in the highly modified anal fin of the male. It appears, on basis of color pattern and premaxillary teeth, to be more closely related to *beckfordi* and *bifasciatus* than to any other known nannostominan.

Both *N. beckfordi* and *N. bifasciatus* appear related. They lack specialized or distinctive characters that set the other species of *Nannostomus* apart from them. They both lack an adipose fin; apparently both have at least some perforated lateral-line scales and have only moderately modified anal fins in the male. Their color patterns are somewhat different. However, until the color pattern and other characters of the widely distributed *beckfordi* can be studied adequately, it will remain difficult to evaluate its relationship with *bifasciatus*.

Concerning geographical variation within a species, *N. espei*, *N. bifasciatus*, and *P. harrisoni* appear to have restricted ranges, and little or no geographical variation was noted in the specimens utilized in the present study. *Nannostomus beckfordi*, *digrammus*, *trifasciatus*, *marginatus*, *Poecilobrycon unifasciatus*, and *eques* have a wide distribution in South America. Of these, *beckfordi* and *marginatus* were noted to have the greatest geographical variation. Indeed *beckfordi* is so variable that future work based on sufficient collections may show good reasons to recognize many subspecies and perhaps even species of this group of related populations.

Although some morphological, especially live color, variation correlated with geographical distribution was noted in *marginatus*, the close relationship of these population samples seems clearer than those of *beckfordi*. Some degree of difference was found in specimens of *trifasciatus* from Peru and British Guiana and this, it seemed, could be correlated with color differences in aquarium specimens said to have come from these respective areas. However, the source of the specimens was never reliable enough for serious consideration.

Insufficient specimens of *digrammus* in good condition were at hand to consider geographical variation in color pattern or other characters.

The presence or absence of an ocellus in *unifasciatus* seemed geographically correlated, along with a few other characters. Undoubtedly *ocellatus* and *unifasciatus* will be recognized as subspecies when sufficient study material becomes available.

Poecilobrycon eques seems remarkably constant over its large range from Peru to British Guiana. Both color pattern and morphology of preserved specimens seem quite stable, and I have not noticed any differences in live specimens said to be imported from Peru and British Guiana.

Summary

The characid subtribe Nannostomina (defined by Weitzman, 1964) contains two genera, *Nannostomus* and *Poecilobrycon*. *Poecilobrycon* is divided into two subgenera, *Poecilobrycon* and *Nannobrycon*. *Nannostomus* consists of six known species, *Poecilobrycon* of three, with two of these in the subgenus *Nannobrycon*. The species are as follows:

Nannostomus espei (Meinken)
  Paruma River, British Guiana.

Nannostomus beckfordi Günther
  British Guiana, south through French Guiana, and Surinam, and in the Amazon Basin as far west as the Rio Negro.

Nannostomus bifasciatus Hoedeman
  Surinam River, Surinam.

Nannostomus digrammus Fowler
  Rupununi district of British Guiana and west into Brazil as far as the Rio Negro.

Nannostomus trifasciatus Steindachner
  British Guiana, westward and south into the Amazon Basin as far as the Pébas district of Peru.

Nannostomus marginatus Eigenmann
  British Guiana, southward into the Amazon Basin and as far west as the Caquetá Province of Colombia.

Poecilobrycon harrisoni Eigenmann
  Demerara River, British Guiana.

Poecilobrycon unifasciatus (Steindachner)
  British Guiana, Rio Negro in Brazil north to Rio Orinoco in Venezuela.

Poecilobrycon eques (Steindachner)
  British Guiana south into Amazon Basin and west to Pébas region of Peru, Rio Negro north to Caicara in Venezuela.

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A REVISION OF THE HAMMERHEAD SHARKS (FAMILY SPHYRNIDAE)

By Carter R. Gilbert[1]

Introduction

The hammerhead sharks, so named because of the unusual lateral expansion of the head, comprise a moderately large family of sharks occurring in tropical and temperate waters throughout the world. They are a rather old group; fossil remains have been found in Eocene deposits from Virginia (Shelton P. Applegate, pers. comm.). The family belongs to the relatively speciose and poorly known suborder Galeoidea, in which are found most of the large and all of the dangerous kinds of sharks. Since the hammerheads are well defined, and, with one exception, adequate study material exists for all the species, they form an ideal taxon for systematic study.

The most recent works of a revisionary nature that have appeared on the hammerheads (Tortonese, 1950, pp. 1–39; Fraser-Brunner, 1950, pp. 213–219) list eleven and ten species, respectively; however, the above authors were unable to examine examples of all the species treated or all the extant types. Consequently, a number of conclusions were reached that now appear to be erroneous. The following

[1] Florida State Museum, University of Florida, Gainesville.

is a comparison of the systematic arrangements of the family Sphyrnidae, as presented by Tortonese and Fraser-Brunner, with a classification as determined from the present study:

Proposed	Tortonese, 1950	Fraser-Brunner, 1950
Subgenus *Eusphyra* Gill, 1861		
1. *Sphyrna blochii* (Cuvier, 1817)	*Eusphyra blochii* (Cuvier 1817)	*Sphyrna blochii* (Cuvier, 1817)
Subgenus *Sphyrna* Rafinesque, 1810		
2. *Sphyrna mokarran* (Rüppell, 1835)	*Sphyrna mokarran* (Rüppell, 1835)	*Sphyrna tudes* (Valenciennes, 1822)
	Sphyrna tudes (Valenciennes, 1822)	*Sphyrna ligo*, new species
3. *Sphyrna zygaena* (Linnaeus, 1758)	*Sphyrna zygaena* (Linnaeus, 1758)	*Sphyrna zygaena* (Linnaeus, 1758)
4. *Sphyrna lewini* (Griffith and Smith, 1834)	*Sphyrna lewini* (Griffith, 1834)	*Sphyrna lewini* (Griffith, 1834)
	Sphyrna oceanica (Garman, 1913)	*Sphyrna oceanica* (Garman, 1913)
	Sphyrna diplana Springer, 1941	
5. *Sphyrna couardi* Cadenat, 1951		
Subgenus *Platysqualus* Swainson, 1839		
6. *Sphyrna tiburo tiburo* (Linnaeus, 1758)	*Sphyrna tiburo* (Linnaeus, 1758)	*Sphyrna tiburo* (Linnaeus, 1758)
Sphyrna tiburo vespertina Springer, 1940	*Sphyrna tiburo* (Linnaeus, 1758)	*Sphyrna tiburo* (Linnaeus, 1758)
7. *Sphyrna media* Springer, 1940	*Sphyrna media* Springer, 1940	*Sphyrna media* Springer, 1940
8. *Sphyrna corona* Springer, 1940	*Sphyrna corona* Springer, 1940	*Sphyrna corona* Springer, 1940
9. *Sphyrna tudes* (Valenciennes, 1822)	*Sphyrna bigelowi* Springer, 1944	*Sphyrna bigelowi* Springer, 1944

Another nominal species, *Sphyrna nana*, which was recently described by Sadowsky (1965), is regarded as a synonym of *S. media*, for reasons discussed elsewhere in this paper.

Adequate study material exists for all of the above species, with the exception of *Sphyrna couardi*. I have not seen an entire specimen of this species, although I have examined a head; however, the morphology of the head and chondrocranium, together with the patterns of the Ampullae of Lorenzini, indicate that *S. couardi* is a valid form.

A number of structures have been studied that have proved to be useful in the delineation of the species of *Sphyrna*. All species can be distinguished on the basis of head shape alone. Head shape ranges from evenly rounded and spadelike (*Sphyrna tiburo tiburo*) to extremely wide and narrow (*Sphyrna blochii*). Some forms have an indentation on the median anterior margin of the head, while in others this indentation is lacking. The presence or absence of an outer narial and/or inner narial groove and the relative length of the latter help to distinguish even the smallest individuals of a particular species.

The various chondrocrania also are distinctive. Shape of both the anterior and posterior parts of the preorbital process, degree of development of the "wings" on the olfactory cartilage, development of the rostral "wings," shape of the rostral cartilage, presence or absence of accessory rostral cartilages, presence or absence of a rostral fenestra, and shape of the anterior fontanelle all differ from species to species.

The arrangement of the Ampullae of Lorenzini on the ventral surface of the head is relatively constant for each species, with the arrangement of those in the anterior-median area being particularly diagnostic. These ampullae, which are long canals filled with mucus, comprise a highly modified part of the lateral-line system, and it has been suggested that they may be involved in the detection of temperature changes, hydrodynamic pressure changes, tactile stimulation, and/or electric gradients (Young, 1962, p. 172). For brevity, these structures are referred to as mucal pores throughout this paper.

Teeth vary according to species, although in several instances the differences are rather slight. Shape and arrangement of the teeth, as well as the presence or absence of serrations, are distinctive.

There are differences between the species in size and shape of the fins and in the positions of these structures relative to each other. The positions of the fourth and fifth gill slits in relation to the insertion of the pectoral fin and the relative lengths of the gill slits are important. Finally, the various species differ in the presence or absence of a lower precaudal pit and the shape of the upper precaudal pit.

Recent studies by Drs. Victor G. Springer and J. A. F. Garrick (1964) on carcharhinid sharks indicate that the nature and number of the vertebrae can be an extremely useful taxonomic tool, often showing differences not evident from the study of external morphology. Unfortunately, the value of vertebral characters was not recognized while my study was in progress, and consequently only a few counts were made for the species of *Sphyrna*.

Other characters that are probably of taxonomic importance in hammerheads are the morphology of the pelvic claspers and the electrophoretic patterns of the serum proteins. The latter were not studied because of the unavailability of fresh specimens and lack of facilities. Because of the relatively small size and immaturity of the available specimens, claspers of only three species, *Sphyrna tudes*, *S. media*, and *S. tiburo*, were examined.

Another problem encountered was the scarcity of large specimens; however, I know of no taxonomically significant characters, with the exception of the pelvic claspers, that are not evident in the embryos and young. Although it would be desirable to know the full extent of the various morphometric changes occurring during growth, such data probably would not alter the present taxonomic conclusions.

The degree of confidence in the taxonomic conclusions reached in this paper is dependent largely upon the number of specimens available and on the extent of geographic coverage. The decision reached concerning the status of *Sphyrna mokarran*, therefore, does not rest on as firm a basis as for *S. lewini* and *S. zygaena* because far fewer specimens of *mokarran* were seen and the geographic coverage of the last two species was much better. Only one specimen of *Sphyrna tudes* from the Mediterranean was examined, and, as stated previously, *S. couardi* was represented only by a head. In the case of *S. tudes*, however, only one other specimen of this species outside of the western Atlantic area is known by me to be present in collections.

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Materials and Methods

Specimens examined or recorded are from the following museum collections: Academy of Natural Sciences of Philadelphia (ANSP); British Museum (Natural History) (BMNH); California Academy of Sciences (CAS); Field Museum of Natural History (formerly Chicago Natural History Museum) (FMNH); Museum of Comparative Zoology, Harvard University (MCZ); Museum National d'Histoire Naturelle (Paris) (MNHN); Scripps Institution of Oceanography (SIO); Stanford University (SU); University of California, Los Angeles (UCLA); Florida State Museum, University of Florida (UF); University of Miami, Institute of Marine Science (UMML); University of Pisa (Italy) (UP); University of Michigan, Museum of Zoology (UMMZ); United States National Museum (USNM).

Proportional measurements for all specimens were made according to the methods described by Springer (1964, pp. 562–568). Measurements are expressed in thousandths of total length (TL). Various external morphological characters are illustrated and labelled in figures 1 and 2. While the specimen on which figure 1 is based is not a member of the family Sphyrnidae, most of the characters apply equally to the hammerhead sharks.

Head-pore and chondrocranial terminologies (figs. 2, 3) are adapted from Daniel (1922, p. 59) and Tortonese (1950a, p. 9), respectively.

All radiographs of the chondrocrania were made on type M Kodak Industrial film with a "hard ray" machine (Miller, 1957, pp. 29–40).

Additional proportional measurements, other than those found in the tables, were also taken. These have not been included, however, since they give no information not already expressed by the measurements in the tables.

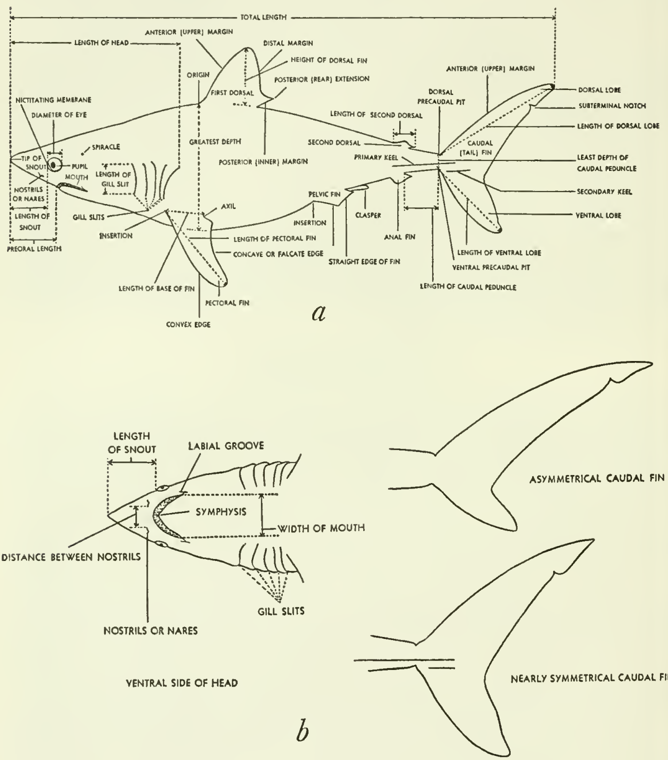


FIGURE 1.—External features of a shark with indications for measurement: *a*, lateral view of body; *b*, ventral view of head and comparison of caudal fins. (Drawings by Craig Phillips, from Garrick and Schultz, 1963, pp. 5, 6.)

As indicated in plates 7C, D, one of the main chondrocranial features separating *Sphyrna corona* and *S. media* is rostral cartilage length. This difference has been expressed as a ratio by dividing the rostral cartilage length by the distance between the tips of the preorbital cartilages (fig. 17). Values were obtained by measuring the distances between the points marked by X (rostral cartilage length) and Y (distance between tips of preorbital cartilage) in figure 3.

In addition, *S. corona* and *S. media* may also be distinguished by difference in snout length. The values have been expressed as a ratio by dividing snout length by head width; these are compared in figure 16.

In general, determination of the patterns of the Ampullae of Lorenzini on the ventral surface of the head becomes progressively easier with an increase in size of the individual. This is subject to variation, however, even within the same series of specimens.

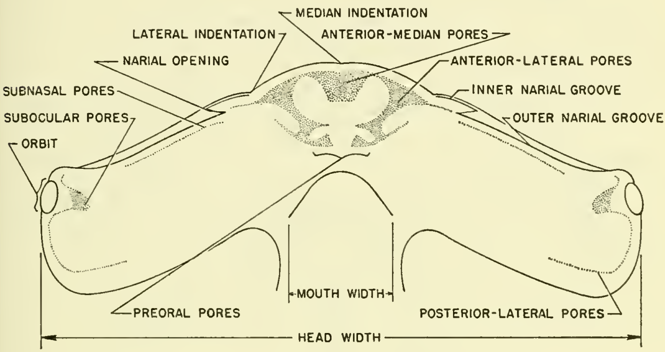


FIGURE 2.—Ventral side of head, showing important morphological features and mucal pore patterns (terminology of mucal pores adapted from Tortonese, 1950a, p. 9; drawing by Paul Laessle).

Since a whole specimen of *Sphyrna couardi* was not available and the head examined was seen after most of the figures were prepared, this species has not been included in the species key, in most of the tables, or in figures 4 and 22. Also, no diagnosis or description is given under the account of the species.

Information regarding life histories, morphometric changes resulting from growth, and zoögeography are usually included in separate sections rather than in the individual species accounts. If, in a species account, there is no discussion of morphological variation, it may be assumed that no noteworthy variation was discovered. New names, new combinations of names, and information pertaining to original descriptions and type material have been included in the synonymies; if the nomenclatural history of a species is of sufficient complexity, additional discussion is presented elsewhere in the species account. More complete synonymies, based on references for the western Atlantic region, may be found in Bigelow and Schroeder (1948).

Localities from which specimens were examined are represented on the distribution maps by solid symbols; literature records are represented by open symbols.

In the tabulation of proportions values have been separated, as much as practicable, by geographic area. In cases where paucity of specimens does not permit an adequate comparison, and if the specimens do not appear to be different from those from other areas,

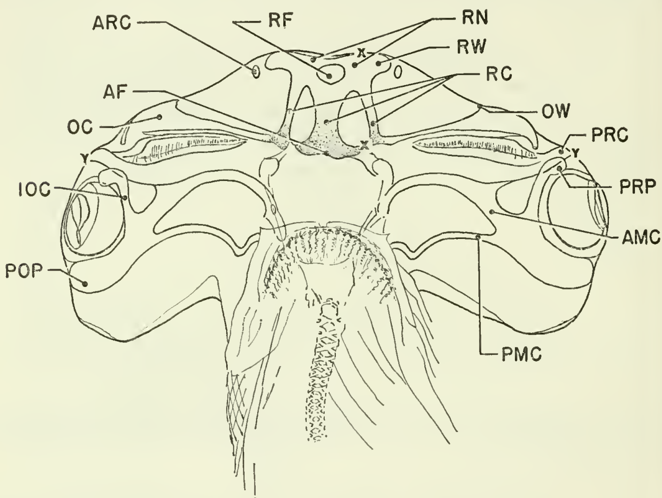


FIGURE 3.—Diagram of hammerhead chondrocranium (terminology adapted from Daniel, 1922, p. 59): AF (anterior fontanelle), AMC (anterior mediorbital connection), ARC (accessory rostral cartilage), IOC (innerorbital cartilage), OC (olfactory cartilage), OW (olfactory wing), PMC (posterior mediorbital connection), POP (postorbital process), PRC (preorbital cartilage), PRP (preorbital process), RC (rostral cartilages), RF (rostral fenestra), RN (rostral node), RW (rostral wing). (Drawing by Paul Laessle).

values have been combined. An exception to this was made in the case of the single specimen of *Sphyrna tudes* from the Mediterranean. This specimen is the holotype, and a comparison with material from the western Atlantic was desirable.

Classification

The hammerhead sharks have, in the past, been accorded family status by most of the investigators responsible for the major works on fish classification (Gill, 1861, pp. 403–412; Jordan, 1923; Berg, 1940), while others (Regan, 1906, pp. 722–758; Norman, unpubl. ms.) have regarded this group as a subfamily of the Carcharhinidae. Berg's action apparently was based primarily on the studies by White (1937).

Although White (1937) retained the Sphyrnidae as a distinct family, she gave no convincing reasons supporting this decision. Little was said about the relationships of the sphyrnids and carcharhinids, and the only places where they were compared were in the key and in the discussion of the pelvic claspers. While the pelvic claspers obviously constitute a valuable taxonomic character for the separation of various species, their value in determining interspecific relationships has been subject to question. According to White (1937, p. 94), "They [the claspers] tend to vary within the order [Galea] . . . so inconsistently that they are of little value in establishing relationships." Final judgment should be reserved until a more intensive study is made of most or all the species.

The sphyrnids and carcharhinids share a large number of morphological characters. Both have (1) the first dorsal fin anterior to the pelvic fins; (2) no naso-oral groove; (3) the keels of the dermal denticles complete and dentate on the posterior edge and situated on a flat surface; (4) a nictitating membrane; (5) teeth few in number, never multicuspidate; (6) an asterospondylic type of vertebrae, which has the appearance of a "maltese cross" when viewed in cross section; (7) a "scroll type" spiral valve; (8) three rows of valves on the conus arteriosus; and (9) an ovoviviparous type of reproduction.

The fact that the sphyrnids and carcharhinids have so many basic characters in common suggests a close relationship; however, most of these features are found also in other families, some of which are not intimately related to these two groups. The "maltese cross" pattern of the vertebrae is as well developed in the family Triakidae as it is in the carcharhinids and sphyrnids. In addition, the nictitating membrane, which has been thought to be unique to the latter two families, also occurs in the triakids (V. G. Springer and J. A. F. Garrick, in litt.).

Recent unpublished studies by Dr. Shelton P. Applegate indicate that the hammerheads, in addition to the pronounced lateral expansion of the head, differ from carcharhinid sharks in the following ways: (1) The vertebrae, in cross section, show a convexity of the uncalcified canal of the neural and haemal arches that is "butterfly-like" in shape, rather than straight, and (2) in the teeth the lower blade has a smooth, symmetrical arc, whereas in carcharhinid genera there is a definite break in the arc on the side away from the crown. I regard these differences as sufficient justification for continued recognition of the hammerheads as a distinct family.

Genus *Sphyrna* Rafinesque

Cestracion Klein *in* Walbaum, 1792, p. 580. (Type species, *Squalus zygaena* Linnaeus, by subsequent designation of Gill, Ann. Lyceum Nat. Hist. New York, vol 7, p. 403, 1861; name inadmissable, as result of International Commission rulings of 1907 and 1910.)

Sphyrna Rafinesque, 1810, pp. 46, 60. (Type species, *Squalus zygaena* Linnaeus, by subsequent designation of Jordan and Gilbert, U.S. Nat. Mus. Bull. 16, p. 26, 1883.)

Sphyrnias Rafinesque, 1815, p. 93. (Name substituted for *Sphyrna* Rafinesque, 1810.)

Cestrorhinus Blainville, 1816, p. 121. (Type species, *Squalus zygaena* Linnaeus, by subsequent designation of Fowler, Bull. Geol. Surv. New Jersey, vol 4, p. 77, 1911.)

Zygaena Cuvier, 1817, p. 127. (Type species, *Squalus zygaena* Linnaeus, by absolute tautonymy; genus name preoccupied by *Zygaena* Fabricius, 1775, for Lepidoptera.)

Zygoena Risso, 1826, p. 125. (Emended spelling for *Zygaena* Cuvier, 1817.)

Sphyrnichthys Thienemann, 1828, p. 408. (Substituted for *Sphyrna* Rafinesque, 1810.)

Zygana Swainson, 1839, p. 318. (Apparently a typographical error; should be spelled *Zygaena*.)

Platysqualus Swainson, 1839, p. 318. (Type species, *Squalus tiburo* Linnaeus, by original designation.)

Sphyra van der Hoeven, 1855, p. 68. (Emended spelling for *Sphyrna* Rafinesque, 1810.)

Reniceps Gill, 1861, pp. 403, 412. (Type species, *Squalus tiburo* Linnaeus, by original designation.)

Eusphyra Gill, 1861, pp. 403, 412. (Type species, *Zygaena blochii* Cuvier, by original designation.)

PHYLOGENY.—There has, in the past, been some question as to whether the genus *Sphyrna* has had a monophyletic or polyphyletic origin. Members of the genus are characterized by certain apparently basic morphometric characters, in addition to the widely expanded head, which indicate derivation from a single common ancestor. The most important of these are: No middorsal ridge on the posterior part of the back; dermal denticles not closely overlapping; teeth moderately to strongly oblique; labial furrow either small or absent; body deeply compressed; pectoral fin short. Of the above characters, the last two may have evolved in direct response to the lateral widening of the head, and thus should be viewed with caution. The remaining characters are not likely to have been affected by such a change, and are thus regarded as fundamental evidence of a close relationship among the species of *Sphyrna*. Perhaps the most convincing study supporting a monophyletic derivation has resulted from the work by Starr and Fosberg (1957, pp. 292–295, figs. 1 and 2), in which serum proteins were analyzed using electrophoretic techniques. Work done by various investigators (the most important and extensive being that of C. G. Sibley, of Cornell University, on birds) has shown that the patterns resulting from these analyses may be valuable indicators of higher relationships in the various groups of vertebrate animals. In the paper by Starr and Fosberg, analyses were made of the serum proteins from one specimen of *Sphyrna lewini*, two specimens of *Sphyrna tiburo*, two of *Rhizoprionodon terraenovae*, and two of *Aprionodon isodon*. The patterns of the latter two species, both of which are members of the family Carcharhinidae, differed notably from each other and from the patterns in the two species of *Sphyrna*. On the other hand, the patterns in *Sphyrna lewini* and *S. tiburo* showed a marked similarity, thus suggesting a close phylogenetic relationship. It would be desirable to run similar tests on *Sphyrna blochii*, which is the most divergent species of hammerhead and the one most likely to have evolved independently. Applegate (in litt.), however, informs me that the teeth in *S. blochii* are similar to those of other hammerheads, although he has not yet studied the vertebrae of this species. In all likelihood, the family Sphyrnidae has had a monophyletic origin.

Sphyrna tudes, *Sphyrna corona*, and *Sphyrna media* show a closer phylogenetic relationship than any other species of hammerheads (fig. 4). All possess a number of common morphological features, some of which are not found in other members of the genus (table 1, figs. 14–22, and pls. 7 C, D and 8). In addition, the three species share several other characters which, although not confined to them alone, further demonstrate a close relationship. The form in which the various characters most closely approach those found in the above species is *S. tiburo* (table 1, figs. 4, 11, 21, and 22, and pls. 7 A, B); as a result, these four apparently closely related species are grouped together in the subgenus *Platysqualus*. The respective lengths of the anal fin and anal fin base, the relative lengths of the gill slits, the diameter of the orbit in relation to the distance from the anterior edge of the orbit to the outer margin of the narial opening, the relative positions of the orbits and anterior part of the mouth, the presence of a lower precaudal pit, the appearance of the upper precaudal pit, and several chondrocranial characters all are similar in these four species. Finally, the species are comparable in size, all apparently reaching a maximum size of about 5 feet.

Within the subgenus *Platysqualus*, *Sphyrna media* seems to show a slightly closer relationship to *S. tiburo* than does *S. corona*. This assumption is based, first, on the greater overall similarity of the chondrocrania (pls. 7 A–D), as well as similarities in appearance of the anterior-median pore patch (figs. 22*e*–*h*).

The fifth species, *Sphyrna blochii*, is strikingly different from all other species of *Sphyrna* in several characters. The extreme expansion of the head, the presence of an outer narial groove, the greatly decreased total number of vertebrae, and the marked enlargement of the vertebrae situated over the posterior part of the coelom are all unique to this species, and it is consequently placed in a separate subgenus, *Eusphyra*. *S. blochii* is so different from the other hammerheads that recognition of *Eusphyra* as a genus would not be unwarranted.

Contrary to the relative ease with which the relationships of the preceding species are discerned, those of *Sphyrna zygaena*, *S. lewini*, *S. couardi*, and *S. mokarran* are more difficult. The main feature indicating a fairly close interrelationship among these species is similarity in maximum size. All reach a total length of at least 12 feet, more than twice that attained by any other members of the genus. *S. zygaena* and *S. lewini* (and probably *S. couardi*) have certain features in common, such as a low second dorsal fin with a long lobe; a short anal fin base, the length of which is never more than slightly greater than the pectoral base; a long slender anterior part of the preorbital process of the chondrocranium; a deeply falcate anal fin; and a deep, widely V-shaped upper precaudal pit, with a definite ridge on the anterior margin. This suggests that they probably are more closely related to each other than to *S. mokarran* (fig. 4, table 1, and figs. 6–10).

The following examples, however, illustrate the difficulties one encounters in attempting to determine the relationships of *S. zygaena*, *S. lewini* (including *S. couardi*) and *S. mokarran:* The overall shape of the rostral node, anterior-median pore patch, and anterior part of the preorbital process in the chondrocranium of *Sphyrna zygaena* are most similar to those found in *S. blochii; S. zygaena* and *S. mokarran* are the only hammerheads lacking a wing on the olfactory cartilage; *S. lewini* and *S. mokarran* are the only members of the genus that ordinarily have a rostral fenestra; *S. mokarran* and *S. blochii* have, as do *S. tudes*, *S. media*, *S. corona*, and *S. tiburo*, a rather tall second dorsal fin; *S. mokarran* has, as do *S. tudes*, *S. media*, *S. corona*, and *S. tiburo*, a blunt, clublike knob at the end of the anterior part of the preorbital process of the chondrocranium; and *S. mokarran* is unique, among the hammerheads, in having a deeply falcate pelvic fin.

Despite the difficulties encountered in interpreting the relationships of the above four species, they appear to be related more closely to one another than to any other group of species of *Sphyrna* and thus are included in the subgenus *Sphyrna*.

In the preceding discussion, nothing was said regarding head width, although this is almost the only basis for previous separations of the genus *Sphyrna* into separate genera and subgenera. For example, Tortonese (1950a, pp. 3–6) placed *Sphyrna tiburo* in the subgenus *Platysqualus* and placed *Sphyrna blochii* in a separate genus, *Eusphyra*. Although I have followed both of these allocations (in modified form), the differences in head width have had comparatively little to do with my decision.

The phylogenetic conclusions may be summarized as follows:

1. The nine species of *Sphyrna*, on the basis of morphological evidence and electrophoretic analyses of serum proteins, likely evolved from a single common ancestor.

2. *Sphyrna tudes*, *Sphyrna corona*, and *Sphyrna media*, with numerous identical morphological characters, some of which are unique, are regarded as the most closely related members of the genus *Sphyrna*.

3. *Sphyrna tiburo*, with a number of morphological characters similar to those in *S. tudes*, *S. corona*, and *S. media*, appears to occupy a phylogenetic position intermediate between these three species and other members of the genus *Sphyrna*. Therefore, because of their close relationship, the four species are placed in the subgenus *Platysqualus*.

4. *Sphyrna blochii* possesses several characters that are markedly different from those found in other hammerheads, such as an extremely expanded head, an outer narial groove, a reduced number of vertebrae, and enlarged vertebrae over the posterior part of the coelom. It is placed in a separate subgenus, *Eusphyra*, although elevation of this taxon to the generic level might be justified.

5. The interrelationships of *Sphyrna zygaena*, *S. lewini*, *S. couardi*, and *S. mokarran* are more difficult to determine, although *zygaena*, *lewini*, and *couardi* seem to show a closer relationship to each other than to *mokarran*. The most important feature shared by the four species is their large maximum size. They are referred to the subgenus *Sphyrna*.

Growth changes.—Certain modifications in shape of the head of sphyrnids occur with increase in size and age, for which there is nothing comparable in other carcharhinid sharks. In young hammerheads, particularly embryos, the anterior margin of the head is more or less broadly rounded, becoming gradually straighter with increase in size and age until sometimes, as in *Sphyrna mokarran* and *Sphyrna tudes*, this margin is nearly straight (figs. 7*a* and 20*c*). In *Sphyrna blochii*, which has the most widely expanded head of any member of the genus, the lateral extensions of the head in embryonic and early postembryonic specimens are nearly parallel to the body axis (fig. 5*c*). With an increase in size of the individual, these structures become situated nearly perpendicular to the body (fig. 5*b*). It has long been thought that such changes in head shape would make hammerhead taxonomy a difficult problem. Such is not the case.

Those head characters of greatest importance in distinguishing species of sphyrnids, such as structure of the chondrocranium, nature of the intranarial and extranarial grooves, and pattern of the mucal pores on the ventral surface of the head, appear to change very little throughout life, whereas the shape of the fins may be modified with an increase in body size. Other postcephalic features seem to remain fairly constant.

Negative allometric growth occurs in the head of sphyrnids since, with an increase in total body length, there is a proportional decrease in the following characters: Width of head, tip of snout to nares, tip of snout to orbit, tip of snout to symphysis of jaws, diameter of orbit, and intranarial width.

The shape of the upper precaudal pit, changing with an increase in size of the individual, undergoes the greatest modification during

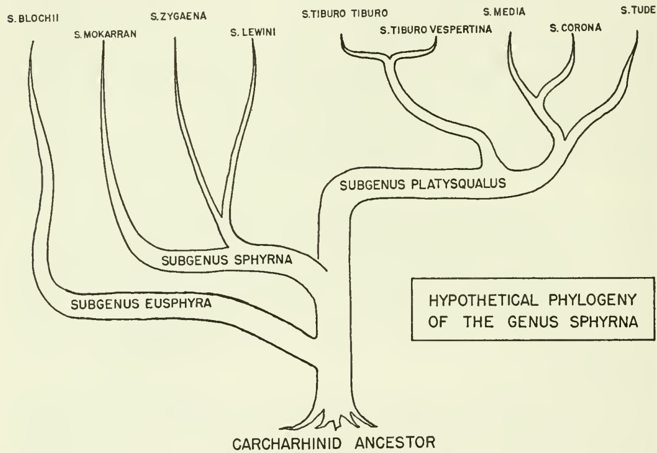


FIGURE 4.—Hypothetical phylogeny of the genus *Sphyrna* (figure by Paul Laessle). (*S. couardi*, which was not included, is closely related to *S. lewini*.)

early growth and likely reaches its final form before the shark is 1,000 mm. long; this is illustrated, from specimens of *Sphyrna media* measuring 356 and 900 mm. TL, in figures 21*f*, *g*.

Other morphometric changes are indicated with an increase in size (tables 2–9), although more large specimens must be examined before the validity of these changes can be established. Pronounced modifications, particularly in length of the trunk between the axil of the pectoral fin and the insertion of the pelvic fin, have been shown to occur in squaloid sharks (Garrick, 1960, pp. 546–548). Since most squaloids do not reach a very large size, however, considerable changes in body proportions can occur with a relatively small increase in total body length. The galeoid sharks, on the other hand, usually reach a much larger size, and thus proportional changes are not likely to be so pronounced within a comparable size range.

As indicated previously, a straightening of the fins and fin lobes occurs as the shark approaches maturity. In this process the fins (particularly the first dorsal) become increasingly more erect and pointed, whereas the anal fin tends to become somewhat more falcate. In contrast to these true morphometric changes are the unfolding of the fins after birth, a phenomenon that might be compared with the situation in a newly emerged butterfly. Curling of the fins is most pronounced in embryos of *Sphyrna mokarran*, although the reason for this is not clear.

The dermal denticles undergo a noticeable morphological change with an increase in size and age, showing an increased number of "teeth" on the posterior margin. As indicated by Bigelow and Schroeder (1957, p. 24), however, this does not result from changes in the original denticle, but instead occurs as the result of one or more denticle replacements.

In *Sphyrna lewini* there is a progressive darkening of the tips of the pectoral fins with increasing size and age, so that in large specimens these extremities are black. This also may be true to a greater or lesser degree for *S. zygaena* and *S. mokarran*, although I have not yet substantitated it.

Variation among specimens of the same species is discussed under the accounts of the individual species.

Life history and ecology.—No detailed discussion of hammerhead ecology is presented here, since most of the available information has appeared in works by Springer (1939, pp. 9–41; 1940b, pp. 188–194), Bigelow and Schroeder (1948, pp. 407–449), and Baughman and Springer (1950, pp. 96–152). The following is a summary of the information appearing in their papers.

The larger species of *Sphyrna* (*S. zygaena*, *S. mokarran*, *S. lewini*, and, presumably, *S. couardi*) apparently occur both in inshore and offshore waters and have even been known to move into brackish areas. *S. tiburo*, in contrast, seems to prefer shallow embayments and rarely ventures far from land. Little is known about the habitat of the remaining three species.

Hammerheads swim near the surface of the water. It is doubtful if any species descends to very great depths, since there have been no verified captures below a hundred fathoms (Stewart Springer, in litt.).

Sphyrnids feed largely on fish and squid and also may take such items as shrimp, crabs, stingrays, and sharks, including individuals of their own species. The larger hammerheads are regarded as dangerous, and there are substantiated records of fatal attacks on humans (Gudger, 1937, pp. 417, 418).

Hammerheads along the eastern North American coast are known to migrate northward in summer and southward in winter, often traveling in schools in both inshore and offshore waters (Bigelow and Schroeder, 1948, pp. 442–444). To the north, *Sphyrna zygaena* is the only species involved in such migrations, whereas, to the south, *S. lewini* is the predominant species. The fact that the only specimens of *Sphyrna zygaena* seen by me from south of the Carolinas (UMML 5639 and UMML 10444, from Miami, Fla.) were taken in winter seems to confirm this. Presumably similar migrations occur in other parts of the world.

Although *S. media* and *S. corona* have been taken in the same areas from Panama Bay north to southern Mexico (map 5), in only one of the collections examined (from Chiapas, Mexico) were the two actually taken together. Whether this is due to a partial ecological separation or simply to lack of material is presently not known.

The number of young in a brood appears to be directly proportional both to size of the individual and to maximum size of the species. The smallest recorded brood (8) was found in *S. tiburo*, the largest (38) in *S. mokarran*.

Zoogeography.—The present distribution of the hammerhead sharks indicates, on the whole, a slow rate of evolution. The members of the subgenus *Sphyrna* (*S. zygaena*, *S. lewini*, *S. couardi*, and *S. mokarran*) apparently have undergone no intraspecific differentiation, despite worldwide distributions (for three of the four species) and long periods of separation of the various segments of their respective populations. The five forms included within the subgenus *Platysqualus* (*S. tudes*, *S. corona*, *S. media*, *S. tiburo tiburo*, and *S. tiburo vespertina*) are morphologically similar to one another, and thus presumably have undergone a more recent evolution. Only in the case of *S. tiburo* is it possible to estimate how long it has taken for evolution to have occurred, because the two subspecies probably differentiated following the most recent (Pliocene) emergence of the Central American isthmus. However, the presence of individuals of this species with a head shape more or less intermediate between typical *tiburo* and *vespertina* indicates that the above explanation may not be as simple as first appears. Possibly the initial separation goes farther back and the intermediate examples have resulted from a partial reamalgamation of the stocks.

Insufficient evidence exists to explain the present distribution of *S. tudes*, *S. corona*, and *S. media*. Evolution of these three species is almost certainly correlated with the various submergences and emergences of the Central American land mass, although it is impossible to determine the exact sequence of events. Judging from morphological evidence, however, *S. tudes* evolved first, later followed by differentiation of the other two species. The presence of *S. tudes* in both the Mediterranean and western Atlantic is unusual in that few species display such a distribution pattern. This common occurrence may be due either to recent migration in one direction or the other, or to a long period of isolation during which the two populations have, for some reason, failed to differentiate to the species level.

The distribution of *Sphyrna zygaena* is a classic example of an antitropical distribution (Ekman, 1953, p. 250). Presumably the now-disjunct north-south distribution of this species (map 2) was continuous during one or more of the Pleistocene glacial periods, when equatorial waters were cooler than at present. As the glaciers retreated and seas became warmer, *S. zygaena* gradually disappeared from the tropical regions, perhaps remaining for a time in deeper waters where temperatures were cooler (equatorial submergence).

One may conclude from present distributions that the subgenus *Platysqualus* evolved in the western Tethys Sea, a prehistoric body of water that formerly extended from the Eastern Pacific-West Indian region to what is now southeast Asia (Ekman, 1953, pp. 63–67). Should it have evolved in the Indo-Pacific region, one or more species of the subgenus would likely still be found there, since environmental conditions in this area have remained stable over a long period of time. The subgenus *Eusphyra* apparently evolved in the Indo-Pacific, as the only included species, *Sphyrna blochii*, is restricted to that region. It is impossible to determine the center of origin of the subgenus *Sphyrna*, since three of the species in this group have a worldwide distribution.

Key to Species of *Sphyrna*

(Based primarily on specimens 1,000 mm. TL or smaller)

1a. Greatest maximum width of head almost 50 percent of total body length; outer narial groove present; nares not present near eyes, situated more than half distance from eyes to anterior-median notch; upper precaudal pit as in figure 21*a;* anterior-median pores on ventral surface of head as in figure 22*a;* chondrocranium as in plate 5. . . . **Sphyrna blochii** (Cuvier) Indo-Pacific region, from Persian Gulf to northern Australia and southern Philippines.

1b. Greatest maximum width of head not more than 32 percent of total body length; outer narial groove absent; nares present near eyes; upper precaudal pit not as in figure 21*a;* anterior-median pores on ventral surface of head not as in figure 22*a;* chondrocranium not as in plate 5 2

2a. Anal fin and base longer, former measuring from 9.8 to 13.5 percent, and latter from 6.5 to 9.9 percent of total body length; fifth gill slit about as long as first gill slit, both somewhat shorter than three middle slits; fifth gill slit situated above insertion of pectoral fin; orbit smaller, its horizontal diameter less than shortest distance from anterior edge of orbit to outer margin of narial opening (at least in smaller specimens); teeth relatively weak, median ones often more or less needle-like in appearance; lower precaudal pit present (may also be present in *S. lewini*); posterior lobe of first dorsal fin extending beyond insertion of pelvic fin (in *S. tudes*, *S. corona*, and *S. media* only); maximum size smaller, the largest specimens probably not over 4 or 5 feet TL . . . 3

3a. Head not widely expanded, greatest width about 21 percent of total body length (usually less than 20 percent); anterior margin of head evenly rounded or slightly pointed in median line, never with median notch; posterior lobe of first dorsal fin terminating anterior to insertion of pelvic fin; origin of first dorsal fin situated well posterior to axil of pectoral fin; eyes not situated distinctly anterior to mouth, line drawn between posterior margins of orbits either intersecting or passing just anterior to symphysis of lower jaw; upper precaudal pit as in figure 21*e*; anterior-median pores on ventral surface of head as in figure 22*e*; chondrocranium as in plates 7A, B 4

4a. Head with more evenly rounded anterior margin (fig. 12*b*); greatest width of head measuring slightly less as shown in table 6; fig 13

Sphyrna tiburo tiburo (Linnaeus)

Western Atlantic, from New England to southern Brazil.

4b. Head with less evenly rounded anterior margin (fig. 12*a*), usually coming to a point at tip of rostrum; greatest width of head measuring slightly more as shown in table 6; fig. 13.

Sphyrna tiburo vespertina Springer

Eastern Pacific, from southern California to Equador.

3b. Head widely expanded, the least width 22 percent of total body length; anterior margin of head not always evenly rounded, usually with a more or less distinct median notch (sometimes evenly rounded in *S. media*); posterior lobe of first dorsal fin terminating posterior to insertion of pelvic fin; origin of first dorsal fin situated above or slightly posterior to axil of pectoral fin; eyes situated anterior to mouth, line drawn between posterior margins of orbits passing well anterior to symphysis of lower jaw; upper precaudal pit not as in figure 21*e*; anterior-median pores on ventral surface of head not as in figure 22*e*; chondrocranium not as in plates 7A, B 5

5a. Inner narial groove present; well-defined median notch present on anterior margin of head; anterior-median pores on ventral surface of head as in figure 22*h*; chondrocranium as in plates 8A, B.

Sphyrna tudes (Valenciennes)

Gulf of Mexico south to Uruguay; also recorded from western Mediterranean Sea.

5b. Inner narial groove absent; no well-defined median notch present on anterior margin of head (poorly defined notch may be present in some individuals); anterior-median pores on ventral surface of head not as in figure 22*h*; chondrocranium not as in plates 8A, B . . . 6

6a. Distance from tip of snout to symphysis of upper jaw slightly shorter, usually less than 40 percent of head width (table 7; fig. 16); anal fin more deeply falcate, with a more pointed apex (figs. 14*a*, 15*a*); mouth slightly broader (figs. 14*b*, 15*b*); anterior-median pores on ventral surface of head as in figure 22*f*; chondrocranium as in plate 7c; maximum size possibly larger, the largest specimen

examined about 3½ feet long . . . . . **Sphyrna media** Springer
Eastern Pacific, from Panama to Gulf of California; also in southern Caribbean and southwestern Atlantic, from Panama to Brazil.

6b. Distance from tip of snout to symphysis of upper jaw slightly longer, usually more than 40 percent of head width (table 8; fig. 16); anal fin less deeply falcate, with a more rounded apex (fig. 18*a*); mouth slightly narrower (fig. 18*b*); anterior-median pores on ventral surface of head as in figure 22*g*; chondrocranium as in plate 7D; maximum size possibly smaller, the largest specimen examined a little over 2 feet long . . . **Sphyrna corona** Springer
Eastern Pacific, from Colombia to southern Mexico.

2b. Anal fin and base shorter, former measuring from 8.2 to 10 percent, and latter from 3.8 to 6.7 percent of total body length; fifth gill slit shorter than first gill slit (fourth gill slit about as long as first gill slit); fifth gill slit situated behind insertion of pectoral fin; orbit larger, its horizontal diameter greater than shortest distance from anterior edge of orbit to outer margin of narial opening; teeth broad, not needle-like in appearance; lower precaudal pit absent; posterior lobe of first dorsal fin not extending to above insertion of pelvic fin; maximum size larger, some individuals reaching 20 feet TL 7

7a. Inner narial groove absent; pelvic fin falcate; second dorsal fin higher, length of its anterior margin greater than length of anterior margin of anal fin; lobe of second dorsal fin shorter, not extending nearly to caudal pit, and, when extended vertically upward, about equal to greatest height of fin; teeth strongly serrate, even in small individuals; anterior-median pores on ventral surface of head as in figure 22*b*; chondrocranium as in plate 6A . . . . **Sphyrna mokarran** (Rüppell)
Circumtropical in distribution, but apparently absent from the more isolated oceanic islands.

7b. Inner narial groove present; pelvic fin not falcate; second dorsal fin lower, length of its anterior margin less than length of anterior margin of anal fin; lobe of second dorsal fin longer, extending nearly to caudal pit, and, when extended vertically upward, definitely exceeding greatest height of fin; teeth smooth in small individuals, often weakly serrate in large individuals; anterior-median pores on ventral surface of head not as in figure 22*b*; chondrocranium not as in plate 6A 8

8a. Median notch absent from anterior margin of head; inner narial groove extending at least halfway from narial opening to median part of anterior margin of head; base of anal fin shorter, about equal in length to base of second dorsal fin and slightly less than base of pectoral fin; rostral fenestra ordinarily absent; anterior-median pores on ventral surface of head as in figure 22*c*; chondrocranium as in plate 6C.

Sphyrna zygaena (Linnaeus)
Antitropical in distribution; occurring in cooler waters of northern and southern hemispheres, but absent from intervening tropical waters.

8b. Median notch present on anterior margin of head; inner narial groove not extending halfway from narial opening to median part of anterior margin of head; base of anal fin longer, greater in length than bases

of either second dorsal or pectoral fins; rostral fenestra present; anterior-median pores on ventral surface of head as in figure 22*d*.*
Sphyrna lewini (Griffith and Smith)
Circumtropical in distribution; common in all warm seas.

**Sphyrna couardi* Cadenat keys out to this point, but was not included here since a whole specimen was not examined. It differs from *S. lewini*, however, in having a deeper and more robust head (pl. 9), in minor differences in the chondrocranium (pl. 10), in having the anteriomedian pore patch completely instead of partially divided, and (according to the original description) in having the tips of the pectoral fins white.

Dignaosis of Family and Genus

Distinguished primarily by the shape of the head, which is expanded laterally, and which is accompanied by a corresponding modification of the chondrocranium. Eyes situated at tips of lateral expansions, and nares situated at varying distances along anterior margin of head. Olfactory capsules and orbital region widely expanded, and the three rostal cartilages broadly expanded where joined anteriorly. Midline of back posterior to first dorsal fin without a middorsal ridge. Second dorsal fin always much smaller than first dorsal. Body compressed, the depth of the trunk (measured at origin of first dorsal) from 4 to 5½ times in distance from tip of snout to upper precaudal pit. Caudal peduncle about two-thirds as wide as deep. Upper precaudal pit strongly developed. Lower precaudal pit present in some species, absent in others; when present, not as prominent as upper pit and only about half as wide.

Subgenus *Eusphyra* Gill

The subgenus *Eusphyra*, which includes only *Sphyrna blochii*, is distinguished by the following unique characters: Head extremely expanded, the greatest width from 42.0 to 49.2 percent of total body length; outer narial groove present; total number of vertebrae few (117 and 124 in two specimens examined); body vertebrae 51 to 54, there being from 15 to 16 fewer body than caudal vertebrae; vertebrae over posterior part of coelomic cavity expanded in size; upper precaudal pit merely a narrow longitudinal groove (fig. 21*a*); orbit separated from nares by a distance many times diameter of orbit; a unique anterior-median pore patch on underside of head, the patch characterized by a sharp, pointed angle at outer-posterior corner and a more or less straight posterior edge (fig. 22*a*); and various chondrocranial characters (pl. 5).

Sphyrna (Eusphyra) blochii (Cuvier)

FIGURES 5, 21*a*, 22*a*; PLATES 1, 5

Squalus zygaena (misidentification) Bloch, 1785, vol. 1, pl. 117. (Figure.)
Zygaena blochii Cuvier, 1817, p. 127. (Original description [in footnote]: "Ajoutez l'espèce représentée par Bl. 117, reconnaissable à ses narines placées bien plus près du milieu [*Z. Nob. Blochii*]. Sa deuxième dorsale est

aussi bien plus près de la caudale. L'espèce à large tête, donnée, sous le nom de *pantouflier*." Description based on figure in Bloch, 1785; no type specimen; no type locality.)

Zygaena latycephala van Hasselt, 1823, p. 315. (Originally written *Latycephala;* type locality, Java.

Zygaena laticeps Cantor, 1837, p. 315. (Original description; based on adult specimen of *S. blochi;* type locality, Calcutta.)

Zygana laticeps Swainson, 1838, p. 134. (Illustration of head; generic name misspelling of *Zygaena.*)

Sphyrna blochii Müller and Henle, 1841, p. 54. (Locality unknown.)

Sphyrnias blochii Gray, 1851, p. 50. (India; Singapore.)

Eusphyra blochii Gill, 1861, pp. 403, 412. (Name; new generic name.)

Cestracion (*Zygaena*) *blochii* Duméril, 1865, p. 383. (Indian Ocean.)

Sphyrna zygaena (misidentification) Bridge, 1904, p. 450. (Figure.)

Zygaena blochi Volz, 1907, p. 237. (Benkulen, Sumatra.)

Sphyrna blochi Pellegrin, 1912, p. 2. (Singapore.)

Cestracion blochii Garman, 1913, pp. 156–157. (Synonymy; description; range.)

Cestracion blochi Hora, 1924, p. 464. (Tale Sap, Siam.)

Sphyrna (*Eusphyra*) *blochii* McCulloch and Whitley, 1925, p. 129. (Reference.)

Specimens examined.—(Range in size: 333–880 mm. TL). Pacific Ocean: British North Borneo: SU 13815 (1), no further data; FMNH 21836 (1), Sandakan. Burma: SU 14495 (1), FMNH 40914 (1), Southern Moscos group, South Island. India: SU 41989 (1), Krusadai Island, Gulf of Mannar, Pumbau District, Madras; USNM 195846 (2), ANSP 69397 (1), Bombay. Java: FMNH 15655 (1), FMNH 15656 (1), UMMZ 177111 (6), MCZ 1389 (1 mutilated head), Batavia. Malaya: BMNH 1902.5.28.37 (1), coast of Perak; BMNH 1860.3.19.890 (2), Singapore.

Nomenclature.—Although *Sphyrna blochii*, in common with the other hammerheads, has been placed in several different genera, *Eusphyra* is the only genus which has been erected (Gill, 1861, p. 412) for the sole reception of this species. Gill considered that two unique morphological features of *blochii* (the position of the nares, which are nearer the tip of the rostrum than the eyes, and the extreme elongation of the lateral extensions of the head) constituted sufficient reason for placing the species in a distinct genus. There has been some difference of opinion among recent investigators as to whether *Eusphyra* should be regarded as a good genus. In some of the most important recent works (Bigelow and Schroeder, 1948; Tortonese, 1950a) this classification has been followed, but in an even greater number of cases it has been considered a subgenus of *Sphyrna*. For reasons that are discussed elsewhere in this paper, I follow the latter alternative.

Diagnosis.—See diagnosis of subgenus *Eusphyra*.

Description.—Meristic data appear in table 2. Characters mentioned in the diagnosis of the subgenus *Eusphyra* are not repeated here. A comparison of *S. blochii* with other members of the genus is presented in table 1.

Intranarial distance from one-seventh to one-sixth of TL; anterior margin of head broadly curved medially, the lateral expansions of the head pointing posteriorly in embryonic individuals and extending nearly perpendicularly from body in larger specimens; distinct median scallop present on anterior margin of head; inner narial groove present and distinct, extending about half of distance from narial opening to

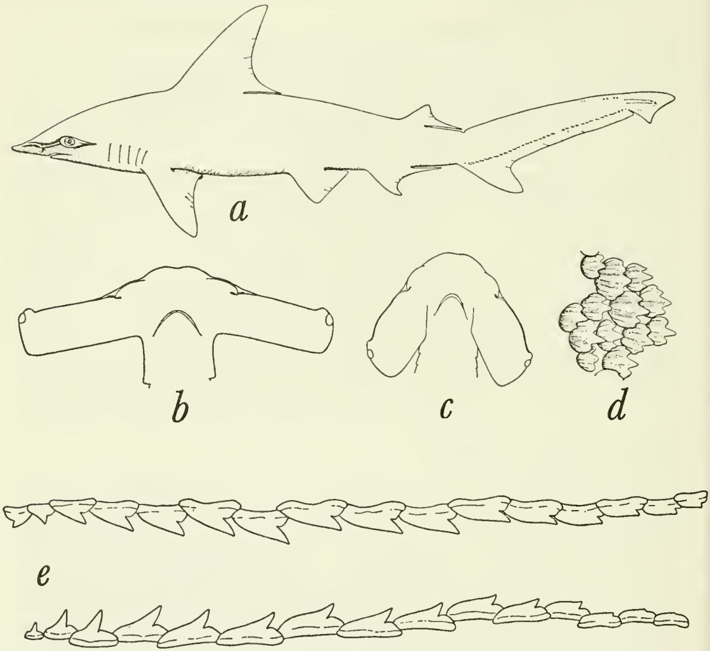


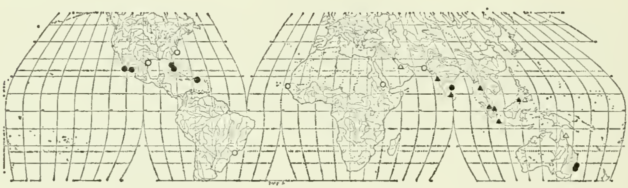
FIGURE 5.—*Sphyrna blochii*: *a*, female, 622 mm. TL, from Sandakan, North Borneo (FMNH 21836); *b*, head of adult, 0.2 × natural size (FMNH 21836); *c*, head of juvenile, 333 mm. TL, from Batavia, Java, 0.6 × natural size (UMMZ 177111) *d*, dermal denticles (FMNH 21836); *e*, teeth series from left side of upper and lower jaws (FMNH 21836). (Drawings by Dorothea B. Schultz.)

median scallop; narial depression present; outer posterior corner of lateral expansions of head situated posterior to corner of mouth in specimens of all sizes; narial flap broad, blunt at tip, with the outer edge curving gradually inward; length of snout about one-eighth of head width; greatest transverse distance between corners of mouth about one-seventh of greatest width of head; symphysis of jaws situated posterior to a transverse line drawn between posterior margin of orbits; labial furrows absent.

Origin of first dorsal fin above or slightly anterior to axil of pectoral fin, a perpendicular line drawn ventrally from origin usually intersecting axil; fifth gill slit situated distinctly behind, and fourth gill slit above (or very slightly posterior to) insertion of pectoral fin; posterior lobe of first dorsal fin terminating well anterior to insertion of pelvic fin; first through fourth gill slits nearly equal in length, and all longer than fifth gill slit; first dorsal fin relatively slender, not perfectly erect, a line drawn perpendicularly from apex of fin intersecting free rear margin of fin (posterior lobe) about halfway along its length; base of first dorsal fin about three-fifths head length and almost twice length of pectoral fin base; anterior margin of first dorsal fin nearly straight, slightly curved near apex; upper half of distal margin of first dorsal fin straight, the lower half falcate; lobe of first dorsal fin (free posterior margin) slightly less than one-half length of base; origin of second dorsal fin situated over posterior third of anal base; second dorsal fin moderately tall, its greatest height five-eighths to five-sevenths as long as base, and about five-sevenths greatest height of anal fin; second dorsal fin base about four-sevenths length of anal base; lobe of second dorsal fin long, its length about twice greatest height of fin, and extending almost to upper precaudal pit; anterior margin of pectoral fin three-fourths to four-fifths length of head, and about equal to greatest height of first dorsal; pectoral fin about three-fifths as broad as long; pectoral fin base four-fifths to seven-eighths length of anal fin base; anterior margin of pectoral slightly convex; distal margin of pectoral slightly falcate; apex of pectoral pointed; inner corner of pectoral narrowly rounded; pelvic fin about five-sixths length of anal fin; anal fin base slightly longer than pectoral and pelvic bases and more than 1½ times as long as second dorsal fin base; height of anal fin about two-sevenths again as much as height of second dorsal fin; anal fin deeply falcate toward apex and nearly straight toward tip of lobe; length of caudal fin about one-third of TL; upper margin of caudal slightly convex; terminal part of caudal about two-ninths of total length of fin; posterior margin of terminal part of caudal fin shallowly falcate; terminal apex of caudal broadly pointed; lower lobe of caudal moderately narrow and short; length of lower caudal lobe one-third to two-fifths as long as upper lobe; lower caudal lobe not erect, sloping posteriorly at about a 35° angle from a perpendicular to the body axis; anterior margin of lower caudal lobe convex; posterior margin of lower caudal lobe nearly straight; lower precaudal pit absent.

Anterior margin of rostral node of chondrocranium straight; accessory rostral cartilages absent; anterior fontanelle (viewed ventrally) appearing extremely broad and shallowly U-shaped, with a shallow, broad, median notch; small, pointed wings present on sides of rostral node; anterior wing of olfactory cartilage prominent, pointed, and projecting medially; anterior part of preorbital process long and slender; posterior part of preorbital process terminating in an angular knob.

Teeth $\frac{15\text{–}0\text{–}16}{14\text{–}1\text{–}14}$ (one specimen examined); teeth not serrated; teeth in both jaws notably oblique, with none (except the median tooth) perfectly erect, the teeth becoming progressively more oblique toward corners of mouth, and those nearest the corners having cusps pointing almost straight back; cusps visible on all teeth, although those near corner of mouth in lower jaw poorly developed; teeth 6 through 10 in upper jaw notably larger than others; tooth 1 notably smaller than tooth 2 in lower jaw; teeth 2 through 10 in lower jaw gradually increasing in size.



MAP 1.—Distribution of species.
▲ *Sphyrna blochii* ● *Sphyrna mokarran*
(Solid = specimens examined; hollow = confirmed literature references.)

Dermal denticles (examined from upper part of back beneath first dorsal fin) not closely overlapping, the blades steeply raised; length of denticle (measured to tip of median marginal "tooth") as great, or nearly as great, as width; five strong ridges usually present, and as many bluntly pointed teeth usually present on posterior margin of denticle, the outer ridges and teeth sometimes rudimentary or absent, particularly in small individuals; median tooth on denticle ordinarily slightly longer than more distal teeth; pedicel short and broad.

Individuals gray or grayish brown dorsally, becoming more pale below; no markings on fins.

Maximum total length not recorded, possibly not more than several feet.

RANGE.—*Sphyrna blochii* is restricted to the Indo-West Pacific area and is one of the two species of hammerheads not found in the Western Hemisphere. It is known from the Persian Gulf (Blegvad and Løppenthin, 1944, p. 41, fig. 12) eastward throughout the East Indies, and north to southern China and the southern Philippines (Herre, 1930, p. 142). The species also has been recorded from Queensland, Australia (Ogilby, 1908, p. 4); this area apparently represents both the eastern and southern limits of its range.

Sphyrna blochii, while perhaps not as closely restricted to continental waters as *Sphyrna tiburo*, nevertheless appears to be incapable of traversing broad stretches of ocean, as evidenced by its absence from outlying oceanic islands (map 1).

Subgenus *Sphyrna* Rafinesque

The subgenus *Sphyrna*, which includes *S. zygaena*, *S. lewini*, *S. couardi*, and *S. mokarran*, is distinguished by only two unique characters. These are: A large orbit, the greatest horizontal diameter greater than distance from anterior margin of orbit to narial opening; and a large maximum size, individuals reaching a size of from 12 to 20 feet in total length.

The subgenus is also distinguished by: A moderately expanded head, the greatest width from 22.9 to 30.2 percent of total body length (in specimens less than 1,000 mm. TL); first through fourth gill slits nearly equal in length, and all somewhat longer than fifth gill slit; anal fin and anal fin base relatively short, the former not over 11.0 percent, and the latter not over 7.5 percent, of TL; fifth gill slit situated distinctly behind, and fourth gill slit above (or very slightly anterior to) insertion of pectoral fin; presence of a deep narial depression; absence of an outer narial groove; lobe of first dorsal fin terminating well anterior to insertion of pelvic fin; total number of vertebrae ranging from 174 to 206 (usually 190 or more), with those over posterior part of coelomic cavity not expanded in size.

Sphyrna (Sphyrna) mokarran (Rüppell)

FIGURES 6, 7, 21*b*, 22*b*, Plates 2, 6A

?*Squalus tiburo* (misidentification) Risso, 1810, p. 35. (Identification by description of head and reference to Lacepede, "Squale pantouflier"; Nice; very rare.)

Zygaena tudes Valenciennes, 1822, pp. 225–226. (In part; original description; illustration of head; type specimens apparently represent more than one species; types from Mediterranean Sea, Cayenne, and Coromandel; specific name *tudes* subsequently restricted to a species other than one here called *Sphyrna mokarran*.)

Sphyrnichthys zygaena (misidentification) Thienemann, 1828, p. 408. (General; identification probable because teeth described as "gezähnelte.")

Zygaena mokarran Rüppell, 1835, pp. 66–67. (Original description; figures of head, teeth, and body; type specimen, a male 2510 mm. TL, Senckenberg Museum no. 3590; type locality, Massaua, Red Sea.)

Sphyrna malleus (misidentification) L. Agassiz, 1838, pp. 235, 303. (Identification probable because teeth serrate.)

Sphyrna mokarran Müller and Henle, 1841, p. 54. (Red Sea.)

Sphyrna tudes Müller and Henle, 1841, p. 53. (In part; identification from reference to Valencennes, 1822.)

?*Sphyrna chiereghini* Nardo, 1847, p. 111. (Name only.)

Sphyrnias mokarran Gray, 1851, p. 50. (In part; identification by reference to Valenciennes, 1822.)

Sphyrnias tudes Gray, 1851, p. 50. (In part; identification by reference to Valenciennes, 1822.)

Cestracion (Zygaena) mokarran Duméril, 1865, p. 383. (Compiled.)

Cestracion (Zygaena) tudes Duméril, 1865, p. 384. (In part; description from Valenciennes, 1822.)

Squalus zygaena (misidentification) de la Blanchere, 1868, p. 499. (Teeth described as "dentelees.")

Cestracion tudes Ninni, 1872, p. 10. (Not seen.)

Cestracion mokarran Bleeker, 1873, p. 115. (Chinese drawing.)

Zygaena dissimilis Murray, 1887, p. 103. (Original description; type locality, Kurrachee.)

Sphyrna (Platysqualus) tudes Jordan and Evermann, 1896, p. 217. (Name; West Indies and Mediterranean; references to specimens from Gulf of California and Indian Ocean perhaps do not pertain to this species.)

Cestracion zygaena (misidentification) Radcliffe, 1916, p. 263. (Identification by description of teeth in illustration as serrate; specimens 12 ft., 6 in. long; Beaufort, N.C.)

Sphyrna zygaena (misidentification in part) Coles, 1919, p. 41. (Identification by shape of head in photo, of 13 ft., 10 in. female; Cape Lookout, N.C.)

Platysqualus tudes Howell-Rivero, 1936, p. 44. (Identification probable because of large size, 12 to 14 ft.; Cuba.)

Sphyrna lewini (misidentification in part) Fowler, 1941, p. 215. (Figure of *S. mokarran* incorrectly labelled *S. lewini*.)

Sphyrna ligo Fraser-Brunner, 1950, pp. 213–219. (Original description; figure; holotype, an embryo, BMNH 1890.9.23.231; type locality, Clarence River, New South Wales, Australia; radiograph of head seen.)

Specimens examined.—(Range in size: 435–675 mm. TL; heads of larger specimens also examined). Atlantic Ocean: Senegal: (photograph seen), Gorée. United States (Florida): USNM 106543 (1), USNM 108453 (1), USNM 108454 (1), FMNH 63092 (1), MCZ 35247 (1), SU 14330 (1), Englewood; FMNH 530, Captiva Pass; USNM 186087 (2), 25°56′ N., 81°47′ W.

Pacific Ocean: Australia: USNM 40014 (1), USNM 40026 (1), MCZ 969 (1), Richmond River, New South Wales; BMNH 1890.9.23.231 (x-ray of head of holotype of *Sphyrna ligo*), Clarence River, New South Wales. India: USNM 12622 (1), Madras. Mexico: USNM 29645 (1), USNM 37162 (1), Mazatlan; UCLA 52–252 (1), Bahia Almejas, Isla Santa Margarita, Baja California.

Nomenclature.—*Zygaena mokarran* was described by Rüppell (1835, pp. 66–67, pl. 17, fig. 3) from the Red Sea, at Massaua. The illustration (pl. 2), though inaccurate in certain details, particularly the conformation of the fins, is readily identified by the shape of the head. In addition, the type specimen (Senckenberg Museum no. 3590) has been illustrated recently by Klausewitz (1960, p. 293).

For many years the species herein called *Sphyrna mokarran* was known as *Sphyrna tudes*. Tortonese (1950b, pp. 1030–1033) was the first to point out that the three type specimens of *Zygaena tudes* actually comprise two species, one of which may be *S. mokarran*. Only two of the types are apparently now extant (one from Nice, France; the second from Cayenne, French Guiana), neither of which is *S. mokarran*. However, since the missing specimen is from an area (Coromandel, India) where the species represented by the two existing types does not occur, and since there is a fairly close superficial resemblance between the two species in question, one can assume that the Coromandel individual was probably *Sphyrna mokarran*.

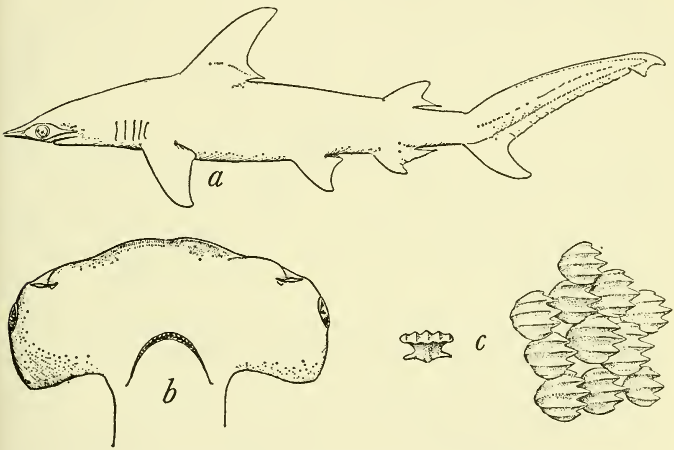


Figure 6.—*Sphyrna mokarran*: *a*, juvenile male, 673 mm. TL, from Englewood, Fla. (USNM 106543); *b*, head, 0.2 × (USNM 106543); *c*, dermal denticles, about 49 × (USNM 106543). (From Bigelow and Schroeder, 1948, p. 430.)

Diagnosis.—Characters mentioned in the diagnosis of the subgenus *Sphyrna* are not repeated here.

Sphyrna mokarran is unique among members of the genus *Sphyrna* in having a deeply falcate pelvic fin and strongly serrated teeth at all sizes. *S. mokarran* is also characterized by a deep median indentation (scallop) on anterior margin of head; absence of an inner narial groove, this structure represented by a thin line; a tall second dorsal fin, the height of the fin slightly greater than height of anal fin; a short second dorsal lobe, the length of the lobe equal to height of fin and extending only about one-half of distance from posterior part of fin base to upper precaudal pit; a shallow upper precaudal pit, with an acutely pointed posterior ridge to upper precaudal pit (fig. 21*b*); an anterior-median pore patch in which the outer-posterior corners are sharply angled and the posterior edge is straight (fig. 22*b*); presence of a rostral fenestra, and several other chondrocranial characters (pl. 6A).

A comparison of *S. mokarran* with other members of the genus is presented in table 1.

Description.—Meristic data appear in table 3. Characters mentioned in the diagnoses of the subgenus *Sphyrna* and *S. mokarran* are not repeated here.

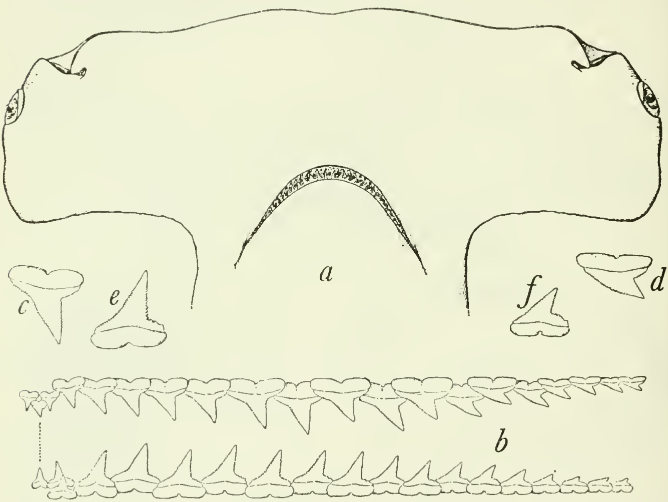


Figure 7.—*Sphyrna mokarran*: *a*, head of small adult, 1,660 mm. TL, from Englewood, Fla., 0.09 × natural size (USNM 108453); *b*, teeth series from left side of upper and lower jaws (USNM 108453), about natural size; *c*, fifth upper tooth; *d*, twelfth upper tooth; *e*, fifth lower tooth; *f*, eleventh lower tooth. (*c-f*, about 1.5 ×.) (From Bigelow and Schroeder, 1948, p. 429.)

Head moderately expanded, the greatest width from 22.9 to 27.3 percent of TL (in specimens less than 1,000 mm. long); shallow scallops present on anterior margin of head about halfway between nares and tip of snout; outer posterior corner of lateral expansion of head posterior to corner of mouth in smaller specimens, anterior to corner of mouth in larger individuals; narial flap broad, broadly pointed at tip, with the outer edge curving abruptly inward; orbit large, the horizontal diameter almost equal to length of shortest (fifth) gill slit;

length of snout from one-third to one-fourth of head width; greatest transverse distance between corners of mouth about one-fourth of greatest width of head; symphysis of jaws situated posterior to a transverse line drawn between posterior margins of orbits; labial furrows absent.

Origin of first dorsal fin above axil of pectoral fin, a perpendicular line drawn ventrally from origin intersecting at, or slightly behind, this point; first dorsal fin tall, slender, and pointing strongly posteriorly, a line drawn perpendicularly from apex of fin passing well back of fin lobe; base of first dorsal fin slightly less than one-half head length and almost twice length of pectoral fin base; anterior margin of first dorsal fin broadly curved (excessively curved in embryonic and early post-embryonic individuals); upper two-thirds of distal margin of first dorsal fin straight or slightly falcate toward tip, the lower one-third distinctly falcate; lobe of first dorsal fin about one-third length of base; origin of second dorsal fin situated slightly behind origin of anal fin; second dorsal fin base slightly greater than four-fifths length of anal fin base; anterior margin of pectoral fin slightly longer than one-half length of head and a little less than greatest vertical height of first dorsal fin; pectoral fin two-thirds as broad as long; pectoral fin base about four-fifths length of anal fin base; anterior margin of pectoral broadly rounded (strongly curved in embryos and early post-embryos); distal margin of pectoral broadly falcate; apex of pectoral broadly pointed; inner corner of pectoral broadly rounded; length of pelvic fin almost equal to length of anal fin; pelvic fin base slightly less than length of anal base; anterior margin of pelvic nearly straight, except near apex, where it is broadly curved; length of anal fin slightly greater than length of pelvic fin; anal fin base slightly (up to one-sixth) longer than pectoral, pelvic, and second dorsal fin bases; anal fin deeply falcate toward apex, nearly straight toward tip of lobe; length of caudal fin nearly a third of TL; upper margin of caudal slightly convex; terminal part of caudal about one-fourth of total length of fin; posterior margin of terminal part of caudal fin notably falcate; terminal apex of caudal broadly pointed; lower lobe of caudal narrow and long, the distance from angle included by the upper and lower caudal lobes to tip of latter going about $2\frac{1}{2}$ times in anterior margin of lower caudal lobe; length of lower caudal lobe one-third to two-fifths as long as upper lobe; lower caudal lobe not erect, sloping posteriorly at about a 45° angle from a perpendicular to body axis; anterior margin of lower caudal lobe convex; posterior margin of lower caudal lobe nearly straight or slightly concave.

Anterior margin of rostral node of chondrocranium straight; accessory rostral cartilages absent; anterior fontanelle (viewed ventrally) shallow and nearly straight on posterior margin; prominent, broad, bluntly rounded wings present on sides of rostral node; no anterior wing on olfactory cartilage; tip of anterior part of preorbital process very short, blunt, and rather thick; posterior part of preorbital process terminating in an evenly rounded knob.

Total number of vertebrae 205 to 206 (in two specimens examined); body vertebrae 95 to 98, there being from 10 to 11 fewer body than caudal vertebrae.

Teeth $\frac{17\text{–}2 \text{ or } 3\text{–}17}{16 \text{ or } 17\text{–}1 \text{ to } 3\text{–}16 \text{ or } 17}$; upper teeth triangular, on expanded bases, the first tooth erect, symmetrical, but the subsequent upper teeth increasingly oblique toward corners of mouth; second to tenth or eleventh teeth the largest in both upper and lower jaws; outermost teeth in both jaws with distinct cusps; one or two series of teeth functional in alternating rows along sides of upper jaw and usually two rows along sides of lower jaw.

Dermal denticles (examined from upper part of back beneath first dorsal fin) evenly and closely spaced, but with skin often visible in between, the blades thin and little arched; length of denticle (measured to tip of median marginal "tooth") about same as width; small specimens with from three to five, larger specimens with five or even six, smooth-topped ridges, and as many short, broadly pointed marginal teeth on dermal denticle; median tooth on denticle slightly longer than more distal teeth; pedicel short and thick.

Individuals with gray or grayish brown dorsally, becoming more pale below; no markings on fins.

Maximum total length reputedly about 20 feet.

Variation.—Comparatively few specimens of *Sphyrna mokarran* were available for study, and of these a large percentage (including all individuals from the Indo-Pacific region) were very small embryos. Specimens of this species are characterized by strongly curled bodies at this stage of development, and this, together with the paucity of specimens, tends to negate apparent differences, such as orbital diameter and length of second dorsal fin base, between specimens from the Atlantic and Pacific regions (table 3). In addition, radiographs of the chondrocrania show no apparent differences. For these reasons, as well as the fact that neither of the other hammerheads of worldwide distribution (*S. zygaena* and *S. lewini*) show any noticeable intraspecific differentiation, it seems best to recognize but one species, *Sphyrna mokarran*.

Range.—*Sphyrna mokarran* is circumtropical in distribution (map 1). However, it does not usually appear to be as common as *Sphyrna lewini*, a species occupying a similar range.

S. mokarran is found in the western Atlantic, including the Gulf of Mexico and Caribbean Sea, from North Carolina south to Brazil.

It is present in the eastern Atlantic, at least off the northwest coast of Africa (Cadenat, 1951, pp. 96–97) and in the Red Sea. Despite its presence in the last two areas, there are no substantiated records from the intervening Mediterranean (Tortonese, 1950a, p. 36). This is probably not due to lack of adequate collecting, as certain other species, such as the carcharhinid shark *Rhizoprionodon acutus* (Victor G. Springer, pers. comm.), show a similar hiatus in distribution.

Sphyrna mokarran is present in the eastern Pacific from the Gulf of California south to Panama and probably northwestern South America. It occurs in the Pacific from southern Japan south to Australia, although it appears to be absent from New Zealand and the more eastern parts of Oceania. *S. mokarran* is found throughout the East Indies and westward, in the northern Indian Ocean, to east Africa.

Sphyrna (*Sphyrna*) *zygaena* (Linnaeus)

FIGURES 8, 9, 21c, 22c; PLATE 6c

Squalus zygaena Linnaeus, 1758, p. 234. (By reference to illustration by Willughby, 1686; no type specimen; type locality, "Europe," "America.")

Squalus zygena Bonnaterre, 1788, p. 9. (Atlantic and Mediterranean.)

Sphyrna zygaena Rafinesque, 1810, p. 46. (Identification by included references; Sicily.)

?*Cestrorhinus caroliniensis* Blainville, 1816, p. 121. (Name only.)

?*Cestrorhinus pictus* Blainville, 1816, p. 121. (Name only.)

Zygaena zygaena Cuvier, 1817, p. 127. (General; identification by references.)

Zygaena malleus Valenciennes, 1822, p. 223. ("French" coasts; Brazil.)

Zygaena vulgaris Cloquet, 1830, p. 621. (At least in part; general.)

Zygaena subarcuata Storer, 1848, p. 70. (Identified by description of 2 ft. specimen; type presumably in MCZ [not located]; type locality, Provincetown, Cape Cod.)

Sphyrnias zygaena Gray, 1851, p. 48. (In part; identification by references, but also includes *lewini* [misspelled "*lewisii*"].)

Sphyrna malleus van der Hoeven, 1855, p. 262. (General; Mediterranean; identification by reference to Linnaeus.)

Cestracion zygaena Gill, 1861, p. 403. (Name only; identification by reference to Linnaeus, 1758.)

Cestracion subarcuata Gill, 1862, p. 59. (Name only; evidently based on *Zygaena subarcuata* Storer, 1848.)

?*Cestracyon zygaena* Poey, 1881, p. 348. (Refers primarily to *Sphyrna lewini;* specimens from Mediterranean may apply in part to *S. zygaena.*)

?*Zygoena malleus* Sauvage, 1891, p. 510. (May refer entirely or in part to *Sphyrna lewini.*)

?*Sphyrna* (*Zygaena*) *zygaena* Imms, 1905, p. 43. (Pharyngeal denticles; name only; may refer entirely or in part to *S. lewini.*)

?*Sphyrna* (*Sphyrna*) *zygaena* McCulloch and Whitley, 1925, p. 129. (Reference; may refer in part to *S. lewini.*)

Sphyrna (*Cestracion*) *zygaena* von Bonde, 1933, p. 377. (South Africa; skull and nerves; identification by photo of head.)

Zygaena zigaena Nobre, 1935, p. 425. (Portugal; identification by description of head.)

Specimens examined.—(Range in size: 457–2,663 mm. TL). Atlantic Ocean (including Mediterranean Sea): Azores: USNM 94502 (1), Terceira. Brazil: MCZ 451 (1), MCZ 35364–35365 (2), Rio de Janeiro. Italy: USNM 28452 (1), Livorno; ANSP 604 (1), (no further data). United States (Florida): UMML 5639 (head), off Alligator Reef, Monroe Co.; UMML 10444 (1), off North Miami, Dade Co. (in Gulf Stream). (Massachusetts): USNM 10418 (1), USNM 83980 (1), Woods Hole; MCZ 36425 (1), USNM 33268 (1), Buzzards Bay, Woods Hole; USNM 31527 (1), Stuart's Pond, Buzzards Bay; MCZ 1159 (1), Nahant; MCZ 1416 (1), Cape Cod. (Mary-

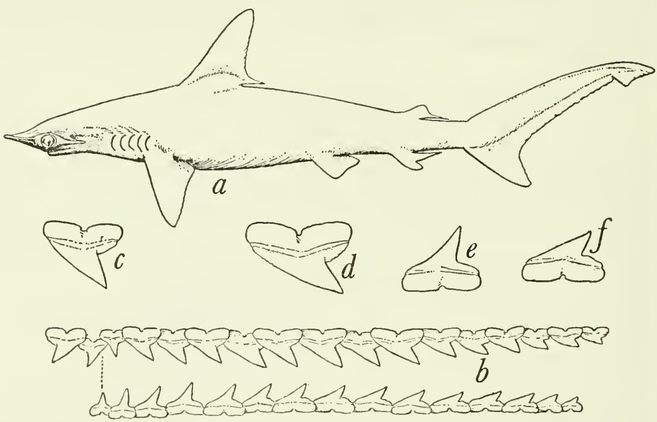


Figure 8.—*Sphyrna zygaena: a*, juvenile female, 687 mm. TL, from Nahant, Mass. (MCZ 1159); *b*, upper and lower teeth, left side, about 1.7 ×; *c*, second upper tooth; *d*, ninth upper tooth; *e*, third lower tooth; *f*, ninth lower tooth. (*c-f*, about 3.8 ×.) (From Bigelow and Schroeder, 1948, p. 437.)

land): USNM 76681–76683 (3), Ocean City. (New Jersey): USNM 93845 (3), USNM 120495 (11), Barnegat Bay, Seaside Park; ANSP 522 (1), Holly Beach. (New York): CAS 19189 (1), Graves End Bay; USNM 116447 (5), Sandy Hook; UMMZ 115903 (1), Long Island; MCZ 136 (2), no further data. (Virginia): USNM 119699 (1), off Virginia Beach; USNM 6090 (1), Norfolk.

Pacific Ocean: Australia: USNM 29020 (head), USNM 39992 (1), Sydney (Port Jackson). Ecuador: USNM 127758 (head), Gulf of Guayaquil, 81°13′ W., 4°13′ S.; MCZ 383 (1), Galapagos Islands. Japan: USNM 23383 (stuffed skin), USNM 71779 (1), Tokyo market;

USNM 51289 (head), Wakanoura; USNM 51291 (head), Nagasaki; FMNH 57423 (1), Osaka market; MCZ 1042 (1), Yenoshima; SU 24125 (1), Misaki; UMMZ 179078 (1), vicinity of Choshi; UMMZ 179079 (1), Hakata Bay, northern Kyushu; UMMZ 179080 (1), Suruga Bay. Mexico: USNM 190592 (10), Gulf of California, southern end of Angel de la Guarda Island; UMMZ 61032 (1), Cedros Island. New Zealand: UMML uncataloged (2), Bay of Islands, North Island. Panama: MCZ 515 (1), no further data. Peru: USNM 77711 (head), I. Lobos de Tierra; MCZ 421 (1), MCZ 441 (3), Magdalena Bay; MCZ 382 (2), Payta; SIO 58–29 (1), "off Peru"; SU 13003 (1), no further data. United States (California): SIO 58–224, SIO 58–382 (jaws), off La Jolla, San Diego County; LACM uncataloged (jaws and chondrocranium), off San Diego.

Diagnosis.—Characters mentioned in the diagnosis of the subgenus *Sphyrna* are not repeated here.

Sphyrna zygaena is characterized (as is *S. lewini*, its closest relative) by a long second dorsal fin lobe and a low second dorsal fin, the length of the former about twice greatest height of fin. The anterior-median pore patch on the underside of the head is unique, the patch characterized by a broad, smoothly rounded angle at the outer-posterior corner and a broad, pointed posterior extension in the median-posterior area (fig. 22*c*).

S. zygaena is distinguished from *S. lewini* by lack of a median indentation (scallop) on anterior margin of head; a longer inner narial groove, which extends at least 50 percent of distance from inner margin of nares to tip of snout; orbit closer to nares, being separated by a distance equal to about half of greatest horizontal diameter of eye; tip of second dorsal lobe not reaching as near to upper precaudal pit, the lobe extending, at most, about two-thirds of distance from second dorsal base to pit; a slightly more deeply falcate anal fin, the deepest part of the notch on the distal margin situated slightly posterior to a line drawn perpendicularly from the posterior axil of the fin; a shorter anal base, the length of which is slightly less than length of pectoral base; a more acutely pointed posterior ridge to the upper precaudal pit (fig. 21*c*); absence of a lower precaudal pit; absence of a rostral fenestra; and several other chondrocranial characters (pl. 6c).

A comparison of *Sphyrna zygaena* with other members of the genus *Sphyrna* is presented in table 1.

Description.—Meristic data appear in table 4. Characters mentioned in the diagnoses of the subgenus *Sphyrna* and of *S. zygaena* are not repeated here.

Head moderately expanded, the greatest width from 26.1 to 29.0 percent of TL (in specimens less than 1,000 mm. long); shallow

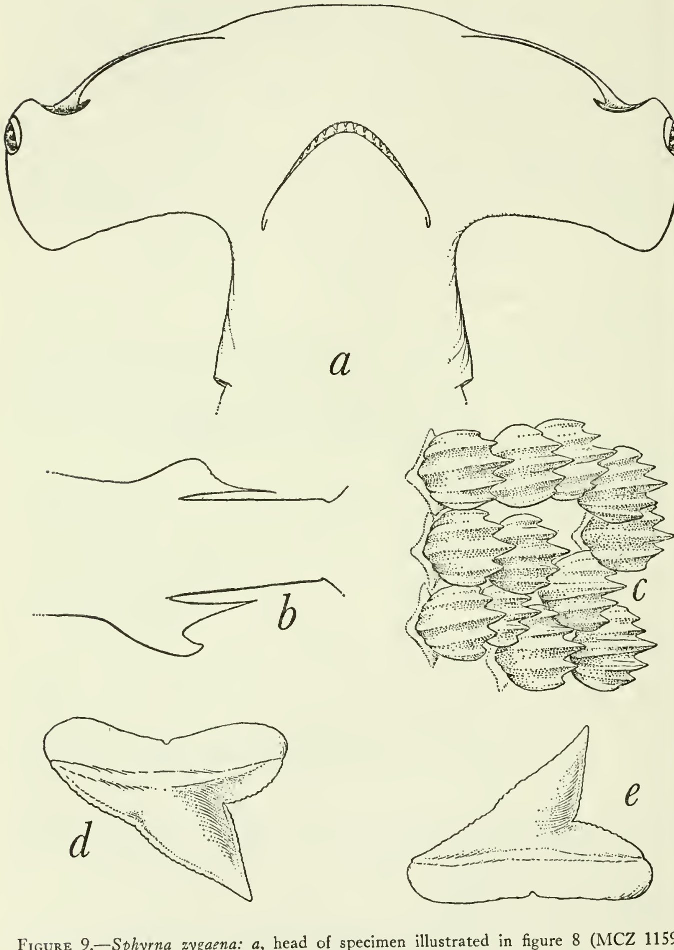


FIGURE 9.—*Sphyrna zygaena: a*, head of specimen illustrated in figure 8 (MCZ 1159), ventral view, about 0.45 × natural size; *b*, second dorsal and anal fins; *c*, dermal denticles, about 45 ×; *d*, fourth upper tooth; *e*, fifth lower tooth. (*d-e*, about 9 ×.) (From Bigelow and Schroeder, 1948, p. 438.)

scallops present on anterior margin of head, about halfway between nares and tip of snout; outer posterior corner of lateral expansion of head posterior to corner of mouth, probably in specimens of all sizes; narial flap broad, moderately pointed at tip, with the outer edge curving evenly inward; orbit large, the horizontal diameter about equal to length of longest (second) gill slit; length of snout from one-fifth to one-fourth of head width; greatest transverse distance between corners of mouth from one-fifth to one-fourth of greatest width of head; symphysis of jaws situated posterior to a transverse line drawn between posterior margins of orbits in specimens of all sizes; labial furrow present at corners of lower jaw only (concealed when mouth is closed), about one-fifth as long as greatest horizontal diameter of eye.

Origin of first dorsal fin above posterior axil of pectoral fin, a perpendicular line drawn ventrally from origin intersecting axil; first dorsal fin broad, rather erect (not as erect as in large examples of *Sphyrna tudes*), a line drawn perpendicularly from apex of fin passing close behind base; base of first dorsal fin from two-fifths to nine-twentieths of length of head, and from three-fourths again to nearly twice length of pectoral fin base; anterior margin of first dorsal fin evenly curved, with the part nearest the apex very strongly curved; distal margin of first dorsal fin strongly falcate; lobe of first dorsal fin about one-third length of base; origin of second dorsal fin situated about halfway back above base of anal fin; second dorsal fin base from three-fifths to four-fifths length of anal fin base; anterior margin of pectoral fin from one-half to two-thirds length of head (higher values usually apply to larger individuals) and about equal to or slightly greater than greatest vertical height of first dorsal fin; pectoral fin about two-thirds as broad as long; anterior margin of pectoral moderately convex; distal margin of pectoral slightly falcate; apex and inner corner of pectoral rounded; length of pelvic fin about four-fifths length of anal fin; length of pelvic fin base approximately equal to length of anal fin base; anterior margin of pelvic fin weakly convex, the distal margin nearly straight; length of anal fin equal to or slightly greater than length of pelvic fin; height of anal fin about a third again as much as height of second dorsal; length of caudal fin nearly a third of TL; upper margin of caudal fin nearly straight; terminal part of caudal about one-fifth of total length of fin; posterior margin of terminal part of caudal fin moderately falcate; terminal apex of caudal narrowly rounded; lower lobe of caudal relatively narrow and long, the distance from angle included by upper and lower caudal lobes to tip of latter going about twice in anterior margin of lower caudal lobe; length of lower caudal lobe one-third to two-fifths as long as upper lobe; lower caudal fairly erect, sloping posteriorly at about a 35° angle from a perpendicular to the body axis; anterior margin of lower caudal lobe weakly convex; posterior margin of lower caudal lobe nearly straight.

Anterior margin of rostral node of chondrocranium nearly straight, or with a broad, very shallow median indentation; accessory rostral cartilages absent; anterior fontanelle (viewed ventrally) rather deep and evenly rounded, with no noticeable median notch; short, rounded wings present on sides of rostral node; anterior wing of olfactory cartilage absent, represented only by a small "bump"; anterior part of preorbital process long and slender, and without a sharp angle on anterior edge; posterior part of preorbital process terminating in an evenly rounded knob.

Total number of vertebrae 196 (in one specimen examined); body vertebrae 101, there being six more body than caudal vertebrae.

Teeth $\frac{13 \text{ to } 15\text{–}0 \text{ or } 1\text{–}13 \text{ to } 15}{12 \text{ to } 14\text{–}1\text{–}12 \text{ to } 14}$; teeth weakly serrate in large individuals; first upper tooth nearly symmetrical and erect; subsequent upper teeth strongly oblique, their inner margins straight or evenly convex, their outer margins deeply incised and with the outermost teeth with very small, though well-developed cusps; lower teeth similar to upper, though smaller; first four teeth in lower jaw rather erect and with narrow cusps; one small symmetrical tooth at symphysis of lower jaw, none or one in upper jaw; one to two series of teeth functional along sides of upper jaw, and two to three series functional toward center; two to three series functional in lower jaw.

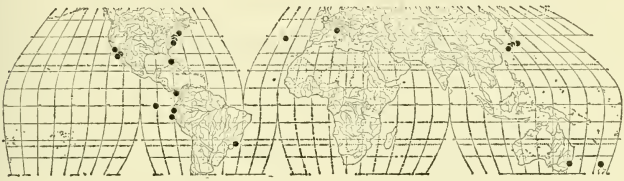
Dermal denticles (examined from upper part of back beneath first dorsal fin) closely overlapping, the blades thin and moderately arched; length of denticle (measured to tip of median marginal "tooth") as great, or nearly as great, as width; small specimens usually with three, large specimens with up to seven, sharp-toothed ridges, and from three to five pointed marginal teeth present on denticle; median tooth on denticle slightly longer than more distal teeth; pedicel very short.

Individuals deep olive to brownish gray dorsally, shading to white ventrally; tip of ventral surface of pectoral fin sometimes faintly gray black in life.

Maximum total length probably between 12 and 13 feet.

Range.—*Sphyrna zygaena* has an antitropical distribution, occurring in cooler waters of both the Northern and Southern Hemispheres but apparently absent from the intervening warmer areas (map 2). It is present in the western Atlantic from Nova Scotia and northern New England south to (occasionally) southern Florida (UMML 5639 and UMML 10444), and from Argentina and Uruguay to (probably) northern Brazil (exact northern limits of range in South American waters uncertain). Stewart Springer (pers. comm.) states that he knows of no authentic record for this species from the Gulf of Mexico or Caribbean, all literature records applying to *Sphyrna lewini*, which is common there.

In the eastern Atlantic *Sphyrna zygaena* is known from Scotland south to Senegal, in northwest Africa (Cadenat, 1951, p. 46), and also from the Mediterranean Sea. Records of *S. zygaena* farther south along the coast of Africa (Irvine, 1947, pp. 89, 90) and from South Africa (Smith 1953, pp. 46, 47) may not have been based on this species, however, since in neither case were adequate descriptions given, and the hammerheads pictured represent species other than *zygaena*. Considering that the cool waters off South Africa are suitable for *S. zygaena*, however, it is likely that the species does occur there.



MAP 2.—Distribution of *Sphyrna zygaena*.
(Solid = specimens examined; hollow = confirmed literature references.)

In the eastern Pacific *Sphyrna zygaena* is known from western South America (Chile, Peru, and the Galapagos Islands) and (one record) Panama, and from southern California and Mexico (south to the Gulf of California), but intensive collecting has failed to reveal its presence between the above two areas. In the northwestern Pacific *S. zygaena* is common around southern Japan, although the exact northern limits of its range there are uncertain. It seems to be absent from the Hawaiian Islands and the East Indian area, but is present off New Zealand and southern Australia. It probably is also present in the southern parts of the Indian Ocean as well.

Sphyrna (Sphyrna) lewini (Griffith and Smith)

FIGURES 10, 21*d*, 22*d*; PLATES 3, 6B, 9B, 10B

?*Cestrorhinus caroliniensis* Blainville, 1816, p. 121. (Name only.)
?*Cestrorhinus pictus* Blainville, 1816, p. 121. (Name only.)
Zygaena malleus Valenciennes, 1822, p. 223. (In part; description; illustration of head; Mediterranean Sea and Atlantic Ocean; teeth described as denticulate.)
?*Zygaena indica* Van Hasselt, 1823, p. 315. (Type locality: Java.)
Zygaena lewini Griffith and Smith, *in* Cuvier, Griffith, and Smith, Animal Kingdom, vol. 10, p. 640, pl. 50, 1834. (Original description; figure; no type specimen; type locality, south coast of New Holland.)
Sphyrnias zygaena (misidentification in part) Gray, 1851, p. 48. (In part; *malleus* included in synonymy.)

Sphyrna lewini Duméiil, 1858, p. 261. (Possibly in part; Gorrée, West Africa.)

Cestracion leeuwenii Day, 1865, p. 271. (Description; Malabar; distinguished from *C. zygaena*.)

Cestracion (*Zygaena*) *leeuwenii* Duméril, 1865, p. 383. ("Cotes de la terre de Leeuwen" [Australia].)

?*Cestracion* (*Sphyrna*) *zygaena* (misidentification) Steindachner, 1870, p. 576. (Possibly in part; name only; Senegambia.)

Zygaena erythraea (Ehrenberg) Klunzinger, 1871, p. 666. (Name in synonymy.)

Zygaena leuwinii Ramsay, 1881, p. 96. (Possibly in part; name only; Port Jackson, Australia.)

Cestracyon zygaena (misidentification) Poey, 1881, p. 348. (Porto Rico, Guiana, Mediterranean area, East Indies; refers primarily to *Sphyrna lewini;* specimens from Mediterranean may apply in part to *S. zygaena*.)

?*Sphyrna zygaena* (possible misidentification) Studer, 1889, p. 263. (Moreton Bay.)

?*Zygoena malleus* (possible misidentification) Sauvage, 1891, p. 510. (May refer entirely or in part to *Sphyrna zygaena*.)

?*Sphyrna* (*Zygaena*) *zygaena* (possible misidentification) Imms, 1905, p. 43. (Pharyngeal denticles; name only; may refer entirely or in part to *Sphyrna zygaena*.)

?*Sphyrna tudes* (possible misidentification) Ogilby, 1908, p. 4. (May refer to *Sphyrna mokarran*.)

Cestracion oceanica Garman, 1913, pp. 158–159. (Original description; type locality, Society Islands.)

Cestracion lewini Ogilby, 1916, pp. 81, 94. (Moreton Bay, Queensland.)

Sphyrna (*Sphyrna*) *lewini* McCulloch and Whitley, 1925, p. 129. (Reference.)

?*Sphyrna* (*Sphyrna*) *zygaena* (possible misidentification) McCulloch and Whitley, 1925, p. 129. (May refer in part to *Sphyrna lewini*.)

Sphyrna oceanica Fowler, 1928, p. 23. (Copied.)

Cestracion zygoena (probable misidentification) Chevey, 1932, p. 6. (Cochin China; misidentification probable because of locality.)

Sphyrna diplana Springer, 1941, pp. 46–52. (Original description; type locality, Englewood, Fla.)

Specimens examined.—(Range in size: 386–1,755 mm. TL). Atlantic Ocean: "Atlantic": MCZ 393 (1), no further data. "Europe": MCZ 673 (1), no further data. "West Indies": SU 11830 (1), no further data. Bahamas: UMML 10867 (1), off west end Grand Bahamas Island. Brazil: MCZ 462 (4), Rio de Janeiro; MCZ 314 (1), MCZ 470 (1), SU 52717–52719 (3), Rio Grande do Sul; SU 52874 (1), Florianopolis; SU 14046 (1), Santos. Cuba: USNM 111350 (chondrocranium), no further data. Italy: UP uncataloged (1), Livorno. Guinea: USNM uncataloged (1, head and fins), 9° 34′ N., 16° 18′ W. Jamaica: USNM 29999 (1), no further data. Liberia: USNM 179705–179706 (2), Messurado River beach. Mexico: MCZ 39646 (1), off Ciudad Carmen, Campeche; SU 11696 (1), no further data. Panama: USNM 79282 (1), USNM 79285 (1), ANSP 49936–49937 (2 heads), Colon. Surinam: USNM 159196 (1), 06°23′ to 06°20′ N., 54°47′ to 54°51′ W.; USNM 159197 (1), USNM 159199 (1), 06°27′ to 06°25′ N., 55°05′ to 55°10′ W. Trinidad: FMNH 3165 (2), no further data; SU 19193 (1), 1°29′ N., 10°39′ W. (This locality, as listed, is not close to Trinidad.) United States (Florida): USNM 106544 (1), UMMZ 155050 (1), Englewood; USNM 108451 (holotype of *Sphyrna diplana*), Englewood; USNM 133580 (1), Merritt Island, Brevard Co.: UF 455 (1), Matanzas Inlet, St. Johns Co.; UF 4208 (1), Fernandina, Nassau Co. (Georgia): UF 5463 (1), mouth of St. Simons Sound, Glynn Co. (South Carolina): USNM 25180 (1), Charleston; USNM, 32°42′ N., 79°02′ W. (Texas): FMNH 37798 (1), Port Aransas; USNM 158561 (1), Freeport; MCZ 35223 (1) MCZ 35826–35828 (3), USNM 116449 (3), USNM 118660 (1), Galveston; SU 18390 (1), no further data.

Pacific Ocean (including Indian Ocean and Red Sea): Aden: BMNH 1925.7.20.32.37 (6), Gulf of Aden. Burma: SU 14496 (1), South Moscos Island group. Celebes: MCZ 479 (1), no further data; USNM 170557 (1), Makassar market. China: SU 14150 (1), Tinghai, Chu Shan Island; USNM 130604 (1), Foochow. Costa Rica: SIO 52–94 (1), Puntarenas. Eritrea: USNM 49330 (1), Red Sea, at Massaua. Hawaii: MCZ 471 (1), USNM 151539 (1), Honolulu; USNM 52642 (1), USNM 52644 (1), Honolulu, 28°31′00″ N., 141°47′00″ W.; SU 12765 (1), SU 14088 (1), MCZ 79 (1), MCZ 456 (1), no further data. India: SU 14398 (1), Calicut. Java: USNM 72476 (1), Batavia. Japan: UMMZ 177119 (1), Southern Chosen (South Korea?). Mexico: SU 11696 (1), no further data; USNM 120376 (head), Gulf of California, off San Marcos Island. New Caledonia: USNM 111201 (head), USNM 111243–111244 (2 dried skins), no further data. Panama: ANSP 565 (1), MCZ 517 (2), "Pacific side," no further data; USNM 29289 (1), USNM 111414 (stuffed skin), no further data; ANSP 82186 (2), San Miguel Bay, Garachine Pt.; MCZ 1063 (1), MCZ 1059–1061 (3), Panama Bay, San Miguel Island; MCZ 1088–1092 (5), Panama Bay, near Panama; UCLA 53–275 (3), Panama Bay, between Panama City and Punta Gorda. Philippines: USNM 170554 (1), Iloilo market; USNM 170555–170556 (2), Manila market; USNM 56337 (1), Cavite. Society Islands: MCZ 460 (3), USNM 153587 (1) (syntypes of *Cestracion oceanica*), no further data.

Nomenclature.—*Sphyrna lewini* was originally described (as *Zygaena lewini* Griffith and Smith, 1834, p. 640, pl. 50) from the south coast of Australia, or "New Holland," as it was then called. Although the description lists none of the important diagnostic features, the accompanying picture (pl. 3) is identifiable, and can be recognized by the distinct median indentation on the anterior part of the head and the low second dorsal fin with a long lobe.

In the past Griffith has been cited as the original describer of *Sphyrna lewini*, a circumstance resulting from the inclusion of his name on the title page as author of the supplementary sections in the English (1834) edition of Cuvier's "The Animal Kingdom." Apparently overlooked, however, is the fact that there are actually two consecutive title pages to each volume, and, on the second page of volume 10, under the heading "The Class Pisces," the names of Edward Griffith and Charles Hamilton Smith appear, thus indicating their responsibility for the new sections on the orders of fishes. The past confusion has resulted because only Griffith's name appears on the first title page (entitled "The Animal Kingdom") as author of the additions, although the words "and others" are written in small type underneath. It is clear from the above that Cuvier had no part in the preparation of these supplements, thereby eliminating him as a codescriber of the species named therein; and therefore, Griffith and Smith should be regarded as describers of *Sphyrna lewini* and other new forms appearing in this volume.

For a long time *Sphyrna lewini* was confused with the superficially similar *S. zygaena*. Garman seems to have been the first to recognize the distinctness of the two species, since, in his monograph of the sharks (1913, pp. 158–159), he described a new hammerhead, *Cestracion oceanica*, which he noted was "closely allied to *C. zygaena*, [and] similar in most respects." In the comparison of this species with *zygaena*, reference was made to the long inner narial groove of the latter (extending more than halfway from the nares to the middle of the snout). The length of the inner narial groove in *oceanica*, together with other characters mentioned in the original description, would lead one to suspect that this species is identical with *Sphyrna lewini*, a suspicion that is confirmed by examination of the four syntypes (MCZ 460 [3 spec.]; USNM 153587 [1 spec.]). Although Garman distinguished the young of the above species, there is no evidence that he recognized the adults, a situation that is difficult to understand in view of the fact that the difference in length of the inner narial groove, which he recognized in the young, remains constant at all sizes.

Springer (1941, pp. 46–52) was the first to demonstrate conclusively that *S. zygaena* and *S. lewini* are specifically distinct. At the time, however, he was unaware that the Atlantic and Pacific populations of *lewini* are morphologically indistinguishable, and he consequently described the former population as a new species, *S. diplana*.

Tortonese (1950a, pp. 21–28), although continuing to recognize both *S. diplana* and *S. lewini*, strongly questioned their taxonomic separation. He did not synonymize the two species, however, due to a lack of material from critical areas. In addition, Tortonese doubted the validity of *Sphyrna oceanica* (1950a, p. 28), which, as he correctly suspected, is identical with *lewini*.

Fraser-Brunner (1950, pp. 213–219) synonymized *S. diplana* with *S. lewini*, although he continued to recognize *S. oceanica* as valid, citing supposed differences in size of eye, length of snout, relative position of first dorsal fin, size of second dorsal fin, and shape of head. Examination of specimens from the Gulf of Aden (BMNH 1925.7.20. 32.37), which were identified by Fraser-Brunner as *S. oceanica*, fails to substantiate his conclusion that this nominal species is a valid form.

DIAGNOSIS.—Characters mentioned in the diagnosis of the subgenus *Sphyrna* are not repeated here.

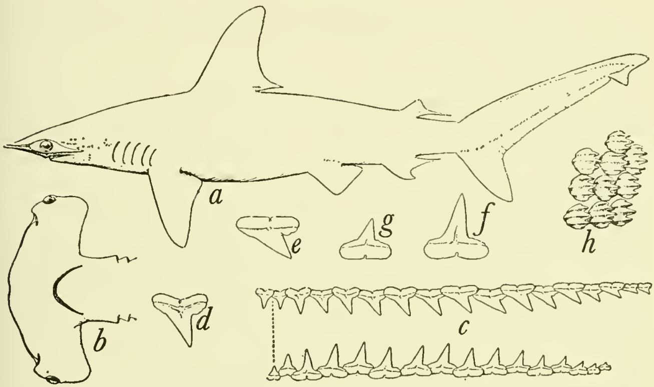


FIGURE 10.—*Sphyrna lewini: a*, juvenile female, 639 mm. TL, from Rio de Janeiro, Brazil (MCZ 462); *b*, ventral view of head; *c*, upper and lower teeth, left side, about 0.55 ×; *d*, fourth upper tooth; *e*, twelfth upper tooth; *f*, third lower tooth; *g*, eleventh lower tooth; *h*, dermal denticles, about 42 ×. (*d-g*, about natural size.) (From Bigelow and Schroeder, 1948, p. 415.)

Sphyrna lewini is characterized (as is *S. zygaena*, its closest relative) by a long second dorsal fin lobe and a low second dorsal fin, the length of the former about twice greatest height of fin. The anterior-median pore patch on the underside of the head is unique, the patch characterized by a rather sharp, smoothly rounded angle at the outer-posterior corner and by a narrow triangular area, which is devoid of pores, in the median-posterior region (fig. 22*d*).

S. lewini is distinguished from *S. zygaena* by a median indentation (scallop) on anterior margin of head; a shorter inner narial groove, which extends 40 to 45 percent of distance from inner margin of nares to tip of snout; orbit farther from nares, being separated by a distance slightly less than greatest horizontal diameter of eye; tip of second dorsal lobe reaching closer to upper precaudal pit, the lobe extending from three-fourths to four-fifths of distance from second dorsal base to pit; a slightly less deeply falcate anal fin, the deepest part of the notch on the distal margin situated slightly anterior to a line drawn perpendicularly from the posterior axil of the fin; a longer anal base, the length of which is about equal to length of pectoral base; a more obtusely pointed posterior ridge to the upper precaudal pit (fig. 21*d*); occasional presence of a lower precaudal pit; presence of a rostral fenestra; and several chondrocranial characters (pl. 6B).

A comparison of *Sphyrna lewini* with other members of the genus is presented in table 1.

Description.—Meristic data appear in table 5. Characters mentioned in the diagnoses of the subgenus *Sphyrna* and of *S. lewini* are not repeated here.

Head moderately expanded, the greatest width from 24.0 to 30.2 percent of TL (in specimens less than 1,000 mm. long); shallow scallops present on anterior margin of head, about halfway between nares and tip of snout; outer posterior corner of lateral expansion of head posterior to corner of mouth, probably in specimens of all sizes; narial flap broad, moderately pointed at tip, with the outer edge curving evenly inward; orbit large, the horizontal diameter almost equal to length of shortest (fifth) gill slit; length of snout about one-third of head width in smaller specimens, to about one-fifth of head width in larger specimens; greatest transverse distance between corners of mouth from one-fifth to one-fourth of greatest width of head; symphysis of jaws situated posterior to a transverse line drawn between posterior margins of orbits in specimens of all sizes; labial furrow present at corner of lower jaw only (concealed when mouth is closed), about one-fifth to one-fourth as long as greatest horizontal diameter of eye.

Origin of first dorsal fin above or slightly posterior to axil of pectoral fin, a perpendicular line drawn ventrally from origin intersecting anterior third of pectoral fin; first dorsal fin broad, rather erect (not as erect as in large specimens of *Sphyrna tudes*), a line drawn perpendicularly from apex of fin passing close behind base; base of first dorsal fin about one-half length of head and from half again to almost twice length of pectoral fin base; anterior margin of first dorsal fin evenly curved, with part nearest apex very strongly curved; distal margin of first dorsal fin strongly falcate; lobe of first dorsal fin about one-third length of base; origin of second dorsal fin situated about halfway back above base of anal fin; second dorsal fin base from three-fifths to four-fifths length of anal fin base; anterior margin of pectoral fin from one-half to two-thirds length of head (higher values usually apply to larger individuals) and about equal to greatest vertical height of first dorsal fin; pectoral fin about two-thirds as broad as long; anterior margin of pectoral fin moderately convex; distal margin of pectoral straight or slightly falcate; apex and inner corner of pectoral fin rounded; pelvic fin equal in length or slightly less (about four-fifths as long) than anal fin; pelvic fin base approximately equal in length to anal fin base; anterior margin of pelvic fin weakly convex, the distal margin nearly straight; anal fin equal in length or slightly greater than pelvic fin; height of anal fin about a third again as much as height of second dorsal fin; caudal fin nearly a third of TL; upper margin of caudal fin nearly straight; terminal part of caudal about one-fifth of total length of fin; posterior margin of terminal part of caudal fin moderately falcate; terminal apex of caudal narrowly rounded; lower lobe of caudal relatively narrow and long, the distance from angle included by upper and lower caudal lobes to tip of latter going from 1½ to 2 times in anterior margin of lower caudal lobe; lower caudal lobe one-third to two-fifths as long as upper lobe; lower caudal lobe fairly erect, sloping posteriorly at about a 35° angle from a perpendicular to body axis; anterior margin of lower caudal lobe weakly convex; posterior margin of lower lobe nearly straight.

Anterior margin of rostral node of chondrocranium nearly straight, or with a very shallow median indentation; accessory rostral cartilages absent; anterior fontanelle (viewed ventrally) appearing broad and shallowly U-shaped, with no noticeable median notch; prominent, bluntly rounded wings present on sides of rostral node; anterior wing of olfactory cartilage prominent, pointed, and projecting medially; anterior part of preorbital process long and slender, with a sharp angle on anterior edge; posterior part of preorbital process terminating in an evenly rounded knob.

Total number of vertebrae 174 to 204 (in nine specimens examined; only one individual with less than 192); body vertebrae 86 to 100, the relative number of body to caudal vertebrae varying from six more to twelve less.

Teeth $\frac{\text{15 or 16–0 to 2–15 or 16}}{\text{15 or 16–1 or 2–15 or 16}}$; teeth sometimes weakly serrate in large individuals; first tooth smaller than second, the 15th and 16th very small; teeth 1 through 3 in upper jaw nearly symmetrical and erect, with the subsequent teeth becoming increasingly oblique toward corners of mouth; cusps present on all teeth; lower teeth with somewhat narrower cusps than uppers, similarly oblique, but with successive series tending to become more erect and their cusps relatively more narrow with growth.

Dermal denticles (examined from upper part of back beneath first dorsal fin) closely overlapping, the blades thin and moderately arched; length of denticle (measured to tip of median marginal "tooth") as great, or nearly as great, as width; small specimens usually with three, large specimens with four or five, sharp-toothed ridges, and as many pointed marginal teeth present on denticle; median tooth on denticle slightly longer than more distal teeth; pedicel very short, moderately slender.

Individuals deep olive to brownish-gray dorsally, shading to white ventrally; tip of ventral surface of pectoral fin faintly gray-black to dark black in life.

Maximum total length probably between 12 and 13 feet.

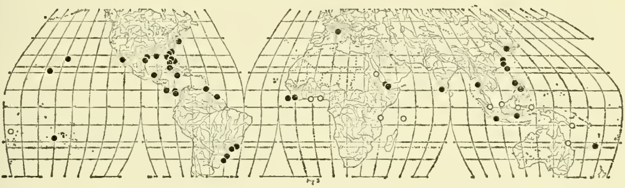
Variation.—With the possible exception of the teeth, *Sphyrna lewini* shows little noticeable geographic variation in external morphological characters. This can be seen from table 5, in which morphometric data have been recorded from specimens from throughout the range. Those characters that are considered to be of basic taxonomic importance, such as the structure of the chondrocranium (pl. 6b), the form of the anterior-median pore patch on the underside of the head (fig. 22*d*), the length and development of the intranarial groove, the position and length of the gill slits, and the shape and position of the fins, remain quite constant.

Although the teeth in *Sphyrna lewini* are ordinarily smooth, in some cases they may be very weakly serrate. This apparently occurs only in larger specimens, at least 5 or 6 feet in length. The serrated condition has long been thought to be characteristic only of the Pacific population (Sadowsky, 1965, p. 2), and, in fact, was one of the reasons for Springer's naming the Atlantic population as a new species, *S. diplana*. However, Dr. Shelton P. Applegate has recently informed me (in litt.) that he has seen specimens of this species from the western Atlantic with serrated teeth. In view of this, and because there seem to be no concomitant characters to suggest that more than one species is involved, I choose to regard *S. diplana* as a synonym of *S. lewini.*

A series of nine vertebral counts is available for specimens from widely scattered parts of the range. Although the total number of vertebrae ranges from 174 to 204, variation in eight of the nine individuals is only from 192 to 204. The reduced count in the other specimen (USNM 25180—from Charleston, S.C.) is due both to a decreased number of body and caudal vertebrae. It is difficult to say at this time what the significance of this unusually low count is.

Range—*Sphyrna lewini* is circumtropical in distribution (map 3). In the western Atlantic it occurs from southern Brazil (and possibly Uruguay) north to New Jersey (Bigelow and Schroeder, 1948, p. 419; Backus, 1960, p. 244). In the eastern Atlantic its range is not so well defined. It occurs in the Mediterranean Sea (Bigelow and Schroeder, 1948, p. 419) and along the African coast south at least to Liberia and Ghana (Bigelow and Schroeder, 1948, p. 419). The northern limits of its range in the eastern Atlantic are uncertain, although it has never been recorded from the British Isles.

Sphyrna lewini is found in the western Pacific from southern Australia north to southern Japan and Korea, and in the eastern Pacific from northwestern South America to the Gulf of California. The fact that it is the only species of hammerhead definitely recorded from the Hawaiian Islands (Gosline and Brock, 1960, p. 91) may indicate that it is a more pelagic species than *Sphyrna mokarran*, which also logically might be expected to occur there.



MAP 3.—Distribution of *Sphyrna lewini*.
(The most westerly record from Africa is now known to represent *S. couardi;* solid=specimens examined; hollow=confirmed literature references.)

Sphyrna lewini apparently does not extensively penetrate cool waters (i.e., in which the temperature does not rise above the low 70's F.). Although its range overlaps that of *S. zygaena* to some extent, there are relatively few records of the two species having been taken together (Herald, 1961, p. 31, fig.).

Sphyrna (Sphyrna) couardi Cadenat

PLATES 9A, 10A

Sphyrna couardi Cadenat, 1951, pp. 98–99. (Original description; compared with *S. diplana* and *S. bigelowi;* tips of pectoral fins described as white; type locality: "off West Africa".)

Specimens examined.—Guinea: USNM uncataloged (1 head, 425 mm. in width), 12°06′ N, 17°22′ W.

DISCUSSION—*Sphyrna couardi* was described by Cadenat (1951, pp. 98–99) from "off West Africa." The description was very brief and there was no illustration, although the form was said to resemble *S. diplana* (=*S. lewini*), differing from that species (and from all other members of the family Sphyrnidae) in having the inferior part of the pectoral fin white and a longer and smaller head. While I have not seen a whole specimen of *S. couardi*, I have examined a large head (USNM uncatalogued) collected by Dr. Bruce B. Collette from off West Africa. This head, which is 425 mm. wide, has been compared with the head of a typical specimen of *S. lewini*, 445 mm. wide (USNM uncataloged), from the same geographic area. Photographs of these appear in plate 10 and radiographs in plate 9.

The most striking difference between the two heads is the deeper, more robust appearance of *S. couardi* (also see measurements in table 10). This is confusing, since Cadenat described *S. couardi* as having a "longer and smaller" head than *S. lewini;* however, this apparent discrepancy may simply be a matter of semantics. The overall appearance of the head, in fact, seems closer to *S. mokarran* than *S. lewini;* however, *couardi* and *mokarran* may readily be distinguished by the presence of a distinct intranarial groove and nonserrated teeth in the former species, and by chondrocranial structure and differences in pore patterns on the ventral surface of the head.

The mucal pore patches on the ventral surface of the head are basically similar in *S. couardi* and *S. lewini,* although the anterior-median patch in the former is completely separated medially instead of being divided about halfway as in the latter (fig. 22*d*). The chondrocrania of the two forms also are similar (pls. 9 A, B), the main difference being in the appearance of the preorbital process. In *S. couardi* this structure is shorter and has a distinct knob at the angle, whereas in *S. lewini* it is longer and lacks a distinct knob. In addition, the olfactory wings in *S. couardi* are blunt and do not come to a sharp point as in *S. lewini.* In this case, however, the wing tips are rather ragged in appearance, suggesting that this possibly may be an aberrant condition.

In conclusion, the above evidence seems to indicate that *Sphyrna couardi* is a valid species of restricted range and that it is most closely related to *Sphyrna lewini.*

Subgenus *Platysqualus* Swainson

The subgenus *Platysqualus,* which is here considered to include *Sphyrna tudes, S. media, S. corona,* and *S. tiburo,* is distinguished by the following unique characters: First and fifth gill slits nearly equal in length and both somewhat shorter than the three middle slits; anal fin and anal fin base longer than in any other group of sphyrnids, the former 11.0 to 13.5 percent, and the latter 7.5 to 9.0 percent, of TL; anal base a fourth to half again as long as pectoral base; upper precaudal pit broadly semicircular or slightly pointed in shape, the ends pointing anteriorly (figs. 21*e–i*); lower precaudal pit present (this feature also sometimes present in *S. lewini*); fifth gill slit above insertion of pectoral fin (slightly posterior in *S. tiburo*); lobe of first dorsal fin extending past insertion of pelvic fin (in all but *S. tiburo*); teeth weak, nonserrated, with narrow pointed cusps; accessory rostral cartilages often present (none observed in *S. tiburo*).

In addition, the subgenus is characterized by: A fairly high second dorsal fin, its greatest height about equal to greatest height of anal fin; a shallowly falcate anal fin; eyes situated anterior to mouth, a line drawn between the posterior margins of orbits passing anterior to symphysis of jaws (intersecting symphysis in larger specimens of *S. tiburo*); a small orbit, separated from nares by a distance greater than horizontal diameter of orbit; absence of an outer narial groove; a variable total number of vertebrae, ranging in number from 142 to 202, with those over posterior part of coelomic cavity not enlarged; a small maximum size, probably not exceeding 4 or 5 feet. Perhaps the maximum size in some cases is even less (e.q., *S. corona*).

Sphyrna (Platysqualus) tiburo (Linnaeus)

Diagnosis.—Characters mentioned in the diagnosis of the subgenus *Platysqualus* are not repeated here.

Sphyrna tiburo is unique among members of the genus *Sphyrna* in having the head only slightly expanded, either spade or shovel shaped, and measuring from 14.4 to 24.5 percent of TL in specimens up to 1,000 mm. long (higher values usually apply to smaller individuals and/or to individuals of the subspecies *vespertina*). The anterior-median pore patch on the underside of the head is also unique, the patch characterized by a rather sharp, but smoothly rounded angle at the posterior corner and by a long, narrow median posterior extension (fig. 22*e*).

Sphyrna tiburo is also distinguished by the anterior margin of the head being more or less evenly rounded between the eyes, with neither a median scallop nor narial depressions present; no inner narial groove; origin of first dorsal fin distinctly posterior to axil of pectoral fin, a perpendicular line drawn ventrally from origin of dorsal intersecting posterior part of pectoral fin; teeth not serrated, with short, weak, rather blunt cusps.

A comparison of *Sphyrna tiburo* with other members of the genus is presented in table 1.

Description.—Meristic data appear in table 6. Characters mentioned in the diagnoses of the subgenus *Platysqualus* and of *S. tiburo* are not repeated here.

Intranarial distance from one-tenth to one-sixth of TL (lower values usually apply to larger individuals); outer posterior corners of lateral expansions of head broadly rounded and situated posterior to corners of mouth; narial flap broad, blunt at tip, with the outer edge curving gradually inward; length of snout about two-fifths of head width; greatest transverse distance between corners of mouth from one-third to a little more than two-fifths of greatest width of head; symphysis of jaws situated, in smaller individuals, slightly anterior to a transverse line drawn between posterior margins of orbits, while in larger individuals a line drawn between these points passes through the symphysis; a weakly marked labial furrow present on lower jaw only, the furrow extending only a short distance (concealed when mouth is closed).

Fourth gill slit situated anterior to, and fifth gill slit slightly posterior to, insertion of pectoral fin; posterior lobe of first dorsal fin terminating just anterior to insertion of pelvic fin (the dorsal and pelvic fins being in closer proximity only in *S. tudes*, *S. corona*, and *S. media*); first dorsal fin relatively slender, not perfectly erect, a line drawn perpendicularly from apex of fin barely intersecting lobe of fin; base of first dorsal fin about two-fifths length of head and at least half again length of pectoral fin base; anterior margin of first dorsal fin evenly curved, with the part nearest the apex more strongly curved; distal margin of first dorsal fin moderately falcate; lobe of first dorsal fin from four-ninths to almost one-half length of first dorsal base; origin of second dorsal fin situated about a third of way back above base of anal fin; second dorsal fin rather tall, its greatest height about two-thirds length of base, and about equal to greatest height of anal fin; second dorsal fin base about five-eighths of anal fin base; lobe of second dorsal fin rather long, its length about a third again greatest height of same fin, and extending about two-thirds of distance from posterior part of second dorsal base to upper precaudal pit; anterior margin of pectoral fin from one-half to nearly two-thirds length of head (higher values usually apply to larger individuals); pectoral fin four-fifths as broad as long; pectoral fin base five-eighths to three-fourths length of anal fin base; anterior margin of pectoral moderately convex; distal margin of pectoral nearly straight; apex and inner corner of pectoral rounded; pelvic fin about three-fourths length of anal fin; pelvic fin base about three-fourths length of anal fin base; anterior margin of pelvic fin weakly convex; distal margin of pelvic fin very shallowly falcate; anal fin about one-fourth again as long as pelvic fin; anal fin base from one-fourth to over one-third again as long as pectoral and pelvic fin bases, and from three-fifths again to nearly twice as long as second dorsal fin base; height of anal fin about equal to greatest height of second dorsal fin; anal fin weakly falcate toward apex and nearly straight toward tip of lobe; caudal fin from one-fourth to nearly one-third of total body length; upper margin of caudal nearly straight; terminal part of caudal about one-fourth of total length of fin; posterior margin of terminal part of caudal fin nearly straight or slightly falcate; both terminal and lower apices of caudal narrowly rounded in smaller specimens, somewhat more pointed in larger individuals; lower caudal lobe appearing relatively broad and short, the distance from the angle included by the upper and lower caudal lobes to tip of latter going from 2 to 2½ times in anterior margin of lower caudal lobe; lower lobe of caudal one-third to two-fifths as long as upper lobe; lower caudal lobe sloping posteriorly at about a 45° angle from a perpendicular to the body axis; anterior margin of lower caudal lobe weakly convex; posterior margin of lower caudal lobe nearly straight.

Anterior margin of rostral node of chondrocranium either straight or with a poorly defined indentation; accessory rostral cartilages absent; rostral fenestra absent; anterior fontanelle (viewed ventrally) appearing broad and shallowly U-shaped, with a distinct, rounded, median notch; prominent pointed wings present on sides of rostral node; anterior wing of olfactory cartilage prominent, pointed, and projecting medially; anterior part of preorbital process short and rather blunt, with a moderately sharp angle on anterior edge; posterior part of preorbital process terminating in a knob, the anterior corner of which is evenly rounded and projects forward, and the posterior corner of which is somewhat more angulate (pls. 7 A, B).

Total number of vertebrae 142 to 172 (seven specimens examined); body vertebrae 71 to 88, the relative number of body to caudal vertebrae varying from 9 more to 2 less.

Teeth $\frac{\text{12 to 14–0 or 1–12 to 14}}{\text{12 to 14–1–12 to 14}}$; teeth not serrate; first upper tooth erect and symmetrical, but subsequent upper teeth becoming increasingly oblique toward corners of mouth; teeth 3 through 10 or 11 largest in both jaws; cusps evident only on teeth 1 through 9 in specimens examined (through 11 or 12 according to Bigelow and Schroeder, 1948, p. 423); lower teeth shorter than upper teeth, with narrower cusps and slightly broader bases, the first through third teeth erect and symmetrical, the fourth through seventh or eighth slightly oblique, the eighth and subsequent teeth without cusps or definite cutting edges; three series of teeth functional in front and one or two series functional along side of upper jaw; four to six series functional in front, usually two functional along side, and three functional toward corner of mouth of lower jaw.

Dermal denticles (examined from upper part of back beneath first dorsal fin) closely overlapping, the blades rather steeply raised; length of denticle (measured to tip of median marginal "tooth") as great, or nearly as great, as width; five strong ridges usually present, and as many long, sharp-pointed teeth (these teeth are sometimes blunted or broken) usually present at posterior margin of denticle, the outer ridges and teeth sometimes rudimentary or absent, particularly in smaller individuals; median tooth on denticle ordinarily slightly longer than more distal teeth; pedicel short and slender.

Individuals gray or grayish brown dorsally, becoming progressively more pale below, and often with small dark spots on side of body; occasional spots on caudal fin.

Variation.—Specimens of *Sphyrna tiburo* from the Pacific usually have more pointed heads than specimens from the Atlantic (figs. 12*a*, *b*). This difference is also reflected in proportional measurements, the relative width of the head and transverse distance between the nares averaging slightly greater for specimens from the Pacific (table 6 and fig. 13). As a result, Springer (1940a, pp. 161, 162) described the Pacific population as a new species, *Sphyrna vespertina*, although Bigelow and Schroeder (1948, p. 428) later placed it in the synonymy of *S. tiburo*.

For several reasons the two populations are regarded here as having differentiated only to the subspecies level. First, no differences comparable to those found for head shape were discovered for other morphometric characters (table 6). In addition, some individuals are intermediate in head shape (fig. 12*c*). As mentioned previously, such specimens possibly may have resulted from a partial reamalgamation of the populations following initial differentiation of the two forms.

Vertebral counts were made on four specimens of *S. tiburo tiburo* and three of *S. tiburo vespertina*. These counts, which range from 163 to 172 for the latter form and from 142 to 170 for the former, are interesting both because of the wide range in variation found in the typical subspecies and also because of the close agreement in vertebral number between two of the individuals of *S. tiburo tiburo* and the three specimens of *S. tiburo vespertina*. The two specimens of *S. tiburo tiburo* with the lowest counts (142 and 143) are from the eastern Gulf of Mexico, while those with the higher counts (159 and 170) are from Rhode Island and Brazil. (It should be mentioned here that these differences are not attributable solely to variation in number of caudal vertebrae.) Although it is possible that larger series of counts will show this apparent difference to be clinal in nature, a study of vertebral variation in sharks, recently completed by Drs. V. G. Springer and J. A. F. Garrick (1964) indicates the existence of a number of closely related species differing only in vertebral counts. This suggests that those specimens of *S. tiburo tiburo* from the eastern Gulf of Mexico represent a sibling form that may be distinguished from other populations of the same subspecies only by number of vertebrae.

Range.—Despite statements to the contrary (Bigelow and Schroeder, 1948, pp. 424–425; Herre, 1953, p. 27; Briggs, 1960, p. 173; and 1961, p. 552), there appear to be no substantiated records of *Sphyrna tiburo* outside of the Western Hemisphere.

Sphyrna tiburo tiburo is common in shallow, inshore waters of the western Atlantic, where it ranges from southern Brazil northward, regularly, to southern North Carolina and, occasionally, to southern New England. All but three records are from continental waters, and these exceptions are from Bimini, in the western Bahamas, and from Cuba, less than 100 miles from the mainland. Although the species is known to be well established on Bimini, there is no evidence of a permanent population on Cuba, and it is possible that records from the latter area have resulted from market specimens that were caught on the other side of the Florida Straits.

Sphyrna tiburo vespertina is common in similar habitats in the eastern Pacific from southern California to Equador.

Locality records for *Sphyrna tiburo* are plotted on map 4.

Sphyrna (Platysqualus) tiburo tiburo (Linnaeus)

FIGURES 11, 12*b*, *c*, 13, 21*e*, 22*e*; PLATE 7A

Squalus tiburo Linnaeus, 1758, p. 234. (Original description; no type specimen; type locality, "America".)

Sphyrna tiburo Rafinesque, 1810, p. 47. (New generic name for *Squalus tiburo* Linnaeus, 1758; misspelled "liburo," obviously a typographical error.)

Cestrorhinus tiburo Blainville, 1816, p. 121. (Name only.)

Zygaena tiburo Valenciennes, 1822, pp. 226–227. (Description; illustration of head; Brazil.)

Zygaena (Squalus) tiburo Leuckart, 1836, p. 22. (Illustration; early embryo, yolk stalk and yolk.)

Platysqualus tiburo Swainson, 1839, p. 318. (Description; new generic name proposed without comment.)

Sphyrnias tiburo Gray, 1851, p. 50. (In list.)

Reniceps tiburo Gill, 1861, pp. 403, 412. (Name; new generic name proposed despite availability of *Platysqualus*.)

Cestracion tiburo Gill 1862, p. 59. (In North American catalogue.)

Sphyrna (Reniceps) tiburo Jordan and Evermann, 1896, p. 217. (Range.)

Cestracion zygaena (misidentification) Radcliffe, 1916, pl. 43, fig. 2. (Photo of jaws, evidently mislabeled by accident.)

SPECIMENS EXAMINED.—(Range in size: 350–910 mm. TL). Bahamas: UMMZ 174384 (1), Bimini. Brazil: MCZ 464 (3), USNM 43359 (head and tail), Bahia; MCZ 469 (1), SU 52715 (1), SU 52873 (1), USNM 104318 (2), Recife (Pernambuco); SU 52713 (1), SU 52714 (1), Ponta de Mucuripe, Fortaleza; MCZ 27 (1), MCZ 90 (2), MCZ 153 (5), MCZ 162 (5), MCZ 394 (4), MCZ 416 (4), MCZ 439 (2), MCZ 450 (2), MCZ 461 (5), Rio de Janeiro; SU 14047 (1), FMNH 46997 (1), Santos; SU 52872 (1), Vitoria market. Colombia: USNM 94754 (1), Caribbean Sea, near Puerto Colombia (and Barranquilla). Cuba: USNM 2710 (1), MCZ 522 (2), no further data. Mexico: MCZ 39645 (1), off Ciudad Carmen, Campeche. Nicaragua: USNM 78180 (1), Punta Gorda. Panama: USNM 79315 (1), ANSP 49841–49847 (7), ANSP 49938–49940 (3 heads), Colon. Surinam: USNM 159198 (1), 06°27′ to 06°25′ N., 55°05′ to 55°10′ W.; USNM 159201 (1), 06°20′ to 06°19′ N., 54°33.5′ to 54°38.5′ W. United States

(Alabama): USNM 119827 (1), near Cedar Pt., Mississippi Sound. (Florida): USNM 26582 (1), UF 1407 (4), UF 5649 (1), UF 7061 (1), UF 8948 (1), Cedar Key, Levy Co.; USNM 30687 (1), Pensacola; USNM 34733–34734 (2), St. Marys River; USNM 39882 (1), off Cape Sable; USNM 47334 (1), USNM 184870 (1), Tampa Bay; USNM 57242 (1), Alligator Light; USNM 62773 (1), USNM 118995 (1), FMNH 7038 (1), Key West; USNM 92594 (1), USNM 116888 (1), MCZ 755 (1), Tortugas; USNM 108455 (1), SU 14329 (1), Englewood; USNM 125763 (1), near West Pass, Apalachicola Bay; CAS 19306 (1), MCZ 35847 (1), Pine Island Sound; UF 1416 (1), Daytona Beach pier,

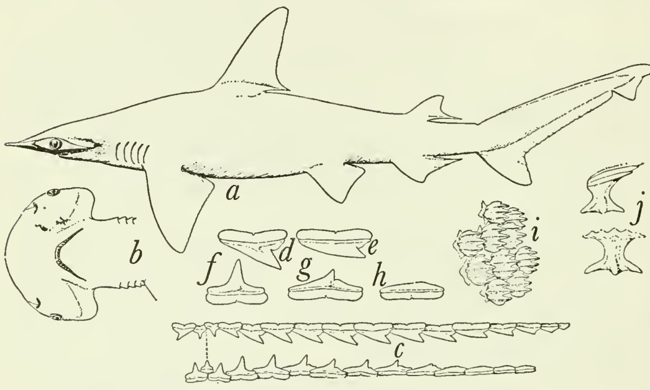


FIGURE 11.—*Sphyrna tiburo: a*, juvenile female, 367 mm. TL, from Rio de Janeiro, Brazil (MCZ 90); *b*, head of same specimen, ventral view; *c*, upper and lower teeth, left side, of male, 812 mm. TL, from Tortugas, Fla. (MCZ 848), about 1.5 ×; *d*, fourth upper tooth; *e*, tenth upper tooth; *f*, second lower tooth; *g*, seventh lower tooth; *h*, tenth lower tooth; *i*, dermal denticles, about 14 × (MCZ 90); *j*, lateral and apical views of dermal denticle, about 26 ×. (*d-h*, about 3 ×.) (From Bigelow and Schroeder, 1948, p. 421.)

Volusia Co.; UF 4208 (1), Fernandina Beach, Nassau Co.; UF 4211 (1), St. Augustine, St. Johns Co.; UF 7061 (1), Spanish Harbor Key (west end–Atlantic side), Monroe Co. (Georgia): UF 5463 (1), off St. Simons Island, Glynn Co. (Louisiana): USNM 127114–127115 (2), Barataria Bay channel; USNM 127116 (1), Bayou Fifi; USNM 155648 (1), Gulf of Mexico, south of New Orleans, 28°36′ N., 91°00′ W. (Mississippi): USNM 147793 (1), no further data; FMNH 21590 (1), Horn Island. (New Jersey): USNM 9270 (1), Delaware Bay, Beesleys Pt., between Great Egg and Peck Bays. (North Carolina): USNM 51894 (3), Beaufort. (Rhode Island): ANSP 581 (1), Newport. (South Carolina): USNM 25171 (1), MCZ 78 (skin), Charleston. (Texas): USNM 82710 (2), Chame Point Pass; USNM 116450 (5), MCZ 35824–35825 (2), MCZ 36157 (1), MCZ 36240–36245 (9), Galveston; USNM 127101 (1), USNM 155964 (18), Corpus Christi; USNM 127104 (1), Harbor Island; USNM 127106 (1), Parateria (Grand Pass); USNM 127109 (1), ca. 13 mi. off Bay Chalaud; FMNH 37794–37796 (3), Port Aransas, Aransas; FMNH 11195–11198 (4), Laguna Madre, Point Isabel. (Virginia): USNM 125760 (1), Lynnhaven Roads, just west of Cape Henry light; MCZ 138 (skin), Hampton Roads; FMNH 1622 (1), Ocean View.

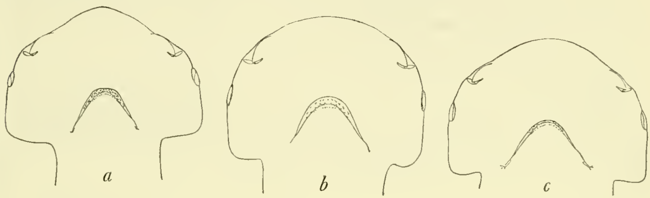


FIGURE 12.—*Sphyrna tiburo: a*, head of *S. t. vespertina*, a specimen 636 mm. TL (UCLA 58–46), from Gulf of California, showing pointed head; *b*, head of *S. t. tiburo*, a specimen 637 mm. TL (USNM 57242), from southern Florida, showing rounded head; *c*, head of *S. t. tiburo*, a specimen 880 mm. TL (USNM 127106), from Texas, showing intermediate condition of head. (Drawings by Dorothea B. Schultz.)

DIAGNOSIS.—*Sphyrna tiburo tiburo* differs from *S. tiburo vespertina* in having a slightly narrower and more evenly rounded head. These differences are illustrated in figures 12 and 13.

Sphyrna (Platysqualus) tiburo vespertina Springer

FIGURE 12*a*; PLATE 7B

Sphyrna vespertina Springer, 1940a, pp. 161, 164–166. (Original description; comparisons; range; holotype, a 769 mm. female, SU 11584; type locality, Panama City; paratypes, a 520 mm. female, SU 11881, same locality as holotype; and a 938 mm. male, formerly Carnegie Museum no. 5675, from Guayaquil, Ecuador.)

SPECIMENS EXAMINED.—(Range in size: 277–880 mm. TL). Ecuador: USNM 88677 (1), FMNH 59350 (1), Guayaquil. El Salvador: USNM 21627 (1), Acajutla. Mexico: USNM 190595 (1), Camorore Beach, ca. 3 mi. north of Mazatlán, Sinaloa; UCLA 51–4 (1), Gulf of California, Bocochibampo Bay, Sonora; UCLA 52–250 (4), Almejas Bay, at anchorage off Santa Margarita Island, Baja California; UCLA 58–46 (1), Gulf of California, south of Bahia Topolobampo, off Isla San Ignacio and Isla Macapule, Sinaloa; CAS (W 55–167) (1), Gulf of California, south end of Angel de la Guarda Island; CAS 3987 (1), Guaymas; SIO 47–53 (1), Gulf of California, 15 mi. from mouth of Río Colorado, Baja California. Panama: USNM 190591 (2), Panama Bay, 1–3 mi. SE of Isla Taboga and 2–4 mi. from Rio Pacora; UCLA 53–275 (3), Panama Bay, between Panama City and Punta Gorda; UCLA 58–305 (1), Panama Bay, offshore between Rio Chico and Punta de la Plata; FMNH 62438 (2), Punta Chame and Punta Anton, Panama Bay; SU 11584 (holotype of *Sphyrna vespertina*), Panama City; SU 11881 (one paratype of *S. vespertina*), Panama City; MCZ 80 (1), MCZ 516 (1), no further data.

Diagnosis.—*Sphyrna tiburo vespertina* differs from *S. tiburo tiburo* in having a slightly broader and more pointed head. These differences are illustrated in figures 12 and 13.

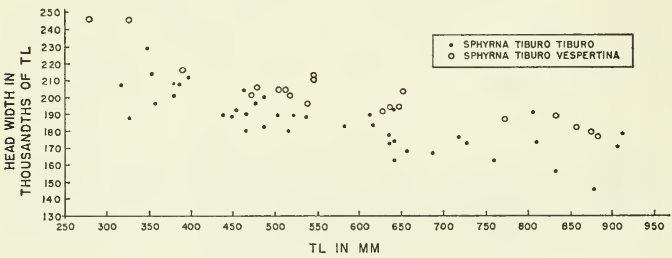


Figure 13.—Comparison of head width in the two subspecies of *Sphyrna tiburo*. (Figure by Paul Laessle.)

Sphyrna (Platysqualus) media Springer

Figures 14, 15, 16, 17, 21 *f*, *g*, 22*f*; Plate 7c

Sphyrna tudes (misidentification) Jordan, 1895, p. 383. (Mazatlán, Sinaloa.)

Cestracion tudes (misidentification) Meek and Hildebrand, 1923, p. 59. (Colón, Panama.)

?*Sphyrna tiburo* (misidentification) Kumada and Hiyama, 1937, p. 17. (Description could apply to either *S. tiburo*, *S. media*, or *S. corona*; illustration is either of *S. media* or *S. corona*.)

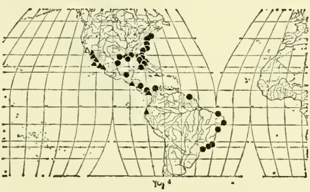
Sphyrna media Springer, 1940a, pp. 161–169. (Original description; illustration of head; holotype, a partially defleshed 900 mm. male, SU 11583; type locality, Mazatlán, Sinaloa, Mexico; one paratype, a 745 mm. female, USNM 28160, from Mazatlán.)

Sphyrna nana Sadowsky, 1965, pp. 1–12. (Original description; illustrations of head and body; holotype, a 1,330 mm. female, São Paulo Zoological Museum [POB] 7172; type locality, off Cananéia, Brazil [lat. 25° S., long. 47°52′ W.].)

Specimens examined.—(Range in size: 337–900 mm. TL; heads of larger specimens also examined; estimated length of largest, ca. 1025 mm.). Atlantic Ocean (including Caribbean Sea): Brazil: SU 52716 (head only), Vitoria. Panama: MCZ 500 (1), USNM 79284 (1), Colon market.

Pacific Ocean: Costa Rica: USNM 196140 (6), Gulf of Nicoya. Mexico: UCLA 58–47 (2, including one head), Gulf of California, south of Bahia Topolobampo, off Isla San Ignacio and Isla Macapule, Sinaloa; FMNH 63093 (2), above San Benito, Chiapas; SIO 60–88 (3), Gulf of California, 21°55′ N., 105°37′ W.; SU 11583 (holotype of *Sphyrna media*—partial skin), Mazatlan, Sinaloa; USNM 28160 (1 paratype of *Sphyrna media*), Mazatlan, Sinaloa. Panama: USNM 190593 (4), UCLA 58–304 (4, including three heads), (all originally UCLA 58–304), Panama Bay, offshore between Punta de Hicacal and Rio Pasiga; USNM 50376 (1), no further data.

Initially *Sphyrna media* and *Sphyrna corona* were regarded by me as synonymous. This conclusion was based mainly on the fact that difference in anterior contour of the head, which was the primary basis for Springer's original separation of the two forms, does not remain constant, the head shape grading from the more evenly rounded condition of *S. media* to the more lobate situation found in *S. corona*. In addition, the chondrocrania of the two forms are very similar, as are



Map 4.—Distribution of subspecies.
● *Sphyrna tiburo tiburo*
▲ *Sphyrna tiburo vespertina*
(Solid = specimens examined; hollow = confirmed literature references.)

the various external morphological features. Closer examination of the chondrocrania, however, revealed several relatively small, but nonetheless constant, differences. With a firm basis for separation thus available, it was found that other morphological differences, which were at first thought to be due to individual variation, also could be used to separate the two species. The various distinguishing features are discussed in the diagnoses of the respective species.

Diagnosis.—Characters mentioned in the diagnosis of the subgenus *Platysqualus* are not repeated here.

Sphyrna media differs from the closely related *S. tudes* in the following characters: Anterior margin of head more rounded (particularly in large specimens), with no pronounced median notch; inner narial groove absent; anterior-median pore patch on underside of head with the posterior margin more broadly rounded than in *S. tudes* and with a pointed median-posterior extension (fig. 22*f*); narial depression very shallow; first dorsal fin of larger specimens (600 mm. or more) less erect and less broadly triangular, a line drawn perpendicularly from apex of fin not intersecting base of fin.

Sphyrna media differs from *S. corona* in having a narrower postorbital process to the chondrocranium, with the anterior edge of this structure posterior, rather than anterior, to the angle formed by the juncture of the innerorbital and anterior mediorbital cartilages (pl.7c); a slightly deeper anterior fontanelle; and shorter rostral cartilages. The last difference has been objectively shown by dividing the transverse distance between the tips of the preorbital cartilages into the

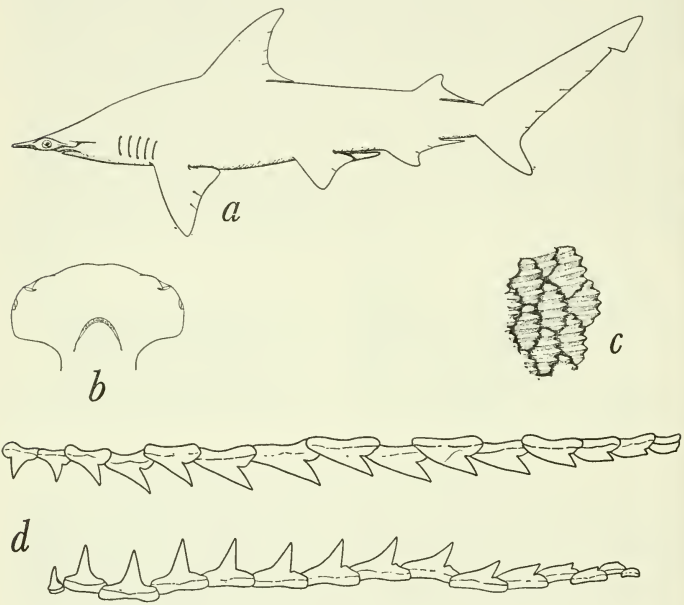


FIGURE 14.—*Sphyrna media: a*, adult male, 900 mm. TL, from Panama Bay (UCLA 58–304); *b*, head of same specimen, about 0.12 ×; *c*, dermal denticles of same specimen; *d*, upper and lower teeth, left side, of same specimen, about 1.5 ×. (Drawings by Dorothea B. Schultz.)

length of the rostral cartilage. For *S. media* the range of values thus obtained is from 18.1 to 24.0 percent, and for *S. corona* from 25.9 to 30.5 percent; these have been plotted and may be seen in figure 17.

Sphyrna media also differs from *S. corona* in having a slightly shorter snout. A comparison of snout lengths may be seen in figures 15*b*, 16, and 18*b*. Although there is some overlap in values for the two species, when specimens of a comparable size are compared lower values are obtained for *S. media*.

Sphyrna media also differs from *S. corona* in having: The anal fin more deeply falcate and with a more pointed apex (figs. 14*a*, 15*a*); anterior-median pore patch on underside of head with the posterior margin more broadly rounded and with a pointed median-posterior extension (fig. 22*f*); a more pointed upper precaudal pit in smaller specimens (fig. 21*g*); and a slightly wider mouth. When the transverse distance between the corners of the mouth is divided by the head width, the values obtained are somewhat greater for *S. media* Finally, *Sphyrna media* may be a larger species. The largest specimen of *Sphyrna media* seen (a head) was calculated to be 1025 mm. TL, while of the 17 specimens of *Sphyrna corona* examined, the largest (the holotype) measured only 672 mm. More specimens of *S. corona* must be seen to definitely confirm this, however.

A comparison of *Sphyrna media* with other members of the genus is presented in table 1.

Description.—Meristic data appear in table 7. Characters mentioned in the diagnoses of the subgenus *Platysqualus* and of *S. media* are not repeated here.

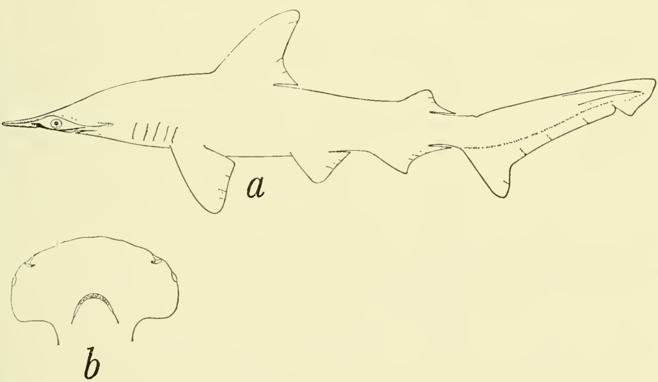


Figure 15.—*Sphyrna media: a*, juvenile female, 356 mm. TL, from Chiapas, Mexico (FMNH 63093); *b*, head of same specimen. (Drawings by Paul Laessle.)

Head moderately expanded, the greatest width measuring from 22.3 to 27.3 percent of TL; character of anterior-median margin of head somewhat variable, evenly rounded in some individuals, with no median indentation, and with a broad, very shallow median depression in others; outer posterior corner of lateral expansion of head situated anterior to corner of mouth; narial flap broad, bluntly pointed at tip, with the broadly curved outer edge curving sharply inward; a very short labial furrow present at corner of lower jaw in larger specimens, not noticeable in smaller specimens.

Origin of first dorsal fin slightly posterior to axil of pectoral fin, a perpendicular line drawn ventrally from origin intersecting anterior third of pectoral fin; base of first dorsal fin one-third to one-half length of head and about twice length of pectoral fin base; anterior margin of first dorsal fin broadly and evenly curved, particularly in larger individuals; distal margin of first dorsal fin rather deeply falcate, particularly on lower two-thirds of fin; lobe of first dorsal fin from two-fifths to one-half length of first dorsal base; origin of second dorsal fin situated about two-fifths of way back above base of anal fin; second dorsal fin tall, its greatest height about three-fourths length of base and from three-fourths to four-fifths of greatest height of anal fin; second dorsal fin base from one-half to five-eighths of anal fin base; lobe of second dorsal fin rather long, its length about a third again greatest height of fin and extending from two-thirds to three-fourths of distance from posterior part of second dorsal base to upper precaudal pit; pectoral fin from two-fifths to two-thirds length of head (higher values usually apply to larger individuals); pectoral fin two-thirds as broad as long; length of pectoral fin base from five-eighths to three-fourths length of anal fin base; inner two-thirds of anterior margin of pectoral fin straight, outer third slightly convex; distal margin of pectoral fin slightly falcate; apex of pectoral broadly pointed in small specimens, slightly more acute in larger individuals; inner corner of pectoral narrowly rounded; length of pelvic fin from two-thirds to four-fifths length of anal fin; length of pelvic fin base from five-ninths to three-fourths length of anal fin base; anterior margin of pelvic fin straight or slightly convex; distal margin of pelvic very slightly falcate; anal fin from one-tenth to one-third again as long as pelvic fin; length of anal fin base one-fourth to four-ninths again as long as pectoral and pelvic fin bases and from three-fifths again to nearly twice as long as second dorsal fin base; height of anal fin one-fifth to one-fourth greater than height of second dorsal fin; length of caudal fin from one-fourth to nearly one-third of total body length; upper margin of caudal fin evenly convex; terminal part of caudal slightly less than one-fourth of total length of fin; lower posterior margin of terminal part of caudal fin nearly straight or slightly falcate; both terminal and lower apices of caudal broadly pointed; lower lobe of caudal appearing relatively narrow and long, particularly in larger individuals, the distance from the angle included by the upper and lower caudal lobes to tip of latter going about 1¾ times in anterior margin of lower caudal lobe; lower caudal lobe about one-third as long as upper lobe; lower caudal lobe rather erect, sloping posteriorly at about a 25 to 30° angle from a perpendicular to the body axis: anterior margin of lower caudal lobe weakly convex toward base, more strongly convex toward apex; posterior margin of lower caudal lobe nearly straight.

Anterior margin of rostral node of chondrocranium varying slightly, from broadly convex to broadly and shallowly concave; rostral fenestra absent; anterior fontanelle (viewed dorsally) deep and broadly U-shaped, with the sides of the U slanting slightly inward; a distinct median notch present on anterior fontanelle; fairly prominent (though not as prominent as in *S. tudes*), broad, obtusely pointed wings present

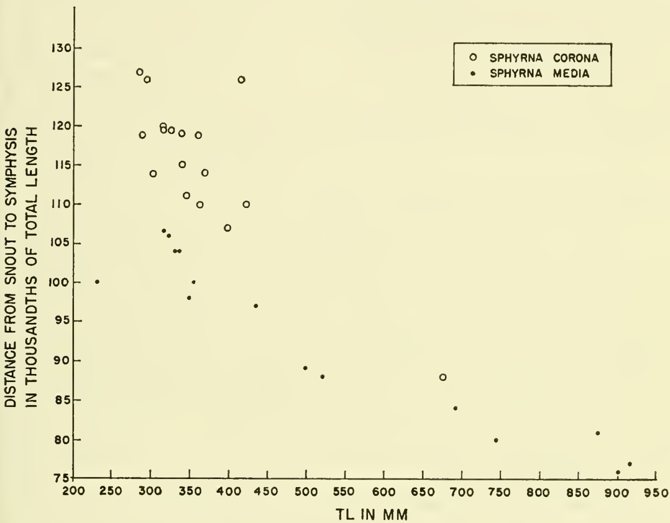


FIGURE 16.—Comparison of snout length in *Sphyrna media* and *Sphyrna corona*. (Figure by Paul Laessle.)

on sides of rostral node; anterior wing of olfactory cartilage fairly prominent (though not as prominent as in *S. tudes*), pointed, and projecting medially; tip of anterior part of preorbital process short (not as short as in *S. mokarran*) and rather thick, with a sharp angle on the anterior edge.

Total number of vertebrae 191 to 196 (10 specimens examined); body vertebrae 100 to 103, there being from 7 to 14 more body than caudal vertebrae.

Teeth $\frac{14\text{–}1\text{–}13}{14\text{–}1\text{–}14}$, $\frac{14\text{–}1\text{–}14}{14\text{–}1\text{–}14}$, $\frac{14\text{–}0\text{–}14}{13\text{–}1\text{–}14}$, $\frac{13\text{–}2\text{–}12}{14\text{–}1\text{–}14}$, $\frac{13\text{–}2\text{–}13}{14\text{–}1\text{–}14}$, and $\frac{13\text{–}1\text{–}12}{13\text{–}1\text{–}13}$

(first two counts listed by Springer, [1940a, p. 163]); upper teeth oblique, becoming increasingly so toward corners of mouth in upper jaw; teeth 6 to 9 or 10 longest, the outer teeth very low, but with a definite cusp; in lower jaw, teeth 2 through 8 longest (tooth 1 not markedly smaller however), the outermost two or three teeth very short, round, and without a definite cusp; one or two series of teeth functional in alternating rows along sides of upper jaw and two to three rows along sides of lower jaw.

Dermal denticles (examined from upper part of back beneath first dorsal fin) evenly and closely spaced, overlapping but little, the blades thick and rather strongly arched; length of denticle (measured to tip of median marginal "tooth") less than width; small specimens with three, larger specimens usually with up to five, sharp-topped ridges, and as many sharp-pointed marginal teeth (especially deep and pointed in small individuals) on denticle; median tooth on denticle slightly longer than more distal teeth; pedicel short and broad.

Individuals gray or grayish brown dorsally, becoming progressively more pale below; no markings on fins.

STATUS OF *Sphyrna nana*.—Sadowsky (1965) recently described a new species of hammerhead, *Sphyrna nana*, from southern Brazil, based on a single adult female, 1,330 millimeters long. This form was said to differ from *S. media* in having a shorter snout, a larger orbit, the anterior margin of the head not regularly oval and with prenarial convexities, a shorter distance between the eye and nares, a shorter distance between the nares, a shorter upper caudal lobe, a greater interdorsal distance, and a longer first dorsal fin base. Unfortunately, no mention was made either of the morphology of the chondrocranium or of the arrangement of the mucal pores on the ventral surface of the head.

The following measurements were given for the holotype of *S. nana:* Head width (190); snout to first gill slit (169); snout to first dorsal origin (308); snout to second dorsal origin (637); distance between first and second dorsal bases (233); snout to pectoral insertion (204); snout to pelvic insertion (466); horizontal diameter of orbit (15); length of first dorsal base (95); length of second dorsal base (43); length of second dorsal lobe (45); height of second dorsal fin (37); length of anal base (80); length of anal lobe (33); height of anal fin (36); length of pectoral base (54); length of pelvic base (34); length of caudal fin (251). If one compares these measurements with those listed for *S. media* in table 7, it can be seen that, for those characters that undergo little or no proportional change with an increase in total body length, the values for *S. nana* generally fall within the range of values for *S. media*. For those characters that undergo pronounced allometric change with an increase in length (head width, distance from snout to symphysis, head length, distance between first and second dorsal bases, and snout to pectoral insertion), the values given for *S. nana* are about what one would expect in individuals of *media* around 1,300 millimeters long. Of the various measurements listed for *S. nana*, only three (distance from snout to pelvic insertion, horizontal diameter of orbit, and length of caudal fin) seem to fall outside the range of variation one would normally expect to find in a large individual of *S. media*.

Thus, with few exceptions the proportional measurements in *S. nana* and *S. media* are very similar, and those in which there is slight disagreement are not sufficiently different to warrant recognition of a second species. The contour of the anterior margin of the head, another character that supposedly differentiates *S. nana* and *S. media*, falls within the normal range of variation for *S. media* (as discussed elsewhere in this paper).

In conclusion, while the validity of *S. nana* cannot be categorically denied until the natures of the chondrocranium and the pore patches on the ventral surface of the head are known, I so far can find no evidence to indicate that it is specifically distinct from *S. media*.

Variation.—*Sphyrna media* shows more than the usual amount of variation in configuration of the anterior margin of the head. Some specimens have an evenly rounded head (fig. 15*b*), while in others the head is faintly lobate, with a slight median indentation or scallop (fig. 14*b*). Those individuals with more lobate heads may be distinguished only with difficulty from specimens of *S. corona*. That this condition is not strictly a function of size is shown by the fact that one of the largest specimens of *S. media* examined, a 900 mm. male (UCLA 58–304) from Panama Bay, was at first identified as *S. corona* on the basis of head shape.

Variation in the median scallop on the anterior margin of the head was found to result from a comparable variation in the tip of the rostral cartilage. Considerable variation was found also in the degree of development and/or presence of the accessory rostral cartilages, a single series of specimens sometimes showing all degrees of development.

Range.—*Sphyrna media* occurs in the eastern Pacific, from the Gulf of California south at least as far as Panama Bay, in the southern Caribbean, and in the southwestern Atlantic (map 5).

The occurrence of *Sphyrna media* in the Caribbean is confirmed by two specimens (USNM 79284, MCZ 500) from the Colon (Panama) market, which were collected around the turn of the century. Presence of the species in this area is further substantiated by Stewart

Springer (1949, pp. 17–26), who lists (under the name "scoophead shark") a female, 1,125 mm. long, containing eight embryos, which was collected in April 1949, from the Gulf of Paria, Trinidad.

There is, in the Stanford University collection, the head of a specimen of this species (SU 52716) from Vitoria, Brazil. Since this locality is so far removed from Trinidad, the next closest place from which *S. media* has been recorded, one might regard the record with suspicion. However, the intervening area has not been well collected, and further exploration will likely show the species to be more widely distributed in the western Atlantic than presently appears.

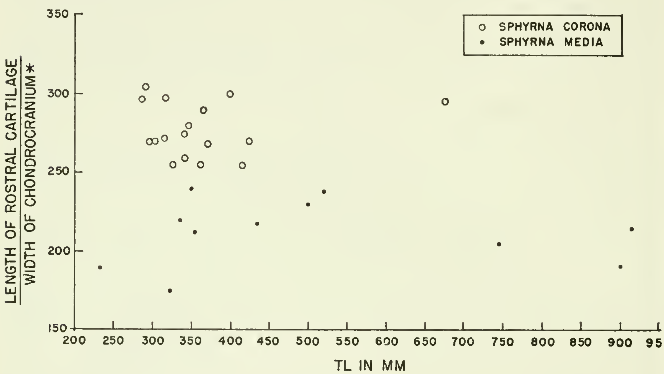


FIGURE 17.—Comparison of rostral cartilage length (expressed as a ratio) in *Sphyrna media* and *Sphyrna corona*. Width of chondrocranium measured from tips of preorbital cartilages. (Figure by Paul Laessle.)

Sphyrna (Platysqualus) corona Springer

FIGURES 16, 17, 18, 21*h*, 22*g*; PLATE 7D

?*Sphyrna tiburo* (misidentification) Kumada and Hiyama, 1937, p. 17. (Description could apply to either *S. tiburo* or *S. media;* illustration is either of *S. media* or *S. corona.*)

Sphyrna corona Springer, 1940a, pp. 161–169. (Original description; illustration of head; holotype, a 672 mm. male, SU 11882; type locality, Panama Bay, at Panama City, Panama.)

SPECIMENS EXAMINED.—(Range in size: 231–672 mm. TL). Pacific Ocean: Colombia: UCLA 51–283 (1), Boca Candelaria, 50 mi. south of Buenaventura. Costa Rica: UCLA 54–167 (1), Golfo de Nicoya, Chira Flats, off Isla Chira. Mexico: FMNH 72521 (2), off Chiapas coast, above San Benito. Panama: CAS (W 53–273) (3), Panama Bay, 1–3 mi. southeast of Taboga, and 2–4 mi. off Rio Pacora; UCLA

53–275 (9), Panama Bay, between Panama City and Punta Gorda; SU 11882 (holotype of *Sphyrna corona*), Panama City.

Diagnosis.—Characters mentioned in the diagnosis of the subgenus *Platysqualus* are not repeated here.

Sphyrna corona differs from the closely related *S. tudes* in much the same way that *S. media* differs from that species (see diagnosis of *S. media*). Unlike *S. media*, however, the shape of the anterior-median pore patch on the underside of the head is very similar in *S. corona* and *S. tudes* (figs. 22*g*,*h*).

Sphyrna corona differs from *S. media* in having a broader postorbital process to the chondrocranium, with the anterior edge of this structure anterior, rather than posterior, to the angle formed by the juncture

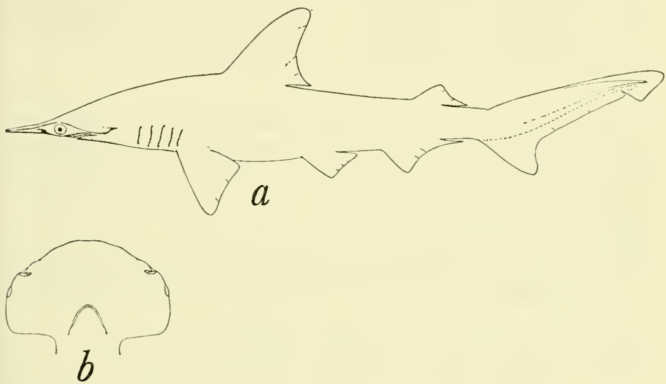


Figure 18.—*Sphyrna corona: a*, juvenile female, 371 mm. TL, from Chiapas, Mexico (FMNH 72521, ex 63093); *b*, head of juvenile male, 402 mm. TL, from Panama Bay (UCLA 53–275), about 0.6 × natural size. (Fig. *a* drawn by Paul Laessle, fig. *b* by Dorothea B. Schultz.)

of the innerorbital and anterior mediorbital cartilages (pls. 7c,d); a slightly shallower anterior fontanelle; and longer rostral cartilages. (The last character is discussed at greater length in the diagnosis of *S. media*.)

Sphyrna corona also differs from *S. media* in having: A slightly longer snout (fig. 18*b*); a less deeply falcate anal fin with a more rounded apex (fig. 18*a*); anterior-median pore patch on underside of head with the posterior margin less broadly rounded and without a pointed median-posterior extension (fig. 22*g*); a more broadly rounded upper precaudal pit in smaller specimens (fig. 21*h*); and a slightly narrower mouth. Finally, *S. corona* may not reach as large a maximum size as *S. media*, because the largest specimen examined (672 mm.) was little over half as large as the largest specimen of *S. media* that was seen.

A comparison of *Sphyrna corona* with other members of the genus is presented in table 1.

DESCRIPTION.—Since most of the morphological characters in *Sphyrna corona* are similar to those found in *S. media*, the following description has been condensed so as to avoid repetition. Only those characters in which actual counts or measurements are cited are listed in the following account. For other characters see either the diagnoses of *S. corona* or the subgenus *Platysqualus*, or the description of *S. media*.

MAP 5.—Distribution of species.
● *Sphyrna tudes* ▲ *Sphyrna media*
▼ *Sphyrna corona*
★ *Sphyrna media* and *Sphyrna corona*
(Solid = specimens examined; hollow = confirmed literature references.)

Meristic data appear in table 8.

Head moderately expanded, the greatest width measuring from 23.7 to 29.1 percent of TL; teeth $\frac{13\text{–}?\text{–}13}{12\text{–}1\text{–}13}$ (count given for holotype by Springer, 1940a, p. 163) $\frac{14\text{–}14}{14\text{–}1\text{–}14}$ and $\frac{14\text{–}14}{14\text{–}1\text{–}14}$.

RANGE.—*Sphyrna corona* has one of the most restricted ranges of any species of hammerhead, occurring only in the eastern Pacific from southern Mexico south at least to the coast of Colombia (map 5).

Sphyrna (*Platysqualus*) *tudes* (Valenciennes)

FIGURES 19, 20, 21*i*, 22*h*; PLATES 4, 8

Zygaena tudes Valenciennes, 1822, pp. 225–226. (Illustration of head; original description [apparently based on two species, *S. tudes* and *S. mokarran*]; types from Nice and Cayenne are *S. tudes*, as here recognized, while type from Coromandel probably is *S. mokarran*.)

Sphyrna tudes Müller and Henle, 1841, p. 53. (In part; identification by reference to Valenciennes, 1822.)

Sphyrna bigelowi Springer, 1944, pp. 274–276. (Original description; illustration; type locality, Uruguay; holotype, a 385 mm. male [USNM 87682]; paratypes, a 395 mm. male from Uruguay [USNM 120751], and a 900 mm. female from Rio de Janeiro, Brazil [MCZ 463].)

SPECIMENS EXAMINED.—(Range in size: 213–900 mm. TL). Western Atlantic Ocean (including Caribbean Sea and Gulf of Mexico):

Brazil: MCZ 463 (paratype of *S. bigelowi*), Rio de Janeiro. French Guiana: MNHN 1019 (lectoparatype of *Zygaena tudes*), Cayenne. Surinam: ANSP 377 (1), ANSP 516 (1), (no further data); USNM 156721 (1), 1 mi. southeast of Paramaraibo light ship; USNM 159197 (1), USNM 159199 (1), 06°27′ to 06°25′N., 55°05′ to 55°10′W.; USNM 159227 (2), 06°20.5′N. to 06°19.5′N., 54°54′W. to 54°49′W.; USNM 159228 (4), USNM 159229 (4), 06°22′N., 55°04′ to 55°08′W. United States (Mississippi): USNM 195957 (8), Gulf of Mexico, 29°54′N., 88°06′W. (Oregon Sta. 2110). Uruguay: USNM 87682 (holotype of *Sphyrna bigelowi*), no further data; USNM 120751 (paratype of *S. bigelowi*), no further data. Venezuela: USNM 123217 (head), Gulf of Venezuela, Anway Bay.

Mediterranean Sea: France: MNHN 1049 (lectotype of *Zygaena tudes*), Nice.

Nomenclature.—The original description of *Zygaena tudes* (Valenciennes, 1822, pp. 225–226, pl. 12, figs. 1*a* and *b*) was based on specimens, in the Museum National d'Histoire Naturelle, from Nice, France (cat. no 1049); Cayenne, French Guiana (cat. no. 1019); and Coromandel, India (specimen lost). As has previously been shown, these specimens comprise two species: The one currently called *Sphyrna tudes* (Gilbert, 1961, p. 480), which is characterized by the tip of the first dorsal fin extending beyond the insertion of the pelvic fins, the first and fifth gill slits nearly equal in length, with the latter situated above the insertion of the pectoral fin, and a small maximum size (perhaps not over 4 or 5 feet); and the one presently called *Sphyrna mokarran* (Gilbert, 1961), characterized by the tip of the first dorsal fin not reaching the insertion of the pelvic fins, the first gill slit longer than the fifth gill slit, with the latter situated posterior to the insertion of the pectoral fin, and a large maximum size (up to 20 feet). I here restrict the name *tudes* to those specimens from Nice and Cayenne, and designate as lectotype of *Zygaena tudes* the 346 mm. female (no. 1049) on which the illustration in the original description was based (pl. 4).

Diagnosis.—Characters mentioned in the diagnosis of the subgenus *Platysqualus* are not repeated here.

Sphyrna tudes differs from the closely related *S. corona* and *S. media* in the following characters: Anterior margin of head straighter (particularly in large specimens), with a pronounced median notch; inner narial groove present; anterior-median pore patch on underside of head divided into two broadly rounded lobes and separated by a deep, wide, median indentation (fig. 22*b*); narial depression slightly deeper; first dorsal fin of larger specimens (600 mm. or more) more erect and more broadly triangular, a line drawn perpendicularly from apex of fin intersecting base of fin.

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A comparison of *Sphyrna tudes* with other members of the genus is presented in table 1.

Description.—Meristic data appear in table 9. Characters mentioned in the diagnoses of the subgenus *Platysqualus* and of *S. tudes* are not repeated here.

Head moderately expanded, the greatest width measuring from 27.5 to 31.5 percent of TL; inner narial groove extending 3.5 to 4.0 percent of distance from narial openings to median notch; outer posterior corner of lateral expansion of head situated posterior to

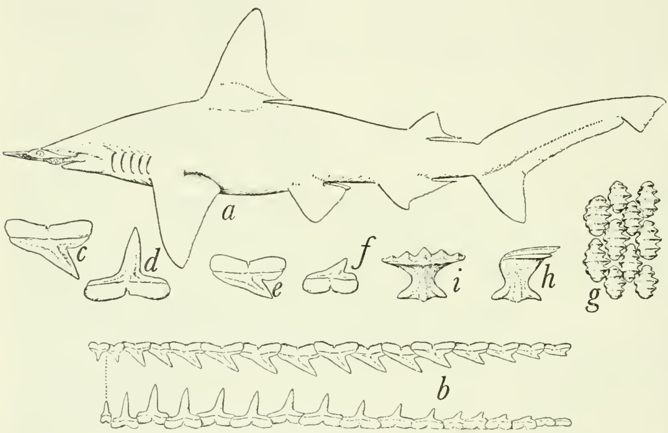

Figure 19.—*Sphyrna tudes: a*, subadult male, 886 mm. TL, from Rio de Janeiro, Brazil (MCZ 463); *b*, upper and lower teeth, left side, of same specimen, about 1.5 ×; *c*, fifth upper tooth; *d*, twelfth upper tooth; *e*, fifth lower tooth; *f*, twelfth lower tooth; *g*, dermal denticles of MCZ 463, about 17 ×; *h*, dermal denticle, side view, about 34 ×; *i*, dermal denticle, apical view, about 34 ×. (*c-f*, about 3 ×.) (From Bigelow and Schroeder, 1948, p. 410.)

corner of mouth in smaller specimens, anterior to corner of mouth in larger individuals; narial flap rather narrow (particularly in smaller specimens), pointed at tip, with the broadly curved outer edge curving sharply inward; length of snout about two-fifths of head width in smaller specimens to about one-third of head width in larger specimens; greatest transverse distance between corners of mouth from one-fifth to one-fourth of greatest width of head; a very short labial furrow present at corner of lower jaw in larger specimens, not noticeable in smaller specimens.

Origin of first dorsal fin slightly posterior to axil of pectoral fin, a perpendicular line drawn ventrally from origin intersecting anterior third of pectoral fin; base of first dorsal fin three-eighths to four-ninths length of head and from a third again to not quite twice length of pectoral fin base; anterior margin of first dorsal fin broadly and evenly curved, particularly in larger individuals, with the part nearest the apex a little more strongly curved; upper distal margin of first dorsal broadly convex, lower margin broadly but distinctly falcate; lobe of first dorsal fin a little less than one-half length of first dorsal base; origin of second dorsal fin situated about two-fifths of way back above base of anal fin; second dorsal fin tall, its greatest height from two-thirds to four-fifths length of base and from two-thirds to four-

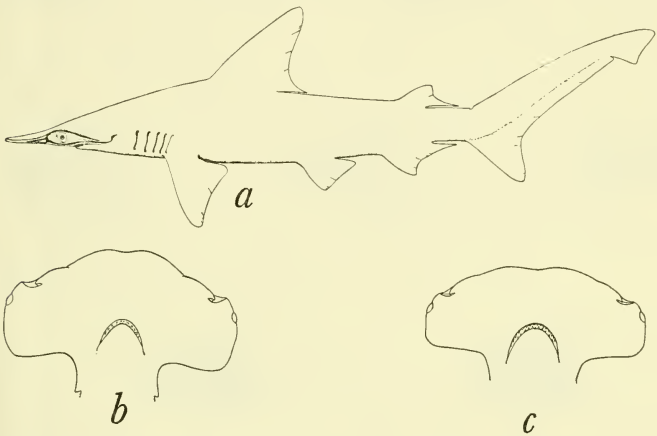

FIGURE 20.—*Sphyrna tudes: a*, juvenile female, 402 mm. TL, from Mississippi (USNM 195957); *b*, head of same specimen, about 0.3 ×; *c*, head of small adult, from Gulf of Venezuela (USNM 123217), about 0.18 ×. (Drawings by Dorothea B. Schultz.)

fifths of greatest height of anal fin; second dorsal fin base slightly greater than one-half of anal fin base; lobe of second dorsal fin long, its length from a third to half again greatest height of fin, and extending from two-thirds to three-fourths of distance from posterior part of second dorsal base to upper precaudal pit; pectoral fin from one-half to two-thirds length of head (higher values usually apply to larger individuals); pectoral fin two-thirds as broad as long; length of pectoral fin base from two-thirds to three-fourths length of anal fin base; inner two-thirds of anterior margin of pectoral fin straight, outer third distinctly convex; distal margin of pectoral fin nearly straight or very slightly falcate; apex of pectoral broadly pointed;

inner corner of pectoral fin narrowly rounded; length of pelvic fin from two-thirds to nine-tenths length of anal fin; length of pelvic fin base from five-ninths to seven-eighths length of anal fin base; anterior and distal margins of pelvic fin nearly straight; anal fin from one-eighth to one-third again as long as pelvic fin; length of anal fin base from one-third to one-half again as long as pectoral and pelvic fin bases and about twice as long as second dorsal fin base; height of

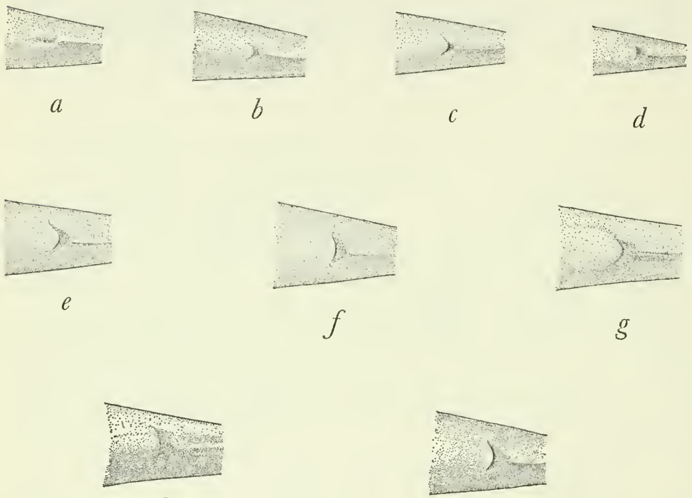

FIGURE 21.—Appearance of upper precaudal pit: *a*, *Sphyrna blochii*, 615 mm. female, from North Borneo (FMNH 21836); *b*, *S. mokarran*, 675 mm. male, from Florida (USNM 106543); *c*, *S. zygaena*, 580 mm. male, from Virginia (USNM 119699); *d*, *S. lewini*, 495 mm. female, from Texas; *e*, *S. t. tiburo*, 880 mm. female, from Texas (USNM 127106); *f*, *S. media*, 900 mm. female, from Panama Bay (UCLA 58–304); *g*, *S. media*, 356 mm. female, from Chiapas (FMNH 63093); *h*, *S. corona*, 371 mm. male, from Chiapas (FMNH 72521, ex. 63093); *i*, *S. tudes*, 825 mm. male, from Surinam (USNM 156721). (Figs. *a-f*, *i* drawn by Dorothea B. Schultz; figs. *g*, *h* by Paul Laessle.)

anal fin from one-fifth to one-third greater than height of second dorsal fin; anal fin deeply falcate toward apex, nearly straight toward tip of lobe; length of caudal fin nearly a third of total body length; upper margin of caudal fin slightly convex; terminal part of caudal about one-fourth of total length of fin; lower posterior margin of terminal part of caudal fin nearly straight or slightly falcate; both terminal and lower apices of caudal broadly pointed; lower lobe of caudal appearing relatively narrow and long, the distance from the angle included by the upper and lower caudal lobes to tip of latter going about 1½ times in anterior margin of lower caudal lobe; lower caudal lobe about one-third as long as upper lobe; lower caudal lobe rather erect, sloping posteriorly at about a 25 to 30° angle from a perpendicular to the body axis; anterior margin of lower caudal lobe weakly convex; posterior margin of lower lobe nearly straight.

Anterior margin of rostral node of chondrocranium with a broad, deep, median indentation; accessory rostral cartilages usually present; rostral fenestra usually absent (present in one individual examined); anterior fontanelle (viewed dorsally) deep and broadly V-shaped, with an indistinct median notch on the posterior margin; prominent, broad, obtusely pointed wings present on sides of rostral node; anterior wing of olfactory cartilage prominent, pointed, and projecting medially; tip of preorbital process short (though not as short as in *S. mokarran*), rather thick, with a sharp angle on the anterior edge; postorbital process terminating in an angular knob, the anterior corner of which may be either broadly pointed or narrowly rounded, and the posterior corner of which forms a broadly rounded angle.

Total number of vertebrae numbering from 195 to 202 (five specimens examined); body vertebrae numbering from 107 to 110, there being from 12 to 25 more body than caudal vertebrae.

Teeth $\frac{15\text{–}0\text{–}15}{16\text{–}1\text{–}15}$ and $\frac{16\text{–}0\text{–}16}{15\text{–}1\text{–}15}$ (two specimens counted; latter count for lectotype); upper teeth oblique, becoming increasingly so toward corners of mouth in upper jaw; teeth 4 or 5 to 11 longest, the outer teeth very low, but with a definite cusp; in lower jaw teeth 2 to 7 or 8 longest, the outermost two very short, rounded, without a definite cusp; one or two series of teeth functional in alternating rows along sides of lower jaw, and two to three rows along sides of lower jaw.

Dermal denticles (examined from upper part of back beneath first dorsal fin) evenly and closely spaced, overlapping but little, the blades thick and rather strongly arched; length of denticle (measured to tip of median marginal "tooth") less than width; small specimens with three, larger specimens usually with up to five, sharp-topped ridges, and as many sharp-pointed marginal teeth (especially deep and pointed in small individuals) on denticle; median tooth on denticle slightly longer than more distal teeth; pedicel long and rather slender.

Individuals gray or grayish brown dorsally, becoming progressively more pale below; no markings on fins.

Variation.—Examination of the lectotype (designated elsewhere in this paper) of *Zygaena tudes*, a 346 mm. female from Nice, France, indicates that the Mediterranean and western Atlantic populations of *Sphyrna tudes* are morphologically indistinguishable. The only unusual feature of the lectotype is the presence of a small rostral fenestra (pl. 8B). However, the occasional presence of such a fenestra in *S. zygaena* and *S. blochii* (in which species it is ordinarily absent) suggests that the type specimen is merely a variant with regard to this character.

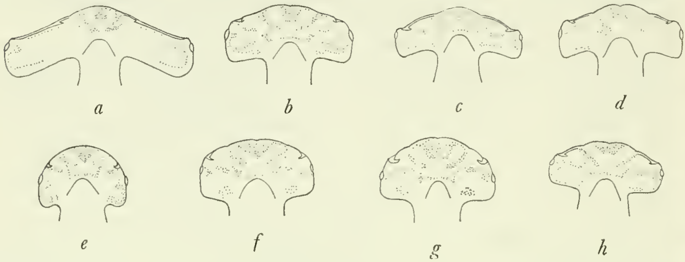

FIGURE 22.—Distribution of pores on ventral side of head: *a, Sphyrna blochii; b, S. mokarran; c, S. zygaena; d, S. lewini; e, S. tiburo; f, S. media; g, S. corona; h, S. tudes.* (Drawings by Paul Laessle.)

RANGE.—*Sphyrna tudes* is restricted to the western Atlantic Ocean and the western Mediterranean Sea. In the western Atlantic it occurs from Uruguay (Springer, 1944, p. 274) to the northern Gulf of Mexico (Gilbert, 1961, p. 480). In the western Mediterranean it is recorded from Nice, France (the type locality) and Livorno, Italy (Tortonese, 1950a, pp. 31, 32; 1950b, p. 1031).

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TABLE 1.—*Comparison of important diagnostic characters in species of* Sphyrna [1]

	Outer narial groove	Inner narial groove	Median indentation of snout	Size of orbit [2]	Length of anal base [3]	Width of head [4]	Position of 5th gill relative to pectoral fins	Position of 1st dorsal fin tip relative to pelvic fins	Distal margin of pelvic fin	Teeth	Lower pre-caudal pit	Rostral fenestra
S. blochii	Present	Present	Present	Small	Short	Very wide	Posterior	Anterior	Straight	Smooth	Absent	Absent [7]
S. mokarran	Absent	Absent	Present	Large	Short	Wide	Posterior	Anterior	Falcate	Serrate	Absent	Present
S. zygaena	Absent	Present	Absent	Large	Short	Wide	Posterior	Anterior	Straight	Smooth [5]	Absent	Absent [7]
S. lewini	Absent	Present	Present	Large	Short	Wide	Posterior	Anterior	Straight	Smooth [6]	Absent	Present
S. conardi	Absent	Present	Present	Large		Wide				Smooth		Present
S. tiburo	Absent	Absent	Absent	Intermediate	Long	Narrow	Above	Anterior	Straight	Smooth	Present	Absent
S. media	Absent	Absent	Present [8]	Small	Long	Wide	Above	Posterior	Straight	Smooth	Present	Absent
S. corona	Absent	Absent	Present [8]	Small	Long	Wide	Above	Posterior	Straight	Smooth	Present	Absent
S. tudes	Absent	Present	Present	Small	Long	Wide	Above	Posterior	Straight	Smooth	Present	Absent [7]

[1] Numerical values expressed in thousandths of total length; values are for specimens under 1000 mm. TL.
[2] Large: usually over 20; small: usually under 20.
[3] Long: usually over 65; short: usually under 65.
[4] Very wide: usually over 400; wide: usually 230–300; narrow: usually under 200.
[5] Weakly serrate in adults.
[6] Sometimes weakly serrate in adults.
[7] Small fenestra occasionally present.
[8] Poorly developed, often absent in *S. media*.

TABLE 2.—*Measurements of* Sphyrna blochii (*proportions expressed in thousandths of total length*)

	Size range in mm.			
	300–399	400–599	600–799	>800
	Number of specimens			
	4	4	2	1
Head width	337–492(391.2)	441–481(463.8)	432–456(444.0)	420
Internarial distance	152–165(157.5)	160–167(164.0)	153–164(158.5)	152
Snout to symphysis	66–78(70.8)	63–72(66.5)	56–64(60.0)	54
Head length	221–237(229.0)	197–213(205.0)	195–197(196.0)	195
Snout to 1st gill slit	173–176(174.5)	151–168(159.5)	153–154(153.5)	153
Snout to 1st dorsal origin	244–266(256.5)	217–258(228.8)	214–219(216.5)	214
Snout to 2nd dorsal origin	565–626(583.3)	560–575(565.8)	577–584(580.5)	567
Distance between 1st and 2nd dorsal bases.	191–248(216.5)	209–242(226.8)	243–247(245.0)	232
Snout to pectoral insertion	187–224(204.8)	193–206(197.5)	171–204(187.5)	191
Snout to pelvic insertion	392–432(415.3)	390–420(408.3)	395–397(396.0)	395
Horizontal diameter of orbit	14–21(16.5)	14–18(15.8)	13–15(14.0)	13
Length of 1st dorsal base	105–113(110.3)	103–114(107.8)	111–117(114.0)	121
Length of 2nd dorsal base	35–44(39.3)	34–40(37.5)	39–40(39.5)	44
Length of pectoral base	51–56(53.5)	50–58(53.5)	54–63(58.5)	55
Length of pelvic base	52–59(55.3)	53–54(53.5)	59–60(59.5)	61
Length of 2nd dorsal lobe	43–47(44.8)	47–53(50.0)	50–57(53.5)	51
Height of 2nd dorsal fin	22–30(26.0)	22–27(24.3)	26–27(26.5)	28
Length of anal base	58–62(60.0)	55–65(60.3)	69–71(70.0)	64
Length of anal lobe	34–39(36.3)	39–44(40.8)	38–45(41.5)	39
Height of anal fin	32–36(33.8)	34–39(37.0)	37–38(37.5)	40
Length of caudal fin	317–329(323.5)	332–339(335.8)	335–338(336.5)	331

TABLE 3.—*Measurements of* Sphyrna mokarran (*proportions expressed in thousandths of total length*)

	Size range in mm. (N=number of specimens)			
	N	400–599	N	600–799
Head width				
Atlantic	3	231–244(239.3)	1	235
Pacific	4	225–230(228.3)	1	273
Internarial distance				
Atlantic	3	170–175(173.0)	1	170
Pacific	4	157–173(164.8)	1	190
Snout to symphysis				
Atlantic	3	73–81(78.0)	1	73
Pacific	4	66–80(74.3)	1	82
Head length				
Atlantic	3	220–232(227.3)	1	226
Pacific	4	212–235(226.5)	1	250
Snout to 1st gill slit				
Atlantic	3	177–187(182.3)	1	171
Pacific	4	166–187(179.8)	1	200
Snout to 1st dorsal origin				
Atlantic	3	273–289(280.7)	1	284
Pacific	4	253–289(277.3)	1	285

TABLE 3.—*Measurements of* Sphyrna mokarran (*proportions expressed in thousandths of total length*)—Continued

	Size range in mm. (N=number of specimens)			
	N	400–599	N	600–799
Snout to 2nd dorsal origin				
Atlantic	3	581–600(592.3)	1	595
Pacific	4	555–579(568.5)	1	599
Distance between 1st and 2nd dorsal bases				
Atlantic	3	193–211(202.7)	1	213
Pacific	4	189–205(196.0)	1	208
Snout to pectoral insertion				
Atlantic	3	197–215(204.3)	1	207
Pacific	4	187–226(211.0)	1	244
Snout to pelvic insertion				
Atlantic	3	421–436(427.3)	1	434
Pacific	4	432–449(439.5)	1	469
Horizontal diameter of orbit				
Atlantic	3	20–25(22.7)	1	22
Pacific	4	29–33(31.3)	1	26
Length of 1st dorsal base				
Atlantic	3	97–100(99.0)	1	98
Pacific	4	85–98(92.7)	1	106
Length of 2nd dorsal base				
Atlantic	3	54–67(60.0)	1	52
Pacific	4	41–51(45.8)	1	56
Length of 2nd dorsal lobe				
Atlantic	3	40–46(42.3)	1	39
Pacific	4	46–48(46.5)	1	45
Height of 2nd dorsal fin				
Atlantic	3	28–39(33.3)	1	38
Pacific	4	27–41(35.3)	1	47
Length of anal base				
Atlantic	3	61–67(64.0)	1	61
Pacific	4	56–73(63.5)	1	67
Length of anal lobe				
Atlantic	3	33(33.0)	1	30
Pacific	4	32–39(35.3)	1	31
Height of anal fin				
Atlantic	3	28–33(30.0)	1	33
Pacific	4	34–40(36.5)	1	40
Length of pectoral base				
Atlantic	3	53–58(55.7)	1	54
Pacific	4	49–54(51.8)	1	58
Length of pelvic base				
Atlantic	3	56–59(57.3)	1	60
Pacific	4	53–56(54.8)	1	56
Length of caudal fin				
Atlantic	3	310–335(325.3)	1	309
Pacific	4	307–320(313.0)	1	289

TABLE 4.—*Measurements of* Sphyrna zygaena (*proportions expressed in thousandths of total length*)

	Size range in mm. (N=number of specimens)					
	N	400–599	N	600–799	N	>800
Head width						
Atlantic	8	261–290(276.9)	3	262–276(268.7)	0	—
Pacific	10	261–285(273.3)	2	276–279(277.5)	1	260
Internarial distance						
Atlantic	8	194–209(201.5)	3	189–198(193.3)	0	—
Pacific	10	190–207(197.3)	2	191–203(197.0)	1	186
Snout to symphysis						
Atlantic	8	62–77(70.6)	3	67–70(68.3)	0	—
Pacific	10	65–73(69.6)	2	64–65(64.5)	1	45
Head length						
Atlantic	8	219–245(230.8)	3	218–226(221.3)	0	—
Pacific	10	225–242(231.9)	2	219–227(223.0)	1	210
Snout to 1st gill slit						
Atlantic	8	170–192(178.3)	3	168–180(173.3)	0	—
Pacific	10	172–189(180.4)	2	167–171(169.0)	1	162
Snout to 1st dorsal origin						
Atlantic	8	264–291(275.6)	3	267–270(269.0)	0	—
Pacific	10	266–288(278.5)	2	263–274(268.5)	1	273
Snout to 2nd dorsal origin						
Atlantic	8	589–626(606.4)	3	595–602(599.0)	0	—
Pacific	10	592–626(605.3)	2	602–614(608.0)	1	635
Distance between 1st and 2nd dorsal bases						
Atlantic	8	228–245(236.1)	3	238–251(243.0)	0	—
Pacific	10	221–244(236.1)	2	241–253(247.0)	1	—
Snout to pectoral insertion						
Atlantic	8	207–224(214.5)	3	198–207(203.3)	0	—
Pacific	10	209–226(217.1)	2	195–202(198.5)	1	198
Snout to pelvic insertion						
Atlantic	8	440–468(450.3)	3	438–446(443.3)	0	—
Pacific	10	440–458(451.3)	2	439–443(441.0)	1	454
Horizontal diameter of orbit						
Atlantic	8	23–30(25.8)	3	23–25(24.0)	0	—
Pacific	10	24–31(28.0)	2	24(24.0)	1	12
Length of 1st dorsal base						
Atlantic	8	90–105(95.8)	3	91–98(95.0)	0	—
Pacific	10	86–105(95.8)	2	93–100(96.5)	1	102
Length of 2nd dorsal base						
Atlantic	8	28–35(31.9)	3	30–33(31.3)	0	—
Pacific	10	29–38(33.3)	2	28–38(33.7)	1	25

TABLE 4.—*Measurements of* Sphyrna zygaena (*proportions expressed in thousandths of total length*)—Continued

	Size range in mm. (N=number of specimens)					
	N	400–599	N	600–799	N	>800
Length of 2nd dorsal lobe						
Atlantic	8	43–52(47.0)	3	44–47(45.7)	0	—
Pacific	10	43–48(45.1)	2	46–49(47.5)	1	—
Height of 2nd dorsal fin						
Atlantic	8	16–22(18.9)	3	18–21(19.7)	0	—
Pacific	10	16–23(19.5)	2	21–23(22.0)	1	—
Length of anal base						
Atlantic	8	43–57(47.3)	3	42–47(45.0)	0	—
Pacific	10	44–52(46.9)	2	42–44(43.0)	1	—
Length of anal lobe						
Atlantic	8	39–44(42.1)	3	42–44(43.3)	0	—
Pacific	10	38–43(41.1)	2	43–45(44.0)	1	—
Height of anal fin						
Atlantic	8	24–35(27.6)	3	26–29(27.7)	0	—
Pacific	10	24–30(27.0)	2	26–27(26.5)	1	29
Length of pectoral base						
Atlantic	8	47–58(53.4)	3	50–57(54.0)	0	—
Pacific	10	49–56(52.8)	2	53–60(56.5)	1	—
Length of pelvic base						
Atlantic	8	40–46(43.1)	3	39–45(42.0)	0	—
Pacific	10	41–47(44.3)	2	40–41(40.5)	1	—
Length of caudal fin						
Atlantic	8	293–311(303.5)	3	290–301(294.7)	0	—
Pacific	10	295–312(303.1)	2	298(298.0)	1	269

TABLE 5.—*Measurements of* Sphyrna lewini (*proportions expressed in thousandths of total length*)

	Size range in mm. (N=number of specimens)									
	N	300–399	N	400–599	N	600–799	N	800–900	N	>1,000
Head width										
Atlantic	2	280–284(282)	16	268–302(287.0)	6	258–285(274.0)	1	257	1	240
Eastern Pacific	—	—	8	260–291(276.1)	4	256–277(267.5)	—	—	—	—
Western Pacific and Indo-Australia	2	266–285(275.5)	12	246–287(264.8)	3	261–280(269.0)	—	—	—	—
Internarial distance										
Atlantic	2	205–213(209.0)	16	190–218(203.9)	6	193–212(201.7)	1	181	1	175
Eastern Pacific		—	8	187–211(200.3)	4	184–202(195.8)		—		—
Western Pacific and Indo-Australia	2	197–204(200.5)	12	180–214(193.3)	3	186–205(197.3)		—		—
Snout to symphysis										
Atlantic	2	81–86(83.5)	16	72–83(79.1)	6	67–77(71.3)	1	64	1	46
Eastern Pacific	—	—	8	73–81(77.8)	4	68–73(70.3)	—	—	—	—
Western Pacific and Indo-Australia	2	83–85(84)	12	69–83(73.9)	3	66–70(67.3)	—	—	1	41

TABLE 5.—*Measurements of* Sphyrna lewini (*proportions expressed in thousandths of total length*)—Continued

	Size range in mm. (N=number of specimens)									
	N	300–399	N	400–599	N	600–799	N	800–900	N	>1,000
Head length										
Atlantic	2	253–265(259.0)	16	220–256(241.0)	6	217–238(227.7)	1	210	1	197
Eastern Pacific	—	—	8	221–247(233.7)	4	216–237(225.0)	—	—	—	—
Western Pacific and Indo-Australia	2	244–273(258.5)	12	213–250(233.0)	3	203–226(215.3)	—	—		—
Snout to 1st gill slit										
Atlantic	2	198–200(199.0)	16	177–196(189.6)	6	166–192(177.3)	1	168	1	162
Eastern Pacific		—	8	174–200(188.6)	4	160–184(173.8)		—		—
Western Pacific and Indo-Australia	2	194–206(200.0)	12	169–196(181.8)	3	165–179(170.0)		—		—
Snout to 1st dorsal origin										
Atlantic	2	282–307(294.5)	16	261–298(285.7)	6	268–285(277.1)	1	259	1	230
Eastern Pacific	—	—	8	279–303(291.8)	4	263–286(273.4)	—	—	—	—
Western Pacific and Indo-Australia	2	294–301(297.5)	12	276–312(294.4)	3	254–271(263.7)	—	—	1	282
Snout to 2nd dorsal origin										
Atlantic	2	606–618(612.0)	16	587–625(603.4)	6	572–600(584.7)	1	575	1	551
Eastern Pacific	—	—	8	591–637(612.9)	4	579–606(591.3)	—	—	—	—
Western Pacific and Indo-Australia	2	593–622(607.5)	12	598–657(615.3)	3	591–602(595.0)	—	—	—	—
Between 1st and 2nd dorsal bases										
Atlantic	2	198–207(202.5)	16	199–224(210.0)	6	222–242(232.7)	1	233	1	227
Eastern Pacific	—	—	8	196–222(210.4)	4	208–240(228.3)	—	—	—	—
Western Pacific and Indo-Australia	2	195–219(207.0)	12	194–244(213.9)	3	219–236(226.0)	—	—	1	281
Snout to pectoral insertion										
Atlantic	2	230–235(232.5)	16	202–242(225.8)	6	199–221(211.8)	1	200	1	177
Eastern Pacific	—	—	8	216–233(222.3)	4	206–232(215.3)	—	—	—	—
Western Pacific and Indo-Australia	2	225–253(239.0)	12	200–231(217.2)	3	206–215(210.3)	—	—	1	196
Snout to pelvic insertion										
Atlantic	2	460–464(462.0)	16	435–472(450.1)	6	427–456(441.7)	1	422	1	390
Eastern Pacific	—	—	8	429–462(446.0)	4	431–459(442.0)	—	—	—	—
Western Pacific and Indo-Australia	2	456–479(467.5)	12	404–475(444.3)	3	439–451(445.3)	—	—	1	464
Horizontal diameter of orbit										
Atlantic	2	26(26)	16	21–29(23.8)	6	19–22(20.8)	1	19	1	14
Eastern Pacific	—	—	8	21–26(23.5)	4	21–23(21.8)	—	—	—	—
Western Pacific and Indo-Australia	2	27–28(27.5)	12	20–26(23.4)	3	21(21)	—	—	1	11
Length of 1st dorsal base										
Atlantic	2	105–111(108.0)	16	93–113(107.7)	6	94–106(101.0)	1	95	1	94
Eastern Pacific	—	—	8	99–110(104.2)	4	92–102(98.5)	—	—	—	—
Western Pacific and Indo-Australia	2	97–109(103.0)	12	92–110(104.3)	3	102–110(106.3)	—	—	1	91
Length of 2nd dorsal base										
Atlantic	2	35–37(36.0)	16	34–42(38.6)	6	32–40(36.3)	1	35	1	35
Eastern Pacific	—	—	8	32–41(36.4)	4	31–38(34.8)	—	—	—	—
Western Pacific and Indo-Australia	2	34–38(36.0)	12	28–38(34.0)	3	33–44(37.0)	—	—	1	23

TABLE 5.—*Measurements of* Sphyrna lewini (*proportions expressed in thousandths of total length*)—Continued

	Size range in mm. (N=number of specimens)									
	N	300–399	N	400–599	N	600–799	N	800–900	N	>1,000
Length of 2nd dorsal lobe										
Atlantic	2	49–50(49.5)	16	43–53(49.0)	6	44–51(48.2)	1	48	1	48
Eastern Pacific	—	—	8	45–52(48.9)	4	47–50(48.5)	—	—	—	—
Western Pacific and Indo-Australia	2	45–51(48.0)	12	44–56(49.6)	3	44–52(48.7)	—	—	—	—
Height of 2nd dorsal fin										
Atlantic	2	22(22.0)	16	19–24(21.8)	6	17–23(20.7)	1	22	1	23
Eastern Pacific	—	—	8	18–23(21.0)	4	18–22(20.8)	—	—	—	—
Western Pacific and Indo-Australia	2	21–23(22.0)	12	16–22(20.2)	3	20–21(20.3)	—	—	1	23
Length of anal base										
Atlantic	2	53–56(54.5)	16	48–60(53.8)	6	47–55(51.5)	1	47	1	53
Eastern Pacific	—	—	8	48–59(51.9)	4	45–51(49.0)	—	—	—	—
Western Pacific and Indo-Australia	2	51–54(52.5)	12	43–54(50.2)	3	48–64(54.7)	—	—	1	40
Length of anal lobe										
Atlantic	2	40(40.0)	16	33–46(38.9)	6	37–45(40.3)	1	40	1	40
Eastern Pacific	—	—	8	35–43(38.9)	4	37–41(38.8)	—	—	—	—
Western Pacific and Indo-Australia	2	38–47(42.5)	12	34–44(40.2)	3	38–39(38.3)	—	—	—	—
Height of anal fin										
Atlantic	2	28–30(29.0)	16	28–34(30.5)	6	27–33(29.2)	1	28	1	29
Eastern Pacific	—	—	8	26–31(28.9)	4	27–34(29.8)	—	—	—	—
Western Pacific and Indo-Australia	2	26–29(27.5)	12	24–32(28.3)	3	29–32(30.0)	—	—	1	25
Length of pectoral base										
Atlantic	2	59–61(60.0)	16	50–61(54.6)	6	48–60(53.0)	1	51	1	50
Eastern Pacific	—	—	8	48–57(52.1)	4	49–55(53.0)	—	—	—	—
Western Pacific and Indo-Australia	2	61(61.0)	12	48–57(51.8)	3	51–59(55.0)	—	—	—	—
Length of pelvic base										
Atlantic	2	53–54(53.5)	16	49–59(54.2)	6	49–54(51.5)	1	50	1	50
Eastern Pacific	—	—	8	49–58(53.9)	4	47–54(51.5)	—	—	—	—
Western Pacific and Indo-Australia	2	51–54(52.5)	12	50–60(53.9)	3	48–55(52.0)	—	—	—	—
Length of caudal fin										
Atlantic	2	305–314(309.5)	16	291–332(316.4)	6	287–318(302.7)	1	295	1	284
Eastern Pacific		—	8	300–325(313.9)	4	294–327(308.0)		—		—
Western Pacific and Indo-Australia	2	308–317(312.5)	12	296–323(313.3)	3	295–308(302.0)		—		—

TABLE 6.—*Measurements of subspecies of* Sphyrna tiburo (*proportions expressed in thousandths of total length*)

	Size range in mm. (N=number of specimens, A=Atlantic, P=Pacific)							
	N	200–399	N	400–599	N	600–799	N	>800
Head width	8							
tiburo (A)	3	186–229(206.0)	14	178–204(188.6)	12	160–192(174.1)	7	143–189(168.0)
vespertina (P)		215–245(227.7)	8	194–213(202.4)	5	185–203(193.0)	4	175–188(180.3)
Internarial distance								
tiburo (A)	8	137–156(144.9)	14	121–148(131.7)	12	114–129(119.7)	7	100–132(118.4)
vespertina (P)	3	153–160(156.0)	8	140–155(146.1)	5	125–144(133.2)	4	122–140(130.8)
Snout to symphysis								
tiburo (A)	8	94–99(97.0)	14	78–90(83.9)	12	72–80(76.0)	7	73–82(75.8)
vespertina (P)	3	93–96(94.5)	8	82–91(86.0)	5	75–82(79.0)	4	73–81(77.0)

TABLE 6.—*Measurements of subspecies of* Sphyrno tiburo (*proportions expressed in thousandths of total length*)—Continued

	Size range in mm. (N=number of specimens, A=Atlantic, P=Pacific)							
	N	200–399	N	400–599	N	600–799	N	>800
Head length								
tiburo (A)	8	234–249(242.8)	14	216–244(228.7)	12	205–223(214.9)	7	201–227(212.3)
vespertina (P)	3	238–246(242.0)	8	222–240(231.9)	5	208–215(214.3)	4	200–215(208.8)
Snout to 1st gill slit								
tiburo (A)	8	186–204(195.4)	14	173–196(183.3)	12	159–185(170.8)	7	153–174(163.7)
vespertina (P)	3	190–196(193.3)	8	178–194(187.8)	5	162–180(173.0)	4	157–169(162.5)
Snout to 1st dorsal origin								
tiburo (A)	8	295–331(309.9)	14	287–326(303.9)	12	268–319(295.4)	7	277–310(298.6)
vespertina (P)	3	297–316(307.7)	8	283–312(298.9)	5	279–333(302.3)	4	280–300(290.8)
Snout to 2nd dorsal origin								
tiburo (A)	8	576–611(591.8)	14	588–625(601.5)	12	595–634(610.3)	7	605–634(614.2)
vespertina (P)	3	587–600(594.3)	8	556–619(598.1)	5	585–628(608.6)	4	600–636(615.0)
Distance between 1st and 2d dorsal bases								
tiburo (A)	8	181–202(188.4)	14	192–219(207.1)	12	199–233(218.7)	7	214–253(235.0)
vespertina (P)	3	188–191(189.7)	8	189–212(202.6)	5	204–229(212.8)	4	214–242(230.3)
Snout to pectoral insertion								
tiburo (A)	8	220–243(233.3)	14	203–230(213.8)	12	188–222(201.3)	7	194–214(203.8)
vespertina (P)	3	224–240(231.0)	8	200–235(218.2)	5	195–215(205.1)	4	185–220(197.3)
Snout to pelvic insertion								
tiburo (A)	8	421–446(431.3)	14	430–450(438.2)	12	426–456(444.0)	7	385–471(442.3)
vespertina (P)	3	427–448(436.7)	8	428–470(445.3)	5	412–446(427.4)	4	435–455(443.8)
Horizontal diameter of orbit								
tiburo (A)	8	21–23(22.3)	14	19–23(20.1)	12	18–20(18.8)	7	15–17(16.0)
vespertina (P)	3	21–24(22.3)	8	18–23(20.4)	5	16–20(18.2)	4	14–18(16.3)
Length of 1st dorsal base								
tiburo (A)	8	85–97(90.1)	14	90–106(96.1)	12	93–110(100.4)	7	92–107(98.7)
vespertina (P)	3	88–98(92.0)	8	77–102(93.3)	5	86–101(92.4)	4	98–104(100.3)
Length of 2nd dorsal base								
tiburo (A)	8	46–52(48.8)	14	42–58(50.8)	12	44–57(50.8)	7	41–57(47.8)
vespertina (P)	3	47–51(49.0)	8	42–55(48.2)	5	42–52(47.2)	4	45–51(48.0)
Length of 2nd dorsal lobe								
tiburo (A)	8	38–49(44.1)	14	39–51(46.6)	12	43–53(48.6)	7	45–55(50.0)
vespertina (P)	3	43–47(45.0)	8	43–51(47.0)	5	47–53(49.8)	4	48–56(52.7)
Height of 2nd dorsal fin								
tiburo (A)	8	24–41(33.5)	14	31–41(35.8)	12	35–43(39.3)	7	35–41(37.5)
vespertina (P)	3	26–37(32.0)	8	32–40(35.4)	5	34–43(38.2)	4	38–44(40.3)
Length of anal base								
tiburo (A)	8	70–84(75.5)	14	65–86(73.4)	12	64–89(76.3)	7	71–83(79.8)
vespertina (P)	3	74–83(78.3)	8	69–88(77.6)	5	69–88(79.0)	4	73–85(76.8)
Length of anal lobe								
tiburo (A)	8	33–39(35.5)	14	32–39(33.6)	12	27–38(34.8)	7	25–37(32.8)
vespertina (P)	3	31–38(34.7)	8	35–39(37.3)	5	33–39(36.4)	4	30–37(34.3)
Height of anal fin								
tiburo (A)	8	30–38(34.0)	14	28–35(32.3)	12	30–38(33.0)	7	30–36(32.0)
vespertina (P)	3	35–38(36.3)	8	29–37(33.4)	5	33–38(35.0)	4	26–36(32.3)
Length of pectoral base								
tiburo (A)	8	49–63(56.3)	14	53–65(59.6)	12	51–69(59.3)	7	57–66(60.3)
vespertina (P)	3	58–60(59.3)	8	56–64(60.4)	5	54–60(56.3)	4	58–67(62.5)
Length of pelvic base								
tiburo (A)	8	52–63(57.5)	14	55–64(59.4)	12	58–67(62.3)	7	60–66(62.3)
vespertina (P)	3	52–60(55.7)	8	56–70(61.0)	5	55–65(58.8)	4	58–64(61.5)
Length of caudal fin								
tiburo (A)	8	281–307(292.0)	14	266–294(280.9)	12	250–291(270.1)	7	234–276(258.9)
vespertina (P)	3	288–295(292.3)	8	278–294(287.5)	5	269–296(280.6)	4	249–270(255.8)

TABLE 7.—*Measurements of* Sphyrna media (*proportions expressed in thousandths of total length*)

	Size range in mm.			
	200–399	400–599	600–799	>800
	Number of specimens			
	7	3	2	2
Head width	231–333(289.3)	223–264(247.3)	232–236(234.0)	228–232(230.0)
Internarial distance	182–204(194.0)	162–191(177.0)	166–171(168.5)	167–169(168.0)
Snout to symphysis	100–107(103.7)	88–97(91.3)	80–84(82.0)	76–81(78.5)
Mouth width	67–76(71.7)	61–71(65.7)	62–65(63.5)	62–72(67.0)
Head length	251–264(256.7)	222–257(242.7)	218	211–238(224.5)
Snout to 1st gill slit	204–216(210.7)	183–200(192.7)	171–179(175.0)	176–215(195.5)
Snout to 1st dorsal origin	301–321(306.7)	267–322(302.0)	285–300(292.5)	281–306(293.5)
Snout to 2nd dorsal origin	592–619(605.5)	575–628(604.7)	598–618(608.0)	615–645(630.0)
Distance between 1st and 2nd dorsal bases	182–196(192.0)	202–216(207.0)	213	227–233(230.0)
Snout to pectoral insertion	231–251(245.3)	206–241(222.3)	211–226(218.5)	195–210(202.5)
Snout to pelvic insertion	421–439(432.0)	418–446(429.3)	421–437(429.0)	387–392(389.5)
Horizontal diameter of orbit	19–25(20.9)	18–21(19.3)	16–17(16.5)	14–15(14.5)
Length of 1st dorsal base	97–111(103.8)	90–99(93.7)	90–105(97.5)	106–107(106.5)
Length of 2nd dorsal base	43–52(48.0)	44–46(45.0)	45–50(47.5)	44–49(46.5)
Length of 2nd dorsal lobe	45–49(47.1)	48–51(49.7)	51–54(102.5)	55–63(59.0)
Height of 2nd dorsal fin	30–38(34.3)	30–37(33.0)	35–39(37.0)	39
Length of anal base	72–83(80.3)	73–84(80.0)	86–90(88.0)	84–85(84.5)
Length of anal lobe	36–38(37.3)	39	31–38(34.5)	39–48(43.5)
Height of anal fin	39–47(42.5)	38–43(40.7)	39–46(42.5)	41
Length of pectoral base	50–57(53.8)	53–57(54.3)	52–56(54.0)	59–62(60.5)
Length of pelvic base	54–62(59.2)	60–65(62.3)	48–61(54.5)	66–67(66.5)
Length of caudal fin	279–297(289.3)	290–310(298.0)	287–297(292.0)	289–306(297.5)

TABLE 8.—*Measurements of* Sphyrna corona (*proportions expressed in thousandths of total length*)

	Size range in mm.		
	200-399	400–599	>600
	Number of specimens		
	12	2	1
Head width	259–291(275.4)	261–262(261.5)	237
Internarial distance	181–206(192.3)	203–210(182.0)	161
Snout to symphysis	110–127(117.1)	107–109(108.0)	88
Mouth width	59–69(65.6)	60–63(61.5)	57
Head length	250–281(270.3)	251–261(256.0)	223
Snout to 1st gill slit	209–230(218.9)	203–210(206.5)	179
Snout to 1st dorsal origin	315–345(328.6)	309–318(313.5)	312
Snout to 2nd dorsal origin	595–640(613.9)	588–617(602.5)	625
Distance between 1st and 2nd dorsal bases	174–202(188.1)	185–205(195.0)	228
Snout to pectoral insertion	253–277(262.3)	238–263(250.5)	236
Snout to pelvic insertion	436–465(450.1)	428–447(437.5)	438
Horizontal diameter of orbit	17–22(18.8)	17–18(17.5)	13
Length of 1st dorsal base	89–104(97.4)	94	85
Length of 2nd dorsal base	39–47(43.6)	43–49(46.0)	39
Length of 2nd dorsal lobe	40–52(45.1)	46–49(47.5)	48
Height of 2nd dorsal fin	28–33(30.4)	30–34(32.0)	33
Length of anal base	82–92(87.5)	87–89(88.0)	86
Length of anal lobe	33–43(37.8)	40–41(40.5)	36
Height of anal fin	32–41(36.8)	40–43(41.5)	36
Length of pectoral base	52–61(55.6)	55–59(57.0)	50
Length of pelvic base	48–60(53.1)	53–59(56.0)	61
Length of caudal fin	268–290(279.3)	284–288(286.0)	265

TABLE 9.—*Measurements of* Sphyrna tudes (*proportions expressed in thousandths of total length*)

	Size range in mm. (N=number of specimens)							
	N	200–399	N	400–599	N	600–799	N	>800
Head width								
Western Atlantic	13	299–319(310.0)	1	304	2	276–285(280.5)	1	280
Mediterranean	1	321	0	—	0	—	0	—
Internarial distance								
Western Atlantic	13	221–234(228.5)	1	219	2	202–209(205.5)	1	206
Mediterranean	1	231	0	—	0	—	0	—
Snout to symphysis								
Western Atlantic	13	94–117(105.1)	1	92	2	80(80.0)	1	72
Mediterranean	1	104	0	—	0	—	0	—
Mouth width								
Western Atlantic	13	61–69(64.7)	1	68	2	65–69(67.0)	1	69
Mediterranean	1	69	0	—	0	—	0	—
Head length								
Western Atlantic	13	229–263(242.2)	1	233	2	224–226(225.0)	1	227
Mediterranean	1	243	0	—	0	—	0	—
Snout to 1st gill slit								
Western Atlantic	13	190–211(200.5)	1	193	2	186–189(187.5)	1	184
Mediterranean	1	197	0	—	0	—	0	—
Snout to 1st dorsal origin								
Western Atlantic	13	293–334(309.8)	1	305	2	299–306(302.5)	1	290
Mediterranean	1	319	0	—	0	—	0	—
Snout to 2nd dorsal origin								
Western Atlantic	13	580–625(597.0)	1	606	2	601–619(610.0)	1	622
Mediterranean	1	243	0	—	0	—	0	—
Distance between 1st and 2nd dorsal bases								
Western Atlantic	13	178–209(190.7)	1	203	2	199–209(204.0)	1	224
Mediterranean	1	182	0	—	0	—	0	—
Snout to pectoral insertion								
Western Atlantic	13	215–251(231.1)	1	225	2	227–228(227.5)	1	212
Mediterranean	1	246	0	—	0	—	0	—
Snout to pelvic insertion								
Western Atlantic	13	397–427(413.5)	1	412	2	405–428(416.5)	1	393
Mediterranean	1	434	0	—	0	—	0	—
Horizontal diameter of orbit								
Western Atlantic	13	15–23(18.0)	1	15	2	15(15.0)	1	18
Mediterranean	1	20	0	—	0	—	0	—
Length of 1st dorsal base								
Western Atlantic	13	89–109(98.0)	1	108	2	103–104(103.5)	1	108
Mediterranean	1	95	0	—	0	—	0	—
Length of 2nd dorsal base								
Western Atlantic	13	41–51(44.2)	1	45	2	41–44(42.5)	1	48
Mediterranean	1	45	0	—	0	—	0	—
Length of 2nd dorsal lobe								
Western Atlantic	13	41–47(44.0)	1	47	2	53–58(55.5)	1	56
Mediterranean	1	42	0	—	0	—	0	—
Height of 2nd dorsal fin								
Western Atlantic	13	29–33(31.0)	1	29	2	33–36(34.5)	1	39
Mediterranean	1	35	0	—	0	—	0	—
Length of anal base								
Western Atlantic	13	75–99(84.6)	1	83	2	83–93(88.0)	1	84
Mediterranean	1	84	0	—	0	—	0	—
Length of anal lobe								
Western Atlantic	13	28–33(32.1)	1	37	2	37–42(39.5)	1	34
Mediterranean	1	35	0	—	0	—	0	—
Height of anal fin								
Western Atlantic	13	36–47(40.4)	1	46	2	47(47.0)	1	47
Mediterranean	1	51	0	—	0	—	0	—

TABLE 9.—*Measurements of* Sphyrna tudes *(proportions expressed in thousandths of total length)*—Continued

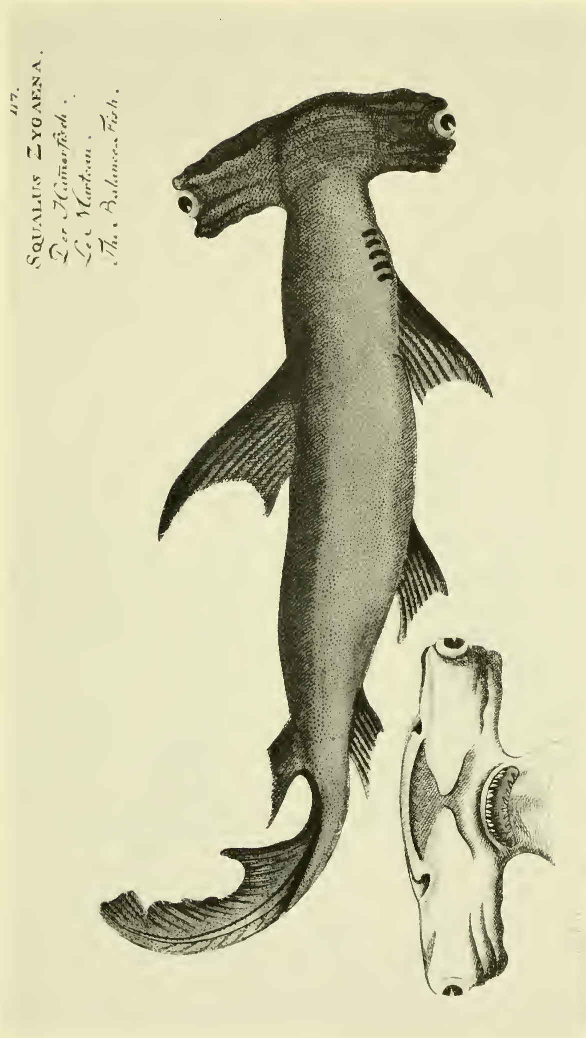
	Size range in mm. (N=number of specimens)							
	N	200–399	N	400–599	N	600–799	N	>800
Length of pectoral base								
Western Atlantic	13	53–58(55.2)	1	57	2	60–62(61.0)	1	59
Mediterranean	1	55	0	—	0	—	0	—
Length of pelvic base								
Western Atlantic	13	50–60(55.0)	1	54	2	64–67(65.5)	1	73
Mediterranean	1	59	0	—	0	—	0	—
Length of caudal fin								
Western Atlantic	13	290–313(302.4)	1	295	2	293–297(295.0)	1	286
Mediterranean	1	292	0	—	0	—	0	—

TABLE 10.—*Measurements of heads of* Sphyrna lewini *and* S. couardi *from Gulf of Guinea* [1]

	Head width	Snout to symphysis	Nares to posterior margin of head [2]	Mouth gape	Inner narial groove
S. lewini	445. 0	93. 5	93. 5	103. 5	83. 0
proportion	—	. 210	. 210	. 233	. 187
S. couardi	425. 0	115. 0	117. 5	119. 5	89. 0
proportion	—	. 270	. 276	. 281	. 209

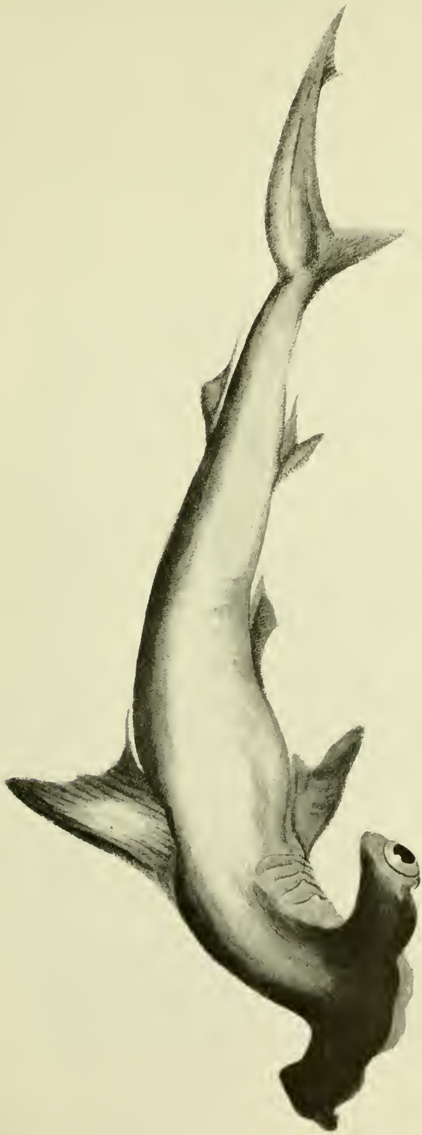
[1] One specimen from each species. Under each species the first row represents the empirical lengths (in millimeters); the second row, the proportional values (in thousandths of head width), obtained by dividing head width into the respective measurements.

[2] Shortest vertical distance.

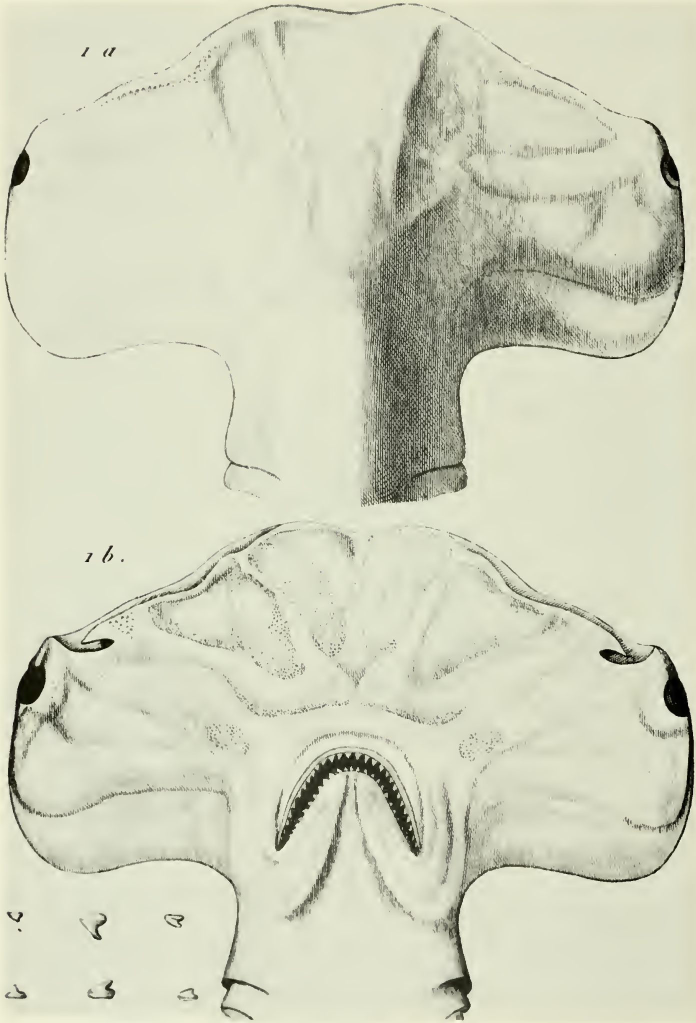


Original illustration of *Zygaena blochii* (misidentified as *Squalus zygaena*), from Bloch (1785, vol. 1, pl. 117).

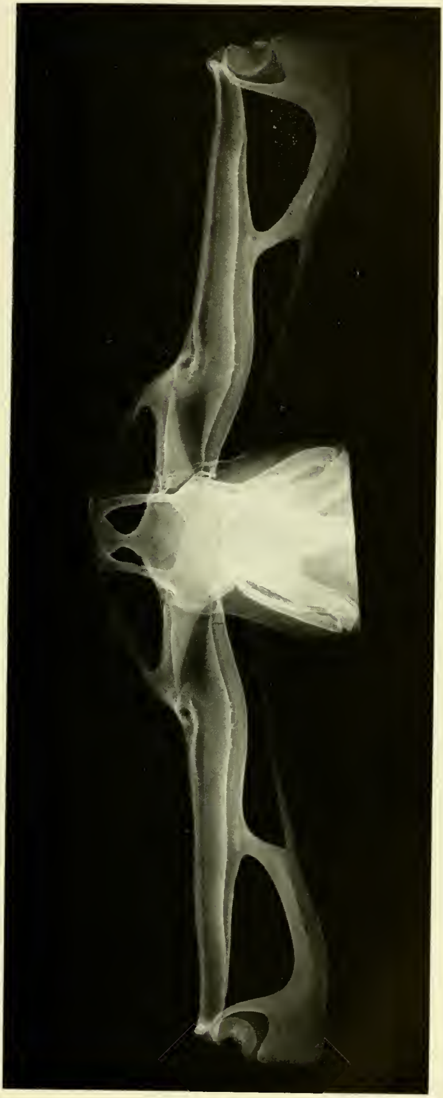
Original illustration of *Zygaena mokarran*, from Rüppell (1835, pl. 17, fig. 3).



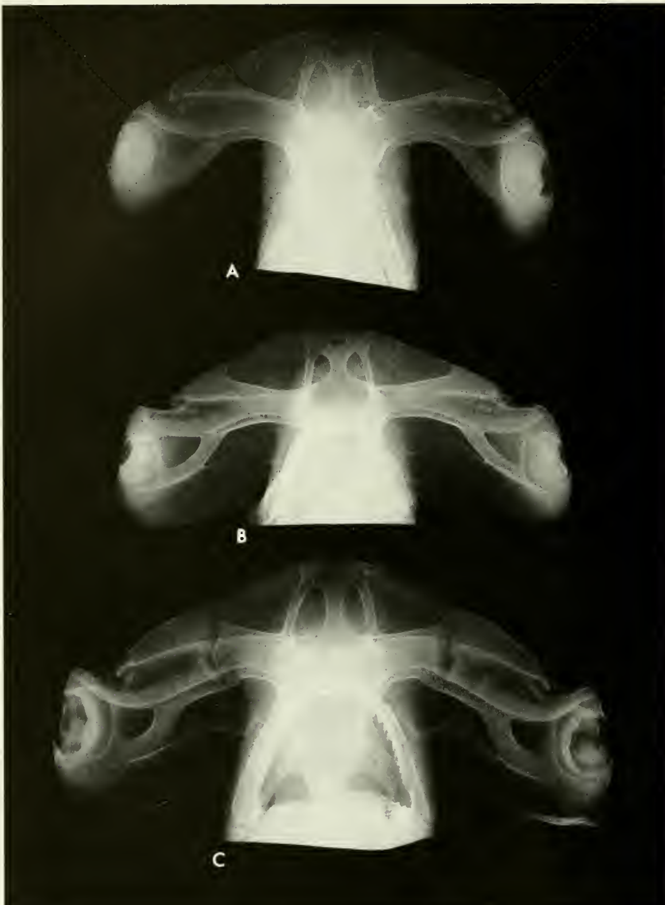
Original illustration of *Zygaena lewini*, from Griffith and Smith, *in* Cuvier, Griffith, and Smith (1834, p. 640, pl. 50).



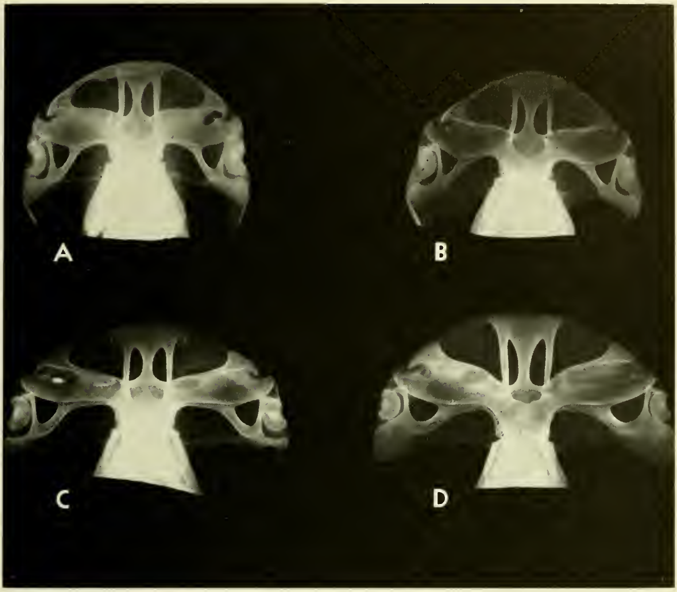
Original illustration of *Zygaena tudes*, from Valenciennes (1822, pl. 12, figs. 1a, b).



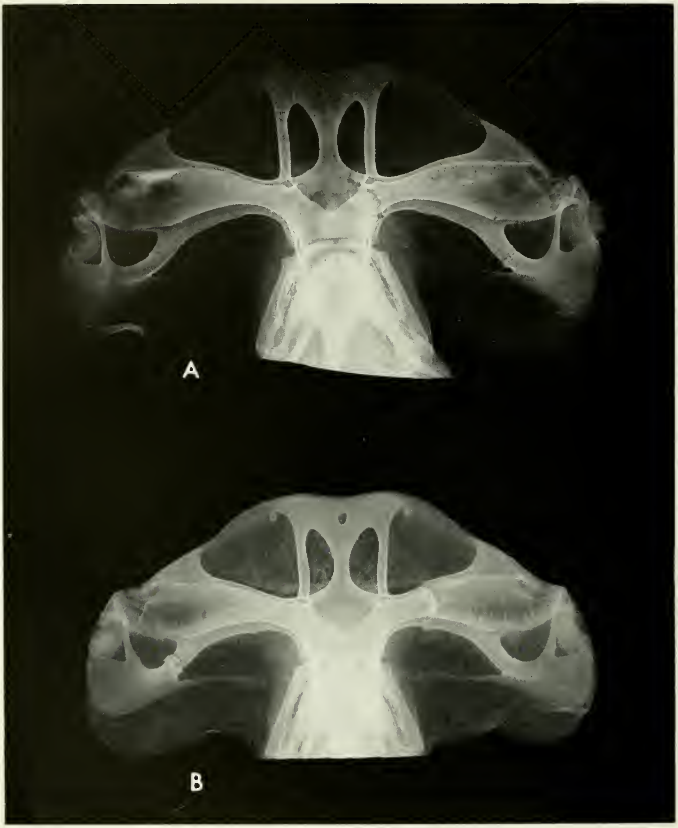
Radiograph of chondrocranium of *Sphyrna blochii*, a specimen 470 mm. TL, from Java (FMNH 15656).



Radiographs of chondrocrania of several species of *Sphyrna:* A, *S. mokarran*, 560 mm. TL, from Florida (USNM 186087); B, *S. lewini*, 447 mm. TL, from Liberia (USNM 179706); C, *S. zygaena*, 590 mm. TL, from Italy (USNM 28452).

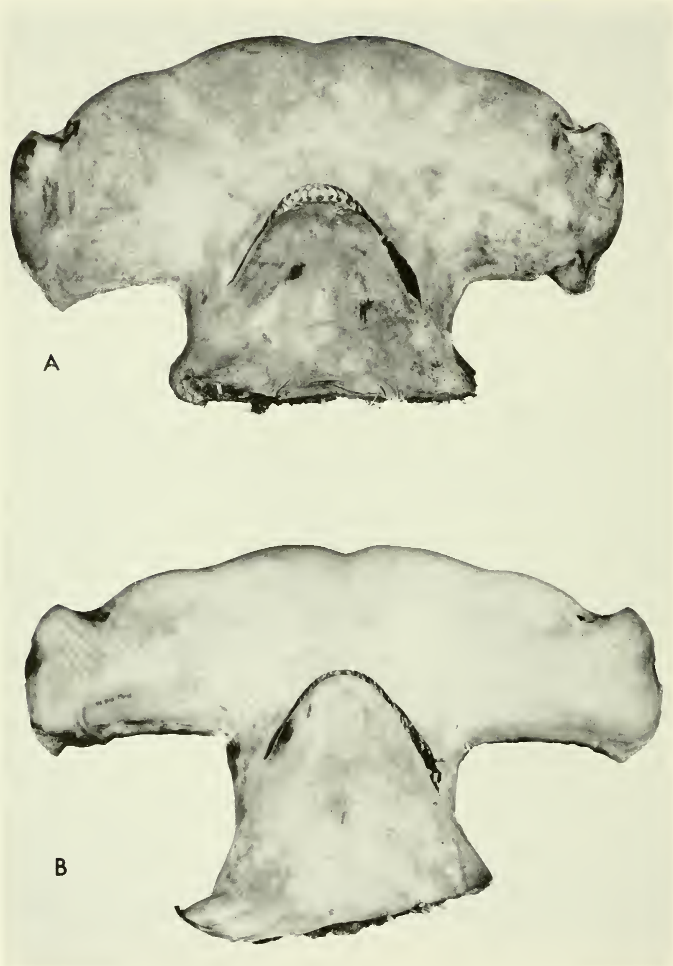


Radiographs of chondrocrania of several species of *Sphyrna:* A, *S. tiburo tiburo*, 388 mm. TL, from Nicaragua (USNM 78180; B, *S. tiburo vespertina*, 545 mm. TL, from Mexico (UCLA 51–4); C, *S. media*, 337 mm. TL, from Mexico (FMNH 63093); D, *S. corona*, 371 mm. TL, from Mexico (FMNH 72521, ex. 63093).



Radiographs of chondrocrania of *Sphyrna tudes:* A, a specimen 390 mm. TL (holotype of *S. bigelowi*) from Uruguay (USNM 87682); B, a specimen 346 mm. TL (lectotype of *S. tudes*) from France (MNHN 1049).

Radiographs of chondrocrania: A, *S. couardi*, head 425 mm. wide, from Guinea (USNM uncat.); B, *S. lewini*, head 445 mm. wide, from Guinea (USNM uncat.).



Photographs of heads: A, *S. couardi*, head 425 mm. wide, from Guinea (USNM uncat.); B *S. lewini*, head 445 mm. wide, from Guinea (USNM uncat.).

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NEOTROPICAL MICROLEPIDOPTERA, X [1]

SYSTEMATIC POSITION OF TWO TAXA ERRONEOUSLY PLACED IN THE FAMILY STENOMIDAE (LEPIDOPTERA)

By W. Donald Duckworth
Associate Curator, Division of Lepidoptera

Revisionary studies presently being conducted on the Stenomidae have revealed two incorrectly placed taxa. One, a monobasic genus, is transferred to the Tortricidae; the other represents a new genus and is transferred to the Oecophoridae.

The author wishes to acknowledge with thanks the cooperation and aid of Mr. P. E. S. Whalley of the British Museum (Natural History) and Dr. Fritz Kasy of the Natural History Museum, Vienna, Austria for allowing him to study the type specimens in their charge.

The author also wishes to thank Andre Pizzini for the line drawings in this paper and Jack Scott for the photographic work.

The work on this paper was aided by the National Science Foundation Grant GB-1800.

[1] Prepared with the aid of a National Science Foundation Grant. Previous parts of this same series are: I and II, Clarke, 1962, Proc. U.S. Nat. Mus., vol. 113, no. 3457, pp. 373–388; III, Clarke, 1964, ibid., vol. 115, no. 3480, pp. 61–84; IV, Duckworth, 1964, ibid., vol. 116, no. 3497, pp. 97–114; V, Obraztsov, 1964, ibid., vol. 116, no. 3501, pp. 183–196; VI, Clarke, 1964, ibid., vol. 116, no. 3502, pp. 197–204; VII, Obraztsov, 1966, ibid., vol. 118, no. 3727, pp. 221–232; VIII, Duckworth, 1966, ibid., vol. 118, no. 3531, pp. 391–404; IX, Obraztsov, 1966, ibid., vol. 118, no. 3535, pp. 577–622.

Family Oecophoridae

Mattea, new genus

Type species: *Cryptolechia phoenissa* Butler, 1883, Trans. Ent. Soc. London, 1883, p. 81; pl. 11, figs. 12, 12a.

Head with appressed scales; lateral tufts spreading; antenna simple in female, finely ciliated ventrally in male; basal segment with pecten; labial palpus recurved, just reaching base of antenna. Forewing with costa slightly arched, termen oblique, tornus rounded; 11 veins; 2 well before angle; 7 and 8 coincident to termen; remainder separate. Hindwing as broad as forewing; 8 veins; 3 and 4 connate; 6 and 7 subparallel.

Male genitalia: Uncus present, well developed. Gnathos a lightly sclerotized, simple band. Anellus a simple plate. Harpe with clasper. Aedeagus with inception of ductus ejaculatorius near midpoint.

Female genitalia: Genital plate reduced to a thin, sclerotized band. Bursa copulatrix reduced, signum absent.

Remarks: The exact position of this genus in the family Oecophoridae is virtually impossible to ascertain until a revision of the Neotropical species is undertaken. In addition, careful attention to the Australian and New Zealand fauna will be necessary since the distributional relationships between these areas and the west coast of South America are poorly understood.

The genus is distinguished by veins 7 and 8 of the forewing being coincident to the termen. Coincidence of veins 7 and 8 is not uncommon in the family, but the termination in other genera is on the costa. The genitalia present a number of striking characters, such as the inception of the ductus ejaculatorius being near the midpoint of the aedeagus and the presence of a reduced bursa copulatrix in the females. However, the genital characters of the Neotropical genera are still poorly known, and until they are studied no definite conclusions can be drawn.

Mattea phoenissa (Butler), new combination

FIGURE 1; PLATE 1 (FIG. a)

Cryptolechia phoenissa Butler, 1883, Trans. Ent. Soc. London, 1883, p. 81, pl. 11, figs. 12, 12a.

The original description of this species is quite accurate and reads as follows: "Wings sericeous carmine-red; primaries above with a a small triangular golden spot at outer third of dorsal margin; fringe at apex tipped with bright ochreous; thorax purplish brown; antennae carmine; palpi whitish; abdomen dark brown; wings below of a clearer carmine-red than above; base of secondaries and pectus bronze-brown; legs and venter whity-brown. Expanse of wings, 16 mm.

In addition to the characters given in the original description, the details of the wing venation, head, and male and female genitalia are illustrated in figures 1*a–e*.

Type: In the British Museum (Natural History).

Type locality: Corral, Chile.

Distribution: Chile: Corral; Llanquihue, Peulla (March); Centro-Austral (Jan.–Mar.).

Remarks: This species was described originally in the family Gelechiidae, and this association was followed by Calvert (1886) in his catalog of Chilean Lepidoptera. Busck (1934) listed the species as *Stenoma phoenissa* in his catalog of the family Stenomidae, and this combination has persisted until now. Examination of the type specimen, however, clearly indicates that the genus should be placed in the Oecophoridae. The remote position of veins 6 and 7 in the hindwing and the presence of pecten on the basal segment of the antenna are both good oecophorid characters which are not found in the Stenomidae.

Family Tortricidae

Subfamily Sparganothiinae

Rhynchophyllis Meyrick

FIGURE 2; PLATE 1 (FIG. b)

Rhynchophyllis Meyrick, 1932, Exotic Microlepidoptera, vol. 4, pp. 288–289.

Type species: *Rhynchophyllis categorica* Meyrick, by monotypy.

This monobasic genus was established for a new species, *R. categorica*, described from a single female specimen from Jaragua, "Santa Catharina" (Santa Catarina), Brazil. Meyrick included the genus in the Xyloryctidae (=Stenomidae) with the following comment: "A highly peculiar insect; the hindwings are normal for the Xyloryctidae, to which therefore it must be referred, but the rest of the structure is very abnormal; possibly there is some relationship to *Falculina*, which is suggested by the superficial appearance, but this may be delusive." Examination of the type specimen in the Natural History Museum, Vienna, Austria, which remains the only known example of this species, clearly indicates its proper placement in the Tortricidae rather than in the Stenomidae. The correct systematic position within the Tortricidae must await a revision of the Neotropical members of the family. On the basis of the ribbon-like signum, the genus is tentatively assigned to the subfamily Sparganothiinae.

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Calvert, W. Bartlett
1886. Catalogo de Los Lepidópteros de Chile. Anales Univ. Chile, vol. 69, pp. 1–44.

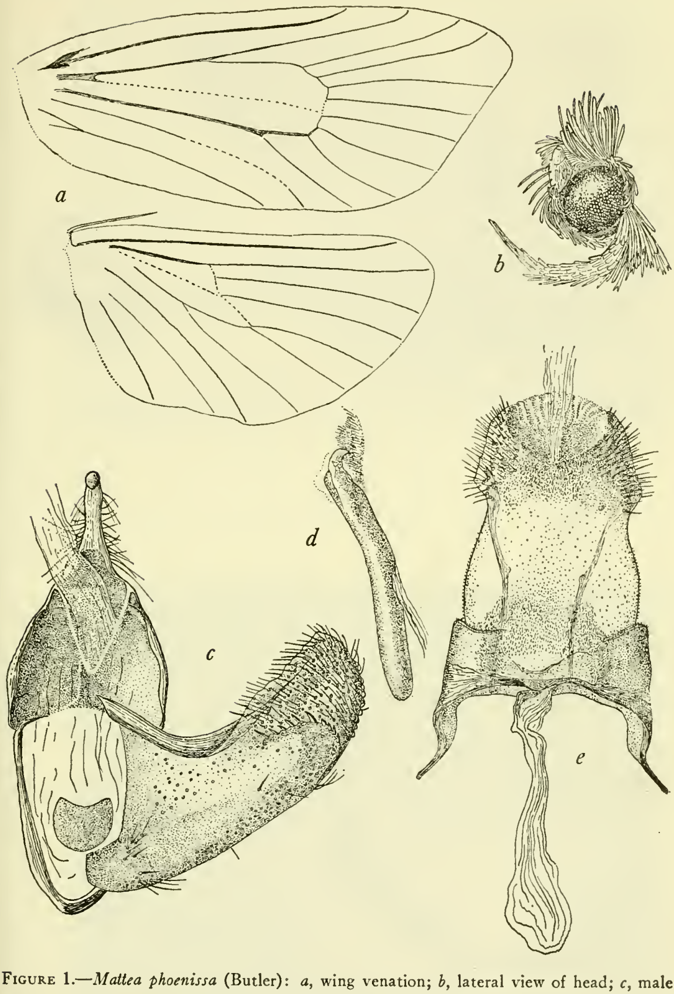

FIGURE 1.—*Mattea phoenissa* (Butler): *a*, wing venation; *b*, lateral view of head; *c*, male genitalia; *d*, aedeagus; *e*, female genitalia.

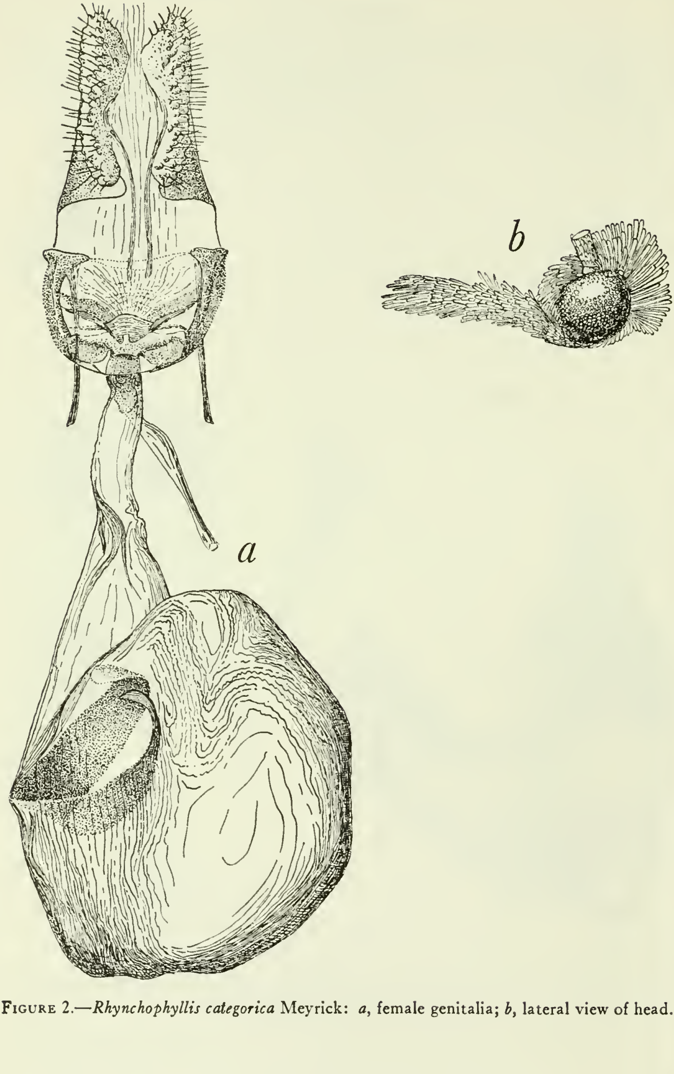

FIGURE 2.—*Rhynchophyllis categorica* Meyrick: *a*, female genitalia; *b*, lateral view of head.

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FIGURE a, *Mattea phoenissa* (Butler). FIGURE b, *Rhynchophyllis categorica* Meyrick.

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BENTHIC AMPHIPODA OF MONTEREY BAY, CALIFORNIA

By J. Laurens Barnard
Associate Curator, Division of Crustacea

The fauna of benthic subintertidal Amphipoda in Monterey Bay, California is compared to that of southern California south of Point Conception. This study of northern Amphipoda complements a study of southern Amphipoda of Baja California (Barnard, 1964a). The two surveys have been conducted in order to determine the affinities of various Amphipoda of southern California.

The extrinsic distributions of southern California Amphipoda are poorly known except for those species from Baja California reported by Shoemaker (1925, 1942), Barnard (1964a), and those from Oregon, Washington, and British Columbia reported by Calman (1898), Walker (1898), Thorsteinson (1941), Barnard (1954), Bousfield (1958), and Mills (1961, 1962). Most of the cited papers have treated only intertidal species. Although Monterey Bay has not been considered to be a typical cold-temperate area, the present analyses indicate the cold-temperate character of several California Amphipoda.

I am indebted to Dr. R. E. Stevenson of Florida State University, formerly of the Allan Hancock Foundation, who directed the California State Water Pollution Control Board survey of California.

G. F. Jones, aboard the RV/*Velero IV*, was instrumental in collecting and processing the samples. Captain Fred C. Ziesenhenne identified the ophiuroids dominating the bottom samples. Dr. Joel W. Hedgpeth of Pacific Marine Station loaned specimens of a new species of *Protomedeia*. The Beaudette Foundation and the Smithsonian Institution supported the project and the National Science Foundation provided funds for illustration (grant G–10750).

Methods and Data

The benthos of Monterey Bay, in water depths of 15 to 116 m (table 1) is represented by those 46 samples charted in figure 1. They are relatively evenly distributed in proportion to bathymetry. The coastal benthos of southern California is represented by 348 samples evenly proportioned to depths between 10 and 200 m. The two groups of samples, although disparate, are roughly proportional in number to their respective bottom areas. Any comparisons between the Amphipoda of the two areas must be viewed with caution.

Samples of sediment and fauna were collected with an orange-peel grab taking a surface area of 0.25 m^2. Barnard and Jones (1960) have considered the average mechanical efficiency of the grab to be about 80 percent if large numbers of samples are taken on diverse substrates. The efficiency decreases on hard-packed sand bottoms and increases on soft silty bottoms. Calculations of frequencies of Amphipoda in the 348 southern California samples employed the 80 percent efficiency rule. Those of Monterey Bay employed a 100 percent efficiency rule. All sedimentary samples from Monterey Bay, with one exception, exceeded 1.5 m^3, the mark of 100 percent efficiency. Presumably differences in depth of penetration of the grab in those samples of 100 percent areal efficiency would not affect tallies of Amphipoda except for those listriellas inhabiting deep burrows of polychaetes and echiuroids.

Sedimentary samples were washed through meshes of 0.7 mm square openings and the residues preserved in a mixture of seawater and formaldehyde. Amphipoda and those other animals considered to be dominants in the samples were removed to alcohol in the laboratory. The remaining materials were represerved and stored in the collections of the Allan Hancock Foundation. Thorson's (1957) methods were used to determine standing-crop dominance.

Planning and conducting of the surveys were based on USHO charts contoured in English fathoms, but the bathymetric data have been converted to meters herein. Hence the depth classifications of benthic areas in southern California, quoted in meters, are not in standard intervals of 10, 20, 30 m, etc., but are in converted intervals of 10, 20, 30, etc., fms.

Geographic Positions and Environments

The region of southern California, with a median latitude of 33° N, extends from Point Conception on the north to the international border between California amd Mexico on the south. The coastal length is approximately 300 km. Monterey Bay, with a latitude of approximately 36.5° N, lies 275 km north of Point Conception. The bay occurs near the southern end of the cold-temperate Oregonian zoogeographic province and is within the Montereyan subprovince. Monterey Bay is broad, semilunar, and about 30 km wide. Its shelf is narrow and cut by the shoreward ends of the Monterey Canyon complex occurring just north of the area shown in figure 1. The benthic enviroment, except for intertidal areas, has been scarcely explored, but several known environmental differences between Monterey Bay and southern California are explained below.

Surface waters of Monterey Bay are dominated by the upwelling of cool subsurface layers (California Cooperative Fishery Investigations, 1952–1964). Sea-surface temperatures vary between 10° and 14° C. The average sea-surface temperature of southern California, at 33° N during 1957–1960, was about 17.5°, and the range was 14° to 23° C (Jones and Barnard, 1963). Upwelling occurs from place to place and is especially prominent in the Gulf of Santa Barbara, where waters are entrained by the California current.

The shelf of the southern part of Monterey Bay lies in greater water depths than do Santa Monica Bay (Hartman, 1956) and San Pedro Bay (Barnard and Ziesenhenne, 1961) of southern California. Very little of Monterey Bay is shallower than 37 m (20 fms). Those southern bays have a large share of benthic area in the 27–46 m (15–25 fms) depth interval. As a result, the benthic fauna of Monterey Bay is dominated by deep-water ophiuroid communities, whereas the southern bays are dominated by shallow-water ophiuroid communities or nonophiuroid communities. The distribution of the communities in Monterey Bay is shown in figure 1. Contours are necessarily diagrammatic because of low sampling frequencies. The principal ophiuroids are *Amphioda urtica* (Lyman), *Amphipholis squamata* (Delle Chiaje), *Amphiura arcystata* H. L. Clark, and *Amphioplus strongyloplax* (H. L. Clark). The southern bays are dominated principally by the *Amphioplus hexacanthus* H. L. Clark community (Barnard and Ziesenhenne, 1961), which occurs only on the inshore margins of Monterey Bay. The deep-water *Amphiodia urtica* is the common dominant of the outer shelf of southern California. The prevalence of *A. strongyloplax, A. amphacantha,* and *A. arcystata* in depths of less than 100 m in Monterey Bay is a reflection of the northern emergence of communities occurring in southern California only on coastal slopes in depths exceeding 120 m. These communities have not been sampled frequently in southern California because of steeply sloping bottoms and diffuse sampling grids.

The headland of Monterey Peninsula has a rocky substrate but to the northeast a long, slightly concave shoreline is composed of sand beach. A community dominated by the polychaete *Nothria* species occurs on inshore sand bottoms in depths of less than 30 m; presumably it is similar to that described from southern California by Barnard (1963).

The Amphipod Fauna

Because most of the Monterey shelf lies in depths exceeding 50 m, the station grid embraces only 13 samples in depths of 10 to 50 m. Those few samples have little comparative significance to samples from southern California. Thus, this discussion is confined to the 33 samples from depths of 50 to 139 m. The Amphipoda occurring in Monterey Bay are listed in rank in table 2, with their frequencies of individuals and their limitations to depths of 50 to 139 m. They are compared with rankings of species from similar depths in southern California (tables 3, 4, 5, 6).

Half of the 20 most abundant species occurring in southern Californian depths of 94–183 m (table 6) also occur in the first 20 of Monterey Bay in depths of 50–139 m (table 2). Those southern California species not found in the list of abundant Monterey species are *Ampelisca pacifica*, *Westwoodilla caecula*, *Ampelisca brevisimulata*, *Orchomene decipiens*, *Nicippe tumida*, *Ampelisca pugetica*, *Lysianassa holmesi*, *Paraphoxus robustus*, *Pardisynopia synopiae*, and *Lysianassa oculata* (the latter is number 22 in Monterey Bay). Because all of those species do occur in low frequency in Monterey Bay, this poor comparison is probably a circumstance of low sampling frequency. These data also indicate that shallow waters of Monterey Bay, despite the occurrence of upwelling, are too warm for the occurrence of deep-water species.

A 50 percent correspondence in predominant species occurring both on the Monterey deep shelf and in southern California depths of 75 to 92 m also occurs (table 5). Some deep-water species, i.e., *Nicippe tumida* and *Pardisynopia synopiae*, occur dominantly in the southern California section but not in Monterey Bay.

Only 8 of the 20 predominant species occurring in depths of 57 to 73 m also predominate in Monterey Bay. Similarly, neither *Nicippe tumida* nor *Urothoe varvarini* are abundant in Monterey Bay (table 4). The same is true in depths of 39 to 55 m (table 3).

These poor faunal congruencies may result from the low densities of the individual species in the Monterey samples. For instance, the 20 species of Monterey Bay occurring most frequently (1–21, less 3) tally 220 individuals per m^2, whereas they tally 493 individuals in southern California depths of 75–92 and 94–183 m. The frequency of the 20th most abundant species in Monterey Bay is 2.4 individuals whereas the 20th of southern California is about 7.0 individuals per m^2. Fifty-eight species occur on the deep shelf of Monterey but more than 110 species occur in depths of 75 to 183 m in southern California. Of the 110 southern California species, 12 have frequencies of less than 0.2 individuals per m^2 and 39 have less than 1.0 individuals. This demonstrates the influence of sampling frequency.

All 58 species of the Monterey deep shelf occur in southern California except for *Centromedon pavor* and *Protomedeia penates*. In shallow waters, only *Eohaustorius sencillus* (of 23 species not found in the deep zone) is not recorded from southern California. This strong relationship is a result of the extreme intermixture of northern and southern elements in the fauna of southern California. Perhaps the intermixture results from southward range extensions of northern species inhabiting areas of upwelling.

On the other hand, many of the Amphipoda of Monterey Bay were not collected in the survey of Baja California (Barnard, 1964a). Thirty-seven open-sea samples were collected there, an effort comparable to that of Monterey Bay. A comparison of Monterey Bay and Baja California probably suffers the effects of small numbers of samples more than would a comparison between a large and a small number. The sampling stations of Baja California were scattered throughout 300 km of the coastal length and occurred in a variety of environments. Approximately 113 species occur in the fauna of Monterey Bay and Baja California, but only 61 species occur in both areas. The remaining species are listed in groups of northern and southern species in tables 7 and 8.

These data provide an estimate of the northern or southern affinities of more than 100 of the 167 species of Amphipoda occurring on the benthos of southern California. A large share of the species occurs in all three areas. Records from the literature supply information for some of the other Amphipoda, and a few species are assigned to regions by determining the general distribution of their genera. Facts and approximations are combined in a checklist of species from southern California (table 9). Only those species with detectable affinities are annotated with appropriate statements. The southern California fauna is estimated to be comprised of 24 percent northern or cold-water species, 13 percent southern or warm-water species, 5 percent bathyal affinity, and 58 percent interregional or poorly known distribution. Northern species occur generally in deep water, southern species in shallow water, and ubiquitous species in one or both. The percentages support the conclusion that southern California lies at the northern end of the warm-temperate province but that the deep-water shelf is inhabited primarily by submergent cold-temperate species.

Presumably 16 species of table 8, marked with asterisks, represent northeastern Pacific endemic boreal elements which may be found throughout the Oregon province (in shallow depths in the northern portion). Approximately 28 (35 percent) of the 81 known species of Monterey Bay are of cold-temperate distribution. Purely tropical influence is small. The remaining species are of presumed warm-temperate affinities.

The intertidal zone of California north of Point Conception has several cold-temperate species (Barnard, MS), whereas the middepths of Monterey Bay and southern California have very few, if any, of these elements. These facts indicate that amphipodan distributions are strongly controlled by temperature and that a wide latitude of ecothermic response is possible for mud-bottom species through submergence because of substrate similarities between shallow and deep waters. The floral substrates of intertidal waters have a narrow range of submergence owing to the absence of illumination in deep waters. Thus phycophilous Amphipoda cannot submerge to the extent of their mud-bottom congeners. The thermal tolerances of the cold-temperate intertidal species must therefore be greater than those of mud dwellers. The temporal evolution of these intertidal distributions may be favorably controlled by the occurrence of a wide variety of available niches and an extensive food supply.

Northwestern Pacific Relationships

Only 12 of the 81 species of Monterey Bay have been found in the northwestern Pacific region embracing the Japan Sea, Okhotsk Sea, and Bering Sea (table 10). Two of those species, *Argissa hamatipes* and *Nicippe tumida*, may be cosmopolitan in cold water. They may submerge to great depths in the tropics, the former possibly occurring even in shallow tropical seas. *Leucothoe spinicarpa* is a eurybathic cosmopolite occurring in sponges. The genus *Anonyx* is enormously diverse in the northwestern Pacific region but declines in diversity by southerly increments. Only 2 species of *Anonyx* occur in California, south of Monterey Bay. *Corophium uenoi* rarely occurs in the open sea of California, but it is abundant in lagoons and estuaries (Newport Bay, Morro Bay) and may have been introduced from Japan in oyster transplants. The remaining 7 species of table 10, with the exception of *Ampelisca macrocephala* and *Paraphoxus obtusidens*, are scarce on the Monterey shelf. Probably they submerge or are depleted to the south of southern California. *Ampelisca macrocephala* is an extremely abundant deep-shelf species in California and is replaced in bathyal depths by its anoculate subspecies, *A. m. unsocalae*. *Paraphoxus obtusidens* is a paneastern Pacific eurythermal species ranging from the subarctic into the tropics. It scarcely submerges to the south, but it may occur in warm latitudes primarily in areas of upwelling.

TABLE 1.—Metric depths of stations in Monterey Bay shown in figure 1 (uncorrected for tidal levels).

Station	Depth	Station	Depth	Station	Depth
6425	24	6444	17	6459	84
6426	54	6445	25	6460	87
6427	63	6446	52	6462	85
6428	61	6447	63	6463	87
6429	73	6448	55	6464	82
6430	78	6449	35	6465	93
6431	93	6450	34	6466	106
6432	98	6451	56	6469	109
6433	107	6452	53	6471	139
6435	116	6453	24	6474	115
6438	97	6454	15	6477	107
6439	67	6455	76	6478	101
6440	19	6456	77	6479	96
6442	24	6457	75	6480	103
6443	38	6458	80		

TABLE 2.—Frequency of 58 species of Amphipoda in Monterey Bay in depths of 50–139 m, with percent of restriction of each species to this depth zone (third species, based on 33 samples, eliminated in all calculations described in text; NSS = not statistically significant).

Name of species	Individuals per m²	Percent of specimens collected between 50 and 139 m	Present in no. of samples
Paraphoxus fatigans	73	76	18
(kind 1)	(13)	(39)	(6)
(kind 2)	(61)	(94)	(17)
Paraphoxus bicuspidatus	24	100	17
Kermystheus ociosa NSS	14	100	4
Phoxocephalus homilis	13	100	6
Photis lacia	12	100	8
Paraphoxus similis	12	87	12
Photis californica	11	100	2
Ampelisca macrocephala	10	96	19
Heterophoxus oculatus	9. 7	95	15
Byblis veleronis	9. 6	100	22
Ampelisca romigi	8. 8	100	2
Metaphoxus frequens	7. 3	80	15
Paraphoxus obtusidens	4. 4	94	10
Ampelisca compressa	4. 1	100	10
Paraphoxus variatus	3. 9	60	4
Aoroides columbiae	3. 6	27	6
Ampelisca cristata	3. 2	70	7
Synchelidium sp. A	2. 9	100	9

TABLE 2.—Frequency of 58 species of Amphipoda in Monterey Bay in depths of 50–139 m, with percent of restriction of each species to this depth zone (third species, based on 33 samples, eliminated in all calculation described in text; NSS=not statistically significant)—Continued

Name of species	Individuals per m²	Percent of specimens collected between 50 and 139 m	Present in no. of samples
Anonyx adoxus	2. 7	100	1
Urothoe varvarini	2. 6	100	4
Protomedeia articulata	2. 4	73	9
Lysianassa oculata	2. 3	100	9
Hippomedon denticulatus	2. 1	88	6
Synchelidium sp. G	2. 1	82	6
Ampelisca pacifica	2. 0	100	6
Ampelisca pugetica	2. 0	21	7
Monoculodes emarginatus	2. 0	100	6
Paraphoxus robustus	2. 0	100	6
Listriella goleta	1. 8	92	10
Orchomene pacifica	1. 7	100	2
Nicippe tumida	1. 5	100	5
Pardisynopia synopiae	1. 5	100	3
Dexamonica reduncans	1. 4	100	3
Orchomene decipiens	1. 4	100	4
Westwoodilla caecula	1. 2	100	6
Ampelisca hancocki	1. 1	100	4
Photis brevipes	1. 1	6	4
Opisa tridentata	0. 9	100	2
Melita desdichada	0. 8	100	2
Ampelisca brevisimulata	0. 6	100	3
Metaphoxus fultoni	0. 6	50	1
Paraphoxus epistomus	0. 6	100	1
Ampelisca milleri	0. 5	100	1
Acidostoma hancocki	0. 3	100	1
Lysianassa holmesi	0. 3	100	2
Centromedon pavor	0. 3	100	1
Lepidepecreum gurjanovae	0. 3	100	2
Maera danae	0. 3	100	1
Pachynus barnardi	0. 3	100	1
Prachynella lodo	0. 3	100	2
Synchelidium shoemakeri	0. 3	100	1
Anonyx carinatus	0. 2	100	1
Argissa hamatipes	0. 2	100	1
Microdeutopus schmitti	0. 2	0+	1
Photis macrotica	0. 2	100	1
Protomedeia penates	0. 2	100	1
Stenothoe frecanda	0. 2	100	1
Synchelidium sp. E	0. 2	100	1

Other species from Monterey Bay found in shallow water: *Ampelisca lobata, Amphilochus picadurus, Bathymedon roquedo, Corophium uenoi, Eohaustorius sencillus, Erichthonius brasiliensis, Eurystheus thompsoni, Ischyrocerus litotes, Leucothoe alata, Leucothoe spinicarpa, Liljeborgia kinahani, Listriella diffusa, Maera simile, Meguluropus longimerus, Megamphopus mamolus, Metopella aporpis, Monoculodes norvegicus, Monoculodes spinipes, Panoploca rickettsi, Parapleustes pugettensis, Photis bifurcata, Podocerus cristatus, Tiron biocellata.*

TABLE 3.—The most abundant species in depths of 39–55 m in southern California.

Species	Individuals per m²	Species	Individuals per m²
Ampelisca brevisimulata	68	*Listriella goleta*	14
Heterophoxus oculatus	58	*Paraphoxus obtusidens*	14
Paraphoxus bicuspidatus	44	*Ampelisca pacifica*	14
Amphideutopus oculatus	41	*Paraphoxus epistomus*	14
Paraphoxus similis	36	*Ampelisca pugetica*	11
Metaphoxus frequens	33	*Ampelisca compressa*	11
Ampelisca cristata	32	*Byblis veleronis*	8. 0
Photis brevipes	19	*Lysianassa oculata*	7. 7
Photis californica	19	*Podocerus cristatus*	7. 3
Photis lacia	17	*Paraphoxus stenodes*	7. 0

TABLE 4.—The most abundant species in depths of 57–73 m in southern California.

Species	Individuals per m²	Species	Individuals per m²
Paraphoxus bicuspidatus	134	*Amphideutopus oculatus*	12
Ampelisca brevisimulata	63	*Ampelisca indentata*	11
Heterophoxus oculatus	51	*Photis lacia*	11
Paraphoxus similis	45	*Ampelisca cristata*	9. 8
Metaphoxus frequens	35	*Lysianassa oculata*	9. 6
Ampelisca pacifica	31	*Ampelisca macrocephala*	9. 0
Ampelisca pugetica	21	*Nicippe tumida*	8. 8
Byblis veleronis	15	*Urothoe varvarini*	8. 6
Photis brevipes	15	*Paraphoxus robustus*	8. 3
Protomedeia articulata	13	*Lysianassa holmesi*	7. 4

TABLE 5.—The most abundant species in depths of 75–92 m in southern California.

Species	Individuals per m²	Species	Individuals per m²
Paraphoxus bicuspidatus	125	*Photis lacia*	24
Metaphoxus frequens	35	*Byblis veleronis*	15
Ampelisca macrocephala	34	*Lysianassa holmesi*	11
Ampelisca pacifica	33	*Photis californica*	11
Ampelisca brevisimulata	31	*Lysianassa oculata*	11
Heterophoxus oculatus	27	*Paraphoxus obtusidens*	10
Ampelisca pugetica	26	*Phoxocephalus homilis*	10
Paraphoxus similis	25	*Ampelisca hancocki*	8. 6
Paraphoxus robustus	25	*Pardisynopia synopiae*	8. 6
Urothoe varvarini	25	*Nicippe tumida*	8. 3

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TABLE 6.—The most abundant species in depths of 94–183 m in southern California.

Species	Individuals per m²	Species	Individuals per m²
Paraphoxus bicuspidatus	98	*Orchomene decipiens*	12
Ampelisca macrocephala	84	*Nicippe tumida*	11
Ampelisca romigi	45	*Ampelisca pugetica*	10
Heterophoxus oculatus	35	*Protomedeia articulata*	9. 6
Metaphoxus frequens	33	*Lysianassa holmesi*	9. 2
Photis lacia	27	*Paraphoxus similis*	8. 6
Ampelisca pacifica	21	*Paraphoxus robustus*	8. 3
Phoxocephalus homilis	19	*Urothoe varvarini*	8. 1
Westwoodilla caecula	16	*Pardisynopia synopiae*	7. 1
Ampelisca brevisimulata	13	*Lysianassa oculata*	6. 5

TABLE 7.—Amphipoda of Baja California not recorded from Monterey Bay (species marked with asterisks probably occur in both areas but were absent in the collections).

Acuminodeutopus heteruropus
Ampelisca indentata
Ampelisca mexicana
Ampelisca shoemakeri
Ampelisca venetiensis
Amphideutopus oculatus
Ampithoe ramondi
Cheiriphotis megacheles
Chevalia aviculae
Elasmopus antennatus
Eusiroides monoculoides
Gaviota podophthalma
Gitana calitemplado
**Listriella albina*
**Listriella eriopisa*
**Listriella melanica*
Lembos audbettius
Lysianassa dissimilis
Megaluropus ?agilis
Megamphopus effrenus (intertidal N of Point Conception)
Megamphopus martesia (intertidal N of Point Conception)
**Melphisana bola*
Metopa dawsoni
Monoculodes hartmanae
Ocosingo borlus (intertidal N of Point Conception)
Orchomene magdalenensis
Paraphoxus stenodes
Photis viuda
Platyischnopus metagracilis
Platyischnopus viscana
Podocerus brasiliensis
Pontogeneia quinsana
Pseudokoroga rima
Rudilemboides stenopropodus
Stenopleustes monocuspis
Stenothoides bicoma

TABLE 8.—Amphipoda of Monterey Bay not recorded from coastal shelf of Baja California; some species may occur on the slope in depths exceeding 100 m (asterisks mark possible northeastern Pacific cold-temperate species of the coastal shelf).

Anonyx adoxus
**Anonyx carinatus*
**Centromedon pavor*
Corophium uenoi
**Dexamonica reduncans*
**Eohaustorius sencillus*
**Kermystheus ociosa*
**Lepidepecreum gurjanovae*
**Lysianassa holmesi*
**Lysianassa oculata*
**Megamphopus mamolus*
Monoculodes norvegicus
**Monoculodes spinipes*
**Opisa tridentata*
Orchomene pacifica
**Paraphoxus similis*
**Parapleustes pugettensis*
**Photis lacia*
**Stenothoe frecanda*
**Protomedeia penates*
Urothoe varvarini

TABLE 9.—Benthic Amphipoda of the coastal shelf of southern California in depth classes of 9–18, 19–37, 38–55, 56–73, 74–92, and 93–183 m, from a survey of 348 samples (occurrences of the species in the surveys of Monterey Bay and Baja California are shown; other significant records are listed for various species, and the presumed affinities where significant, are stated).

Name of species	Monterey	Baja California	Literature records	Probable affinity	Southern California metric depth class
Acidostoma hancocki	x	sp. x		Northern	18–183
Acuminodeutopus heteruropus		x		Southern	18–92
Allorchestes angustus			Oregon	Northern	18
Ampelisca brevisimulata	x	x			18–183
Ampelisca compressa	x	x			18–183
Ampelisca cristata	x	x			18–183
Ampelisca furcigera			Okhotsk, Bering	Northern	183
Ampelisca hancocki	x	x			18–183
Ampelisca indentata		x		Southern	37–92
Ampelisca lobata	x	x			18–92
Ampelisca macrocephala	x	x	Cold-temperate	Northern	18–183
Ampelisca milleri	x	x			37–183
Ampelisca pacifica	x	x			18–183
Ampelisca pugetica	x	x			18–183
Ampelisca romigi	x	x			37–183
Amphideutopus oculatus		x		Southern	18–183
Amphilochus neapolitanus		x	Tropicopolitan	Southern	18
Amphilochus picadurus		x			18–37
Ampithoe plumulosa					18
Ampithoe simulans			Oregon	Northern	18
Anonyx carinatus	x			Northern	55–183
Aoroides columbiae	x	x			18–183
Argissa hamatipes		x			18–183
Atylus tridens			British Columbia	Northern	18
Batea transversa				Southern	18–37
Bathymedon pumilus				Bathyal	73–183
Bathymedon roquedo				Bathyal	92–183
Bruzelia tuberculata			Cold-temperate	Northern	183
Byblis veleronis	x	x			37–183
Ceradocus spinicaudus			Oregon	Northern	18
Cerapus tubularis		x			18–55
Cheiriphotis megacheles		x	Tropicopolitan	Southern	18
Chevalia aviculae		x	Tropicopolitan	Southern	18
Corophium acherusicum					18

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Name of species	Monterey	Baja California	Literature records	Probable affinity	Southern California metric depth class
Corophium baconi		x			18–55
Corophium uenoi	x		Japan	Northern	18
Dexamonica reduncans	x			Northern	55–183
Dulichia monacantha			Cold-temperate	Northern	92
Elasmopus antennatus		x			18–73
Eohaustorius sencillus	x			Northern	18
Eohaustorius washingtonianus				Northern	18–37
Ericthonius brasiliensis	x	x			18–183
Ericthonius hunteri			Cold-temperate	Northern	73–183
Eurystheus thompsoni	x	x			18–183
Garosyrrhoe bigarra					55
Gaviota podophthalma		x		Southern	18–73
Gitana calitemplado		x			18–55
Gitanopsis vilordes					18
Haploops spinosa			Cold-temperate	Northern	183
Harpiniopsis epistomata				Bathyal	92–183
Harpiniopsis fulgens				Bathyal	183
Harpiniopsis galera				Bathyal	92–183
Heterophlias seclusus			American tropical	Southern	18
Heterophoxus oculatus	x	x			18–183
Hippomedon denticulatus	x	x	Cold-temperate	Northern	18–183
Hyale rubra frequens					18
Ischyrocerus litotes	x	x			18–183
Ischyrocerus pelagops		x			18–37
Jassa falcata					18
Kermystheus ociosa	x				37–183
Lembos audbettius		x		Southern	55–92
Lembos concavus				Southern	18
Lepidepecreum garthi				Northern	92–183
Lepidepecreum gurjanovae	x			Northern	18–183
Leucothoe alata	x	x			18
Leucothoe spinicarpa	x	x			18–183
Leucothoides pacifica				Southern	18
Liljeborgia brevicornis				Northern	18
Listriella albina		x			18–183
Listriella diffusa	x	x			18–92
Listriella eriopisa		x			18–183
Listriella goleta	x	x			18–183
Listriella melanica		x			18–183
Lysianassa dissimilis		x			18
Lysianassa holmesi	x				18–183
Lysianassa oculata	x				18–183
Maera danae	x		Cold-temperate	Northern	183
Maera simile	x	x	Oregon	Northern	18–183
Mandibulophoxus uncirostratus			Indo-Pacific	Southern	18
Megaluropus longimerus	x	x			18–37
Megamphopus mamolus	x				18
Megamphopus martesia		x		Southern	18
Melita dentata			Cold-temperate	Northern	18
Melita desdichada	x	x			55, 183
Melphisana bola		x			18–73
Metaceradocus occidentalis				Southern	18–73
Metaphoxus frequens	x	x			18–183
Metaphoxus fultoni	x	x			18–183
Metopa dawsoni		x			55–183

Table 9.—Benthic Amphipoda of the coastal shelf of southern California in depths classes of 9–18, 19–37, 38–55, 56–73, 74–92, and 93–183 m, from a survey of 348 samples (occurrences of the species in the surveys of Monterey Bay and Baja California are shown; other significant records are listed for various species, and the presumed affinities where significant, are stated)—Continued

Name of species	Monterey	Baja California	Literature records	Probable affinity	Southern California metric depth class
Metopella aporpis	x	x			92–183
Microdeutopus schmitti	x	x			18–55
Monoculodes emarginatus	x	x			55–183
Monoculodes hartmanae		x			18–183
Monoculodes murrius					18–92
Monoculodes norvegicus	x		Cold-temperate	Northern	37–183
Najna ?consiliorum			Japan Sea	Northern	18
Neomegamphopus roosevelti			Baja California	Southern	18
Netamelita cortada					18
Nicippe tumida	x	x		Bathyal	37–183
Ocosingo borlus		x			"Shallow"
Opisa tridentata	x			Northern	18–183
Orchomene anaquela					37–92
Orchomene decipiens	x	x(sp.)			18–183
Orchomene magdalenensis		x		Southern	18
Orchomene pacifica	x		Northwest Pacific	Northern	55–183
Pachynus barnardi	x	x			18–183
Panaploea rickettsi	x	x			183
Parajassa angularis					18
Parametopella ninis					18–183
Paraphoxus abronius					18–92
Paraphoxus bicuspidatus	x	x			18–183
Paraphoxus cognatus					Pelagic
Paraphoxus daboius					18–183
Paraphoxus epistomus	x	x			18–183
Paraphoxus fatigans	x	x			18–183
Paraphoxus floridanus			Florida	Southern	18–55
Paraphoxus heterocuspidatus					18–55
Paraphoxus jonesi					18
Paraphoxus lucubrans					18–92
Paraphoxus obtusidens	x	x			18–183
Paraphoxus oculatus			Cold-temperate	Northern	183
Paraphoxus robustus	x	x			18–183
Paraphoxus similis	x				18–183
Paraphoxus spinosus					18–183
Paraphoxus stenodes		x			18–92
Paraphoxus tridentatus					18–37
Paraphoxus variatus	x	x			18–92
Parapleustes oculatus				Northern	183
Parapleustes pugettensis					18–183
Pardaliscella symmetrica				Bathyal	92–183
Pardisynopia synopiae	x	x		Bathyal	55–183
Photis bifurcata	x	x			18–92
Photis brevipes	x	x			18–183
Photis californica	x	x			18–92
Photis lacia	x			Northern	18–183
Photis macrotica	x	x			55–183
Phoxocephalus homilis	x	x			73–183
Platyischnopus viscana		x	Baja California	Southern	18
Pleustes platypa			Rare So. Calif.	Northern	18
Podocerus brasiliensis		x	Tropicopolitan	Southern	18
Podocerus cristatus	x	x			18–183
Polycheria antarctica					18
Pontogeneia rostrata			Northwest Pacific	Northern	18
Prachynella lodo	x	x			37–183

TABLE 9.—Benthic Amphipoda of the coastal shelf of southern California in depths classes of 9–18, 19–37, 38–55, 56–73, 74–92, and 93–183 m, from a survey of 348 samples (occurrences of the species in the surveys of Monterey Bay and Baja California are shown; other significant records are listed for various species, and the presumed affinities where significant, are stated)—Continued

Name of species	Monterey	Baja California	Literature records	Probable affinity	Southern California metric depth class
Protomedeia articulata	x	x		Northern	18–183
Pseudokoroga rima		x		Southern	18
Rhachotropis inflata			Cold-temperate	Northern	183
Rhachotropis oculata	x		Cold-temperate	Northern	73–183
Rudilemboides stenopropodus					18–73
Schisturella cocula				Bathyal	183
Socarnes illudens		x		Northern	183
Stenopleustes monocuspis		x		Southern	73–183
Stenothoe frecanda	x				55–183
Stenothoides bicoma		x			18–183
Stenula modosa					73–183
Sympleustes subglaber			Genus northern	Northern	18–183
Synchelidium rectipalmum					18–183
Synchelidium shoemakeri	x				18–183
Synchelidium sp. A	x				18–183
Synchelidium sp. E	x				18–183
Synchelidium sp. G	x				18–183
Tiron biocellata	x	x			18–183
Uristes entalladurus			Baja California		18
Urothoe varvarini	x		North Pacific	Northern	37–183
Westwoodilla caecula	x	x	Cold-temperate	Northern	18–183

TABLE 10.—Amphipoda of Monterey Bay recorded from the northwestern Pacific Ocean.

Depths of 15–49 m	Depths of 50–139 m
Corophium uenoi	*Ampelisca macrocephala*
Leucothoe spinicarpa	*Argissa hamatipes*
Monoculodes norvegicus	*Hippomedon denticulatus*
	Maera danae
	Nicippe tumida
	Orchomene pacifica
	Paraphoxus obtusidens
	Westwoodilla caecula
	Urothoe varvarini

Family Acanthonotozomatidae

Panoploea rickettsi Shoemaker

Panoploea rickettsi Shoemaker, 1931, pp. 1–5, figs. 1, 2.—Barnard, 1964a, p. 212.

Material: 6425 (1).

Distribution: Monterey Bay to San Quintin Bay, Baja California, 10–92 m.

Family Ampeliscidae

Ampelisca brevisimulata Barnard

Ampelisca brevisimulata Barnard, 1954a, pp. 33–35, pls. 23, 24; 1964a, p. 212.

Material: 6433 (1), 6435 (2), 6471 (1).

Distribution: Caribbean Sea and eastern Pacific Ocean from Panama to Monterey Bay, 11–172 m.

Ampelisca compressa Holmes

Ampelisca compressa.—Barnard, 1960a, pp. 31–32; 1964a, p. 213.

Material: 6427 (1), 6428 (4), 6429 (2), 6430 (3), 6435 (1), 6447 (9), 6448 (2), 6451 (1), 6452 (2), 6471 (2).

Distribution: Western Atlantic Ocean, Caribbean Sea, eastern Pacific Ocean from Panama to Puget Sound, Washington, 1–266 m.

Ampelisca cristata Holmes

Ampelisca cristata.—Barnard, 1954a, pp. 26–28, pls. 17, 18; 1964a, p. 213.

Material: 6426 (3), 6427 (7), 6428 (1), 6429 (5), 6430 (2), 6446 (1), 6447 (2), 6449 (2), 6450 (1), 6453 (5).

Distribution: Caribbean Sea and eastern Pacific Ocean from Ecuador to Tomales Bay, California, 6–152 m.

Ampelisca hancocki Barnard

Ampelisca hancocki Barnard, 1954a, pp. 37–38, pl. 26; 1964a, p. 213.

Material: 6433 (1), 6451 (1), 6465 (1), 6471 (2), 6474 (2).

Distribution: Eastern Pacific Ocean from Monterey Bay to Costa Rica, 9–157 m.

Ampelisca lobata Holmes

FIGURE 2*a*

Ampelisca lobata.—Barnard, 1954a, pp. 11–14, pls. 5, 6; 1964a, p. 214.

Material: 6425 (24).

Distribution: Caribbean Sea, eastern Pacific Ocean from Ecuador and the Galapagos Islands to Monterey Bay, 0–183 m.

Ampelisca macrocephala (Liljeborg)

Ampelisca macrocephala.—Barnard 1954a, pp. 41–43, pl. 29; 1960a, pp. 28–30, fig. 7; 1964a, p. 214.

Material: 6426 (1), 6427 (2), 6428 (1), 6430 (3), 6431 (2), 6432 (4), 6433 (9), 6435 (14), 6438 (2), 6443 (2), 6446 (2), 6450 (1), 6451 (1), 6455 (2), 6460 (1), 6464 (3), 6465 (1), 6466 (3), 6470 (4), 6471 (12), 6478 (1).

Distribution: Subarctic-boreal in the North Atlantic and North Pacific Oceans, submerging in waters of low latitudes, 5–1686 m.

Ampelisca milleri Barnard

Ampelisca milleri Barnard, 1954a, pp. 9–11, pls. 3, 4; 1964a, p. 215.

Material: 6474 (3).

Distribution: Eastern Pacific Ocean from Ecuador and the Galapagos Islands to San Francisco Bay, California, 15–187 m in the open sea, from shallow water in San Francisco Bay.

Ampelisca pacifica Holmes

Ampelisca pacifica.—Barnard 1954a, pp. 31–33, pls. 21, 22; 1964a, p. 215.

Material: 6432 (3), 6458 (4), 6466 (2), 6471 (2), 6477 (1), 6478 (1).

Distribution: Caribbean Sea, eastern Pacific Ocean from Panama to Monterey Bay, California, 24–183 m.

Ampelisca pugetica Stimpson

Ampelisca pugetica.—Barnard 1954a, pp. 49–51, pls. 35, 36; 1960a, p. 31, fig. 9; 1964a, p. 215.

Material: 6425 (46), 6426 (1), 6427 (3), 6428 (2), 6430 (2), 6447 (3), 6452 (1), 6463 (1).

Distribution: Caribbean Sea, eastern Pacific Ocean from Peru to Puget Sound, Washington, 9–183 m.

Ampelisca romigi Barnard

Ampelisca romigi Barnard, 1954a, pp. 18–20, pls. 10, 11; 1960a, p. 34; 1964a, pp. 215–216.

Material: 6471 (10), 6474 (48).

Distribution: Caribbean Sea, eastern Pacific Ocean from Ecuador to Monterey Bay, 3–504 m.

Byblis veleronis Barnard

Byblis veleronis Barnard, 1954a, pp. 52–54, pls. 37, 38; 1964a, p. 216.

Material: 6426 (1), 6428 (3), 6429 (2), 6430 (4), 6431 (2), 6432 (8), 6433 (2), 6435 (2), 6438 (2), 6447 (1), 6451 (5), 6452 (3), 6455 (4), 6458 (2), 6462 (1), 6464 (2), 6465 (1), 6466 (6), 6470 (2), 6471 (3), 6474 (6), 6480 (1).

Distribution: Monterey Bay to the Gulf of California, 31–422 m.

Family Amphilochidae

Amphilochus picadurus Barnard

Amphilochus picadurus Barnard, 1962c, pp. 126–129, fig. 4; 1964a, p. 217.

Material: 6425 (4).

Distribution: Monterey Bay to southern California, 33° N., 4–41 m.

Family Aoridae

Aoroides columbiae Walker

Aoroides columbiae Barnard, 1961, p. 180; 1964a, pp. 217–218.

Material: 6425 (57), 6432 (2), 6433 (2), 6435 (2), 6440 (1), 6445 (8), 6470 (1), 6471 (6), 6474 (11).

Distribution: Puget Sound, Washington to San Quintin Bay, Baja California, 0–180 m.

Microdeutopus schmitti Shoemaker

Microdeutopus schmitti Shoemaker, 1942, pp. 18–21, fig. 6; 1959a, pp. 32–33, pl. 9; 1961, p. 180; 1964a, p. 218.

Material: 6425 (419), 6425 (1).

Distribution: Monterey Bay to Cape San Lucas, Baja California, 0–43 (65?) m.

Family Corophiidae

Corophium uenoi Stephensen

Corophium uenoi Stephensen, 1932, pp. 494–498, figs. 3, 4.—Barnard, 1952, pp. 28–32, pls. 8, 9; 1959a, p. 39.—Nagata, 1960, p. 178.—Barnard, 1961, p. 183; 1964b, p. 112, chart 16.

Material: 6425 (3).

Distribution: Japan; eastern Pacific Ocean from Monterey Bay at 24 m depth, to San Quintin Bay, Baja California, rarely occurring in the open sea, more often in lagoons or estuaries such as Morro Bay, Newport Bay, and San Quintin Bay, intertidal to 2 m.

Ericthonius brasiliensis (Dana)

Ericthonius brasiliensis.—Barnard 1955a, pp. 37–38; 1959a, p. 39; 1961, p. 183; 1964a, p. 219.

Material: 6425 (69), 6445 (2).

Distribution: Cosmopolitan in tropical, warm-temperate and some boreal seas, 0–130 m.

Family Dexaminidae

Dexamonica reduncans Barnard

Dexamonica reduncans Barnard, 1958, pp. 130–132, pls. 26, 27.

Material: 6433 (2), 6471 (6), 6474 (1).

Distribution: Monterey Bay to southern California, 33° N, in Monterey Bay from 107 to 139 m in depth, in southern California from about 55 to 183 m.

219–939—66——3

Family Eusiridae

Rhachotropis oculata (Hansen)

Figures 2*b–f*

Rhachotropis oculata.—Stephensen, 1944, pp. 97–98.—Gurjanova, 1951, pp. 712–713, fig. 496.

Stebbing (1906) stated that the rostrum of this species is small. Although the heads of the specimens at hand resemble Hansen's figure reproduced by Gurjanova (1951), the rostra are long and hidden from lateral view by the first antennae. Article 3 of antenna 1 is not as short as or indistinct as that described by Stebbing or figured by Hansen. Small specimens, difficult to separate from *R. inflata* Sars, may be distinguished by the produced corner of the second pleonal epimeron.

Material: Hancock *Velero* stations 1027 (2), 1149 (4), 4753 (1), 4772 (1), 4824 (1), 5615 (1), 5760 (1), 6001 (1), 6006 (1).

Records: Coastal shelf of southern California and Santa Catalina Island, 64–274 m, caught in benthic grabs and dredges, probably a demersal species infrequently collected in benthic closing devices.

Distribution: North Atlantic and North Pacific Oceans, Bering Sea, Okhotsk Sea, Japan Sea, 20–274 m. These are the southernmost records of this species in the eastern Pacific Ocean.

Family Gammaridae

Maera danae (Stimpson)

Maera danae.—Shoemaker, 1955, pp. 53–54 (with references).—Barnard, 1964b, pp. 108–109.

Maera loveni.—J. L. Barnard, 1962b, p. 103, fig. 19 (not Bruzelius).

Material: 6462 (2), 85 m.

Additional record: 4770 (1), southern California, 33°21′ N., 117°34′ W., 15 m.

Remarks: According to Shoemaker (1955) this species lacks an articulated spine at the palmar defining corner of gnathopod 2, but a spine is present on the specimens at hand, yet the second articles of pereopods 3–5 are broad, not slender as in *M. loveni*, and distinct eyes are present. Regardless of the gnathopodal spine, the specimens are identified as *M. danae*.

Distribution: North Atlantic and North Pacific Oceans, in the North Pacific known as far south as San Quintin Bay in shallow water but primarily a subarctic species submerging with depth toward the tropics, rather rare in southern California and usually occurring in depths of about 200 m.

Maera simile Stout

Maera simile.—Barnard, 1959a, pp. 24–25, pl. 4; 1964a, p. 222.

Material: 6425 (1).

Distribution: Coos Bay, Oregon to San Quintin Bay, Baja California, 0–43 m.

Megaluropus longimerus Schellenberg

Megaluropus longimerus.—Barnard, 1962b, p. 103, figs. 20, 21; 1964a, p. 224.

Material: 6440 (3), 6442 (3).

Distribution: Lagos, Nigeria; in the eastern Pacific Ocean from Monterey Bay to San Ramon Bay, Baja California, 10–108 m.

Melita desdichada Barnard

Melita desdichada Barnard, 1962b, p. 110, fig. 22; 1964a, p. 224.

Material: 6455 (4), 6460 (1).

Distribution: Monterey Bay to San Ramon Bay, Baja California, 10–108 m.

Family Haustoriidae

Eohaustorius sencillus Barnard

Eohaustorius sencillus Barnard, 1962f, pp. 249–252, figs. 1, 2.

Material: 6444 (19), 6445 (1), 6454 (28).

Distribution: Monterey Bay to Point Conception, California, 14–25 m.

Urothoe varvarini Gurjanova

Urothoe varvarini Gurjanova, 1953, pp. 219–221, figs. 3, 4.—Barnard, 1957, pp. 82–84.—Gurjanova, 1962, pp. 426–428, fig. 142.

Material: 6433 (1), 6438 (1), 6471 (6), 6474 (9).

Distribution: Northwestern Pacific Ocean, Japan Sea, Okhotsk Sea, 5–13 m; California from Monterey Bay to southern California at 33° N, 40–200+ m.

Family Isaeidae (=Photidae)

Eurystheus thompsoni (Walker)

Eurystheus thompsoni.—Barnard, 1959a, p. 36; 1961, p. 182; 1964a, p. 237.

Material: 6425 (44), 6445 (1).

Distribution: Puget Sound, Washington to Magdalena Bay, Baja California, 0–135 m.

Kermystheus ociosa Barnard

Kermystheus ociosa Barnard, 1962a, p. 23, fig. 8.

Material: 6432 (2), 6435 (2), 6471 (7), 6474 (81).

Distribution: Monterey Bay to the coastal shelf of southern California between Point Conception and San Diego, 27–165 m.

Megamphopus mamolus Barnard

Megamphopus mamolus Barnard, 1962a, pp. 23–26, fig. 9.

Material: 6425 (68), 6445 (9).

Distribution: Monterey Bay to Point Conception, California, at the latter in a red algal *Diopatra* bed, 16 m; at Monterey in depths of 24–25 m.

Photis bifurcata Barnard

Photis bifurcata Barnard, 1962a, pp. 30–31, fig. 10; 1964a, p. 240.

Material: 6425 (332), 6445 (15).

Distribution: Monterey Bay to San Cristobal Bay, Baja California, 11–93 m.

Photis brevipes Shoemaker

Photis brevipes Shoemaker, 1942, pp. 25–27, fig. 9.—Barnard, 1962a, pp. 31–33, fig. 11; 1964a, pp. 240–241.

Material: 6425 (58), 6445 (7), 6471 (2), 6477 (5).

Distribution: Coos Bay, Oregon to Magdalena Bay, Baja California, 0–135 m.

Photis californica Stout

Photis californica.—Barnard, 1962a, pp. 33–36, figs. 12, 13; 1964a, p. 241.

Material: 6471 (12), 6474 (58).

Distribution: Monterey Bay to San Cristobal Bay, Baja California, 10–98 m, in southern California; maximum depth in Monterey Bay 139 m.

Photis lacia Barnard

Photis lacia Barnard, 1962a, pp. 42–44, fig. 18.

Material: 6425 (4), 6430 (?2), 6432 (2), 6433 (9), 6465 (1), 6469 (3), 6471 (34), 6474 (24), 6477 (2).

Distribution: Monterey Bay to southern California, 32° N, 9–146 m, abundant on the shelf in depths of 73–92 m (38 individuals per m^2).

Photis macrotica Barnard

Photis macrotica Barnard, 1962a, p. 44, fig. 19; 1964a, p. 241.

Material: 6474 (1).

Distribution: Monterey Bay to San Cristobal Bay, Baja California, 55–157 m.

Protomedeia articulata Barnard

Protomedeia articulata Barnard, 1962a, pp. 48–50, fig. 21; 1964a, p. 242.

Material: 6426 (1), 6429 (1), 6438 (1), 6445 (6), 6455 (6), 6456 (1), 6457 (2), 6458 (2), 6466 (1), 6471 (?1).

Distribution: Monterey Bay to San Quintin Bay, Baja California, 18–200+ m.

***Protomedeia penates*, new species**

FIGURE 3

Diagnosis of male: Article 2 of gnathopod 1 lacking posterodistal swelling; article 7 of gnathopod 1 overlapping palm by more than 75 percent of its length, palm with triangular process and defined by one stout spine; palm of gnathopod 2 with defining tooth exceeding transverse palm and bearing small basal tooth anterior to it; inner ramus of uropod 3 slightly shorter than outer ramus.

Female: Gnathopods with oblique palms defined by large spines.

Notes: Article 2 of pereopod 5 has a small dorsoposterior tooth; pleonal epimeron 3 bears lateral setae, variable in extent and often absent, especially in males.

Holotype: Allan Hancock Foundation no. 5923, male 6.0 mm.

Type locality: White Gulch, Tomales Bay, California, sta. 1–59–10, June 29, 1959, depth of 48 feet, on dark sand and mud, associated with *Chone* and *Pectinaria*, collected by Dr. Joel W. Hedgpeth and Dr. Ralph G. Johnson, 8 specimens.

Material: 6455 (4).

Relationship: Morphologically, this species is most closely related to *Protomedeia fasciatoides* Bulycheva (1952) but differs in having a longer palmar tooth of male gnathopod 2 and oblique palms on the female gnathopods. The absence of a posterodistal prominence on article 2 of gnathopod 1 distinguishes *P. penates* from *P. fasciata* Krøyer (Sars, 1895, pl. 196), a species having a distinctive aspect as illustrated by Gurjanova (1951). The largest male, 7.0 mm, from station 6455, is obviously fully mature and lacks the gnathopodal prominence. *Protomedeia popovi* Gurjanova (1951) is also similar to *P. penates*, but the male has a more oblique gnathopodal palm lacking the subsidiary palmar tooth.

Distribution: Tomales Bay to Monterey Bay, California, 15–76 m.

Family Ischyroceridae

***Ischyrocerus litotes* (Barnard)**

Ischyrocerus litotes—Barnard, 1962a, pp. 53–56, figs. 23, 24; 1964a, pp. 226–227.

Material: 6425 (1).

Remarks: I may have been in error in removing this species from its original position in *Microjassa* because of the slight difference in size of coxae 5 and 6. As in *Microjassa*, coxa 1 of this species is small in contrast to members of *Ischyrocerus*. Both genera probably should be emended to permit *I. litotes* to be included with

Microjassa. *Ischyrocerus litotes* at least forms a bridge between the two concepts. Its small size, very shiny, slick body, and poor pigment in alcohol make it highly distinctive from other species of *Ischyrocerus*.

Distribution: Monterey Bay to San Cristobal Bay, Baja California, 1–157 m.

Family Leucothidae

Leucothoe alata Barnard

Leucothoe alata Barnard, 1959a, pp. 19–20, pl. 1; 1962c, p. 132, figs. 7, D, E, F; 1964a, p. 227.

Material: 6425 (5).

Distribution: Monterey Bay to San Ramon Bay, Baja California, 0–24 m.

Leucothoe spinicarpa (Abildgaard)

Leucothoe spinicarpa—Sars, 1895, p. 100, pl. 101, fig. 1—Barnard, 1962c, p. 132, figs. 7, A, B, C; 1964a, p. 227.

Material: 6425 (2).

Distribution: Cosmopolitan, 0–1505 m.

Family Liljeborgiidae

Liljeborgia kinahani (Bate)

Liljeborgia kinahani.—Sars, 1895, pp. 532–533, pl. 188, fig. 1.—Chevreux and Fage, 1925, p. 157, fig. 157.—Barnard, 1964a, p. 228.

Material: 6425 (5).

Distribution: Possibly bipolar, rare in southern California, in the eastern Pacific Ocean known as far south as off San Quintin Bay, Baja California, 24–41 m.

Listriella diffusa Barnard

Listriella diffusa Barnard, 1959b, pp. 18–20, figs. 3–5; 1964a, p. 228.

Material: 6440 (1).

Distribution: Monterey Bay to San Cristobal Bay, Baja California, 12–172 m.

Listriella goleta Barnard

Listriella goleta Barnard, 1959b, pp. 20–22, figs. 5–7; 1964a, p. 229.

Material: 6427 (1), 6428 (2), 6429 (1), 6431 (1), 6446 (1), 6448 (1), 6450 (1), 6451 (2), 6466 (1), 6477 (1), 6480 (1).

Distribution: Monterey Bay to San Cristobal Bay, Baja California, 12–200+ m.

Family Lysianassidae

Acidostoma hancocki Hurley

Acidostoma hancocki Hurley, 1963, pp. 37–40, figs. 9, 10.

Material: 6429 (2).

Distribution: Monterey Bay to southern California, 33° N, 22–73 m.

Anonyx adoxus Hurley

FIGURE 4

Anonyx adoxus Hurley, 1963, pp. 108–112, figs. 35, 36.

Diagnosis: Eyes dark, rather small for genus, forming an elongated oval of even dimensions, not expanded at either end; epistome and upper lip not differentially produced; coxa 1 rounded ventrally; gnathopod 1 with article 6 concave posteriorly, narrowing distally, palm short, coarsely serrate, dactyl strongly overlapping palm; palm of gnathopod 2 short, slightly produced, dactyl short, fitting palm perfectly; pereopods 1 and 2 with hooked, unstriated spine at base of article 7; all pereopods with large spines on sixth articles; inner ramus of uropod 2 not abnormally shortened, bearing small constriction on dorsal margin; rami of uropod 3 subequal in length, article 2 of outer ramus very small (see figure); first pleonal epimeron differing on the two sides of the adult specimen, on the left side with the anterior edge straight, on the right side produced anteriorly (see figures); second pleonal epimeron with rounded anteroventral corner, posterior corner with small, blunt tooth; third pleonal epimeron rounded at anteroventral corner, posterior corner with moderately slender, medium-sized tooth; body lacking sculpture or minute ornamentation.

Material: 6432, female, 10.0 mm, and 17 hatched juveniles.

Remarks: This adult specimen has the special characteristics noted by Hurley in his key (1963, p. 103), but it differs slightly in the configuration of its epistome-labrum complex, the accessory flagellum is shorter, and marginal spines are absent from the telsonic lobes. The weakly hooked, blunt distal spines of the sixth articles on pereopods 1–2 are small, as shown by Hurley. However, the minute ornamentation of the spines has the appearance of the large spines of the *A. liljeborgi* group of the genus.

Anonyx adoxus most closely resembles *Anonyx nugax* (Phipps) and its varieties as arranged by Gurjanova (1962), but the eyes of *A. adoxus* are not differentially widened. The following species, references to which may be found in Gurjanova (1962), differ from the specimen at hand in the morphology of the parts and appendages listed: *A. liljeborgi*, upper lip and uropod 2, third pleonal epimeron; *A. affinis*, *A. minimus*, uropods 2 and 3; *A. validus*, third pleonal epimeron; *A. kurilicus*, *A. magnus*, uropod 2; *A. ampulloides*, *A. laticoxae*, uropod 2 and eyes; *A. ochoticus*, eyes and epistome; *A. compactus* and *A. oculatus*, eyes and spines of pereopods 1 and 2.

Distribution: Monterey Bay (type locality), 18–98 m.

Anonyx carinatus (Holmes)

Lakota carinata Holmes, 1908, pp. 498–500, fig. 9.—Gurjanova, 1962, pp. 302–303, fig. 100.

Anonyx carinatus.—Hurley, 1963, pp. 103–108.

Material: 6477 (1).

Distribution: Monterey Bay to southern California, 33° N., 69–200 m.

Centromedon pavor, new species

FIGURE 5

Diagnosis: Lateral cephalic lobes short, rounded terminally, separated from large rostral area by deep concavity; antenna 1 very stout, articles 2 and 3 short, telescoped into article 1, article 1 of flagellum heavily armed with aesthetes; coxa 5 with well-defined posterior lobe; urosomite 1 bulbous dorsally.

Holotype: Allan Hancock Foundation no. 5922, female, 2.9 mm.

Type locality: Station 6459, Monterey Bay, California, 84 m, September 1959.

Material: Two specimens from the type locality and 6462 (1), 6477 (1).

Relationship: The genus *Centromedon* became monotypic when Barnard (1962d) removed all but its type species to the genus *Uristes*. *Centromedon pumilus* (Liljeborg) differs from *C. pavor* in having very acute, projecting lateral cephalic lobes, slender first antennae, a symmetrically lobed fifth coxa, and a poorly ornamented first urosomite. As the specimens at hand and that figured by Sars are females, these differences cannot be attributed to sexual dimorphism. The mouthparts of *C. pavor* correspond to those figured for *C. pumilus* by Sars (1895, pl. 34, fig. 2).

Hippomedon denticulatus (Bate)

Hippomedon denticulatus.—Hurley, 1963, pp. 137–140, fig. 45.—Barnard, 1964a, p. 230; 1964b, pp. 80–82.

Material: 6426 (1), 6430 (1), 6445 (2), 6447 (1), 6471 (4), 6474 (2), 6477 (5).

Distribution: Subarctic-boreal of North Atlantic and North Pacific Oceans, 0–924 m; in the eastern Pacific its southern record is off San Cristobal Bay, Baja California.

Lepidepecreum gurjanovae Hurley

Lepidepecreum gurjanovae Hurley, 1963, pp. 49–53, figs. 13, 14.

Material: 6469 (1), 6474 (1).

Distribution: In the northeastern Pacific Ocean from about 33° N to about 49° N, 109–1740 m.

Lysianassa holmesi (Barnard), new combination

Aruga holmesi Barnard, 1955b, p. 100, pls. 27, 28.—Gurjanova, 1962, pp. 299–301, figs. 98, 99.
Lysianopsis holmesi.—Hurley, 1963, pp. 74–75, fig. 21b.

Material: 6431 (1), 6474 (1).

Distribution: Monterey Bay to Ecuador, 1–183 m.

Remarks: I am carrying Hurley's synthesis of various lysianassid genera one more step by fusing *Lysianopsis* Holmes, along with *Aruga* Holmes, *Shoemakerella* Pirlot, *Arugella* Pirlot, and *Pronannonyx* Schellenberg to *Lysianassa*. This procedure is discussed in another paper (Barnard, MS).

Lysianassa oculata (Holmes), new combination

Aruga oculata Holmes, 1908, pp. 505–507, figs. 14, 15.—Barnard, 1955b, p. 98, pl. 29, figs. a-f,h,j.—Gurjanova, 1962, pp. 294–296, fig. 96.
Lysianopsis oculata.—Hurley, 1963, p. 74, fig. 21c.

Material: 6426 (1), 6428 (1), 6429 (1), 6431 (6), 6438 (1), 6439 (1), 6448 (1), 6451 (2), 6455 (1).

Distribution: Monterey Bay to southern California, 32° N, 18 to ?300 m, generally shallower than 100 m.

Opisa tridentata Hurley

Opisa tridentata Hurley, 1963, pp. 26–30, figs. 4, 5.

Material: 6435 (1), 6471 (3), 6474 (2).

Distribution: Monterey Bay to southern California, 33° N, 44–183 m.

Orchomene decipiens Hurley, new combination

Orchomenella decipiens Hurley, 1963, pp. 127–130, figs. 43, 44.
Orchomene species.—Barnard, 1964a, p. 231.

Material: 6435 (1), 6471 (5), 6474 (2), 6477 (1).

Distribution: Monterey Bay to San Cristobal Bay, Baja California, 35–180 m.

Remarks: Barnard (1964b) synonymized *Orchomenella* Sars with *Orchomene* Boeck.

Orchomene pacifica (Gurjanova)

Orchomenella pacifica Gurjanova, 1938, pp. 252–254, fig. 3; 1951, p. 287, fig. 155; 1962, pp. 174–177, figs. 52, 53.
Orchomene pacifica.—Barnard, 1964b, pp. 92–93, fig. 13.

Material: 6471 (7), 6474 (4).

Distribution: Northwestern Pacific Ocean, Japan Sea, Okhotsk Sea, 29–129 m; California from Monterey Bay to southern California, 33° N, 46–183 m.

Pachynus barnardi Hurley

Pachynus barnardi Hurley, 1963, pp. 31–35, figs. 6, 7.
Pachynus species, Barnard, 1964a, p. 232.

Material: 6458 (1), 6469 (1).

Distribution: Monterey Bay to San Ramon Bay, Baja California, 12–183 m.

Prachynella lodo Barnard

Prachynella lodo Barnard, 1964a, p. 233, fig. 7.

Material: 6426 (1), 6471 (1).

Distribution: Monterey Bay to San Cristobal Bay, Baja California, 10–157 m.

Family Oedicerotidae

Monoculodes emarginatus Barnard

Monoculodes emarginatus Barnard, 1962e, pp. 361–363, fig. 4; 1964a, p. 234.

Material: 6432 (2), 6435 (2), 6438 (1), 6466 (3), 6469 (1), 6471 (4).

Distribution: Monterey Bay to San Quintin Bay, Baja California, 55–200+ m.

Monoculodes norvegicus (Boeck)

Monoculodes norvegicus.—Sars, 1895, pp. 301–302, pl. 107, fig. 1.—Barnard, 1962e, p. 367 (with references).

Material: 6425 (1).

Distribution: Subarctic-boreal in the North Atlantic and North Pacific Oceans, occurring in southern California as about 1.3 individuals per m^2 on the coastal shelf, in depths of 20–146 m.

Monoculodes spinipes Mills

Monoculodes spinipes Mills, 1962, pp. 12–14, fig. 3.—Barnard, 1962e, pp. 368–369, fig. 10.

Material: 6454 (1).

Distribution: British Columbia to Point Conception, California, intertidal to 20 m.

Synchelidium species A

A new species with vestigial rostrum, manuscript in preparation.

Material: 6427 (1), 6428 (1), 6429 (7), 6430 (2), 6431 (3), 6438 (2), 6465 (1), 6466 (1), 6474 (1).

Distribution: Monterey Bay to southern California, 32° N, 10–100+ m.

Synchelidium species E

A new species, manuscript in preparation.

Material: 6435 (1), 116 meters.

Distribution: Monterey Bay to southern Califronia, 32° N, about 40–183+ m.

Synchelidium species G

A new species, manuscript in preparation.

Material: 6435 (2), 6439 (4); varietal type: 6426 (2), 6427 (3), 6433 (2) 6440 (3), 6469 (1).

Distribution: Monterey Bay to southern California, 32° N, 10 to slightly more than 120 m.

Synchelidium shoemakeri Mills

Synchelidium shoemakeri Mills, 1962, pp. 15–17, figs. 4, 6A.

Material: 6432 (2), 98 m.

Distribution: British Columbia south to southern California, intertidal in northern end of its range, subtidal in southern California, to depths slightly exceeding 100 m but very rare below 40 m.

Westwoodilla caecula (Bate)

Westwoodilla caecula.—Mills, 1962, pp. 509, figs. 1, 6A.—Barnard, 1962e, p. 370; 1964a, p. 235.

Material: 6427 (1), 6431 (1), 6435 (3), 6438 (1), 6469 (1), 6474 (1).

Distribution: A cold-temperate species of the North Atlantic and North Pacific Oceans, in the eastern Pacific known as far south as Todos Santos Bay, Baja California; intertidal in British Columbia but occurring in southern California in 12–200 m.

Family Pardaliscidae

Nicippe tumida Bruzelius

Nicippe tumida.—Barnard, 1959c, pp. 39–40, figs. 1, 2; 1964a, p. 235.

Material: 6431 (2), 6433 (1), 6457 (1), 6465 (2), 6466 (4).

Distribution: Apparently cosmopolitan, submerging in the tropics, 34–1367 m.

Pardisynopia synopiae Barnard

Pardisynopia synopiae Barnard, 1962b, pp. 77–79, figs 3, 4; 1964a, pp. 235–236.

Material: 6431 (2), 6435 (2), 6438 (3), 6465 (1), 6469 (1), 6471 (1).

Distribution: Monterey Bay to San Quintin Bay, Baja California, 53–200+ m.

Family Phoxocephalidae

Heterophoxus oculatus (Holmes)

Heterophoxus oculatus.—Barnard, 1960b, pp. 320–324, pls. 59–61; 1964a, p. 242.

Material: 6425 (3), 6431 (2), 6432 (3), 6433 (2), 6455 (5), 6456 (1), 6457 (4), 6458 (5), 6459 (1), 6462 (1), 6464 (8), 6465 (8), 6471 (1), 6474 (8), 6477 (13), 6480 (1).

Distribution: Puget Sound, Washington to Panama, 13–1785 m; in San Quintin Bay, Baja California, 2 m.

***Metaphoxus frequens* Barnard**

Metaphoxus frequens Barnard, 1960b, pp. 304–306, pls, 51, 52; 1964a, p. 242.

Material: 6425 (12), 6426 (1), 6428 (4), 6429 (2), 6430 (4), 6431 (1), 6432 (5), 6433 (12), 6435 (6), 6438 (3), 6458 (1), 6466 (2), 6470 (2), 6471 (3), 6477 (1), 6480 (1).

Distribution: Monterey Bay to Isabel Island, Mexico, 13–458 m.

***Metaphoxus fultoni* (Scott)**

Metaphoxus fultoni.—Chevreux and Fage, 1925, pp. 106–107, figs. 96, 97.—Barnard, 1964a, pp. 242–243.

Material: 6425 (4), 6474 (4).

Distribution: Eastern Atlantic Ocean and Mediterranean Sea, from England to Tunisia; in the eastern Pacific Ocean from Monterey Bay to San Cristobal Bay, Baja California, 0–170 m.

***Paraphoxus bicuspidatus* Barnard**

Paraphoxus bicuspidatus Barnard, 1960b, pp. 218–221, pls. 15, 16; 1964a, p. 243, fig. 12.

Material: 6430 (8), 6431 (21), 6432 (22), 6433 (23), 6435 (13), 6438 (13), 6447 (2), 6448 (6), 6451 (13), 6452 (12), 6455 (4), 6456 (2), 6457 (1), 6458 (5), 6466 (7), 6469 (4), 6471 (5).

Distribution: Monterey Bay to Santa Maria Bay, Baja California, 8–210 m.

***Paraphoxus epistomus* (Shoemaker)**

Paraphoxus epistomus.—Barnard, 1960b, pp. 205–209, pls. 6–8; 1964a, p. 243.

Material: 6429 (4).

Distribution: Mendocino County in northern California to Panama, 0–182 m; northwestern Atlantic Ocean from New Hampshire to South Carolina.

***Paraphoxus fatigans* Barnard**

Figures 6, 7

Paraphoxus fatigans Barnard, 1960b, pp. 209–210, pl. 9; Barnard, 1964a, p. 244.

Material: Kind 1: 6426 (48), 6427 (14), 6428 (1), 6429 (3), 6440 (5), 6442 (17), 6443 (18), 6444 (6), 6445 (32), 6446 (18), 6448 (1), 6449 (7), 6450 (6), 6453 (2), 6454 (40). Kind 2: 6427 (38), 6428 (33), 6429 (54), 6430 (60), 6431 (30), 6432 (14), 6433 (23), 6435 (11), 6438 (24), 6445 (2), 6446 (8), 6447 (26), 6448 (41), 6449 (4), 6451 (6), 6452 (4), 6453 (18), 6466 (25), 6469 (1), 6471 (1).

Remarks: The most common members of *Paraphoxus* in Monterey Bay are the most difficult to identify. These specimens have several characters which are intermediate between those of *P. fatigans* and *P. daboius* (both Barnard, 1960b). Two kinds of fifth pereopods occur which resemble the figures of *P. fatigans* published by Barnard. The first gnathopods of *P. fatigans* are slender, those of *P. daboius* strongly expanded and those of the specimens at hand are intermediate between the two species. The two species and the specimens at hand have small female eyes. The epistomal cusp is usually longer than it is in either *P. fatigans* or *P. daboius.*

The two configurations of pereopod 5 are: Article 2 has more than 3 very small teeth crowded together on the posterior margin, the oblique ventral edge being slightly convex rather than truncate as in *P. fatigans* from southern California (figs. 6*d,k,l*); article 2 has only 2 or 3 slightly enlarged, less crowded teeth, the oblique ventral margin being nearly truncate (fig. 6*c*). A third kind of rare occurrence, is shown in figures 6*a,e,i,j;* the posterior teeth of article 2 are very large and resemble those of *P. variatus* Barnard (1960b).

Although the gnathopods of the specimens at hand are stouter than those of *P. variatus,* the enlarged teeth of pereopod 5 on some individuals demonstrate the close relationship of the *P. fatigans* complex with *P. variatus.* Barnard (1960b) has already considered the possibility that *P. fatigans* is a phenotype of *P. variatus,* but a clarification of the problem is complicated by the additional differences displayed by the specimens from Monterey Bay.

The Monterey *fatigans* complex resembles *Paraphoxus epistomus,* of which only a few specimens have been found in the present samples. *Paraphoxus epistomus* may be distinguished by the horizontal ventral edge (either truncate or slightly convex) of article 2 on pereopod 5 and by the slightly stouter gnathopods. A few specimens assigned to *P. fatigans* show a relationship to *P. epistomus* because of the peduncular setosity of uropod 2. Most of these specimens have the elongated epistomal process.

Distribution: Monterey Bay to Todos Santos Bay, Baja California, 12–162 m.

Paraphoxus obtusidens (Alderman)

Paraphoxus obtusidens.—Barnard, 1960b, pp. 249–259, pls. 33–37; 1964a, p. 244.

Material: 6429 (1), 6430 (1), 6431 (6), 6432 (3), 6433 (5), 6435 (1), 6438 (1), 6439 (1), 6444 (1), 6453 (1), 6469 (3), 6471 (5).

Distribution: Kurile Islands to Columbia, South America, 0–180 m.

Paraphoxus robustus Holmes

Paraphoxus robustus.—Barnard, 1960b, pp. 235–236, pl. 25; 1964a, p. 244.

Material: 6431 (1), 6432 (2), 6433 (4), 6466 (1), 6471 (1), 6474 (4).

Distribution: Puget Sound, Washington to San Quintin Bay, Baja California, 4–183 m.

Paraphoxus similis Barnard

Paraphoxus similis Barnard, 1960b, pp. 230–233, pls. 22, 23.

Material: 6431 (2), 6432 (6), 6438 (3), 6444 (11), 6456 (1), 6458 (11), 6459 (1), 6465 (10), 6466 (6), 6474 (17), 6477 (13), 6478 (4), 6480 (2).

Distribution: Puget Sound, Washington, to southern California, 32° N, 31–324 m, abundant on the shelf of southern California in depths of 55–110 m.

Paraphoxus variatus Barnard

Paraphoxus variatus Barnard, 1960b, pp. 198–202, pls. 3, 4; 1964a, p. 245.

Material: 6426 (14), 6428 (2), 6446 (2), 6447 (8), 6450 (17).

Distribution: Monterey Bay to San Ramon Bay, Baja California, 5–93 m.

Phoxocephalus homilis Barnard

Phoxocephalus homilis Barnard, 1960b, p. 301, pls. 49, 50; 1964a, p. 245.

Material: 6433 (1), 6456 (10), 6471 (12), 6474 (51), 6477 (9), 6480 (5).

Distribution: Monterey Bay to San Cristobal Bay, Baja California, 62–200+ m.

Family Pleustidae

Parapleustes pugettensis (Dana)

Parapleustes pugettensis.—Barnard and Given, 1960, pp. 43–45, fig. 4 (with synonymy).—Shoemaker, 1964, pp. 410–413, fig. 10.

Material: 6445 (1), 25 m.

Distribution: West coast of Alaska, 62° N to southern California, 32° N, where it is moderately abundant in the intertidal zone and on shallow water epifloras.

Family Podoceridae

Podocerus cristatus (Thomson)

Podocerus cristatus.—Barnard, 1962a, pp. 67–69, figs. 31, 32; 1964a, p. 246.

Material: 6425 (11).

Distribution: Probably cosmopolitan in the Indo-Pacific tropical and warm-temperate regions, southwest Africa, New Zealand, Hawaii, Australia, in the eastern Pacific Ocean from Monterey Bay to Turtle Bay, Baja California, 0–171 m.

Family Stenothoidae

Metopella aporpis Barnard

Metopella aporpis Barnard, 1962c, pp. 142–145, figs. 12, 13; 1964a, p. 246.

Material: 6425 (1), 24 m.

Distribution: Monterey Bay to San Cristobal Bay, Baja California, 24–140 m, south of Point Conception not shallower than 84 m.

Stenothoe frecanda Barnard

Stenothoe frecanda Barnard, 1962c, p. 151, fig. 18.

Material: 6471 (1)

Distribution: Monterey Bay to southern California shelf, 64–92 m.

Family Synopiidae (=Tironidae)

Tiron biocellata Barnard

Tiron biocellata Barnard, 1962b, p. 75, fig. 2; 1964a, p. 247.

Material: 6440 (1).

Distribution: Monterey Bay to San Cristobal Bay, Baja California, 11–180 m.

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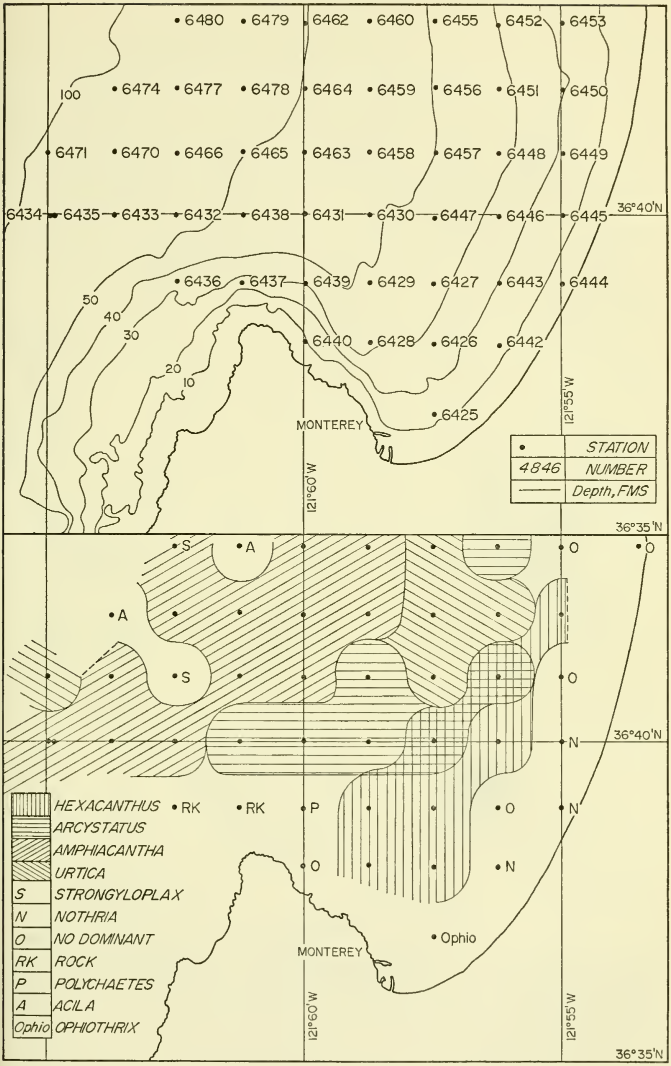

Figure 1.—Upper, station locations in Monterey Bay; lower, distribution of community dominants.

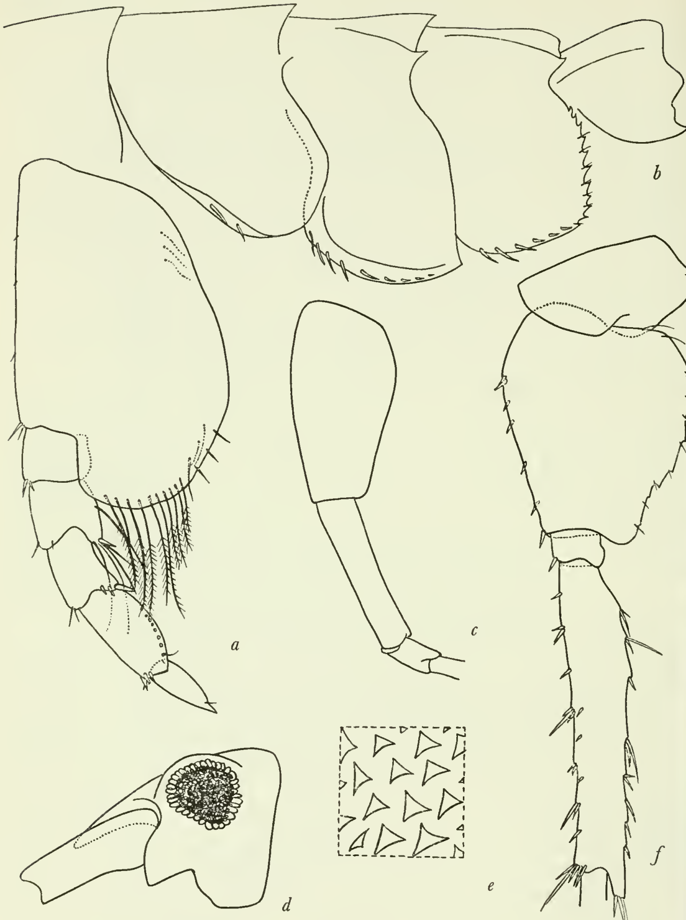

FIGURE 2.—*Ampelisca lobata* Holmes, female, 4.0 mm, sta. 6425: *a*, pereopod 5. *Rhachotropis oculata* (Hansen), male, 8.0 mm, sta. 1149 (southern California): *b*, dorsally toothed segments, left to right, pereonal 7, pleonal 1–4; *c*, peduncle of antenna 1; *d*, head; *e*, cuticular scales of chitin; *f*, pereopod 5.

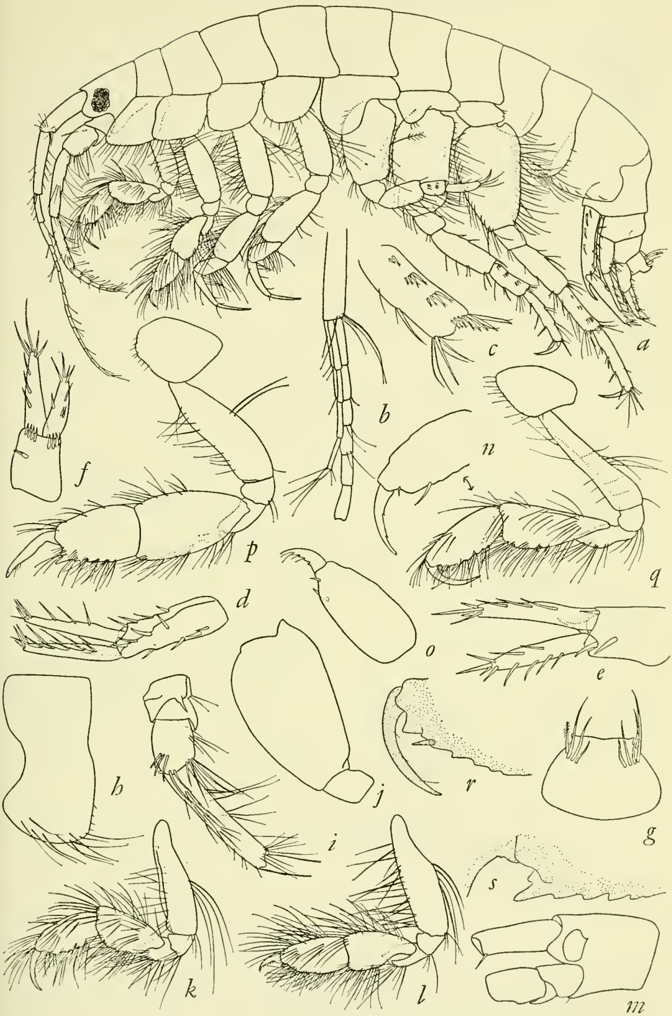

FIGURE 3.—*Protomedeia penates*, new species, White Gulch, Tomales Bay, female, 7.0 mm: *a*, lateral view; *b*, antenna 1 to show accessory flagellum; *c*, article 5 of pereopod 4; *d–f*, uropods 1, 2, 3; *g*, telson; *h*, pleonal segment 2; *i*, base of peduncle of antenna 2; *j*, articles 2–3 of pereopod 5; *k,l*, gnathopods 1, 2; *m*, head; *n,o*, articles 6–7 of gnathopods 1, 2. Male, 6.0 mm: *p,q*, gnathopods 2, 1; *r,s*, palms of gnathopods 1, 2.

FIGURE 4.—*Anonyx adoxus* Hurley, female, 10.0 mm, sta. 6432: *a*, head; *b*, antenna 1; *c,d*, gnathopod 1; *e,f*, gnathopod 2; *g–k*, pereopods 1, 2, 3, 4, 5; *l,m*, uropods 1, 2; *n,o*, uropod 3 with and without setae; *p*, telson; *q*, pleonal epimera 1–3, left to right, right side of pleonal epimeron 1 offset.

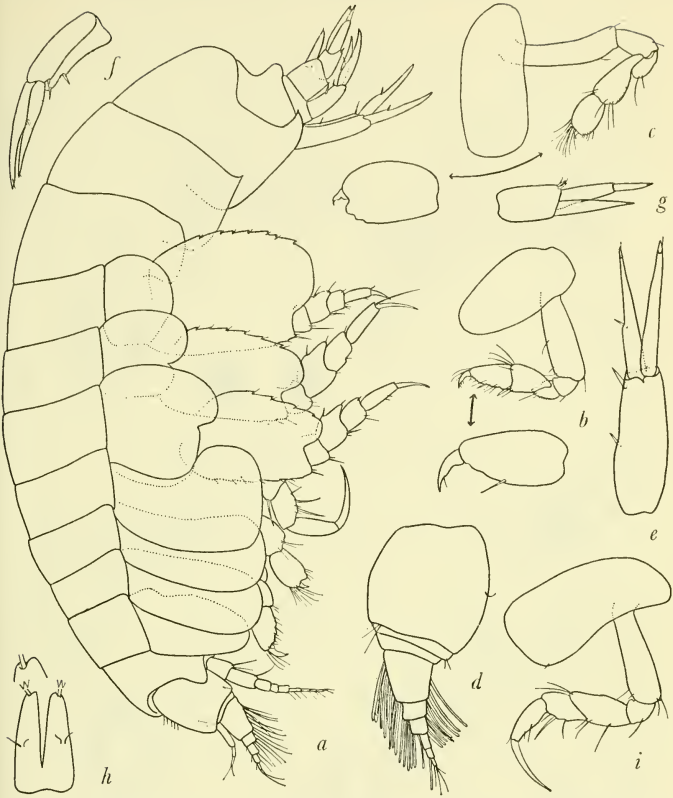

FIGURE 5.—*Centromedon pavor*, new species, holotype, female, 2.9 mm, sta. 6459: *a*, lateral view; *b,c*, gnathopods 1, 2; *d*, antenna 1; *e–g*, uropods 1, 2, 3; *h*, telson; *i*, pereopod 1.

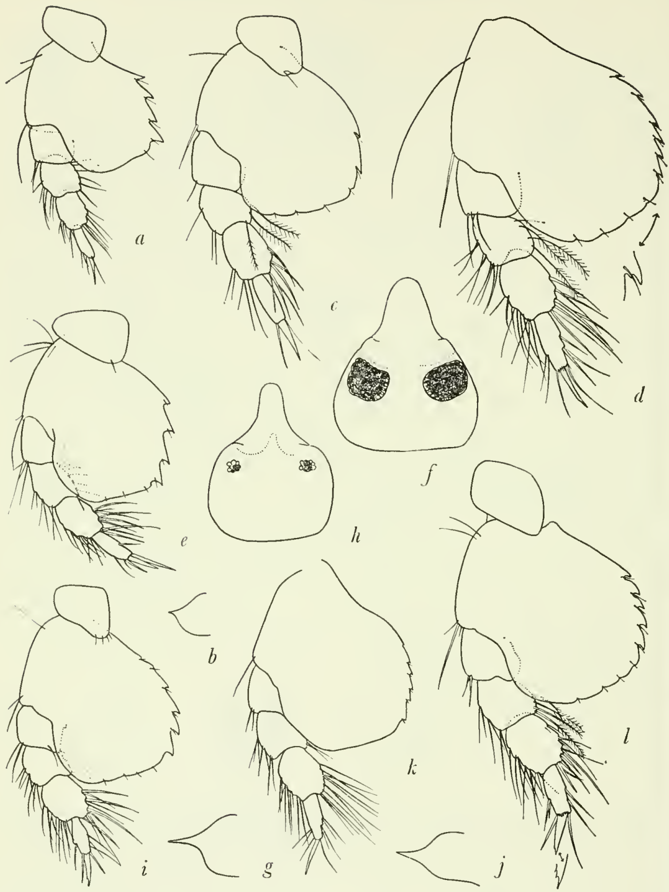

Figure 6.—*Paraphoxus fatigans* Barnard, male, 2.5 mm, sta. 6448, variant: *a*, pereopod 5; *b*, epistome. Female, 2.8 mm, sta. 6493, kind 2: *c*, pereopod 5. Male, 3.1 mm, sta. 6426, kind 1: *d*, pereopod 5. Male, 3.5 mm, sta. 6448, variant: *e*, pereopod 5; *f*, head; *g*, epistome. Female, 3.5 mm, sta. 6448, variant: *h*, head; *i*, pereopod 5; *j*, epistome. Female, 3.8 mm, sta. 6426, kind 1: *k*, pereopod 5. Female, 3.0 mm, sta. 6454, kind 1: *l*, pereopod 5.

Explanation of Figure 7

Figure 7.—*Paraphoxus fatigans* Barnard, female, 3.0 mm, sta. 6454, kind 1: *a,b*, gnathopod 1. Female, 3.5 mm, sta. 6448, variant: *c,d*, gnathopod 1. Male, 2.5 mm, variant: *e,f*, gnathopod 1. Male, 3.1 mm, sta 6426, kind 1: *g,h*, gnathopod 1. Male 3.5 mm, sta. 6448, variant: *i,j*, gnathopods 1, 2. Female, 2.8 mm, sta. 6493, kind 2: *k*, gnathopod 1.

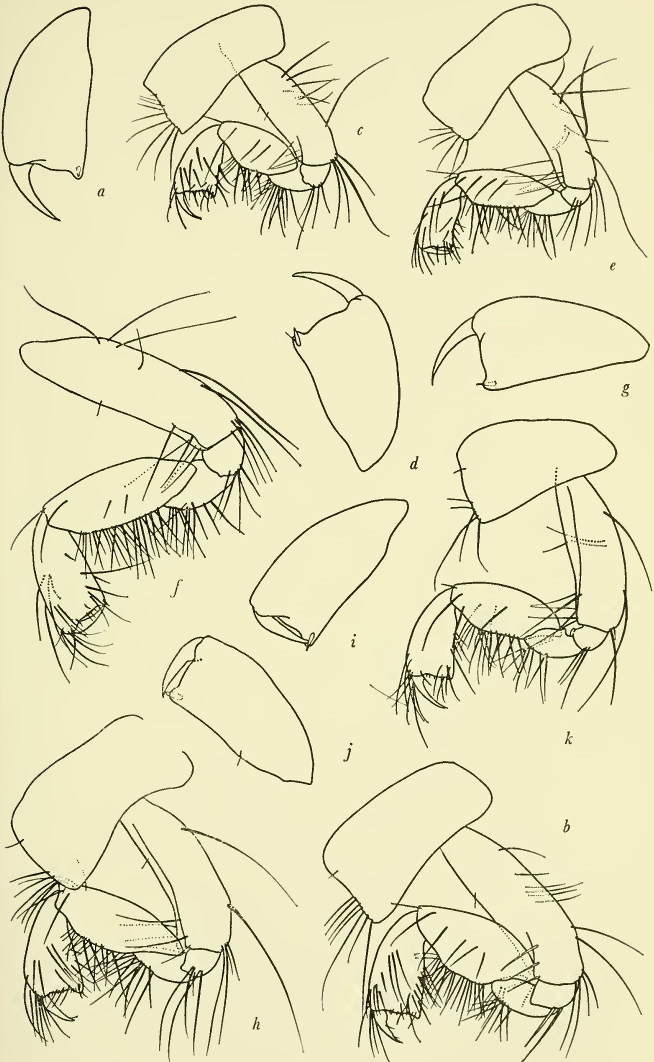

FIGURE 7.—Explanation on facing page.

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A NEW GENUS AND SIX NEW SPECIES OF ENTOCYTHERID OSTRACODS (OSTRACODA, ENTOCYTHERIDAE)

By Horton H. Hobbs, Jr., and Margaret Walton [1]

The conservatism that marked the supraspecific treatment of this group of epizootic ostracods for 58 years was broken with the establishment of the family Entocytheridae by Howe (1961) and the appearance of a familial revision in the following year by Hart (1962). Even with the elevation of Hoff's (1942) subfamily Entocytherinae in 1961, only two genera were recognized. In his generic revision, however, Hart proposed the recognition of two subfamilies containing 11 genera. We have followed his recommendations and are adding an additional genus to the subfamily Entocytherinae.

At the time of the preparation of this manuscript, descriptions of at least three more genera of entocytherids are in press. Therefore, it seems somewhat futile to offer a key for the separation of established genera that will be obsolete prior to its publication; furthermore, there are undescribed species available to those currently studying these animals which will require the erection of additional genera.

The assemblage of species described here was collected from various areas in the United States, and all of them were associated with crayfishes. The ostracod genera represented are *Dactylocythere*, *Don-*

[1] Hobbs: Department of Zoology, Smithsonian Institution; Walton: 1116 Richmond Blvd., Danville, Va.

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naldsoncythere, *Entocythere*, the new genus *Thermastrocythere*, and *Unicnocythere*.

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Genus *Dactylocythere* Hart, 1962

Dactylocythere brachystrix, new species

Figures 1*a*-*d*

Male.—Eye present. Shell (fig. 1*b*) with highest portion posterior to midlength and with dorsal and ventral margins more gently tapered anteriorly than posteriorly; ventral margin of shell entire; submarginal setae anteriorly, ventrally, and posteriorly somewhat evenly spaced, absent dorsally. Range of shell size of 10 specimens recorded in table 1.

Copulatory complex (figs. 1*a*, *d*) with posterior margin of peniferum expanded into three humps; both anteroventral and posteroventral extremities directed anteroventrally. Penis small, its length approximately one-third the anterior-posterior dimension of distal portion of peniferum, and situated at level of base of ventral two-fifths of peniferum. Accessory groove extending dorsally almost to ventral extremity of spermatic duct. Dorsal finger slender with its terminal seta extending to ventral margin of finger guard; ventral finger gently curved throughout its length. Finger guard prominent with its anterior margin straight and its ventral margin emarginate with three small prominences. Clasping apparatus with vertical and horizontal rami somewhat distinctly delimited; vertical ramus with a bend of about 45° just proximal to midlength and joining horizontal ramus (external borders) at an angle of about 100°; internal border or horizontal ramus with three evenly spaced teeth and apex with three denticles; external borders of both rami entire.

Female.—Shell of triunguis female (fig. 1*c*) distinctly larger than that of male, with its greatest height slightly posterior to midlength and distinctly lower anteriorly than posteriorly; ventral margin entire; marginal setae as in male. Prominent J-shaped rod and ruffled amiculum present. Range of shell size of 8 specimens recorded in table 1.

Type-locality and range.—Otter Creek, Cumberland County, Tenn., approximately 3.5 miles upstream from the Obed River on the Cumberland Plateau. This species is known only from the type locality where it was found associated with *Dactylocythere pachysphyrata*, new species.

TYPES.—The holotypic male, the allotypic female, and a dissected paratypic male are deposited in the U.S. National Museum (nos. 111251, 111252). Paratypes are in the collections of C. W. Hart, Jr., and the joint collection of the authors.

HOST.—An undescribed species of the genus *Cambarus*.

RELATIONSHIPS.—*Dactylocythere brachystrix* is closely related to *D. daphnioides* (Hobbs, 1955), *D. runki* (Hobbs, 1955), *D. chalaza* (Hobbs and Walton, 1962), and *D. pachysphrata*, new species, but differs from all of them in possessing an accessory groove on the peniferum which extends dorsally only to the ventral extremity of the loop of the spermatic duct. In the other species, the groove reaches the dorsal extremity of the loop.

REMARKS.—The name *brachystrix* is derived from the Greek βραχυς, meaning short, and from στριξ, meaning groove, referring to the short accessory groove of the peniferum of the male.

Dactylocythere pachysphyrata, new species

FIGURES 1*e–g*

MALE.—Eye present. Shell (fig. 1*g*) highest posterior to midlength and with dorsal and ventral margins more gently tapered anteriorly than posteriorly; submarginal setae limited largely to anterior, anterodorsal, posterior, and posterodorsal areas, nowhere abundant, rare ventrally, and absent dorsally. Range of shell size of eight specimens recorded in table I.

Copulatory complex (figs. 1*e, f*) with posterior margin of peniferum entire; anteroventral extremity directed ventrally and posteroventral extremity directed anteriorly. Penis small, its length about one-fourth of anterior-posterior dimension of distal portion of peniferum, and situated at level of base of ventral two-fifths of peniferum. Accessory groove extending dorsally to level of dorsalmost extremity of loop of spermatic duct. Dorsal finger moderately stout with its terminal seta extending to ventral margin of finger guard; ventral finger slender, curved throughout its length, somewhat strongly so at base of proximal two-fifths. Finger guard prominent with its anterior margin straight and its ventral margin slightly emarginate but without distinct prominences. Clasping apparatus with vertical and horizontal rami indistinctly delimited by thickened "ankle"; vertical ramus with a bend of about 30° at distal end of proximal two-fifths; internal border of vertical ramus inclined anteroventrally at approximately a 45° angle to main axis; internal border of horizontal ramus with three teeth; apex of clasping apparatus with three denticles; external borders of both rami entire, their posteroventral extensions forming a right angle.

FEMALE.—Unknown.

TYPE-LOCALITY AND RANGE.—Otter Creek, Cumberland County, Tenn., approximately 3.5 miles upstream from the Obed River on the Cumberland Plateau. This species is known only from the type locality where it was found associated with *Dactylocythere brachystrix.*

TYPES.—The holotypic male and a dissected male paratype are deposited in the U.S. National Museum (nos. 111253 and 111254). Paratypes are in the collections of C. W. Hart, Jr., and the joint collection of the authors.

HOST.—An undescribed species of the genus *Cambarus.*

RELATIONSHIPS.—*Dactylocythere pachysphyrata* is related to the same group of species as is *D. brachystrix.* While they share a number of features in common, the most conspicuous is the thickened "ankle" of the clasping apparatus. It is less closely allied to *D. steevesi* (Hart and Hobbs, 1961) in which the vertical ramus of the clasping apparatus is more uniformly thickened. It may be distinguished from *daphnioides* by lacking a posteroventral extension of the shell; from *chalaza* by possessing more than one tooth on the internal border of the clasping apparatus; and from *runki* by possessing a much more prominently thickened "ankle."

REMARKS.—The name *pachysphyrata* is derived from the Greek παχυς, meaning thick, and σφυρον, meaning ankle, referring to the thickened junction of the vertical and horizontal rami of the clasping apparatus of the male.

Genus *Donnaldsoncythere* Rioja, 1942

Donnaldsoncythere cayugaensis, new species

FIGURES 1*h-k*

MALE.—Eye present. Shell (fig. 1*i*) with highest portion posterior to midlength; dorsal margin tapering more gently anteriorly than posteriorly, and ventral margin entire; submarginal setae somewhat evenly, if widely, spaced around entire perimeter of shell. Range of shell size of 10 specimens recorded in table 1.

Copulatory complex (figs. 1*j*, *k*) with peniferum terminating distally in a bilobed rounded prominence; anteroventral margin of posterior lobe thickened. Dorsal and ventral fingers slender and almost straight with terminal seta of dorsal finger reaching level of penis guides on peniferum. Clasping apparatus with distal portion directed at about a 45° angle to basal portion and not clearly divisible into vertical and horizontal rami; margins entire except distal portion of internal border with two teeth and distal extremity with four denticles.

FEMALE.—Shell of triunguis female (fig. 1*h*) much higher than that of male and higher posteriorly than anteriorly; ventral margin with a

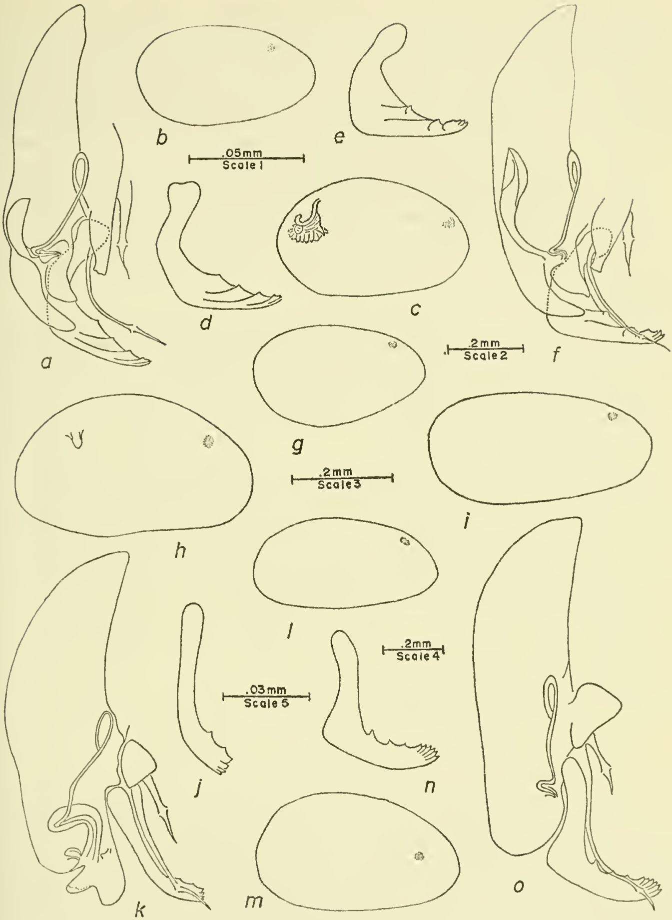

FIGURE 1.—*Dactylocythere brachystrix: a*, copulatory complex of male; *b*, right valve of male; *c*, right valve of triunguis female; *d*, clasping apparatus of male. *Dactylocythere pachysphyrata: e*, clasping apparatus of male; *f*, copulatory complex of male; g, right valve of male. *Donnaldsoncythere cayugaensis: h*, right valve of triunguis female; *i*, right valve of male; *j*, clasping apparatus of male; *k*, copulatory complex of male. *Entocythere kanawhaensis: l*, right valve of male; *m*, right valve of triunguis female; *n*, clasping apparatus of male; *o*, copulatory complex of male. (Scale 1: figs. *a, d, e, f, k, n, o;* scale 2: figs. *b, c, g;* scale 3: figs. *h, i;* scale 4: figs. *l, m;* scale 5: fig. *j.*)

219–940—66——2

distinct concavity just anterior to midlength. Length of allotype .360 mm.; height .240 mm.

Type-locality and range.—Tributary to Fall Creek, 1 mile east of Summer Hill Village, Cayuga County, N.Y., on Route 90 (elevation 1440 ft.). Fall Creek is a tributary to Cayuga Lake. Here it was found on *Cambarus robustus* Girard in association with a species near *Donnaldsoncythere scalis* Hobbs and Walton (1963).

Two additional localities on Salmon Creek and Fall Creek in Tompkins County, N.Y., are in the Cayuga Lake drainage. A fourth locality is the Salmon River, 8 miles east of Pulaski, Oswego County, N.Y., on Route 13. The Salmon River drains directly into Lake Ontario.

Types.—The holotypic male, the allotypic female, and a dissected paratypic male are deposited in the U.S. National Museum (nos. 111255 and 111256). Paratypes are in the collections of C. W. Hart, Jr., and the joint collection of the authors.

Host.—In all the localities cited above, this ostracod was found on *Cambarus robustus* Girard.

Relationships.—*Donnaldsoncythere cayugaensis* is most closely allied to *D. ileata* Hobbs and Walton (1963) and differs from it chiefly in the bilobed ventral extention of the peniferum and in the slightly more bent clasping apparatus. On the average, it is slightly larger than *ileata*, although some specimens of the latter are longer and higher than the smallest specimen of *cayugaensis*.

Remarks.—The name *cayugaensis* refers to the presence of the species in the Lake Cayuga drainage system.

Genus *Entocythere* Marshall (1903)

Entocythere kanawhaensis, new species

Figures 1*l*-*o*

Male.—Eye present. Shell (fig. 1*l*) distinctly elongate, highest just posterior to midlength, and with dorsal margin evenly contoured, tapering gently both anteriorly and posteriorly; ventral margin entire; submarginal setae present except dorsally between level of eye and anus; setae mostly regularly spaced but somewhat closer together posteriorly. Length of holotype .615 mm., height .300 mm.; length of paratype male .600 mm.; height .300 mm.

Copulatory complex (figs. 1*n*, *o*) with posterior and ventral margins of peniferum entire, the latter rounded; entire peniferum of almost uniform thickness and without ornamentation. Penis small, its length approximately one-fourth the anterior-posterior dimension of distal portion of peniferum, and situated very dorsal to ventral extremity of peniferum. Dorsal finger slender with its terminal seta reaching level of penis; ventral finger, also slender, and sinuous. Clasping apparatus with distinct vertical and horizontal rami meeting at an angle of approximately 100°. Vertical ramus slightly convex anteriorly with both margins entire; horizontal ramus slightly convex ventrally with external border entire, internal border with three distinct teeth and six apical denticles.

FEMALE.—Shell of triunguis female (fig. 1*m*) proportionately higher than that of male and larger; posterior declivity of dorsal margin more sudden than in that of male; ventral margin entire. Submarginal setae as in male. Length of allotype .698 mm., height .398 mm.

TYPE-LOCALITY AND RANGE.—Rapids in New River at Pembroke, Giles County, Va., where it was associated with *Donnaldsoncythere ileata* Hobbs and Walton (1963).

Two additional specimens were taken from the Cascades on Little Stony Creek, also in Giles County. Here it was associated with *D. ileata*, *D. scalis* Hobbs and Walton (1963), and *Phymocythere phyma* (Hobbs and Walton, 1962).

TYPES.—The holotypic male and the allotypic female are deposited in the U.S. National Museum (no. 111257). A paratype male is in the joint collection of the authors.

HOSTS.—At the type locality, the specimens were taken from *Cambarus sciotensis* Rhoades. At the Cascades the specimen was found in a collection of crayfishes including *C. sciotensis* and *C. b. bartonii* (Fabricius).

RELATIONSHIPS.—*Entocythere kanawhaensis* seems to have its closest affinities with *E. dorsorotunda* Hoff (1944) and *E. elliptica* Hoff (1944) but differs from both species by possessing only three teeth along the internal border of the horizontal ramus of the clasping apparatus of the male.

REMARKS.—The name *kanawhaensis* refers to the fact that the species is an inhabitant of the Kanawha River drainage system.

Thermastrocythere, new genus

DIAGNOSIS.—Terminal tooth of mandible with cusps. Copulatory complex of male without finger guard; ventral portion of peniferum appearing to be deeply incised (actually apparent rami at least partially ensheathed by delicate membrane), its posterior "ramus" slender and curved with apex directed anteriorly, its apparent anterior "ramus" also curved with tip directed ventrally—the two rami appearing to oppose one another; anterior "ramus" consisting of the prominent penis; penis large, its length subequal to anterior-posterior dimension of distal portion of peniferum. Clasping apparatus extending ventrally beyond peniferum with distinct slender vertical and horizontal rami, the former one-third longer than latter; extensions of rami forming an angle of approximately 80° to 85°; internal and external borders of vertical ramus and external border of horizontal ramus entire; internal border of horizontal ramus with two teeth, one just proximal to midlength and the other subapical; apex with four denticles.

TYPE-SPECIES.—*Thermastrocythere harti*, new species.

REMARKS.—The name *Thermastrocythere* is derived from the Greek *θερμαστρις*, meaning tongs or pincers, referring to the forcipate appearance of the ventral portion of the peniferum.

Thermastrocythere harti, new species

FIGURES 2*e–g*

MALE.—Eye present. Shell (fig. 2*e*) with highest portion slightly posterior to midlength and with dorsal margin more gently tapering posteriorly than anteriorly; ventral margin of shell entire; submarginal setae present anteriorly, posteriorly, and ventrally but absent dorsally, anterior and anteroventral setae closer together than posterior and posteroventral ones. Range of shell size of 10 specimens recorded in table 1.

Copulatory complex (figs. 2*f, g*) as described in the diagnosis. In addition, dorsal finger slender with tip of apical seta reaching level of base of penis; ventral finger with moderate curve near base and a less prominent one a short distance proximal to base of terminal seta.

FEMALE.—Female unknown.

TYPE-LOCALITY, RANGE, AND HOSTS.—Cache Creek at White Wolf Crossing, Fort Sill, Comanche County, Okla., on *Orconectes nais* (Faxon).

Additional localities include: Six Mile Creek near Waunakee, Dane County, Wis., on *Orconectes p. propinquus* (Girard) and *O. virilis* (Hagen): McSpadin Falls, 10 miles northeast of Talequah on Route 10, Cherokee County, Okla., on *Orconectes meeki brevis* Williams, *O. nana* Williams, and *O. neglectus neglectus* (Faxon); small stream, 13 miles west of Madison, Dane County, Wis., on *O. p. propinquus* and *O. virilis;* Yahara River near Sun Prairie where it crosses Route 19, Dane County, Wis., on *O. p. propinquus* and in association with *Entocythere cambaria* Marshall; White Pines State Forest, Ogle County, Ill., on *O. virilis;* and 5.9 miles west of Eyota on Route 14, Olmsted County, Minn., on *Cambarus d. diogenes* Girard and *O. virilis*, in association with *Rhadinocythere serrata* (Hoff).

TYPES.—The holotypic male and two paratypic males are deposited in the U.S. National Museum (nos. 111258 and 111259). Paratypes are in the collections of C. W. Hart, Jr., and the joint collection of the authors.

Relationships.—*Thermastrocythere harti* has its closest affinities with members of the genus *Uncinocythere* (Hart, 1962) and is perhaps more closely allied to *U. simondsi* (Hobbs and Walton, 1960) than to any other species; similarities exist in the armature of the clasping apparatus and in the distal portion of the peniferum; however, the penis in *harti* reaches the anteroventral extremity of the peniferum—an arrangement that does not exist in any known species of the genus *Uncinocythere*.

Remarks.—We are pleased to name this species in honor of our friend and colleague, C. W. Hart, Jr., who has contributed much to our knowledge of the entocytherids.

Genus *Uncinocythere* Hart, 1962

Uncinocythere stubbsi, new species

Figures 2*a–d*

Male.—Eye present. Shell (fig. 2*b*) highest near midlength and with dorsal margin evenly contoured anteriorly and posteriorly; ventral margin convex without an emargination; submarginal setae evenly but widely spaced anteriorly, ventrally, and posteriorly, absent dorsally. Range of shell size of 10 specimens recorded in table 1.

Copulatory complex (figs. 2*a*, *d*) with posterior margin of peniferum entire, its ventral margin excised with anteroventral extremity directed ventrally and posteroventral extremity directed anteroventrally; anteroventral portion with a heavy, acute, dorsally directed penis guide. Penis of moderate size, its length approximately one-half anterior-posterior dimension of distal portion of peniferum and situated far distal to base of clasping apparatus within ventral one-third of area between dorsal margin of spermatic loop and ventral extremity of peniferum. Dorsal and ventral fingers slender, latter with strong caudal bend at distal end of proximal one-third. Clasping apparatus with vertical and horizontal rami of subequal lengths, and extensions of their rounded junction forming angle of less than 90°. Vertical ramus entire but with distal one-third curved posteriorly. External border of horizontal ramus gently rounded and entire; internal border with three teeth—largest immediately proximal to midlength and two smaller ones near distal extremity; terminal extremity with three teeth.

Female.—Shell of triunguis female (fig. 2*c*) distinctly larger than that of male with its greatest height slightly posterior to midlength and distinctly lower anteriorly than posteriorly; ventral margin with emargination near midlength; submarginal setae as in male. Range of shell size of 10 specimens recorded in table 1.

TYPE-LOCALITY AND RANGE.—A tributary of Big Turnbull Creek (to Harpeth and Cumberland Rivers) on the property of Bethany Hills Church Camp in the southern portion of Cheatham County, Tenn.

TABLE 1.—*Measurements (in mm.) of shells*

	Sex	Length	Height	Length/Height
Dac. brachystrix				
Mean	♂	.473±.009	.273±.008	1.73±.031
Minimum	♂	.465	.263	1.67
Maximum	♂	.488	.293	1.78
Mean	♀	.483±.022	.296±.012	1.63±.030
Minimum	♀	.442	.270	1.59
Maximum	♀	.510	.325	1.70
Dac. pachysphyrata				
Mean	♂	.436±.004	.253±.015	1.73±.039
Minimum	♂	.428	.240	1.68
Maximum	♂	.443	.255	1.81
Don. cayugaensis				
Mean	♂	.450±.008	.248±.007	1.82±.062
Minimum	♂	.435	.240	1.71
Maximum	♂	.460	.260	1.92
T. harti				
Mean	♂	.358±.013	.201±.011	1.78±.093
Minimum	♂	.338	.188	1.65
Maximum	♂	.390	.218	1.92
U. stubbsi				
Mean	♂	.281±.008	.161±.003	1.75±.067
Minimum	♂	.270	.158	1.64
Maximum	♂	.293	.165	1.85
Mean	♀	.324±.009	.189±.005	1.74±.113
Minimum	♀	.315	.180	1.62
Maximum	♀	.345	.195	1.83

This species is known only from the type locality.

TYPES.—The holotypic male, the allotypic female, and a dissected paratypic male are deposited in the U.S. National Museum (nos. 111260 and 111261). Paratypes are in the collections of C. W. Hart, Jr., and the joint collection of the authors.

HOST.—*Orconectes rusticus* subsp. (?)

RELATIONSHIPS.—*Uncinocythere stubbsi* has its closest affinities with those species of the genus having a distinct bifid ventral (or posteroventral) margin of the peniferum: *U. ericksoni* (Kozloff, 1955), *U. caudata* (Kozloff, 1955), *U. neglecta* (Westervelt and Kozloff, 1959), *U. simondsi* (Hobbs and Walton, 1960), and *U. pholetera* (Hart and Hobbs, 1961). It differs from *U. caudata* in lacking a posteroventral acute projection of the shell; from *U. ericksoni* and *U. neglecta* in possessing only three teeth at the extremity of the ventral ramus of the clasping apparatus; from *U. pholetera* in having the vertical and horizontal rami of the clasping apparatus subequal in length and with the distal two teeth of the horizontal ramus closer together, the distal

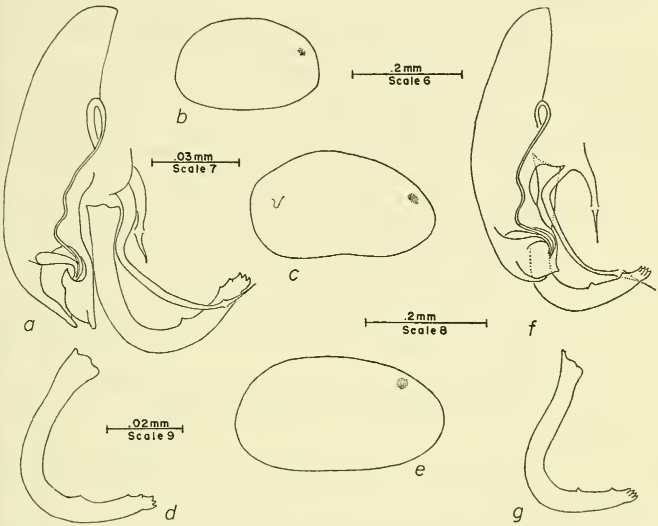

FIGURE 2.—*Uncinocythere stubbsi: a*, copulatory complex of male; *b*, right valve of male; *c*, right valve of female; *d*, clasping apparatus of male. *Thermastrocythere harti: e*, right valve of male; *f*, copulatory complex of male; *g*, clasping apparatus of male.

one more distally situated than in *pholetera;* and from *U. simondsi* in having the penis situated in the distal third of the area between dorsal margin of the spermatic loop and the ventral margin of the peniferum. It differs from all of its relatives in the arrangement of the penis guide.

REMARKS.—It is a pleasure to name this species in honor of John M. Stubbs, of the Tennessee Game and Fish Commission, who has so generously aided us in our studies of crayfishes and their epizootic ostracods in Tennessee.

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NEOTROPICAL MICROLEPIDOPTERA, XI[1]

REVISION OF GENUS IDOLATTERIA (LEPIDOPTERA: TORTRICIDAE)

By Nicholas S. Obraztsov[2]

The genus *Idolatteria* Walsingham is endemic to the Neotropical region, and includes, as far as known, few species. They are poorly represented in the collections, and the material available for the present study amounted to only 15 specimens consisting of eight species, three of which were new. No ecological information is known concerning this genus; thus, it is not known whether the moths

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[2] Deceased May 6, 1966.

are actually rare in nature, or if their apparent rarity is due merely to the fact that their habitats have not been discovered by collectors.

In their appearance the *Idolatteria* species are strikingly colored moths, superficially very similar to those of the genera *Pseudatteria* Walsingham and *Atteria* Walker. Especially impressive is the fact that the resemblance is displayed even in a parallelism of the various types of the wing pattern observed in these three genera. For instance, *Idolatteria xanthocapna* (Meyrick) might easily be confused with *Pseudatteria heliocausta* (Dognin), and the two new *Idolatteria* species, *I. fasciata* and *I. cantharopisca*, could be mistaken for dwarfs of *P. cantharopa* (Meyrick). Only careful examination of structural characters can provide a definitive generic separation of the specimens belonging to the three named genera.

The most important generic distinction is present in the genitalia, and according to this character all three genera must be referred to three separate tribes of the subfamily Tortricinae of the family Tortricidae. *Pseudatteria* belongs to the tribe Polyorthini, *Atteria* to Anacrusiini, and *Idolatteria* to Archipini. Actually the wing venation alone is satisfactory for separating the three genera. *Idolatteria* and *Pseudatteria* differ from *Atteria* in having the veins R_4 and R_5 of the forewing separate; in the latter genus they are stalked. In *Idolatteria* the vein R_5 of the forewing runs to the termen, in *Pseudatteria* to the wing apex.

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Genus *Idolatteria* Walsingham, 1913

FIGURES 1–3; PLATES 1–8

Atteria (not Walker).—Druce, 1901, Ann. Mag. Nat. Hist., ser. 7, vol. 7, p. 440.

Pseudatteria (in part).—Meyrick, 1912, *in* Wagner, Lepidopterorum catalogus, pt. 10, p. 16; 1913, *in* Wytsman, Genera insectorum, fasc. 149, p. 22; 1930, Exotic Microlepidoptera, vol. 3, p. 607.—Clarke, 1955, Catalogue of the type specimens of Microlepidoptera in the British Museum described by Edward Meyrick, vol. 1, p. 227, 326; 1958, ibid., vol. 3, pp. 199, 200.

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Type species: *Idolatteria simulatrix* Walsingham, 1913; by monotypy and original designation.

Head smooth, sides of vertex with cristae of longer and raised scales. Antenna dentate, in female with teeth shorter, in both sexes biciliate, with setae shorter than width of antennal shaft; scapus cylindrical. Labial palpus about three times as long as width of eye, obliquely ascending, with apex rather porrect; basal segment pronounced; second segment longest of all segments, smoothly scaled, slightly dilated apicad; terminal segment about half as long as second, tapering distad, and ending rather acutely. Proboscis moderate. Thorax smooth.

Forewing smoothly scaled, elongate subrectangular; costa strongly arched in basal third, then gently arcuate to almost straight; apex rotundate; termen convex, slightly oblique; tornus broadly rotundate; dorsum very gently arched to almost straight or flatly undulate. No costal fold in male. Twelve veins, all separate: S gently sinuate; R_1 from about middle of discal cell; R_2 less than twice as close to R_3 as to R_1; R_3 twice as remote from R_4 as latter from R_5; R_4 running to costa, R_5 to termen, never in apex, although sometimes rather close to it; M_1 nearer to R_5 than to M_2; M_2, M_3, and Cu_1 almost equidistant, latter originating from lower angle of discal cell; Cu_2 from about two-thirds of discal cell; A_1 indiscernible basally, distinct tornally; basal fork of A_{2+3} about one-fourth as long as entire vein. Hindwing subtrapezoidal, as broad as forewing or narrower; costa gently arched or slightly sinuate; apex rotundate; termen gently convex to almost flat; tornus broadly and flatly rotundate; dorsum straight or slightly concave in external portion, strongly curved basally. Eight veins: S straight or slightly sinuate; R and M_1 closely parallel to about their half, then diverging; M_2 gently descending basad, and at basis about twice as close to M_3 as at termen; M_3 and Cu_1 connate or stalked, originating at lower angle of discal cell; Cu_2 from two-thirds of discal cell; A_1 well developed or vestigial; A_2 with basal fork, twice as close to A_3 as to A_1. No cubital pecten.

Male genitalia.—Eighth abdominal segment with a subtriangular mensis ventralis having a slightly stronger sclerotized proximal angle. Uncus hooklike, moderately long, strongly sclerotized; gnathos with a dilated middle process; socius absent or indicated by few hairs on internolateral fold of tegumen. Tegumen moderately broad with shoulders oblique; pedunculi moderately broad, narrowing ventrad; saccus broad, not deep, laterally dilated. Valva moderately sclerotized, roundly and broadly dilated in basal two-thirds, and ending with a much narrower cucullus turned upward; valvula with ventral portion longitudinally folded and reaching into cucullus, and with basal portion bearing a haired pulvinus; sacculus stronger sclerotized, rather broad, without a free tip, and with ventral edge subangular. Fultura superior complete, narrowed at middle; fultura inferior flatly subcordate, with weak, haired dorsal papillae; caulis moderately long. Aedeagus moderately long, tubular, narrowed and pointed ventroapically, with a long, obliquely located orificium dorsoapically; coecum penis curved downward, slightly tapering to bottom, ending with a narrow process, or without such a process; cornuti flat, rather long, narrowed at base and apically, and lying over one other.

Female genitalia.—Papillae anales pelmiform, oblong, soft, and haired. Sinus vaginalis infundibular or somewhat tureen shaped, cephalically rounded or flat. Lamella antevaginalis narrow, encircling sinus vaginalis cephalically; lamella postvaginalis composed of two triangular pieces located caudolaterad of ostium bursa and connected to dorsal, membranous wall of sinus vaginalis. Antrum short, tubular, membranous or slightly sclerotized, bearing two narrow, lateral collicule; ductus bursa rather short; bursa copulatrix membranous; cervix bursae variously long and broad, but generally moderate; corpus bursa rotundate or slightly elongate, smooth or somewhat rugose; signum strongly sclerotized, with a basal plate elevated over external surface of corpus bursa, narrowly extended caudad and cephalad, and having a variously pronounced capitulum; internal process of signum dagger shaped, straight or curved.

Remarks.—In spite of its very distinct appearance, *Idolatteria* is morphologically very close to the genus *Argyrotaenia* Stephens, having similar wing venation and very similar genitalia. The genitalic resemblance of these two genera is so complete, even in details, that it is impossible to separate one genus from the other, using only these characters. The external distinction consists of very long labial palpi of *Idolatteria* and the bright coloring of the wings and the body of the moths of this genus. Also the pattern of the wings is completely distinct in both *Idolatteria* and *Argyrotaenia*. The labial palpi of *Idolatteria* further differ from those of *Argyrotaenia* in having a tapering, subacute terminal segment which in the latter genus is more cylindrical and blunt.

Key to *Idolatteria* Species

1. Forewing with not less than nine costal streaks; at least two subtermina spots basad of terminal spots; bands in discal area (if any present) narrow and irregular 2
   Forewing with four costal spots, all of them in external third of costa; a very large, round or somewhat piriform spot in subterminal area; two broad bands crossing forewing from costa to (or almost to) dorsum 7
2. Forewing without spots on dorsum 3
   Forewing with spots on dorsum 4
3. Termen of forewing with three smaller and two larger spots; hindwing darker than forewing . . . . xanthocapna Meyrick

Termen of forewing with two large spots; hindwing concolorous with forewing . . . . **mydros**, new species
4. Discal spots of forewing at part fused into transverse rows . . **maon** Druce
Discal spots of forewing not fused into transverse rows 5
5. Forewing with few spots in discal cell and between its end and terminal spots; few spots on dorsum and none in supradorsal area. **simulatrix** Walsingham
Forewing with discal spots numerous, also in supradorsal area; many spots on dorsum 6
6. Hindwing with terminal and subterminal spots larger than few discal spots. **orgias** Meyrick
Hindwing with terminal and subterminal spots smaller than many of discal spots . . . . **pyropis** Walsingham
7. Cilia of both wings orange, slightly grayish on tips of hindwing. **cantharopisca**, new species
Cilia of forewing black; that of hindwing black or orange checked with black in front of terminal dots . . . . **fasciata**, new species

Idolatteria xanthocapna (Meyrick)

Plate 1

Pseudatteria xanthocapna Meyrick, 1930, Exotic Microlepidoptera, vol. 3, p. 607.—Clarke, 1955, Catalogue of the type specimens of Microlepidoptera in the British Museum described by Edward Meyrick, vol. 1, p. 326; 1958, ibid., vol. 3, p. 200, pl. 100, figs. 4–4b.

Idolatteria xanthocapna.—Obraztsov, 1966, Proc. U.S. Nat. Mus., vol. 118, no. 3535, pp. 619.

Male genitalia.—Uncus moderately long, curved, tapering apicad, with tip obtuse. Valva roundly dilated in basal portion; cucullus rather narrow, far not reaching upper level of dilated portion of valva. Aedeagus with a very short apical tip.

Type.—Holotype, male (genitalia on slide 4428, JFGC), Manizales, Caldas, Colombia (A. M. Patino); BM.

Remarks.—Known as a single male specimen. Superficially this species reminds one of *Pseudatteria heliocausta* (Dognin) but differs from the latter both structurally and in the wing markings.

Idolatteria simulatrix Walsingham

Figure 1; Plate 2

Idolatteria simulatrix Walsingham, 1913, *in* Godman and Salvin, Biologia Centrali-Americana, Lepidoptera Heterocera, vol. 4, p. 214; 1914, ibid., vol. 4, p. 270, pl. 8, fig. 8.

Female genitalia.—Sinus vaginalis infundibular, abruptly narrowed toward ostium bursae; lamella antevaginalis narrow, with lateral portions inclined mediad and incurved, and medial portion forming a short arch bent cephalad. Antrum coincident with short, cylindrical portion of ductus bursa bearing two lateral colliculi.

Signum narrow, dagger shaped, very insignificantly curved; caudal and cephalic extensions of its basis narrow and almost equally long; capitulum somewhat flat.

TYPE.—Holotype, female (genitalia on slide 2770), Geronimo, Vera Paz, Guatemala (Champion; Godman and Salvin Collection; 66270); BM.

REMARK.—The holotype is the only known specimen of this species.

***Idolatteria mydros*, new species**

PLATE 3

FEMALE.—Antenna [only basal third present] black. Labial palpus dark brown, basal segment and inner surface of second segment yellow. Head dark brown; face and marginal cristae yellow. Thorax dark brown with posterior margin orange yellow; most of tegula yellow. Abdomen dark brown. Forewing reddish orange with markings dark brown, iridescent bluish separated by cream-white interspaces, and arranged as follows: nine variously broad streaks on costa, last two of them occasionally connected at tips; a circular, moderately sized apical spot closely touching a larger terminal spot, located below and slightly incised at termen and interiorly; a second terminal, slightly elongate spot, located closer to tornus, and also incised at termen and interiorly; an elongate spot at tornus; a more or less round spot dorsad of last two costal streaks and basad of upper terminal spot, slightly larger than latter; a small spot (on right forewing accompanied by a very minute dot) located above tornal spot; some little, faint dots along external borders of orange area; cilia cream white, in front of terminal spots and around tornus black. Length of forewing 11 mm. Hindwing red orange with black spots: a preapical spot on costa, an apical spot and six marginal spots along termen and tornus; an obscure spot almost midway between discocellulars and termen; cilia grayish black.

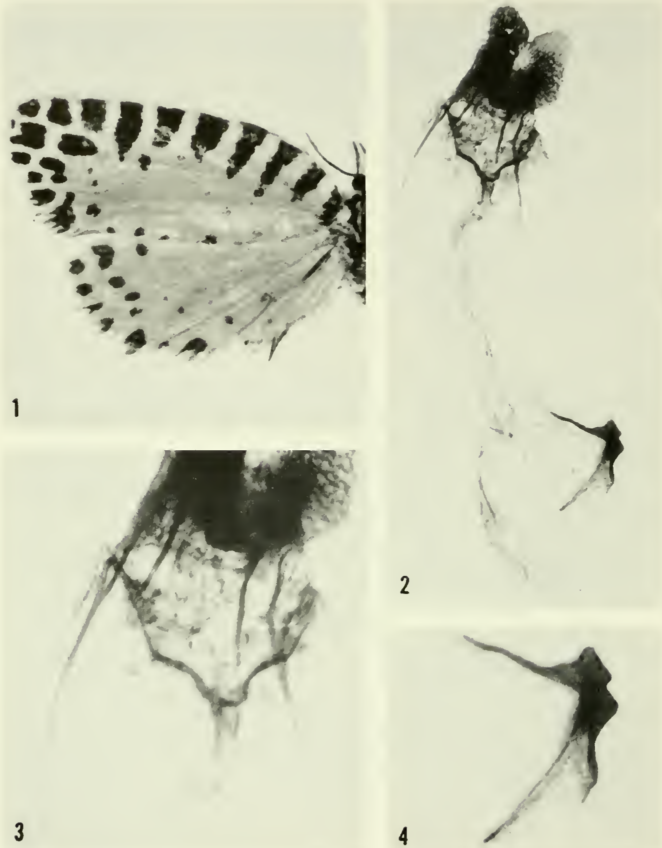
MALE.—Unknown.

FEMALE GENITALIA.—Sinus vaginalis flatly infundibular, narrowed at ostium bursae; lamella antevaginalis narrow, with lateral portions inclined mediad and medial portion forming a short arch, bent cephalad. Antrum short, joined to a narrower, almost cylindrical portion of ductus bursae bearing two lateral colliculi. Signum curved, dagger shaped; caudal and cephalic extensions of its basis strongly thickened, almost equally long and broad; capitulum not separated, forming highest point of basis of signum.

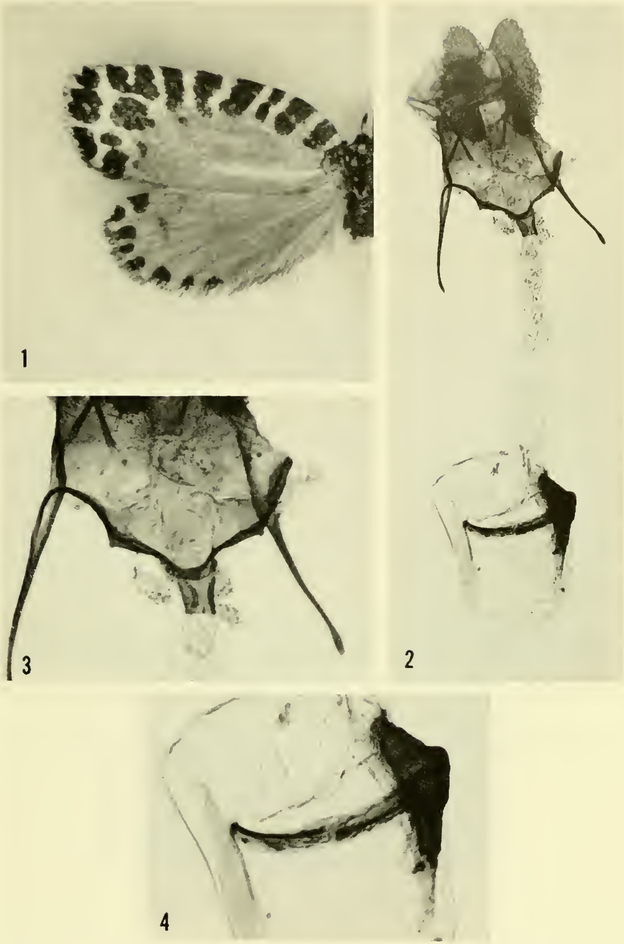
TYPE.—Holotype, female (genitalia on slide 1-Obr., Jan. 22, 1961), Loja vicinity, Ecuador, 1887; USNM 67735.

REMARKS.—Somewhat similar to *simulatrix* Walsingham, but with

FIGURES 1–3.—*Idolatteria xanthocapna* (Meyrick), holotype, male: 1, left wings; 2, caudal aspect of genitalia with valvae spread and aedeagus removed; 3, lateral aspect of aedeagus. (From Clarke, 1958.)



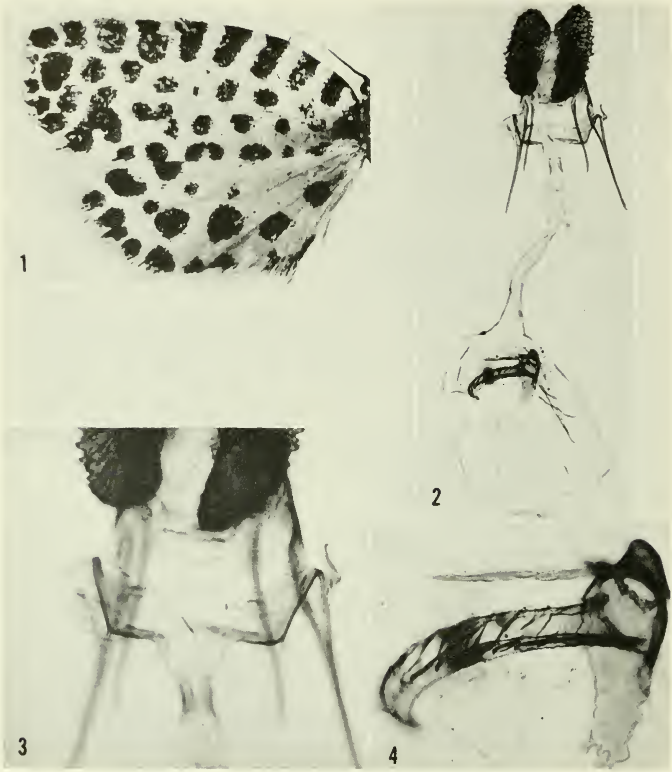
FIGURES 1–4.—*Idolatteria simulatrix* Walsingham, holotype, female: 1, left wings; 2, ventral aspect of genitalia; 3, detail of sinus vaginalis; 4, detail of signum.



FIGURES 1–4.—*Idolatteria mydros*, new species, holotype, female: 1, left wings; 2, ventral aspect of genitalia; 3, detail of sinus vaginalis; 4, detail of signum.

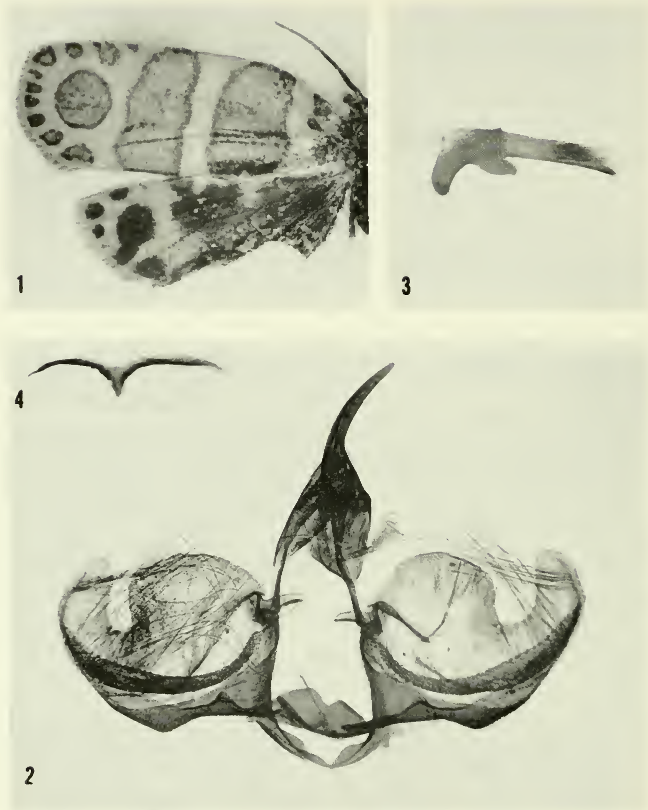
FIGURES 1–4.—*Idolatteria pyropis* Walsingham, females: 1, holotype, left wings; specimen from Monteverde, Costa Rica: 2, ventral aspect of genitalia; 3, detail of sinus vaginalis; 4, detail of signum.

FIGURES 1–4.—*Idolatteria maon* (Druce), holotype, female: 1, right wings (image reversed) 2, ventral aspect of genitalia; 3, detail of sinus vaginalis; 4, detail of signum.



Figures 1-4.—*Idolatteria orgias* (Meyrick), holotype, female: 1, left wings; 2, ventral aspect of genitalia; 3, detail of sinus vaginalis; 4, detail of signum. (From Clarke, 1958.)

FIGURES 1–7.—*Idolatteria fasciata*, new species, holotype, male: 1, left wings, 2, caudal aspect of genitalia with valvae spread and aedeagus removed; 3, lateral aspect of aedeagus; allotype, female: 4, right wings (image reversed); 5, ventral aspect of genitalia; 6, detail of sinus vaginalis; 7, detail of signum.



Figures 1–4.—*Idolatteria cantharopisca*, new species, holotype, male: 1, left wings; 2, caudal aspect of genitalia with valvae spread and aedeagus removed; 3, lateral aspect of aedeagus; 4, ventral aspect of mensis ventralis.

only two terminal spots and without any dorsal spot on the forewing. The submarginal spots of the forewing are dissimilar in shape, and on the hindwing the submarginal row of spots is represented by only one indistinct spot. The female genitalia resemble those of *simulatrix*, but the signum is of a quite different shape. The specific name is derived from the Greek word μυδρος, meaning "a red-hot mass."

Idolatteria pyropis Walsingham

Figure 2; Plate 4

Idolatteria pyropis Walsingham, 1914, *in* Godman and Salvin, Biologia Centrali-Americana, Lepidoptera Heterocera, vol. 4, p. 270, pl. 8, fig. 9.

Female genitalia.—Sinus vaginalis tureen shaped; lamella antevaginalis narrow, straight cephalically. Antrum membranous, broader than adjacent, cylindrical portion of ductus bursae bearing two lateral colliculi. Signum dagger shaped, slightly curved apically; caudal extension of its basis longer than cephalic extension; capitulum semirotundate.

Type.—Holotype, female (abdomen missing), Volcan de Irazu, Costa Rica, 6000–7000 ft. (H. Rogers; Godman and Salvin Collection; 66225); BM.

Other specimen examined.—One female (genitalia on slide 757-Obr.), Monteverde, Puntarenas, Costa Rica, 4600 ft., Feb. 28, 1962 (C. W. Palmer); AMNH.

Remarks.—No male of this species is known. There are some color differences between the holotype, which appears somewhat faded, and the other specimen examined, due probably to different collection times. The antennae, labial palpi, head, thorax, and the wing markings, described by Walsingham as being "purplish fuscous" or "dark purple," are found by the present author as having these colors in the holotype. In the newly collected specimen they are almost black with a slight bluish hue. The head would best be described as being black with a large, cream-white spot on the face and with concolorous cristae externad of the eyes. The patagia are black. The thorax is also black with two anterior, mediolateral yellow streaks becoming pale orange distally; the posterior margin of the thorax is orange; the external cristae of the tegulae are cream white. The abdomen is bluish black with narrow postsegmental bands orange dorsally, whitish laterally and ventrally, and also whitish on the dorsal surface of the tip. The arrangement of the wing spots is approximately the same in both of the examined specimens, although the size and shape of separate spots are slightly distinct. In spite of all the mentioned differences, there are no grounds to treat the above specimens as belonging to two separate species.

Idolatteria maon (Druce)

PLATE 5

Atteria maon Druce, 1901, Ann. Mag. Nat. Hist., ser. 7, vol. 7, p. 440.
Pseudatteria maon.—Meyrick, 1912, *in* Wagner, Lepidopterorum catalogus, pt. 10, p. 16; 1913, *in* Wytsman, Genera insectorum, fasc. 149, p. 22.
Idolatteria maon.—Durrant, 1914, *in* Godman and Salvin, Biologia Centrali-Americana, Lepidoptera Heterocera, vol. 4, p. 270.

FEMALE GENITALIA.—Sinus vaginalis tureen shaped; lamella antevaginalis narrow, straight cephalically. Antrum membranous, broader than adjacent, cylindrical portion of ductus bursae bearing two lateral colliculi touching each other medially. Signum strong, dagger shaped, insignificantly curved; caudal extension of its base a little longer than cephalic extension; capitulum broadly rounded, but moderately prominent.

TYPE.—Holotype, female (genitalia on slide 5762), Chiguinda, Ecuador (C. Buckley; 6610); BM.

REMARK.—The holotype is the only specimen known.

Idolatteria orgias (Meyrick)

PLATE 6

Pseudatteria orgias Meyrick, 1930, Exotic Microlepidoptera, vol. 3, p. 607.—Clarke, 1955, Catalogue of the type specimens of Microlepidoptera in the British Museum (Natural History) described by Edward Meyrick, vol. 1, p. 227; 1958, ibid., vol. 3, p. 199, pl. 99, figs. 3–3c.
Idolatteria orgias.—Obraztsov, 1966, Proc. U.S. Nat. Mus., vol. 118, no. 3535, pp. 619.

FEMALE GENITALIA.—Sinus vaginalis tureen shaped; lamella antevaginalis narrow, straight cephalically. Antrum membranous, infundibular, much broader than adjacent portion of ductus bursa bearing two lateral colliculi. Signum dagger shaped, broad, curved; caudal extension of its basis narrow and long; cephalic extension much broader and slightly shorter, and with scalloped margins; capitulum with tip slightly narrowed.

TYPE.—Holotype, female (genitalia on slide 4440, JFGC), Pacho, East Cordilleras, Colombia, 7250 ft. (Paravicini Collection); BM.

OTHER SPECIMENS EXAMINED.—One female (one wing and abdomen missing), Bogota, Cundinamarca, Colombia (Felder Collection; 400159); BM. One female (genitalia on slide 4441, JFGC), same locality; USNM.

REMARKS.—The male is unknown. All three female specimens are very similar, varying slightly in the shape and size of separate wing spots.

***Idolatteria fasciata*, new species**

PLATE 7

MALE.—Antenna blackish brown with black annulation; tip white scaled. Labial palpus black with inner surface of basal and second segments cream yellow. Head black; face encircled by cream yellow. Thorax black with prismatic blue hue; its middle, posterior margin, and tips of tegula orange. Abdomen brown black with orange yellow, on ventral surface paler, postsegmental rings. Forewing orange with markings prismatic blue or violet, arranged as follows: A narrow band at wing basis, oblique externad; a broad, almost vertical band before middle of forewing and crossing it from costa to dorsum; a third band, parallel to and almost as broad as former, and located just beyond middle of forewing; a large, round or slightly piriform spot in external third of forewing, separated from or connected to a much smaller tornal spot; a triangular costal streak in interspace of first and second bands; two or three more or less rotundate costal dots distad of third transverse band, and a similar dot on forewing apex; five more or less separate dots on termen; cilia black. Length of forewing 9.5–10.0 mm. Hindwing orange with brownish-black spots: an irregularly shaped spot at wing basis, separate or fused with a dorsal spot; a more or less rotundate spot at middle of disc, separate or fused with a dorsal spot, other than already mentioned; sometimes these two dorsal spots fused together; a rotundate or slightly piriform spot in external portion of wing, lying free or occasionally reaching to termen; a small preapical dot on costa; a more or less rotundate apical dot; two or three terminal dots; cilia orange yellow, slightly checked with black in front of terminal dots, or entirely black.

FEMALE.—Similar to male, but with antenna not white at tip; third band of forewing not reaching dorsum, or connected with it by means of a narrow streak; interspace of second and third bands of forewing with spots, a larger one on costa, a smaller on dorsum; spots in basal half of hindwing fused together. Length of forewing 11 mm.

MALE GENITALIA.—Uncus moderately long, tapering apicad, basally distinctly broader than apically, with tip somewhat obtuse. Valva strongly rotundate dilated in basal portion; cucullus moderately broad; sacculus before middle with an arcuate elevation directed dorsad. Aedeagus with a moderately long tip; coecum penis elongate, acutely narrowed at bottom.

FEMALE GENITALIA.—Sinus vaginalis tureen shaped, rounded at bottom; lamella antevaginalis narrow, equally arcuate. Antrum cylindrical, fused with adjacent portion of ductus bursa bearing two lateral colliculi. Signum straight, dagger shaped; caudal and cephalic extensions of its basis almost equally long, but former with a weakly sclerotized prologation reaching into cervix bursae; capitulum rotundate, slightly prominent.

Types.—Holotype, male (genitalia on slide 8667), Bolivia, 1903 ("Staudinger"); BM. Allotype, female (genitalia on slide 6603), Rio Zongo, Bolivia, 750 m. (A. H. Fassal); BM. Paratypes: One male (genitalia on slide 6604), Andes, Bolivia, 1920; one female, Bolivia; BM. One male, Rio Zongo, Yungas, Bolivia, 1200 m., 1895–1896 (Garlepp); ZMB.

Remarks.—Very similar to the following species, *cantharopisca*, with which it is compared. As a manuscript name, *fasciata* has been used by Walsingham on the labels of some specimens, now becoming the types of this species.

Idolatteria cantharopisca, new species

Figure 3; Plate 8

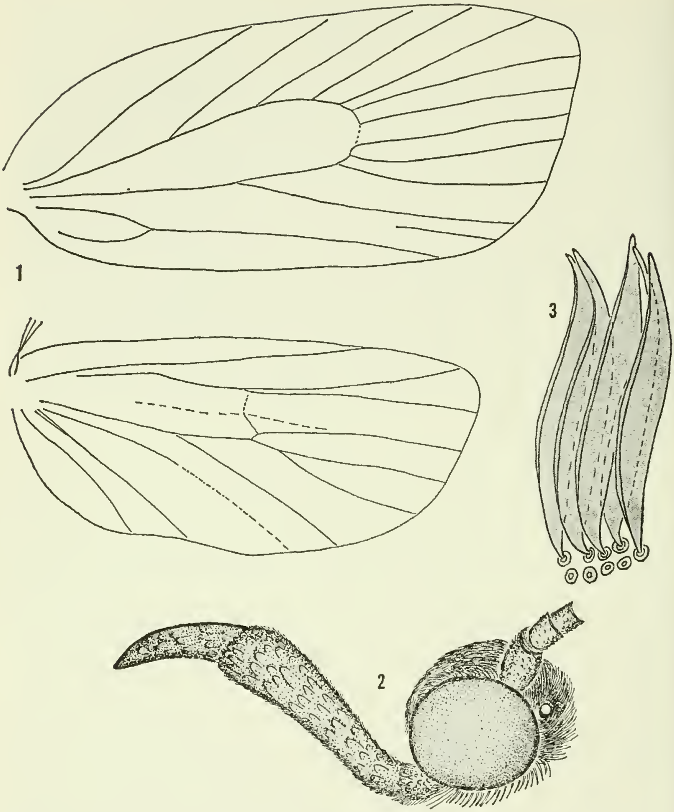
Male.—Antenna entirely black with a prismatic blue hue. Labial palpus black, at basis and on inner surface of basal and second segments orange. Head black with greenish hue; face encircled by orange. Thorax black with greenish hue, at posterior margin and on tips of tegulae orange. Abdomen entirely greenish black. Forewing orange with prismatic green markings narrowly outlined with black and arranged as follows: A narrow, transverse basal arcuate outward; a very broad, transverse band in basal half of forewing, externad of former band; a slightly narrower, transverse band crossing forewing just externad of its middle; a large, round spot in external third of forewing; three costal dots in same area; an apical dot, five terminal dots, and a slightly larger tornal dot; cilia entirely orange. Length of forewing 10 mm. Hindwing orange with black markings, arranged as follows: A wide area consisting of at least three large spots fused together, occupying more than basal half of hindwing, and including some orange dots; a piriform, black spot externad of this area and reaching termen; a black costal spot connected with basal area; a preapical dot on costa; an apical dot, accompanied by a smaller dot on termen; a larger spot on tornus; cilia orange, slightly grayish at tips.

Female.—Unknown.

Male genitalia.—Uncus rather long, narrow, tapering apicad, and ending acutely. Valva with a rather narrow cucullus; sacculus before middle with a triangular tooth directed dorsad. Aedeagus moderately long, with a narrow, long tip; coecum penis elongate, rounded at bottom.

Type.—Holotype, male (genitalia on slide B.26), "Loeotal," Bolivia, 2600 m., 1891 (Garlepp); ZMB.

Remarks.—Very similar to *Idolatteria fasciata*, new species, but differs from it in some details. The antenna is not white at the tip, and is not annulated. The labial palpus has the basis and the inner surface of the basal and second segments deep orange. On the forewing the markings are green. Most of the discal spots of the hindwing are joined into a common, black area. The cilia of both wings are entirely orange, only those of the hindwing turn slightly grayish toward the tips. The uncus of *cantharopisca* is somewhat longer and narrower than in *fasciata*, and has a more acute tip. The tooth in the basal half of the sacculus is triangular, not obtuse as in *fasciata*. The bottom of the coecum penis is rotundate, and has no process. Superficially the new species reminds one of a little specimen of *Pseudatteria cantharopa* (Meyrick). The specific name *cantharopisca* is derived from the name of this *Pseudatteria* species and the Greek diminutive suffix ισκη.



FIGURES 1–3.—*Idolatteria* Walsingham, morphological characters: 1, wing venation of *I. simulatrix* Walsingham, holotype, female; 2, head of *I. pyropis* Walsingham, female, Monteverde, Costa Rica; 3, cornuti of *I. cantharopisca*, new species, holotype.

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RANGE AND VARIATIONS OF SUBSPECIES OF *CAMBARUS LONGULUS* (DECAPODA, ASTACIDAE)

By Hugo A. James [1]

As a result of the loss of the type specimens and confusion arising from an erroneous restriction of the type locality of the typical subspecies, the crayfish *Cambarus longulus* Girard, 1852, has been poorly understood; furthermore, the ranges of its two previously described subspecies have never been clearly delineated.

This report is based on a restudy of much of the material seen by previous authors and of representatives of all the collections of *C. longulus* in the U.S. National Museum (including those previously a part of the collection of H. H. Hobbs, Jr.). In addition, personal field studies within the ranges of all three subspecies herein recognized have supplemented the study of preserved specimens. A total of approximately 1300 specimens in 265 collections from 219 localities have been included.

The maps have been prepared from drainage, contour, and base maps obtained from the U.S. Geological Survey, Washington, D.C.

The present paper is a portion of a master's thesis presented to the Graduate Faculty of the University of Virginia. Completion of the study was supported, in part, by grants from the National Science

[1] University of Bridgeport, Bridgeport, Connecticut.

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A History of the Species

1852. Girard, having examined specimens of crayfish of uncertain locality (somewhere "within the middle States of the Union"), concluded that they were sufficiently different from the then-known forms of *C. diogenes* and *C. bartonii* to warrant the designation *Cambarus longulus* (p. 90). In this work, he first employed *Cambarus* as a subgeneric name.

1870. The genus *Cambarus* was divided by Hagen into four groups (p. 31), *C. bartonii* being made the type for his Group III into which all similar forms were placed. Having examined Girard's type of *C. longulus*, Hagen indicated that it was probably an abnormal *C. bartonii* (pp. 78, 79) and he erroneously placed it in his Group III as "*Cambarus Bartonii*."

1885. Faxon, having examined Hagen's description of Girard's type of *C. longulus*, as well as several similar specimens in the USNM collections, intimated that Girard's *C. longulus* was valid (1885a, p. 66), yet he did not consider his own total number of specimens sufficiently adequate to warrant reestablishing *longulus* as a species. Instead, on the basis of specimens taken from eastern Tennessee, West Virginia, and Cumberland Gap, Va., he described and named *longirostris* as a variety of the species *C. bartonii* (1885a, pp. 65, 66) and stated: "The specimens described above under the name of *C. bartonii* var. *longirostris*, perhaps are the same form as *C. longulus* . . . in accord with Hagen's description of Girard's type" (1885a, p. 66).

1890. Faxon ". . . after examining the large number of specimens (over one hundred, including females and both forms of the male) . . ." restored *longulus* "to the full rank of a species." The variety *longirostris*, however, was retained as a varietal form of *C. bartonii* on the basis of an inadequate number of specimens (pp. 623, 624). In this paper, Faxon erred in designating *C. longirostris* as *C. spinirostris* but corrected his own error: "(*lapsu calami pro 'longirostris'*)" (Faxon 1914, p. 424).

1898. In his "Observation on the Astacidae," Faxon listed several new localities for specimens of both "*Cambarus longulus* Girard" and "*Cambarus bartonii longirostris*" deposited in the USNM. It should be noted that he still retained the specific name of *longulus* (pp. 649–650).

1899. Hay, in "Synopsis of North American Invertebrates," placed *longirostris* with *C. longulus* as a subspecies of the latter (p. 966) and characterized both subspecies in a clear, concise key to the North American Astacidae.

1903. Harris, in a compilation of data (1903, p. 58), referred to *C. b. longulus* and *C. b. longirostris.* I have presumed this to be in error owing to Harris' interpretation of Faxon (1885a).

1905–1912. Having erected four subgenera of *Cambarus,* Ortmann established the subgenus *Bartonius* (1905, p. 120), which was declared a synonym of *Cambarus* for reason of priority by Fowler, who listed, in the place of *Bartonius,* the subgenus *Cambarus* (1912, pp. 340–341).

1914. For some unexplained reason, Faxon reduced *longulus* to subspecific rank calling it "*Cambarus bartonii longulus*" and retained *longirostris* as "*C. bartonii longirostris.*" He completely omitted Hay's designation and wrote: "The character of the suborbital margin of the carapace seems to be very constant within the limits of a good subspecies, and it may prove to be the really diagnostic feature for separating *C. b. longulus* and *C. b. longirostris*" (pp. 389, 424). Fifteen years before, Hay (1899, p. 966) had utilized this identical diagnostic feature in his key.

1931. Ortmann, following Fowler, listed both "*Cambarus* (*Cambarus*) *longulus longulus* Girard (1852)" and "*Cambarus* (*Cambarus*) *longulus longirostris* (Faxon) (1855)" (pp. 118, 121). Ortmann considered the type locality for *longirostris* to be "The first *exact* locality given by Faxon ('85b) . . . Doe River, Carter Co., Tennessee" (p. 121).

1942. Ten years later, in a revision of the genus *Cambarus,* Hobbs, primarily adopting Ortmann's ideas of subgeneric relationships, elevated the previously recognized subgenera to the rank of genus within the new subfamily Cambarinae.

1959–1961. Hobbs (1959, p. 896) indicated that there are two subspecies of *Cambarus longulus* and subsequently indicated to the present writer that a third (form) probably should be recognized.

Cambarus longulus Girard

The species *Cambarus longulus* Girard (1852) belongs to the Bartoni Section (Ortmann, 1931, p. 105) of *Cambarus* Erichson (1846) (as redefined by Hobbs 1942a, p. 354) and, as herein recognized, consists of three subspecies: *Cambarus longulus longulus, C. longulus longirostris* Faxon, and *C. longulus chasmodactylus,* new subspecies.

Geographical limits—The limits of the range of the species *C. longulus,* although more specifically designated within the geographical discussions of the respective subspecies are: North: represented by *C. l. longulus,* in the upper James drainage in Greene County (on the eastern side of the Blue Ridge) and Highland County (to the west of the Blue Ridge) in Virginia, and by *C. l. chasmodactylus* in Greenbrier drainage in Pocahontas County, W. Va. South: represented by *C. l. longulus* in the upper Yadkin drainage of Wilkes County (east of the Blue Ridge) and by *C. l. longirostris* in Will's Creek (Coosa River drainage), DeKalb County, Ala. East: in the upper piedmont province by *C. l. longulus* from the Rivanna River (James drainage), Fluvanna County, Va., southward to the Yadkin River in North Carolina. West: by *C. l. chasmodactylus* from the Greenbrier River in West Virginia and *C. l. longirostris* from a direct tributary to the Tennessee River in Lawrence County, Tenn. (Map 1).

Key to Subspecies of *Cambarus longulus*

1. Suborbital angle well defined and acute . . . . **longirostris** Faxon (1885)
   Suborbital angle markedly reduced or absent, never acute 2
2. Length of dactyl of chela less than twice the length of the inner margin of the palm . . . . **longulus** Girard (1852)
   Length of dactyl of chela twice (or more) the length of the inner margin of the palm . . . . **chasmodactylus**, new subspecies

Cambarus longulus longulus Girard

Cambarus longulus Girard, 1852, Proc. Acad. Nat. Sci. Philadelphia, vol. 6, p. 90.
Cambarus longulus Faxon, 1890 (part) pp. 623, 624.—Ortmann, 1902, p. 277.—Harris, 1903 (part) p. 107.—Fowler, 1912, p. 344.—Ortmann, 1913 (part), pp. 335, 337, 339, 352, 353, 375, 376.—Brimley, 1938, p. 503.
Cambarus Bartonii Hagen, 1870 (part), pp. 7, 9, 75, 78, 79.—Faxon, 1884 (part), p. 145; 1885a, pp. 11, 64, 66.
Cambarus bartonii longulus.—Faxon, 1885a, p. 66 (by implication).—Harris, 1903 (part), pp. 58, 107, 138, 142, 154–155, 159.—Faxon, 1914, pp. 390, 424.
Cambarus longulus longulus.—Hay, 1899 (by implication) (part), pp. 959, 966.—Ortmann, 1913 (part), pp. 336, 337, 375.—Hobbs 1950, p. 349; 1959 (part), 896.—Johnson, R. M., 1957, pp. 178, 182; 1959, pp. 181, 183.—Johnson, T. L., 1960, p. 229.
Cambarus (Bartonius) longulus.—Ortmann, 1905 (part), pp. 120, 122, 128, 129.
Cambarus (Cambarus) longulus longulus.—Ortmann, 1931 (part), pp. 106, 107, 108, 118–121, 123, 124, 128, 134.

Diagnosis.—Concolorous, or speckled, in shades of blue to orange. Rostrum with swollen margins, lacking marginal spines or tubercles, tapering somewhat abruptly to a short acumen, length .40–1.1 (average .95) times postorbital width. Suborbital angle and branchiostegal spines strongly reduced or absent; lateral spines or tubercles on carapace usually present, but absent in certain populations; postorbital spines and ridges weak. Areola from 29 to 42 (average 37) percent of length of carapace: 2.3–5.9 (average 3.5) times longer than broad; and with 4–6 punctations across narrowest part. Antennal scale 1.7–3.2 (average 2.5) times longer than broad (pl. 1*a*). Chela (pl. 1*j–m*) almost devoid of tubercles; inner margin of palm with an indistinct row of weak serrations; all surfaces with scattered, deep punctations. Palm broad, with widely gaping (in adults), subcylindrical fingers which meet only at their tips; inner base of immovable finger with tuft of plumose setae in immature animals, and, except in upper James River, to some degree in older forms. Proximomesial angle of inner margin of palm strongly hooked proximally, forming, with carpus, a deep-curved acute angle (pl. 1*mm:* C); length of inner margin of palm (pl. 1*mm:* A) at least twice that of distance between spine of carpus and proximal extremity of inner margin of palm when the chela is fully extended (pl. 3*mm:* B) (in well over 75 percent of examined specimens). Width of palm .53–1.0 (average .80) times dactyl length; length of outer margin of chela 1.5–3.6 (average 2.7) times that of inner margin of palm and 1.0–2.6 (average 1.7) times greater than the length of dactyl. First pleopod of first-form male reaches coxa of third pereiopod when abdomen is flexed. (For detailed description of first pleopod of first-form male, see Hart, 1952, p. 47; Parish, 1948, figs. 2, 4.)

REMARKS.—Faxon (1898, p. 650) (1914, pp. 389, 424) lists as *C. l. longulus* several collections which should be referred to *C. l. chasmodactylus* or *C. longulus longirostris;* Newcombe (1929, maps 268, 278, 286) and Fleming (1938) repeat the errors of Faxon. All collections erroneously recorded as *C. l. longulus* are listed by me with their proper designations in list I (p. 7).

Of the three subspecies, *C. l. longulus* appears to be the most variable. Although most populations possess a tuft of plumose setae at the base of the immovable finger of the chelae, those of the upper James drainage typically lack such a tuft. Ortmann (1931, pp. 118–124) notes the absence of lateral spines on the carapace of nine of his specimens of *C. l. longulus*. He was correct only with respect to a minority of populations; most have spines.

Some taxonomic characters, previously used by other investigators, must be disregarded or used only in part. Size, although of interest, gives little indication of subspecific variation; most *C. l. longulus* are, on the average, smaller than *C. longulus longirostris* or *C. l. chasmodactylus*; the carapace length of the largest first-form male *C. l. longulus* examined is 34 mm. and its hand length 29 mm. This male is larger than some first-form males of *C. longulus longirostris* and *C. l. chasmodactylus:* hence, size (sexually mature adults) as a taxonomic criterion must be used in combination with other characters. Color and color pattern of living specimens are sometimes useful in separating populations of *C. l. longulus* (speckled green to orange versus concolorous blue greens and browns). Color pattern is of slight intersubspecific value in that neither of the other subspecies shows the speckled condition; however, neither do the majority of the population of *C. l. longulus*.

Specimens examined.—I have examined approximately 100 collections from 78 localities in Virginia, West Virginia, and North Carolina, including adults of both sexes, both forms of male, and juveniles, representing a minimum of 500 specimens. I have no authenticated records of this subspecies having been taken from Tennessee (see list III, p. 7).

Geographic distribution.—It would appear that *C. l. longulus* is limited geographically to the James, Roanoke, and Yadkin River systems of the Atlantic drainage (maps 1, 2). The southernmost record is from the Yadkin River drainage, Wilkes County, N. C. (map 2, no. 92). The northern limit seems to be in the headwaters of the James in Highland County, Va., west of the Blue Ridge (map 2, nos. 51–53) and in Greene County, east of it (map 2, nos. 43–50). It is found as far east as the Rivanna River (James drainage) and its tributaries (map 2, no. 36) but does not, from my data, extend west into or beyond the New River drainage or north into the Shenandoah as some records erroneously indicate (see lists I, II).

A list of all localities and drainage systems in which *C. l. longulus* has been found has been deposited with the U.S. National Museum.[2] Many collections incorrectly labeled as *C. l. longulus* must herewith be removed and reassigned to other taxa.

Because the labels for his type specimens had been lost, Girard (1852, p. 90) cites the locality only as "Middle States." Ortmann (1931, p. 118), listing the first of Faxon's reported localities (1890, p. 623), designates "the first exact locality . . . as a supplementary type-locality . . . South River, Waynesboro, Augusta Co., Virginia. (Faxon) (to Shenandoah and Potomac)." This choice of type locality seems inadmissible, for no member of the species *C. l. longulus* has been found since in the Potomac drainage. Neither Girard (loc. cit.) nor Hagen (1870, p. 78) mentions the presence of a lateral spine on the type specimen, but Hagen does note that between the fingers there "is a large bunch of hairs." From this combination of characteristics, it would seem more likely that Girard's type came from the James drainage, east of the Blue Ridge.

Synonymical reassignments.—On the basis of available data, many collections (listed below), previously recorded as *C. l. longulus*, now must be reassigned either to another species or to the subspecies *C. longulus longirostris* or *C. l. chasmodactylus*. Inappropriate names and/or localities are so indicated in the synonomy.

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[2] Copies may be obtained by writing to the author or to the U.S. National Museum, where these data are on file (no 254736) in the office of the Registrar.

List I

(Forms recorded as *C. l. longulus* that must be relegated to other species)

Faxon, 1890.	1. Waynesboro, Potomac River—no *C. longulus* are known from this drainage.
Harris, 1903.	2. A compilation of data, repeating the errors after Faxon 1884–1890.
Ortmann, 1913.	3. "Shenandoah River (Faxon)," Potomac drainage—see 1 above.
Ortmann, 1931.	4. As in Ortmann 1913—see 3 above.
Fleming, 1938.	5. Errors as in Faxon to 1914.

List II

(Forms recorded as C. *l. longulus* that must be relegated to C. *l. chasmodactylus*)

Faxon, 1890.	1. Wytheville, Va. (New River).
	2. Reed Creek, Wytheville, Va. (New River).
Hay, 1899.	3. Hay derived his key on the basis of known collections that include *C. l. chasmodactylus*.
Harris, 1903.	4. See list I, no. 2.
Ortmann, 1905.	5. Errors as in Faxon through 1898.
Ortmann, 1913.	6. Upper Kanawha River (presumed to be New River drainage; if not, this collection then belongs in list I).
	7. Greenbrier River (New River).
	8. New River.
Faxon, 1914.	9. Greenbrier River (New River).
	10. Bluestone River (New River).
Newcombe, 1929.	11. A compilation, errors as in Faxon, 1914 (list II, nos. 9, 10).
Ortmann, 1931.	12. A listing of known localities, errors as in Faxon, 1890 (list I, no. 1) and Ortmann, 1913 (list II, nos. 6, 7, 8).
Fleming, 1938.	13. Errors as in Faxon to 1914.
Hobbs, 1959.	14. According to collections on which Hobbs key was based, part of C. *l. longulus* belongs here.

List III

(Forms recorded as *C. l. longulus* that must be relegated to *C. longulus longirostris*)

Faxon, 1890.	1. South Fork of Holston River (Tennessee River)—*C. l. longulus* is entirely absent from Tennessee and the Tennessee River system.
	2. Spring Creek to French Broad River.
	3. Watauga River (Holston River).
	4. Knoxville, Tenn.
	5. Eastern Tennessee.
	6. Holston River drainage system.

Faxon, 1898.	7. Tennessee, Cumberland Gap.
	8. Tennessee, Tazewell.
	9. Tennessee, Greeneville.
	10. Tennessee, Knoxville.
Harris, 1903.	11. See list I, no. 2.
Ortmann, 1905.	12. Errors as in Faxon to 1898.
Ortmann, 1913.	13. Holston and Clinch River systems—corrected by Ortmann, 1931.
Brimley, 1938.	14. Lists both *C. l. longulus* and *C. longulus longirosilis*—both are *C. longulus longirostris* from French Broad drainage.
Fleming, 1938.	15. Errors as in Faxon to 1914.
Hobbs, 1959.	16. These forms of *C. l. longulus* from Tennessee and the Tennessee River system in southwestern Virginia are *C. longulus longirostris.*

List IV

(Other synonymical records not fitting into lists I, II, III)

Hagen, 1870	1. "A female type of *C. longulus* . . . differs from *C. Bartonii* in having its hands smooth . . . I think it is *C. Bartonii*"—This specimen more logically belongs to *C. l. longulus.*
Faxon, 1914	2. "I have seen an interesting lot of specimens (from above Kanawha Falls) that combine the characters of *C. b. montanus* and *C. b. longulus.* . . . These specimens are in the U.S. National Museum, No. 23990, and in the Museum of Comparative Zoology, No. 7401."—Having examined the former collection, the present writer, although uncertain of its specific status, excludes the above from the *C. longulus* group.

Coloration and color pattern.—Most *C. l. longulus* are concolorous, usually a brown or green with shades of ivory to tan beneath. A mottled pattern is known from two widely separated localities (fig. 2*c*). One, the Swift Run, a tributary of the North Fork of the Rivanna River (James drainage) in Greene County, Va. (map 2, no. 50) is entirely of the brown phase (orange to dark brown). The other mottled pattern is found in some tributaries of the Smith and South Mayo Rivers (Dan River to Roanoke drainage) in Patrick County (map 2, nos. 65–70); these are variously colored within individual populations. Colors range from yellow orange through shades of green and brown and, like the James River specimens, have their underparts tinted ivory to tan. It would appear that the background color of these mottled "Roanoke *longulus*" is in shades of tan and that only the mottling seems to vary. These two very similarly patterned and colored populations of crayfish occur in streams almost 125 miles apart.

Cambarus longulus longirostris Faxon

Cambarus Bartonii var. *longirostris*.—Faxon, 1885a, Mem. Mus. Comp. Zool., vol. 3, p. 64; 1885a (part), p. 64; 1885b, p. 358; (as *C. bartonii longirostris*); 1890, pp. 623, 624; 1898 (part), p. 649.—Harris, 1903 (part), pp. 58, 75, 154.—Ortmann, 1905 (part), pp. 128, 129, 135.—Faxon, 1914, pp. 389, 424.—Newcombe, 1929, p. 286.

Cambarus bartonii spinirostris.—Faxon, 1890, pp. 623, 624.

Cambarus longulus.—Faxon, 1890 (part), pp. 623, 624; 1898 (part), p. 650.—Harris, 1903 (part), pp. 58, 107, 138, 154, 155, 159.—Ortmann, 1913 (part), pp. 335, 337, 362, 375.—Fleming, 1938, pp. 299, 300, 301.—Brimley, 1938, p. 502.—Hobbs, 1959 (part), p. 898;

Cambarus longulus longirostris.—Hay, 1899, pp. 959, 966; Johnson, 1957, pp. 178, 182; 1959, pp. 181, 183.—Hobbs, 1959 (part), p. 898.

Cambarus (*Cambarus*) *longulus longirostris*.—Ortmann, 1931 (part), pp. 121–124.

Cambarus longerosilis Brimley, 1938, p. 503.

Diagnosis.—Concolorous in shades of blue green through orange, or bicolorous with two dark dorsal saddles of varying widths; one on posterior part of carapace and the other immediately cephalic to cervical groove (figs. 2*a,b*). Rostrum with strongly swollen margins, without spines or tubercles, abruptly tapering to moderately short acumen, length .78–1.1 (average 1.0) times postorbital width. Suborbital angle and postorbital spines and ridges strong (pl. 1*r*). Branchiostegal spines and lateral spines or tubercles on carapace absent. Length of areola 2.3–5.9 (average 4.0) times width, 30–39 (average 36) percent of length of a carapace, and with 3–10 punctations across narrowest part (average 7–8). Antennal scale 1.7–3.0 (average 2.3) times longer than broad. Chela mostly as in *C. l. longulus* (pl. 1*n,o*), length of outer margin of chela 1.5–1.8 (average 1.7) times length of dactyl and 2.6–4.4 (average 3.1) times length of inner margin of palm, length of dactyl of chela 1.5–3.0 (average 1.9) times length of inner margin of palm, and width of palm .52–.88 (average .72) times length of dactyl. First pleopod of first-form male as pictured (pl. 1*f,g*).

Remarks.—Faxon (1885a, p. 64) indicates that his collection of three specimens"from Cumberland Gap (Claiborne Co., Tenn.) have well-marked lateral spines on the carapace." Since the chela of this Powell River form differs from that of the typical *C. longulus*, it is, presumably (awaiting further data), other than the species *C. longulus*. Some specimens of *C. longulus longirostris* do have a minute tubercle in place of the lateral spine.

Little difference exists between *C. longulus longirostris* and the other two subspecies. Variations in all characteristics thus far observed, exclusive of the suborbital angle, overlap to some degree those of the other subspecies: average ratios calculated for *C. longulus longirostris* usually lie midway between those calculated for *C. l.*

longulus and *C. l. chasmodactylus.* The setaceous tuft at the base of the immovable finger of the chela may be present or absent but, as in *C. l. longulus,* it seems to be consistent within a population; older, late intermolt animals do not seem to lose the tuft of setae as readily as do those of *C. l. longulus* or *C. l. chasmodactylus.* Most *C. longulus longirostris* are larger than *C. l. longulus* and smaller than *C. l. chasmodactylus.* The largest, a first-form male, has a carapace that measures 43 mm. in length and a chela, 56 mm. long. Both color and color pattern vary in different parts of the range; figures 2*a,b* illustrate two of the pattern variations. Neither *C. l. longulus* nor *C. l. chasmodactylus* possesses the vivid saddle pattern seen in so many *C. longulus longirostris* populations, particularly those orange-colored animals from Lawrence County and the less colorful individuals from the Hiwassee drainage, Tennessee. Most *C. longulus longirostris* are a blue green or brown not unlike the concolorous *C. l. longulus.*

There are so many variations in this crayfish that, beyond the presence of the suborbital angle, no characteristic has been observed that will serve to distinguish *C. longulus longirostris* from the other subspecies.

Specimens examined.—I have examined approximately 500 specimens from 113 collections taken from 97 localities in Alabama, Georgia, North Carolina, Tennessee, and Virginia. Many of these collections contain both sexes and both forms of the male.

Geographic distribution.—*Cambarus longulus longirostris* is confined to tributaries of the Tennessee and Coosa Rivers. Reports from the Clinch River, "West Virginia" are erroneous; the Clinch River, Tennessee drainage, does not extend into West Virginia; one need only note this location to know that Faxon erred and probably meant Clinch River in western Virginia. The northern limit appears to be in the upper Clinch (map 2, no. 202), Tazewell County, Va.; its southernmost boundary is Will's Creek (Coosa drainage) (map 1, no. 96), DeKalb County, Ala. Having recorded five collections from Will's Creek in DeKalb County, I believe it is highly probable that this is the locality meant by Faxon (1898, p. 649), not "Will's Creek, *Pollard, Escambia Co.* [italics mine], Alabama." I have no knowledge of a Will's Creek in Escambia County. Ortmann (1931, p. 123), assuming that the county listed by Faxon was correct, notes this record as being "extremely doubtful" giving instead as the southernmost locality, Catoosa County, Ga. (Tennessee River drainage). Two collections from Lawrence County, (map 1, nos. 209, 210) and one from Lauderdale County, Ala. (map 1, no. 98) mark the westernmost limit of the range. Although many collections have been made both east and west of the southwestern localities, no *C. longulus longirostris* has been found closer than those collected from Marion

County, Tenn. (map. 1, nos. 143–145). It would seem that here the ecologically restricted *C. longulus longirostris* has been forced into its isolated strongholds by the invasion of members of the genus *Orconectes*. It is probable that these western records, especially those of Lawrence County, Tenn., are relict populations. No ecological data are available for the Lauderdale, Ala. specimens, although I suspect they would conform to those of Lawrence County. The northeastern limit is marked by the North Fork of the Holston River, Bland County, Va. (map. 2, no. 186).

That the three subspecies of *C. longulus* are allopatric is clearly evidenced where the headwaters of separate drainage systems interdigitate. For example, White Top Creek (map 2, near no. 195) northeast of Konnarock, in Smyth County, Va. (Holston drainage), in which *C. longulus longirostris* is found, is less than a mile from Lewis Creek (map 2, no. 248) near Troutdale, Grayson County (new drainage) where *C. l. chasmodactylus* occurs.

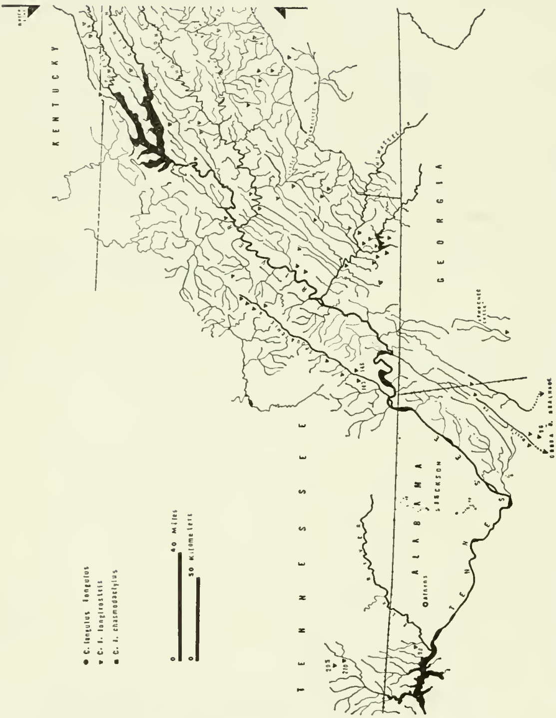
In many localities *C. longulus longirostris* is particularly abundant; in one such locality (map 2, no. 195), Big Laurel Creek, Smyth County, Va., Hobbs (personal communication) collected 99 specimens in a single seine haul over approximately 100 square feet.

Ortmann (1931, p. 123) wrote that *C. longulus longirostris* had "not been found in the Tennessee River below Knoxville, and the mouth of the Clinch, nor in its eastern tributaries (Little River, Little Tennessee, and Hiawassee [sic] Rivers)." I have recorded specimens from Louden County (below Knoxville), Roane County (below the mouth of the Clinch); Monroe County (Little Tennessee), McMinn, Bradley, and Polk Counties (Hiwassee); also previously unrecorded are localities in Lawrence County, Tenn., Lauderdale County, Ala., and Armuchee Creek, Floyd County, Ga. (Coosa drainage).

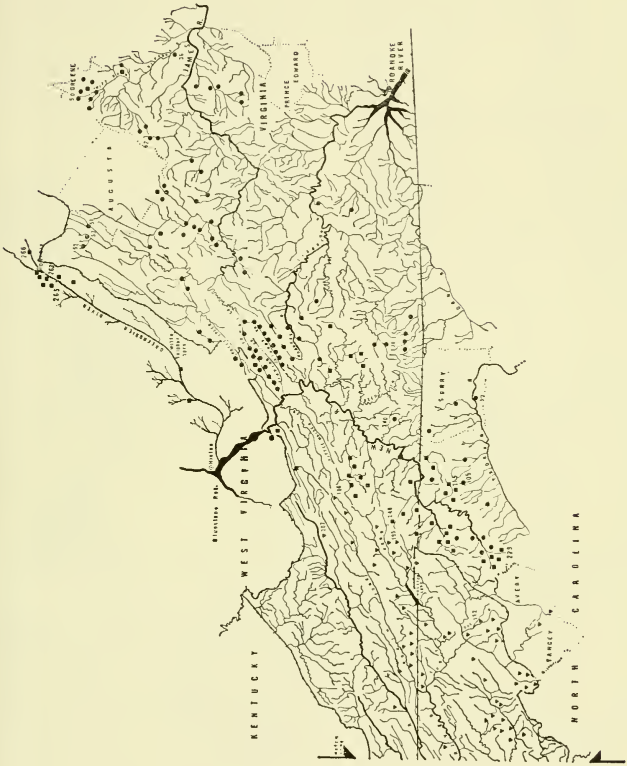
Faxon's type locality (1885b, p. 358) is "Doe River, Elizabethon, Carter County, Tenn.," from which he had three females. Ortmann (1931, p. 121), Hobbs, and Holt subsequently have collected specimens from this locality (map 2, no. 112).

The only incorrect listing of *C. longulus longirostris* of which I am aware is "Cumberland Gap" (Faxon, 1885a), as previously discussed. This locality has been repeated in Faxon (1898), Harris (1903), and again in Ortmann (1931). The error is logical; except for the difference in chelae and the presence of lateral spines on the carapace, this form is superficially much like *C. longulus longirostris*.

Those locality records listed by previous authors for *C. l. longulus* that actually apply to *C. longulus longirostris* are included in list III, p. 7.



MAP 1.—Distribution and range of *Cambarus longulus* (numbers refer to collection localities).



Map 2.—Distribution and range of *Cambarus longulus* (numbers refer to collection localities).

***Cambarus longulus chasmodactylus*, new subspecies**

Cambarus Bartonii Hagen, 1870 (part), p. 76.—Faxon, 1885a (part), pp. 60, 61.
Cambarus longulus Faxon, 1890 (part), pp. 623, 624.—Ortmann, 1913 (part), pp. 335, 337, 375.
Cambarus longulus longulus.—Hay, 1899 (part), pp. 959, 966.—Hobbs, 1959 (part), p. 898.
Cambarus bartonii longulus.—Harris, 1903 (part), pp. 58, 107, 138, 146, 148, 154, 155, 159.—Faxon, 1914, p. 389, 390.—Newcombe, 1929, map, pp. 268, 278, 280, 286.
Cambarus (*Bartonius*) *longulus*.—Ortmann, 1905 (part implied), pp. 120, 122, 128, 129.
Cambarus (*Cambarus*) *longulus longulus*.—Ortmann, 1931 (part), pp. 106, 107, 108, 118–121, 123, 128, 134–136.
Cambarus subspecies.—Johnson, 1957, pp. 178, 182; 1959, pp. 181, 183.

Diagnosis.—Concolorous, blue green tinged with shades of cream to rust. Rostrum with strongly swollen margins, without marginal spines or tubercles, acumen tapering abruptly to upturned apex, with a punctate depression posteromedially; length of rostrum 1.5–2.2 (average 1.9) times longer than wide; .69–1.1 (average 1.0) times postorbital width and .17–.28 (average .23) times carapace length. Suborbital angle and branchiostegal spines absent, lateral spines absent except in specimens from one locality in Carroll County, Va. (map 2, no. 240); postorbital ridges and spines strong, cheeks with scattered low tubercles. Areola 3.5–6.0 (average 4.4) times longer than broad, length 34–37 (average 27) percent of length of carapace and with 4–10 (average 6–7) punctations across narrowest part. Antennal scale 1.6–2.7 (average 2.2 times longer than broad), spine strong. Inner margin of palm of chela with a row of squamous tubercles, remainder smooth; all surfaces with scattered, deep punctations, some on dorsal surfaces form linear rows. Palm broad, fingers of adults intensely gaping, meeting only at tips; immovable finger, subtriangular in cross section, with basal tuft of plumose setae, frequently reduced or absent in adult forms (pl. 1*y*,*z*) but present in all juveniles (pl. 1*w*,*x*); dactyl ovate to subcylindrical in cross section. Both fingers with single row of low tubercles on opposable surfaces, single tubercle near distal end of immovable finger often enlarged. "Hook" of proximomesial angle in inner margin of palm weak or obsolete, forming with carpus a deep weakly curved obtuse angle (pl. 1*zz:* C); length of inner margin of palm (pl. 1*zz:* A) of fully extended chela less than twice that of distance between spine of carpus and proximal extremity of inner margin of palm (pl. 1*zz:* B). Width of palm .48–.74 (average .61) times length of dactyl, length of outer margin of chela 2.6–4.7 (average 3.6) times length of inner margin of palm and 1.2–1.8 (average 1.6) times greater than length of dactyl. First pleopod of first- and second-form males and annulus ventralis of fe-

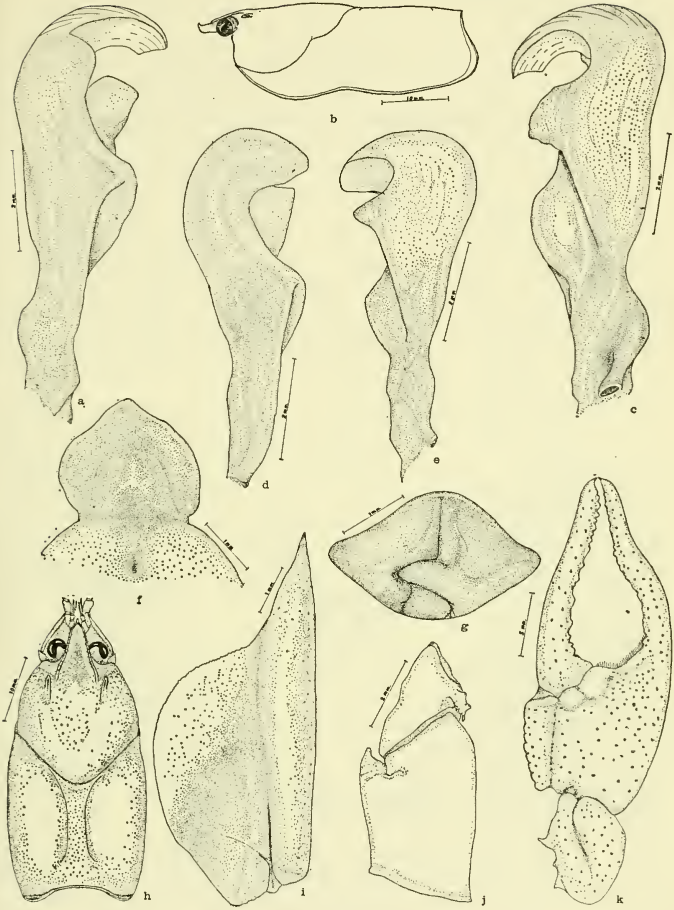


FIGURE 1.—*Cambarus longulus chasmodactylus*, new subspecies: *a*, lateral view of first pleopod of first-form male; *b*, lateral view of carapace; *c*, mesial view of first pleopod of first-form male; *d*, lateral view of first pleopod of second-form male; *e*, mesial view of first pleopod of second-form male; *f*, epistoma; *g*, ventral view of annulus ventralis; *h*, dorsal view of carapace; *i*, upper surface of right antennal scale; *j*, basipodite and ischiopodite of third right pereiopod of first-form male; *k*, upper surface of right chela and carpus of first-form male.

male imperceptibility different from *C. l. longulus* (pl. 1*d,e,u;* figs. 1*a,c–e,g*).

Holotype male, form i.—Body about 1.5 times broader than deep. Greatest width of carapace at level of midlength of areola (21.4 mm.). Abdomen shorter than carapace (34.0 and 39.7mm.) and narrower (16.0 and 21.4). Areola about 4.1 times longer than broad with six punctations across narrowest part. Cephalic section of carapace about 1.6 times length of areola. Areola about 38 percent of entire length of carapace (figs. 1*b,h*).

Rostrum with thickened margins, without marginal spines or tubercles, gently tapering, dorsally concave with deep punctations scattered in caudally situated oval depression; rostrum with thickened, cephalically converging margins forming an indistinct acumen with upturned apex, a row of setaceous punctations along mesial base of thickened margins. Subrostral ridges weak but visible along entire length of rostrum in dorsal aspect.

Postorbital ridges conspicuous, terminating cephalically in a small corneous spine; grooves of postorbital ridges well developed and bearing fine setae. Suborbital angle obsolete, replaced by a slight rounded projection just above level of base of antenna. Branchiostegal spine reduced to a small angular prominence. Carapace without lateral spines. Upper surface of carapace and lateral portion of branchiostegites punctate. Few granulations on lateral surface immediately caudal to cervical groove, but many on cephalolateral regions.

Cephalic section of telson with two spines in each caudolateral corner. Epistome with a slight cephalomedian projection (fig. 1*f*).

Antennules of usual form with a strong spine present on ventral side of basal segment. Antennal scale broadest just proximal of midlength, with outer distal margin terminating in a long, acute, corneous spine.

Right chela (fig. 1*k*) conspicuously punctate above and below, flattened, and about twice wider than deep (20–10 mm.). Inner margin of palm with single median row of nine squamous tubercles scarcely rising above contour of margin; longitudinal row of deep punctations present above and lateral to row of squamous tubercles. Upper surface of palm with two large tubercular swellings at base of dactyl. Immovable finger strongly convex laterally and without well-defined grooves or ridges; proximal half subtriangular in cross section, distal half ovate; basal portion almost as deep as wide; opposable margin with a tuft of setae proximally and with a more distal row of 16 rounded, corneous tubercles; larger tubercle present just below tubercular row and slightly distal to midlength; a row of minute denticles on distal third of opposable margin just ventral to row of tubercles. Dactyl convex mesially along proximal two-thirds and without ridges or grooves. Concave opposable margin with row of 18 rounded corneous tubercles and distal third with a row of minute denticles ventral to tubercular row.

Carpus of right pereiopod longer than broad (14.0–10.5 mm.), with a deep longitudinal furrow above. Dorsal and lateral surfaces punctate; mesial surface with one large spinous tubercle near mid-length and a much smaller one proximally; ventral surface with two tubercles on distal margin.

Merus of first right pereiopod punctate laterally and mesially. A small tubercle near upper distal margin. Lower surface with a row of eight tubercles mesially (the two most distal enlarged and spinous), and two laterally.

Hooks on ischiopodites of third pereiopods only (fig. 1*j*); hooks heavy and projecting proximally a little beyond distal end of basipodite. Coxae of fourth pereiopods with caudomesial swollen prominences.

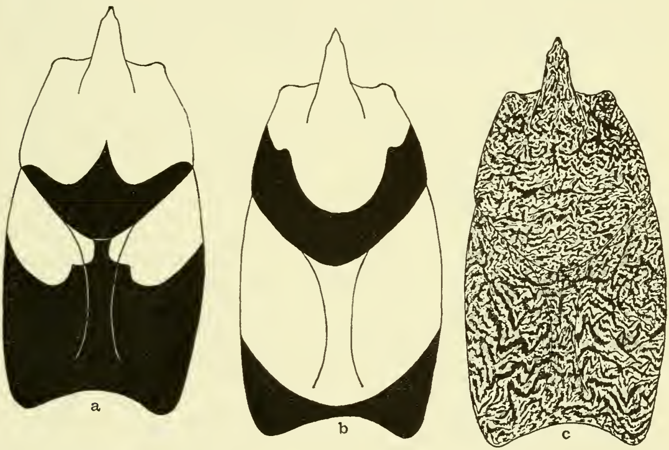


FIGURE 2.—*a*, Saddle pattern of "orange phase" of *Cambarus longulus longirostris* from Lawrence County, Tenn.; *b*, saddle pattern of the less colorful phase of *C. longulus longirostris* from Hiwassee drainage system in Polk County, Tenn.; *c*, a mottled phase of *C. l. longulus* from Dan River headwater (map 2, no. 70).

First pleopod reaching coxopodite of third pereiopod when abdomen is flexed. Tip terminating in two parts (figs. 2*a*, *c*); mesial process bulbous, noncorneous, bent caudolaterally and bearing a minute spine at its tip. Slight shoulder on lateral surface arising gradually from base of central projection.

Morphotype male, form ii.—Differs from the holotype as follows: Cephalic section of telson with three spines in right and two in left caudolateral corners. Minute spinelike tubercle on left side of carapace immediately caudal to cervical groove. Areola with seven punctations across narrowest part. Inner margin of palm of chela, with a row of six squamous tubercles; opposable margin of immovable finger with 17 tubercles and that of dactyl with 19. Upper distal portion of merus with two tubercles and lower surface with a mesial row of ten tubercles. Hooks on ischiopodite of third pereiopods much reduced in size. First pleopod without corneous elements (figs. 1*d*, *e*); swollen prominence of fourth pereiopods smaller.

Allotype female.—Differs from the holotype as follows: Areola with five punctations across narrowest part. Opposable margin of immovable finger of right chela with 13 rounded tubercles, and that of dactyl with 15. Upper distal portion of left merus with two tubercles and lower surface with mesial row of seven. Rhomboid annulus ventralis with a high V-shaped ridge caudally and a medial longitudinal trough, deepest at apex of bend in sinus; sinus originates at caudal end of trough, makes a V-shaped arc dextrally and then bends caudally cutting midcaudal margin of annulus (pl. 1*u*; fig. 1*g*).

Measurements (in millimeters) of *C. l. chasmodactylus* are as follows:

	holotype	*allotype*	*morphotype*
rostrum			
length	9.1	8.4	8.3
width	4.5	4.3	4.2
postorbital ridges (distance between)	9.1	8.5	8.9
carapace			
maximum depth	14.3	14.0	15.0
maximum width	21.4	20.0	21.6
length	39.7	36.5	38.8
cephalic length	24.2	22.0	24.0
areola			
length	15.2	14.1	14.9
width	3.7	2.6	3.4
abdomen			
length (including telson)	34.0	34.5	35.0
width (at widest part)	16.0	17.7	16.6
antennal scale			
length	5.1	5.1	5.6
width	2.5	2.5	2.6
right chela			
palm width	20.0	14.0	17.5
palm depth	10.0	7.5	8.8
inner margin of palm length	13.6	9.1	11.7
right chela hand (outer margin)			
length	47.2	32.0	42.9
length of dactyl	29.0	20.6	27.8
right carpus			
length	14.0	9.0	12.0
width	10.5	8.0	9.0

Ratios of measured characters of *C. l. chasmodactylus* are as follows:

	holotype	*allotype*	*morphotype*
carapace W/L	1.50	1.40	1.44
L of cephalic part of carapace; areola L	1.59	1.56	1.61
Rostrum L/carapace L	.23	.23	.21
Rostrum L/W	.20	.20	.20
Rostrum L/postorbital width	1.00	.99	.94
areola L/W	4.10	5.40	4.40
areola L/carapace L	.38	.39	.38
antennal scale L/W	2.40	2.00	2.20
palm of chela W/L of dactyl	.69	.68	.63
hand of chela L/L inner margin of palm	3.50	3.50	3.70
hand of chela L/L of dactyl	1.60	1.60	1.50
dactyl of chela L/L inner margin palm	2.10	2.30	2.40

Type-locality.—"East Fork of the Greenbrier River 9.7 mi. W. of Virginia State line on U.S. Hwy. 250, Pocahontas County, West Virginia [map 2, no. 263]. Here the river is between 50 and 100 feet in width and up to 3 feet in depth. Its slightly clouded water flows sluggishly to moderately over tilted bed rock strata on which are strewn many stones and a considerable amount of silt. The crayfish are abundant and lie concealed beneath the loose rocks" (Hobbs, pers. comm.).

Disposition of type.—The holotype male (USNM 115513), allotype female (USNM 115514), and the morphotype male (USNM 115516) are deposited in the U.S. National Museum. Of the remaining 161 paratypes (USNM 115515), 17 males, Form I, 5 males, Form II, 16 females, 3 juvenile males, and 2 juvenile females are also in the U.S. National Museum; 7 males, Form I, 5 males, Form II, and 1 female are in: (a) Museum of Comparative Zoology, Harvard; (b) the collection of G. H. Penn, Tulane University; (c) the collection of Alejandro Villalobos, Institute de Biologia, Mexico, D.F.; and (d) 2 males, Form I, 2 males, Form II, 2 females, and 1 juvenile male are in the collection of the author at the University of Bridgeport, Bridgeport, Conn.

Remarks.—Ortmann (1931, p. 120) was aware of the differences between *C. l. longulus* and *C. l. chasmodactylus* and wrote that in those "specimens from the New River drainage . . . the moveable finger may be over twice as long as the inner margin of the palm." This has been a completely reliable characteristic for distinguishing all the normal (chelae unregenerated) specimens I have seen.

On the basis of Faxon's work (1885a, pp. 60, 61; 1890, p. 623), I suspect that Hagen's "Greenbrier River" record (1870, p. 76) is *C. l. chasmodactylus*, but I do not have sufficient information to synonymize it. Further investigation may identify the above as well as Faxon's records of "Reed Creek, West of Wytheville, Wythe Co., (Virginia)"; and those "near White Sulphur Springs, Greenbrier Co., West Va." (1885a, pp. 60, 61) as *C. l. chasmodactylus*.

While *C. l. longulus* is the most variable of the subspecies, *C. l. chasmodactylus* appears to be the most stable. Little or no differences occur between even widely separated populations. One exception is the collection of nine specimens from Carroll County, Va., in which all juveniles and adults (as well as males and females) possess strong lateral spines on the carapace. This collection (map 2, no. 240) was made in a tributary of Crooked Creek (New River drainage). All other specimens including those from Reed Island Creek, an adjacent tributary to the New River, lack these lateral spines. Additional collecting in this area will be necessary before further comment may be made.

The largest available specimen of *C. l. chasmodactylus* is a female with a carapace length of 55 mm.; the largest chela I have seen measures 78 mm. in length by 26.5 mm. in width; only the hand of this animal is available. Size, however, must be disregarded as a diagnostic feature since many first-form males have a carapace length as little as 30 mm. and, as noted, the largest first-form male of *C. l. longulus* (the smallest of the subspecies) is 34 mm.

Specimens examined.—I have examined approximately 275 specimens in 56 collections from 44 localities; all are confined to the New River drainage system of North Carolina, Virginia, and West Virginia.

Entirely confined to the New River system, the known range of *C. l. chasmodactylus* extends northward to the upper reaches of the Greenbrier River in West Virginia (map 2, nos. 261–268); the most southern record is from Watauga County, N.C., in the headwaters of the South Fork of the New River (map 2, no. 229). Both eastern and western boundaries are formed by those Appalachian Mountains delimiting the New Valley.

There appears to be complete geographic isolation between this and the other two subspecies. In Alleghany County, N.C. (map 2, no. 215), *C. l. chasmodactylus* was collected from a tributary of the New River only a few miles from where *C. l. longulus* was collected in the Yadkin drainage in Wilkes County (map 2, no. 105), but nowhere in the entire range is there evidence of sympatry.

Ecological Distribution

The general habitat of the species *Cambarus longulus* has been noted by various investigators (Ortmann, 1913, pp. 375, 376; 1931, pp. 119, 123; Hobbs, 1950, p. 349; Reid, 1961, p. 249). Members of *C. longulus* are highly restricted stream or river inhabitants that live under or between rocks, away from the shore, in moderate to swiftly flowing, cool to cold water. The species does not, from all accounts, frequent quiet pools, springs, or mountain "feeder brooks." Stream beds are typically of rock-strewn sand or gravel and relatively free of silt deposits.

Most specimens of *C. l. longulus* were taken from riffle areas in the lower mountain or upper piedmont streams. The water, clear or comparatively so, ranges from 2°–24° C. The current, over riffles, has been recorded as moderate to rapid. In streams with both pool and riffle areas, *C. l. longulus* was found only in the riffles. Stream beds of sand or gravel and strewn with rocks are characteristic of the habitats in which this crayfish usually is found. The size of the stream seems to have little, if any, influence on whether or not *C. l. longulus* frequents it.

The subspecies *C. l. chasmodactylus* varies from the typical subspecies in seeming to prefer larger, often turbulent streams. It is found abundantly in Reed Creek, Wythe County, Va.; typically, this animal, as described by Ortmann (1931, p. 119) lives "in the usual way under stones in *flowing water* [italics mine]."

Of the three subspecies, *C. longulus longirostris* is by far the least ecologically restricted. A cursory examination of the wide distribution (maps 1, 2) should suggest the apparent adaptability of this crayfish to the larger streams and rivers as well as to the smaller tributaries. In McMinn County, Tenn., it was found to be numerous in beds of *Nasturtium* sp. in a spring run; nearby, occasional animals were found in debris littering a stream bed of silt and sand, where there were but few rocks.

Serological Affinities

Johnson, in 1957 and again in 1959, using agar diffusion and tube precipitation techniques, serologically compared, among others, the three subspecies of *Cambarus longulus* (*Cambarus* sp. = *C. l. chasmodactylus*). Antigen (crayfish serum) and antibody (rabbit anti-crayfish serum) reactions, when compared (1957, p. 182; 1959, p. 183), indicate the close affinities of the three.

Summaries of Ratios

The tabulation below summarizes the collective quantitative data (figures of each column represent ratios of measurements of selected characters; upper row, minimum ratio; middle, maximum; lower, average):

Characteristic Ratio	*longulus*	*longirostris*	*chasmodactylus*
	0. 10	0. 19	0. 17
rostrum L/carapace L	0. 26	0. 28	0. 28
	0. 20	0. 22	0. 25
	1. 1	1. 3	1. 5

Characteristic Ratio	*longulous*	*longirostris*	*chasmodactylus*
rostrum L/W	2. 2	2. 3	2. 2
	1. 6	1. 8	1. 9
	0. 40	0. 78	0. 69
rostrum L/post orbital	1. 1	1. 1	1. 1
W*	0. 95	1. 0	1. 0
	2. 3	2. 3	3. 5
areola L/W	5. 9	5. 9	6. 0
	3. 5	4. 0	4. 4
	0. 20	0. 30	0. 34
areola L/carapace L	0. 42	0. 39	0. 47
	0. 37	0. 36	0. 37
	1. 7	1. 7	1. 6
antennal scale L/W	3. 2	3. 0	2. 7
	2. 5	3. 3	2. 2
	0. 53	0. 52	0. 48
palm W/dactyl L	1. 0	0. 88	0. 74
	0. 80	0. 72	0. 61
	1. 5	2. 6	2. 6
hand of chela L/inner	3. 6	4. 4	4. 7
palm margin L	2. 7	3. 1	3. 6
	1. 0	1. 5	1. 2
hand of chela L/dactyl	2. 6	1. 8	1. 8
L	1. 7	1. 7	1. 6
	1. 3	1. 5	2. 0
dactyl of chela L/inner	2. 0	3. 0	3. 4
palm margin L	1. 6	1. 9	2. 4

*Distance between anterolateral margins of postorbital spines or ridges.

Summary

As a result of the present study, three allopatric subspecies of *Cambarus longulus* Girard have been recognized. *Cambarus longulus longulus* is found in the lower mountain and piedmont streams of the Atlantic drainage, from the James south to the Yadkin Rivers. *Cambarus longulus chasmodactylus,* herein described, is restricted to the New River system from North Carolina to western West Virginia. *Cambarus longulus longirostris* frequents the Tennessee drainage system above Wilson reservoir, and the Coosa River drainage in northwestern Georgia and eastern Alabama.

Although all three subspecies are associated with riffle areas of lotic habitats, *C. longulus longirostris* appears to have a broader ecological tolerance than do the two other subspecies.

While *C. l. chasmodactylus* exhibits few variations throughout its range, *C. l. longulus,* perhaps because of its low vagility, has within its range several recognizable local populations.

It is concluded that these three crayfishes represent offshoots of a common stock which, while believed to be not too far removed from the primitive members of the genus, have become, for the most part, ecologically, highly specialized for life in restricted areas of "young" but not "infant" streams.

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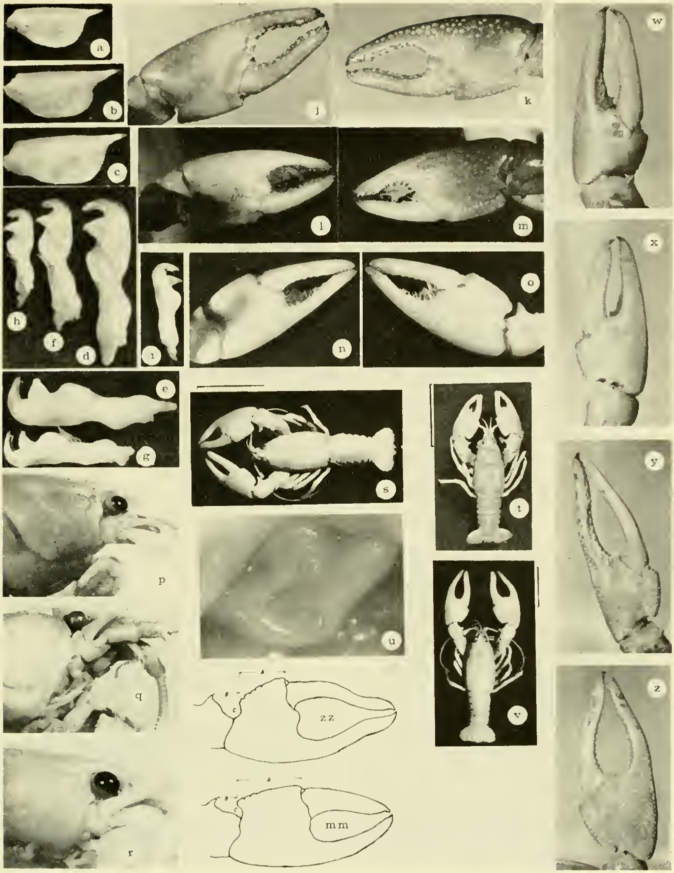

Cambarus longulus longulus: a, dorsal view of antennal scale; *j*, *l*, lower surface of chelae showing extreme variation in setaceous condition; *k*, *m*, upper surface of same; *h*, mesial view of first pleopod of first-form male; *i*, lateral view of same; *p*, lateral view of cephalic region of carapace; *t*, dorsal view of first-form male. *C. longulus longirostris: c*, dorsal view of antennal scale; *f*, *g*, first pleopod of first-form male; *n*, *o*, chelae; *r*, lateral view of cephalic region of carapace; *s*, dorsal view of first-form male. *C. longulus chasmodactylus*, new subspecies: *b*, antennal scale; *d*, *e*, first pleopod of first-form male; *q*, lateral view of cephalic region of carapace; *u*, annulus ventralis (typical of all *C. longulus*); *v*, dorsal view of holotype; *w*, *x*, lower and upper surface of chela of juvenile; *y*, *z*, lower and upper surface of chela of adult; *zz*, upper surface of chela showing key characteristics (compare with *C. l. longulus*, fig. *mm*.). (Scale line equals 30 mm. where given; other photographs not to scale.)

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THE LIZARDS OF ECUADOR, A CHECK LIST AND KEY

By James A. Peters
Curator, Division of Reptiles

This paper constitutes the second of a series devoted to the establishment of a framework upon which additional studies on the ecology and zoogeography of the Ecuadorian herpetofauna can be based. The first paper dealt with the snakes (J. Peters, 1960), and later studies will be concerned with the amphibians. The principle established in the earlier list has been abrogated, at least in part, since I have been forced to revise the genus *Ameiva* strictly on the basis of the Ecuadorian political unit. But I repeat my earlier opinion that such analyses are dangerous and can easily result in perpetuation of difficulties.

Methods

The method of organization in this check list is the same as that of the list of Ecuadorian snakes (J. Peters, 1960). The genera are presented alphabetically, and the species are alphabetical within their genus. It is, I think, true that the average user of the list will be interested in ease and speed of use, not in my contribution to the intricacies of the higher categories of lizard classification (the basic phylogenetic position of the genera concerned is presented on p. 3). For each taxon I have presented a very brief synonymy, beginning with a citation to the original description of that taxon and its type locality, plus the holotype and its location in parentheses. Similar citations and information are included for all taxa described from Ecuador that have been synonymized with other species. I have attempted to include all erroneous records in the literature based upon Ecuadorian specimens, listing them within the synonymy of the species to which they properly belong under the name used by the author, and separated from the citation by a period and dash. Obviously, this is impossible where the specimens have not yet been reexamined, either by myself or by someone discussing them in print, and without question some erroneous identifications have served as the basis for inclusion of some taxa within this list.

An asterisk following either a generic or specific name indicates that that taxon has not yet been collected in Ecuador. In all cases there is reason to anticipate the occurrence of these taxa in Ecuador, but it should never be assumed that all likely members of the fauna have been anticipated. The failings attendant upon all keys exist here as well. Keys must be written on the basis of the known or expected variation, and it is impossible to include all of the individual divergencies from type of which the genome is capable. Merely to reach a name does not put the final stamp of adequate identification on the specimen, but only provides the basis for a thorough check against the available descriptions and comparative material. Two species may share all of the characters utilized in the dichotomies and still be strikingly different from one another.

The catalog number assigned to the type specimen or series is given in parentheses following the citation. The abbreviations used refer to the following museums:

AMNH	American Museum of Natural History, New York.
ANSP	Academy of Natural Sciences, Philadelphia.
BerM	Zoologisches Museum, Berlin, Germany.
BM	British Museum (Natural History), London.
GottM	Göttingen Museum, Göttingen, Germany.
HM	Zoologisches Museum, Hamburg, Germany.
IRB	Institut Royale d'Histoire Naturelle de Belge, Brussels.
LeyM	Museum, Leyden, Netherlands.
MCZ	Museum of Comparative Zoology, Harvard University, Cambridge, Mass.
MunM	Zoologische Sammlung des Bayerischen Staates, Munich, Germany.
PM	Muséum National d'Histoire Naturelle, Paris, France.
RMS	Royal Museum, Stockholm, Sweden.
TurM	Turin Museum, Italy.
UMMZ	University of Michigan Museum of Zoology, Ann Arbor.
USNM	United States National Museum, Washington, D.C.
VM	Naturhistorisches Museum, Vienna, Austria.

Classification

Since the check list is arranged entirely on an alphabetical basis to facilitate quick and effective use, it tells nothing about the relationships and phylogenetic position of the genera and species. The list below will fill this gap, placing the genera in their familial positions. It will be noted that I have not indicated position of the families within the higher categories. This is a consequence of the dilemma posed by the two most recent reviews of lizard classification, published by Romer (1956) and by Underwood (1957). In an analysis of the Ecuadorian lizards alone I find that these authors differ either in the level of category or in the name used (or both) in 28 of 32 instances. To accept either would indicate a completely unjustified negation of the other, unless done on the basis of adequate and thorough review, which I have not undertaken. I follow Underwood (1954) in recognizing the Sphaerodactylidae as a family distinct from the Gekkonidae.

IGUANIDAE
Anolis, Basiliscus, Enyalioides, Enyalius, Iguana, Morunasaurus, Ophryoessoides, Plica, Polychrus, Proctotretus, Stenocercus, Tropidurus, Uracentron

GEKKONIDAE: GEKKONINAE
Phyllodactylus, Thecadactylus

SPHAERODACTYLIDAE
Gonatodes, Lepidoblepharis, Sphaerodactylus

TEIIDAE
Alopoglossus, Ameiva, Anadia, Arthrosaura, Callopistes, Dicrodon, Echinosaura, Ecpleopus, Euspondylus, Iphisa, Kentropyx, Leposoma, Macropholidus, Monoplocus, Neusticurus, Ophiognomon, Pholidobolus, Prionodactylus, Proctoporus, Ptychoglossus, Tupinambis

SCINCIDAE
Ablepharus, Mabuya

ANGUIDAE: DIPLOGLOSSINAE
Diploglossus

AMPHISBAENIDAE
Amphisbaena

Omissions

There are many species that have been recorded as members of the Ecuadorian fauna on the basis of erroneous identification of individual specimens. Where possible, these errors have been placed in their proper species in this check list and can be found in the index. This is based either upon a reidentification appearing in the literature, or upon my own reexamination of the specimens. In addition, however, I have presumed to omit several things, even though a recheck has not been possible. Thus, I have omitted *Ecpleopus gaudichaudii* Duméril and Bibron, which was recorded from Ecuador by F. Müller (1882, p. 157), since it is quite unlikely, although not impossible, that it actually occurs in Ecuador. The same statement applies to *Anolis pulchellus* Duméril and Bibron, which Cornalia (1849, p. 308), recorded from Guayaquil, based with little question upon a misidentification. A discussion on the occurrence of *Polychrus liogaster* Boulenger has been published earlier (J. Peters, 1959).

Acknowledgments

Again I must record my debt to friends, colleagues, and institutions whose assistance facilitates my efforts. It becomes increasingly obvious to me that completion of a work of this type is totally subject to the continued good will and cooperation of many people, and I am pleased that I continue to work without incurring their disfavor.

Dr. Gustavo Orcés-Villagomez, of the Escuela Polytecnica Nacional, in Quito, continues to provide facilities, materials, specimens, knowledge, and friendship. His constant tolerance of my faults, both while I shared his laboratory during my visits to Ecuador and while I bombard him with impossible requests during my stays at home, has never ceased to amaze me. The late Robert Copping, of the British Embassy staff in Quito, was more than congenial as a fellow collector, host, and intermediary in problems, political and otherwise. Robert Mullen and Peter Spoecker, students at Valley State College, and Manuel Olalla, an Ecuadorian citizen, spent the summer of 1962 in the field with me, enduring mule kicks, fungus infections, cold mountain passes, and occasional beer shortages, all in my behalf. Spoecker and Stephen Austin have spent many hours checking the key against Ecuadorian specimens.

M. Boesman, Doris Cochran, J. A. Cochrane, J. Eiselt, Norman Hartweg, Werner Ladiges, Edmond V. Malnate, George Myers, Thomas Uzzell, Charles Walker, and Ernest E. Williams have loaned specimens, provided information, or made work space available at their respective institutions.

I have now made three trips to Ecuador for collecting purposes; the first, in 1954, supported by the Penrose Fund of the American Philosophical Society, the second, in 1958–59, under tenureship of a Fulbright Professorship, and the third, in 1962, under the sponsorship of the National Science Foundation, Grant No. G–21010. To the authorities in charge of each, my sincere thanks.

Key to Genera of Lizards Known or Expected in Ecuador

(Asterisk indicates genus or species has not yet been collected in Ecuador)

1. Feet (at least the forefeet) present; eye definite 2
   Without feet; eye reduced to an indefinite point covered by the skin. *Amphisbaena*

2. Eyelids absent, dorsal scales small and numerous, usually granular and not imbricate 3
   Eyelids present (or, when lacking, the scales of the body are arranged in 13–15 rows and are broad, smooth, and imbricate) 9
3. No adhesive pads on toes 4
   Toes with adhesive pads below 7
4. Nails covered by a sheath of scales 5
   Nails uncovered, without a sheath . . . . *Gonatodes*
5. Sheath of nail symmetrical, as seen from above (fig. 1*b*) 6
   Sheath of nail asymmetrical, as seen from above (fig. 1*a*) . . . *Sphaerodactylus*
6. Five scales in nail sheath (fig. 1*b*) . . . . *Pseudogonatodes**
   Six scales in nail sheath (fig. 1*c*) . . . . *Lepidoblepharis*

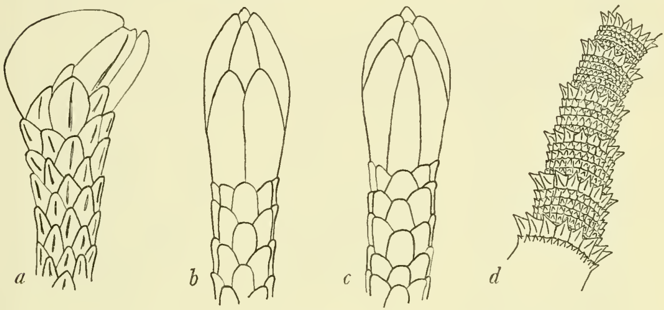

FIGURE 1.—Nail sheaths: *a*, *Sphaerodactylus*, dorsal view; *b*, *Pseudogonatodes*, five scales; *c*, *Lepidoblepharis*, six scales. Tail with rings of spiny scales: *d*, *Morunasaurus annularis*.

7. Digits with two rows of transverse lamellae below throughout length . . . 8
   Digits with single row of lamellae or tubercles below, two large plates under expanded tip of digit . . . . *Phyllodactylus*
8. Digits only partially dilated, ultimate phalanx compressed, arising from dorsum or dilated part of digit . . . . *Hemidactylus**[1]
   Digits totally dilated, ultimate phalanx not compressed but part of dilation. *Thecadactylus*
9. Top of head with granular or irregular flat scales, the largest usually arranged in semicircles over each eye; lacking a median frontal between the eyes; tongue usually fleshy and not extensible 10
   Top of head with regular flat plates; a median frontal between the eyes; tongue not fleshy although extensible and bifurcate 30
10. Tail provided with spines arranged in rings 11
    Tail without spiny rings 14
11. Tail cylindrical or compressed vertically, rings of spiny scales separated (fig. 1*d*) 12
    Tail flattened in a horizontal plane, all caudal scales spiny . . . . *Uracentron*

[1] Known from both Colombia and Peru.

12. A strong transverse gular fold 13
    No transverse gular fold . . . . *Stenocercus*
13. Dorsal crest present . . . . *Enyalioides*
    Dorsal crest absent . . . . *Morunasaurus*
14. Scales below ear subequal in size 15
    A large, round, flat scale below ear . . . . *Iguana*
15. Head produced posteriorly forming a vertical fin (in female, especially young ones, sometimes very inconspicuous) 16
    Head not produced posteriorly 17
16. Toes of hindfoot with fringe of flat scales (fig. 2*a*) . . . . *Basiliscus*
    Toes of hindfoot without fringe (fig. 2*b*) . . . . *Corythophanes**

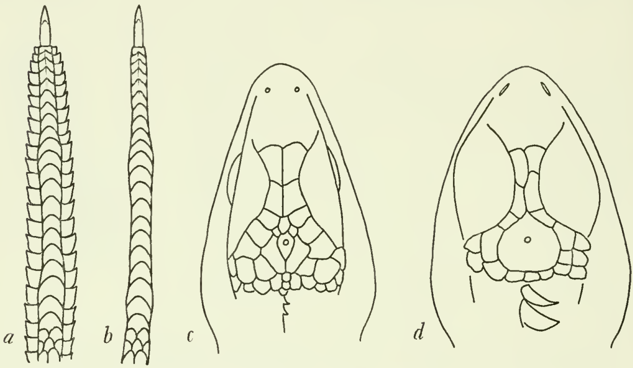

FIGURE 2.—Toe of hindfoot: *a*, *Basiliscus*; *b*, *Corythophanes*. Occipital: *c*, *Leiocephalus* species; *d*, *Tropidurus holotropis*.

17. Toes not dilated but quite cylindrical or compressed 18
    Toes dilated and flattened . . . . *Anolis*
18. A raised dorsal crest or slightly enlarged row of vertebral scales 19
    Dorsal crest absent 26
19. No femoral pores 20
    Femoral pores present . . . . *Enyalioides*
20. A transverse gular fold extending completely across throat 21
    No transverse gular fold extending completely across throat 23
21. Infradigital lamellae distinctly keeled 22
    Infradigital lamellae smooth or vaguely keeled . . . . *Enyalius*
22. Anterior maxillary teeth longest . . . . *Plica*[2]
    Maxillary teeth subequal . . . . *Tropidurus*
23. Occipital small (fig. 2*c*) 24
    Occipital greatly enlarged (fig. 2*d*) . . . . *Tropidurus*

[2] When this key is used for generic identification of non-Ecuadorian forms, *Uranoscodon* will key to *Plica*, since they are identical in external characters used. *Uranoscodon* lacks a sternal fontanelle, *Plica* has one. It is unlikely that *Uranoscodon* occurs in Ecuador.

24. A fold in front of shoulder 25
    No fold in front of shoulder . . . . *Ophryoessoides*
25. Upper head scales keeled . . . . *Proctotretus*
    Upper head scales smooth . . . . *Stenocercus*
26. Femoral pores absent 28
    Femoral pores present. 27
27. Ventrals large, square, in transverse and longitudinal rows and distinct from very small, granular dorsals. . . . . *Ameiva*
    Ventrals not as above . . . . *Polychrus*
28. A transverse gular fold, complete across throat 29
    No complete gular fold, although a fold in front of shoulder may extend part way onto throat 63
29. Dorsals keeled and imbricate . . . . *Tropidurus* (*torquatus* only)
    Dorsals smooth and granular. . . . . *Callopistes*
30. Body scales not semicircular, not very imbricate (although sometimes they are arranged in 16 or fewer rows); lack bony plates underlying the scales . . 31
    Body scales semicircular, usually smooth or slightly keeled and striated (fig. 3*a*), and very imbricate, with underlying bony plates (fig. 3*b*) 60

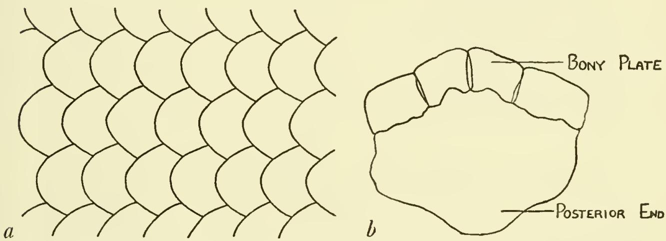

Figure 3.—Body scales of *Diploglossus monotropis: a*, dorsal view; *b*, cross section.

31. Dorsal scales heterogeneous; large keeled scales mixed in with smaller granular ones 32
    Dorsal scales homogeneous. 34
32. Males with 10 or fewer femoral pores; inner ventrals at least slightly keeled 33
    Males with 12 or more femoral pores; inner ventrals smooth . . . *Neusticurus*
33. Nostril in suture between two nasals; ventrals small, elongate, subquadrangular; double collar fold. *Dracaena**
    Nostril in single nasal; ventrals large, squarish; single collar fold . *Echinosaura*
34. Dorsal scales usually granular, always much smaller than ventrals 35
    Dorsal scales as large as, or only slightly smaller than, ventrals, not granular 41
35. More than 20 rows of ventral scales. 36
    Six to 16 rows of ventral scales 37
36. Tail strongly bicarinate dorsally . . . . *Crocodilurus**
    Tail rounded, no raised ridges dorsally . . . . *Tupinambis*

37. Ventral scales keeled 38
    Ventral scales smooth 39
38. Femoral pores present . . . . *Kentropyx*
    Femoral pores absent . . . . *Monoplocus*
39. Ventral surfaces of limbs and tail pale, contrasting strongly with the dark belly 40
    Ventral surfaces of limbs and tail dark, not contrasting strongly with venter of body . . . . *Ameiva*
40. Patch of enlarged scales medially on throat between the angles of jaw (fig. 4*a*); all supraoculars in contact with central head shields; males with heavy spines on sides of anus . . . . *Ameiva*
    No enlarged patch of scales medially on throat between angles of jaw (fig. 4*b*); last two supraoculars separated from frontal and frontoparietal by row of granules; males with no heavy anal spines . . . . *Dicrodon*
41. Five toes on forefoot 42
    Fewer than five toes, if any, on forefoot 57
42. No greatly enlarged dorsal and ventral scale rows 43
    Dorsum and venter with two rows of extremely broad scales, separated laterally by four rows of scales . . . . *Iphisa*
43. A claw on every finger 44
    Innermost finger lacks a claw . . . . *Calliscincopus**
44. No prefrontals (fig. 4*c*) 45
    Prefrontals present (fig. 4*d*) 47

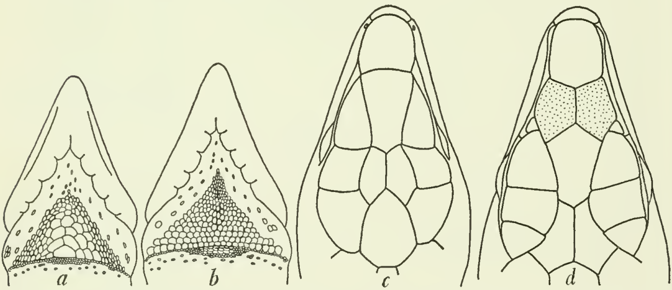

FIGURE 4.—Scales medially on throat between angle of jaws: *a*, *Ameiva edracantha; b*, *Dicrodon guttulatum.* Dorsal view of head: *c*, *Pholidobolus montium; d*, *Neusticurus strangulatus.*

45. Dorsals hexagonal or subhexagonal 46
    Dorsals rectangular . . . . *Proctoporus*
46. No clear separation between ventrals and dorsals . . . . . . *Macropholidus*
    Dorsals and ventrals separated by two or more rows of granular scales *Pholidobolus*
47. Dorsal and ventral scales similar, quadrangular; dorsals in transverse and longitudinal rows 48
    Dorsal scales not arranged in longitudinal rows 49

48. Dorsal scales strongly keeled . . . . *Cercosaura**
Dorsal scales smooth or weakly keeled . . . . *Anadia*
49. Dorsal scales considerably narrower than ventrals; in transverse rows (fig. 5*a*) 50
Dorsal scales in oblique rows, (fig. 5*b*) notably imbricate and keeled . . 56

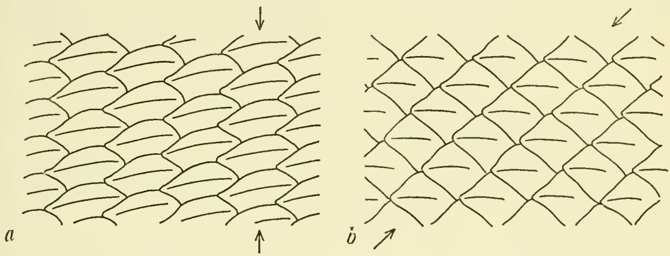

FIGURE 5.—Dorsal scales: *a*, *Alopoglossus festae; b*, *A. copii.*

50. Dorsal scales keeled or with the center of each scale distinctly raised along midline 51
Dorsal scales smooth or weakly keeled. 53
51. Lateral and dorsal scales subequal in size; laterals hexagonal, flat 52
Lateral scales much smaller than dorsals, tubercular or granular. *Prionodactylus*
52. Ventral plates rounded posteriorly, overlapping next row; dorsal caudal scales sharply pointed, overlapping . . . . *Arthrosaura*
Ventral plates square or truncate posteriorly, not overlapping next row; caudal scales truncate, not overlapping, not pointed . . . . . *Ptychoglossus*
53. Lateral scales much smaller than dorsals. 54
Lateral scales and dorsal scales subequal, ventrals and dorsals not separated by zone of smaller scales . . . . *Anadia*
54. Strong collar fold; male with femoral pores 55
Slight or weak collar fold; male without femoral pores . . . . . . *Ecpleopus*
55. Head only slightly larger than neck; 5–7 posterior pre-anals; few large flat temporals . . . . *Euspondylus*
Head clearly larger than neck; less than 5 posterior pre-anals; many small granular temporals. . . . . *Neusticurus*
56. Head scales with many longitudinal striations; interparietal longer than parietals . . . . *Leposoma*
Head scales smooth, may have some striae or keels on the interparietal and parietals; interparietal equal in length to parietals . . . . . . *Alopoglossus*
57. Dorsum with more than two rows of scales. 58
Dorsum with two greatly enlarged rows of scales . . . . *Iphisa*
58. Rear limb rudimentary or absent. 59
Rear limb well developed, pentadactyl . . . . *Gymnophthalmus**
59. An unpaired frontonasal separates nasals. . . . . *Bachia**
Nasals forming a suture on dorsal midline of head. . . . . . . *Ophiognomon*
60. At least two internasals 61
Internasal single . . . . *Gymnophthalmus**

61. One pair of internasals present; body usually striped 62
Two pairs of internasals present; body large and not striped . . . *Diploglossus*
62. Frontoparietals and interparietal fused into a single shield . . . . *Ablepharus*
Frontoparietals and interparietal separate, distinct (although latter may fuse with parietals) . . . . *Mabuya*
63. Scales on tail arranged in concentric, vertical rings . . . . *Stenocercus*
Scales on tail not arranged in vertical rings but in diagonal series . *Proctotretus*

Genus ABLEPHARUS Fitzinger

Ablepharus boutonii poecilopleurus Wiegmann

Ablepharus poecilopleurus Wiegmann, 1835, Nov. Act. Acad. Caes. Leop. Carol., vol. 17, pt. 1, p. 202. Pisacoma Is., Peru (type unknown).

RANGE: Islands off west coast of Peru and Ecuador; Sandwich Is., Savage Is.

Genus ALOPOGLOSSUS Boulenger

1. Gulars not arranged in two longitudinal rows; four pre-anal scales 2
Gulars transversely enlarged and arranged in two longitudinal rows; usually 3 pre-anal scales . . . . *festae*
2. Scales on the side of the neck large and conical; scales on the posterior half of the dorsum in longitudinal rows . . . . *copii*
Scales not as above 3
3. Scales on the side of the neck small, almost granular . . . . *buckleyi*
Scales on the side of the neck keeled, imbricate, not granular . . *carinicaudatus*

Alopoglossus buckleyi (O'Shaughnessy)

Leposoma buckleyi O'Shaughnessy, 1881, Proc. Zool. Soc. London, p. 233, pl. 22, fig. 2. Canelos, Ecuador (BM 1946.8.31.66, male).

RANGE: Amazonian Ecuador and Peru; has also been recorded from Pacific slope of Ecuador (Babahoyo, by Werner, 1910, Mitt. Nat. Mus. Hamburg, vol. 27, p. 30).

Alopoglossus carinicaudatus (Cope)

Leposoma carinicaudatum Cope, 1876, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, p. 160. Valley of Río Marañon, Peru (type unknown).

RANGE: Periphery of Amazon Basin, in British Guiana, Ecuador, and Peru.

Alopoglossus copii Boulenger

Leposoma carinicaudatum.—O'Shaughnessy, Proc. Zool. Soc. London, 1881, p. 233.

Alopoglossus copii Boulenger, 1885, Cat. Lizards British Mus., vol. 2,

p. 383, pl. 20, fig. 1. Pallatanga and Canelos, Ecuador (BM 1946.8.31.-58–59; 1946.9.8.17–18).

RANGE: Amazonian slopes of Ecuador.

Alopoglossus festae Peracca

Alopoglossus festae Peracca, 1904, Boll. Mus. Zool. Univ. Torino, vol. 19, no. 465, p. 7. Vinces, Ecuador (TurM 2875).

RANGE: Pacific slope of Ecuador.

Genus AMEIVA Meyer

1. Frontal plate divided into smaller scales, usually both longitudinally and transversely; prefrontals absent, or if present, not in contact 2
   Frontal plate entire; prefrontal scales in contact 4
2. Mesoptychium with enlarged scales; humerus with row of very large, flat, smooth scales on anterior aspect 3
   Mesoptychium with subequal scales; humerus with 1–2 rows of slightly enlarged, strongly keeled scales . . . . *bridgesii*
3. Eight rows of ventrals on much of venter; single scale separating prefrontals; dorsal head scales not ridged and pitted . . . . *orcesi*
   Six rows of ventrals on all of venter; several small scales separating prefrontals; dorsal head scales heavily ridged and usually pitted . . . *septemlineata*
4. Eight rows of ventral plates; males with group of spines on each side of pre-anal region . . . . *edracantha*
   Ten to twelve rows of ventral plates; no spines in the pre-anal region . . . 5
5. Last two or three supraoculars bordered entirely by granules, not in contact with frontal and frontoparietals . . . . *bifrontata divisa**
   No supraoculars except tiny fourth bordered entirely by granules, in contact with frontal and frontoparietals . . . . *ameiva petersi*

Ameiva ameiva petersi Cope

Ameiva petersi Cope, 1868, Proc. Acad. Nat. Sci. Philadelphia, vol. 30, p. 99. Napo or Marañon, Ecuador (USNM 6639, now lost).

RANGE: Upper Amazonian Basin.

Ameiva bridgesii (Cope)

Holcosus bridgesii Cope, 1869, Proc. Acad. Nat. Sci. Philadelphia, vol. 20, 1868 (1869), p. 306. Ecuador? (ANSP 9651).

RANGE: Northwestern coastal areas of Ecuador; Chocó of Colombia, Gorgona Island.

Ameiva edracantha Bocourt

Ameiva edracantha Bocourt, 1874b, Mission sci. Mexique, p. 263. Mexico (PM 4202).

RANGE: All records of the species, with the exception of the type, are from the coastal area of Ecuador and Peru, from Playas southward.

Ameiva orcesi J. Peters

Ameiva orcesi J. Peters, 1964, Bull. So. California Acad. Sci., vol. 63, p. 123. ½ km. NE of Abdon Calderon, Azuay Prov., Ecuador (USNM149655, male).

RANGE: Valley of the Río Jubones, Azuay Prov., Ecuador.

Ameiva septemlineata A. Duméril

Ameiva septemlineata A. Duméril, 1851, Cat. Méth. Coll. Reptiles, p. 114. "Amerique meridionale" (PM 4198).

Ameiva sexscutata Günther, 1859b, Proc. Zool. Soc. London, p. 402. Andes of Western Ecuador (BM 1946.8.28.35).

RANGE: Moister areas of coastal area of Ecuador, from Guayaquil northward.

Genus AMPHISBAENA Linnaeus

1. A single annulus at midbody contains less than 60 segments; median ventral segments not longer than broad 2
   A single annulus at midbody contains more than 60 segments; median ventral segments longer than broad . . . . *alba*
2. Abdomen as densely colored as dorsum; 190–205 body annuli; 23–27 tail annuli. *fuliginosa varia*
   Abdomen usually nearly immaculate, much lighter than dorsum; 204–215 body annuli; 26–30 tail annuli . . . . *fuliginosa bassleri*

Amphisbaena alba Linnaeus

Amphisbaena alba Linnaeus, 1758, Syst. Nat., 10th ed., vol. 1, p. 229. "America" (RMS).

RANGE: Tropical South America. (No good Ecuadorian records are known.)

Amphisbaena fuliginosa bassleri Vanzolini

Amphisbaena fuliginosa bassleri Vanzolini, 1951, Bull. Mus. Comp. Zool., vol. 106, no. 1, p. 61. Roaboya, Loreto, Peru (AMNH 56606, male).

RANGE: Upper Amazonian basin of Peru and Ecuador.

Amphisbaena fuliginosa varia Laurenti

Amphisbaena varia Laurenti, 1768, Synopsin Reptilium, p. 66. Barro Colorado Is., Panama (MCZ 22070, neotype, Vanzolini, 1951, Bull. Mus. Comp. Zool., vol. 106, no. 1, p. 61).

RANGE: Pacific Coast of Ecuador and Colombia; Panama to Villavicencio, Colombia, in Amazonian South America; east to near Trinidad in Venezuela.

Genus ANADIA Gray

1. Series of black, blue-centered ocelli on sides; 52–58 scales from occipital to tail; 30–32 scales about body . . . . *ocellata*
   No black, blue-centered ocelli on sides; 48 scales from occipital to base of tail; 33 scales about body . . . . *rhombifera*

Anadia ocellata Gray

Anadia ocellata Gray, 1845, Cat. Lizards British Mus., p. 74. "Tropical America" (BM 1946.8.2.2, male).

RANGE: Known from Jerico, Colombia, and Loja, Ecuador.

Anadia rhombifera (Günther)

Cercosaura rhombifera Günther, 1859b, Proc. Zool. Soc. London, p. 405, pl. 20, fig. A. Western Ecuador (BM 60.6.16.11, female).

RANGE: Pacific slope of Ecuador.

Genus ANOLIS Daudin[3]

1. End of snout raised, elongated, or with prominent bulge 2
   End of snout normal, not swollen or elongated 3
2. End of snout produced into an elongate, leaflike structure about as long as the head . . . . *proboscis*
   End of snout swollen, raised, often produced a slight distance beyond tip of maxillary . . . . *punctatus boulengeri*
3. Ventral scales smooth 4
   Ventral scales keeled 21
4. At least two rows of middorsal scales clearly larger than other dorsal and lateral scales 5
   All dorsal scales subequal, granular 15
5. Enlarged dorsal scales smooth 6
   Enlarged dorsal scales keeled 8
6. Enlarged dorsal scales comparatively small, in a few rows which rapidly grade into laterals 7
   Enlarged dorsal scales considerably larger than laterals, in about 12 regular rows . . . . *lionotus**
7. 5–6 enlarged supraoculars, bordered by granules, consisting of one hexagonal smooth plate surrounded by five similar or smaller ones . . . . . *bocourti**
   11–12 small supraoculars, which are only slightly larger than scales on the muzzle . . . . *festae*
8. Head scales enlarged 9
   Head scales granular . . . . *fraseri*
9. Head scales keeled 10
   Head scales smooth . . . . *aequatorialis*

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[3] Two new taxa, *A. biporcatus parvauritus* Williams and *A. nigrolineatus* Williams, have been added to the list of species but are not included in the key to the genus *Anolis*.

10. No supraoculars larger than the scales on snout 11
Some or many supraoculars enlarged, larger than snout scales 13
11. 6–8 upper labials to center of eye 12
10–12 upper labials to center of eye . . . . *latifrons*
12. White beneath, dotted and vermiculated with black; four rows of scales between supraorbital semicircles . . . . *ventrimaculatus**
Uniform white beneath, two rows of scales between supraorbital semicircles. *eulaemus*
13. Supraorbital semicircles separated by one or two rows of scales 14
Supraorbital semicircles separated by two to four rows of scales . *fuscoauratus*
14. Interparietal (occipital) larger than ear opening and in contact with the supraorbital semicircles . . . . *macrolepis**
Interparietal (occipital) equal to or smaller than the ear opening, and separated from the supraorbital semicircles by three or four rows of scales . *peraccae*
15. Head scales smooth 16
Head scales not smooth 18
16. Supraocular scales large, about seven in number 17
Supraocular scales small, about size of scales on rest of head, very numerous. *chloris*
17. Occipital larger than ear opening . . . . *ortoni*
Occipital not larger than ear opening . . . . *transversalis*
18. Head scales rugose 19
Head scales keeled 20
19. Supraocular scales smooth . . . . *fraseri*
Supraocular scales carinate . . . . *gemmosus*
20. Eight labials to below center of eye; 16 lamellae under second and third phalanges of fourth toe . . . . *maculiventris*
10–12 labials to below center of eye; 20–22 lamellae under second and third phalanges of fourth toe . . . . *princeps*
21. At least two rows of enlarged dorsal scales 24
All dorsal scales granular 22
22. Legs long, hindlimb reaches end of snout; digits feebly dilated 23
Legs short, hindlimb reaches ear opening; digital expansions strongly developed. *fraseri*
23. Dorsum uniform brown or olive; may have few small dark spots, distinct dark lateral band from eye to side of body . . . . *granuliceps*
Dorsum with series of large angular spots or rhombs, often confluent into zigzag band; females may have broad, light, dark-edged vertebral band. *scypheus*
24. Enlarged supraocular scales keeled 25
Enlarged supraocular scales smooth . . . . *binotatus*
25. Dorsal scales small, rhomboidal, subimbricate 26
Dorsal scales large, hexagonal, juxtaposed, in longitudinal series 27
26. Supraorbital semicircles separated by two rows of scales . . . . *tropidogaster*
Supraorbital semicircles in contact or separated by one row of scales *gracilipes*
27. Ventral scales larger than dorsals 28
Dorsal scales very large, largest twice as large as ventrals . . . . . *notopholis**
28. Five labials to point below center of eye . . . . *auratus*
Eight or more labials to below center of eye . . . . *bitectus*

Anolis aequatorialis Werner

Anolis aequatorialis Werner, 1894b, Zool. Anz., vol. 17, p. 157. "Ecuador" (VM 16233).

RANGE: Middle altitudes of western slopes in Ecuador.

Anolis auratus Daudin

Anolis auratus Daudin, 1802, Hist. Nat. Reptiles, vol. 4, p. 89. Unknown (type also unknown).

RANGE: Northern South America into Central America.

Anolis binotatus W. Peters

Anolis binotatus W. Peters, 1863, Monatsb. Akad. Berlin, p. 140. Guayaquil, Ecuador (BM 4685).

RANGE: Pacific Ecuador and Colombia; southern Central America.

Anolis biporcatus parvauritus Williams

Anolis biporcatus parvauritus Williams, 1966, Breviora, Mus. Comp. Zool., no. 239, p. 7, illustr. Gorgona Is., Cauca, Colombia, 5–45 m. (MCZ 78935).

RANGE: Lowlands west of the Andes in Colombia and Ecuador.

Anolis bitectus Cope

Anolis bitectus Cope, 1864, Proc. Acad. Nat. Sci. Philadelphia, vol. 16, p. 171. West Ecuador (BM 60.6.16.33).

RANGE: Pacific lowlands of Ecuador.

Anolis chloris Boulenger

Anolis chloris Boulenger, 1898, Proc. Zool. Soc. London, p. 110, pl. 10, fig. 3. Paramba, Ecuador (BM 98.4.28.10).

RANGE: Pacific lowlands of Ecuador; Darien of Panama.

Anolis eulaemus Boulenger

Anolis eulaemus Boulenger, 1908, Ann. Mag. Nat. Hist., ser. 8, vol. 2, p. 516, fig. 1. Pavas, Colombia (BM 1909.4.30.61).

RANGE: Southwestern Colombia; also reported from Ecuador on basis of specimens that differed in several respects from Boulenger's type description, by Despax, 1911, Bull. Mus. Nat. Hist. Paris, vol. 17, no. 1, p. 9.

Anolis festae Peracca

Anolis festae Peracca, 1904, Boll. Mus. Zool. Univ. Torino, vol. 19, no. 465, p. 4. Balzar, Ecuador (TurM 2872).

RANGE: Lowlands of western Ecuador.

Anolis fraseri Günther

Anolis cristatellus.—Günther, 1859a, Proc. Zool. Soc. London, p. 89.

Anolis fraseri Günther, 1859b, Proc. Zool. Soc. London, p. 407. Andes of Western Ecuador (BM 1946.8.8.47, lectotype, per Williams, 1966, p. 12).

Anolis devillei Boulenger, 1880, Bull. Soc. Zool. France, p. 42. Andes of Ecuador (IRB 2006).

RANGE: Higher western slopes of the Andes in Ecuador and Colombia.

Anolis fuscoauratus fuscoauratus Duméril and Bibron

Anolis fusco-auratus Duméril and Bibron, 1837, Erp. Gén., vol. 4, p. 110. "Chile," corrected to Río Mamore, between Loreto and "le confluent du Río Sara," Prov. of Moxas, Bolivia, by Bocourt, 1870, Bull. Nouv. Arch. Mus. Paris, vol. 6, p. 15 (PM 798).

Anolis viridiaeneus W. Peters, 1863, Monatsb. Akad. Berlin, p. 147. Quito, Ecuador (BerM 3889).

Anolis apollinaris.—Burt and Burt, 1930, Proc. U.S. Nat. Mus., vol. 78, art. 6, p. 8.

RANGE: Amazonian slopes of Andes from Ecuador to Bolivia.

Anolis gemmosus O'Shaughnessy

Anolis gemmosus O'Shaughnessy, 1875, Ann. Mag. Nat. Hist., ser. 4, vol. 15, p. 280. Type locality unknown (BM 71.4.16.27).

Anolis squamulatus.—Boulenger, 1882, Ann. Mag. Nat. Hist., ser. 5, vol. 9, p. 458.

Anolis andianus Boulenger, 1885, Cat. Lizards British Mus., vol. 2, p. 60. Milligalli, Ecuador, 6200 feet (BM 82.7.26.7).

Anolis fasciatus Boulenger, 1885, Cat. Lizards British Mus., vol. 2, p. 59, pl. 3, fig. 1. Guayaquil, Ecuador (BM 60.6.16.35).

Anolis elegans Boulenger, 1898, Proc. Zool. Soc. London, p. 109, pl. 10, fig. 2. Chimbo, Ecuador (BM 98.4.28.9).

RANGE: Pacific lowlands of Ecuador.

Anolis gracilipes Boulenger

Anolis gracilipes Boulenger, 1898, Proc. Zool. Soc. London, p. 112, pl. 11, fig. 3. Paramba, Ecuador (BM 98.4.28.22–25).

RANGE: Known only from type locality.

Anolis granuliceps Boulenger

Anolis granuliceps Boulenger, 1898, Proc. Zool. Soc. London, p. 111, pl. 11, fig. 2. Paramba, Ecuador (BM 98.4.28.15–20; TurM 2357; UMMZ 59002).

Anolis breviceps Boulenger, 1913, Proc. Zool. Soc. London, p. 1031, pl. 107, fig. 1. Peña Lisa, Condoto, Colombia (BM 1913.11.12.12–14).

RANGE: Pacific lowlands of Colombia and Ecuador, in Chocó region.

Anolis latifrons Berthold

Anolis latifrons Berthold, 1846, Nachr. Univ. und Königl. Gesell. Wiss. Göttingen, nos. 8–10, p. 11. Popayan, Colombia (GottM).

RANGE: Northwestern Ecuador through the Chocó of Colombia to southern Central America.

Anolis maculiventris Boulenger

Anolis maculiventris Boulenger, 1898, Proc. Zool. Soc. London, p. 111, pl. 11, fig. 1. Paramba, Ecuador (BM 98.4.28.11–12).

RANGE: Lowlands of northwestern Ecuador.

Anolis nigrolineatus Williams

Anolis nigrolineatus Williams, 1965, Breviora, Mus. Comp. Zool., no. 233, p. 4, illustr. Machala, El Oro Prov., Ecuador (MCZ 38940).

RANGE: Known only from Machala and Guayaquil, in Ecuador. There is reason to doubt the validity of both localities, according to Williams, loc. cit.

Anolis ortoni Cope

Anolis ortoni Cope, 1868, Proc. Acad. Nat. Sci. Philadelphia, vol. 30, p. 97. Napo or Upper Marañon, Ecuador-Peru (present location of type unknown).

Anolis bouvieri.—O'Shaughnessy, 1881, Proc. Zool. Soc. London, p. 243.

RANGE: Amazonian Basin.

Anolis peraccae Boulenger

Anolis peraccae Boulenger, 1898, Proc. Zool. Soc. London, p. 108, pl. 10, fig. 1. Chimbo, Ecuador and Río Peripa, Ecuador (BM 98.4.-28.4–8; TurM 2358).

Anolis irregularis Werner, 1901, Verh. Zool.–Bot. Gesell. Wien, vol. 51, p. 594. Ecuador (BerM 16592).

RANGE: Northwestern Ecuador.

Anolis princeps Boulenger

Anolis princeps Boulenger, 1902, Ann. Mag. Nat. Hist., ser. 7, vol. 9, p. 54. Carondolet (BM 1901.6.27.2), Río Lita (BM 1901.3.29.83); Paramba (BM 1901.3.29.95–96). Specimens from St. Javier and Salidero are not marked as types in the BM, although these places were mentioned in the type description.

RANGE: Lowlands of Northwestern Ecuador.

Anolis proboscis J. Peters and Orcés-V.

Anolis proboscis J. Peters and Orcés-V., 1956, Breviora, Mus. Comp. Zool., no. 62, p. 2, illustr. Cunuco, 5 km. northwest of Mindo, 1200 m., Pichincha Prov., Ecuador (MCZ 54300).

RANGE: Northwestern Ecuador.

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Anolis punctatus boulengeri O'Shaughnessy

Anolis nasicus.—O'Shaughnessy, 1880, Proc. Zool. Soc. London, p. 491.

Anolis boulengeri O'Shaughnessy, 1881, Proc. Zool. Soc. London, p. 242, pl. 24. Canelos, Ecuador (BM 80.12.8.43).

Range: Amazonian Ecuador.

Anolis scypheus Cope

Anolis scypheus Cope, 1864, Proc. Acad. Nat. Sci. Philadelphia, vol. 16, p. 172. Caracas, Venezuela, according to Barbour (BM 1946.-8.8.55, also XXII.5.3.F).

Anolis chrysolepis.—O'Shaughnessy, 1880, Proc. Zool. Soc. London, p. 491.

Range: Amazonian drainage of Venezuela, Peru, Ecuador.

Anolis transversalis A. Duméril

Anolis transversalis A. Duméril, 1851, Cat. Méth. Coll. Reptiles, p. 57. South America (actually Sarayacu, Peru, according to E. E. Williams) (PM).

Anolis buckleyi O'Shaughnessy, 1880, Proc. Zool. Soc. London, p. 492, pl. 49. Canelos, Ecuador (BM 80.12.8.45–46).

Range: Amazonian Ecuador and Peru.

Anolis tropidogaster Hallowell

Anolis tropidogaster Hallowell, 1857, Proc. Acad. Nat. Sci. Philadelphia, vol. 8, 1856 (publ. 1857), p. 224. Colombia (ANSP 7618).

Anolis stigmosus Bocourt, 1869, Bull. Nouv. Arch. Mus. Paris, vol. 5, p. 43. Magdalena River, Colombia (PM 2427).

Anolis chrysolepis. —Boulenger, 1882, Ann. Mag. Nat. Hist., ser. 5, vol. 9, p. 458.

Anolis lemniscatus Boulenger, 1898, Proc. Zool. Soc. London, p. 113, pl. 10, fig. 4. Chimbo, Ecuador (BM 98.4.28.27–31; TurM one syntype; MCZ 16783).

Range: Western slopes of Colombia and Ecuador.

Genus ARTHROSAURA Boulenger

Arthrosaura reticulata reticulata (O'Shaughnessy)

Cercosaura (*Pantodactylus*) *reticulata* O'Shaughnessy, 1881, Proc. Zool. Soc. London, p. 230, pl. 22, fig. 1. Canelos, Ecuador (BM 1946.-9.1.5).

Range: Amazonian Ecuador.

Genus BASILISCUS Laurenti

1. Ventral scales smooth 2
   Ventral scales keeled . . . . *vittatus*

2. A high dorsal crest and a high caudal crest, both crests with the upper edges serrate but not scalloped, both covered with thin, somewhat enlarged scales. *basiliscus*

No high dorsal crest but a serrate series of compressed trihedral tubercles, touching or separated by smaller scales; a low, serrate ridge on tail. *galeritus*

Basiliscus basiliscus (Linnaeus)

Lacerta basiliscus Linnaeus, 1758, Syst. Nat., 10th ed., vol. 1, p. 206. "America australi" (type unknown).

RANGE: Northwestern Ecuador and Colombia; southern Central America.

Basiliscus galeritus A. Duméril

Basiliscus galeritus A. Duméril, 1851, Cat. Méth. Coll. Reptiles, p. 61. "N.-Grenade," which is Colombia (PM 2130–31).

Ptenosaura seemani Gray, 1852, Ann. Mag. Nat. Hist., ser. 2, vol. 10, p. 438. "Quibo, on West coast of America" (BM).

RANGE: Pacific slopes of Colombia and Ecuador to Panama and Costa Rica.

Basiliscus vittatus Wiegmann

Basiliscus vittatus Wiegmann, 1828, Isis von Oken, vol. 21, p. 373. Mexico, restricted by Smith and Taylor, 1950, Bull. U.S. Nat. Mus., no. 199, p. 72, to Veracruz, Veracruz (BerM 549–551).

RANGE: Mexico through Central America on both coasts as far as Colombia. Recorded from Ecuador by Boulenger, 1885, Cat. Lizards British Mus., vol. 2, p. 109.

Genus CALLOPISTES Gravenhorst

Callopistes flavipunctatus (Duméril and Bibron)

Aporomera flavipunctata Duméril and Bibron, 1839, Erp. Gén., vol. 5, p. 72. South America (PM 8298, 2 specimens).

RANGE: Inter-Andean valleys of Peru and southern Ecuador.

Genus DICRODON Duméril and Bibron

Dicrodon guttulatum Duméril and Bibron

Dicrodon guttulatum Duméril and Bibron, 1839, Erp. Gén., vol. 5, p. 138. Peru (PM 1116).

Cnemidophorus lentiginosus Garman, 1892b, Bull. Essex Inst., vol. 24, p. 92. San Francisco de Posorja, Ecuador (MCZ 10775–76).

Ameiva leucostigma Boulenger, 1899a, Proc. Zool. Soc. London, p. 517. Guayaquil, Ecuador (BM 1946.8.8.69–70).

RANGE: Dry coastal Ecuador, north to southern limits of Esmeraldas Prov.; coastal Peru.

Genus DIPLOGLOSSUS Wiegmann

Diploglossus monotropis (Kuhl)

Scincus monotropis Kuhl, 1820, Beitr. Zool. und Vergl. Anat., p. 128. "Jamaica," probably erroneous (type unknown).

Tiliqua jamaicensis Gray, 1839, Ann. Nat. Hist., vol. 2, p. 293. Jamaica (Mus. Chatham).

RANGE: Pacific coast of Ecuador and presumably Colombia; Central America to Costa Rica.

Genus ECHINOSAURA Boulenger

Echinosaura horrida horrida Boulenger

Echinosaura horrida Boulenger, 1890, Proc. Zool. Soc. London, p. 82, pl. 8, fig. 1. Ecuador (BM 1946.8.31.60–61).

RANGE: Pacific lowlands of Ecuador.

Genus ECPLEOPUS Duméril and Bibron

Ecpleopus affinis W. Peters

Ecpleopus affinis W. Peters, 1862b, Abh. Akad. Wiss. Berlin, p. 199, pl. 3, fig. 1. Unknown (MunM).

Cercosaura gaudichaudi.—Günther, 1859a, Proc. Zool. Soc. London, p. 89.

RANGE: Higher Pacific slopes and inter-Andean valleys, from Ambato south, in Ecuador.

Genus ENYALIOIDES Boulenger

1. Dorsal crest distinct 2
   Dorsal crest indistinct . . . . *leechi**
2. Spines on nuchal crest not isolated from spines on dorsal crest 3
   Spines of nuchal crest prominent and completely isolated from spines on dorsal crest . . . . *palpebralis**
3. One or two femoral pores on each side 4
   Three or four femoral pores on each side 6
4. Ventrals keeled 5
   Ventrals smooth or indistinctly keeled . . . . *praestabilis*
5. Dorsal granules very fine, more than sixteen between lateral denticulation and dorsal crest . . . . *microlepis*
   Dorsal granules larger, fewer than sixteen between lateral denticulation and dorsal crest . . . . *oshaughnessyi*
6. Dorsal scales heterogeneous in size 7
   Dorsal scales homogeneous 8
7. Larger scales forming two irregular longitudinal series on each side of back and irregular vertical series on flanks . . . . *heterolepis*
   A single series of enlarged scales on each side of dorsum . . . . . . *microlepis*

8. Ventral scales smooth or indistinctly keeled . . . . *laticeps laticeps*
Ventral scales usually strongly keeled . . . . *laticeps festae*

Enyalioides heterolepis (Bocourt)

Enyalius heterolepis Bocourt, 1874, Ann. Sci. Nat., ser. 5, vol. 19, art. 4, p. 1. Veragua, Panama (PM 4067).

Enyalioides mocquardi Despax, 1911, Bull. Mus. Nat. Hist., vol. 17, no. 1, p. 10. "Ecuador" (PM 06–226 to 06–228).

RANGE: Northwestern Ecuador into Panama.

Enyalioides laticeps laticeps (Guichenot)

Enyalius laticeps Guichenot, 1855, in Castelnau, Exp. Amér. Mérid., Reptiles, p. 20. Fonteboa, Upper Amazon, Brazil (PM 6821–22).

RANGE: Upper Amazon?

Enyalioides laticeps festae Peracca

Enyalioides festae Peracca, 1897, Bo . Mus. Zool. Univ. Torino, vol. 12, no. 300, p. 3. Valley of the Río Santiago, Ecuador (TurM 2169, 2 syntypes).

RANGE: Amazonian Colombia and Ecuador.

Enyalioides microlepis (O'Shaughnessy)

Enyalius microlepis O'Shaughnessy, 1881, Proc. Zool. Soc. London, p. 238, pl. 24, fig. 2. Sarayacu, Ecuador (BM 1946.8.5.70).

RANGE: Pacific lowlands of Ecuador.

Enyalioides oshaughnessyi (Boulenger)

Enyalius oshaughnessyi Boulenger, 1881, Proc. Zool. Soc. London, p. 246, pl. 26. Ecuador (IRB 2009).

RANGE: Amazonian Ecuador and Colombia.

Enyalioides praestabilis (O'Shaughnessy)

Enyalius praestabilis O'Shaughnessy, 1881, Proc. Zool. Soc. London, p. 240, pl. 25, fig. 1. Pallatanga and Canelos, Ecuador (BM 1946.-8.9.15).

RANGE: Amazonian Ecuador.

Genus ENYALIUS Wagler

Enyalius zonatus Wettstein

Enyalius zonatus Wettstein, 1926, Anz. Akad. Wiss. Wien, vol. 63, p. 1. "Ecuador" (VM 17188–89).

RANGE: Known only from types.

Genus EUSPONDYLUS Tschudi

1. Largest infraorbital about equal in size to smaller labials . . . . . . *guentheri*
Largest infraorbital much smaller than any labial. . . . . *maculatus*

Euspondylus guentheri (O'Shaughnessy)

Ecpleopus (*Euspondylus*) *guentheri* O'Shaughnessy, 1881, Proc. Zool. Soc. London, p. 235, pl. 23, fig. 1. Sarayacu, Ecuador (BM 1946.8.8.99).

RANGE: Amazonian Ecuador.

Euspondylus maculatus Tschudi

Euspondylus maculatus Tschudi, 1845, Archiv für Naturg., vol. 11, p. 161. Vicinity of Moyabamba, Peru (type unknown, not in VM).

Ecpleopus fraseri O'Shaughnessy, 1879, Ann. Mag. Nat. Hist., ser. 5, vol. 4, p. 296. Guayaquil, Ecuador (BM 58.7.25.14).

RANGE: Coastal areas of northern Peru and southern Ecuador.

Genus GONATODES Fitzinger

1. Basal phalanges of digits cylindrical (fig. 6*a*). . . . . *caudiscutatus*
   Basal phalanges of digits slightly but distinctly depressed (fig. 6*b*). . *concinnatus*

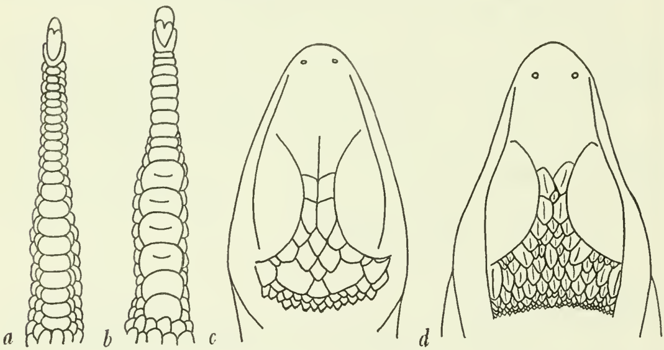

FIGURE 6.—Basal phalanges of digits: *a*, *Gonatodes caudiscutatus; b*, *G. concinnatus.* Scales in occipital region: *c*, *Ophryoessoides iridescens; d*, *O. guentheri.*

Gonatodes caudiscutatus caudiscutatus (Günther)

Gymnodactylus caudiscutatus Günther, 1859b, Proc. Zool. Soc. London, p. 410. W. Ecuador (BM 1946.9.7.6–9).

Gonatodes collaris Garman, 1892, Bull. Essex Inst., vol. 24, p. 83. Wreck Bay, Chatham Is., Galapagos (MCZ 9432).

RANGE: Chocó of Colombia and Ecuador; Galapagos Is.

Gonatodes concinnatus O'Shaughnessy

Goniodactylus ferrugineus.—Cope, 1868, Proc. Acad. Nat. Sci. Philadelphia, vol. 30, p. 97.

Goniodactylus concinnatus O'Shaughnessy, 1881, Proc. Zool. Soc. London, p. 237, pl. 23, fig. 2. Canelos, Ecuador (BM 1946.9.7.10–12).

Goniodactylus buckleyi O'Shaughnessy, 1881, Proc. Zool. Soc. London, p. 238, pl. 23, fig. 3. Pallatanga and Canelos, Ecuador (BM 1946.-9.7.13–15).

RANGE: Lower Amazonian slopes of Ecuador.

Genus GYMNOPHTHALMUS Merrem*

Gymnophthalmus speciosus speciosus (Hallowell)*

Blepharactisis speciosus Hallowell, 1861, Proc. Acad. Nat. Sci. Philadelphia, 1860 (publ. 1861), p. 484. Nicaragua (type lost).

RANGE: Uncertain. Presumably Central America and part of northern South America, with a questionable record from Chile. Existence in Ecuador not verified by any specimens known to me.

Genus IGUANA Laurenti

Iguana iguana iguana (Linnaeus)

Lacerta iguana Linnaeus, 1758, Syst. Nat., 10th ed., vol. 1, p. 206. "Indiis" (type unknown).

Iguana tuberculata Laurenti, 1768, Syn. Reptilium, p. 49 (type and type locality unknown to me).

RANGE: Northern South America to Costa Rica; on both Pacific and Amazonian slopes in Ecuador.

Genus IPHISA Gray

Iphisa elegans Gray

Iphisa elegans Gray, 1851, Proc. Zool. Soc. London, vol. 19, p. 39. Para, northern Brazil (BM 1946.9.1.1).

RANGE: Known from type locality, which may be erroneous, the Guianas, and from Santiago-Zamora Prov., Ecuador.

Genus KENTROPYX Spix

1. Dorsal scales keeled, at least in part 2
   Dorsal scales smooth. . . . . *altamazonicus*
2. Femoral scales which touch the row of femoral pores anteriorly hardly as large as the median gulars. . . . .*calcaratus*
   Same scales larger than the median gulars . . . . *pelviceps*

Kentropyx altamazonicus Cope

Centropyx altamazonicus Cope, 1876, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, pt. 2, p. 162. Moyobamba, Peru (ANSP 13105).

RANGE: Amazonian Ecuador and Peru.

Kentropyx calcaratus Spix

Kentropyx calcaratus Spix, 1825, Spec. Nov. Lacert. Brasil, p. 21, pl. 22, fig. 2. Itapicurú, in Provincia Maranhão, Brazil (Leipzig?).

RANGE: Northern Amazonian Basin of South America.

Kentropyx pelviceps Cope

Centropyx pelviceps Cope, 1868, Proc. Acad. Nat. Sci. Philadelphia, vol. 30, p. 98. Napo or Upper Amazon of Ecuador (formerly USNM 6638, now ANSP 9556).

Centropyx dorsalis.—O'Shaughnessy, 1881, Proc. Zool. Soc. London, p. 228.

RANGE: Amazonian lowlands of Ecuador.

Genus LEPIDOBLEPHARIS Peracca

1. Dorsal scales homogeneous 2
   Dorsal scales granular with enlarged scales scattered irregularly over back. *ruthveni*
2. Scales on snout larger than those on rest of head 3
   No enlarged scales on snout . . . . *festae*
3. No enlarged anterior gulars 4
   Scales immediately behind mental larger than rest of gulars . . . . *buchwaldi*
4. Mental without clefts . . . . *oxycephalus*
   Two clefts in rear part of mental . . . . *intermedius*

Lepidoblepharis buchwaldi Werner

Lepidoblepharis buchwaldi Werner, 1910, Mitt. Nat. Mus. Hamburg, vol. 27, p. 8. Hacienda Clementina, Babahoyo, Ecuador (HM 808).

RANGE: Known only from types.

Lepidoblepharis festae Peracca

Lepidoblepharis festae Peracca, 1897, Bol. Mus. Zool. Univ. Torino, vol. 12, no. 300, p. 2 with fig. San José de Cuchipamba, Ecuador (TurM 2163).

RANGE: Amazonian slopes of Ecuador and Río Jurua region of Brazil.

Lepidoblepharis intermedius Boulenger

Lepidoblepharis intermedius Boulenger, 1914, Proc. Zool. Soc. London, p. 814, pl. 1, fig. 2. Peña Lisa, Condoto, Colombia (BM 1914.5.21.5).

RANGE: Chocó of Colombia and Ecuador.

Lepidoblepharis oxycephalus (Werner)

Gonatodes oxycephalus Werner, 1894a, Zool. Anz., vol. 17, p. 413. Ecuador (type unknown; not in VM).

RANGE: Unknown.

Lepidoblepharis ruthveni Parker

Lepidoblepharis ruthveni Parker, 1926, Ann. Mag. Nat. Hist., ser. 9, vol. 17, p. 295. Chimbo, Ecuador (BM 98.4.28.3, female; TurM 2645).

RANGE: Pacific slope of Ecuador.

Genus LEPOSOMA Spix

Leposoma parietale (Cope)

Mionyx parietalis Cope, 1885, Proc. American Philos. Soc., vol. 23, p. 96. Pebas, Peru (probably ANSP).

RANGE: Amazonian Colombia, Ecuador, and Peru.

Genus MABUYA Fitzinger

Mabuya mabouya (Lacépède)

Lacerta mabouya Lacépède, 1788, Hist. Nat. Quad. Ovip. Serpents, vol. 1, p. 378, pl. 24. Type and type locality unknown; restricted to the Antilles by Latreille, 1802 (*fide* Dunn); further restricted to the Lesser Antilles by Dunn, 1936, vol. 87, p. 544; still further restricted to St. Vincent Is. by Smith and Taylor, 1950, p. 156.

Mabuia cepedei.—Cope, 1868, Proc. Acad. Nat. Sci. Philadelphia, vol. 30, p. 100.

Mabuia aenea.—O'Shaughnessy, 1881, Proc. Zool. Soc. London, p. 236.

Mabuya agilis.—Peracca, 1897, Bol. Mus. Zool. Univ. Torino, vol. 12, no. 300, p. 13; Boulenger, 1887, Cat. Lizards British Mus., vol. 3, p. 190; Parker, 1934, Ann Mag. Nat. Hist., ser. 10, vol. 14, p. 271.

RANGE: Low and moderate elevations from central Mexico to Brazil.

REMARKS: The proper name for the species of *Mabuya* from Ecuador is very much in doubt. I follow Stuart (1963, Misc. Publ. Mus. Zool. Univ. Mich., no. 122, p. 76), in using this combination, although Taylor (1956, U. Kans. Sci. Bull., vol. 38, pt. 1, p. 297) said that "it must be regarded as doubtful whether the species *Mabuya mabouya* is represented on the mainland of Central America." A thorough review, both biological and taxonomic, is very much in order for this species in order to permit accurate definition of subspecies and, perhaps, species masquerading under this name.

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Genus MACROPHOLIDUS Noble

Macropholidus annectens Parker

Macropholidus annectens Parker, 1930, Ann. Mag. Nat. Hist., ser. 10, vol. 5, p. 569. Loja City, Ecuador (BM 1930.1.30.2, female).

RANGE: Upper drainage of Río Zamora, Ecuador.

Genus MONOPLOCUS Günther

Monoplocus dorsalis Günther

Monoplocus dorsalis Günther, 1859b, Proc. Zool. Soc. London, p. 404. "Andes of Western Ecuador" (originally BM, now lost).

RANGE: Uncertain; this has not been taken since the type was collected. The type is no longer extant.

Genus MORUNASAURUS Dunn

Morunasaurus annularis (O'Shaughnessy)

Hoplocercus annularis O'Shaughnessy, 1881, Proc. Zool. Soc. London, p. 244, pl. 25, fig. 2. Canelos, Ecuador (BM 1946.8.10.35).

RANGE: Amazonian Ecuador.

Genus NEUSTICURUS Duméril and Bibron [4]

1. Pronounced tubercles on limbs 2
   No tubercles on limbs . . . . *strangulatus strangulatus*
2. Granular scales of sides interspersed with fairly regular rows of enlarged, keeled scales . . . . *ecpleopus*
   Granular scales of sides uniform in size; no keeled, enlarged scales. . *cochranae*

Neusticurus cochranae Burt and Burt

Neusticurus ecpleopus cochranae Burt and Burt, 1931, Bull. American Mus. Nat. Hist., vol. 61, p. 350. San José de Sumaco, Ecuador (AMNH 28891, male).

RANGE: Amazonian lowlands of Northern Ecuador.

Neusticurus ecpleopus Cope

Neusticurus ecpleopus Cope, 1876, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, pt. 2, p. 161. Peru (probably ANSP).

Neusticurus tuberculatus Shreve, 1935, Occ. Pap. Boston Soc. Nat. Hist., vol. 8, p. 209. Sarayacu, Ecuador (MCZ 37711, male).

Custa bicarinata.—Günther, 1859b, Proc. Zool. Soc. London, p. 404.

RANGE: Amazonian lowland in Ecuador and northern Peru.

[4] Arrangement following Uzzell, Bull. American Mus. Nat. Hist., in press.

Neusticurus strangulatus strangulatus (Cope)

Euspondylus strangulatus Cope, 1868, Proc. Acad. Nat. Sci. Philadelphia, vol. 30, p. 99. Ecuador (ANSP 7538).

Euspondilus festae Peracca, 1897, Boll. Mus. Zool. Univ. Torino, vol. 12, no. 300, p. 10. Valleys of the Río Zamora (TurM 2157) and the Río Santiago (TurM 2156), Ecuador.

RANGE: Eastern slopes of the Ecuadorian Andes, and a dubious record from Pallatanga, on the western slopes of Ecuador.

Genus OPHIOGNOMON Cope

1. Hindlimb half as long as pre-anal plates; 20 scales around the body . *trisanale*
   Hindlimb reduced to tiny stub; 26–28 scales around the body . . . *abendrothii*

Ophiognomon abendrothii (W. Peters)

Chalcides (*Hapalolepis*) *Abendrothii* W. Peters, 1871, Monatsb. Akad. Berlin, p. 399. Sarayacu, Peru (BerM 7132–7134 and BM 73.-4.30.9).

RANGE: Amazonian slopes in Ecuador and Peru.

Ophiognomon trisanale Cope

Ophiognomon trisanale Cope, 1868, Proc. Acad. Nat. Sci. Philadelphia, vol. 30, p. 100. "Napo or Upper Marañon, Ecuador" (formerly USNM 6637, now ANSP 9637).

RANGE: Amazonian Ecuador.

Genus OPHRYOESSOIDES Duméril

1. Scales in occipital region large (fig. 6*c*, p. 22). 2
   Scales in occipital region small (fig. 6*d*) 3
2. Head scales quite rugose; pair of dorsolateral crests present . . . . . *aculeatus*
   Head scales not rugose; no dorsolateral crests. . . . . *iridescens*
3. Supraoculars transversely dilated 4
   No large, dilated supraoculars 5
4. Four broadly dilated supraoculars . . . . *formosus*
   Six broadly dilated supraoculars . . . . *haenschi*
5. Less than 55 scales around body 6
   More than 56 scales around body. . . . . *guentheri*
6. Sides of belly black; small postfemoral and postaxillary dermal pouches. . . 7
   Sides of belly red or pink; large postaxillary and postfemoral dermal pouches. *rhodomelas*
7. 47 or more scales around body . . . . *festae*
   Less than 47 scales around body . . . . *ornatus*

Ophryoessoides aculeatus (O'Shaughnessy)

Leiocephalus aculeatus O'Shaughnessy, 1879, Ann. Mag. Nat. Hist., ser. 5, vol. 4, p. 303. Moyobamba, Peru (BM 1946.8.12.33–36).

Leiocephalus angulifer Werner, 1901, Verh. Zool.-Bot. Gesell. Wien, vol. 51, p. 595. Ecuador (BerM 16594).

RANGE: Amazonian slopes of Ecuador and Peru.

Ophryoessoides festae (Peracca)

Leiocephalus festae Peracca, 1897, Bol. Mus. Zool. Univ. Torino, vol. 12, no. 300, p. 6. Cuenca, Ecuador (TurM 2619).

RANGE: Inter-Andean plateau in Cuenca Hoya, Ecuador.

Ophryoessoides formosus (Boulenger)

Liocephalus formosus Boulenger, 1880, Bull. Soc. Zool. France, p. 43. Andes of Ecuador (IRB 2007).

RANGE: Known only from the type.

Ophryoessoides guentheri (Boulenger)

Liocephalus ornatus.—Günther, 1859b, Proc. Zool. Soc. London, p. 408.

Liocephalus trachycephalus.—Boulenger, 1882, Ann. Mag. Nat. Hist., ser. 5, vol. 9, p. 458.

Liocephalus guentheri Boulenger, 1885, Cat. Lizards British Mus., vol. 2, p. 169, pl. 13. Guayaquil and Sarayacu, Ecuador and a questioned report from Colombia (BM 58.7.25.16–18; 59.9.26.6; 60.6.16.18–21; 71.2.7.7–10; 71.4.16.53; 80.12.8.53).

RANGE: Apparently confined to the Inter-Andean plateau in Ecuador.

Ophryoessoides haenschi (Werner)

Liocephalus haenschi Werner, 1901, Verh. Zool.–Bot. Gesell. Wien, vol. 51, p. 595. Balzapamba, Ecuador (BerM 16595).

RANGE: Known only from the type.

Ophryoessoides iridescens (Günther)

Liocephalus iridescens Günther, 1859b, Proc. Zool. Soc. London, p. 409, pl. 20, fig. B. Andes of Ecuador (BM 60.6.12.2–7).

RANGE: From Guayaquil to El Oro Prov., in drier coastal areas.

Ophryoessoides ornatus ornatus (Gray)

Leiocephalus ornatus Gray, 1845, Cat. Lizards British Mus., p. 219. Guayaquil, Ecuador (BM 1946.8.29.72).

RANGE: West Coast of Ecuador.

Ophryoessoides rhodomelas (Boulenger)

Liocephalus rhodomelas Boulenger, 1899b, Ann. Mag. Nat. Hist., ser. 7, vol. 4, p. 455. Oña, Ecuador (BM 1946.8.29.77–80).

RANGE: Inter-Andean plateaus of southern Ecuador.

Genus PHOLIDOBOLUS Peters

Pholidobolus montium W. Peters

Ecpleopus (*Pholidobolus*) *montium* W. Peters, 1862b, Abh. Akad. Wiss. Berlin, p. 196, pl. 2, fig. 3. Quito, Ecuador (BerM 900, LeyM 3401).

Cercosaura gaudichaudi.—Boulenger, 1882, Ann. Mag. Nat. Hist., ser. 5, vol. 9, p. 459.

RANGE: Inter-Andean Ecuador.

Genus PHYLLODACTYLUS Gray

Phyllodactylus reissii W. Peters

Phyllodactylus reissii W. Peters, 1862a, Monatsb. Berlin Akad., p. 626. Guayaquil, Ecuador (BerM 3734).

Phyllodactylus guayaquilensis Werner, 1910, Mitt. Nat. Mus. Hamburg, vol. 27, p. 4. Guayaquil, Ecuador (HM 989).

Phyllodactylus abruptiseriatus Werner, 1913, Mitt. Nat. Mus. Hamburg, vol. 30, p. 4. "wahrscheinlich Brasilien" (formerly HM, now destroyed).

RANGE: Coastal Ecuador up to 1250 meters, perhaps also coastal Peru.

REMARKS: These three species are regarded as synonymous by James R. Dixon (1962, personal communication), and his scheme is being followed in anticipation of publication of his results. *P. tuberculosus* is not Ecuadorian, and references to it in the literature are probably this species.

Genus PLICA Gray

1. Side of neck with tufts of small, erect, spinelike scales . . . . *plica*
   Side of neck without spines . . . . *umbra*

Plica plica (Linnaeus)

Lacerta plica Linnaeus, 1758, Syst. Nat., 10th ed., vol. 1, p. 208. "Indiis" (type not located).

Hypsibates agamoides.—Cope, 1868, Proc. Acad. Nat. Sci. Philadelphia, vol. 30, p. 97.

RANGE: Northern South America to Bolivia, east of the Andes.

Plica umbra (Linnaeus)

Lacerta umbra Linnaeus, 1758, Syst. Nat., 10th ed., vol. 1, p. 207. "Meridionalibus" (type unknown).

RANGE: Northern South America, east of the Andes.

Genus POLYCHRUS Cuvier

1. Scales of sides same size or smaller than dorsals and not separated by tiny granules. 2
   Scales of sides slightly larger than dorsals and separated from each other by tiny granular scales . . . . *femoralis*
2. Canthus rostralis at least somewhat rounded; scales on pectoral region smooth or very weakly keeled 3
   Canthus rostralis distinctly angular; scales on pectoral region strongly keeled, may be bi- or tricarinate, usually unicarinate. . . . . . . *gutturosus gutturosus*
3. Low series of raised scales forming midventral crest from mental to gular appendage . . . . *marmoratus*
   No low series of raised scales forming midventral crest on chin. *gutturosus spurrellii*

Polychrus femoralis Werner

Polychrus femoralis Werner, 1910, Mitt. Nat. Mus. Hamburg, vol. 27, p. 21. Guayaquil, Ecuador (formerly HM, apparently destroyed).
RANGE: Lowlands in southwestern Ecuador.

Polychrus gutturosus gutturosus Berthold

Polychrus gutturosus Berthold, 1846, Nachr. Univ. und Königl. Gesell Wiss. Göttingen, nos. 8–10, p. 11. Popayan, Colombia (GottM).
RANGE: Higher western Andean slopes of Ecuador and Colombia and northward to Costa Rica and Nicaragua.

Polychrus gutturosus spurrellii Boulenger

Polychrus spurrellii Boulenger, 1914, Proc. Zool. Soc. London, p. 814. Peña Lisa, Condoto, Colombia (BM 1946.8.8.33–34).
RANGE: Chocó of northwestern Ecuador and Colombia.

Polychrus marmoratus (Linnaeus)

Lacerta marmorata Linnaeus, 1758, Syst. Nat., 10th ed., vol. 1, p. 208. "Hispania" (type unknown).
RANGE: Amazonian basin of South America.

Genus PRIONODACTYLUS O'Shaughnessy

1. Fewer than 25 transverse rows of ventral plates from the edge of the collar to pre-anal shields 2
   25 or more transverse ventral rows . . . . *ocellifer*
2. 35 or more scales from occiput to base of tail. 3
   Fewer than 35 scales from occiput to base of tail . . . . *vertebralis*
3. Fewer than 40 scales about middle of body . . . . *oshaughnessyi*
   40 or more scales about middle of body . . . . *manicatus*

Prionodactylus manicatus (O'Shaughnessy)

Cercosaura (Prionodactylus) manicata O'Shaughnessy, 1881, Proc. Zool. Soc. London, p. 231, pl. 22, fig. 3. Canelos and Pallatanga, Ecuador (BM 1946.8.2.1).

RANGE: Amazonian Ecuador.

Prionodactylus ocellifer Werner

Prionodactylus ocellifer Werner, 1901, Verh. Zool.-Bot. Gesell. Wien, vol. 51, p. 596. Ecuador (BerM 16593).

RANGE: Known only from type, which lacks specific data.

Prionodactylus oshaughnessyi Boulenger

Cercosaura (Pantodactylus) argulus.—O'Shaughnessy, 1881, Proc. Zool. Soc. London, p. 229.

Prionodactylus oshaughnessyi Boulenger, 1885, Cat. Lizards British Mus., vol. 2, p. 392, pl. 21, fig. 1. Canelos and Pallatanga, Ecuador (BM 1946.8.31.18–20).

RANGE: Amazonian Ecuador.

Prionodactylus vertebralis (O'Shaughnessy)

Cercosaura (Pantodactylus) vertebralis O'Shaughnessy, 1879, Ann. Mag. Nat. Hist., ser. 5, vol. 4, p. 298. Intac, Ecuador (BM 1946.8.31.35).

RANGE: Higher Pacific slopes of Ecuador; also reported from Zamora, Ecuador, by Parker, 1934, Ann. Mag. Nat. Hist., ser. 10, vol. 14, p. 270. Darien, Panama.

Genus PROCTOPORUS Tschudi

1. Pores present in pre-anal area; at least one supraocular in contact with upper palpebrals; adpressed limbs do not touch. 2
   No pores in pre-anal area; superciliary series usually complete except in *columbianus*; adpressed limbs usually meet. 3
2. Supraoculars four; two, three, and four usually in contact with upper palpebrals; no sexual dimorphism in femoral pore number . . . . *meleagris*
   Supraoculars three; usually only two in contact with palpebrals; sexual dimorphism in femoral pore number . . . . *unicolor*
3. Fewer than 50 scales from occiput to base of tail 4
   More than 50 scales from occiput to base of tail; disc in lower eyelid not divided by vertical grooves into two or three sections. . . . . *pachyurus**
4. Superciliary series incomplete, second or second and third supraoculars in contact with upper palpebrals; adpressed limbs separated or barely touching. *columbianus*
   Superciliary series usually complete (occasionally not in *striatus*); limbs usually broadly overlapping when adpressed. 5

5. Dorsal scales smooth. . . . . *simoterus*
   Dorsal scales striated or keeled 6
6. Males with ocelli in pattern; a dorsolateral light stripe present; dorsal scales keeled . . . . *oculatus*
   Males without ocelli in pattern; dorsals keeled or striate 7
7. Dorsal pattern of longitudinal dark brown stripes on light brown, or uniform light brown; scales striate . . . . *striatus*
   Dorsal pattern not linear, consisting of small black spots on a dark brown background; dorsals feebly but distinctly keeled. . . . . *hypostictus*

Proctoporus columbianus Andersson

Proctoporus columbianus Andersson, 1914, Arkiv für Zool., vol. 9, no. 3, p. 3, fig. 1. Colombia (RMS).

Proctoporus oculatus (part).—Burt and Burt, 1931, Bull. American Mus. Nat. Hist., vol. 61, p. 369.

RANGE: Eastern slopes of Andes in Colombia and Ecuador.

REMARKS: The record from Abitagua, by Burt and Burt (ibid.), probably belongs to an undescribed subspecies of this species, according to Uzzell, 1958, Occ. Pap. Mus. Zool. U. Mich., no. 597, p. 7.

Proctoporus hypostictus Boulenger

Proctoporus hypostictus Boulenger, 1902, Ann. Mag. Nat. Hist., ser. 7, vol. 9, p. 55. Paramba, Ecuador (BM 1901.3.29.105).

RANGE: Higher western slopes of Andes in Ecuador.

Proctoporus meleagris Boulenger

Proctoporus meleagris Boulenger, 1885, Cat. Lizards British Mus., vol. 2, p. 415, pl. 22, fig. 2. Western Ecuador (BM 60.6.16.18).

RANGE: Higher western slopes of Andes in Ecuador, up to 3000 meters.

Proctoporus oculatus (O'Shaughnessy)

Ecpleopus oculatus O'Shaughnessy, 1879, Ann. Mag. Nat. Hist., ser. 5, vol. 4, p. 297. Intac, Ecuador (BM 78.1.25.5).

RANGE: Higher western slopes of Andes in Ecuador.

Proctoporus simoterus (O'Shaughnessy)

Emphrassotis simoterus O'Shaughnessy, 1879, Ann. Mag. Nat. Hist., ser. 5, vol. 4, p. 296. Intac, Ecuador (BM 1946.9.1.6).

RANGE: Western slopes of Andes in Ecuador.

Proctoporus striatus (W. Peters)

Ecpleopus (*Oreosaurus*) *striatus* W. Peters, 1862b, Abh. Akad. Wiss. Berlin, p. 201. Santa Fe de Bogotá, Colombia (BerM).

Proctoporus oculatus (part).—Burt and Burt, 1931, Bull. American Mus. Nat. Hist., vol. 61, p. 369.

RANGE: Upper eastern slopes of the Andes in Colombia; El Chiral, El Oro Prov., Ecuador(?).

REMARKS: Uzzell, 1958, Occ. Pap. Mus. Zool. U. Mich., no. 597, p. 7, indicates that the specimen Burt and Burt listed as *Proctoporus oculatus* from El Chiral may belong to *P. striatus* Peters, but that it is not clearly so, showing several distinct differences. The record certainly makes no zoogeographic sense at all, and it is likely that the El Chiral specimen represents a new species.

Proctoporus unicolor (Gray)

Riama unicolor Gray, 1858, Proc. Zool. Soc. London, p. 446, pl. 15, fig. 2. Western Ecuador (BM 53.7.25.44).

Proctoporus pachyurus.—Günther, 1859a, Proc. Zool. Soc. London, p. 89, and 1859b, ibid., p. 407.

Proctoporus lividus Thominot, 1889, Bull. Soc. Philom. Paris, ser. 8, vol. 1, p. 25. Ecuador (PM 5812, 2 specimens).

RANGE: Western slopes and inter-Andean valleys of northern Ecuador.

Genus PROCTOTRETUS Duméril and Bibron

Proctotretus ornatissimus (Girard)

Saccodeira ornatissima Girard, 1858, Proc. Acad. Nat. Sci. Philadelphia, 1857 (1858), p. 198. Obrajillo and Yanga, Peru (USNM 5655).

RANGE: Interior highlands of Ecuador and Peru; southern Ecuadorian hoyas only.

Genus PTYCHOGLOSSUS Boulenger

1. Eight rows of ventral plates; three pairs of chinshields, two in contact on midline; frontal not longer than broad; four supraoculars . . . . *brevifrontalis*
 Ten rows of ventral plates; four pairs of chinshields, one pair in contact on midline; frontal longer than broad; three supraoculars. . . . . . . *picticeps*

Ptychoglossus brevifrontalis Boulenger

Ptychoglossus brevifrontalis Boulenger, 1912, Ann. Mag. Nat. Hist., ser. 8, vol. 10, p. 421. El Topo, Río Pastaza, Ecuador (BM 1946.8.31.63).

RANGE: Amazonian slopes of Ecuador.

Ptychoglossus picticeps (Cope)

Leposoma picticeps Cope, 1885, Proc. American Philos. Soc., vol. 23, p. 99. Pebas, Peru (type not located).

Ptychoglossus bilineatus Boulenger, 1890, Proc. Zool. Soc. London, p. 84, pl. 10, fig. 2. Ecuador (BM 1946.8.2.38).

RANGE: Amazonian Ecuador and Peru.

Genus SPHAERODACTYLUS Wagler

1. No median row of enlarged subcaudals; no black lines on dorsum of head; a dark band across the scapular region. . . . . *scapularis*
   A median row of enlarged subcaudals; five to seven dim longitudinal dark lines on head; no dark band across the scapular region . . . . *lineolatus*

Sphaerodactylus lineolatus Lichtenstein

Sphaerodactylus lineolatus Lichtenstein, 1856, Nomencl. Mus. Zool. Berlin, p. 6. Veragoa, Panamá, which is Veragua (BerM 417).

RANGE: Central America from British Honduras south to Panama; Colombia; reported in Ecuador on the basis of USNM 65451, from Macas.

Sphaerodactylus scapularis Boulenger

Sphaerodactylus scapularis Boulenger, 1902, Ann. Mag. Nat. Hist., ser. 7, vol. 9, p. 54. St. Javier, Ecuador (BM 1946.8.30.70).

RANGE: Northwestern Ecuador.

Genus STENOCERCUS Duméril and Bibron

1. Caudal scales without spines 2
   Caudal scales strongly spinose 5
2. Vertebral scales raised and pointed, forming a denticulate ridge. 3
   No raised and pointed vertebral scales . . . . *varius*
3. Ventral scales approximately same size as largest dorsals 4
   Ventral scales considerably larger than largest dorsals . . . . *humeralis*
4. Dorsal scales mucronate; caudal scales mucronate. . . . . *nigromaculatus*
   Dorsal scales not mucronate; caudal scales not or but very shortly mucronate. *boettgeri*
5. Caudal whorls subequal . . . . *simonsii*
   Caudal whorls alternately larger and smaller. . . . . *carrioni*

Stenocercus boettgeri Boulenger

Stenocercus boettgeri Boulenger, 1911, Ann. Mag. Nat. Hist., ser. 8, vol. 7, p. 22. Huancabamba, Peru (BM 1946.8.11.92–99).

RANGE: Highland areas of Peru and Ecuador.

Stenocercus carrioni Parker

Stenocercus carrioni Parker, 1934, Ann. Mag. Nat. Hist., ser. 10, vol. 14, p. 264. Zamora, Ecuador (BM 1933.6.24.75, male).

RANGE: Known only from type locality.

Stenocercus humeralis (Günther)

Microphractus humeralis Günther, 1859a, Proc. Zool. Soc. London, p. 90. Andes of Western Ecuador (BM 1946.8.11.76–77).

RANGE: Interandean Plateau of Ecuador, from Cuenca Valley southward.

REMARKS: Boulenger, 1885, Cat. Lizards British Mus., vol. 2, p. 134, notes two specimens from Guayaquil and indicates that they are the types. However, all records of the species have come from mountainous areas.

Stenocercus nigromaculatus Noble

Stenocercus nigromaculatus Noble, 1924, Occ. Pap. Boston Soc. Nat. Hist., vol. 5, p. 112. Huancabamba, Peru (MCZ 17975).

RANGE: Highlands of Northern Peru.

Stenocercus simonsii Boulenger

Stenocercus simonsii Boulenger, 1899b, Ann. Mag. Nat. Hist., ser. 7, vol. 4, p. 454. Oña, Ecuador (BM 1946.8.11.73–74).

RANGE: Highlands of Ecuador.

Stenocercus varius Boulenger

Stenocercus varius Boulenger, 1885, Cat. Lizards British Mus., vol. 2, p. 134, pl. 8, fig. 3. Unknown (BM 71.4.16.53).

RANGE: Highlands of Ecuador.

Genus THECADACTYLUS Oken

Thecadactylus rapicaudus (Houttuyn)

Gekko rapicaudus Houttuyn, 1782, Verh. Zeeuw. Genootsch. Wet. Vlissingen, vol. 9, p. 323, pl. 3, fig. 1. "American Islands," restricted to Chichen Itza, Yucatán, Mexico, by Smith and Taylor, 1950, U.S. Nat. Mus. Bull., no. 199, p. 49 (type unknown).

RANGE: Lesser Antilles, Mexico, Central America, northwestern South America. Known from lowlands on both sides of the Andes in Ecuador.

Genus TROPIDURUS Wied

1. At least a few dorsal scales keeled 2
   Dorsal scales smooth . . . . *peruvianus*
2. Ventral scales smooth 3
   Ventral scales keeled . . . . *holotropis*
3. A dorsal denticulation or crest . . . . *occipitalis occipitalis*
   No dorsal denticulation or crest . . . . *torquatus**

Tropidurus holotropis Boulenger

Tropidurus holotropis Boulenger, 1912, Ann. Mag. Nat. Hist., ser. 8, vol. 10, p. 420. Alpayacu, Río Pastaza, Ecuador (BM 1946.8.29.64).

RANGE: Amazonian slopes in Ecuador and Peru.

Tropidurus occipitalis occipitalis W. Peters

Tropidurus (*Laemopristus*) *occipitalis* W. Peters, 1871b, Monatsb. Akad. Wiss. Berlin, p. 645. Peru (BerM 6446).

Tropidurus continentalis Müller, 1924, Mitt. Zool. Mus. Berlin, vol. 11, no. 1, p. 82. Machalilla, Ecuador (BerM 26397).

RANGE: Coastal areas of southwestern Ecuador and northwestern Peru.

Tropidurus peruvianus peruvianus (Lesson)

Stellio peruvianus Lesson, 1826, *in* Duperrey, Voy. "Coquille," Reptiles, vol. 5, pl. 2, fig. 2; vol. 2, pt. 1, 1830, p. 40. Callao and Payta, Peru (PM 6873).

RANGE: Coastal southwestern Ecuador and northwestern Peru.

Genus TUPINAMBIS Daudin

1. About 30 ventral scales across middle of belly; one loreal . . . . *nigropunctatus*
   36 to 40 ventral scales across middle of belly; two loreals . . . . . . *teguixin**

Tupinambis nigropunctatus Spix

Tupinambis nigropunctatus Spix, 1825, Spec. Nov. Lacert. Brasiliam, p. 18, pl. 20. Brazil (Leipzig?).

RANGE: Amazon Basin.

REMARKS: *Tupinambis teguixin* (Linnaeus) was recorded from "Napo or the Upper Marañon" by Cope, 1868, Proc. Acad. Nat. Sci. Philadelphia, vol. 30, p. 99. It is very likely that the species is Ecuadorian, but I know of no other records.

Genus URACENTRON Kaup

Uracentron flaviceps (Guichenot)

Doryphorus flaviceps Guichenot, 1855, *in* Castelnau, Exp. Amér. Mérid., Reptiles, p. 26, pl. 3, fig. 2. Sarayacu, Peru (PM 6882).

RANGE: Upper Amazonian areas of Ecuador and Peru.

REMARKS: Guibé, 1954, Cat. Types Lézards Paris Mus., p. 41, indicates that *flaviceps* is a synonym of *Uracentron azureum* (Linnaeus). I have seen no documentation of this synonymy and retain *flaviceps* until such documentation is published. *Uracentron castor* (Cope), 1870, was described from Pebas, "Ecuador," but this locality is actually in Peru. No Ecuadorian specimens are known to me, but the species is to be expected in Ecuador, if it is validly distinct from *flaviceps*.

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NOCTUID MOTHS OF THE AMERICAN GENUS EUSCEPTIS HÜBNER

By E. L. Todd [1]

This paper, a revision of the genus *Eusceptis* Hübner, is the first of a proposed series of revisionary papers on the American species of the noctuid subfamily Acontiinae. The purpose of this paper is to provide keys, illustrations, and descriptions that will facilitate identifications, and to assemble the accumulated knowledge pertaining to the distribution and biology of the species of the genus. The revision is the result of a study of the literature and the specimens in the collection of the United States National Museum, supplemented by specimens and information received from the following individuals and institutions: D. S. Fletcher, British Museum (Natural History), London, England; W. Forster, Zoologische Sammlung des Bayerischen Staates, Munich, Germany; H. K. Clench, Carnegie Museum, Pittsburgh, Pa.; J. G. Franclemont, Cornell University, Ithaca, N.Y.; F. H. Rindge, American Museum of Natural History, New York, N.Y.; F. F. Yépez, Universidad Central de Venezuela, Maracay, Venezuela; P. Köhler, Buenos Aires, Argentina; C. M. Biezanko, Pelotas, Rio Grande do Sul, Brazil; and C. V. Covell, Jr., Louisville, Ky. Their assistance is gratefully acknowledged.

[1] Entomology Research Division, Agriculture Research Service, U.S. Department of Agriculture, Washington, D.C.

The line drawings of genitalia were prepared by Arthur Cushman, Scientific Illustrator, Entomology Research Division. The photographs of adult moths were made by staff photographers of the Photographic Services, U.S. Department of Agriculture.

Genus *Eusceptis* Hübner

Eusceptis Hübner, 1823, Zuträge zur Sammlung exotischer Schmettlinge [sic], Zweites Hundert, p. 21.—Hampson, 1910, Catalogue of the Lepidoptera Phalaenae in the British Museum, vol. 10, p. 793.—Sherborn, 1922, Index animalium 1801–1850, p. 2250.—Schulze, et al, 1929, Nomenclator animalium generum et subgenerum, vol. 2, p. 1232.—Hemming, 1937, "Hübner," vol. 2, p. 198.—Neave, 1939, Nomenclator zoologicus, vol. 2, p. 370. (Type species: *Eusceptis irretita* Hübner, monobasic.)

Eugraphia Guénée, 1852, Histoire naturelle des insectes: Species général des lépidoptères, vol. 6 (Noctuélites, II), p. 208.—Walker, 1857, List of the specimens of lepidopterous insects in the collection of the British Museum, pt. 12, p. 776.—Scudder, 1882, Bull. U.S. Nat. Mus., no. 19, pt. 2, p. 119.—Druce, 1889, *in* Godman and Salvin, Biologia Centrali-Americana, Insecta, Lepidoptera, Heterocera, vol. 1, p. 304; 1896, Ann. Mag. Nat. Hist., ser. 6, vol. 18, p. 42.—Hampson, 1910, Catalogue of the Lepidoptera Phalaenae in the British Museum, vol. 10, p. 792.—Strand, 1913, Arch. Naturg., vol. 79 (A), nos. 7–9, p. 62; 1916, Arch. Naturg., vol. 82 (A), nos. 1–13, p. 39.—Schulze, et al, 1929, Nomenclator animalium generum et subgenerum, vol. 2, p. 1274.—Draudt, 1939, *in* Seitz, Gross-Schmetterlinge der Erde, vol. 7, p. 397.—Neave, 1939, Nomenclator zoologicus, vol. 2, p. 326.—Biezanko, Ruffinelli and Carbonell, 1957, Rev. Fac. Agron. Univ. Rep. Uruguay, no. 46, p. 53. (Type species: *Eusceptis irretita* Hübner, monobasic.) [New synonymy.]

The generic names *Eusceptis* Hübner and *Eugraphia* Guénée are isogenotypic. Guénée, 1852, accepted Hübner's specific name, but not his generic name. Instead, he proposed *Eugraphia* as the generic name for *irretita* Hübner. The Hübnerian generic name has also been ignored in all subsequent taxonomic treatments and in all catalogs.

Head with proboscis well developed; labial palpi small, nearly porrect, very slightly curved dorsad, third segment very short, second segment three or four times as long, vestiture mainly of appressed scales except longer and looser along ventral margin especially of two basal segments; frons slightly bulbous, smooth or roughened medially, clothed mostly with appressed, incurved scales; eyes large, hemispherical, naked; ocellus small, adnate to upper margin of eye immediately caudad of base of antenna; antenna usually more or less filiform, oval or cuneate in cross section, pubescent ventrally and shortly spiculate, males of *E. effusa* (Druce) and *E. atriora,* new species, with longer spicules. Vestiture of thorax a mixture of scales and hair, no obvious crests present, metathoracic scales occasionally as slight decumbent crest; tympanum shielded dorsally by a large alular fan of very large scales. Abdomen clothed with hair and scales, no dorsal tufts present, terminal tufts about genitalia in males of *effusa* and *atriora*. Legs rather stout, tarsus longer than tibia; tibia of foreleg about half as long as femur, bearing a well-developed epiphysis, tibia of middle and hindlegs longer; inner spurs of pairs on middle and hindlegs about twice as long as outer spur; tibia of middle leg rough scaled with median and apical tufts. Forewing traingular, apex rounded, termen rounded except slightly excavate before tornus, inner margin slightly sinuous, excavate distally; hindwing more or less rounded, very slightly angled at Cu_1, inner margin expanded over abdomen in *effusa* and *atriora*, a hair pencil on ventral surface of expansion; venation of general noctuid type, forewing with R_3 from R_2 adnate with R_4 to form small elliptical accessory cell, R_3 stalked with R_4 for one-fourth their length from apex of accessory cell, stalk of R_3+R_4 connate with R_5 at apex of accessory cell, M_1 from mdc slightly below accessory cell, M_2 from just above lower angle of discal cell, M_3 from lower angle of discal cell, Cu_1 from just basad of lower angle of discal cell, M_2 and Cu_1 approximately equidistant from one another, R_1 and Cu_2 from the outer third of the two sides of the discal cell; hindwing with Rs and M_1 connate from upper angle of discal cell, M_2 from below middle of discocellulars, very weak or partially obsolescent, parallel to M_3, M_3 and Cu_1 connate or shortly stalked from lower angle of discal cell; length of forewing 9 to 17 mm.

Male genitalia with moderate, slightly curved uncus, uncus with a minute hooked spine at apex, a row of basally directed spines along either ventrolateral margin of uncus; scaphium of two straplike sclerotizations, each terminating in a dense hair tuft; juxta irregularly diamond shaped with an elongate, dorsal, straplike sclerotization; valves moderately large, widest just before apex, interfacial processes when present usually asymmetrical, sacculus well developed, usually bearing a large apical or costal spine, a large clasper usually present on one or both valves, absent in *E. irretita* Hübner; when present apex usually hooked, length of clasper usually bearing a row of fascicles of hair and frequently a row of sclerotized triangular dentations; corona short, consisting of about 10 spines, absent in *E. irretita* and *E. koehleri*, new species, coronal spines nearly as long as width of corona; aedeagus moderate, slightly shorter than valve, slightly sinuous, largest at apex, vesica with scobinate areas but no conspicuous cornuti. Female genitalia with valve of ovipositor roundly pointed, moderately sclerotized bearing rows or clumps of large setae basally and clumps of smaller setae distally, posterior apophyses slightly longer than anterior pair; posterior margin of seventh abdominal sternite usually emarginate medially, the lateral lobes thus formed usually slightly different in size and shape; ductus bursae usually with a sclerotization near ostium, absent in *E. obscura* (Schaus), remainder broad, twisted, and irregularly furrowed; bursa copulatrix membranous, lacking signa, internally uniformly spiculate, the spicules extremely minute except in *E. obscura.*

The immature stages and food plants of the species of *Eusceptis* Hübner are completely unknown.

The genus *Eusceptis* Hübner belongs to the tribe Acontiini and apparently is most closely related to the genus *Acontia* Ochsenheimer (=*Tarache* Hübner). The two were separated in the "Key to the Genera" (Hampson, 1910, Catalogue of the Lepidoptera Phalaenae in the British Museum, vol. 10, pp. 7 and 8) by choices "d^2" and "e^2," the difference being whether the frons possessed a rounded prominence or no prominence. The species of *Acontia* usually do possess a more bulbous frons than the species of *Eusceptis,* but it is a very slight difference of degree and scarcely sufficiently distinctive to be considered diagnostic for these genera. In the generic diagnoses in the same work, Hampson (op. cit., pp. 723 and 792), indicates that *Acontia* (as *Tarache*) species have a decumbent metathoracic crest which is lacking in *Eusceptis* (as *Eugraphia*) species. In some species of *Acontia* the decumbent crest is no more developed than in the species of *Eusceptis.* The two genera are very closely related, but may be separated by the nature of the uncus of the male genitalia. In *Eusceptis* the uncus has a row of basally directed spines along either ventrolateral margin. The uncus is simple in *Acontia.*

The species of the genus are essentially found in the neotropics, but some species approach the temperate regions of North and South America.

Key to Adults of *Eusceptis*

(Based on wing maculation)

1. Hindwing black . . . . **obscura** (p. 6)
   Hindwing mostly white, orange, or yellow 2
2. Forewing with some yellow or orange in the terminal area between vein M_1 and the tornus 4
   Terminal area of forewing dark 3
3. Dark marginal band of hindwing of male nearly uniform in width; same band of female usually terminating at about Cu_2 . . . . **effusa** (p. 7)
   Dark marginal band of hindwing of male tapering toward anal angle, width at $Rs+M_1$ about twice width at Cu_2; same band of female reaching anal angle . . . . **atriora** (p. 8)
4. Outer, dark costal mark of forewing about equal in width to median mark. 5
   Outer, dark costal mark of forewing about twice as wide as median mark . 6

5. Outer, dark costal mark of forewing looped basad immediately above lower angle of cell; orange terminal line of forewing curved around apex, nearly reaching costa . . . . **koehleri** (p. 11)
   Outer, dark costal mark of forewing usually not looped basad above lower angle of cell; orange terminal line of forewing not curved around apex. **irretita** (p. 10)
6. Dark basal part of ocellate spots of postmedian area of forewing separate; fringe usually paler than oblique bar, especially at outer edge 7
   Dark basal part of ocellate spots of forewing united into a sinuous line; fringe uniformly dark 9
7. Hindwing of male mostly white with orange near outer margin only; subterminal, oblique, gray bar of forewing of female wider at basal end than at apex . . . . **extensa** (p. 17)
   Hindwing of male mostly orange; subterminal, oblique, gray bar of forewing of female usually widest near apex; distal yellow area level with apex of Cu_2 as wide as or wider than base of oblique, gray bar 8
8. Fringe of forewing more or less concolorous with gray terminal line; terminal line extending from dark apex almost to tornus (South America). **splendens** (p. 13)
   Fringe of forewing usually paler than gray terminal line; terminal line not reaching apex or crossing anal vein (Central America) . . **lelae** (p. 16)
9. Hindwing of male orange; oblique, subterminal, gray bar of forewing divided or paler at middle; hindwing of female lacking a fuscous spot at apex. **robertae** (p. 18)
   Hindwing of male with basal half whitish; oblique, subterminal, gray bar not divided or paler at middle; female with fuscous spot present at apex of hindwing . . . . **paraguayensis** (p. 19)

Key to Males of *Eusceptis*

(Based on genitalia)

1. Valves lacking a corona (figs. 19 and 20) 2
   Valves with a conspicuous short corona (example, fig. 22) 3
2. Sacculus of right valve greatly enlarged, right valve with clasper present distad of sacculus (fig. 20) . . . . **koehleri** (p. 11)
   Sacculus of right valve not enlarged, subequal to sacculus of left valve, valves simple, clasper absent (fig. 19) . . . . **irretita** (p. 10)
3. Left valve lacking a clasper (fig. 22) . . . . **obscura** (p. 6)
   Left valve with a clasper (example, fig. 23) 4
4. Sacculus of left valve more than half as long as valve, apex of sacculus produced into a large dorsally directed spine (figs. 23 and 24) 5
   Sacculus of left valve short, usually decidedly less than half as long as valve, spine of sacculus small or arising from near middle of costal margin (example, fig. 27) 6
5. Costal spine of sacculus of right valve longer than distance from its base to apex of sacculus; sacculus of left valve only slightly wider than sacculus of right valve (fig. 24) . . . . **effusa** (p. 7)
   Costal spine of sacculus of right valve shorter than distance from its base to apex of sacculus; sacculus of left valve distinctly wider than sacculus of right valve (fig. 23) . . . . **atriora** (p. 8)

6. Clasper of left valve short, apex scarcely reaching apical third of valve . . 7
   Clasper of left valve long, reaching beyond apex of valve 9
7. Sacculus of right valve with a spine projecting from the dorsal margin (fig. 29) . . . . **extensa** (p. 17)
   Sacculus of right valve lacking a spine on the dorsal margin (figs. 25 and 27) 8
8. Clasper of left valve nearly straight, apex slightly clubbed (fig. 25). **lelae** (p. 16)
   Clasper of left valve hooked, apex usually pointed (fig. 27) . **splendens** (p. 13)
9. Clasper of right valve short, reaching about to middle of valve (fig. 31). **robertae** (p. 18)
   Clasper of right valve long, reaching slightly beyond apex of valve (fig. 34). **paraguayensis** (p. 19)

Eusceptis obscura (Schaus), new combination

Figures 7, 8, 22

Acontia obscura Schaus, 1898, Journ. New York Ent. Soc., vol. 6, no. 2, p. 117.

Eugraphia obscura (Schaus).—Hampson, 1910, Catalogue of the Lepidoptera Phalaenae in the British Museum, vol. 10, p. 795, pl. 174, fig. 3.—Draudt, 1939, *in* Seitz, Gross-Schmetterlinge der Erde, vol. 7, p. 397.

Acontia trilinea Schaus, 1898, Journ. New York Ent. Soc., vol. 6, no. 2, p. 117. [New synonymy.]

Eugraphia trilinea (Schaus).—Hampson, 1910, Catalogue of the Lepidoptera Phalaenae in the British Museum, vol. 10, p. 795, pl. 174, fig. 2.—Draudt, 1939, *in* Seitz, Gross-Schmetterlinge der Erde, vol. 7, p. 397.

The uniformly black hindwings of this species separate it from all the other known species of the genus. Length of forewing: male, 16 mm.; female, 17mm.

Types: The type of *obscura* (USNM 10658), a female from Guadalajara, Mexico, and that of *trilinea* (USNM 10659), a male from Jalapa, Mexico, are in the collection of the U.S. National Museum.

Distribution: Known only from Guadalajara and Jalapa, Mexico. Only four specimens are known to have been collected.

Remarks: Schaus indicated in the original descriptions that *trilinea* (fig. 7) and *obscura* (fig. 8) might represent the two sexes of a single species. The two names apply to the same species, but it is possible that the specimen named *trilinea* may represent a distinct form. The two known male specimens have the same genitalia (fig. 22), but they differ in maculation of the forewing, one specimen being dark like the type of *obscura*. Because only two males are available for study, it is not known whether specimens exist that are intermediate in maculation of the forewing between the dark type of *obscura* and the orange-streaked type found in *trilinea*. The solution of this problem must of necessity await the collection of more specimens of this species.

Method of determination: By examination of the type.

Eusceptis effusa (Druce), new combination

FIGURES 4, 5, 24

Eugraphia effusa Druce, 1889, *in* Godman and Salvin, Biologia Centrali-Americana, Insecta, Lepidoptera, Heterocera, vol. 1, p. 304, table 28, fig. 12; 1898, ibid, vol. 2, p. 492.—Hampson, 1910, Catalogue of the Lepidoptera Phalaenae in the British Museum, vol. 10, p. 794.—Strand, 1913, Arch. Naturg., vol. 79 (A), nos. 7–9, p. 62.—Draudt, 1939, *in* Seitz, Gross-Schmetterlinge der Erde, vol. 7, p. 397.

This species and the following one, *E. atriora*, new species, differ from the other species of the genus in which the ground color of the hindwing is orange, yellow, or white (figs. 1–3, 9–18) in that the forewing distad of the postmedial band (excluding the costal pale spot) is dark (figs. 4–6), lacking the yellow or orange line that extends from tornus toward apex in the terminal area of the forewing of the other species. They also have a medial line of metallic scales in the basal and distal black costal marks of the forewing. The costal marks are uniformly dark in the other species. In addition, the hindwings of males of *effusa* and *atriora* are modified. The inner margin of the hindwing is expanded, upturned and curved over the abdomen. This modified area of the hindwing forms a concavity on the ventral surface and contains a tuft of long hairs. *E. effusa* (Druce) and *E. atriora*, new species, are extremely closely related entities; however, there are a number of differences in maculation and in the male genitalia. One of the more obvious differences is the degree of development of the dark marginal band of the hindwing. In *effusa* males the marginal band of the hindwing is nearly uniform in width and extends from the apex to about Cu_1. In males of *atriora* the marginal band at $Rs+M_1$ is about twice as wide as at Cu_2, the band being distinctly tapered and extending from apex to beyond Cu_2. In the females of *effusa* the marginal band is rather similar to that of the males of *atriora*, but usually it is broader and more truncate at about Cu_2. In females of *atriora* the marginal band is much like that of *effusa* to Cu_2, but continues to taper on to the anal angle. One female specimen from Cayuga, Guatemala does have the marginal band terminating in a tapered point, but the band does not extend to the anal angle. There are other differences in maculation between the two species. Those differences and the differences in the male and female genitalia will be discussed in the description of *atriora*. Length of forewing: male, 14 mm.; female, 14 to 15 mm.

Type: The type, a female from Volcan de Chiriqui, Panama, is in the collection of the Königliche Zoologische Museum, Berlin, Germany.

Distribution: Southern Texas to Panama. Specimens from the following localities have been examined. Texas: Brownsville. Mexico: Misantla, Tamazunchale, Poza Rica. Guatemala: Cayuga, Quirigua.

A female from Santa Clara Valley, Costa Rica has been referred to this species by Druce and by Hampson. It will be necessary to examine the specimen to determine whether it is correctly placed. It is possible that it should be referred to the following species, *atriora*.

Remarks: Because I have this species only from localities in or to the north of Guatemala, and because it was not found in the large series of noctuids collected by Zetek and others on Barro Colorado Island, Canal Zone, Panama, the type locality (Panama) cited by Druce might be incorrect. Unless Druce misread the locality label on the type, it does not seem likely that it could be proved that an error might have occurred. On the other hand, the existence of specimens from Costa Rica and/or Panama or the subsequent collection of the species from those countries would certainly eliminate any doubt as to the correctness of the type locality.

Method of determination: This species is easily recognized by the excellent illustration of the female type accompanying the original description.

***Eusceptis atriora*, new species**

Figures 6, 23

Head with proboscis well developed; labial palpi small, very slightly curved dorsad, apical segment slightly exceeding ventral margin of frons, third segment very short (0.3 mm.), second segment four times as long, vestiture mainly of appressed, pale yellow scales except longer and looser along ventral margin, especially first segment and base of second segment, dorsum and dorsolateral area of second segment dark brown or black; frons smooth, scarcely exceeding anterior margin of eye, vestiture of appressed, down and incurved pale yellow scales; eyes, large, hemispherical, naked, about equal to frons in width; ocellus small (0.1 mm.), adnate to upper margin of eye immediately caudad of base of antenna; antenna black, filiform, spiculate laterally and ventrally, the spicules of the male about twice as long (0.1 mm.) as those of the female and more numerous. Vestiture of patagia, tegulae, and thorax a mixture of pale yellow hair and scales; a slight decumbent, metathoracic crest present. Abdomen orange dorsally and laterally, pale yellow or white ventrally with terminal black scales on segments 3 to 7 in the females, the males with much less black scaling except on segment 7; dorsal tufts absent. Pectus clothed with large, pale yellow or white scales and long, sparse, white hair; tympanum shielded dorsally by a very large alular fan of broad pale yellow scales. Legs banded with dark brown and pale yellow or white scales, the dark brown scales highly iridescent in certain lights; foreleg with tibia and tarsus clothed with dark brown scales except some pure white scales at base and apex of first tarsomere and at base of second tarsomere, scales of distal three-fifths of femur dark brown, scales of basal part white, trochanter clothed with longer, less appressed, pale yellow scales; middle leg similar to foreleg except tibia with a broad median ring of loose pale yellow scales, the dark scales at apex long, loose, down curved, forming a broad tuft, white scales at base of femur extending along dorsum to apex, tibial spurs dark brown except extreme apex of long, inner spur white; hindleg similar to middle leg except scales of tibia appressed, pale median part white and extending to base along dorsum, basal tibial spurs white except apical half of short outer spur. Venation of wings as for genus, accessory cell very small and narrow as in *effusa*. Wing shape as in *effusa* (figs. 4–6), male with inner margin of hindwing modified, upcurved over abdomen and bearing a tuft of long hairs in the pocket formed on the ventral surface. Pattern of maculation of upper surface of wings as illustrated (fig. 6, female), male resembling female except dark marginal band of hindwing less extensive, reaching only slightly beyond Cu_2. Ground color of basal part of forewing pale yellow; dark part of dark brown scales some iridescent brassy green in certain lights, some pale blue white scales usually present above tornus in cells Cu_1 and Cu_2; Y-shaped transverse line of metallic gray scales heavily bordered by dark brown scales. Hindwing yellow orange except dark brown marginal band, fringe dark with some white at outer edge; ventral surfaces of wings similar to dorsal surfaces except metallic gray Y-shaped transverse line of forewing absent, apical orange spot of hindwing larger and fringe of hindwing mostly white, basal costal band of dorsal surface of forewing absent on ventral surface of that wing in males. Length of forewing: male, 13 to 14 mm.; female, 14 to 15 mm.

Male genitalia as illustrated (fig. 23), very similar to that of *effusa* (fig. 24) except sacculus of left valve distinctly wider than sacculus of right valve, dorsally directed process of sacculus of left valve extending beyond costal margin of valve at a point well below corona, costal spine of sacculus of right valve shorter than distance from its base to apex of sacculus, and costal angle of apex of right sacculus forming a short, triangular projection. Female genitalia very similar to those of *effusa* except right lobe of seventh abdominal sternite weakly sclerotized along median emargination, left lobe of seventh abdominal sternite with a short, blunt projection medially at base of lobe, dorsal sclerotization of vaginal chamber about twice as long as wide.

Type: Type female, Sixaola River, Costa Rica, April 1907, Wm. Schaus (USNM 64639); 1 female paratype, same place, September; and 1 female paratype, Guapiles, Costa Rica, 850 ft. alt., May 1907, Wm. Schaus, in the U.S. National Museum, Washington, D.C. Two male paratypes, Sixaola River, Costa Rica, September, in the Carnegie

Museum, Pittsburgh, Pa. One female paratype, Costa Rica, Nevermann in the Zoologische Sammlung des Bayerischen Staates, Munich, Germany.

Distribution: Known only from Costa Rica.

Remarks: At the beginning of this study I thought the three female examples in the U.S. National Museum probably represented a dark form of *effusa* in which there was a greater development of the dark marginal band of the hindwing. This seemed to be a reasonable conclusion because other species of the genus, especially those of the *splendens* complex, do show considerable variation in the degree of development of the dark marginal band of the hindwings. However, when males became available for study, constant differences, even if slight, were found to exist in the genitalic characters and other differences in maculation were recognized. The broad sacculus of the left valve, the differently directed apical process of the left sacculus, the shorter costal spine of the right sacculus of the male genitalia, the differences in the sclerotized parts of the female genitalia, the heavy dark markings of the forewing, the presence of blue white patches of scales in cells Cu_1 and Cu_2 of the forewing, and the dark fringe of the hindwing (yellow in *effusa*) convinced me that this entity should be considered to be a species distinct from *effusa*.

The known localities for the species are both from the Caribbean side of Costa Rica. It is possible, therefore, that this species is geographically isolated from *effusa*, which may occur on the Pacific side of Costa Rica. Proof of the correctness of this supposition must of necessity depend on further collections of material from that country.

Eusceptis irretita **Hübner**

FIGURES 1, 19

Eusceptis irretita Hübner, 1823, Zuträge zur Sammlung exotischer Schmettlinge [sic], Zweites Hundert, p. 21, figs. 305, 306.

Eugraphia irretita (Hübner).—Guénée, 1852, Histoire naturelle des insectes: Species général des lépidoptères, vol. 6 (Noctuélites, II), p. 208.—Walker, 1857, List of the specimens of lepidopterous insects in the collection of the British Museum, pt. 12, p. 776.—Druce, 1889, *in* Godman and Salvin, Biologia Centrali-Americana, Insecta, Lepidoptera, Heterocera, vol. 1, p. 304.—Hampson, 1910, Catalogue of the Lepidoptera Phalaenae in the British Museum, vol. 10, p. 793, fig. 211.—Strand, 1913, Arch. Naturg., vol. 79 (A), nos. 7–9, p. 62.—Hemming, 1937, "Hübner," vol. 2, p. 198.—Draudt, 1939, *in* Seitz, Gross-Schmetterlinge der Erde, vol. 7, p. 397.

Noctua melanogramma Perty, 1833, Delectus animalium articulatorum quae in itinere per Brasiliam . . ., p. 163, pl. 32, fig. 10.—Walker, 1857, List of the specimens of lepidopterous insects in the collection of the British Museum, pt. 12, p. 776 [as a synonym of *irretita* Hübner].

This species, the type of the genus, is also the smallest species of the genus. It agrees with *E. koehleri*, new species, and differs from the other similarly marked species in that the outer dark costal mark of the forewing is about equal in width to the medial costal mark. *E. irretita* Hübner differs from *koehleri* by its slightly smaller size, by the absence of a loop in the outer costal mark of the forewing immediately above the lower angle of the cell, by the orange terminal line of the forewing not being curved around the apex of the wing, and by the characteristic male genitalia (fig. 19). The valvae of the male genitalia are simple, without spines or processes developed from or immediately beyond the sacculus. Length of the forewing: male, 9 to 10 mm.

Types: The present location of the type of *irretita* is unknown. It may be in the Naturhistorisches Museum, Vienna, Austria. Hübner's type was from Brazil. The type of *melanogramma* was from "Provincia Bahiensi," Brazil. It may be in the collection of the Zoologische Sammlung des Bayerischen Staates, Munich, Germany. At least part of Perty's types were received by that institution.

Distribution: *E. irretita* apparently is restricted to Brazil, possibly to the northeastern part of that country. Only four males have been examined. One is unlabeled, the other three are from Bahia and Pernambuco, Brazil.

Remarks: The illustration of Perty's *melanogramma* appears to be of a female. At least the marginal band of the hindwing is extensive and similar to that of the female of the related *koehleri*.

Method of determination: The species was identified from the excellent illustrations accompanying the original description. Perty's *melanogramma* was recognized as a synonym by means of the good illustration in his work.

***Eusceptis koehleri*, new species**

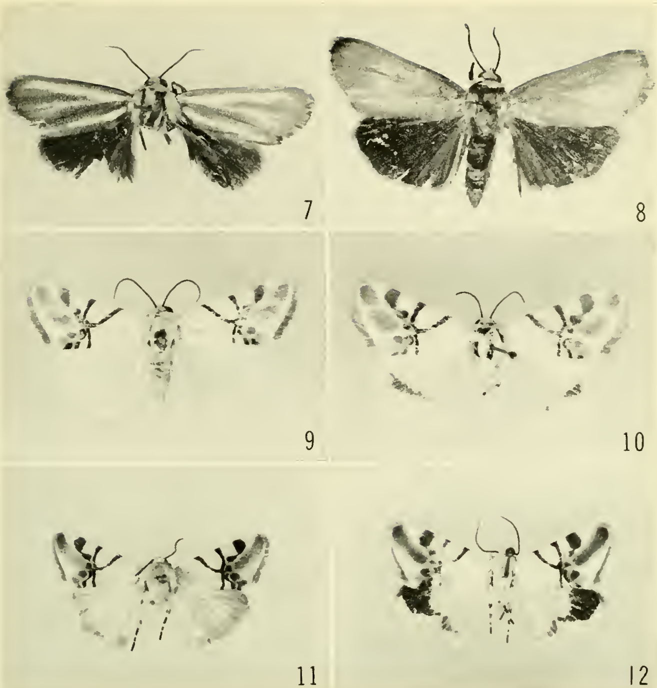
FIGURES 2, 3, 20, 21

Head with proboscis well developed; labial palpi small, very slightly upcurved, apical (third) segment slightly exceeding ventral margin of frons, third segment very short, second segment about four times as long, vestiture mainly of closely appressed pale yellow scales, except longer and looser at venter of first segment and second segment black dorsally and dorsolaterally; frons slightly bulbous, exceeding anterior margin of eye about one-fourth length of eye, rather rough medially, depressed before slightly porrect ventral margin, vestiture of appressed, down and incurved pale yellow scales; eyes large, about equal to frons in width, naked, hemispherical; antennae black, filiform, densely pubescent ventrally, with minute spicules present laterally and ventrally. Vestiture of patagia, tegulae, and thorax a mixture of pale yellow hair and scales; a slight decumbent, metathoracic crest present. Abdomen orange dorsally and laterally, pale yellow ventrally with lateral and/or terminal black scaling on segments 3 through 7; dorsal tufts absent. Pectus clothed with large, pale yellow or white scales and long, sparse, white hair; tympanum nearly covered by very large alular fan of broad yellow scales. Legs mainly pale basally, dark distally; foreleg with tibia and tarsus dark brown except small white spot at middle of tibia and white rings at base and apex of first tarsomere and apex of second; middle leg pale yellow except for dark brown knee spot, broad apical brown band on tibia (including spurs) and dark tarsus, tarsomeres 1 and 2 marked with white like those of foreleg; hindleg colored like preceding leg except dark knee spot absent. Venation of wings as for genus. Maculation of male similar to that of *irretita* (see figs. 1 and 2), except that outer, dark costal mark of forewing is distinctly looped basad immediately above lower angle of cell and terminal orange line extends around apex of wing. Basal half of upper surface of forewing lemon yellow, transverse lines black, subterminal oblique mark and fringe slate gray. Upper surface of hindwing orange around margins, white medially, a fuscous spot at apex. Ventral surface of forewing with ground color orange, median and apical costal marks, subterminal oblique mark and fringe dark fuscous or black; hindwing ventrally like upper surface except orange of costa brighter and small postmedial and antemedial spots present. Female colored as in male except upper surface of hindwing orange with broad marginal fuscous band, the latter incurved slightly at Cu_2; ventrally postmedial fuscous mark extending nearly to anal angle, broadest between M_2 and caudal end, antemedial spot variable in size, absent in one specimen. Length of forewing: male, 12 mm.; female, 12 to 13 mm.

Male genitalia of type specimen partially destroyed by dermestids; however, the valves are preserved and are distinctive (fig. 21). Right valve enlarged, much broader than left valve, sacculus broad, produced and curved toward costa at apex, a longer, curved process developed immediately distad of sacculus from near ventral margin of the valve. Female genitalia as illustrated (fig. 20), ductus bursae broad, rather long, only slightly sclerotized; caudal margin of seventh abdominal sternite not asymmetrical as in the females of the *splendens* complex.

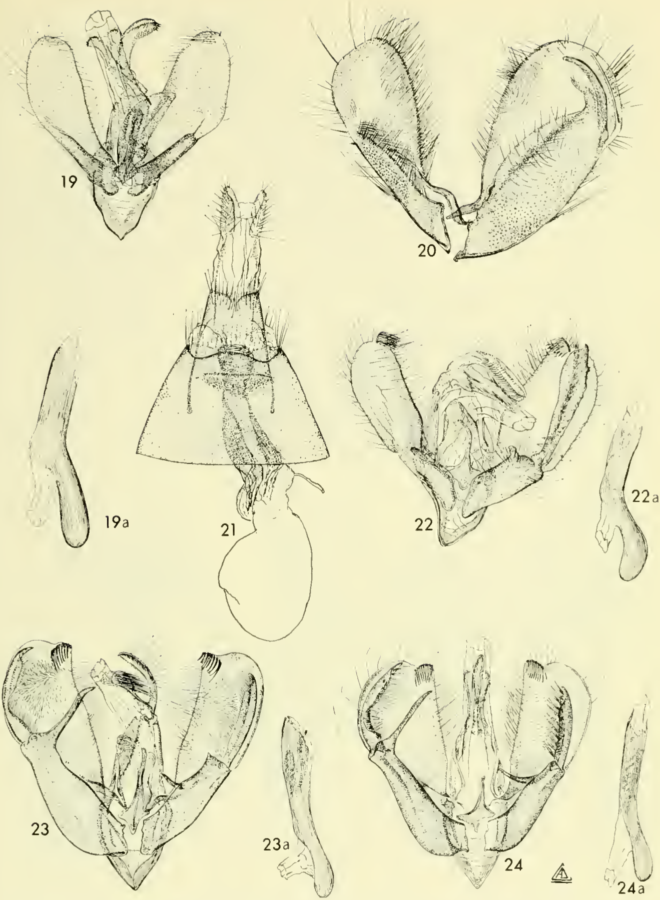
Types: Type male and two female paratypes, Alta Gracia, La Granja, Sierras de Cordoba, Argentina, C. Bruch, in the private collection of P. Köhler, Buenos Aires, Argentina. One female paratype, same data, in the U.S. National Museum.

FIGURES 1–6.—Dorsal view of adults of *Eusceptis* species: 1, *irretita*, male, Bahia, Brazil; 2, *koehleri*, male, type, Alta Gracia, La Granja, Sierra de Cordoba, Argentina; 3, *koehleri*, female, paratype, same place; 4, *effusa*, male, "Central America"; 5, *effusa*, female, Misantla, Mexico; 6, *atriora*, female, type, Sixaola River, Costa Rica.

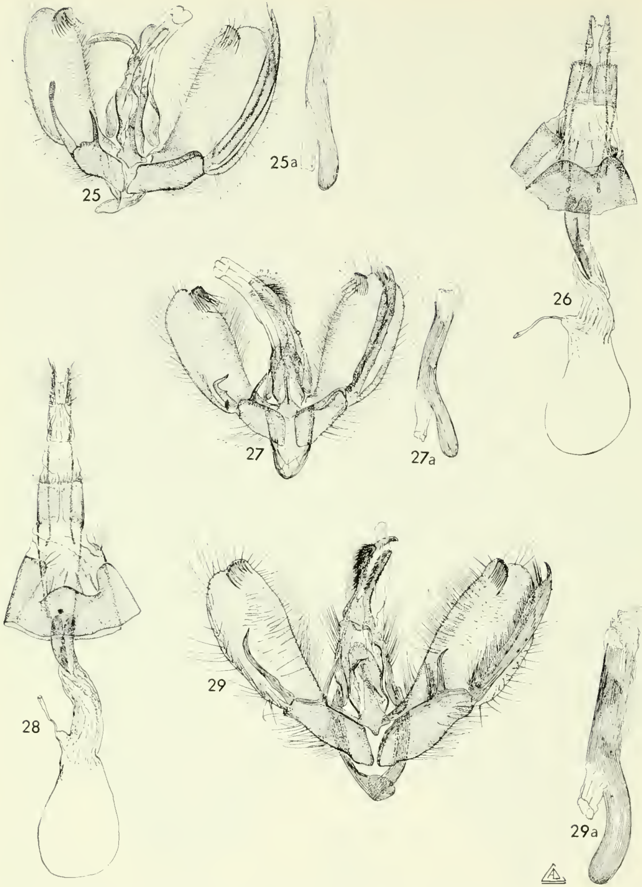


FIGURES 7–12.—Dorsal view of adults of *Eusceptis* species: 7, *obscura*, male, type of *trilinea* Schaus, Jalapa, Mexico; 8, *obscura*, female, type, Guadalajara, Mexico; 9, *robertae*, male, type, Tucumán, Argentina; 10, *robertae*, female, paratype, same place; 11, *paraguayensis*, male, Misiones, Argentina; 12, *paraguayensis*, female, Sapucay, Paraguay.

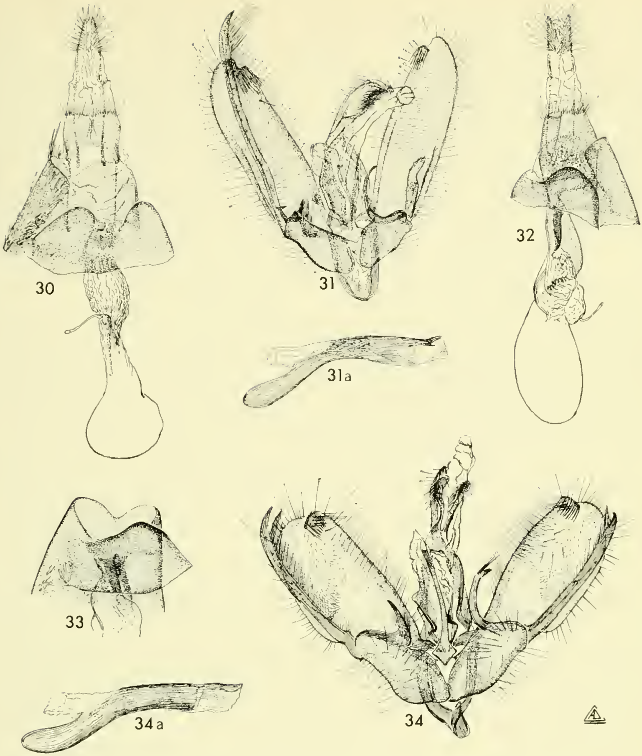
Figures 13–18.—Dorsal view of adults of *Eusceptis* species: 13, *lelae*, male, type, Avangarez, Costa Rica; 14, *lelae*, female, paratype, Mexico; 15, *splendens*, male, Zaruma, El Oro, Ecuador; 16, *splendens*, female, Rancho Grande, Aragua, Venezuela; 17, *extensa*, male, Viçosa, Minas Geraes, Brazil; 18, *extensa*, female, Puerto Bertoni, Paraguay.



Figures 19–24.—Male and female genitalia of *Eusceptis* species (aedeagus of male removed and figured separately): 19, *irretita*, male, Bahia, Brazil; 20, *koehleri*, male, type, Alta Gracia, La Granja, Sierra de Cordoba, Argentina (valves only); 21, *koehleri*, female, paratype, same place; 22, *obscura*, male, Guadalajara, Mexico; 23, *atriora*, male, paratype, Sixaola River, Costa Rica; 24, *effusa*, male, Cayuga, Guatemala.



FIGURES 25–29.—Male and female genitalia of *Eusceptis* species (aedeagus of male removed and figured separately): 25, *lelae*, male, type, Avangarez, Costa Rica; 26, *lelae*, female, paratype, Mexico; 27, *splendens*, male, Zaruma, El Oro, Ecuador; 28, *splendens*, female, Aroa, Venezuela; 29, *extensa*, male, Misiones, Argentina.



Figures 30–34.—Male and female genitalia of *Eusceptis* species (aedeagus of male removed and figured separately): 30, *extensa*, female, Puerto Bertoni, Paraguay; 31, *robertae*, male, paratype, Tucumán, Argentina; 32, *robertae*, female, paratype, same place; 33, *paraguayensis*, female, Sapucay, Paraguay (ductus bursae); 34, *paraguayensis*, male, Misiones, Argentina.

Distribution: Known only from the type locality.

Remarks: This species agrees with *irretita* and differs from the similarly marked species in that the outer, dark costal mark of the forewing is about equal in width to the median costal mark. The species is slightly larger than *irretita*, has the outer, dark costal mark of the forewing distinctly looped immediately above lower angle of the cell, and has the terminal orange line extending around the apex of the wing. In addition, the male genitalia are specifically distinct.

Eusceptis splendens (Druce), new combination

FIGURES 15, 16, 27, 28

Eugraphia splendens Druce, 1896, Ann. Mag. Nat. Hist., ser. 6, vol. 18, p. 42.—Hampson, 1910, Catalogue of the Lepidoptera Phalaenae in the British Museum, vol. 10, p. 793, pl. 174, fig. 1 [in part].—Strand, 1913, Arch. Naturg., vol. 79 (A), nos. 7–9, p. 62.— Kaye and Lamont, 1927, Mem. Dept. Agric. Trinidad and Tobago, no. 3, p. 66 [in part].—Draudt, 1939, *in* Seitz, Gross-Schmetterlinge der Erde, vol. 7, p. 397 [in part].

Eugraphia irretita (Hübner).—Weymer and Maasen not Hübner, 1890, Lepidopteren gesammelt auf einer Reise durch Colombia, Ecuador, Peru, Brasilien, Argentinien und Bolivien in den Jahren 1868–1877 von Alphons Stubel, p. 67.

The *splendens* complex is composed of at least five species, some of which have been misidentified as *splendens* or treated as forms or aberrations of that species. The species of this complex (figs. 9–18) may be separated from the other species of the genus by the following combination of maculational characters: hindwing with some orange, yellow, or white, terminal area of forewing with some yellow between vein M_1 and tornus, and outer, dark costal mark of forewing about twice as wide a median costal mark.

The species of the *splendens* complex form three segregates on genitalic and maculational characters. *E. splendens* (Druce) and *E. lelae*, new species, extremely closely related species, form one segregate. Two other species, *E. paraguayensis* (Draudt) and *E. robertae*, new species, belong to a second distinct segregate. The fifth species, *E. extensa* (Strand), is intermediate on maculation and genitalic characters and is considered to be a separate segregate. The species and the segregates of the *splendens* complex can be identified by means of the characters utilized in the keys.

The known geographic distribution of the four species of the *splendens* complex in South America is illustrated on map 1. The fifth species, *E. lelae*, new species, is known to occur in Mexico, Guatemala, and Costa Rica.

E. splendens (Druce) is redescribed in this paper because other species of the complex have been confused with it in the past and because a detailed description of *splendens* will simplify the descriptions of new species of the complex.

Head with proboscis well developed; labial palpi small, very slightly curved dorsad, apical segment slightly exceeding ventral margin of frons, apical segment very short (0.3 mm.), second segment about three times as long, vestiture mainly of appressed, pale yellow scales except longer and looser along ventral margin of first and second segments, dorsum and dorsolateral area of second segment light brown; frons smooth, scarcely exceeding anterior margin of eye, vestiture of appressed, pale yellow scales; eyes large, hemispherical, naked, about equal to frons in width; ocelli present, moderate, adnate to upper margin of eye immediately caudad of base of antenna; antenna dark reddish brown, filiform, ventral pubescent area wedge-shaped in the male, round in the female, weakly spiculate. Vestiture of patagia, tegulae, and thorax a mixture of pale yellow hair and scales; a slight, decumbent, metathoracic crest present. Abdomen mostly orange dorsally and laterally, the two basal segments pale yellow, the remainder orange, the terminal segments darkest; venter pale yellow except caudolateral angles and terminal margins of sternites light to dark brown, the amount of brown variable, last three sternites of females usually brown; dorsal tufts absent. Pectus clothed with large white, appressed scales and long pale yellow hair and scales; tympanum shielded dorsally by a very large alular fan of very large pale yellow scales. Legs banded with various shades of brown and pale yellow or white scales, foreleg darkest; tarsus of foreleg dark brown except base and apex of first tarsomere and apex of second tarsomere ringed with white, tibia dark brown distally, light yellowish brown basally, a small median white point between the two shades of brown, femur with basal third white, remainder yellowish brown; tarsus of middle leg similar to that of foreleg, white bands of tarsomeres slightly broader, tibia with a broad band of loose pale yellow scales, base yellowish brown, apex darker forming a terminal brush, base and dorsum of femur white, remainder yellowish brown, tibial spurs usually white except basal half of short outer spur yellow brown; hindleg similar to middle leg except white bands of tarsomeres broader, scales of tibia more appressed, pale band white, dark terminal part with shorter scales and forming a shorter less prominent tuft, tibial spurs usually white except basal part of short outer spur of terminal pair yellowish brown. Venation as for genus. Wing shape and pattern of maculation of dorsal surface of wings as illustrated (figs. 15 and 16). Ground color of dorsal surface of forewing pale lemon yellow; transverse lines, oblique subterminal bar and fringe gray brown, subterminal bar darkest toward apex, paler and slightly narrowing toward base, fringe and terminal line more or less unicolorous, the dark scaling usually extending to tornus; some dull reddish brown shading basad of base of oblique subterminal bar and beyond upper ocellate spot of postmedial band; ocellate spots of postmedial band composed of basal brown crescent, median blue gray line and an outer dark mark, outer dark mark of lower ocellate spot nearly black, usually darker than similar mark of other ocellate spot. Hindwing yellow orange, paler in male than in female, especially toward base; a dark brown apical spot usually present, larger in females than in males, in some females a dark subterminal spot present on costa. Ventral surface of wings mostly yellowish orange, paler, nearly white before apical dark spots; dark brown marks of forewing consisting of oblique subterminal bar, two outer costal marks and a dark outer mark of lower ocellate spot, oblique subterminal bar with apical third much darker than remainder of bar, basal part vague or absent in males. Length of forewing: male, 12 to 14 mm.; female, 12 to 15 mm.

Male and female genitalia as illustrated (figs. 27, 28). Clasper of left valve of male genitalia hooked or bent dorsad, the apex of the clasper variable in shape, pointed or weakly clavate; left sacculus only with a costal spine. Ductus bursae of female genitalia with a sclerotized groove to the right; ductus seminalis arising from a lobe on the right side of bursa copulatrix.

Type: A female from Guayaquil, Ecuador in the British Museum (Natural History), London, England via the Druce collection. In the original description Druce does not indicate the number of specimens, but he indicates the specimen described was a male. The statement in the original description (1896, p. 42) ". . . secondaries bright chrome-yellow, with three black spots close to the apex. . . ." proves that the specimen was a female and that Druce was in error as to the sex. Males either lack an apical black spot on the hindwing or have only a single spot, females may have one, two, or three spots. Examples appearing to have three spots actually have the apical spot divided into two spots by yellow orange scales along vein M_1. In the British Museum there are four other specimens from Guayaquil, Ecuador (Dolby-Tyler collection); but they were in that collection before the type (see Hampson, 1910, p. 793).

Distribution: This species occurs in northern South America. Thirty specimens from the following localities have been examined. Ecuador: El Oro, Zaruma. Colombia: Popayan. Venezuela: Aroa; Las Quiguas, Carabobo; Rancho Grande, Aragua; Alto de Yuma, near Güigüe, Carabobo; El Limón, near Maracay, Aragua; Maracay, Aragua; and Santa Lucia, Miranda. Trinidad: Caparo. In addition to the five specimens from Guayaquil, Ecuador, there is one female from Trinidad in the British Museum (Natural History).

Remarks: This species is very similar to *E. lelae*, new species, from which it may be separated by slight differences in maculation, genitalia, and by geographical distribution as explained in the discussion of *lelae*. It may be separated from the other species of the *splendens* complex by the characters indicated in the keys.

Method of determination: The species was identified from the illustration in Hampson, 1910, pl. 174, fig. 1. A photograph of a specimen so identified was then compared with the type for me by Mr. D. S. Fletcher at the British Museum.

***Eusceptis lelae*, new species**

FIGURES 13, 14, 25, 26

This species is very similar to *splendens* except the gray brown terminal line usually does not cross the anal vein or reach the apex of the forewing, the fringe usually paler; the dull reddish-brown shading basad of base of oblique subterminal bar and distad of upper ocellate spot of forewing paler; outer dark mark of upper ocellate spot nearly as dark as similar mark of lower ocellate spot; clasper of left valve straight or nearly so, clubbed apically (fig. 25). Length of forewing: male, 13 to 14 mm.; female, 14 to 15 mm.

Type: Type male, Avangarez, Costa Rica, July–August, William Schaus (USNM 64640); 1 male paratype, same place, July, Schaus and Barnes collectors; 1 male paratype, Chejel, Guatemala, June, Schaus and Barnes collectors; 1 male paratype, Cayuga, Guatemala, April, Schaus and Barnes collectors; 1 female paratype, Mexico, no date or collector, and 1 female paratype, Mexico City, Mexico, no date or collector, in the collection of the U.S. National Museum. One male paratype, Quirigua, Guatemala, September, Schaus and Barnes collectors, in the Carnegie Museum, Pittsburgh, Pa.

Distribution: This species is known to occur in Mexico, Guatemala, and Costa Rica.

Remarks: *E. lelae*, new species, and *E. splendens* (Druce) differ in maculation from *E. extensa* (Strand) in that the gray brown subterminal oblique bar of the female is not widest at base and in that the hindwing of the male is mostly yellow orange. They differ from the other two species of the complex in that the basal parts of the ocellate spots of the forewing do not form a sinuous line and in that the fringe is not uniformly dark. In the male and female genitalia *lelae* and *splendens* agree and differ from the other species of the *splendens* complex because the right valve lacks a costal spine of the sacculus and the sclerotized part of the ductus bursae forms a groove to the left side.

This species is named after my mother in recognition of her encouragement of my boyhood entomological interests.

Eusceptis extensa (Strand), new combination

FIGURES 17, 18, 29, 30

Eugraphia extensa Strand, 1913, Arch. Naturg., vol. 79 (A), nos. 7–9, p. 62.
Eugraphia splendens f. *extensa* Strand.—Draudt, 1939, *in* Seitz, Gross-Schmetterlinge der Erde, vol. 7, p. 397.

The pattern of maculation of the dorsal surface of the forewing of this species is like that of *splendens* except the gray brown oblique subterminal bar is widest toward the base. The pattern of maculation of the dorsal surface of the hindwing is more like that of *E. paraguayensis* (Draudt). The males have the hindwing mostly white with a narrow marginal band of yellow and a dark brown apical spot. The hindwing of the female is yellowish orange usually with a heavy dark brown marginal band, the latter being widest at costa, bent basad at M_3, usually broken at Cu_2 and followed by a short recurved spur of brown scales. The ventral surfaces of the wings of the male are like those of *splendens* except the hindwing is mostly white. The markings of the ventral surface of the forewing of the female are very dark and usually fused together into a large median and subterminal spot connected to the dark costal marks. The amount of dark scaling present on both surfaces of the hindwing of females is variable, but more so on the ventral surface, varying from two moderate spots, one at apex and one on costa, to a repetition of the broad marginal band usually occurring on the dorsal surface. Length of forewing: male, 14 mm.; female, 14 to 15 mm.

Male and female genitalia as illustrated (figs. 29 and 30), intermediate to those of the other two segregates of the *splendens* complex. Left clasper of male genitalia decidedly smaller than clasper of right valve as in *splendens* and *lelae*, but costal margin of sacculus of right valve with a well-developed spine as in *robertae* and *paraguayensis*. Sclerotized groove in ductus bursae of female genitalia short, extending along ventral surface, not directed to either the left or right side.

Type: A female from Huayabamba, Peru, in the collection of the Königliche Zoologische Museum, Berlin, Germany.

Distribution: Ten examples of this species from the following localities have been examined. Brazil: Viçosa, Minas Geraes, and Chapada near Cuyabá, Matto Grosso. Argentina: Remsers, Missiones and "Misiones." Paraguay: Puerto Bertoni. Bolivia: Prov. del Sara. There are two females of this species from Salto Grande, Paraná and Campinas, São Paulo, Brazil in the British Museum (Natural History). This species appears to be intermediate in distribution, occupying a range between those of the *splendens-lelae* and the *paraguayensis-robertae* segregates.

Remarks: There are several reasons for questioning the determination that the species treated is actually *extensa*. First, the type is officially unavailable to me and no illustration of it exists. Second, I have not seen any examples of this genus from Peru and I do not know of the existence of other museum specimens. Peruvian entomologists were unable to supply examples. Third, there is a question about the type locality. There are at least three populated places named Huayabamba in Peru. Two are in the northern part of San Martín and Cajamarca. The other is in the southern part of Cusco. In the original description the abbreviation "or." follows the type locality. I presume it refers to the Spanish word, oriente, meaning east. All three Peruvian localities named Huayabamba are on the eastern side of the Andes, but the one in Cusco is at least 5° east of the other two and it is much nearer to the known range of the species I am identifying as *extensa* in this paper. An examination of the genitalia of the type would verify whether the name *extensa* is correctly applied.

Method of determination: This species has been determined as *extensa* by comparison with the original description, especially the remarks on the maculation of the hindwing. It is true that the maculation of that wing does vary to some extent in the other species of the complex and therefore, the character alone is not completely reliable; but considering our total knowledge of the complex, I believe the name is correctly applied.

***Eusceptis robertae*, new species**

Figures 9, 10, 31, 32

Structure, vestiture, and coloration of head, thorax, and abdomen as in *splendens*. Coloration of legs also similar except base of tibia of foreleg as dark as apical part, other two pairs of legs with dark areas reduced, femora nearly completely white, tibia of middle leg with smaller tufts. Pattern of maculation of forewing differing from that of *splendens* in that the basal parts of the two ocellate spots form a sinuous line, the two basal transverse lines are darker than the broad costal spot and the oblique subterminal bar, the oblique subterminal bar usually obsolescent in the middle, and the fringe uniformly dark. Ventral surface of forewing of male mostly yellowish orange with two black costal spots, basal part only of oblique subterminal bar usually present, entirely absent in some specimens. Ventral surface of forewing of female with more dark markings than male, oblique subterminal bar divided into two spots or with apex and basal parts darker than median area. Hindwings of male yellowish orange, lacking dark marks on both surfaces. Position and shape of dark marks on dorsal surface of hindwing of female variable, located between Rs and anal veins (fig. 10) on two examples, but extending from apex to Cu_1 on another example. Ventral surface of hindwing of female yellowish orange with a dark median costal mark. Length of forewing: male, 13 to 14 mm.; female, 14 to 15 mm.

Male genitalia distinctive (fig. 31), clasper of left valve long and slender, exceeding apex of valve; clasper of right valve reduced, less than one-third length of valve. Female genitalia (fig. 32) with the sclerotized fold and groove on the right side of ductus bursae; ductus seminalis from right side of bursa copulatrix; right side of posterior margin of seventh abdominal sternite forming a short, broad lobe, the shape and size somewhat variable.

Type: Type male, Tucumán, Argentina, R. Schreiter (USNM 64641); 5 males and 1 female paratypes, same place and collector; 1 male and 1 female paratypes, same place, P. Girard in the U.S. National Museum, Washington, D.C. Two males and 1 female paratypes, Tucumán, Argentina, P. Köhler, in the personal collection of Mr. Köhler, Buenos Aires, Argentina.

Distribution: Known only from the type locality.

Remarks: The sinuous line formed by the basal parts of the ocellate spots of the forewing, the long clasper of the left valve of the male genitalia, and the sclerotized groove of the right side of the ductus bursae of the female genitalia will enable the entomologist to separate this species and *E. paraguayensis* (Draudt) from the other species of the *splendens* complex. The obsolescence of the median part of the oblique subterminal bar on either or both surfaces of the forewing, the yellowish-orange hindwing of the male, the absence of dark apical marks on the ventral surface of the hindwing of the female, and the reduced clasper of the right valve of the male genitalia distinguish examples of *robertae* from *paraguayensis*. I name this species with affection after my wife, Roberta.

Eusceptis paraguayensis (Draudt), new combination and new status

FIGURES 11, 12, 33, 34

Eugraphia splendens ab. 1, Hampson, 1910, Catalogue of the Lepidoptera Phalaenae in the British Museum, vol. 10, p. 793. [Infrasubspecific, not available.]

Eugraphia splendens ab. *paraguayensis* Strand, 1916, Arch. Naturg., vol. 82 (A), nos. 1–13, p. 39. [Infrasubspecific, not available.]

Eugraphia splendens f. *paraguayensis* Strand (= ab. 1 Hampson), Draudt, 1939, *in* Seitz, Gross-Schmetterlinge der Erde, vol. 7, p. 397.

Eugraphia splendens paraguayensis Strand.—Biezanko, Ruffinelli, and Carbonell, 1957, Rev. Fac. Agron. Univ. Republ. Uruguay, no. 46, p. 53.

This species agrees with *robertae* and differs from the other species of the *splendens* complex in that the basal part of the ocellate spots of the forewing form a sinuous line; in that the fringe of the forewing is uniformly dark; in that the clasper of the left valve of the male genitalia is long, exceeding the apex of the valve; and in that the sclerotized groove of the ductus bursae and the origin of the ductus seminalis of the female genitalia are located on the right side. *E. paraguayensis* (Draudt) differs from *robertae* as follows: hindwing of male white with a yellowish orange marginal band; oblique subterminal bar of forewing not obsolescent in median area on either surface of the wing; and clasper of right valve (fig. 34) not reduced, exceeding apex of valve. Length of forewing: male, 12.5 mm.; female, 13 to 15 mm.

Type: A type specimen has not been designated for this species. The treatments by Strand and Draudt were based on the description of specimens studied and referred to "Ab. 1" of *Eugraphia splendens* by Hampson. Hampson did not state how many specimens were examined, but the descriptive paragraph indicates both sexes and at least two females were present. Three specimens, one male and two females, from Sapucay, Paraguay are in the British Museum (Natural History). These are, without doubt, the series studied by Hampson. I hereby select the male of that series as the lectotype of the species.

Distribution: This species is recorded from Paraguay southeast through Misiones, Argentina into southern Brazil and northwestern Uruguay. I have examined only four specimens from the following localities—Paraguay: Sapucay. Argentina: Misiones. Brazil: Guarani, Rio Grande do Sul. Biezanko, Ruffinelli, and Carbonell record the species from Artigas, Uruguay.

Remarks: Hampson recognized that examples of this species were different from those of *splendens*, but he treated them as an unnamed aberration of that species. Subsequently Strand proposed a name, but continued to consider it to be an aberration of *splendens*. According to Articles 1 and 45 (c) of the International Code of Zoological Nomenclature, 1961, this infrasubspecific usage is to be excluded from the species-group names and is not available from that date. Draudt then treated the name as a form of *splendens*. On this point, Article 45 (e) (i) states, "Before 1961, the use of either of the terms "variety" or "form" is not to be interpreted as an express statement of either subspecific or infrasubspecific rank." I accept Draudt's usage of "form" in this genus to be equivalent of subspecific rank and in accordance with Article 10 (b) cite him as author of the name and consider it available as of that date.

Method of determination: A photograph of a male specimen that agrees with the original description was compared with the specimen selected as lectotype. Mr. D. S. Fletcher who made the comparison for me indicates they are the same.

Name of Undetermined Application

Eugraphia splendens f. *seriata*

Eugraphia extensa ab. *seriata* Strand, 1913, Arch. Naturg., vol. 79 (A), nos. 7–9, p. 63. [Infrasubspecific, not available.]

Eugraphia splendens f. *seriata* Strand.—Draudt, 1939, *in* Seitz, Gross-Schmetterlinge der Erde, vol. 7, p. 397.

This name, like *paraguayensis*, must be credited to Draudt and date from that work. The specimen studied by Strand, a female from Brazil, is in the Königliche Zoologische Museum, Berlin, Germany. The description of the dark markings of the ventral surface of the hindwing indicates a pattern unlike any example of the *splendens* group known to me. It is, however, most likely that the type is either an aberrant specimen of *extensa* or *paraguayensis*. The description of the dorsal surface of the hindwing agrees with the pattern of maculation of those species. An examination of the nature of the basal part of the ocellate spots of the forewing would indicate to which *seriata* is related, but would not necessarily indicate it was either particular species. There is, of course, the possibility that it represents a distinct species. Because I have not seen examples that agree with the description, because large areas of Brazil remain practically unknown entomologically, and because the type is officially unavailable to me, I feel obligated to consider *seriata* as a name of undetermined application.

Species Transferred to Other Genera

Tarachidia bruchi (Breyer), new combination

Eugraphia bruchi Breyer, 1931, Rev. Soc. Ent. Argentina, vol. 3, p. 309.

This species, the type of which I have examined through the courtesy of Mr. Pablo Köhler, Buenos Aires, Argentina, is closely related to, but specifically distinct from, *Tarachidia viridans* Schaus. It is not at all closely related to the species of *Eusceptis* Hübner. Recent studies of mine at the British Museum (Natural History) revealed to me that *E. bruchi* Breyer is the same species described by Hampson as *Tarachidia albisecta* (1910, Catalogue of the Lepidoptera Phalaenae in the British Museum, vol. 10, p. 689, pl. 169, fig. 22). The Hampson name, *Tarachidia albisecta*, is the correct name for the species.

MAP 1.—Localities of known occurrence of the South American species of the *Eusceptis splendens* complex (Goode Base Map, courtesy Dept. of Geography, University of Chicago).

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REVISION OF NEARCTIC GELECHIIDAE, I

THE LITA GROUP (LEPIDOPTERA: GELECHIOIDEA)

By Ronald W. Hodges [1]

Introduction

Busck's (1903) revision of the North American Gelechiidae is the only comprehensive treatment of the family for a major part of the Nearctic Region. Its usefulness is greatly limited by the large number of species described since 1903, the number of species described before that date but not correctly determined by Busck, the number of undescribed species, the inadequacy of descriptions based on maculation and venation for specific determination, and the recognition of the male and female genitalia as character systems with taxonomic value.

Subsequent to 1903 numerous gelechiids have been described by Busck, Braun, Walsingham, Kearfott, Meyrick, Forbes, Keifer, Freeman, Clarke, and Powell. Of these authors, only the last five have figured the genitalia of new species. In 1939 Busck published an extremely important work, "Restriction of the genus *Gelechia* . . . ,"

[1] Entomology Research Division, Agriculture Research Service, U.S. Department of Agriculture, Washington, D.C.

in which he defined several genera and associated species (formerly in *Gelechia*) with each genus. Only one or two representatives of each genus were figured; thus, most of the names, even though correctly associated generically, are not recognizable as species in that work. The result is that most of the described Nearctic gelechiids cannot be determined from the existing literature.

Failure to associate species with earlier names has led nearly all workers to describe and redescribe several species while leaving closely related, valid species unnamed. To avoid this situation I have examined nearly all of the existing type specimens and before completion of this series of papers plan to study all of them. Some types, particularly those of Chambers, are no longer extant. An attempt will be made to associate his names with species whenever possible.

This paper on the *Lita* group is the first of a series, the purpose of which is to make known the described and undescribed Nearctic gelechiids, to illustrate each species, and to present keys for identification of the genera and species. The most useful part of the work will appear last: the summary of major groups and keys to genera. However, until the fauna is moderately well known, generic definitions will continue to change.

Because of their small size, Microlepidoptera, in general, have been poorly collected; thus, distributional information usually is inadequate to give a complete picture of the geographic range of any species. One serious ramification of this point is that clinally variable character systems may remain unrecognized, and thus two or more populations may be given names when they represent discontinuous samples of a species rather than samples of two or more species. Variation appears to be the rule in the Lepidoptera and may occur in maculation, coloration, vestiture, size and shape of abdominal sclerites, width of antennal segments, or characters of the genitalia. However, suspected or anticipated variation cannot be confirmed on the basis of few specimens from widely scattered localities. Until much more diligent collecting is done for nearly all major Nearctic locality types, works of this nature are necessarily sketchy and subject to further revision.

As would be anticipated for a relatively large family, the larval habits are moderately diverse; but on the whole, living plant tissues are attacked. Some species are leaf or needle miners for all or part of the larval stage; many are leaf rollers or tiers; some are stem borers or gall formers; some feed in developing seed heads of composites; some are external feeders; and some feed on dried seeds. Normally, some shelter is present, whether it be a silk webbing, a gall, or a leaf roll. A few species, such as the pink bollworm [*Pectinophora* *gossypiella* (Saunders)], the Angoumois grain moth [*Sitotroga cerealella* (Olivier)], the potato tuberworm [*Phthorimaea operculella* (Zeller)], and the lodgepole needle miner [*Coleotechnites milleri* (Busck)], are economically important. *Crasimorpha infuscata* Hodges is being studied for potential use as a biological control agent of a weed in Hawaii. The food plants and life histories of most species are unknown, and their study offers a challenge to anyone interested in rearing insects.

To insure relatively uniform handling and observation of specimens for study purposes, I have included the following comments: (1) Adult moths should be mounted and spread, and care should be taken so that the maculation is preserved and all parts are present. (2) Genitalic preparations should be made from the best specimens available so that later maculational comparisons can easily be made. (3) Age of the specimen must be considered when colors are observed. Several colors change over a period of time; thus, specimens that appear dark black or brown when relatively fresh become rather uniform yellow brown upon aging. Many gelechiids have a light dusting of blue green when they are alive; this color usually disappears within a few days after death. (4) The source of light available when the specimens are observed and the angle of light incidence on the scale surfaces will affect the appearance of colors. In this study the colors were seen under incandescent illumination (GE transparent bulb in an AO illuminator). (5) Maculation of most species is variable to some degree, and comparisons with illustrations and descriptions must be made with this fact in mind. (6) Both the male and the female genitalia can vary; so, several genitalic preparations may be necessary to learn the range of variation. (7) In many genera (e.g., *Recurvaria* Haworth, *Coleotechnites* Chambers, *Lita* Treitschke) the tegumen and vinculum should be opened so that they are approximately in the same plane rather than being in parallel planes. In most illustrations a ventral view of the male genitalia is shown to present characters of the juxta, gnathos, and uncus; however, a ventrolateral or lateral view of some species is also necessary to show the shape of the valvae. (8) Species of some genera, particularly *Dichomeris* Hübner, have the female frenulum fused so that the position of the retinaculum (medial rather than subcostal) or presence of the ovipositor must be observed to verify the sex. (9) Terminology of male genitalic structures, particularly of the valva, juxta, and vinculum, is apt to be somewhat misapplied because of fused parts. In some instances the valvae and vinculum appear to flow into one another rather than being separate. Reference to the illustrations should clarify any questions concerning the name used for a particular part.

In the systematic part of this paper I describe the maculation and color pattern of an individual specimen which usually is the one, or one of those, figured. Label data are presented verbatim with the exception that dates have been converted to a standard form.

The following individuals have been extremely helpful in the loan or donation of material, rearing of specimens, and sharing of information: J. D. Bradley, Annette F. Braun, J. F. G. Clarke, H. Clench, P. J. Darlington, D. R. Davis, E. A. Dickason, W. D. Duckworth, H. E. Evans, D. C. Ferguson, O. S. Flint, Jr., J. G. Franclemont, T. N. Freeman, M. O. Glenn, H. Grant, R. C. Hall, H. J. Hannemann, Lars Hedström, C. P. Kimball, A. B. Klots, C. D. MacNeill, L. M. Martin, J. A. Powell, F. H. Rindge, K. Sattler, P. J. Spangler, G. A. Struble, E. L. Todd, W. G. Tremewan, P. Viette, and A. K. Wyatt.

Abbreviations used for location of specimens are as follows:

ANSP	Academy of Natural Sciences, Philadelphia, Pennsylvania.
AMNH	American Museum of Natural History, New York, New York.
AFB	Collection of Annette F. Braun, Cincinnati, Ohio.
BMNH	British Museum (Natural History), London, England.
CAS	California Academy of Sciences, San Francisco, California.
CNC	Canadian National Collection, Ottawa, Canada.
CM	Carnegie Museum, Pittsburgh, Pennsylvania.
CPK	Collection of Charles P. Kimball, West Barnstable, Massachusetts.
CNHM	Chicago Natural History Museum, Chicago, Illinois.
CU	Cornell University, Ithaca, New York
JGF	Collection of John G. Franclemont, Ithaca, New York.
LACM	Los Angeles County Museum, Los Angeles, California.
MOG	Collection of Murray O. Glenn, Henry, Illinois.
MCZ	Museum of Comparative Zoology, Cambridge, Massachusetts.
NSMS	Nova Scotia Museum of Science, Halifax, Nova Scotia.
USNM	United States National Museum, Washington, D.C.
UCB	University of California, Berkeley, California.

Mr. J. Scott, staff photographer, Smithsonian Institution, made the photographs used in the illustrations.

Work on this revision was started while I was a postdoctoral fellow with the National Science Foundation.

Taxonomic Treatment.—Suprageneric taxa are present in the Gelechiidae; however, their definition and relationships are in part connected with comparable units in the Gelechioidea. On the basis of material seen to date the Nearctic genera can be segregated into five groups; and for convenience the well-known genera, *Isophrictis* Meyrick, *Recurvaria*, *Gelechia* Hübner, *Dichomeris*, and *Anacampsis*

Curtis, are used to exemplify them. I am not certain what status should be assigned to these groups. For example, the *Isophrictis* group is as distinct from the other four as the timyrids are from the five; in other words, the two are equal in rank. Thus, I am inclined to treat each as a subfamily or tribe of the Gelechiidae. This problem becomes even more complex when other units are studied, e.g., the Xylorictidae, Copromorphidae, Oecophoridae, Momphidae, Symmocidae. After studying the venational and genitalic illustrations in Clarke's (1955, 1963, and 1965) work on the Meyrick types, the interrelationships among these so-called families become apparent— or put in another manner—the means of distinguishing one from another appear to be lacking. Several genera of xylorictids have oecophorid-type genitalia. The male genitalia of *Isophrictis* are more closely related to those of oecophorids than to the *Gelechia* type, but the wing shape and venation ally them with the gelechiids. In the same manner "*Hypatima*" *zesticopa* Meyrick (Gelechiidae) is close to *Meleonoma stomata* (Meyrick) (Oecophoridae). The question then must be asked: What criteria are valid for establishing relationships? Obviously, our present system does not truly reflect a natural system; but at this time I am in no position to rally adequate evidence to form the basis of a sound system. I do feel that we should be very cautious about proposing new taxa of family rank because this practice eventually would lead to a system wherein many small groups would be recognized but no interrelationships shown.

The *Lita* group, a member of the larger taxon exemplified by *Gelechia*, is closely related to *Gelechia* and *Gnorimoschema* Busck, and is arbitrarily separated from them by the presence of a terminal row (or rows) of caudally directed, modified setae on the uncus. In *Lita*, *Arla* Clarke, *Neodactylota* Busck, and *Eudactylota* Walsingham, these setae are scalariform; in *Friseria* Busck, *Sriferia*, new genus, *Rifseria*, new genus, *Schizovalva* Janse, *Parapsectris* Meyrick, *Araeovalva* Janse, and *Leuronoma* Meyrick, these setae are stout and usually long. *Neofriseria* Sattler is closely related to the *Lita* group, particularly in the structure of the valvae; but because the uncus lacks the terminal setae, it is excluded. A feature, apparently common to all of these genera and to *Gelechia* and *Gnorimoschema*, is the culcitula (new term proposed for the membranous pillowlike base of the gnathos); however, because I know the South African genera only through Janse's (1949–1964) diagnoses and illustrations, I cannot be certain whether this structure is always present.

The geographic distribution of the *Lita* group may be summarized as follows: *Lita*, 1 Holarctic, 1 Palearctic, and 20 Nearctic species; *Arla*, *Neodactylota*, *Eudactylota*, *Sriferia*, *Rifseria*, and *Friseria* are Nearctic; and *Parapsectris*, *Araeovalva*, *Leuronoma*, and *Schizovalva* are

Ethiopian (southern Africa). The South African genera are closely allied with *Friseria*. Sattler (1960) has shown that none of the Palearctic species of the *Gelechia* complex are referable to the *Lita* group with the exception of two species of *Lita*. Also, no Indo-Australian or Neotropical gelechiid examined to date is a member of the *Lita* group.

Key to the Genera of the *Lita* Group

1. Valva consisting of a simple lobe 2
   Valva consisting of a compound lobe or two or more lobes 4
2. Valva very broad at base, apex narrow . . . . **Araeovalva** Janse
   Valva linear, slightly expanded apically 3
3. Lobes of juxta separate (figs. 100, 103) . . . . . **Eudactylota** Walsingham
   Lobes of juxta connected (at least by membrane) nearly to apex (fig. 66). **Lita** Treitschke
4. Aedeagus linear, length more than 10 times maximum width . . **Arla** Clarke
   Aedeagus stout or with expanded base 5
5. Caudal setae of uncus scalariform . . . . **Neodactylota** Busck
   Caudal setae of uncus not flattened 6
6. Valva consisting of two simple lobes, each linear and somewhat expanded distally 7
   Valva consisting of two or more lobes, lobes complex or saccal lobe very broad basally 8
7. Aedeagus broad basally, very slender on distal three-fourths; costal lobe of valva shorter than medial lobe . . . . **Rifseria,** new genus
   Aedeagus stout, narrowest beyond middle, apex somewhat expanded; costal lobe of valva longer than medial lobe . . . . **Sriferia,** new genus
8. Costal lobe of valva slender, simple; saccal lobe very broad basally, becoming narrow, then relatively slender to apex . . . . **Schizovalva** Janse
   Costal lobe of valva with medial or basal projections 9
9. Uncus emarginate medially . . . . **Leuronoma** Meyrick
   Uncus even or produced medially 10
10. Hook of gnathos curved before one half, then straight and gradually tapering to apex . . . . **Parapsectris** Meyrick
    Hook of gnathos curved at or beyond middle, abruptly turned just before apex . . . . **Friseria** Busck

Lita Treitschke

Lita Treitschke, 1833, Die Schmetterlinge Europas, vol. 9 (pt. 2), p. 76.

Type-species: *Tinea virgella* Thunberg, 1794 (=*Lita zebrella* Treitschke, 1833), designated by Walsingham, 1915, *in* Godman and Salvin, Biologia Centrali-Americana, vol. 42 (Lepidoptera–Heterocera, vol. 4), p. 410.

Head: smooth scaled; frontovertical processes present or absent; tongue moderate, scaled on basal one-third to one-half; labial palpus recurved, second and third segments slender, subequal in length, a short tuft on anterior surface of second segment; antenna two-thirds to four-fifths length of forewing, simple. Forewing: broadly lanceolate; 12 veins present; 2 from cell at three-fourths length of cell; 3 and 4 distant to short stalked; 7 and 8 stalked. Hindwing: subquadrate, outer margin gradually moving to apex; 8 veins present; 3 and 4 connate or stalked; 5 closer to 4 than to 6 basally, curved upward from origin; 6 and 7 separate. Male genitalia: vinculum moderately broad; saccus developed; juxta fused basally with vinculum, lobes setate apically; valva linear, simple, slightly expanded apically; aedeagus moderately slender to stout, a linear, heavily sclerotized flange often present; manica with numerous short spicules near juncture with aedeagus; tegumen long; uncus broad, short with an apical row of broad scales; gnathos present, a strong hook; culcitula present. Female genitalia: corpus bursae membranous with numerous spinules; two signa present; an incomplete, sclerotized ring between ostium bursae and inception of ductus seminalis; ostium bursae a simple opening at base of eighth sternum, no associated sclerotized plates present; apophyses anteriores shorter than apophyses posteriores.

Lita species form an extremely compact group based upon the sum of all examined characters. Two basic wing patterns occur: one with a series of lines and/or dashes paralleling the veins, the other with spots, sometimes forming bands, at the middle and apex of the cell and occasionally with an oblique fascia at the base of the forewing. One species has both types within its range of variation. Frontal modifications in the form of raised prominences occur in eight species. When fully developed, three elements are present, a dorsal protuberance rising from the vertex, a medial protuberance rising from the frontoclypeus, and a ventral, low-margined, elliptical depression. The dorsal and medial protuberances become partially or wholly fused in some species. The male genitalia are nearly homogeneous among the species: aedeagal differences serve to distinguish groups of species. The female genitalia are also relatively uniform; however, the relative degree of sclerotization and curvature of the apophyses anteriores and the shape of the signa show minor differences. In *variabilis* (Busck) variation in the relative length of the ductus and corpus bursae occurs; thus, variation may be anticipated in other species. For males the sternum and tergum of the eighth abdominal segment differ in the shape of the anterior and posterior margins. Specific variation occurs, but many species can be defined by these characters. The relative width of antennal segments, particularly in males, and the width and shape of the sensory areas are diagnostic characters for some species. In others both characters seem to vary.

The group of species with a striate wing pattern forms, in part, a most confusing complex for satisfactory morphological analysis.

Unfortunately, the food plant is known for only three species of the complex, and in most instances few representatives of any one species are present in collections. Moreover, most specimens are from scattered localities; moderate series are available for only two species; and, in each of these two series variation seems to be relatively limited.

The species involved are *jubata*, new species, *nefrens*, new species, *princeps*, *recens*, new species, *rectistrigella*, *sironae*, new species, *thaliae*, new species, and *variabilis*. Within the series of *variabilis* in the USNM collection are specimens with the same maculation as *rectistrigella*, but which were not so identified. Also some of the specimens that were in the determined series of *rectistrigella* have been referred elsewhere. This is not to say that some species of the *variabilis* group do not have constant maculational differences. *L. princeps*, *recens*, and *sironae* usually can be identified on the basis of maculation alone.

Representatives of some populations, here designated as species, may prove to be races of variable species; however, the morphology of a limited number of specimens leads me to segregate several entities. Busck (1939) resurrected Treitschke's genus *Lita* and defined it using characters of the male and female genitalia. He included ten species of which *diversella* (Busck) and *prorepta* (Meyrick) are referable to *Arla* and *Sriferia*, new genus, respectively. *Lita crocipunctella* Walsingham is clearly a species of *Chionodes* and so is transferred. Thirteen new species are described in this paper, and *princeps* (Busck) is transferred from *Gnorimoschema* Busck; thus, the known world fauna consists of 22 species. *Lita solutella* (Zeller) is Palearctic, *virgella* (Thunberg) is Holarctic, and the remaining species are Nearctic, mainly western.

Key to Species of *Lita*

1. Frons and vertex produced 2
   Frons and vertex smooth, not produced 9
2. Distal portion of dorsal frontal protuberance with narrowly elliptical cross section (fig. 64) . . . . **jubata**, new species
   Distal portion of dorsal frontal protuberance with broadly elliptical or circular cross section 3
3. Forewing pattern a series of longitudinal lines (figs. 33, 34). **nefrens**, new species
   Forewing pattern with transverse or oblique elements (figs. 8, 15) . . . 4
4. Forewing with a dorsal, transverse band (or two spots combining to form band) at one-third (figs. 15, 17) 5
   Forewing lacking a dorsal, transverse band at one-third 6
5. Dorsal element of frontal protuberance tapering to apex; ventral element raised and partially fused with dorsal one (fig. 65) . . **puertella** (Busck)
   Dorsal element of frontal protuberance slightly expanded apically; ventral element low (fig. 59) . . . . **deoia**, new species
6. Margin of dorsal element of frontal protuberance heavily sclerotized (figs. 61, 62) 7

Margin of dorsal element of frontal protuberance not sharply defined (fig. 58); forewing with a faint oblique band running from costa at one-sixth to dorsum at one-fourth (fig. 9) . . . . **incicur**, new species

7. Forewing with costa pale buff, strongly contrasting with dorsum (fig. 35); dorsal element of frontal protuberance broad to apex (fig. 59). **invariabilis** (Kearfott)

Forewing with costa generally concolorous with dorsum (fig. 14); dorsal element of frontal protuberance tapering to apex (fig. 62) 8

8. Dorsal element of frontal protuberance longest on dorsal margin, ventral portion open to ventral element (fig. 62) . . . . . **geniata**, new species

Dorsal element of frontal protuberance longest on ventral margin, ventral margin present (fig. 61) . . . . **barnesiella** (Busck)

9. Forewing pattern a series of lines parallel to veins (fig. 24) 18

Forewing pattern a series of dots and/or transverse fasciae (figs. 1, 20) . . 10

10. A transverse bar (formed by coalescing of two spots) in cell at one-third length of forewing (fig. 18), remainder of wing without prominent markings . . . . **dialis**, new species

Forewing without a bar at one-third, if present, other dark marks prominent 11

11. Forewing with an oblique band running from costa near base to dorsum at one-fourth (fig. 1) . . . . **virgella** (Thunberg)

Forewing lacking such a complete band, occasionally with a band from middle of wing to dorsum 12

12. Forewing with a faint dark patch basally, outer third often with veins dark (fig. 19) . . . . **pagella**, new species

Forewing lacking basal dark patch, outer third with scales on veins concolorous with those on membrane 13

13. Palearctic species . . . . **solutella** (Zeller)

Nearctic species 14

14. Forewing with a faint oblique line from costa (or near costa) at base to middle of wing at one-fifth (fig. 26) . . . . . **thaliae**, new species, in part

Forewing lacking basal oblique line 15

15. Forewing usually with three well-defined dark spots in cell (fig. 28). **texanella** (Chambers)

Forewing lacking distinct spots in cell (fig. 22) 16

16. Antenna unicolorous cream to cream white basally 17

Antenna brown and white basally . . . . **maenadis**, new species

17. Inner surface of second segment of labial palpus gray buff with at least a few brown or orange-brown scales; apex of valva globose. **obnubila**, new species

Inner surface of second segment of labial palpus white; apex of valva ellipsoidal . . . . **veledae**, new species

18. Forewing with black dashes in cell confluent, usually strongly contrasting with remainder of wing (fig. 31) . . . . **princeps** (Busck)

Forewing with two separate black dashes in cell, or none present . . . 19

19. Male antenna with sensory areas extending to dorsal surface of basal segments; female antenna with ventral sensory area bordered anteriorly with dark brown (darker than scales separating sensory areas). **recens**, new species

Male antenna with sensory areas not extending to dorsal surface, rows of scales separating sensory areas ocherous; female antenna with unicolorous anterior borders 20

20. Vein 3 of forewing from before end of cell, 3 and 4 moderately distant; dorsal margin tapering gradually to apex, dorsal and costal margins slightly convex before apex; flange of aedeagus without a well-defined apical area. 21

Vein 3 of forewing usually from end of cell, 3 and 4 connate or short stalked; dorsal margin slightly angled at end of 2, apex relatively acute; free portion of sclerotized flange of aedeagus with relatively parallel edges, apex blunt . . . . **variabilis** (Busck)

21. Smaller species (forewing length: average 7.9 mm, range 7.0–8.5 mm); forewing with a pale yellow to brownish-orange subcostal streak from near base to one-third, a strong black dash on dorsal margin of cell from near base of two-fifths and another on costal margin of cell from two-fifths to three-fifths (fig. 25) . . . . **sironae,** new species

Larger species (forewing length: average 9.4 mm, range 8.2–11.5 mm); forewing usually lacking pale subcostal streak, many specimens lack the black dashes bordering the cell 22

22. Forewing red brown with dark brown to brown black streaks (fig. 27). **thaliae,** new species, in part

Forewing gray brown, buff brown, or brown, usually not strong red brown; anterior margin of eighth tergum more or less smoothly curved (fig. 24). **rectistrigella** (Barnes and Busck)

Lita virgella (Thunberg)

Figures 1, 66, 136, 169, 170

Tinea virgella Thunberg, 1794, Dissertatio entomologica sistens insecta Suecica, p. 92.

Lita virgella.—Walsingham, 1915, *in* Godman and Salvin, Biologia Centrali-Americana, vol. 42 (Lepidoptera-Heterocera, vol. 4), p. 410.

Anacampsis longicornis Curtis, 1827, British Ent., vol. 4, p. 189.

Tinea histrionella Geyer, 1832, Samml. Europäischer Schmett., Tineae, pl. 70.

Lita zebrella Treitschke, 1833, Die Schmett. Europa, vol. 9, pt. 2, p. 82.

Gelechia alternella Kearfott, 1908, Journ. New York Ent. Soc., vol. 16, p. 185.

Gelechia petulans Braun, 1925, Canadian Ent., vol. 57, p. 125.

Maculation: as in figure 1. Head: anterior surface of tongue covered with white and pale brown scales from base to one-third length; maxillary palpus white, sometimes with dusting of brown, porrect or curved over base of tongue; first segment of labial palpus white with ocherous stripe on outer surface, second segment white with dusting of brown scales, becoming more dense distally, third segment brown with dusting of white scales; scape of antenna brown heavily dusted with white, dorsal surface of shaft with segments brown on basal half, brown mixed with buff on distal half, ventral surface with more buff scales basally, brown distally; frons with a series of whitish scales from margin of eye to base of tongue, scales light brown and pale buff medially; vertex and occiput with scales light to medium brown apically, paler basally. Thorax: uneven brown. Forewing: dark brown with varying amounts of white defining pattern, distal third of wing often suffused with ocherous scales, cilia fuscous, Hindwing:

membrane and cilia fuscous. Prothoracic leg: coxa brown mixed with white on mesal surface, white on outer surface; femur white mixed with brown, mesal surface darker than lateral; tibia brown with white scales basally and apically; tarsus brown, white on base and apex of first segment and apex of second. Mesothoracic leg: similar to prothoracic leg, tibia with more white scales. Metathoracic leg: coxa and femur white with some brown scales; tibia brown laterally with dusting of white basally, a white fascia at one-half, white apically, dorsal tuft white to pale buff; tarsus white with apices of first through third segments white, base of first segment white. Abdomen: brown and buff dorsally, mainly white ventrally. Alar expanse: 12.5–17.0 mm. Male genitalia: as in figure 66 (RWH slide 2563). Female genitalia: as in figure 136 (RWH slide 2555).

Food plant: *Calluna*, *Erica*, *Vaccinium* (Ericaceae). These are European records. *L. virgella* has not been reared in the Nearctic Region.

Types: *virgella*, lectotype, present designation, male, bearing following label: lectotype, male, *Tinea virgella* Thunberg, by R. W. Hodges, in Thunberg Collection, Uppsala, Sweden; *longicornis*, lectotype, present designation, female, bearing following labels: female genitalia slide 3586 R. W. Hodges, lectotype, female, *Anacampsis longicornis* Curtis, by R. W. Hodges 1965, National Museum of Victoria, Melbourne, Australia; *histrionella*, lost; *zebrella*, Hungarian National Museum, Budapest, Hungary; *alternella*, female, USNM; *petulans*, male, CNC.

Specimens examined:

UNITED STATES: Alaska: White Horse, 2 ♂, 2 ♀, May 30, 31, 1916, USNM. California: Deer Park Springs, Lake Tahoe, 1 ♀, June 24–30, LACM; Mineral King, Tulare Co., 1 ♀, July 8–15, CAS; Mt. Shasta, Siskiyou Co., 6 ♂, 2 ♀, Aug. 2 through Sept. 1, 1871, Walsingham, BMNH; Mt. Shasta, 7000 ft., 1 ♀, July 7–24, LACM; Mt. Shasta, 1 ♀, July 16–23, USNM; Panther Meadow, Mt. Shasta, 3 ♂, July 14, 1962, J. Powell, UCB; Ski Bowl, 14 road mi. E Shasta City, 7800 ft., Siskiyou Co., 2 ♂, 3 ♀, July 23, 1962, Rentz and MacNeill, CAS. Colorado: Chimney Gulch, Golden, 4 ♂, Apr. 14, 1908, Oslar, USNM; Denver, S. Park, 1 ♀, USNM; Dream Lake, Rocky Mt. N. P., 1 ♂, Aug. 1, 1929, A. F. Braun, AFB; Hall Valley, Arctic Alpine zone, 11500–12500 ft., Park Co., 1 ♂, July 13–15, 1935, A. B. Klots, AMNH; Loveland, 1 ♂, July 1891, Smith, BMNH. Montana: Glacier Nat. Park, 1 ♀, July 28, 1928, A. F. Braun, AFB. Oregon: Red Top Mountain, 6000 ft., Klamath Co., 1 ♂, 1 ♀, July 7, 1955, J. F. G. Clarke, USNM; Skyline Ridge, Mt. Baker District, 1 ♂, Aug. 27, 1932, J. F. Clarke, CU; Strawberry Lake, Malheur Nat. Forest, 7000 ft., 1 ♀, July 13, 1955, J. F. G. Clarke, USNM. Utah: Mirror Lake, Uintah Mts., Duchesne Co., 1 ♂, July 12, 1936, Klots, AMNH. Washington: Marten Lake, Whatcom Co., 1 ♀, Aug. 15, 1931, J. F. G. Clarke, USNM; Skyline Ridge, Mt. Baker Dist., 5 ♂, 1 ♀, Aug. 25, 27, 1932, J. F. G. Clarke, USNM; Slate Peak, 7200 ft., Okanogan Co., 5 ♂, July 28, 1962, J. F. G. Clarke, USNM; Table Mt., Whatcom Co., 2 ♂, Aug. 28, 1927, J. F. G. Clarke, USNM. Wyoming: University of

Wyoming Campus, Snowy Range, 10000–10500 ft., Albany Co., 9♂, July 17–23, 1935, A. B. Klots, AMNH.

CANADA: ALBERTA: Laggan, 4♂, 4♀, July 4, 10, 1925, O. Bryant, MCZ, USNM; Moraine Lake, 1♂, Aug. 6, 1923, J. McDunnough, AFB; Nordegg, 3♂, 5♀, June 8–19, 1921, J. McDunnough, CNC; Rocky Mountain House, 2♀, June 7, 1921, J. McDunnough, CNC; Shovel Pass, Jasper Park, 1♀, July 1, 1915, CU; Waterton Lakes, 1♀, June 20, 1923, J. McDunnough, CNC; same locality, 1♂, 1♀, May 29, 1922, C. H. Young, CNC. BRITISH COLUMBIA: Clinton, 1♀, June 14, 1938, J. K. Jacob, CNC; Duncans, Vancouver Is., 3♂, 5♀, May 18 through June, Henham, CNC, LACM, USNM; Hedley, 1♂, 1♀, July 19, 1923, C. B. Garrett, CNC; Kathleen Mt., Peachland, 2♂, May 23, 1936, A. N. Gartrell, CNC; Mt. Lolo, Kamloops, 2♂, May 31 and July 2, 1938, G. S. Walley, CNC; Paradise, 4♂, July 14, 1923, W. B. Anderson, CNC; Quamicham Lake, Vancouver Is., 1♂, May 10, 1908, CNC; Royal Oak, 1♀, May 20, 1917, R. C. Treherne, CNC; Sahtlam, 5♂, May 18, 1925, E. H. Blackmoore, CNC; Wellington, 1♂, G. W. Taylor, USNM. LABRADOR: Goose Bay, 1♀, June 17, 1948, W. W. Judd, CNC. MANITOBA: Aweme, 1♂, 6♀, May 15 through 28, N. Criddle, CNC, USNM; Riding Mt. Pk., 5♂, 3♀, June 2–5, 1938, J. McDunnough, CNC. NEW BRUNSWICK: Waweig, 2♂, June 6, 1938, T. N. Freeman, CNC. NORTHWEST TERRITORIES: Aklavik, 1♂, June 27, 1931, Bryant, USNM; Saw Mill Bay, 20♂, 5♀, June 12, 1948, D. F. Hardwick, CNC, USNM. NOVA SCOTIA: Mt. Uniacke, 1♂, June 8, 1950, D. C. Ferguson (McDunnough slide, Gel. 2s), NSMS; Bog, Prospect Road, Halifax, 1♀, June 4, 1954, D. C. Ferguson, NSMS; West Dover, Halifax, 1♂, June 16, 1954, D. C. Ferguson, NSMS. ONTARIO: Geraldton, 1♀, June 6, 1956, J. C. E. Riotte, AMNH; Smokey Falls, Mattagami River, 1♂, June 13, 1934, G. S. Walley, CNC. QUEBEC: Mare du Sault, Laurentides Park, 2550 ft., 1♀, July 10, 1954, Klots and Rindge, AMNH; Thunder River, 1♀, June 18, 1930, W. J. Brown, CNC. White River, 1♂, June 24, 1907, Knab, USNM. YUKON TERRITORY: Rampart House, 1♂, May 31, 1951, C. C. Loan, CNC.

Discussion: The maculation of *virgella* is highly variable, with the amount of white and intensity of the dark brown appearing somewhat different in each specimen. However, as a variable species, the maculation is still distinct from the other species of *Lita*. The pattern of dark brown bars separated by lighter areas is unique in the genus.

Lita solutella (Zeller)

FIGURES 2, 67, 143, 171, 172

Gelechia solutella Zeller, 1839, Isis von Oken, p. 199.
Lita solutella.—Busck, 1929, Proc. U.S. Nat. Mus., vol. 86, p. 573.
Gelechia nigrobipunctatella Lucas, 1932, Bull. Soc. Ent. France, vol. 37, p. 168.

Food plant: *Sarothamnus* (*Spartium*) *scoparius* L. and *Genista* spp.

Types: *solutella*, BMNH; *nigrobipunctatella*, male, Muséum National d'Histoire Naturelle, Paris.

Distribution: Austria, Bulgaria, England, France, Greece, Hungary, Italy, Poland, Spain, Syria, and Turkey.

Discussion: *L. solutella* is included in this treatment of the Nearctic fauna to complete the picture of the genus inasmuch as it is the only extralimital species. It is an extremely variable species in maculation; some specimens are immaculate; others are well marked as is shown in figure 2.

Lita variabilis (Busck)

Figures 3–7, 68–70, 146, 151, 173, 174

Gelechia variabilis Busck, 1903, Proc. U.S. Nat. Mus., vol. 25, p. 871.
Lita variabilis.—Busck, 1939, Proc. U.S. Nat. Mus., vol. 86, p. 573.

Maculation: as in figures 3–7. Head: base of tongue white medially, brown laterally and distally; maxillary palpus white to buff white, folded over base of tongue; labial palpus with first segment pale brown, second segment white with scattered pale brown scales, third segment slightly darker than second with more brown scales; scape of antenna ocherous brown, shaft ocherous brown with more yellow basally than distally; frons, vertex, and occiput pale buff brown, apices of scales slightly darker buff brown. Thorax and forewing: yellow brown, scales with dark medial areas, dark areas of wing black or dark brown, some red brown streaks present; cilia paler than wing, first scale row black tipped, outer scale rows pale brown tipped. Hindwing: fuscous, veins lightly outlined in pale reddish orange, cilia buff. Prothoracic and mesothoracic legs: coxa and femur whitish laterally, brown anteromedially, tibia and tarsus brown, apices slightly pale. Metathoracic leg: coxa and femur whitish with some brown scales; tibia buff gray, apices of scales pale brown, dorsal tuft pale buff; tarsus brown, apices of first, second, and third segments off white. Abdomen: terga ocherous, apices of terga pale, terga 3–8 darker than one and two; first two sterna white, caudal ones gray brown. Alar expanse: 14.5–22.0 mm. Male genitalia: as in figures 68–70 (RWH slides 2572, 2588, and 2614). Aedeagus relatively linear; heavily sclerotized flange with broad apical extension at right angle with aedeagus. Female genitalia: as in figures 146 and 151 (RWH slides 2735 and 2744).

Food plant: Unknown.

Type: Male, USNM.

Specimens examined:

UNITED STATES: ARIZONA: Fort Valley, 7350 ft., 7½ mi. NW Flagstaff, Coconino Co., 24♂, 2♀, Aug. 10–Sept. 6, 1961, R. W. Hodges (RWH slide 2588), CU, USNM; Hart Prairie, 8500 ft., 10 mi. NNW Flagstaff, Coconino Co., 79♂, 18♀, Aug. 11–Sept. 6, 1961, R. W. Hodges (RWH slides 2259, 2584–7, 2589, 2744, and 2745), CU, USNM; Paradise, Cochise Co., 2♂, Oct. 1–7, USNM; Prescott, 1♂, Sept. 24–30, USNM; Redington, 1♂, USNM; White Mountains near McNary, Apache Co., 1♂, Sept. 15–30, 1925, O. C. Poling, USNM. CALIFORNIA: Azusa, Los Angeles Co., 1♂, 2♀, Oct. 12, 1939, Lloyd Martin, LACM; Barton Flats, San Bernardino Co., 1♂, Oct. 1, 1945, Sperry, AMNH; Cedarville, 3♂, Sept. 14, 1933, Jones (AB slide Oct. 10, 1933), USNM;

Ibanpah Mts., San Bernardino Co., 3♂, 1♀, Oct. 5, 1940, Henne and Comstock, LACM; Jacumba, 4♂, Sept. 28–Oct. 1, 1924, Piazza (RWH slide 2917), LACM; USNM; La Puerta Valley, 8♂, Sept. (RWH slide 2921), USNM; Lone Mtn., San Francisco Co., 3♂, Oct. 3–10, 1909, F. X. Williams, CAS; Monachee Meadows, Tulare Co., 8000 ft., 15♂, 3♀, Aug. 8–23 (RWH slides 3151, 3157, and 3158), USNM; near Mono Pass, NW Inyo Co., 12000 ft., 1♂, Aug. 7, 1959, C. D. MacNeill, CAS; Mt. Shasta, Siskiyou Co., 1♂, Aug. 1871, Walsingham, BMNH; Mt. Shasta, 1♀, Aug. 19, 1939, E. C. Johnston, CPK; Mt Shasta City, Nevada Co., 1♂, September (RWH slide 2615), USNM; Siskiyou Co., 1♂, Aug. 22, 1958, J. Powell, UCB; Placer Co., 3♂, 8♀, August–September (RWH slides 2628 and 2920; AB slide Apr. 3, 1931; RWH wing slide 53), AMNH, LACM MCZ, USNM; Rock Creek, 1 mi. SW Tom's Place, Mono Co., 2♂, Aug. 9, 1961 and Sept. 6, 1960, MacNeill, Rentz, and Lundgren, CAS; Ruby Lake, NW Inyo Co., 11500 ft., 2♀, Aug. 13, 1957, MacNeill and Powell, CAS, UCB; Mouth San Gabriel Canyon, Los Angeles Co., 2♂, Nov. 10, 1945, C. Henne, USNM; Upper Santa Ana River, San Bernardino Co., 3♂, 1♀, Sept. 7–14, Sperry and Melander (RWH slide 2922), AMNH, USNM; Silver Lake, Amador Co., 2♂, Aug. 21, 1936, E. C. Johnston (RWH slides 2572, and 3150), CNC, CPK; Twin Lakes, Alpine Co., 3♂, Aug. 21, 1938, E. C. Johnston (RWH slide 2614), CNC, CPK, USNM. Colorado: no locality, 7 ♂ (RWH slides 3430 and 3431; AB slide Oct. 16, 1933), LACM, USNM; no locality, 7000 ft., 1♂ (RWH slide 3442), BMNH; no locality, 7000 ft., 3♂, August 1891, BMNH; no locality, 5000 ft., 4♂, July and August 1891, BMNH; Bear Creek, Morrison, 1♂, Oslar, USNM; Boulder, 1♂, Cockerell, USNM; Capitol City, Hinsdale Co., 3♂, July 25, 26, 1936, Klots, AMNH; Cripple Creek, 1♂, Sept. 3, 1899, USNM; Denver, 6♂, 1♀, Oslar (RWH slide 2924; AB slide Oct. 16, 1933), LACM, USNM; Durango, 1♂, Sept. 26, 1939, E. C. Johnston (RWH slide 2581), CNC; Estes Park, 1♂, Aug. 12, Mrs. Dyar, USNM; Glenwood Springs, 9♂, 3♀, August–September (RWH slide 2923), MCZ, USNM; Morrison, 1♂, August 1891, BMNH; Rocky Mtn. Natl. Park, 1♂, Aug. 15, 1937, Klots, AMNH; Silverton, 2♂, Aug. 8–15, *ex* larva, USNM; South Park, 2♂, Aug. 19, 21, 1905, USNM. Connecticut: Putnam, Windham Co., 1♀, Sept. 5–7, 1961, A. B. Klots, AMNH. Massachusetts: Barnstable, 6♂, Sept. 5–12, C. P. Kimball (JFGC slide 10167). Montana: Boulder, 1♂, 1892, T. Ulke, USNM; Bozeman, 1♂, Aug. 20, 1928, J. McDunnough, CNC; Richel Lodge, 1♂, Aug. 20, 1939, Sperry, USNM. Nevada: Mt. Magruder, Esmeralda Co., 1♀, Sept. 19, 1939, G. Willett, LACM. New Mexico: Hell Canyon, 1♂, Sept. 16, 1916, C. Heinrich, USNM; Indian Spring, 1♀, Sept. 9, 1916, C. Heinrich (RWH slide 2735), USNM; Mescalero, 7000 ft., 1♂, Oct. 27, BMNH; Therma, 3♂, Aug. 12, 1932, AMNH. Utah: Buckboard Flap Camp, 7 mi. W Monticello, 8800 ft., San Juan Co., 1♂, July 28, 1960, Rindge (RWH slide 2882), AMNH. Dividend, 2♂, Sept. 26, 28, BMNH; Eureka, 8♂, Aug. 20–27, 1911, Tom Spalding (RWH slide 2918), LACM, USNM; Stockton, 1♂, September 1908, BMNH. Washington: Kushi Canyon, Yakima Co., 13♂, 1♀, Aug. 20–Sept. 17, E. C. Johnston (RWH slide 2736), CNC; Satus Creek, Yakima Co., 6♂, 1♀, Aug. 19 and Sept. 19, 1949, E. C. Johnston (RWH slides 2632 and 2633), CNC, USNM. Wyoming: Green River L., Wind River Range, 1♂, July 24–Aug. 7, 1935, A. B. Klots, AMNH; Sacajawea Camp, 24 mi. W. Big Piney, 8400 ft., Sublette Co., 2♂, Aug. 2, 1959, Rindge, AMNH; Sheepeater Cliffs, Yellowstone N. P., 1♂, Aug. 17, 1962, Spangler (RWH slide 2640), USNM.

CANADA: British Columbia: Kamloops, 1♂, Sept. 1, 1918, BMNH; Peachland, 2♂, Aug. 21, 22, 1909, J. B. Wallis, USNM. Manitoba: Aweme, 9♂, 2♀, Aug. 14–29, N. Criddle (RWH slides 2748, 2749, 3434–3436; RWH wing slide 56), CNC, USNM; Beulah, 4♂, Aug. 15, (RWH slides 2625 and 2626), USNM; Westbourne, 1♂, Aug. 26, 1908, J. B. Wallis, USNM. Saskatchewan: Attons Lake, 2♂, Aug. 20, 1940, A. R. Brooks (RWH slides 2746 and 2747), CNC, USNM; Earl Grey, 1♂, Aug. 2, 1924, J. D. Ritchie (RWH slide 3443), CNC, Harlan, 2♂, Aug. 10, 11, 1940, A. R. Brooks (RWH slide 3437), CNC; Saskatoon, 1♂, Aug. 14, 1940, A. R. Brooks, CNC.

Discussion: The moths illustrated indicate the range of maculational variation to be anticipated in this species. I have seen a moderate series of specimens from one area; and in it, although maculational variation is great, the extremes in size and color pattern are not present. As a guess, it would seem as though the species is extremely variable but that any given population will have a number of phenotypes smaller than the total of the species. Variability is not confined to maculation, color, and size. It is also expressed in the shape of the apical portion of the heavily sclerotized flange of the aedeagus in the male genitalia and in the relative length of the ductus bursae and corpus bursae in the female genitalia.

As might be expected, several species have been confused under the name *variabilis*. Most of them are easily distinguished by the frontal processes, antennal characters, and the shape of the aedeagus. *L. variabilis* is the only known species of *Lita* with the aedeagus shape as illustrated in figures 68–70.

Lita barnesiella (Busck)

Figures 8, 61, 85, 139, 175, 176

Gelechia barnesiella Busck, 1903, Proc. U. S. Nat. Mus., vol. 25, p. 875.
Lita barnesiella.—Busck, 1939, Proc. U. S. Nat. Mus., vol. 86, p. 573.

Maculation: as in figure 8. Head: tongue pale gray brown basally, becoming darker brown distally; maxillary palpus ascending, nearly attaining ventral margin of frontal depression, pale gray with scattered light brown scales; labial palpus pale gray with a few brown scales on posterior and lateral surfaces of second and third segments, anterior surface brown with a few pale gray scales, third segment brown with dusting of pale gray scales; scape of antenna brown buff, shaft piceous dorsally, ocherous ventrally; frons, vertex, and occiput pale buff, frontovertical processes as in figure 61. Thorax, forewing, and abdomen, pale buff overlaid with dark brown and varying shades of red brown, cilia of forewing pale buff. Hindwing: pale fuscous, veins slightly darker fuscous, cilia and tuft of scales on vein 1 pale buff. Prothoracic leg: coxa brown overlaid with pale buff, apex pale buff; femur and tibia dark brown with scattered pale buff scales, buff scales more abundant on outer surfaces; tarsus dark brown, apices of first, second, and third segments pale buff, ventral surface of first segment pale buff. Mesothoracic leg: coxa off white on outer surface; femur and tibia dark brown with some pale buff flecks, a pale buff fascia just beyond middle of tibia, apex of tibia pale buff; tarsus dark brown dorsally, apices of first, second, and third segments pale buff, apex of fourth segment pale buff laterally. Metathoracic leg: coxa off-white; femur brown, heavily overlaid with pale buff; tibia pale buff with a few brown scales near base, a broad brown fascia just before middle and apex, dorsal scale tuft pale buff; tarsus dark brown externally, base of first segment and apices of all segments pale buff. Alar expanse: 15–25 mm. Male genitalia: as in figure 85 (RWH slide 2618). Heavily sclerotized flange of aedeagus with moderately acute apex, ductus ejaculatorius simplex one-and-one-half times length of aedeagus. Female genitalia: as in figure 139 (RWH slide 3144).

Food plant: Unknown.

Type: Male, USNM.

Specimens examined:

ARIZONA: Maricopa, Pinal Co., 1♂, Oct. 17, 1927, J. A. Kusche, CAS; Kingman, 1♂, Oct. 1–7, USNM; Mohave Co., 1♂, Oct. 8–15, USNM; same locality, 1♂, BMNH; Paradise, Cochise Co., Oct. 1–7, USNM; 4 mi. ESE Pine, 5400 ft., Gila Co., 2♂, Sept. 5, 1961, R. W. Hodges, USNM; Prescott, 8♂, 8♀, Oct. 1–30 (AB slide Aug. 16, 1933), USNM. CALIFORNIA: Loma Linda, 1♀, Nov. 6, G. R. Pilate, AFB; Southern Calif., 1♀ (RWH slide 2619), USNM; Willow Creek, Siskiyou Co., 14♂, Sept. 10–11, 1871, Walsingham (RWH slide 2879), BMNH, USNM. COLORADO: Denver, 6♂, Sept. 15, 1910, Oslar, USNM; same locality, 1♂, 4♀ (AB slide Aug. 11, 1933), USNM; Durango, 1♂, 1♀, Oslar, CAS, USNM; Glenwood Springs, 5♂, 1♀, July 16–September (AB slides Aug. 4, 1933 and Apr. 30, 1937), USNM; same locality, 3♂, Aug. 2, 22, 1892, W. Barnes, USNM; same locality, 2♂, September 1906, BMNH, LACM; Lamar, 4♂, 1♀, Sept. 24, 1945, E. C. Johnston (RWH slide 2573), CNC, USNM; Larimer Co., 2♂, 1♀, June, 4♂, July, 20♂, 2♀, August 1891, BMNH; Mesaverde, 1♂, Sept. 27, 1945, E. C. Johnston (RWH slide 2618), CNC; Rock Creek Canyon, 3♂, Sept. 26–28, 1957, Margot May, CPK; no further locality, 11♂, BMNH, LACM, USNM. NEW MEXICO: Bent, 2♂, 1♀, 10.27, BMNH; Gallup, 1♂, Sept. 11, 1961, R. W. Hodges, USNM; Jemez Springs, 1♂, Oct. 1–7, USNM; Mescalero, 1♂, 10.27, BMNH. TEXAS: Bosque Co., 1♂, Oct. 6, 1876, Belfrage, BMNH. UTAH: Eureka, 2♂, Sept. 6, 9, 1910, T. Spalding, USNM; Stockton, 3♂, 1♀, Aug. 31–Sept. 10, T. Spalding (AB slides Aug. 8, 1933 and Apr. 29, 1937), USNM. WYOMING: Torrington, 1♂, Sept. 2, 1948, R. E. Pfadt (JFGC slide 9896), USNM.

Discussion: The maculation of *barnesiella* is relatively constant. The major variation is in the amount of dark brown and red brown on the forewing and thorax. Some specimens are very pale with the basal and antemedial triangular dark markings as the prominent features; others are moderately dark and have a general suffusion of dark brown on the forewings.

The frontal processes (fig. 61) are the major diagnostic feature of *barnesiella.* Of the four species that might be confused with it by maculation, *texanella*, *pagella*, *incicur*, and *geniata*, the first two have a plain frons. *L. incicur* (fig. 58) has the interior of the dorsal projection spinose, that of *barnesiella* is smooth. The dorsal and medial frontal processes of *geniata* (fig. 62) lack separating margins; those of *barnesiella* are separated by the strong ventral margin of the dorsal process.

Lita incicur, new species

FIGURES 9–13, 58, 78, 137, 140, 177, 178

Maculation: as in figures 9–13. Head: tongue white to pale buff basally, becoming brown subbasally; maxillary palpus off white, folded over base of tongue; labial palpus, first segment with yellow brown and pale brown scales, second segment white with scattered yellow and pale brown scales, third segment with a mixture of white and brown scales; scape of antenna buff with scattered brown scales on dorsal surface, shaft greasy brown, some scales of distal half of basal segments greasy buff; frontovertical processes as in figure 58; frons buff white; vertex and occiput buff. Thorax; varying shades of buff and buff brown. Forewing: pale buff to orange; dark markings brown; cilia pale buff, apices of scales darker. Hindwing; shining fuscous, veins with orange brown, cilia buff. Prothoracic leg: white on posterolateral surface, pale brown with whitish scales on frontomedial surface, apex pale buff; femur brown with whitish scales; tibia brown with a white fascia slightly beyond middle and another at apex; tarsus brown, apices of first three and base of first segment white. Mesothoracic leg: nearly as for prothoracic leg. Metathoracic leg: tibia white with an antemedial and preapical patch of brown scales. Abdomen: terga pale yellow basally, gray brown distally, apices of sterna buff white. Alar expanse: 17–27 mm. Male genitalia: as in figure 78 (RWH slide 2570). Apex of flange of aedeagus sickle shaped. Female genitalia: as in figures 137 and 140 (RWH slides 2616 and 2751).

Food plant: Unknown.

Type: Male, Smokey Valley, 6300 ft., Tulare Co., California, Sept. 28, 1946, C. Henne (RWH slide 2610), USNM type 67643.

Paratypes:

CALIFORNIA: Mammoth Lake, Inyo Co., 1 ♂, Aug. 15, 1921, O. C. Poling, USNM; Mono Pass, Inyo Co., 4 ♂, Aug. 13, 1957, J. Powell (RWH slides 2611 and 2612), UCB, USNM; Monachee Meadows, 8000 ft., Tulare Co., 2 ♂, Aug. 16–23, 1936, USNM; Mt. Shasta, Siskiyou Co., 12 ♂, 13 ♀, August 1871, Walsingham, BMNH, USNM; same locality, 7 ♂, 5 ♀, Aug. 19, 1939, E. C. Johnston (RWH slide 2571), CNC, USNM; Nevada Co., 2 ♂, September, CAS, USNM; same locality as type, 2 ♂, CU, USNM; Tuolumne Meadows, Tuolumne Co., 1 ♂, Aug. 27, 1960, W. E. Ferguson, UCB; Twin Lakes, Alpine Co., 4 ♂, Aug. 21, 1936, E. C. Johnston (RWH slide 2570), CNC, USNM; White Mt. Peak, 12500 ft., 5 mi. S, Mono Co., 1♂, 1♀, Aug. 15, 1960, S. F. Cook (RWH slides 2559 and 2560), UCB, USNM; Willow Creek, Siskiyou Co., 8♂, 3♀, Sept. 10–11, 1871, Walsingham (RWH slides 2877, 2878, 2880, and 3019), BMNH, USNM. Colorado: Glenwood Springs, 4♂, Aug. 16–18, 1892, W. Barnes (AB slide Aug. 12, 1933; RWH slide 2609), USNM. Oregon: Crater Lake Park, South Rim, 7100 ft., 1♂, Sept. 13, 1930, H. A. Scullen, CU. Wyoming: Green River L., Wind River Range, 1♂, July 24–Aug. 7, 1935, A. B. Klots, AMNH; Sacajawea Camp, Middle Piney Creek, 8400 ft., Sublette Co., 1♂, Aug. 14, 1953, Rindge (RWH slide 2883), AMNH; Yellowstone Natl. Park, Madison Jct., 1♂, 2♀; Aug. 19, 1962, Spangler (RWH slides 2606 and 2616), USNM.

Other specimens examined:

California: Mono Pass, Inyo Co., 1♂, Aug. 13, 1957, J. Powell, UCB, same locality, 12000 ft., 10♂, 4♀, MacNeill, and MacNeill, Rentz, and Landgren, CAS; Rock Creek, 1 mi. W. Tom's Plane, Mono Co., 1♂, 3♀, Sept. 6, 1960, MacNeill, CAS.

Discussion: *L. incicur* is similar to *texanella* and *obnubila* but differs from them in having frontovertical processes.

Lita geniata, new species

Figures 14, 62, 81, 179, 180

Maculation: as in figure 14. Head: tongue and maxillary palpus pale buff white, latter folded over base of tongue; labial palpus nearly white, outer surface of first segment and base of second segment with a few yellow-brown scales, scattered pale brown scales apically on second segment and generally on third segment; scape of antenna buff, shaft greasy brown (male, no females seen); scales of frons, vertex, and occiput buff; frontovertical processes as in figure 62. Thorax: varying shades of brown. Forewing: varying shades of brown; darker basally, becoming buff white apically, spots on disc dark brown, almost black; apices of cilial scales darker than remainder of scale. Hindwing: fuscous buff, veins with more yellow orange; cilia pale buff. Legs: buff to off white basally, becoming brown distally; apices of basal tarsal segments off white; metathoracic tibia with pale buff dorsal tuft and three brown scale patches on outer surface, one subbasal, one antemedial, and one preapical. Abdomen: first three terga yellow, remaining terga yellow brown with pale apices; sterna greasy buff white, bases darker than apices. Alar expanse: 15.0–19.5 mm. Male genitalia: as in figure 81 (RWH slide 2604). Apex of heavily sclerotized flange of aedeagus narrow, sickle shaped. Female genitalia: no specimens available.

Food plant: Unknown.

Type: Male, La Puerta Valley, So. Calif., USNM type 67644.

Paratypes:

California: same data as for type, 16♂ (RWH slides 2604 and 2605), BMNH, CNC, CU, UCB, USNM; La Puerta, 3♂, Stephens, USNM; La Puerta Val., 1♂, Oct. 16–23, USNM; Loma Linda, 1♂, Oct. 22, G. R. Pilate, AFB; So. Calif., 1♂, USNM.

Discussion: *L. geniata* may be separated from *barnesiella* as indicated under the latter. The maculation of *geniata* is relatively constant with the exception of the costal area which may be brown to buff. Inasmuch as the known specimens are from one locality (the "So. Calif." specimen may represent the same population), the amount of variation is likely to be small. When other populations are discovered, more phenotypes may be observed.

Lita puertella (Busck)

Figures 15, 16, 65, 80, 149, 181, 182

Gelechia puertella Busck, 1916, Proc. Ent. Soc. Washington, vol. 18, p. 148.
Lita puertella.—Busck, 1939, Proc. U.S. Nat. Mus., vol. 86, p. 573.

Maculation: as in figures 15 and 16. Pale form: head, thorax, and forewing pale yellowish white; labial palpus with a few pale ocherous scales scattered on lateral surface; maxillary palpus folded over base of tongue; shaft of antenna ocherous basally becoming darker distally; markings on forewing brown; hindwing pale fuscous yellow; cilia pale buff; abdomen pale ocher dorsally, pale yellowish white ventrally; legs pale yellowish white, becoming brown distally, prothoracic leg darker than metathoracic leg, apices of tarsal segments yellowish white except last two of prothoracic leg and ultimate segment of mesothoracic leg. Dark form: much as given for pale form but with overlay of brown and red brown. Lower portion of frontal process (fig. 65) with strongly carinate margin, inner surface pitted; dorsal portion with a small, circular cross section, margin even and strongly carinate. Alar expanse: 16–20 mm. Male genitalia: as in figure 80 (RWH slide 2598). Heavily sclerotized flange of aedeagus generally uniform in width, tapering to acute apex. Female genitalia: as in figure 149 (RWH slide 3145).

Food plant: Unknown.

Type: Male, USNM.

Specimens examined:

Arizona: Maricopa, Pinal Co., 1♂, Oct. 17, 1927, J. A. Kusche, CAS; Phoenix, 1♂, Oct. 29, Cockerell, USNM. California: Desert Springs, San Bernardino Co., 4♂, Oct. 17, 1960, Hurd and Powell (RWH slides 2567 and 2568), UCB, USNM; near Essex, San Bernardino Co., 1♂, 3♀, Oct. 30, 1939, J. A. Comstock (RWH slide 3145), LACM, USNM; Ivanpah Mts., San Bernardino Co., 11♂, Oct. 5, 1940, J. A. Comstock (RWH slide 2597), LACM, USNM; same locality, 4♂, Oct. 8, 1940, C. Henne, LACM; La Puerta Valley, So. Calif., 74♂, September through Oct. 23 (AB slides), Sept. 10, 1930, Mar. 2, 1931, and Apr. 28, 1937 (RWH slides 2566, 2598, 2599, and 2600), LACM, USNM; Providence Mts., 3♂, 2♀, Oct. 8, 1936, Sperry, AMNH, CNC; Rock Cr., 1 mi. W Tom's

Place, Mono Co., 3 ♂, Aug. 9, 1959, C. D. MacNeill, CAS; West Riverside, 1 ♂, Oct. 28, 1905 (AB slide Aug. 1, 1933), USNM.

Discussion: *L. puertella* is a highly variable species in regard to maculation, ranging from pale yellowish-white specimens with two prominent dark brown spots on the forewings to brown specimens with the dark brown spots barely discernible. I have seen numerous intermediate stages between the two extremes.

L. deoia and *dialis* superficially resemble *puertella*. *L. dialis* is easily separated because it lacks a frontal process. The lower section of the frontal process of *puertella* has a strong, high ventral margin; that of *deoia* has a rounded, poorly defined ventral margin.

Lita deoia, new species

FIGURE 17, 82, 183, 184

Maculation: as in figure 17. Head: buff white, maxillary palpus folded over base of tongue; outer surface of first segment of labial palpus pale brown, apex of third segment brown; scape of antenna with a dorsomedial brown patch, shaft greasy brown; frontovertical protuberance much as for *invariabilis* (fig. 59), dorsal protuberance more nearly circular, ventral margin slightly flattened. Thorax: buff white. Forewing: buff white, tinged with pale yellow and brown, dark markings brown. Hindwing: shining pale fuscous, veins slightly darker, cilia buff. Prothoracic leg: coxa and femur white on outer surface, inner surface of coxa white with scattered brown scales, inner surface of femur brown with scattered white scales; tibia brown with a postmedial and apical white band; base and apex of basitarsus and apex of second tarsal segment white. Mesothoracic leg: as for prothoracic leg but with more white scales on inner surface of femur, inner surface of tibia white. Alar expanse: 20.5 mm. Male genitalia: as in figure 82 (RWH slide 2556). Apex of flange of aedeagus broad and blunt, much as for *variabilis*. Female genitalia: no specimens available.

Food plant: Unknown.

Type: Male, Smokey Valley, 6000 ft., Tulare Co., Calif., Sept. 28, 1946, C. Henne (RWH slide 2556), USNM type 67645.

Discussion: Superficially, *deoia* looks like the light form of *puertella* or *dialis*. It differs from *dialis* in having frontovertical processes. It may be distinguished from *puertella* (fig. 65) by the ventral margin of the lower frontal processes being poorly defined; in *puertella* this margin is raised and heavily sclerotized. The frontal process of *deoia* is broad, that of *puertella* is narrow; the medial process of *puertella* is raised more than its apical width, that of *deoia* is raised less than one-third its apical width.

L. deoia and *puertella* are very close, and it may be that *deoia* represents a population of *puertella;* however, evidence to support this hypothesis is lacking.

Lita dialis, new species

FIGURES 18, 83, 132, 185, 186

Maculation: as in figure 18. Head: tongue buff; maxillary palpus pale buff, folded over base of tongue; labial palpus white, apex of third segment tinged with yellow brown; scape and base of antenna buff, shaft greasy buff brown apically; frons, vertex, and occiput pale buff. Thorax: buff white. Forewing: buff white to buff, dark spot brown, cilia buff white. Hindwing: shining pale fuscous, veins darker and tinged with yellow gray, cilia buff. Legs brown with scale bases pale brown to white; a white fascia at middle and apex of each tibia, dorsal tuft on metathoracic tibia off white, apices of first three or four tarsal segments and base of basitarsi white. Abdomen: terga greasy ocher, paler on basal terga, apices of terga pale; sterna greasy brown, apices of segments greasy buff, many scales with buff lines. Alar expanse: 17.5–20.0 mm. Male genitalia: as in figure 83 (J.F.G.C. slide 10208). Apex of flange of aedeagus tapering to blunt tip. Female genitalia: as in figure 132 (RWH slide 2603).

Food plant: Unknown.

Type: Male, Paradise, Cochise Co., Ariz., March (RWH slide 2602), USNM type 67646.

Paratypes:

ARIZONA: Southern Arizona, 1♂, USNM; Wickenburg, 1♀, May 20, 1957, Sperry, USNM. NEW MEXICO: Carlsbad, Eddy Co., 2♂, May 17, 1950, E. C. Johnston (RWH slide 2603), CNC. TEXAS: Alpine, 5000–8000 ft., 4♂, April–July, AFB; Brewster Co., 5000 ft., 7♂, 2♀, 4.26, BMNH, USNM; no further locality, 1♂, May 19, 1953, O. J. Robertson (JFGC slide 10208), USNM. MEXICO: Durango, La Resolana, 1♂, Feb. 21, 1953, E. I. Schlinger, UCB.

Discussion: *L. dialis* is similar in appearance to *deoia* and *puertella* but differs from them in lacking frontovertical processes. Individual specimens differ in the amount of brown scaling so that the moths appear pale buff to gray brown.

Lita pagella, new species

FIGURE 19, 20, 84, 145, 187, 188

Maculation: as in figures 19 and 20. Head: tongue buff brown to brown laterally, some pale buff scales medially; maxillary palpus pale buff, folded over base of tongue; first segment of labial palpus white on inner surface, outer surface white basally, brown from middle to apex, pale buff on ventrodistal portion, second segment buff white to white with scattered brown scales, third segment mainly brown on anterior surface, white on posterior surface; scape of antenna orange brown dorsally, buff white ventrally, shaft greasy brown; frons buff white; vertex and occiput buff. Thorax: scales brown, buff brown to pale buff, most scales paler basally than apically. Forewing: orange brown and varying shades brown, cilia orange buff basally, pale buff distally. Hindwing: fuscous, veins dark, cilia pale buff. Prothoracic leg: coxa with anterior surface brown, basal row of scales buff white, posterolateral surface white; femur brown anteriorly, mottled brown and white posteriorly; tibia brown, a buff fascia beyond middle, apex white; tarsus brown, base and apex of first segment buff white. Mesothoracic leg: as for prothoracic leg, outer surface of coxa white, apex of tibia buff. Metathoracic leg: coxa white, outer surface of femur white with scattered brown scales; tibia greasy brown black, an oblique buff white subbasal fascia, another at three-fifths, apex white, dorsal tuft off white; tarsus brown black, base of first segment and apices of all segments pale. Abdomen: first three terga greasy pale yellow, remaining terga pale buff; sterna white to buff white. Alar expanse: 17–19 mm. Male genitalia: as in figure 84 (RWH slide 2608). Apex of flange of aedeagus acute, free portion nearly at right angle with aedeagus. Female genitalia: as in figure 145 (RWH slide 2574).

Food plant: Unknown.

Type: Female, Fort Valley, 7350 ft., 7½ mi. NW Flagstaff, Coconino Co., Ariz., Aug. 27, 1961, Ronald W. Hodges (RWH slide 2574), USNM type 67647.

Paratypes:

Arizona: Mohave Co., 1 ♀, Sept. 8–16, USNM; Paradise, Cochise Co., 8 ♀ Aug. 24–Oct. 7, USNM; White Mts., 7200–11500 ft., 1 ♂, Aug. 10–30, 1925, O. C. Poling, USNM. California: Jacumba, 3 ♂, Sept. 27–Oct. 2, 1924, Piazza (RWH slide 2608), LACM, USNM. Colorado: Colorado Springs, Fountain Valley School, 1 ♂, Aug. 20–31, 1932 (ABK slide 18 Jan. 23), AMNH; Rock Creek Canyon, 1 ♂, Sept. 10, 1947, Margot May (RWH slide 2876), CPK; Salida, 1 ♀, Aug. 27, 1938, Sperry (RWH slide 2884), AMNH. New Mexico: Bent, 3 ♂, October 1927 (RWH slide 3020), BMNH, USNM; Mountain Park, 1 ♀ August 1927, BMNH.

Discussion: *L. pagella* may be separated from *barnesiella* and *incicur* by the smooth frons and from *thaliae* by the entire basal area of the forewing being dark or with dark spots. Some specimens are much paler than the one described.

Lita obnubila, new species

Figures 21, 87, 135, 189, 190

Maculation: as in figure 21. Head: tongue pale buff, some scales brown tipped; maxillary palpus pale buff, folded over base of tongue;

first segment of labial palpus white on inner surface, buff brown on outer surface, second and third segments buff white with scattered brown scales; scape of antenna buff white lightly dusted with brown, shaft greasy buff basally becoming buff brown distally; frons buff white; scales of vertex and occiput buff white with pale brown apices. Thorax: gray buff, scales streaked with gray, many scales with narrow brown border at apex; last row of scales of tegula buff white. Forewing: white, buff white, pale yellow, red brown, and brown; many scales of cilia tipped with red brown. Hindwing: fuscous, veins broadly covered with scales that appear shining orange at some angles of light incidence, cilia buff. Legs: mottled buff white and brown, each succeeding pair paler than the preceding one, apices of tarsal segments and sometimes dorsal surfaces off white. Abdomen: anterior two terga pale yellow, succeeding ones buff white; sterna buff white with scattered brown scales, apices unicolorous. Alar expanse: 19–23 mm. Male genitalia: as in figure 87 (RWH slide 3459). Apex of valva globose. Female genitalia: as in figure 135 (RWH slide 3460).

Food plant: Unknown.

Type: Male, Fort Davis, Tex., 5000 ft., 5.28 (RWH slide 3459), BMNH.

Paratypes:

Same data as for type, 3♂, 1♀ (RWH slides 2881 and 3460), BMNH, USNM.

Discussion: Superficially, *obnubila* appears like some specimens of *texanella;* however, the forewings of *obnubila* lack distinct spots in the cell; the apices of the valvae are globose, ellipsoidal in *texanella;* the two projections on the anterior margin of the eighth sternum (fig. 189) are uniformly broad to the apex, in *texanella* these projections taper somewhat to the apex; the ratio of width of the segment bearing the apophyses anteriores to the total length from the apex of the papillae anales to the anterior margin of the bursa copulatrix is 1:5 in *obnubila,* 1:7 in *texanella. L. obnubila* may be separated from *veledae* by the apices of the valvae being globose and the inner surface of the second segment of the labial palpus being mottled.

***Lita maenadis,* new species**

FIGURES 22, 133

Maculation: as in figure 22. Head: tongue white basally becoming pale brown medially; maxillary palpus white, folded over base of tongue; inner surface of first segment of labial palpus white, scales of outer surface pale buff basally, brown distally, second segment white with scattered brown scales, third segment brownish, bases of scales nearly white; dorsal surface of scape pale buff with brown blotches, ventral surface buff, ventral surface of shaft buff, individual scales of dorsal surface pale buff basally, dark brown distally, several half segments pale buff basally; frons nearly white; vertex and occiput buff white, brown tuft of scales above eye. Thorax: buff white, many scales with darker streaks. Forewing: buff white to white, several brown or red-brown tipped scales; first row of scales of cilia brown tipped, others unicolorous. Hindwing: pale fuscous, veins darker, cilia pale buff. Prothoracic leg: coxa white with several brown tipped scales on anterior surface, posterolateral surface white; femur and tibia brown, bases of scales pale buff, apex of tibia white; tarsus brown, base of first segment and apices of first and second segments white. Mesothoracic leg: much as for prothoracic leg but somewhat lighter, outer surface of coxa white, a white streak just beyond middle of tibia. Metathoracic leg: as for mesothoracic leg but lighter, dorsal tuft on tibia buff white. Alar expanse: 18–20 mm. Male genitalia: no specimens available. Female genitalia: as in figure 133 (RWH slide 2583).

Food plant: *Senecio* species.

Type: Female, Blanco's Corral, White Mts., Mono Co., Calif., 10150 ft., Aug. 25, 1960, P. D. Hurd, *Senecio* (RWH slide 2583), CAS.

Paratype:

Placer Co., Calif., 1♀, August, Koebele, CAS.

Discussion: *L. maenadis* is nearest to *obnubila* but may be separated by the antenna being multicolored basally; in *obnubila* the antenna is unicolorous off white basally.

***Lita veledae*, new species**

FIGURES 23, 88, 191, 192

Maculation: as in figure 23. Head: tongue pale buff to buff white; maxillary palpus buff white, somewhat curved over base of tongue; first segment of labial palpus white on inner surface, white with a few orange scales on outer surface; second segment white on inner surface, white with scattered orange scales on outer surface, third segment mainly white but with numerous orange and pale brown scales anteriorly; scape of antenna buff white on ventral surface, brownish on dorsal surface, shaft pale buff basally (antennae not complete on unique specimen); frons buff white; vertex and occiput buff white tinged with yellow. Thorax: buff white with three brown streaks (possibly grease marks), tegulae tinged with yellow. Forewing: buff white to white, suffused with pale orange brown on dorsal third, a row of yellow scales on outer margin. Hindwing: shining gray white, cilia buff white. Prothoracic leg: coxa white on posterolateral surface, anterior surface buff white; femur white on outer surface, pale brown medially, gray white on edges; tibia pale brown with a gray white fascia at three-fifths, apex gray white; tarsus brown, base and apex of basitarsus and apex of second segment white. Mesothoracic leg: absent on type. Metathoracic leg: coxa and femur buff to buff white, many scales streaked with gray, trochanter nearly white; tibia white with a faint streak of orange-brown scales at one-fourth and another at four-fifths; tarsus white to gray brown depending upon angle of light incidence, ventral surface orange brown basally, brown distally, apices of segments pale. Abdomen: not observed before dissection was made. Alar expanse: 17 mm. Male genitalia: as in figure 88 (RWH slide 2885). Female genitalia: no specimens available.

Food plant: Unknown.

Type: Male, Dixieland, Imperial Co., Calif., Mar. 15–30, 1922, O. C. Poling (RWH slide 2885). USNM type 67648.

Discussion: *L. veledae* may be distinguished from *obnubila* by having the inner surface of the second segment of the labial palpus pure white and by having the apices of the valvae ellipsoidal. In many superficial respects *veledae* is similar to *maenadis* but differs in having the base of the shaft of the antenna unicolorous, whereas that of *maenadis* is brown and white.

All of the characters examined and used to separate *veledae* and *maenadis* may be indicative of nothing more than the two sexes of a species or of two semiseparate populations of a species; however, without further knowledge based on more specimens (and preferably reared series) of either, I am recognizing two entities.

Lita rectistrigella (Barnes and Busck)

FIGURES 24, 72, 144, 193, 194

Gelechia rectistrigella Barnes and Busck, 1920, Contr. Nat. Hist. Lep. N. America, vol. 4, p. 229.

Lita rectistrigella.—Busck, 1939, Proc. U.S. Nat. Mus., vol. 86, p. 573.

Maculation: as in figure 24. Head: tongue gray white basally: maxillary palpus pale buff, folded over base of tongue; labial palpus gray white, liberally dusted with brown; scape of antenna dark brown, shaft ocherous basally becoming brown distally in male, gray white interspersed with brown basally becoming brown distally in female, sensory areas of male usually covering one-half to nearly all of ventral surface of one-half of each segment basally; frons gray white; vertex and occiput buff. Thorax: gray white overlaid with brown. Forewing: streaks of gray white between brown on veins, outer margin with dark brown at ends of veins; scales of cilia gray white, apex of each scale pale brown. Hindwing: fuscous, cilia buff. Legs:

brown with buff to gray white at apices of tarsal segments. Abdomen: ocherous basally, paler distally, posterior margin of segments pale buff; ventral surface yellow white with scattered brown scales. (This description was taken mainly from the specimen used for the photograph. Others differ in the amount of brown present on various surfaces.) Alar expanse: 17.0–20.5 mm. Male genitalia: as in figure 72 (RWH slide 2642). Female genitalia: as in figure 144 (RWH slide 2629).

Food plant: Unknown.

Type: Female, USNM.

Specimens examined:

UNITED STATES: ARIZONA: Douglas, 1 ♀, Sept. 16, 1923, USNM; Mohave Co., 1 ♀, Sept. 16, 1923, USNM; Paradise, Cochise Co., 1 ♀, Oct. 1–7 (RWH slide 2591), USNM; White Mts., 7200 ft., 1 ♂, Aug. 15, 1925, O. C. Poling (RWH slide 2641), USNM. CALIFORNIA: La Puerta Valley, 4 ♂, 2 ♀, September-October 23 (RWH slides 2629 and 2642), USNM; 7 mi. N Temecula, Riverside Co., 1 ♀, Oct. 19, 1960, J. Powell, UCB; Upper Santa Ana River, San Bernardino Co., 1 ♂, 1 ♀, Sept. 15–19, Sperry, USNM; West Riverside, 2 ♂, 1 ♀, Oct. 26, 27, 1925 (AB slide Mar. 21, 1933, RWH slide 2590), USNM. COLORADO: Bear Creek, Morrison, 3 ♂, Aug. 23, 1904 (RWH slide 3432), USNM; Denver, 7 ♂, Sept. 5, 9, Oslar (RWH slides 3424–3429), USNM; Durango, 1 ♀ Sept. 26, 1945, E. C. Johnston (RWH slide 2637), CNC; Lamar, 3 ♂, Sept. 24, 1945, E. C. Johnston (RWH slides 2734, 3433, and 3441), CNC; Rock Creek Canyon, 3 ♂, Sept. 10–29, 1957, Margot May (RWH slides 3438–3440; RWH wing slide 55), CPK, USNM; no locality, 5000 ft., 2 ♂, August 1891, BMNH. MONTANA: Boulder, 1 ♂, Titus Ulke (RWH slide 2750), USNM; Butte, 4 ♂, Sept. 12, 1945, E. C. Johnston (RWH slide 2635), CNC, USNM. NEW MEXICO: Ft. Wingate, 1 ♀, Sept. 1–7, USNM; Hell Canyon, 1 ♂, Sept. 15, 1916, C. Heinrich (RWH slide 2624), USNM; Mesilla, 1 ♂, C. N. Ainslie, USNM. UTAH: Deer Creek, Provo Canyon, 1 ♂, Sept. 16, 1918, T. Spalding, USNM; Eureka, 1 ♂, Aug. 27, 1911, T. Spalding (JFGC slide 9906), USNM; Lehi, 3 ♂, Sept. 29, 30, 1939, H. F. Thornley, CNC; Salt Lake City, 1 ♀, 5–90, Ainslie (RWH slide 2643), USNM; Spanish River, 1 ♂, Sept. 4–8, CNC. WASHINGTON: Satus Creek, Yakima Co., 1 ♂, Sept. 16, 1949, E. C. Johnston (RWH slide 2752), CNC.

CANADA: ALBERTA: Dorothy, 1 ♂, 1921, W. G. Hodgson, BMNH.

Discussion: *L. rectistrigella*, as defined above, includes a relatively homogeneous appearing group of moths. The major criteria for recognition of the males are the width of the sensory areas of the antennae, the aedeagus of the male genitalia, and the smooth frons. A series of specimens from Colorado and Montana have the sensory areas of the male antennae about one-third to one-half the width of a segment, and two well-defined bars are present on the forewings. They would seem to be *variabilis* from these characters; however, the male genitalia place them with *rectistrigella*. Three possible interpretations exist for this series: (1) The width of the male antennal sensory areas is variable and thus has no taxonomic significance in this species. (2) The width of the male antennal sensory areas is not variable and thus is taxonomically significant. (3) The width of the male antennal sensory areas has taxonomic significance at the subspecific level. Of the three possibilities, I have tentatively concluded that the first is correct; however, until the species has been reared and the progeny of known females studied, I cannot be certain. Because no females have been correlated with the series of males under discussion, I have discarded the second interpretation. However, females of several species of *Lita* are uncommon to rare in collections, and it could be that none have been collected. That the series might represent a subspecies of *rectistrigella* seems unlikely inasmuch as a "normal" male is known from Denver, Colorado; six of the second type of male are from Denver. Thus, no geographic separation is apparent.

L. rectistrigella may be separated from the other striate species of *Lita* as follows: *jubata* and *nefrens* have frontal processes; the aedeagus of *variabilis* has the apex of the flange blunt, that of *rectistrigella* is poorly defined; *princeps* has a well-defined bar on the forewing but no other lines, *rectistrigella* has series of lines; *sironae* is a smaller species (alar expanse 14–17 mm.) that consistently has two bars on the forewing, *rectistrigella* is a larger species (alar expanse: 17.0–20.5 mm.) that usually lacks dark bars on the forewing; the antennal segments of *recens* are bicolored (buff white and pale brown) and have the male sensory areas extending to the dorsal surface, the antennal segments of *rectistrigella* are not bicolored, and the sensory areas are confined to the ventral surface; the anterior margin of the eighth tergum of *thaliae* is roughly triangular (fig. 197), that of *rectistrigella* is more evenly rounded (fig. 193).

Lita sironae, new species

Figures 25, 73, 142, 195, 196

Maculation: as in figure 25. Head: tongue with buff white scales basally, brown medially; maxillary palpus with buff white scales, some scales streaked with pale brown; first segment of labial palpus buff brown on outer surface, white on inner surface, second and third segments white with scattered brown scales; ventral surface of scape of antenna greasy buff, some scales brown tipped, dorsal surface pale buff with numerous brown scales, shaft orange becoming darker distally (♂), individual shaft segments white on basal half, pale orange on distal half basally, becoming darker distally (♀); frons, vertex, and occiput pale buff with pale brown to brown apices. Thorax: scales brown streaked with pale buff, scales of distal half of tegula buff white streaked with pale brown. Forewing: streaked with white, buff white, pale yellow, brown, and black; many scales streaked; scales of cilia buff white, apices of basal row tipped with brown, apices of medial and distal rows tipped with pale brown. Hindwing: fuscous with numerous orange scales, cilia buff, apices of scales slightly darker. Prothoracic leg: coxa, femur, and tibia dark brown, scales pale basally, outer surface of coxa gray brown; tarsus yellow brown, apices of first and second and base of first segment white. Mesothoracic leg: coxa buff white; femur, tibia, and tarsus brown, a dorsal white streak at middle of tibia, apex of tibia white, base of basitarsus white, apices of tarsal segments slightly paler than remainder of segments. Metathoracic leg: coxa and femur buff white, many scales of femur streaked with brown; tibia buff white, apices of many scales pale brown to brown, dorsal tuft pale buff, apex white; tarsus pale brown, base of first segment white, apices of segments buff white. Alar expanse: 14–17 mm. Male genitalia: as in figure 73 (RWH slide 2630). Female genitalia: as in figure 142 (RWH slide 2631).

Food plant: Unknown.

Type: Male, San Diego, Calif. (RWH slide 2630), USNM type 67649.

Paratypes:

California: same locality as type, 41 ♂, 11 ♀, May 1–7 and Oct. 8–30 (RWH slide 2631, JFGC slides 9900 and 9901), BMNH, CNC, CU, and LACM; same locality as type, 5 ♂, Oct. 1–16, 1920, Karl Coolidge, LACM, USNM; same locality as type, 3 ♂, 2 ♀, Sept. 21–Nov. 20, 1923, Piazza, LACM, USNM; Desert Springs, San Bernardino Co., 1 ♀, October 17, 1960, Hurd and Powell, UCB; Los Angeles Co., 1 ♀, September, CAS; Mouth, San Gabriel Canyon, Los Angeles Co., 1 ♂, Nov. 11, 1945, C. Henne, USNM.

Other specimens examined:

California: San Diego, 1 ♂, 2 ♀, Oct. 8–15, CAS.

Discussion: *L. sironae* is nearest to *rectistrigella*, differing in having a pale yellow to orange-brown subcostal streak on the base of the forewing and in the smaller average size (7.9 mm. for *sironae*, 9.4 mm. for *rectistrigella*). The signa of *sironae* are from 0.28–0.38 mm. long, and the distance from the outer surface to the apex of the inwardly projecting termen is 0.16–0.22 mm. The same dimensions for *rectistrigella* are 0.72–0.78 mm. and 0.28–0.29 mm. In *sironae* the inwardly projecting termen of the signum is more nearly vertical with the outer margin than is that of *rectistrigella*. In the latter this projection is not abruptly angled from the outer margin.

Lita thaliae, new species

Figures 26, 27, 74, 150, 197, 198

Maculation: as in figures 26 and 27. Head: tongue white basally, becoming pale brown medially; maxillary palpus white, folded over base of tongue; first segment of labial palpus pale brown with a dorsobasal white patch; second and third segments white with scattered pale brown scales; scape of antenna white to buff white with pale brown dusting dorsally; shaft greasy pale orange basally becoming orange brown distally (♂), shaft blotchy greasy brown dorsally, buff ventrally (♀); frons off white; vertex and occiput pale buff. Thorax; mainly buff, some scales streaked with brown and a few brown scales streaked with buff. Forewing: off white, pale buff, pale yellow, and brown; ridges of many scales white or off white; cilia pale to dark buff, scale apices of basal row brown. Hindwing: pale fuscous, veins and costal margin shining pale orange; cilia buff. Prothoracic leg: outer surface white, anteromedial surface a mixture of gray brown and white; femur and tibia pale brown mixed with white, apex and epiphysis of tibia white; tarsus pale brown, base of first segment and apices of first and second segments white. Mesothoracic leg: coxa white; femur appearing gray on outer surface; tibia pale brown, a white streak at middle, apex white; tarsus gray brown, apices of segments and base of first segment pale gray to white. Metathoracic leg: coxa, femur, and tibia white, tibia with a few brown scales; tarsus off white with scattered brown scales. Alar expanse: 19.0–20.5 mm. Male genitalia: as in figure 74 (RWH slide 2578). Female genitalia: as in figure 150 (RWH slide 2582).

Food plant: *Chrysothamnus nauseosus* (Pallas) Britten.

Type: Male, Eureka, Utah, August 16, 1911, Tom Spalding, USNM type 67650.

Paratypes:

California: Nevada Co., 1 ♀, September, CAS; near Sonora Peak, Tuolumne Co., 11000 ft., 1 ♂, Aug. 6, 1959, C. D. MacNeill, CAS; 1 mi. W Tom's Place, Mono Co., 1 ♀, Aug. 13, 1957, ex *Chrysothamnus nauseosus consimilis*, J. Powell (RWH slide 2582), UCB. Colorado: Glenwood Springs, 2 ♂, August 1892, W. Barnes (AB slide Aug. 14, 1933; RWH slide 3249); same locality, 1 ♂, August 1889, MCZ; no further locality, 1 ♂, AMNH. Utah: same locality as type, 20 ♂, 11 ♀, Aug. 16–Sept. 9, 1911 (RWH slides 2577–2580 and 2594), CAS, USNM; Stockton, 1 ♂, Sept. 6, 1907, USNM.

Discussion: The faint oblique line from the costa at the base of the forewing to the middle of the forewing at one-fifth will separate nonstriate specimens of *thaliae* from *pagella*, *barnesiella*, and *texanella*. Superficially, striate specimens of *thaliae* are similar to some specimens of *incicur*, *variabilis*, and *rectistrigella*. By lacking frontovertical processes *thaliae* differs from *incicur*, and in the shape of the aedeagus (*rectistrigella* type) it differs from *variabilis*. *L. thaliae* differs from most known males of *rectistrigella* by having narrow sensory areas on the basal segments of the antenna. The basal extension of the aedeagus differs from that of *rectistrigella* by being more heavily sclerotized. Females of *thaliae* have the heavy setae at the base of the papillae anales numerous and in several rows; females of *recti-*

strigella have a single row of heavy setae in this position. The series of specimens from Utah tends to be relatively uniform in hue, whereas the specimens from Colorado and California are generally darker, often having white areas replaced by pale buff ones.

Lita texanella (Chambers)

FIGURES 28, 29, 76, 148, 199, 200

Anesychia texanella Chambers, 1880, Journ. Cincinnati Soc. Nat. Hist., vol. 2, p. 179.
Lita texanella.—Busck, 1939, Proc. U.S. Nat. Mus., vol. 86, p. 573.

Maculation: as in figures 28 and 29. Head: tongue with a few white scales at base, scales elsewhere pale basally becoming dark brown medially; maxillary palpus white (some scales brown tipped), folded over base of tongue; labial palpus, scales of first segment gray brown basally, dark brown apically, second and third segments white with heavy dusting of dark brown scales; scales of scape of antenna buff with brown tips, shaft yellow orange (♂), buff white with scattered brown scales basally, becoming brown distally (♀); scales of frons pale gray white with pale brown apices, scales of vertex and occiput buff white with brown apices. Scales of thorax and forewing buff white with brown apices and medial streaks, dark marks on forewing formed by scales with broad brown borders, scales of cilia lack medial dark markings. Hindwing: fuscous, cilia buff. Prothoracic leg: coxa white with a few dark scales laterally, anteromedially dark brown, apex buff white; scales of femur, tibia, and tarsus dark brown apically, paler basally, apices of first and second tarsal segments pale. Mesothoracic leg: much as for prothoracic one. Metathoracic leg: paler than prothoracic leg, dorsal tuft on tibia pale buff. Abdomen: ocherous dorsally, segments pale apically, ventral surface pale brown, segments lighter apically. Alar expanse: 21–27 mm. Male genitalia: as in figure 76 (RWH slide 2569). Apex of heavily sclerotized flange of aedeagus blunt. Female genitalia: as in figure 148 (RWH slide 3148).

Food plant: Unknown.

Type: Lectotype, present designation, male, bearing following labels: Type, 1424; 12/4; Chambers, ~~Kentucky~~; *Anesychia texanella*, Texas-Cham.; Lectotype by R. W. Hodges. MCZ.

Specimens examined:

UNITED STATES, TEXAS: Fort Davis, 3♂, 3.28, BMNH; Kerrville, 2♂, 2♀ (AB slide Sept. 25, 1934), USNM; same locality, 1♂, March 10, H. Lacey (RWH slide 2569), USNM; no further locality, 1♂, MCZ.

MEXICO, NUEVO LEON: 3 mi. E Galeana, 5000 ft., 6♂, 8♀, Aug. 7–9, 1963, Duckworth and Davis (RWH slides 3146–3149), CNC, CU, USNM.

Discussion: Some specimens of *incicur* are much like *texanella* on the basis of maculation; however, *texanella* lacks a frontovertical process, *incicur* has one.

Some specimens, particularly females, have more yellow in the basic color scheme than occurs in the specimen described for the species.

***Lita recens*, new species**

FIGURES 30, 75, 147, 201, 202

Maculation: as in figure 30. Head: buff white medially, brown laterally; maxillary palpus buff white, folded over base of tongue; first segment of lavial palpus white on inner surface, pale brown on outer surface, second segment brown heavily dusted with white basally, anterior surface lacking white scales, third segment brown with some white scales, anterior surface off white; dorsal surface of scape of antenna brown, ventral surface buff, a faint anterior white line at base, shaft white and red brown, sensory areas on most of antenna extending to anterior surface (♂), shaft brown with few white scales, sensory areas narrow, obliquely placed on segments, bordered with brown anteriorly (♀); frons, vertex, and occiput mottled buff brown. Thorax: buff brown. Forewing: scales white, buff white, pale yellow, brown, and dark brown, many scales with apices, many scales streaked with a second color; cilia gray white, apices of scales brown. Hindwing: fuscous, scales shining orange at certain angles of light incidence, veins somewhat darker, cilia buff. Prothoracic leg: anterior surface of coxa mottled buff brown, apex pale, posterolateral surface with brown and white scales; femur and tibia brown with few pale scales, posterior surfaces whitish, apex of tibia white; tarsus brown, base and apex of basitarsus and apices of second and third segments white. Mesothoracic leg: as for prothoracic leg but with anterior surface of coxa white. Metathoracic leg: coxa and femur white mixed with gray brown; tibia mottled white, gray brown, and brown on outer surface, dorsal tuft buff white; tarsal segments pale brown to brown, apices pale. Alar expanse: 17–22 mm. Male genitalia: as in figure 75 (RWH slide 2595). Female genitalia: as in figure 147 (RWH slide 2627).

Food plant: *Stenatopsis linearifolius* (de Candolle) Rydberg, leaf tier. *Ericameria cuneata* (Gray) McClatchie.

Type: Male, Mt. Shasta, Calif., Aug. 19, 1939, E. C. Johnston USNM type 67651.

Paratypes:

UNITED STATES: CALIFORNIA: same data as for type, 17♂, 4♀, CNC, CPK, USNM; 8 mi NW Chester, Plumas Co., 1♂, Aug. 18, 1958, J. Powell, UCB; Desert Springs, San Bernadino Co., 1♂, Oct. 17, 1960, Hurd and Powell, UCB; Hungry Valley, 5 mi. S Gorman, Ventura Co., 1♀, Oct. 1, 1959, J. Powell, UCB; Jacumba, 1♂, Sept. 28, 1924, USNM; La Puerta Valley, 2♂, Oct. 16, 1923 (JFGC slide 9909), MCZ, USNM; same locality, 1♂, Stephens, USNM; Lovejoy Butte, Los Angeles Co., 1♂, iss. Sept. 18, 1942, C. Henne, *ex* larva on *Ericameria cuneata spathulata*, USNM; Palmdale, Los Angeles Co., 7♂, 2♀, iss. Sept. 8–25, 1939, J. A. Comstock, larva leaf tyer on *Stenatopsis linearifolius* (JFGC slide 9911), LACM, USNM; Sheep Rock, Siskiyou Co., 1♂, Sept. 3, 1871, Walsingham, BMNH; Truckee, 1♂, Sept. 8–15, USNM. COLORADO: Glenwood Springs, 1♀, Aug. 22, 1892, Barnes (RWH slide 2627), USNM; Salida, 1♂, Aug. 27, 1938, Sperry, USNM. MONTANA: Butte, 2♂, Sept. 12, 1945, E. C. Johnston, CNC. NEW MEXICO: Therma, 1♂, Aug. 12, 1932, Klots, AMNH. OREGON: Baker, 1♂, Sept. 24, 1946, J. H. Baker, USNM; Biggs, 2♂, Oct. 2, 1945, E. C. Johnston, CNC; Crooked R., nr. Ft. Klamath, Jackson Co., 1♀, Sept. 21–23, 1871, Walsingham, BNMH; Lake Co., T 23 S, R 14 E, S21, 3♂, Aug. 20, 1958, G. R. Kraft (RWH slide 2595), USNM. UTAH: Eureka, 1♂, 1♀, Aug. 19, 27, 1911, T. Spalding (JFGC slide 9910), USNM; Stockton, 1♂, Sept. 1, 1904, T. Spalding, USNM. WASHINGTON: Wenatchee, 2♂, Aug. 23 and Sept. 12, 1929, J. F. Clarke (JFGC slide 9908), USNM.

CANADA: BRITISH COLUMBIA: Nicola, 1♂, Sept. 6, 1923, E. R. Buckell, CNC; Oliver, 2♂, Sept. 5, 16, 1953, D. F. Hardwick, J. E. H. Martin, CNC.

Other specimens examined:

CALIFORNIA: nr. Mono Pass, NW, 12,000 ft., Inyo Co., 1♂, Aug. 9, 1959, C. D. MacNeill, CAS; Victorville, San Bernardino Co., 1♀, Oct. 12, 1936, C. Dammers (RWH slide 2753), USNM. MONTANA: Boulder, 1♀, T. Ulke (RWH slide 2751), USNM.

Discussion: *L. recens* is much like some specimens of *variabilis*, *sironae*, and *rectistrigella*. The most obvious differences are those of the antennae (particularly in the male) in which the sensory areas extend to and slightly on the dorsal surface. In the females the anterior dark brown border of the sensory areas will distinguish this species from the others.

Lita princeps (Busck)

FIGURES 31, 86, 153, 203, 204

Gnorimoschema princeps Busck, 1910, Proc. Ent. Soc. Washington, vol. 11, p. 175.
Lita princeps.—Busck, 1939, Proc. U.S. Nat. Mus., vol. 86, p. 573.

Maculation: as in figure 31. Head: tongue with white scales basally; maxillary palpus white with a few pale gray brown scales, folded over base of tongue; first segment of labial palpus white mesally, brown laterally, second and third segments white with scattered brown scales; scape of antenna white with dusting of brown scales, dorsal surface of shaft with segments brown basally, buff white distally, ventral surface buff except for piceous sensory areas; frons white with some pale brown tipped scales; vertex and occiput buff with pale brown tipped scales. Thorax: tegula white with brown tipped scales basally, pale yellow distally; disk pale yellow. Forewing: scales on costal half at base and costal margin buff white with brown tips, scales on area costad and distad of medial brown streak white to buff white with pale brown apices, scales dorsad of brown streak pale yellow, a few buff tipped scales on outer margin, scales of cilia white to buff white with pale brown tips. Hindwing: fuscous, veins slightly darker than membrane, cilia pale buff brown. Prothoracic leg: coxa white on posterior surface, anterior surface brown (scales white tipped with brown); femur, tibia, and tarsus brown with scattered white scales, solid brown on third through fifth tarsal segments, apices of first and second and base of first tarsal segment white. Mesothoracic leg: as for prothoracic leg but with lateral surface of femur and tibia white and a few white scales at apex of third tarsal segment. Metathoracic leg: coxa and femur white with scattered pale brown scales; tibia white ventrally, buff white with some pale brown tipped scales dorsally, dorsal tuft buff white; first tarsal segment white with some brown scales, segments two through five brownish, apices whitish. Abdomen: dorsal surface ocherous basally, mixed pale brown, white, and buff distally and on ventral surface. Alar expanse: 16.5–20.0 mm. Male genitalia: as in figure 86 (RWH slide 2565). Aedeagus stout, maximum width one-fifth maximum length. Female genitalia: as in figure 153 (RWH slide 2564).

Food plant: Unknown.

Type: Female, USNM.

Specimens examined:

UNITED STATES: California: Barton Flats, San Bernardino Co., 1 ♂, Oct. 13, 1945, Sperry, AMNH; Jacumba, 1 ♀, Oct. 1, 1924, (RWH slide 2596), USNM; Rock Creek, 1 mi. W of Tom's Place, Mono Co., 3 ♂ Sept. 6, 1960, C. D. MacNeill, CAS; Upper Santa Ana River, San Bernardino Co., 1 ♂, 12 ♀, Sept. 14–20, 1947 and 48, Sperry (RWH slide 2564) CPK, USNM; no further locality, 1 ♀, BMNH. Colorado: Durango, 1 ♀, Sept. 26, 1945, E. C. Johnston, CNC; Mesaverde, 2 ♂, Sept. 27, 1945, E. C. Johnston (RWH slide 2565), CNC, USNM. Idaho: Hagerman, Blue Gulch, 1 ♀, Sept. 23, 1932, USNM. Montana: Butte, 1 ♀, Sept. 12, 1945, E. C. Johnston, CNC. New Mexico: Frijoles Canyon, 1 ♂, Sept. 8, 1941, Sperry, USNM. Oregon: Crooked River, nr. Ft. Klamath, Jackson Co., 6 ♂, 16 ♀, Sept. 21–23, 1871, Walsingham, BMNH; 15 mi. NW of Vale, 1 ♂, Sept. 9, 1962, K. Goeden, USNM. Utah: Dividend, 5 ♂, 9.28, BMNH; Eureka, 1 ♂, 1 ♀, Aug. 27, 1911, T. Spalding, LACM, USNM; Stockton, 1 ♂, 1 ♀, Aug. 29 and Sept. 12, T. Spalding, USNM. Washington: Dry Falls, 1 ♂, 3 ♀, Sept. 11, 1945, E. C. Johnston, CNC; Pullman, 1 ♂, Sept. 23, 1925, J. F. Clarke (JFGC slide 3237), USNM; Satus Creek, Yakima Co., 2 ♂, 1 ♀, Sept. 16, 19, 1949, E. C. Johnston, CNC; Wenatchee, 5 ♂, Aug. 21–Sept. 5, 1929, J. F. Clarke (AB slide Apr. 4, 1931), USNM.

CANADA: British Columbia: Oliver, 1000 ft. 3 ♂, Aug. 28–Sept. 5, 1953, D. F. Hardwick, CNC; same locality, 2 ♂, 1 ♀, Sept. 8–15, 1953, J. E. H. Martin, CNC.

Discussion: *Lita princeps* differs from the other species of *Lita* by having the two black dashes in the cell usually joined and broad. In most specimens the remainder of the forewing is pale and thus contrasts sharply with the black dash.

Color variation occurs in *princeps* to the extent of a general darkening of all areas. The color description given above was made from a relatively light colored specimen. In some specimens the longitudinal streak on the forewing is divided into its two component parts; however, I have seen no specimens in which the faint longitudinal streaking, typical of *variabilis*, is present.

Lita jubata, new species

FIGURES 32, 63, 64, 77, 141, 205, 206

Maculation: as in figure 32. Head: tongue whitish basally; maxillary palpus buff white, folded over base of tongue; labial palpus whitish, first segment with pale brown scales basally, second segment with brown scales on anterior, medial, and lateral surfaces, third segment solid white on anterior edge, with brown scales elsewhere; antenna cinereous brown, scape and apical half of shaft darker than base of shaft; lower portion of frons pale buff; vertex buff brown; occiput paler than vertex; frontovertical processes as in figures 63 and 64. Thorax and forewing pale buff; darker markings of forewing brown and black; cilia pale, scale apices slightly darker. Hindwing: fuscous, cilia fuscous yellow. Legs: buff white overlaid with brown basally, darker distally, apices of tibiae and first through third or fourth tarsal segments pale. Abdomen: first three terga cinereous yellow, caudal ones greasy pale brown, sterna greasy brown with pale buff apices. Alar expanse: 16–20 mm. Male genitalia: as in figure 77 (JFGC slide 9903). Female genitalia: as in figure 141 (JFGC slide 9905).

Food plant: *Chrysothamnus viscidiflorus* Nuttall and *C. nauseosus* (Pallas) Britten. Specimens were reared from the flowers.

Type: Male, Satus Creek, Yakima Co., Washington, Sept. 19, 1949, E. C. Johnston, CNC.

Paratypes:

CALIFORNIA: 9 mi. S Bridgeport, Mono Co., 3 ♀, Sept. 10, 1957, *ex* flowers *Chrysothamnus*, J. A. Chemsak, UCB, USNM; 1 mi. S Hobart Mills, 1 ♀, Sept. 1, 1957, *Chrysothamnus viscidiflorus typicus*, J. M. Linsley, UCB; Nevada Co., 2 ♀, September (JFGC slide 9905), USNM; Sagehen near Hobart Mills, 1 ♀, Sept. 5, 1957, B. J. Adelson, UCB; Sheep Rock, Siskiyou Co., 1 ♂, Sept. 3, 1871, Walsingham, BMNH; 3 mi. N Termo, Lassen Co., 1 ♀, Sept. 7, 1957, *Chrysothamnus nauseosus speciosus*, J. A. Chemsak, UCB; Twin Lakes, Alpine Co., 1 ♂, Aug. 21, 1936, E. C. Johnston (JFGC slide 4079), USNM. COLORADO: Denver, 1 ♀, Oslar, LACM; Glenwood Springs, 6 ♂, August and September (JFGC slide 9902), MCZ, USNM; Rock Creek vic. Colorado Springs, 1 ♂, Aug. 25, 1935, Klots, AMNH; Salida, 3 ♂, Aug. 26, 27, 1938, Sperry, AMNH, USNM; South Park, 1 ♂, Aug. 21, 1905, LACM. IDAHO: Hagerman-Blue Gulch, 2 ♂, Sept. 23, 1932, USNM; Idaho Falls, Bonneville Co., 1 ♀, Sept. 9, 1950, Rindge, AMNH. MONTANA: Boulder, 1 ♂, 1 ♀, USNM; Bozeman, 1 ♂, Aug. 20, 1928, J. McDunnough, CNC. UTAH: Stockton, 4 ♂, Sept. 1–7, 1904, T. Spalding (JFGC slide 9903), USNM. WASHINGTON: Pullman, 1 ♂, Sept. 18, 1930, J. F. Clarke, CU; Satus Creek, Yakima Co., 21 ♂, 1 ♀, Sept. 16, 19, 1949, E. C. Johnston (RWH slide 2634), CNC, USNM; Wenatchee, 2 ♂, Sept. 5, 1929 (JFGC slide 9904), USNM.

Discussion: *L. jubata* is a striate winged *Lita* of the *rectistrigella* genitalic group. It may be distinguished from the other known species by the frontovertical processes (figs. 63, 64). In *jubata* the vertical process has a linear cross section; other striate winged species have a circular cross sectioned vertical process or lack processes.

***Lita nefrens*, new species**

FIGURES 33, 34, 57, 60, 71, 138, 207, 208

Maculation: as in figures 33 and 34. Head: scales of tongue brown, pale basally, a medial row of white scales basally; maxillary palpus buff white, folded over base of tongue; first segment of labial palpus white mesally, brown on lateral surface, second segment mainly white with a few brown scales on mesal and posterior surfaces, a small dorsobasal patch of brown scales on lateral surface, and a narrow row of brown scales on anterior surface, third segment mainly brown with scattered buff white scale segments, anterior surface white; scape of antenna brown with scattered buff scale segments, shaft ocherous becoming darker apically (♂), shaft brown dorsally, ocherous ventrally, brown apically (♀); frons buff white; vertex and occiput buff brown, scales pale basally, darker apically; frontovertical processes as in figures 57 and 60. Thorax: brown, many scales with buff brown streaks, tegulae brown basally, buff brown apically. Forewing: brown, many scales with buff streaks, light streaks white, buff white or buff; cilia buff white, scale apices pale brown. Hindwing: fuscous with pale ocher reflections, cilia buff. Prothoracic leg: brown; posterolateral surface of coxa white; posterior surface of femur and tibia with many white scales; apices of coxa, femur, tibia, and first two tarsal segments white or off white. Mesothoracic leg: much as for prothoracic leg but with more white scales, tibia with a medial white fascia, base of basitarsus white. Metathoracic leg: with more white than first two, dorsal tibial tuft buff white, dorsal surface of tarsal segments buff white apically. Abdomen: greasy cinereous, dorsum lighter than venter, apices of segments pale. Alar expanse: 15–22 mm. Male genitalia: as in figure 71 (RWH slide 2638). Aedeagus of *rectistrigella* type. Female genitalia: as in figure 138 (RWH slide 2639).

Food plant: *Chrysothamnus nauseosus* (Pallas) Britten.

Type: Male, Sonora Pass, Tuolumne Co., Calif., Aug. 21, 1959, J. Powell, CAS.

Paratypes:

CALIFORNIA: 9 mi. S Bridgeport, Mono Co., 4 ♀, Sept. 10, 1959, J. A. Chemsak, UCB; Monachee Meadows, 8000 ft., Tulare Co., 1 ♀, Aug. 8–15, USNM; Nevada Co., 1 ♀, Sept., G. Willett, LACM; Ravendale, Lassen Co., 2 ♂, 3 ♀, Sept. 7, 1957, *Chrysothamnus nauseosus speciosus*, B. J. Adelson, UCB; same data as type, 4 ♂, 1 ♀ (RWH slide 2638), UCB, USNM; same locality as type, 1 ♀, Aug. 15, 1959, G. I. Stage (RWH slide 2639), USNM; 1 mi. W Tom's Place, Mono Co., 1 ♂, Aug. 13, 1957, J. Powell, *Chrysothamnus nauseosus consimilis*, UCB; Upper Santa Ana R., San Bernardino Co., 1 ♂, Sept. 22, 1947, Sperry, USNM; Westgard Pass, Inyo Co., 1 ♂, 4 ♀, Sept. 14, 15, 1938, G. Willett, LACM. COLORADO: Durango, 3 ♂ Sept. 26, 1945, E. C. Johnston, CNC; Glenwood Springs, 1 ♂, August 1899, MCZ; Lamar, 7 ♂, Sept. 24, 1945, E. C. Johnston, CNC, USNM. NEW MEXICO: Embido, 1 ♂, Sept. 26, Cockerell, USNM. NEVADA: Montgomery Pass, Mineral Co., 3 ♂, 3 ♀, Sept. 16, 1939, Geo. Willett, LACM; Mt. Magruder, Esmeralda Co., 3 ♀, Sept. 19, 1939, Geo. Willett, LACM, USNM. UTAH: Stockton, 1 ♂, Sept. 5, 1904, T. Spalding, CU. WASHINGTON: Dry Falls, 1 ♂, Sept. 11, 1945, E. C. Johnston, CNC.

Other specimens examined:

CALIFORNIA: Rock Cr., 1 mi. W Tom's Place, Mono Co., 2 ♀, Sept. 6, 1960, C. D. MacNeill, CAS; Sonora Pass, Tuolumne Co., 1 ♂, Aug. 21, 1959, C. W. O'Brien, CAS.

Discussion: *L. nefrens* is a striate-winged species with frontovertical processes. It may be separated from *jubata* by the circular cross section of the dorsal process, that of *jubata* has a linear cross section.

The color description of *nefrons* was taken from the type. Some specimens are lighter in hue.

Lita invariabilis (Kearfott)

FIGURES 35, 59, 79, 134, 209, 210

Gelechia invariabilis Kearfott, 1908, Journ. New York Ent. Soc., vol. 16, p. 184.
Lita invariabilis.—Busck, 1939, Proc. U.S. Nat. Mus., vol. 86, p. 573.

Maculation: as in figure 35. Head: tongue pale gray basally, slightly darker distally; maxillary palpus pale gray, folded over base of tongue; first segment of labial palpus nearly white, outer surface tinged with yellow, second segment pale gray dusted with brown, third segment brown dusted with pale gray; scape of antenna pale gray basally becoming light piceous distally, shaft piceous on dorsal surface, ocherous on ventral surface of basal half, piceous on distal half; frons pale buff; vertex and occiput with buff brown-tipped scales medially. Thorax: tawny with scattered pale buff and brown scales. Forewing: costal margin brown intermixed with buff from base to two-thirds length of wing; a broad pale buff band from near base to three-fourths length of wing, margined dorsally by off white; sinuous marking dark brown; area dorsad of this line fulvous; an off-white fascia at three-fourths followed by a mixture of dark brown, fulvous, and gray brown scales; cilia medium gray. Hindwing: pale fuscous, veins slightly darker; cilia and tuft of scales on vein 1 pale buff. Prothoracic leg: coxa, femur, and tibia dark brown overlaid with off white scales; tarsal segments dark brown on anterior and lateral surfaces, base of first and apices of first through third segments off white. Mesothoracic leg: coxa white tinged with pale buff; femur off white, heavily dusted with dark brown; tibia brown with a fascia at one-half and another at apex; tarsus dark brown with base of first and apices of first through third segments off white. Metathoracic leg: coxa and femur off white with scattered brown scales; tibia off white, dorsal scale tuft pale buff, a brown scale patch at two-fifths and another at four-fifths; tarsus brown, first segment with off white basally and apically, second through fifth segments off white apically. Abdomen: buff dorsally, off white to buff ventrally. Alar expanse: 18–22 mm. Male genitalia: as in figure 79 (RWH slide 2592). Heavily sclerotized flange of aedeagus sickle shaped, apex sharply acute, ductus ejaculatorius simplex one-and-one-third to one-and-one-half length of aedeagus. Female genitalia: as in figure 134 (RWH slide 2593).

Food plant: Unknown.

Type: Male, USNM.

Specimens examined:

ARIZONA: Mohave Co., 1♂, Sept. 24–30, USNM. CALIFORNIA: Inyo Co., 5–6000 ft., 4♂, 1♀, Oct. 15–30, 1922, O. C. Poling (RWH slides 2592 and 2593), USNM; Round Valley, Inyo Co., 4♂, 1♀, Oct. 15–30, 1921, O. C. Poling (AB slides Apr. 20, 1937 and Apr. 21, 1937), CAS, USNM; Willow Creek, Siskiyou Co., 1♀, Sept. 10–11, 1871, Walsingham, BMNH. COLORADO: Boulder, 1♀, Sept. 5, Cockerell, USNM; Salida, 2♂, Aug. 26, 1938, Sperry, USNM. NEW MEXICO: Gallinas Canyon, 1♀, BMNH; Gallup, 1♂, Sept. 11, 1961, R. W. Hodges, USNM. OREGON: Biggs, 1♀, Oct. 2, 1945, E. C. Johnston, CNC. UTAH: Dividend, 2♀, 9.28, BMNH; Eureka, 1♂, Sept. 2, 1911, T. Spalding, USNM; Stockton, 3♂, 3♀, Sept. 5–8, 1904, T. Spalding (AB slides Sept. 26, 1934 and Apr. 28, 1937), BMNH, USNM.

Discussion: No other known species of *Lita* has the strongly marked, angular line on the forewing. *L. invariabilis* has, as the name implies, a stable color pattern. Observed variation occurs on the forewings with the dorsal half basally and the apical third ranging from pale to dark red brown.

Arla Clarke

Arla Clarke, 1942, Proc. U.S. Nat. Mus., vol. 92, p. 269.

Type-species: *Arla tenuicornis* Clarke, 1942, original designation. Head: smooth scaled; tongue extending beyond metathoracic coxa, scaled to one-third; maxillary palpus folded over base of tongue; labial palpus recurved, second segment slightly longer than third, all segments slender, apex acute; antenna simple, two-thirds to three-fourths length of forewing, length of basal segments two-thirds width in male, three-halves width in female, pecten absent. Forewing: broadly lanceolate, apex broadly acute; 12 veins present; 6 closer to 7 and 8 than to 5 basally; 7 and 8 stalked, 7 to costa. Hindwing: trapezoidal, outer margin moving gradually to termen, termen slightly produced; 8 veins present; 3 and 4 approximate basally; 5 slightly arched costally near base; 6 separate, straight; 7 slightly sinuous; R_1 running into Sc at one-sixth. Male genitalia: valva bilobate, each lobe extending to base, costal lobe longer than ventral one; saccus developed, tapering to apex; apex of juxta nearly attaining apex of valva; aedeagus slender, a heavily sclerotized flange on caudal half; manica heavily spined or unarmed; tegumen long; uncus shaped like capital letter omega, wide scales on caudal margin; gnathos hook-shaped; culcitula present. Female genitalia: signum absent; ductus bursae heavily sclerotized posteriorly, membranous anteriorly; eighth abdominal segment almost membranous; ostium bursae near anterior margin of eighth sternum; apophyses posteriores more than twice length of apophyses anteriores.

Arla is closely related to *Lita* but may be readily separated by the bilobed valvae and the lack of a signum. The broad basal antennal segments would appear to be a further development of some *Lita* species that have thickened antennal segments.

Only two species of *Arla* are known, and both of them are from the western tier of states.

Key to Species of *Arla*

BASED ON MACULATION

1. Frons gray white; forewing usually red brown; a brown spot above fold at one-third, one on fold at one-half, and one above end of fold, one at two-thirds length of cell, one at end of cell, and one on costa opposite one at end of fold; alar expanse 14.5–16.5 mm . . . . **diversella** (Busck)

   Frons streaked gray white and gray brown; forewing gray brown; three faint brown spots on forewing, one at middle of fold, one in cell slightly beyond one on fold, and one at end of cell; alar expanse 18.0–22.5 mm. **tenuicornis** Clarke

BASED ON MALE GENITALIA

1. Manica with scalelike spines; apex of flange of aedeagus acute; lateral margins of eighth tergum excavated anteriorly (fig. 90) . . . **tenuicornis** Clarke

   Manica without scalelike spines; apex of flange of aedeagus relatively blunt; lateral margins of eighth tergum straight (fig. 91) . . . **diversella** (Busck)

BASED ON FEMALE GENITALIA

1. Sclerotized portion of ductus bursae seven times width of ostium bursae; same region longer than apophyses anteriores . . . . . . **diversella** (Busck)
Sclerotized portion of ductus bursae one and two-thirds width of ostium bursae; same region shorter than apophyses anteriores. **tenuicornis** Clarke

Arla tenuicornis Clarke

FIGURES 36, 89, 90, 152, 211, 212

Arla tenuicornis Clarke, 1942, Proc. U.S. Nat. Mus., vol. 92, p. 269.

Maculation: as in figure 36. Head: tongue mixed gray white and brown; maxillary palpus gray white, apex brown; outer surface of first segment of labial palpus pale brown, scale bases gray white, inner surface off white, second and third segments mixed brown and gray white; dorsal surface of antenna greasy brown, ventral surface ocher in male, alternating bands of greasy brown and ocher in female; frons, vertex, and occiput mixed gray white and pale brown. Thorax: light brown, scale bases pale. Forewing: most scales brown tipped, gray white basally, some scales buff tipped. Hindwing: fuscous, cilia gray buff. Prothoracic leg: coxa mixed gray white and brown; femur, tibia, and tarsus brown (scale bases gray white) a few gray white scales on dorsal surface of tibia at base of epiphysis, apex of tibia, apices of tarsal segments, and base of basitarsus nearly white. Mesothoracic leg: coxa off white; femur, tibia, and tarsus mixed brown and gray white, apices of tibia and tarsal segments and base of basitarsus off white. Metathoracic leg: coxa off white, several scales gray white; trochanter, femur, tibia, and tarsus mixed gray white and pale brown; dorsal tibial tuft off white; base and apex of basitarsus and apices of segments two through four off white. Abdomen: dorsal surface mottled gray white and pale brown. Alar expanse: 18.0–22.5 mm. Male genitalia: as in figures 89 and 90 (RWH slide 3226). Female genitalia: as in figure 152 (RWH slide 3154).

Food plant: Unknown.

Type: Male, USNM.

Specimens examined:

CALIFORNIA: The Geysers, Sonoma Co., 5♂ 8♀, June 3, 21, 1938, E. C. Johnston (RWH wing slide 58), CNC, USNM; Lytle Creek, 1♀, May 18, 1936, Sperry (RWH slide 3152), USNM; Scott's Valley, Lake Co., 2♀, June 17–19, 1871, Walsingham, BMNH; Shasta Retreat, Siskiyou Co., 3♂, 4♀, June 16–23 (AB slides Feb. 14, 1933 and Sept. 4, 1936; JFGC slide 3768; RWH slide 2613), USNM; Yosemite Valley, 1♂, July 1925, E. H. Nast, CAS. WASHINGTON: Brooks Mem. Park, Klickitat Co., 2♂, May 30, 1949, E. C. Johnston, CNC; Kusshi Canyon, Yakima Co., 2♂, May 28, 1949, E. C. Johnston, CNC; Satus

Creek, Yakima Co., 2 ♂, May 28, 1949, E. C. Johnston (RWH slide 3226), CNC. USNM; Stinson Creek, Mason Co., 4 ♂, June 18, 1949, E. C. Johnston, CNC; Warwick, Klickitat Co., 1 ♂, June 9, 1931, T. C. Clarke (JFGC slide 3767), USNM.

Discussion: *A. tenuicornis* may be separated from *diversella* by the relatively uniformly colored forewing, the presence of scalariform spines of the manica, and the broad opening of the ductus bursae. Females of *tenuicornis* approach some specimens of *L. variabilis* in appearance. The lack of a signum will quickly distinguish them from any species of *Lita*.

Arla diversella (Busck), new combination

FIGURES 37, 91, 92, 154, 213, 214

Gelechia diversella Busck, 1916, Proc. Ent. Soc. Washington, vol. 18, p. 149.

Maculation: as in figure 37. Head: tongue gray white for short distance basally, then brown; maxillary palpus gray white; outer surface of first segment of labial palpus brown, inner surface gray white, second segment gray white dusted with brown, third segment as for second but with more brown on inner surface; dorsal surface of antenna greasy brown, ventral surface ocher (♂); dorsal surface of scape and base of shaft mixed brown and gray white, scales of dorsal surface of shaft brown apically, pale basally, ventral surface alternating buff and brown (♀); frons buff white; vertex and occiput pale gray, scales tipped with pale brown. Thorax: red brown, basal row of scales brown; scales on metathorax gray white. Forewing: red brown, brown, and pale gray, cilia pale gray. Hindwing: fuscous, cilia gray buff. Prothoracic leg: coxa and femur brown mixed with gray white; tibia and tarsus brown, scale bases gray white, apex of tibia, base and apex of basitarsus, and apices of second and third tarsal segments gray white. Mesothoracic leg: coxa gray and white; femur, tibia, and tarsus as for prothoracic leg but with more gray white, apex of fourth tarsal segment gray white. Metathoracic leg: much as for mesothoracic leg but paler, dorsal tibial tuft off white. Abdomen: dorsal surface shining pale gray; ventral surface gray brown, apices of sterna pale. Alar expanse: 14.5–16.5 mm. Male genitalia: as in figures 91 and 92 (RWH slide 2557). Female genitalia: as in figure 154 (RWH slide 2558).

Food plant: *Lotus* species.

Type: Female, USNM.

Specimens examined:

CALIFORNIA: Deer Creek, El Dorado Co., 1 ♂, 1 ♀, iss. May 31 and June 6, 1935, reared from *Lotus*, H. H. Keifer, USNM; La Mesa, San Diego Co., 1 ♂, Apr. 15, 1950, E. C. Johnston, CNC; Moraga Ridge, Alameda Co., 1 ♂, June 11, 1936, H. H. Keifer, CAS; Morro Rock, San Louis Obisbo Co., 1 ♀, May 4, 1962, J. Powell, UCB; San Diego Co., 28 ♂, 4 ♀, Apr. 16–June 13, W. S. Wright, Ricksecker (AB slide Mar. 5, 1931; RWH slides 2557 and 2558), LACM, MCZ, USNM.

Discussion: *A. diversella* may be separated from *tenuicornis* as indicated in the keys. The two valval lobes, slender aedeagus, sclerotized ductus bursae, and lack of signum associate *diversella* with *Arla* rather than *Lita*.

The collection record from El Dorado county indicates that *diversella* at least has a wider distribution than coastal Southern California and that it may be found in Oregon and Washington.

Neodactylota Busck

Neodactylota Busck, 1903, Proc. U.S. Nat. Mus., vol. 25, p. 835.

Type-species: *Dactylota snellenella* Walsingham, 1888, original designation.

Head: smooth scaled; tongue moderate, scaled for short distance basally; maxillary palpus slightly folded over base of tongue to drooping; labial palpus recurved, slender, second and third segments subequal in length; antenna with pecten absent, two-thirds to four-fifths length of forewing, simple. Forewing: broadly lanceolate; 12 veins present; 2 from cell at two-thirds length of cell; 2, 3, 4, and 5 subparallel; 6 closer to 7 than to 5; 7 and 8 stalked. Hindwing: dimorphic ♂, outer margin deeply emarginated; 6 veins present, 4 and 5 absent; 6 and 7 united to three-fifths, 6 to outer margin, 7 to costa; ♀, wing quadrate, termen produced; 8 veins present; 3 and 4 separate to short stalked; 5 arising closer to 4 than to 6. Male genitalia: valva with two costal lobes; juxta fused with vinculum basally; aedeagus relatively linear. Female genitalia: ostium bursae on anterior margin to middle of eighth sternum; eighth sternum unadorned to slightly so; apophyses posteriores longer than apophyses anteriores.

The species included in *Neodactylota*, as defined above, can be separated from those in *Eudactylota* by the presence of well or moderately well defined spots on the disk of the forewing; by the hindwing shape being dimorphic between the sexes (the outer margin is deeply emarginated in the male with a concomitant loss of veins 4 and 5, whereas the outer margin of the female is normal); and by the valva having two costal lobes.

With the addition of three new species the total known for the genus is four. However, further collecting in Mexico and adjacent areas of the Southwest may reveal that others exist. Unfortunately, very little is known of the distribution of any of the species.

Key to Species of *Neodactylota*

BASED ON MACULATION

1. Head with metallic lead-colored scales on vertex and occiput. **basilica,** new species
   Head without metallic colored scales 2
2. Dark spots of forewing well defined, surrounded by narrow margin of pale colored scales 3
   Dark spots of forewing not well defined, not margined by pale colored scales. **egena,** new species
3. Second and third segments of labial palpus dark gray with scattered gray white scales, an anterior gray white line on third segment. **snellenella** (Walsingham)
   Second and third segments of labial palpus pale yellow, third segment becoming brown apically . . . . **liguritrix,** new species

PARTIAL KEY BASED ON MALE GENITALIA

1. Medial invagination of juxta extending to base of juxta. **snellenella** (Walsingham)
   Medial invagination of juxta one-third length of juxta 2
2. Distal costal lobe of valva curved and slightly twisted, very slender on distal half . . . . **liguritrix,** new species
   Distal costal lobe straight, gradually tapering to apex. **basilica,** new species

PARTIAL KEY BASED ON FEMALE GENITALIA

1. Eighth tergum produced medially (fig. 157) . . . . **basilica,** new species
   Eighth tergum not produced medially 2
2. Eighth sternum heavily sclerotized, caudal margin emarginate medially, a semicircular sclerotized band parallel with caudal margin (fig. 156). **egena,** new species
   Eighth sternum lightly sclerotized, caudal margin not defined, no special sclerotized bands (fig. 155) . . . . **snellenella** (Walsingham)

Neodactylota snellenella (Walsingham)

FIGURES 38, 93, 95, 155, 215, 216

Dactylota snellenella Walsingham, 1888, Insect life, vol. 1, p. 84.
Neodactylota snellenella.—Busck, 1903, Proc. U.S. Nat. Mus., vol. 25, p. 836.

Maculation: as in figure 38. Head: tongue mottled gray white and brown basally; maxillary palpus gray white with a few brown scales, folded over base of tongue; first segment of labial palpus mainly white with some brown and brown-tipped scales; second segment brown with several white scales, white scales more numerous basally, third segment mainly brown, anterior surface white; scape of antenna brown, scale bases pale, with an anterior white line and a posteroapical white scale row, shaft pale yellow on anterior surface, dorsal surface brown basally, segments brown and pale yellow short distance beyond base; lower portion of frons gray white, many scales brown tipped medially; scales of vertex and occiput buff brown with brown apices, scales of medial area of vertex gray with metallic reflections. Thorax: scales gray, tipped and streaked with brown; apex of tegula pale buff. Forewing: scales yellow, white, gray, buff, red brown, and brown, often streaked with a light or dark hue; most scales tipped with brown. Hindwing: fuscous, margins of scales darker than remainder of scale, scales shining orange at some angles of light incidence; cilia pale buff. Prothoracic leg: anterior surface of coxa gray white, many scales tipped with brown; femur and tibia brown with several gray white scales, outer surface of femur mainly white, tibia with a white scale row just beyond middle and at apex; tarsus dark brown, scales lighter basally, base and apex of basitarsus and apex of second segment white, apex of third segment with a few white scales. Mesothoracic leg: lighter than prothoracic leg; tibia with an oblique white fascia at one-fourth and another at one-half, apex white; base and apex of basitarsus and apices of second and third segments white. Metathoracic leg: coxa and femur mainly white with scattered brown scales; tibia with a broad white streak at one-fourth and another at three-fifths, apex white, scales of dorsal tuft pale buff basally becoming white distally; tarsal segments gray brown basally, broadly marked with white or gray white apically. Abdomen: terga greasy ocher basally, gray brown distally, apices of terga pale; sterna buff white, scales becoming greasy shortly after death of specimen. Alar expanse: 15.5–18.0 mm. Male genitalia: as in figures 93 and 95 (RWH slide 2150). Distal costal lobe of valva about one-fourth length of basal costal lobe; lobes of juxta nearly separated. Female genitalia: as in figure 155 (RWH slide 3155).

Food plant: Unknown.

Type: Lectotype, present designation; male, bearing following labels: (1) Type. (2) Arizona, Morrison, 1883, 35345. (3) Walsingham Collection, 1910–427. (4) *Dactylota snellenella*, Wlsm., U.S. Dept Agr. Div Ent. Ins. Life. I–84 (1888); Type ♂, descr. (5) BM(NH) ♂ genitalia slide no. 9209. In BMNH.

Specimens examined:

ARIZONA: Huachuca Mts., 1♂, Sept. 17, 1903, Oslar, BMNH; Santa Rita Mts., Madera Canyon, 4880 ft., Santa Cruz Co., 2♂, 1♀, May 3–June 7, 1963, J. G. Franclemont (RWH wing slide 80), JGF; no further locality, 1♂, 1881, Morrison (RWH slide 2150), USNM; no further locality, 1♀, 1883, Morrison (RWH slide 3155), BMNH. TEXAS: Ft. Davis, 5000 ft., 1♂, 5. 28, BMNH.

Discussion: The alar expanse of *snellenella* is at least 3 mm. more than that of *basilica*, *liguritrix*, or *egena*. The lack of metallic colored scales on the vertex and the gray white labial palpi will separate *snellenella* from *basilica* and *liguritrix*, respectively.

In Madera Canyon *snellenella* appears to be a spring species inasmuch as no specimens were taken during the 1959 season from June 29–November 11. On the other hand the specimen from the Huachuca Mts. (less than 50 miles distant) was collected in September; thus, the species may emerge sporadically during the year.

Neodactylota liguritrix, new species

FIGURES 39, 102, 106, 217, 218

Maculation: as in figure 39. Head: tongue with mixed buff white and brown scales basally, becoming brown; maxillary palpus buff white, somewhat drooping and curved over base of tongue; first segment of labial palpus nearly white on inner surface, outer surface with brown, second segment pale yellow with some pale brown scales on outer surface at base, third segment yellow, becoming brown apically on inner and anterior surfaces; scape of antenna buff, shaft buff basally, becoming greasy brown distally; frons pale buff; vertex and occiput pale buff, medial scales with dark margins. Thorax: base of tegula and medial area of mesothorax gray brown; apex of tegula and lateral margins of mesothorax pale buff; a lateral dark brown spot on mesothorax near apex of tegula and one at middle of caudal margin; metathorax gray brown to lead colored. Forewing: most scales pale buff, many tipped with gray brown; costal margin gray brown; spots on disk dark brown. Hindwing: fuscous, cilia dark fuscous yellow. Prothoracic leg: gray brown, scale bases pale; some off white scales at base and apex of basitarsus and at apex of second tarsal segment. Mesothoracic leg: coxa with numerous buff white scales on outer surface; femur gray brown; tibia mottled buff and gray brown, mainly buff; dorsal surface of basitarsus and apices of second and third segments off white, remainder gray brown. Metathoracic leg: outer surface of coxa mainly buff, medial scales streaked with brown; trochanter gray brown; femur buff on dorsolateral margin, gray brown on lateral surface; tibia gray brown laterally, a buff fascia at one-fifth and one at base of first pair of tibial spurs, dorsal tuft buff; apex white; tarsus gray brown on outer surface, dorsal surface of first two and base of third segment pale buff, apices of first four segments pale buff. Abdomen: greasy gray brown dorsally, first two terga with ocher cast; scales of sterna gray brown, pale basally. Alar expanse: 10.5–12.0 mm. Male genitalia: as in figures 102 and 106 (RWH slide 3153). Distal costal lobe slender, somewhat sinuous; apex of basal costal lobe twisted; apex of juxta emarginated. Female genitalia: no specimens available.

Food plant: Unknown.

Type: Male, Corpus Christi, Tex., Mar. 28, 1943, at light W. M. Gordon, CU type 4219.

Paratypes:

Same locality as type, 4♂, Mar. 28 and May 22, 1943, W. M. Gordon (RWH slide 3153, RWH wing slide 75), CU, USNM.

Discussion: In appearance, *liguritrix* is nearest to *basilica;* it differs in lacking metallic lead-colored scales on the vertex and occiput. *N. liguritrix* has the dark spots on the disk much more distinct than does *egena.*

Neodactylota basilica, new species

Figures 40, 94, 98, 157, 219, 220

Maculation: as in figure 40. Head: tongue buff white basally; maxillary palpus buff white, somewhat drooping; first segment of labial palpus buff white with some gray-brown scales before middle, second segment pale yellow, third segment pale yellow becoming brown black from middle to apex on anterior and inner surfaces; scape of antenna buff white dorsally, gray brown ventrally, shaft ocher basally becoming greasy brown distally, several segments bicolored; frons buff white; scales of middle of vertex and occiput shining lead colored, lateral scales yellow. Thorax: irregularly mottled with buff white, gray brown, and dark brown; apex of tegula buff white; a lateral dark brown spot on thorax at apex of tegula; caudal margin of mesothorax with a small dark brown spot medially; metathorax with lead gray-colored scales. Forewing: scales buff white with gray-brown apices, spots dark brown; costal margin, especially basally, gray brown. Hindwing: fuscous, cilia slightly paler than membrane. Prothoracic leg: gray brown; a few buff white scales at apex of coxa and at two-thirds and apex of tibia, apices of first two tarsal segments white. Mesothoracic leg: coxa with buff-white scales on outer surface; tibia buff white on dorsal surface; tarsus with buff white on dorsal surface and apex of first and second segments. Metathoracic leg: gray brown; dorsal tuft of tibia buff white; dorsal surface of first two tarsal segments off-white, apex of third and fourth segments buff. Abdomen: lead gray, basal terga with dark ocher reflections; sterna gray brown, first segment buff. Alar expanse 10.5–12.0 mm. Male genitalia: as in figures 94 and 98 (RWH slide 721). Distal costal lobe of valva about one-half length of basal costal lobe; apex of juxta emarginated. Female genitalia: as in figure 157 (RWH slide 1245).

Food plant: Unknown.

Type: Male, Sycamore Canyon, 3800 ft., Santa Cruz Co., Ariz., Sept. 25, 1959, R. W. Hodges, CU type 4220.

Paratypes:

ARIZONA: Peña Blanca Canyon, Santa Cruz Co., 2♂, 1♀, Aug. 7–Sept. 4, 1959, R. W. Hodges (RWH slides 721, 941, and 1245; RWH wing slides 76 and 79), CU, USNM.

Discussion: The metallic lead-colored scales on the vertex and occiput will separate *basilica* from *snellenella, liguritrix,* and *egena.*

Neodactylota egena, new species

Figures 41, 156

Maculation: as in figure 41. Head: tongue pale buff; maxillary palpus pale buff, porrect to drooping along base of tongue; labial palpus pale buff to pale yellow, third segment with brown scales; scape of antenna buff with overlay of brown tipped scales, segments of shaft bicolored basally, pale buff and brown, mainly brown distally; frons pale buff; vertex and occiput gray buff with purple reflections medially, a tuft of orange scales above eye. Thorax: gray brown, scale bases pale, caudolateral margins buff. Forewing: nearly uniform gray brown, scale bases pale; marks on disk brown, not strongly contrasting with gray-brown background; cilia buff. Hindwing: fuscous. Prothoracic leg: coxa pale buff; femur, tibia, and tarsus gray brown; femur with numerous pale buff scales; tibia with apex and some scattered scale rows pale buff; base and apex of basitarsus and apex of second tarsal segment pale buff. Mesothoracic leg: much as for prothoracic leg but with more pale scales. Metathoracic leg: coxa buff white; femur buff white with some gray scales; tibia pale brown ventrolaterally, dorsal tuft pale buff, a fascia at base of first pair of spurs and apex pale buff; tarsus pale brown basally becoming darker distally, dorsal surface of basitarsus and part of second segment pale buff, apices of segments pale. Abdomen: not observed before dissection was made. Alar expanse: 10.5 mm. Male genitalia: no specimens available. Female genitalia: as in figure 156 (RWH slide 1532).

Food plant: Unknown.

Type: Female, Madera Canyon, 4880 ft., Santa Rita Mtns., Ariz. Oct. 19, 1959, R. W. Hodges (RWH slide 1532), CU type 4221.

Discussion: The small size immediately separates *egena* from *snellenella;* the relative indistinctness of the dark spots of the forewings separates it from *basilica* and *liguritrix.*

Eudactylota Walsingham

Eudactylota Walsingham, 1911, *in* Godman and Salvin, Biologia Centrali-Americana, vol. 42 (Lepidoptera-Heterocera, vol. 4), p. 54.

Type-species: *Neodactylota barberella* Busck, 1903, original designation.

Head: smooth scaled; tongue moderate, scaled to one-third or one-half length; maxillary palpus porrect to drooping, somewhat folded over base of tongue; labial palpus recurved, slender, second and third segments subequal in length; antenna with pecten absent, two-thirds to three-fourths length of forewing, simple. Forewing: broadly lanceolate; 12 veins present; 2, 3, 4, and 5 equidistant, subparallel; 7 and 8 stalked, 7 to costa. Hindwing: subquadrate, apex strongly produced, outer margin indented between 5 and 6; 6 and 7 stalked, 6 to outer margin; R_1 showing as cross vein between Sc and Rs. Male genitalia: valva with one costal lobe; juxta fused with vinculum basally, lobes separate, stout setae present near inner margin on distal half; saccus moderate; aedeagus somewhat globose basally; tegumen broad; spined culcitula present; gnathos a strong hook. Female genitalia: ductus bursae long; corpus bursae with a single signum; ostium bursae on eighth sternum, eighth sternum usually with medial folds with numerous fine spines; apophyses posteriores much longer than apophyses anteriores.

Walsingham proposed *Eudectylota* for *barberella* (Busck). Later authors have treated the genus as a synonym of *Neodactylota*; however, the two are distinct on characters of facies, wing shape, venation, and male genitalia as is indicated under *Neodactylota*.

Stomopteryx iobapta Meyrick is transferred to *Eudactylota*, and two new species are described bringing the number of known species to four. Nothing is known of the life history of any species, and very little is known of their distribution.

Key to Species of *Eudactylota*

BASED ON MACULATION

1. Anterior surface of third segment of labial palpus with a white line 2
   Anterior surface of third segment of labial palpus without a white line. **barberella** (Busck)
2. Second segment of labial palpus with interior ventral margin white, ventral margin black . . . . **diadota**, new species
   Ventral margin of second segment of labial palpus with mixed black and white scales 3
3. Outer, apical metathoracic tibial spur white basally, gray black distally (usually); pinkish white fascia on forewing relatively narrow, confined apically, buff streaks along costal and outer margins absent or faint. **iobapta** (Meyrick)
   Outer, apical metathoracic tibial spur white basally and distally, gray black medially; pinkish white fascia on forewing relatively broad, gradually darkening to apex; buff streaks along costal and outer margins prominent. **abstemia**, new species

BASED ON MALE GENITALIA

1. Lobes of juxta distant basally, width of opening greater than basal width of lobe 2
   Lobes of juxta approximate basally 3
2. An invaginated sclerotized band between lobes of juxta (fig. 100). **diadota,** new species
   No sclerotized band between lobes of juxta . . . . **barberella** (Busck)
3. Lobes of juxta separated to base, inner margin uniformly sclerotized (fig. 96). **iobapta** (Meyrick)
   Lobes of juxta separated to one-third, inner margin where lobes join heavily sclerotized (fig. 105). . . . . **abstemia,** new species

BASED ON FEMALE GENITALIA

1. Anterior margin of eighth sternum emarginated medially (fig. 160) 2
   Anterior margin of eighth sternum not emarginated medially (fig. 158) . . . 3
2. Lateral sclerites (folds) of eighth sternum touching medially, caudal margins relatively abruptly angled (70–80 degrees) beyond ostium bursae, no heavily sclerotized ridges caudad of ostium bursae (fig. 160). **abstemia,** new species
   Lateral sclerites (folds) of eighth sternum not touching medially, caudal margins diverging after point of closest proximity, later diverging with approximately a 45 degree angle; heavily sclerotized ridges caudad of ostium bursae present (fig. 159) . . . . **diadota,** new species
3. Lateral sclerites of eighth sternum nearest anteriorly, gradually diverging posteriorly (fig. 158) . . . . **iobapta** (Meyrick)
   Lateral sclerites of eighth sternum nearest posteriorly, becoming indistinct beyond point of proximity (fig. 161) . . . . **barberella** (Busck)

Eudactylota barberella (Busck)

FIGURES 42, 101, 103, 161, 221, 222

Neodactylota barberella Busck, 1903, Proc. U.S. Nat. Mus., vol. 25, p. 836.
Eudactylota barberella.—Walsingham, 1911, *in* Godman and Salvin, Biologia Centrali-Americana, vol. 42 (Lepidoptera-Heterocera, vol. 4), p. 55.

Maculation: as in figure 42. Head: tongue mottled with unicolorous brown and white scales; maxillary palpus white with a few brown scales, curved over base of tongue; first segment of labial palpus white, a dorsolateral row of brown scales, second and third segments brown with scattered white scales, white scales more numerous on basal two-thirds of second segment; dorsal surface of scape of antenna brown, an anterior white line, apex mainly white, ventral surface white, shaft brown with an anterior broken white line, many segments with white scales; frons, vertex, and occiput buff brown, scales with dark apices. Thorax: anterior margin of tegula brown, remainder red brown; mesothorax dark gray brown medially, red brown laterally; metathorax pale buff. Forewing: brown, red brown, gray brown, gray white, and white; many scales with purple reflections. Hindwing: pale fuscous, shining orange at some angles of light incidence, cilia pale fuscous. Prothoracic leg: coxa brown, heavily overlaid with white; femur brown, moderately overlaid with white; tibia and tarsus brown, scale bases pale, especially on tibia, a white fascia at middle and another at apex of tibia, apices of first three tarsal segments white or with white scales. Mesothoracic leg: as for prothoracic leg. Metathoracic leg: coxa white basally, gray brown with purple reflections distally; trochanter gray brown with a few partially white scales medially, pale buff apically; femur brown heavily overlaid with white; tibia brown, scale bases pale, an oblique white fascia at base of first pair of spurs, apex white, dorsal tuft streaked buff and fuscous; tarsus brown, apices of first four segments white. Abdomen: greasy gray brown dorsally, first two terga somewhat ocherous; ventral surface gray brown, first sternum pale yellow, caudal margin of second sternum pale yellow. Alar expanse: 11–14 mm. Male genitalia: as in figures 101 and 103 (RWH slides 2151 and 2152). Female genitalia: as in figure 161 (RWH slide 2153).

Food plant: Unknown.

Type: Female, USNM.

Specimens examined:

UNITED STATES: Arizona: Dewey, 1 ♀, June 16–23, USNM; Fort Valley, 7½ mi. NW Flagstaff, 7350 ft., Coconino Co., 10 ♂, 3 ♀, June 21–Aug. 21, 1961, R.W. Hodges (RWH slides 2152–2154; RWH wing slide 67), BMNH, CU, USNM; Hart Prairie, 10 mi. NNW Flagstaff, 8500 ft., Coconino Co., 3 ♂, June 23 and July 14, 1961, R.W. Hodges (RWH slide 2151), CU, USNM; Williams, 1 ♀, May 27, H.S. Barber (RWH slide 2149), USNM. Colorado: Boulder, 1 ♀, USNM; Boulder, University of Colorado Campus, 1 ♀, July 16, T.D.A. Cockerell, USNM. New Mexico: Las Vegas, 1 ♀, Aug. 11, H.S. Barber (RWH wing slide 68).

MEXICO: Guerrero: Amula, 6000 ft., 1 ♀, Aug. 18, H.H. Smith, USNM.

Discussion: *E. barberella* may be quickly separated from the other species of *Eudactylota* by the lack of an anterior white line on the third segment of the labial palpus. The male genitalia are nearest those of *iobapta* but differ by having the lobes of the juxta slightly swollen before the apex; those of *iobapta* taper gradually to the apex.

Eudactylota iobapta (Meyrick), new combination

Figures 43, 96, 97, 158, 223, 224

Stomopteryx iobapta Meyrick, 1927, Exot. Micr., vol. 3, p. 352.

Maculation: as in figure 43. Head: tongue with white and gray brown scales basally; maxillary palpus white, somewhat drooping at side of tongue; first segment of labial palpus white with a brown saddle near apex, second segment brown heavily dusted with white, third segment brown with an anterior white line and an interrupted white line on inner surface from near base to three-fifths, posterior surface mainly white; antenna brown, scape with an anterior white line continued on shaft as a broken line, a posterior broken white line on shaft from base to beyond one-half; ventral margin of frons white followed by a series of brown and white scales running from anterior margin of eye to middle; vertex and occiput buff brown, scales with dark apices, all with metallic reflections. Thorax: tegula and mesothorax shining orange brown, mesothorax gray brown mesally; metathorax buff. Forewing: mainly shining orange brown, costal margin mixed brown and white, fascia off white, a buff streak on costal margin starting at fascia, cilia buff. Hindwing: fuscous, shining orange brown at certain angles of light incidence, cilia pale fuscous. Prothoracic leg: coxa and femur brown moderately dusted with white; tibia brown with a few scattered white scales, a white streak above base of epiphysis, apex white; tarsus brown, apices of first three segments white. Mesothoracic leg: coxa mainly white, some gray brown scales medially; femur speckled greasy white and brown; tibia brown, scale bases pale, a white fascia at one-half, apex white; tarsus brown, apices of first four segments white. Metathoracic leg: coxa white, gray medially; trochanter mixed gray brown and white; femur speckled brown and white; tibia mainly brown on outer surface, scale bases pale, a white fascia at base of first pair of spurs, apex white, tuft buff to white; tarsus brown, scale bases pale on first segment, apices of first four segments white. Abdomen: greasy gray brown dorsally, first two terga somewhat dark ocher; ventral surface gray brown, scales at apices of sterna with buff white streaks, first sternum pale yellow. Alar expanse: 9–13 mm. Male genitalia: as in figures 96 and 97 (RWH slide 2164). Female genitalia: as in figure 158 (RWH slide 2161).

Food plant: Unknown.

Type: Male, BMNH.

Specimens examined:

UNITED STATES: ARIZONA: Chiricahua Mts., nr. Portal, 3 ♀, July 4 and 8, 1939, A.F. Braun, AFB; Madera Canyon, 4880 ft., Santa Rita Mtns., Santa Cruz Co., 18 ♂, 13 ♀, June 29–Aug. 30, 1959, R.W. Hodges (RWH slides 944, 2160, 2164; RWH wing slide 69), CU, USNM; Palmerlee, 1 ♂, BMNH; Peña Blanca Canyon, Santa Cruz Co., 1 ♂, 15 ♀, Aug. 7–26, 1959, R.W. Hodges (RWH slides 2161 and 2166; RWH wing slide 70), CU, USNM; same locality, 1 ♀, June 7, 1963, J.G. Franclemont, JGF; 4 mi. ESE Pine, 5400 ft., Gila Co., 2 ♀, Sept. 1 and 5, 1961, R.W. Hodges (RWH slide 2163), USNM; West Fork, 6500 ft., 16 mi. SW Flagstaff, Coconino Co., 1 ♂, July 13, 1961, R.W. Hodges (RWH slide 2162), USNM. TEXAS: Alpine, Brewster Co., 1 ♂, 2 ♀, May 22, 1950, E.C. Johnston, CNC; Ft. Davis, Jeff Davis Co., 2 ♀, May 20, 1950, E.C. Johnston, CNC; Limpia Canyon, Jeff Davis Co., 4 ♂, 1 ♀, May 20-June 4, 1950, E.C. Johnston, CNC; Brewster Co., 5000 and 7000 ft., 4 ♂, 5 ♀, 3.28–4.26, AFB, BMNH.

MEXICO: MEXICO: ruins of Teotihuacán, 1 ♂, 1 ♀, July 25, 1963, Duckworth and Davis (RWH slides 3462 and 3463), USNM. NUEVO LEON: 3 mi. E

Galeana, 5000 ft., 2♂, 8♀, Aug. 7–9, 1963, Duckworth and Davis (RWH slides 3333–3335), USNM.

Discussion: Some specimens of *iobapta* are very near *abstemia* in maculation, and for these the genitalia should be examined for placement. The uniformly sclerotized inner margin of the lobes of the juxta will separate *iobapta* from *abstemia* and *diadota;* the lobes of the juxta tapering to the apex will separate *iobapta* from *barberella.*

Specimens vary in the coloration of the forewings: Some are golden brown, others dark brown.

Eudactylota diadota, new species

Figures 44, 99, 100, 159, 225, 226

Maculation: as in figure 44. Coloration: as for *iobapta* except for the following: second segment of labial palpus with a black ventral line, third segment with a white line on anterior and posterior surfaces; forewing with pink scales on costal margin from fascia to apex; metathoracic tibia with an oblique white fascia starting at one-fifth, another starting just before first pair of spurs; abdomen gray buff dorsally, apices of segments buff white, pale gray buff ventrally, apices of segments pale. Alar expanse: 9.5–12.0 mm. Male genitalia: as in figures 99 and 100 (RWH slide 2157). Female genitalia: as in figure 159 (RWH slide 946).

Food plant: Unknown.

Type: Male, Madera Canyon, 4880 ft., Santa Rita Mtns., Ariz., June 29, 1959, R. W. Hodges (RWH slide 2156), CU type 4222.

Paratypes:

Same locality as type, 6♂, 13♀, June 29–Aug. 27, 1959, R.W. Hodges (RWH slides 946, 2157, and 2158; RWH wing slides 71 and 72), BMNH, CU, USNM.

Discussion: Superficially, *diadota* is similar to *iobapta* and *abstemia* but differs in having a black line on the anterior surface of the labial palpus. The pink on the outer costal margin will separate *diadota* from the other species of *Eudactylota.*

Eudactylota abstemia, new species

Figures 45, 104, 105, 160, 227, 228

Maculation: as in figure 45. Coloration: as for *iobapta;* forewing with more pinkish-white scales. Alar expanse: 8–11 mm. Male genitalia: as in figures 104 and 105 (RWH slide 942). Female genitalia: as in figure 160 (RWH slide 2155).

Food plant: Unknown.

Type: Male, Madera Canyon, 4880 ft., Santa Rita Mtns., Ariz., Aug. 12, 1959, R.W. Hodges (RWH slide 942), CU type 4223.

Paratypes:

Same locality as type, 5♂, 21♀, July 14–Aug. 28, 1959, R.W. Hodges (RWH slides 943, 945, and 2155; RWH wing slides 73 and 74), AMNH, BMNH, CAS, CNC, CU, and USNM.

Discussion: *E. abstemia* may be separated from *barberella* by the presence of an anterior white line on the third segment of the labial palpus; from *diadota* by the ventral margin of the second segment of the labial palpus having white scales; and from *iobapta* by the juxtal lobes being heavily sclerotized on the inner basal one-third. The females of *abstemia* and *iobapta* may be separated by the ostium bursae being near the caudal margin of the eighth sternum in *abstemia*, at one-third in *iobapta*.

Friseria Busck

Friseria Busck, 1939, Proc. U.S. Nat. Mus., vol. 86, p. 573.

Type-species: (*Gelechia lindenella* Busck, 1903) =*Gelechia cockerelli* Busck, 1903, original designation.

Head: smooth scaled; tongue moderate, scaled to one-third or one-half; maxillary palpus folded over base of tongue; labial palpus recurved, second and third segments subequal in length, second segment slightly thicker than third, apex acute; antenna two-thirds length of forewing, ciliate in male, simple in female, pecten absent. Forewing: broadly lanceolate, apex broadly acute; 12 veins present; 7 and 8 stalked, 7 to costa. Hindwing: trapezoidal, outer margin gradually moving to termen, apex scarcely produced; 8 veins present; 3 and 4 approximate to connate; 5 arching costally beyond base; 6 and 7 approximate to stalked, usually separate; 7 sinuous; R_1 running into Sc at one-fifth. Male genitalia: valva with costal lobe free, two other lobes from ventral margin of costal lobe (variously developed); vinculum narrow laterally, saccus broadly rounded; aedeagus with base expanded; tegumen broad, gnathos hook shaped; culcitula present; uncus short, caudal margin with long, stout setae. Female genitalia: signum a plate with an inwardly projecting flange from each end (flange very small to large and heavily sclerotized); eighth sternum with lateral folds; ostium bursae near caudal margin of eighth sternum; apophyses posteriores longer than apophyses anteriores.

Friseria is nearest to *Rifseria* and *Sriferia*. The genera may be separated as indicated under *Rifseria*.

Some species of *Friseria* have maculation very similar to that of *Parastega* Meyrick species, and the venation of neither is diagnostic; however, the male genitalia of *Parastega* are characterized by having asymmetrical, single lobed valvae and a long uncus which lacks enlarged setae on the caudal margin. The signum of *Parastega* is as for *Gelechia*.

The known species of *Friseria* occur in the Southwest and Mexico; thus, the genus may have evolved in the Mexican highlands.

Busck (1939) proposed *Friseria* for *cockerelli, lindenella, malindella, sarcochlora, repentina,* and *fuscotaeniaella.* Of these *lindenella, malindella,* and *sarcochlora* are synonyms of *cockerelli,* and *fuscotaeniaella* is removed to *Rifseria,* new genus; *F. infracta* (Walsingham) and *lacticaput* (Walsingham) are transferred from *Gelechia,* and *acaciella* (Busck) is transferred from "*Telphusa.*" Two new species, *nona* and *caieta,* are described, bringing the number of recognized species to seven.

Key to Species of *Friseria*

BASED ON MACULATION

1. Forewing white overlaid with black; two patches of raised scales on fold, one dorsad of fold, and one at end of cell . . . . **caieta,** new species
   Forewing brown, no patches of raised scales 2
2. Forewing dark purplish brown basally, followed by an oblique white or buff fascia running from costa to half way between fold and dorsum 5
   Forewing pale brown basally, if dark brown, not followed by pale colored fascia 3
3. Forewing with middle third purplish black 4
   Forewing varying shades of brown, never with a broad black band at middle . . . . **cockerelli** (Busck)
4. Forewing with an oblique dark brown fascia at one-third, bordered basally by orange scales; outer third of costal margin uniformly dark with black tipped, gray scales . . . . **repentina** (Walsingham)
   Forewing usually lacking complete dark brown fascia at one-third; costal margin pale orange brown with dark streaks, scales usually tipped with white, preceded by black . . . . **nona,** new species
5. Head and basal half of thorax uniformly buff . . . **lacticaput** (Walsingham)
   Head and thorax mottled brown 6
6. Apex of white fascia attenuated (fig. 52) . . . . **acaciella** (Busck)
   Apex of white fascia not attenuated (fig. 54) . . . . **infracta** (Walsingham)

BASED ON MALE GENITALIA

1. Culcitula spined 2
   Culcitula bare . . . . **cockerelli** (Busck)
2. Culcitula large, extending laterally beyond base of gnathos, culcitular setae more than twice medial height of culcitula (fig. 112) 3
   Culcitula small, not extending laterally beyond base of gnathos; culcitular setae not extending laterally beyond base of gnathos; culcitular setae less than one-fourth medial height of culcitula (fig. 118) 4
3. Medial lobe of valva with distal margin convex, apex truncate (fig. 116). **nona,** new species
   Medial lobe of valva with distal margin sinuate, apex acute (fig. 122). **repentina** (Walsingham)
4. Costal lobe of valva with a lobe from ventral surface at one-half its length, valva appearing quadrilobate (fig. 117) . . . . **acaciella** (Busck)
   Costal lobe of valva lacking such a lobe, valva appearing trilobate (fig. 113) . 5
5. Costal lobe of valva with a ventral flange on distal half 6
   Costal lobe of valva without a ventral flange on distal half (fig. 120). **lacticaput** (Walsingham)

6. Lobes from ventral margin of valva more than one-half length of valva (fig. 113) . . . . **caieta,** new species
   Lobes from ventral margin of valva less than one-fourth length of valva (fig. 115) . . . . **infracta** (Walsingham)

Friseria cockerelli (Busck)

FIGURES 46, 47, 107–110, 162, 229, 230

Gelechia cockerelli Busck, 1903, Proc. U.S. Nat. Mus., vol. 25, p. 871.
Friseria cockerelli.—Busck, 1939, Proc. U.S. Nat. Mus., vol. 86, p. 573.
Gelechia lindenella Busck, 1903, Proc. U.S. Nat. Mus., vol. 25, p. 876. [New synonymy.]
Gelechia malindella Busck, 1910, Proc. Ent. Soc. Washington, vol. 11, p. 179. [New synonymy.]
Gelechia sarcochlora Meyrick, 1929, Exot. Micr., vol. 3, p. 491. [New synonymy.]

Maculation: as in figures 46 and 47. Head: tongue mixed gray white and pale brown; maxillary palpus creamy white; outer surface of first segment of labial palpus gray brown (scales pale basally), inner surface white, outer surface of second segment gray brown on basal half, mixed white and gray brown distally, inner surface white with some gray-brown scales near apex, third segment mixed gray brown and pale gray, posterior surface nearly white; dorsal surface of scape of antenna dark brown, ventral surface buff, individual scales of dorsal surface of shaft ocher basally, brown distally, ventral surface pale ocher; frons and lower vertex creamy white, a few dark brown scales before anterior margin of eye; scales of upper vertex and occiput pale buff, apices pale gray brown. Thorax: mixed brown and buff. Forewing: buff, brown, gray brown, and red brown. Hindwing: fuscous, cilia pale buff. Prothoracic leg: coxa mixed creamy white and brown, apex creamy white; femur mixed gray white and brown with a purple cast at certain angles of light incidence; tibia brown with a buff fascia at base of epiphysis and at apex, scale bases pale; tarsus brown, base and apex of basitarsus and apex of second segment pale buff. Mesothoracic leg: coxa and trochanter creamy white; femur mixed gray white and brown; tibia brown, scale bases pale, a scale tuft at middle, apex of scale tuft and of tibia pale buff; tarsus brown, base and apex of basitarsus and apex of second segment pale buff. Metathoracic leg: coxa creamy white basally, gray distally; trochanter creamy white; femur mixed white and brown; tibia mixed creamy white, brown, and pale brown, tuft pale buff, outer tibial spurs brown; tarsus brown and creamy white, apices of first four or all segments pale. Abdomen: mottled gray brown, ventral surface with several gray-white scales. Alar expanse: 12–17 mm. Male genitalia: as in figures 107–110 (RWH slides 1706 and 3224). Female genitalia: as in figure 162 (RWH slide 3225).

Food plant: *Prosopis* spp. Leaf feeder.

Types: *cockerelli,* female, USNM; *lindenella,* male, USNM; *malindella,* male, USNM; and *sarcochlora,* male, BMNH.

Specimens examined:

UNITED STATES: Arizona: Ajo, 5♂, 1♀, Mar. 1–30 and May 1–15, O.C. Poling, MCZ, USNM; Baboquivari Mts., Pima Co., 10♂, 11♀, Apr. 23–Sept. 15, Poling, Sperry, Snow (AB slide June 16, 1937), AMNH, MCZ, USNM; Chiricahua Mts., 1♀, Sept. 22, 1927, J. Kusche, CAS; Fairbanks, San Pedro River, 1♀, Sept. 6, 1927, J. Kusche, CAS; Fish Creek, Tonto Nat. Forest, 1♂, May 9–10, 1918, J.C. Bradley, CU; Ft. Grant, Pinaleno Mts., 3♂, 1♀, July 15–19, 1917, J.C. Bradley, CU; Hot Springs, 1♂, 1♀, June 26, H.S. Barber, USNM; Kensley, Arivaca Rd., 1♂, May 6, 1958, *ex* mesquite leaves, Stephenson and Alexander (JFGC slide 1111), USNM; Madera Canyon, Santa Rita Mtns., 4000–5600 ft., 13♂, 37♀, July 1–Oct. 26, 1959, R.W. Hodges (RWH slides 1710, 1717, and 3223–3225), CU, USNM; Mohave Co., 2♂, 1♀, May 1–15, USNM; Organ Pipe Cactus Nat. Monument, 1♀, Aug. 31, 1961, D. Rentz, CAS; Paradise, Cochise Co., 2♂, March and July, USNM; Peña Blanca Canyon, Santa Cruz Co., 26♂, 48♀, Aug. 7–Sept. 1, 1959, R.W. Hodges (RWH slides 1706–1709), CU, USNM; Phoenix, 2♂, 2♀, Kunze, USNM; 30 mi. E Quijotoa, Pima Co., 1♂, Aug. 28–29, 1927, J.C. Bradley, CU; Ramsey Canyon, Huachuca Mts., 1♀, Sept. 1–2, 1927, J.C. Bradley, CU; San Carlos, 2♂, May 12–13, 1918, J.C. Bradley, CU; Sells P.O., Indian Oasis, Pima Co., 20♂, 18♀, Apr. 1–30, 1923, O.C. Poling (AB slides Aug. 11, 1934, Sept. 28, 1936, and June 11, 1937), MCZ, USNM; Wellton, Yuma Co., 4♂, May 5–6, 1918, J.C. Bradley, CU; no further locality, 4♂, 2♀, Morrison, BMNH. California: Chino Canyon, Palm Springs, 1♂, Apr. 19, 1950, E.C. Johnston, CNC; Cronise Valley, San Bernardino Co., 1♂, Apr. 29, 1956, J. Powell, UCB; Dixieland, Imperial Co., 2♂, Apr. 1–30, 1922, O.C. Poling, USNM; Indio, 2♀, May 1, 1918, J.C. Bradley, CU; La Puerta, 1♂, 1♀, July 1911, Wright and Field, USNM; Mason Valley, 1♂, Aug. 10, 1938, C. M. Dammers, USNM; Mirage Lake, San Bernardino Co., 2♂, 1♀, Apr. 18, 1935, C. Dammers, MCZ, USNM; Needles, 1♀, Apr. 1–6, 1918, J.C. Bradley, CU; Palm Springs, 3♂, 1–6, 1921, K.R. Coolidge, USNM; Surprise Canyon, Panamint Mts., Inyo Co., 1♂, 1♀, Apr. 24, 1957, J. Powell, UCB; Thermal, 100 ft. below tide, 1♂, Aug. 17–18, 1927, CU; 29 Palms, San Bernardino Co., 2♀, Apr. 20–21, 1950, E.C. Johnston, CNC. Nevada: Charleston Mts., Kyle Canyon, Clarke Co., 1♀, Apr. 26, 1950, E.C. Johnston, CNC; Clarke Co., 2♂, Apr. 24–30, USNM. New Mexico: Bent, 1♀, 7.27, USNM; Carlsbad, Otero Co., 1♂, 3♀, May 17, 1950, E.C. Johnston, CNC, USNM; 10 mi. E Deming, 2♂, July 12, 1917, J.C. Bradley, CU; Mesilla, 2♂, 8♀, C.N. Ainslie (AB slides Aug. 12, 1934 and Sept. 24, 1934), USNM; Mesilla Park (mesquite near), 5♂, 3♀, July 12, 1917, J.C. Bradley, CU; Otero Co., 2♂, 3♀, May 10, 1950, E.C. Johnston, CNC, USNM; White City, Eddy Co., 2♂, 8♀, May 14–17, 1950, E.C. Johnston, CNC, USNM. Texas: Alpine, Brewster Co., 1♀, May 22, 1950, E.C. Johnston, CNC; Big Bend Nat. Park, Brewster Co., 1♂, 3♀, June 20, 1950, E.C. Johnston, CNC; Bosque Co., 1♂, May 27, 1876, BMNH; Brownsville, 3♂, 5♀, Feb. 27 through June, Barber, Freeman, and Townsend, CNC, MCZ, USNM; Burnett Co., 1♂, September, F.G. Sharpp, USNM; Corpus Christi, 1♂, June 17, 1943, W.M. Gordon, CU; Cotulla, 1♂, May 12, 1906, Crawford and Pratt, USNM; Fedora, 5♂, Mar. 31 and Apr. 1, MCZ; Fever, 1♀, Apr. 1, 1897, USNM; Ft. Davis, Jeff Davis Co., 1♂, 1♀, May 20, 1950, E.C. Johnston, CNC; Kerrville, 1♂, F.C. Pratt, USNM; Limpia Canyon, Jeff Davis Co., 1♂, 1♀, May 20, 1950, E.C. Johnston, CNC; Marathon, Brewster Co., 1♂, 3♀, May 23, 1950, E.C. Johnston, CNC; Odessa, Ector Co., 1♂, May 30, 1950, E.C. Johnston, CNC; Pecos, Reeves Co., 2♂, 17♀, May 18 and June 2, 1950, E.C. Johnston, CNC, USNM; Sabinal, 3♂, Feb. 26 and Mar. 14, 1910, F.C. Pratt (AB slide Sept. 30, 1937), USNM; San Antonio, 1♂, May 20–22, 1918, J.C. Bradley, CU; San Benito, 1♂, 2♀, August and Sept. 8–15, USNM.

MEXICO: Baja California: Chapala Dry Lake, 1♀, Sept. 25, 1941, Ross and Bohart, CAS; El Marmol, 1♀, Sept. 24, 1941, Ross, and Bohart, CAS. Hidalgo: 3 mi. E Zimapan, 6400 ft., 2♂, 4♀, July 31–Aug. 1, 1963, Duckworth and Davis, USNM. Nuevo Leon: 3 mi. E Galeana, 5000 ft., 1♂, 1♀, Aug. 7–9, 1963, Duckworth and Davis, USNM. Tamaulipas: 4 mi. SW Ciudad Victoria, 1100 ft., 1♀, July 10, 1963, Duckworth and Davis, USNM; 6 mi. S Ciudad Victoria, 1050 ft., 1♂, 1♀, Aug. 6, 1963, Duckworth and Davis, USNM.

Discussion: *F. cockerelli* may be readily separated from the other species of *Friseria* by the buff to dark brown color of the forewings and by the lack of fasciae. *F. caieta* appears blue white and black, the other species have a complete or partial oblique fascia at one-third or one-fourth on the forewing.

The various synonyms of *cockerelli* reflect the species variability in maculation. Meyrick's *sarcochlora* is a pale form; the three Busck names cover pale, medium, and dark forms. In a given locality all gradations between nearly immaculate buff to dark brown specimens are likely to occur. Neither the male nor female genitalia reflect the maculational differences.

Friseria caieta, new species

Figures 48, 111, 113, 124, 163, 231, 232

Maculation: as in figure 48. Head: tongue white with a few brown flecks; maxillary palpus white, a few apical scales tipped with brown; first segment of labial palpus white with a dorsal brown saddle, second segment white with an incomplete brown band near base and a brown band on outer and anterior surfaces before apex, third segment white with a brown ring at one-fourth and a brown ring before apex; dorsal surface of scape of antenna brown with white scales subbasally and at apex, ventral surface white; shaft mixed brown and white or gray basally, becoming mainly brown distally; frons white; vertex and occiput white, some scales with brown apices. Thorax: white, several scales on tegula and middle of mesothorax dark brown tipped. Forewing: white, dark brown, and orange brown, many brown scales with gray bases. Hindwing: fuscous, cilia pale buff. Prothoracic leg: anterior surface of coxa mixed white and brown, femur and tibia brown with some white scale bases, apex of tibia and a fascia at base of epiphysis white; tarsus brown, apices of first three segments white. Mesothoracic leg: coxa and femur mainly white with some brown scales; tibia mainly brown, scale bases white, apex and medial tuft white; tarsus brown, apices of first three segments white. Metathoracic leg: coxa and trochanter white with some gray brown scales; femur white with brown scales; tibia brown (scale bases pale), a subbasal white fascia, another at base of first pair of spurs, apex white; base and apex of basitarsus and apices of second and third segments white. Abdomen: mottled gray brown, buff, and gray, ventral surface paler than dorsal surface. Alar expanse: 12–14 mm. Male genitalia: as in figures 111, 113, and 124 (RWH slide 3219). Female genitalia: as in figure 163 (RWH slide 1238).

Food plant: Unknown.

Type: Male, Madera Canyon, 4880 ft., Santa Rita Mtns., Aug. 23, 1959, R.W. Hodges, CU type 4224.

Paratypes:

ARIZONA: same locality as type, 89♂, 86♀, July 11–Sept. 3, 1959, R.W. Hodges (RWH slides 1235–1238 and 3219; RWH wing slides 61 and 62), AMNH, BMNH, CAS, CNC, CU, UCB, USNM; same locality except for elevation, 4000 ft., 2♂, 5♀, Aug. 9, 1959, R.W. Hodges, CU, USNM; Peña Blanca Canyon, Santa Cruz Co., 9♂, 15♀, Aug. 7–Sept. 1, 1959, R.W. Hodges, CU, USNM,

Other specimens examined:

ARIZONA: Baboquivari Mts., Pima Co., 1♂, 4♀, June 1–Oct. 30, O.C. Poling, USNM; Madera Canyon, 4400 ft., Santa Rita Mts., Pima Co., 1♂, 1♀, June 8 and 9, 1963, J.G. Franclemont, JGF; Paradise, Cochise Co., 1♀, June 1–7, USNM. TEXAS: Alpine, Brewster Co., 1♀, May 22, 1950, E. C. Johnston, CNC; Brewster Co., 7000 ft., 1♀, 4.26, BMNH; Ft. Davis, Jeff Davis Co., 2♀, May 20, 1950, E. C. Johnston, CNC.

Discussion: *F. caieta* may be quickly separated from the other species of *Friseria* by the presence of white scales over most of the forewings and head.

Friseria repentina (Walsingham)

FIGURES 49, 119, 122, 123, 167, 233, 234

Gelechia repentina Walsingham, 1911, *in* Godman and Salvin, Biologia Centrali-Americana, vol. 42 (Lepidoptera-Heterocera, vol. 4) p. 65.
Friseria repentina.—Busck, 1939, Proc. U.S. Nat. Mus., vol. 86, p. 573.

Maculation: as in figure 49. Head: tongue pale buff and pale brown; maxillary palpus orange; outer surface of first segment of labial palpus orange with a few gray-brown scales, inner surface pale buff, second segment orange with a brown ring (incomplete posteriorly) at one-third and another at three-fourths, third segment orange with a brown ring at one-third and another at two-thirds; dorsal surface of scape of antenna brown, an orange band at one-fourth, apex orange; frons pale gray; vertex and occiput orange, most scales with orange brown apices. Thorax: mottled orange brown, brown, and orange;

apex of tegula mainly orange; disk mainly brown. Forewing: orange, red brown, brown, gray brown, and buff; gray-brown scales with purple reflections. Hindwing: fuscous, cilia buff. Prothoracic leg: coxa and femur pale orange heavily dusted with brown; tibia brown with a faint subbasal orange band, another at base of epiphysis, apex orange; tarsus brown, base and apex of basitarsus and apices of second and fifth segments buff. Mesothoracic leg: coxa mainly pale buff, a row of brown-tipped scales before apex; femur buff mottled with brown; tibia brown with subbasal, medial, and apical pale buff fasciae; tarsus brown, base and apex of basitarsus and apices of second and fifth segments pale buff. Metathoracic leg: coxa buff and gray white with some gray-brown splotches; femur buff flecked with brown, brown fasciae at one-fourth and two-thirds; tibia pale brown (scale bases pale) with pale buff to buff white fasciae at one-fifth, middle, and apex, dorsal tuft pale buff, outer spurs pale basally, brown distally; tarsus brown, base and apex of basitarsus and apices of remaining segments pale buff. Abdomen: not available. Alar expanse: 13–15 mm. Male genitalia: as in figures 119, 122, and 123 (AB slide June 10, 1937). Female genitalia: as in figure 167 (RWH slide 3477).

Food plant: Unknown.

Type: Female, BMNH.

Specimens examined:

MEXICO: GUERRERO: Amula, 6000 ft., 1♂, 2♀, Sept. 18, H. H. Smith (AB slide June 10, 1937; RWH slide 3477; RWH wing slide 84), BMNH, USNM.

Discussion: *F. repentina* is close to *nona* but may be separated on maculation as indicated in the key. Unobserved variation may occur in the maculation; however, only three specimens are available for examination. The male genitalic differences as pointed out in the key and shown in the figures are diagnostic.

All of the specimens with the facies of *repentina* and *nona* from Arizona have been *nona*. Further collecting in northern and central Mexico has not turned up additional specimens of either, but this may be a result of each being a fall-emerging species.

Friseria nona, new species

FIGURES 50, 112, 116, 121, 166, 235, 236

Maculation: as in figure 50. Coloration much as for *repentina* with the exception that the orange of *repentina* is generally replaced with buff. Abdomen: mottled buff and gray brown, becoming greasy. Alar expanse: 10.0–13.5 mm. Male genitalia: as in figures 112, 116, and 121 (RWH slide 3220). Female genitalia: as in figure 166 (RWH slide 3222).

Food plant: Unknown.

Type: Male, Madera Canyon, 4880 ft., Santa Rita Mtns., Ariz., Oct. 25, 1959, R. W. Hodges, CU type 4225.

Paratypes:

ARIZONA: same locality as type, 4400–5600 ft., 95♂, 47♀, June 26–Oct. 26, 1959, R. W. Hodges (RWH slides 712, 713, 3220–3222, and 3237–3244; RWH wing slides 63 and 64), AMNH, BMNH, CAS, CNC, CU, USNM; Peña Blanca Canyon, Santa Cruz Co., 5♂, 5♀, Aug. 7–Sept. 1, 1959, R. W. Hodges (RWH slides 3245 and 3246), CU, USNM.

Other specimens examined:

ARIZONA: Aravaipa Canyon, Pinal Co., 1♀, May 21, 1953, Dietrich, CU; Baboquivari Mts., 6♂, 9♀, Apr. 15–July 15, 1924, O. C. Poling, USNM; Chiricahua Mts., near Portal, 1♀, July 5, 1939, A. F. Braun, AFB; Patagonia, 1♀, May 26, 1953, Dietrich, CU; Pinal Mts., 2♂, July and August, 1900, Kunze, USNM; Santa Catalina Mts., Pima Co., 1♀, July 24–31, USNM.

Discussion: See the comments under *repentina* for means of separating the two species.

Friseria lacticaput (Walsingham), new combination

FIGURES 51, 120, 126, 164, 237, 238

Gelechia lacticaput Walsingham, 1911, *in* Godman and Salvin, Biologia Centrali-Americana, vol. 42 (Lepidoptera-Heterocera, vol. 4), p. 61.

Maculation: as in figure 51. Head: tongue buff with a few pale brown-tipped scales basally; maxillary palpus pale buff basally, darker distally; first segment of labial palpus mottled buff and pale brown, inner surface pale buff, second segment pale buff and orange with incomplete pale brown rings at two-fifths and three-fourths, posterior surface nearly white, third segment pale buff with a brown ring at two-fifths and another at four-fifths; dorsal surface of scape orange with a pale brown medial band, ventral surface pale buff, shaft buff on first eight or nine segments then mainly brown; frons, vertex, and occiput buff, many scales tipped with orange. Thorax: orange on basal half, apex of tegula and a line across mesothorax pale buff; apex of mesothorax dark brown; metathorax pale buff. Forewing: dark brown, base orange and pale buff, fascia buff white, tornal area creamy white. Hindwing: fuscous, cilia pale fuscous and buff. Prothoracic leg: coxa and femur buff white, a few brown scales at middle of coxa, a brown fascia just beyond middle of femur; tibia brown and black dorsally; pale buff ventrally, base, part of medial tuft and apex of apical tuft pale buff; tarsus buff with brown-black dorsal saddles on first four segments. Mesothoracic leg: much as for prothoracic leg. Metathoracic leg: coxa, trochanter, and femur buff white, a few post medial brown scales on femur; tibia buff white, a small subbasal patch of brown scales, a pale brown streak at one-fourth, middle of outer tibial spurs dark brown; tarsus mainly buff.

Abdomen: buff white mottled with gray scales on caudal segments. Alar expanse: 10–16 mm. Male genitalia: as in figures 120 and 126 (AB slide Oct. 14, 1936). Female genitalia: as in figure 164 (RWH slide 3476).

Food plant: Unknown.

Type: Female, BMNH.

Specimens examined:

MEXICO: GUERRERO: Amula, 6000 ft., Sept. 18, H.H. Smith (AB slide Oct. 14, 1936; RWH wing slide 84), USNM. YUCATAN: Mérida, 1 ♂, 1 ♀, July 29, 1964, P.J. Spangler (RWH slides 3475 and 3476), USNM.

Discussion: *F. lacticaput* may be separated from *cockerelli, caieta, repentina,* and *nona* by the presence of the buff white to white costal fascia at one-third; and from *acaciella* and *infracta* by the head and anterior half of the thorax being buff.

Forewings of the fresh specimens are nearly black with a slight luster as contrasted with the dark brown of the specimens collected for the "Biologia."

Friseria acaciella (Busck), new combination

FIGURES 52, 53, 117, 118, 125, 165, 239, 240

Telphusa acaciella Busck, 1906, Proc. U.S. Nat. Mus., vol. 30, p. 722.

Maculation: as in figures 52 and 53. Head: tongue mottled buff and brown, dark basally; maxillary palpus pale brown, flecked with buff; outer surface of first segment of labial palpus gray brown, inner and dorsal surfaces buff white, second segment gray brown, apex dark orange, third segment dark brown (scale bases pale), base and middle with orange scales, apex buff; dorsal surface of scape of antenna brown, apex pale, ventral surface buff white, first two scale rows brown, dorsal surface of shaft brown (scale bases pale), ventral surface brown with each half segment buff; scales of frons buff with gray brown apices; vertex and occiput with gray brown to brown-tipped scales, a fascicle of orange scales from dorsal margin of eye. Thorax: mottled dark brown, brown black, and red brown. Forewing: black, dark gray brown, brown, buff white, and orange. Hindwing: fuscous, cilia gray brown tinted with buff. Prothoracic leg: coxa and femur buff flecked with brown, a transverse fascia on femur at three-fourths; tibia brown with orange at base of epiphysis, apex, and at apex of epiphysis; tarsus brown, base and apex of basitarsus, apex of second and entire fifth segment pale buff. Mesothoracic leg: much as for prothoracic leg; medial tibial tuft orange basally, dark brown before apex, gray apically; apex of fourth tarsal segment pale buff. Metathoracic leg: coxa, trochanter, and femur buff white, a transverse brown band near base of trochanter, near base of femur, and at two-thirds of femur; tibia mainly pale buff, gray brown between tibial spurs, outer tibial spurs dark gray brown medially, pale buff basally and apically; apices of all tarsal segments pale buff. Abdomen: mottled pale buff and pale brown. Alar expanse: 11.0–12.5 mm. Male genitalia: as in figures 117, 118, and 125 (RWH slides 3328 and 3330). Female genitalia: as in figure 165 (RWH slide 3331).

Food plant: *Acacia farnesiana* Willdenow and *Mimosa* species.

Type: Female, USNM.

Specimens examined:

UNITED STATES: LOUISIANA: New Orleans, 4♂, 1♀, Oct. 17, 1904, E.S.G. Titus (RWH slides 3328 and 3332), USNM. TEXAS: Brownsville, 7♂, 12♀, Jan. 14–July 4, Barber, Piazza (AB slide Sept. 22, 1936; RWH wing slides 77 and 78), CAS, USNM; Corpus Christi, 1♂, iss. May 17, 1923, ex *Acacia farnesiana* USNM; Los Borregos, Brownsville, 1♂, June 5, 1904, H.S. Barber, USNM; Mercedes, 1♂, 1♀, Jan. 2, 1956, P.T. Riherd, H.L. Schamlzied, CPK, USNM; Nueces River, 5 mi. SW Mathis, 1♂, 3♀, Aug. 12, 1963, Duckworth and Davis, USNM; Richmond, Brazos River, 6♂, 5♀, June 22, 1917, J.C. Bradley, CU, San Benito, 6♂, 9♀, April-Sept. 15 (AB slide Aug. 1, 1933), USNM; San Diego, 1♂, May 23, 1895, E.A. Schwarz, USNM; Victoria, 6♂, 10♀, June, Caudell, Schwarz, Mitchell, Hinds, Bradley, AMNH, CU, USNM.

MEXICO: COAHUILA: 10 mi. N Monclova, 1500 ft., 1♂, July 7, 1963, Duckworth and Davis, USNM. HIDALGO: 3 mi. E Zimapan, 6400 ft., 1♀, July 31–Aug. 1, 1963, Duckworth and Davis, USNM. NUEVO LEON: Anegade Arroya, 1250 ft., 16 mi. S Linares, 5♂, 3♀, July 19, 1963, Duckworth and Davis, USNM; 3 mi. E Galeana, 5000 ft., 1♀, Aug. 7–9, 1963, Duckworth and Davis (RWH slide 3329), USNM. TAMAULIPAS: 4 mi. SW Ciudad Victoria, 1200 ft., 1♂, 5♀, Duckworth and Davis (RWH slide 3331), USNM; 6 mi. S Ciudad Victoria, 1050 ft., Aug. 6, 1963, Duckworth and Davis, USNM; El Salto Falls, 2000 ft., 26 mi. W Antiguo Morelos, 2♀, July 11–14, 1963, Duckworth and Davis, USNM.

Discussion: *F. acaciella* may be separated from *cockerelli*, *caieta*, *repentina*, and *nona* by the fascia from the costa at one-third, from *lacticaput* by the dark thorax; and from *infracta* by the outer margin of the fascia being irregular, pointing to the tornus, whereas that of *infracta* is rounded.

In some specimens the fascia is buff brown; however, no other characters are correlated with this feature, and gradients between this condition and that given in the present description exist.

Friseria infracta (Walsingham), new combination

FIGURES 54, 114, 115, 128, 241, 242

Gelechia infracta Walsingham, 1911, *in* Godman and Salvin, Biologia Centrali-Americana, vol. 42 (Lepidoptera-Heterocera, vol. 4), p. 61.

Maculation: as in figure 54. Head: tongue missing on examined specimen; maxillary palpus greasy brown, pale basally; first segment of labial palpus brown on outer surface, dorsal and inner surfaces buff white, second segment brown with pale orange to buff white bands at one-third, two-thirds, and apex, third segment orange with a brown band at one-third and another at two-thirds; dorsal surface of scape of antenna brown with some orange basally and apically, ventral surface buff, dorsal surface of shaft greasy brown, ventral surface buff and brown; scales of frons, vertex, and occiput gray brown apically, pale basally, a fascicle of orange scales above eye. Thorax: dark gray brown, metathorax buff. Forewing: pale buff, white, dark gray brown, and black. Hindwing: fuscous, cilia fuscous tinged with buff. Prothoracic leg: coxa and femur streaked buff and brown; tibia brown, apex and an incomplete band at base of epiphysis orange to buff white; tarsus brown, base and apex of basitarsus and apices of second and fifth tarsal segments buff. Mesothoracic leg: coxa buff, many scales streaked with gray, trochanter pale buff streaked with brown; femur buff and brown; tibia brown, apex yellow and white; tarsus brown, base and apex of basitarsus and apices of second, fourth, and fifth segments pale buff. Metathoracic leg: coxa and trochanter with some pale brown scales; femur pale buff streaked with brown; tibia pale brown, a pale subbasal streak, another at base of first pair of tibial spurs, and apex nearly white, dorsal tuft streaked buff and buff white; tarsus brown, base of basitarsus, apices of segments two through four, and all of fifth segment buff white. Abdomen: not observed before dissection was made. Alar expanse: 15 mm. Male genitalia: as in figures 114, 115, and 128 (RWH slide 3461). Female genitalia: no specimens available.

Food plant: Unknown.

Type: Male, BMNH.

Specimen examined:

MEXICO: GUERRERO: Amula, 6000 ft., 1♂, Sept. 18, H. H. Smith (RWH slide 3461; RWH wing slide 83), USNM.

Discussion: *F. infracta* may be separated from *cockerelli*, *caieta*, *repentina*, and *nona* by the presence of the costal, white fascia on the forewing; from *lacticaput* by the dark head and thorax; and from *acaciella* by the rounded apical portion of the fascia. The valvae of the male genitalia of *infracta* have an extremely heavily sclerotized costal lobe; the two lobes from the ventral surface are short; whereas the costal lobe of *acaciella* is less heavily sclerotized, has an additional ventrodistal lobe, and one of the lobes from the ventral margin is more than one-half the length of the costal lobe.

Rifseria, new genus

Type-species: *Gelechia fuscotaeniaella* Chambers, 1878.

Head: smooth scaled; tongue moderate, scaled to one-half; maxillary palpus short, folded at base of tongue; labial palpus recurved, second and third segments subequal in length, second segment slightly thickened with scales ventrally, third segment slender, apex acute; antenna two-thirds length of forewing, simple. Forewing: broadly lanceolate, apex acute; 12 veins present; 6, 7, and 8 stalked, 6 to dorsum, 7 and 8 to costa. Hindwing: trapezoidal, apex produced, acute; 8 veins present, 3 and 4 short stalked; 5 from 3+4 at a right angle; 6 and 7 stalked, 6 to termen, 7 to costa, 7 sinuous. Abdomen: second and third terga with lateral patches of stout setae. Male genitalia: valva with two lobes separate to juncture of tegumen and vinculum, dorsal lobe slender; vinculum broad, quadrate medially; aedeagus with expanded base; tegumen long; uncus hood shaped, with an apical row of short, stout setae; gnathos present, hook shaped; culcitula present. Female genitalia: signum lightly sclerotized, elliptical, two short ridges near each end; ostium bursae at caudal margin of eighth sternum; eighth segment heavily sclerotized, anterior margin a thickened sclerotized ridge; apophyses anteriores short, apophyses posteriores moderate.

Rifseria is near *Friseria* and *Sriferia* but differs from both by having 6, 7, and 8 of the forewing stalked, terga two and three with permanent setae, and the apical setae of the uncus short and stout. It differs from *Friseria* in that the costal lobes of the valvae are separate to the base in the males and that the eighth abdominal segment of the female is heavily sclerotized.

Rifseria fuscotaeniaella **(Chambers), new combination**

FIGURES 55, 129, 130, 168, 243, 244

Gelechia fuscotaeniaella Chambers, 1878, Bull. U.S. Geol. Geogr. Surv. Terr., vol. 4, p. 89.

Maculation: as in figure 55. Head: tongue and maxillary palpus brown; first segment of labial palpus brown on outer surface, white on inner surface, outer surface of second segment brown (scales pale basally) on basal third or half, white elsewhere, third segment white except for brown apex and sometimes a brown band at two-thirds; dorsal surface of antenna brown, ventral surface of scape off white, ventral surface of shaft greasy pale brown basally; frons with a row of brown scales from anterior margin of eye to base of tongue, remainder of frons, vertex, and occiput white; a row of brown scales behind eye. Thorax: white; base of tegula brown, apex sometimes red brown; apex of mesothorax dark brown; metathorax gray white. Forewing: white, dark marks brown, some red brown, buff, and pale gray present; cilia white below apex, buff at tornus. Hindwing: fuscous, cilia buff. Prothoracic leg: anteromesal surface brown (scales pale basally), apices of femur, tibia, and tarsal segments buff white. Mesothoracic leg: coxa mainly white, some scales gray; femur, tibia, and tarsus brown (scales pale basally), apices of tibia and tarsal segments buff white. Metathoracic leg: coxa white basally, gray white distally; trochanter pale gray brown, scales with light streaks; femur white dorsally becoming brown ventrally; tibial scales mixed buff white and pale brown, tuft buff white; apices of first four tarsal segments off white, outer surface with a brown dorsal saddle. Abdomen: buff white dorsally, permanent setae orange; ventral surface pale buff, segments two through six with a lateral gray-brown patch. Alar expanse: 10.5–16.0 mm. Male genitalia: as in figures 129 and 130 (RWH slide 1249). Female genitalia: as in figure 168 (RWH slide 1251).

Food plant: Unknown.

Type: Male, MCZ.

Specimens examined:

UNITED STATES: Arizona: Ajo, Pima Co., 1 ♀, Mar. 1–15, 1923, O.C. Poling, USNM; Baboquivari Mts., Pima Co., 1 ♀, Oct. 15–30, 1924, O.C. Poling, USNM; Fort Valley, 7½ mi. NW Flagstaff, 7350 ft., Coconino Co., 1 ♂, July 17, 1961, R.W. Hodges, USNM; Hart Prairie, 10 mi. NNW. Flagstaff, 8500 ft., Coconino Co., 1 ♂, July 12, 1961, R.W. Hodges, USNM; Huachuca, 1 ♀, Aug. 3, 1899, MCZ; Madera Canyon, 4880 and 5600 ft., Santa Rita Mtns., 3 ♂, 5 ♀, Sept. 13–Oct. 27, 1959, R.W. Hodges (RWH slides 1249–1252), CU, USNM; same locality, 2 ♂, 1 ♀, May 11–16, 1963, J. G. Franclemont, JGF; Molino Basin, Santa Catalina Mts., Pima Co., 1 ♀, June 10, 1959, MacNeill, CAS; Palmerlee, 1 ♀, USNM; Paradise, Cochise Co., 2 ♂, June 1–7, USNM; Ramsay Canyon, Huachuca Mts., 1 ♂, July 10–15, 1941, A.B. Klots, AMNH; Redington, 1 ♀, USNM; Vail Lake Road, 9½ mi. SE Flagstaff, 6500 ft., Coconino Co., 1 ♂, 1 ♀, July 11, 18, 1961, R.W. Hodges, USNM. California: Atascadero, 1 ♀, July 26, 1935, E.C. Johnston, USNM; Avalon, Santa Catalina Is., 1 ♂, May 17, 1932, MCZ; 12 mi. SE Ivanpah, San Bernardino Co., 2 ♂, 1 ♀, May 1, 1956, J. Powell, UCB; Los Angeles, 1 ♀, Oct. 26, 1920, K.R. Coolidge (AB slide Sept. 21, 1934), USNM; Lytle Creek, San Bernardino Co., 1 ♀, June 29, 1946, C. Henne (RWH slide 3248), USNM; Mt. Palomar, San Diego Co., 1 ♂, July 18, 1963, J. Powell, UCB; San Diego, 1 ♂, Oct. 20, 1920, K.R. Coolidge (AB slide Sept. 21, 1934), USNM; Walnut Cr., foot Shell Ridge, Contra Costa Co., 1 ♀, Apr. 22, 1962, J. Powell, UCB. Colorado: Boulder, 1 ♀, Cockerell (AB slide June 11, 1937), USNM; Chimney Gulch, Golden, 1 ♀, June 7, 1907, Oslar, USNM; Denver, 1 ♀, MCZ; Glenwood Springs, 2 ♂, August 1899, MCZ, USNM. Nevada: Clarke Co., 1 ♀, May 16–23, USNM. Utah: Eureka, 3 ♂, 1 ♀, Aug. 13–22, 1911, Tom Spalding, USNM; Warner Ranger Sta., 9000 ft., La Sal Mts., 1 ♀, July 1933, A.B. Klots, AMNH.

CANADA: British Columbia: Fraser Mills, 1 ♂, June 22, 1921, L. E. Marmont, USNM. Manitoba: Aweme, 5 ♂, 2 ♀, Sept. 5–25, N. Criddle (AB slide June 11, 1937; RWH wing slide 60), CNC, USNM.

Discussion: *R. fuscotaeniaella* is moderately variable in maculation with gradations between nearly all white and dark specimens known. The head, thorax, and left wings remain of the type specimen. It is a nearly white representative of the species.

Sriferia, new genus

Type-species: *Gelechia prorepta* Meyrick, 1923.

Head: smooth scaled; tongue moderate, scaled to one-half; maxillary palpus porrect; labial palpus recurved, sickle shaped, second and third segments subequal in length, second segment thicker than third; antenna one-half length of forewing, simple. Forewing: broadly lanceolate, apex almost rounded; 12 veins present; 7 and 8 stalked, 7 to costa. Hindwing: trapezoidal, outer margin gradually moving to apex, apex slightly produced, broadly acute; 8 veins present; 3 and 4 short stalked; 5 at right angle from 3 and 4; 6 and 7 separate; 7 sinuous; R_1 merging with Sc near base. Male genitalia: saccus developed, slightly expanded anteriorly; vinculum narrow; valva with two linear costal lobes, separate to juncture between tegumen and vinculum; aedeagus stout, basal half expanded; tegumen long, uncus moderate with apical row of long, stout setae; gnathos hook shaped; culcitula present. Female genitalia: unknown.

Sriferia may be separated from *Friseria* by the lobes of the valvae being separate to the base and by the quadrate saccus and from *Rifseria* by the long apical setae on the uncus, lack of permanent setae on the abdominal terga, and by vein 6 of the forewing being separate from 7 and 8.

Sriferia prorepta (Meyrick), new combination

FIGURES 56, 127, 131, 245, 246

Gelechia prorepta Meyrick, 1923, Exot. Micr., vol. 3, p. 19.
Gelechia fulmenella Busck, 1910, Proc. Ent. Soc. Washington, vol. 11, p. 178. [Preoccupied.]

Maculation: as in figure 56. Head: tongue and maxillary palpus buff white to white; first segment of labial palpus cream white to white, second segment cream white, becoming brownish on anterior surface, third segment brown, posterior surface gray white to cream white basally; dorsal surface of antenna brown, ventral surface of scape and base of shaft buff white; frons white; vertex and occiput gray brown. Thorax: gray brown. Forewing: dark scales gray to purple gray, tipped with brown; fascia white; cilia fuscous, Hindwing: fuscous, cilia gray brown. Prothoracic leg; coxa white basally and apically, gray brown medially; femur, tibia, and tarsus brown, apices of femur, tibia, and first two tarsal segments white. Mesothoracic leg: coxa and femur white, femur gray apically; tibia and tarsus gray brown, apices of tibia and first two tarsal segments white or pale. Metathoracic leg: coxa, trochanter, and femur white with some pale gray scales; tibia and tarsus dark gray to gray brown, a white fascia at base of first pair of tibial spurs, extending into dorsal tuft, gray; apices of first two tarsal segments white or pale. Abdomen: gray, apices of segments pale, first, second, and third terga with orange scales. Alar expanse: 11.0–14.5 mm. Male genitalia: as in figures 127 and 131 (RWH slide 2624). Female genitalia: no specimens available.

Food plant: Unknown.

Type: Male, USNM.

Specimens examined:

ARIZONA: Mohave Co., 2♂, May 1–7 (RWH wing slide 59), USNM. CALIFORNIA: Essex, San Bernardino Co., 2♂, Apr. 10, 1936, C. Dammers (RWH slide 2621), USNM; Split Rock Tank, Mohave Desert, 1♂, May 20, 1938, Sperry, AMNH.

Discussion: No females of *prorepta* are known; thus, the genus cannot be diagnosed for this sex.

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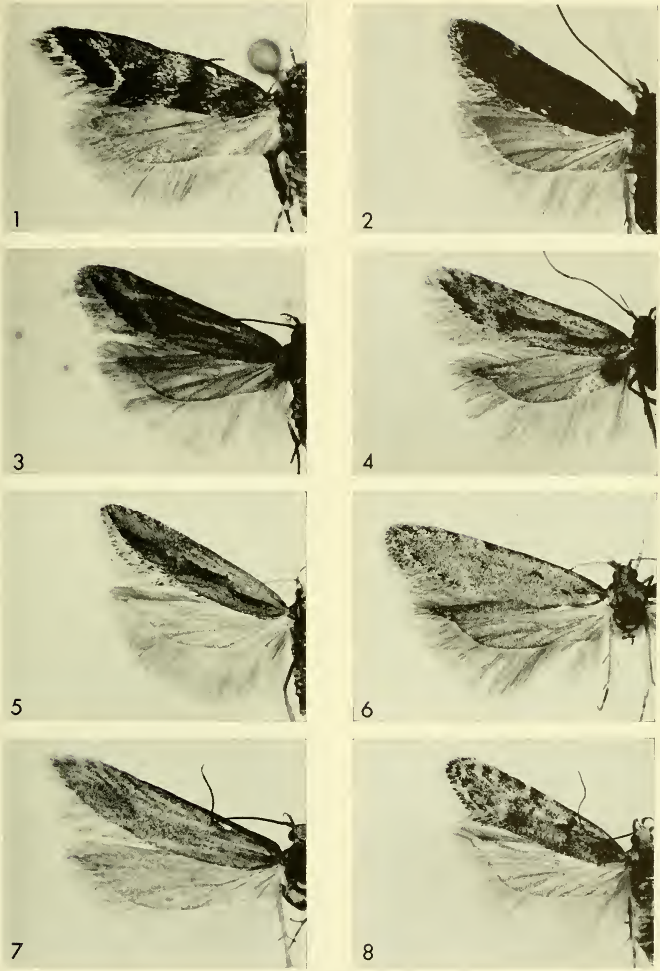
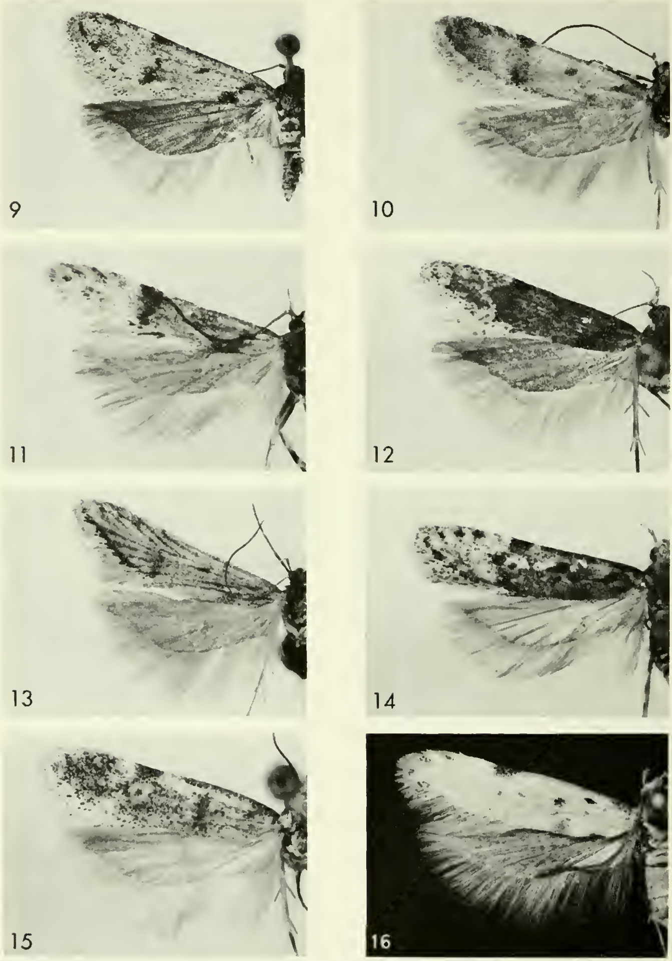
Plates

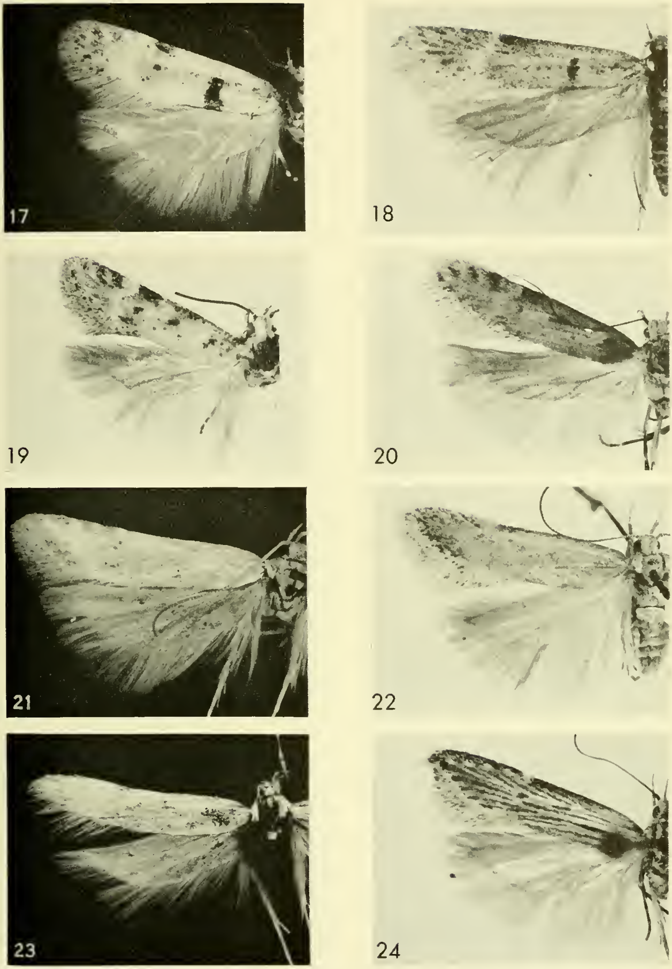
(Figures 1–246)



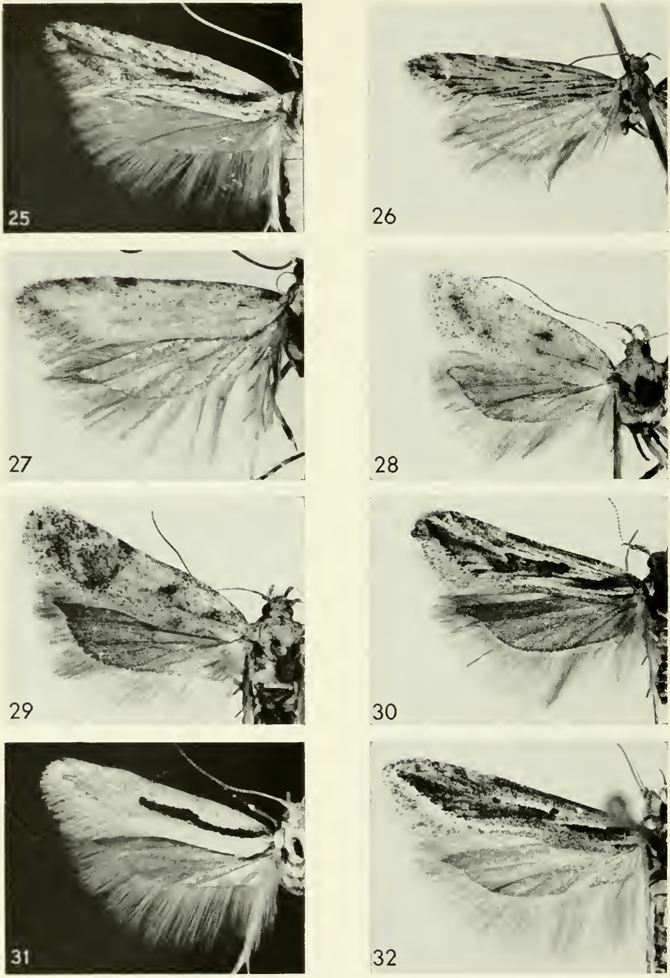
FIGURES 1–8.—Left wings: 1, *Lita virgella*, Golden, Colorado; 2, *L. solutella*, Europe; 3, *L. variabilis*, Ft. Valley, Flagstaff, Ariz.; 4, *L. variabilis*, Satus Creek, Yakima Co., Wash.; 5, *L. variabilis*, Ft. Valley, Flagstaff, Ariz.; 6, *L. variabilis*, Monachee Meadows, Tulare Co., Calif., 7, *L. variabilis*, Hart Prairie, Flagstaff, Ariz., 8, *L. barnesiella*, Pine, Gila Co., Ariz.



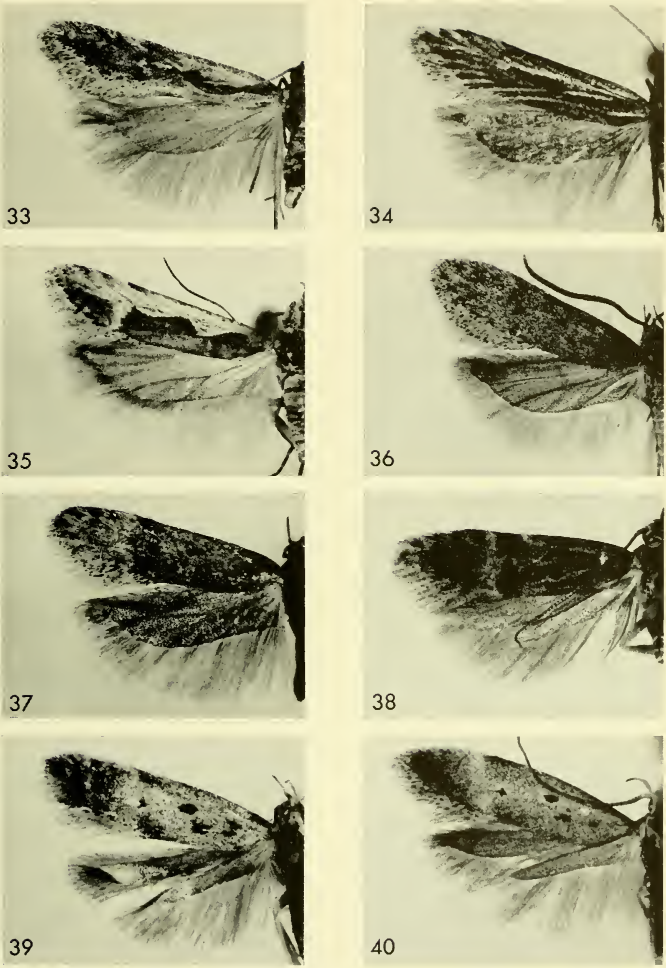
FIGURES 9–16.—Left wings: 9, *Lita incicur*, Yellowstone Nat. Park, Madison Junction, Wyo.; 10, *L. incicur*, Smokey Valley, Tulare Co., Calif.; 11, *L. incicur*, near White Mt. Peak, Mono Co., Calif.; 12, *L. incicur*, Yellowstone Nat. Park, Madison Junction, Wyo.; 13, *L. incicur*, Willow Creek, Siskiyou Co., Calif.; 14, *L. geniata*, La Puerta Valley, Calif.; 15, *L. puertella*, La Puerta Valley, Calif.; 16, *L. puertella*, La Puerta Valley, Calif.



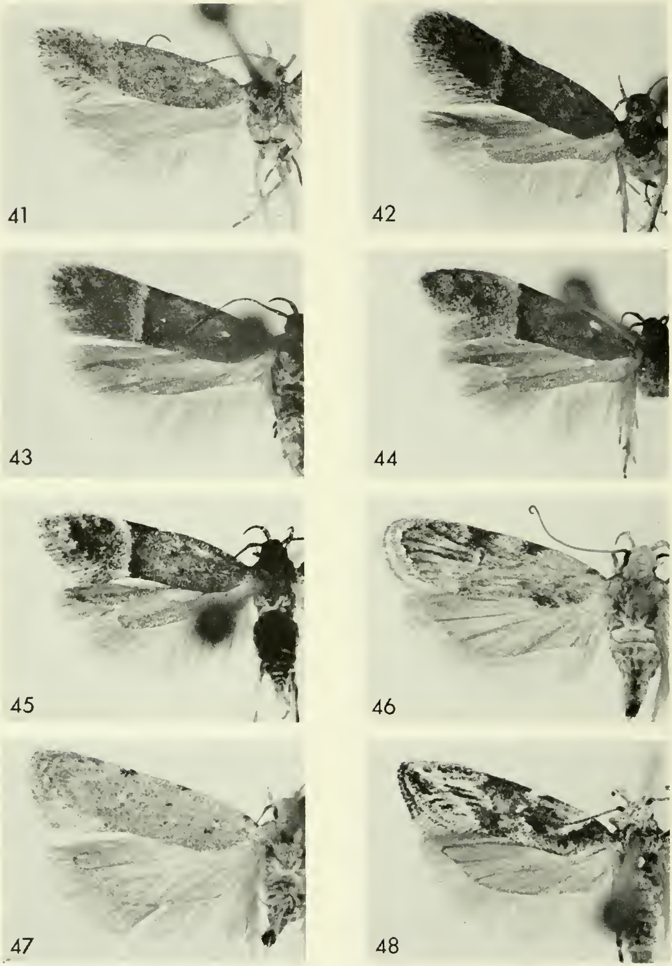
FIGURES 17–24.—Left wings: 17, *Lita deoia*, Smokey Valley, Tulare Co., Calif.; 18, *L. dialis*, Brewster Co., Tex.; 19, *L. pagella*, Jacumba, Calif.; 20, *L. pagella*, Ft. Valley, Flagstaff, Ariz.; 21, *L. obnubila*, Ft. Davis, Tex.; 22, *L. maenadis*, Placer Co., Calif.; 23, *L. veledae*, Dixieland, Imperial Co., Calif.; 24, *L. rectistrigella*, Durango, Colo.



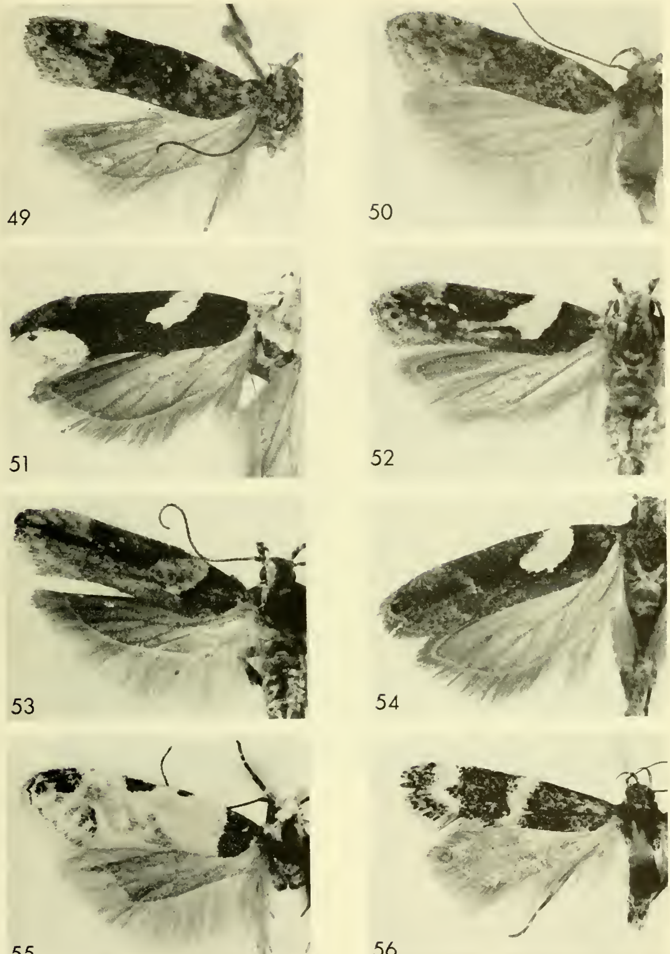
Figures 25–32.—Left wings: 25, *Lita sironae*, San Diego, Calif.; 26, *L. thaliae*, Glenwood Springs, Colo.; 27, *L. thaliae*, Eureka, Utah; 28, 29, *L. texanella*, Galeana, Nuevo Leon, Mexico; 30, *L. recens*, Mt. Shasta, Calif.; 31, *L. princeps*, Jacumba, Calif.; 32, *L. jubata*, Satus Creek, Yakima Co., Wash.



FIGURES 33–40.—Left wings: 33, *Lita nefrens*, Sonora Pass, Tuolumne Co., Calif.; 34, *L. nefrens*, Lamar, Colo.; 35, *L. invariabilis*, Gallup, New Mex.; 36, *Arla tenuicornis*, Brooks Memorial Park, Klickitat Co., Wash.; 37, *A. diversella*, La Mesa, San Diego Co., Calif.; 38, *N. snellenella*, Huachuca Mts., Ariz.; 39, *Neodactylota liguritrix*, Corpus Christi, Tex.; 40, *N. basilica*, Sycamore Canyon, Santz Cruz Co., Ariz.

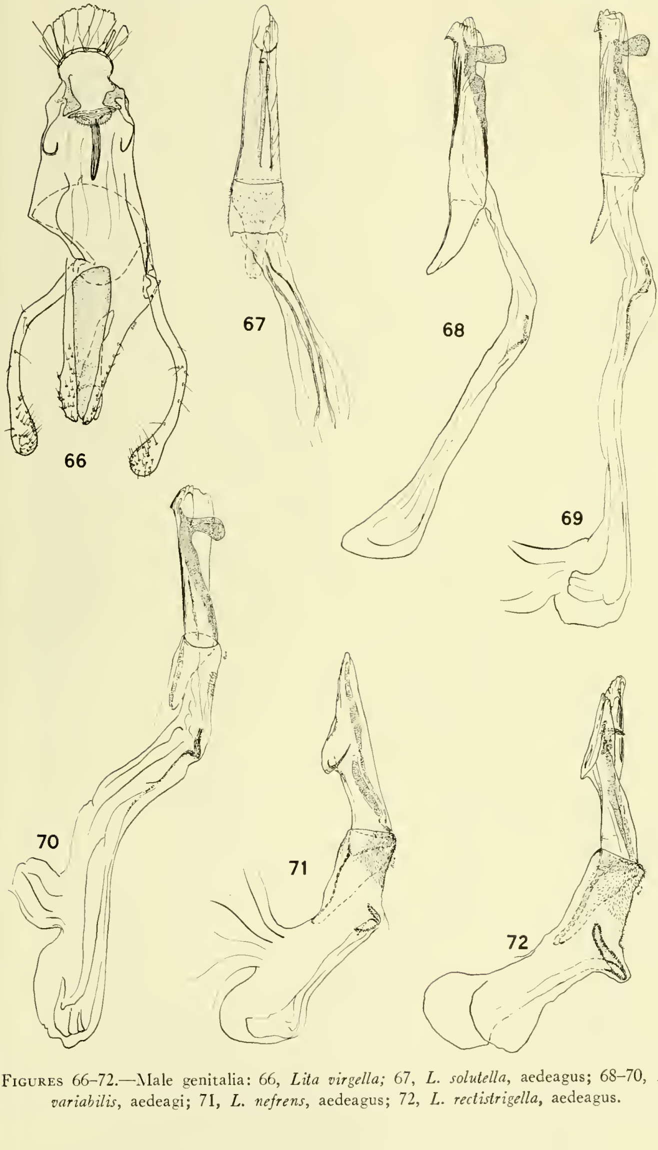


FIGURES 41–48.—Left wings: 41, *Neodactylota egena*, Madera Canyon, Santa Rita Mts., Ariz.; 42, *Eudactylota barberella*, Ft. Valley, Flagstaff, Ariz.; 43, *E. iobapta*, Peña Blanca Canyon, Santa Cruz Co., Ariz.; 44, *E. diadota*, Madera Canyon, Santa Rita Mts., Ariz.; 45, *E. abstemia*, Madera Canyon, Santa Rita Mts., Ariz.; 46, *Friseria cockerelli*, Peña Blanca Canyon, Santa Cruz Co., Ariz.; 47, *F. cockerelli*, Madera Canyon, Santa Rita Mts., Ariz.; 48, *F. caieta*, Peña Blanca Canyon, Santa Cruz Co., Ariz.

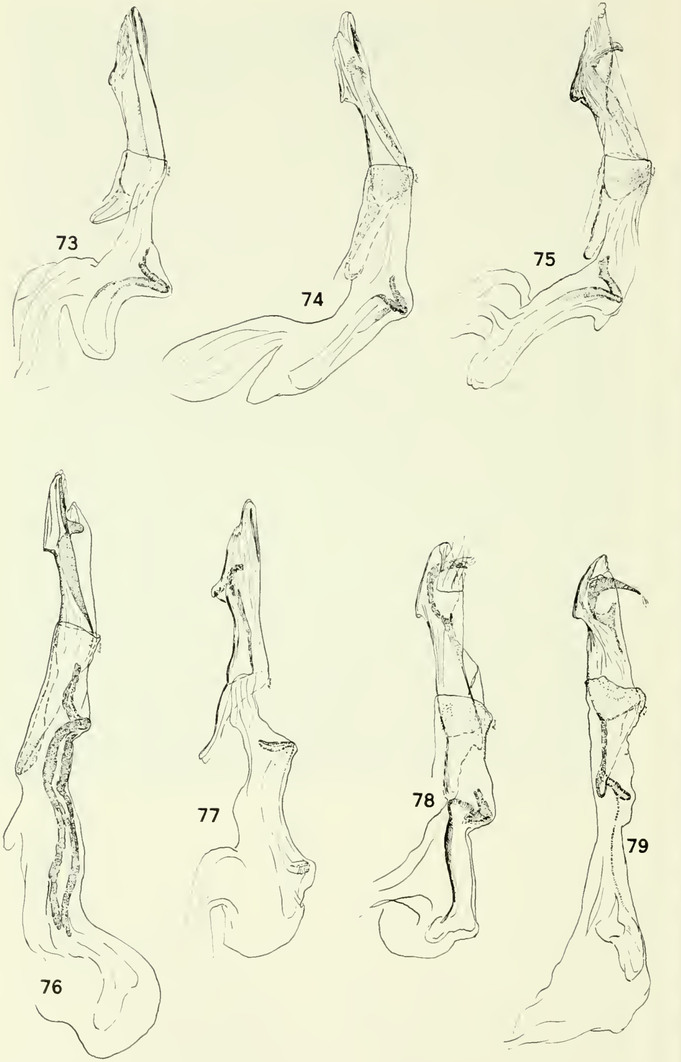


FIGURES 49–56.—Left wings: 49, *Friseria repentina*, Amula, Guerrero, Mexico; 50, *F. nona*, Madera Canyon, Santa Rita Mts., Ariz.; 51, *F. lacticaput*, Amula, Guerrero, Mexico; 52, *F. acaciella*, Corpus Christi, Tex.; 53, *F. acaciella*, New Orleans, La.; 54, *F. infracta*, Amula, Guerrero, Mexico; 55, *Rifseria fuscotaeniaella*, Madera Canyon, Santa Rita Mts., Ariz.; 56, *Sriferia prorepta*, Split Rock Tank, Mohave Desert, Calif.

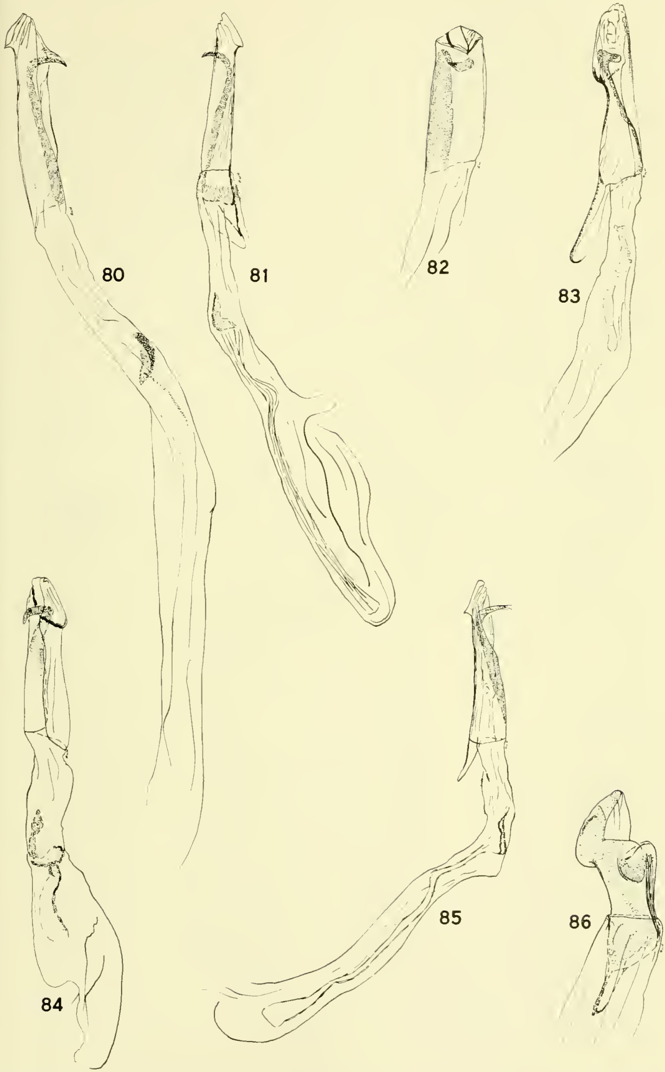
FIGURES 57–65.—Heads: 57, *Lita nefrens*; 58, *L. incicur*; 59, *L. invariabilis*; 60, *L. nefrens*; 61, *L. barnesiella*; 62, *L. geniata*; 63, *L. jubata*; 64, *L. jubata*; 65, *L. puertella*.



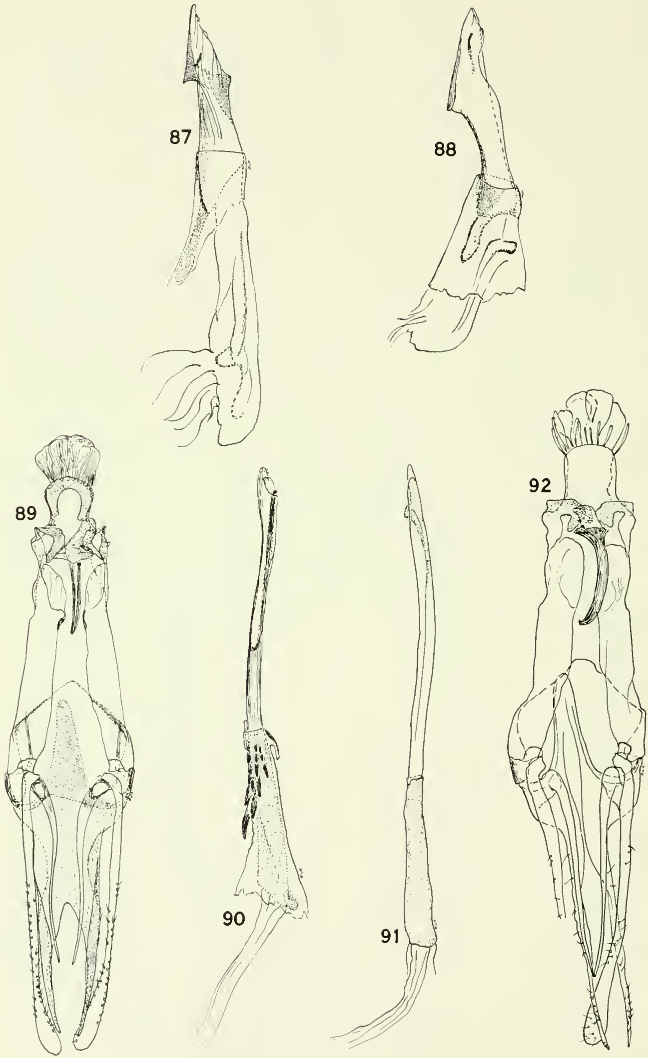
FIGURES 66–72.—Male genitalia: 66, *Lita virgella;* 67, *L. solutella*, aedeagus; 68–70, *L. variabilis*, aedeagi; 71, *L. nefrens*, aedeagus; 72, *L. rectistrigella*, aedeagus.



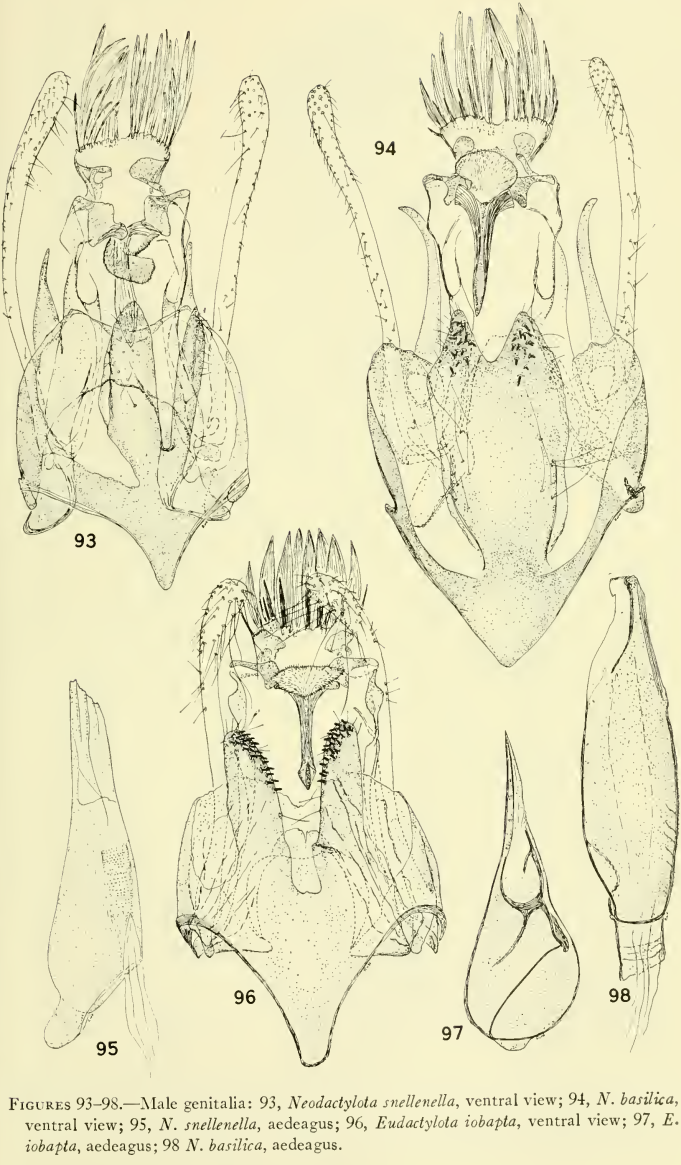
FIGURES 73–79.—Aedeagi: 73, *Lita sironae;* 74, *L. thaliae;* 75, *L. recens;* 76, *L. texanella;* 77, *L. jubata;* 78, *L. incicur;* 79, *L. invariabilis.*



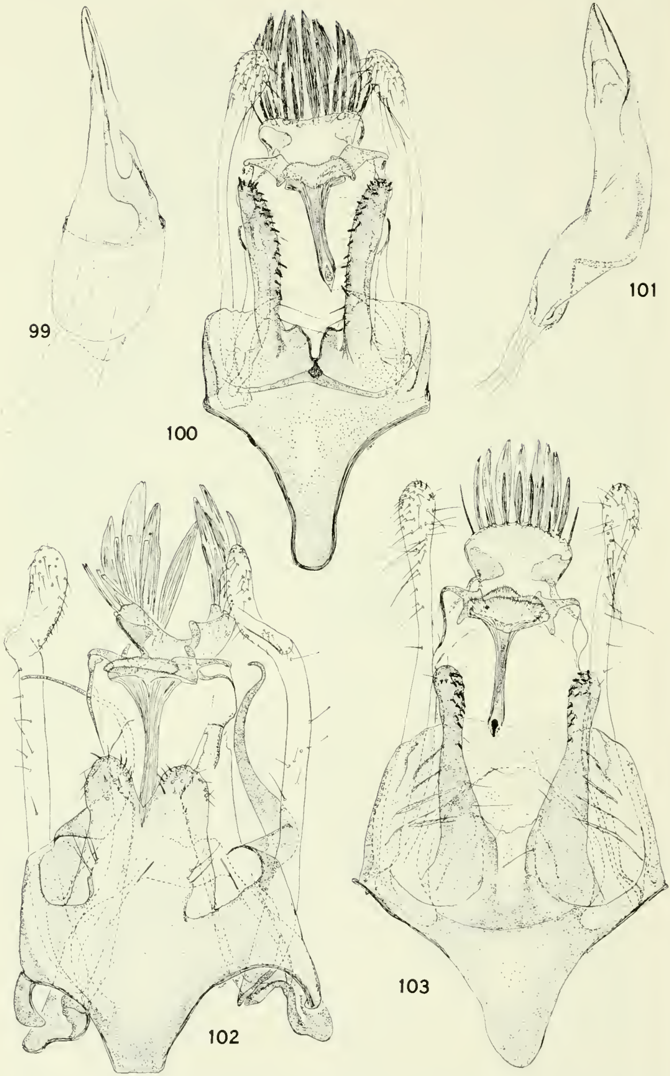
FIGURES 80–86.—Aedeagi: 80, *Lita puertella;* 81, *L. geniata;* 82, *L. deoia;* 83, *L. dialis;* 84, *L. pagella;* 85, *L. barnesiella;* 86, *L. princeps.*



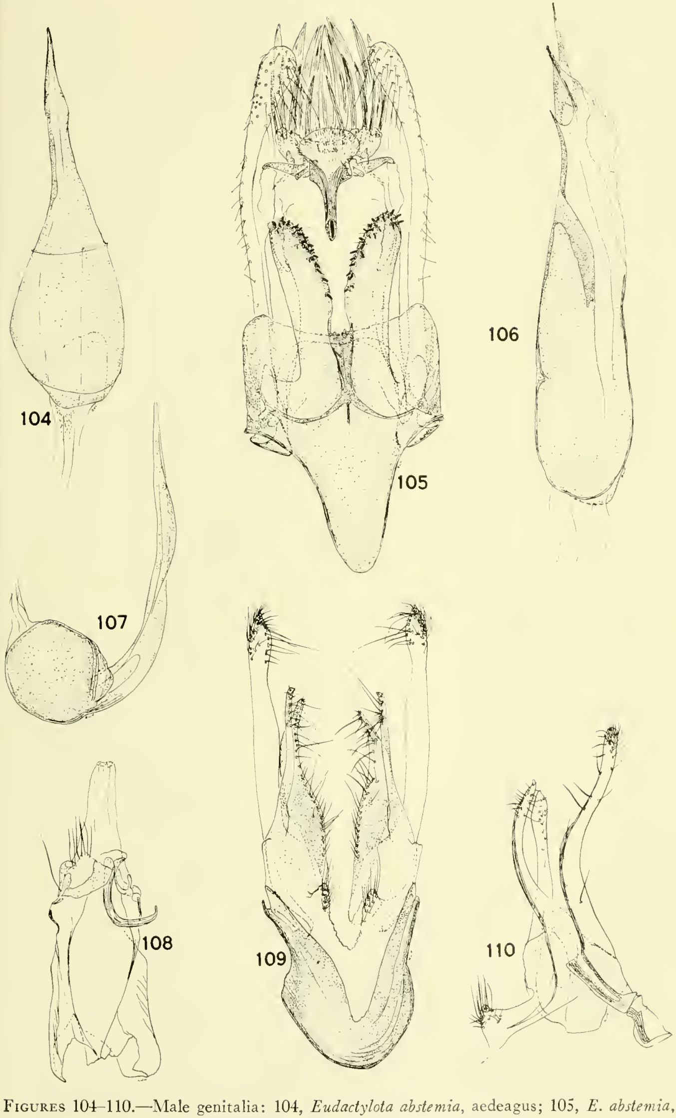
FIGURES 87–92.—Male genitalia: 87, *Lita obnubila*, aedeagus; 88, *L. veledae*, aedeagus; 89, *Arla tenuicornis*, ventral view; 90, *A. tenuicornis*, aedeagus; 91, *A. diversella*, aedeagus; 92, *A. diversella*, ventral view.



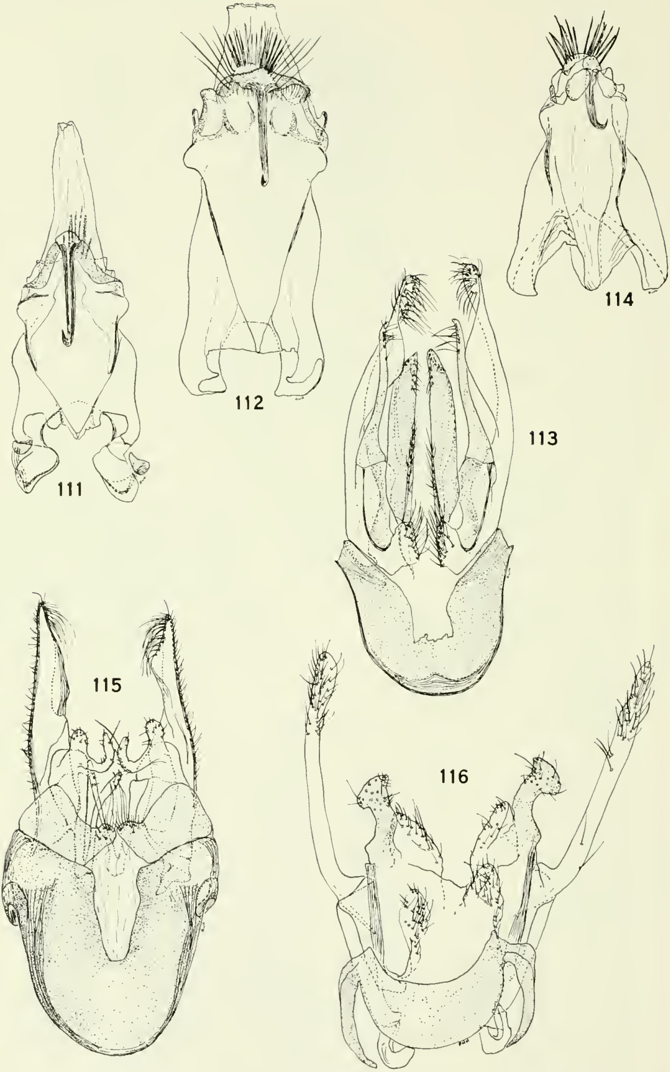
Figures 93–98.—Male genitalia: 93, *Neodactylota snellenella*, ventral view; 94, *N. basilica*, ventral view; 95, *N. snellenella*, aedeagus; 96, *Eudactylota iobapta*, ventral view; 97, *E. iobapta*, aedeagus; 98 *N. basilica*, aedeagus.



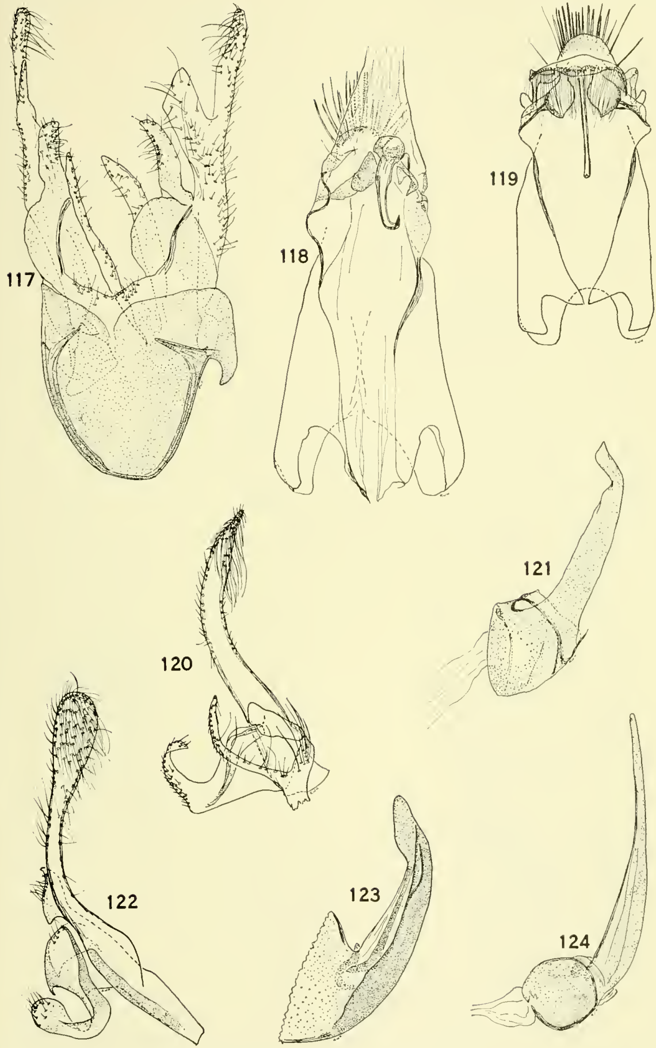
FIGURES 99–103.—Male genitalia: 99, *Eudactylota diadota*, aedeagus; 100, *E. diadota*, ventral view; 101, *E. barberella*, aedeagus; 102, *Neodactylota liguritrix*, ventral view; 103, *E. barberella*, ventral view.



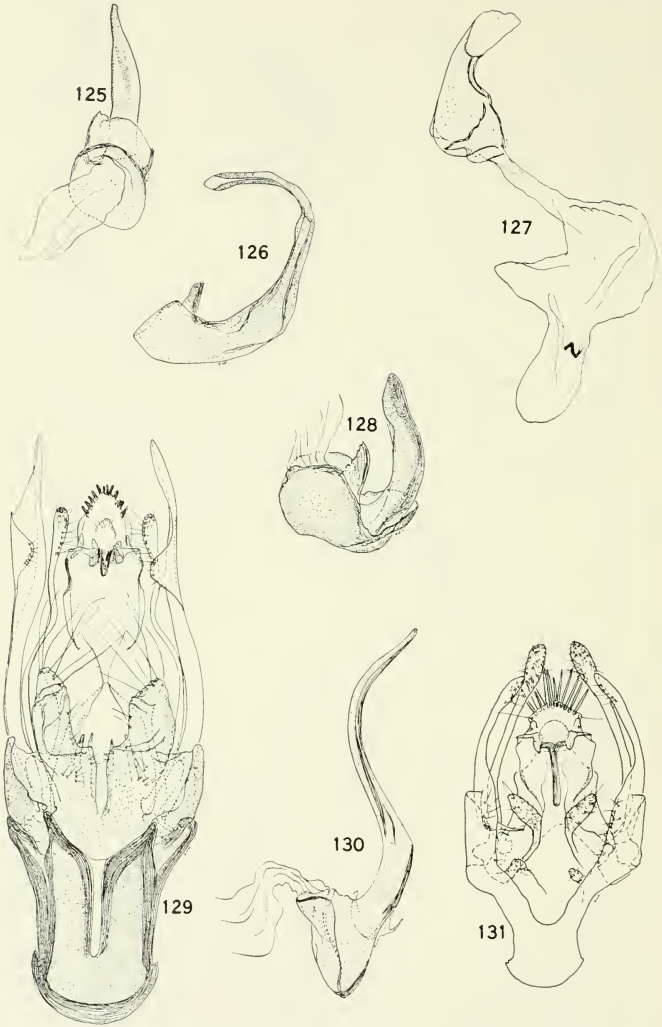
FIGURES 104–110.—Male genitalia: 104, *Eudactylota abstemia*, aedeagus; 105, *E. abstemia*, ventral view; 106, *Neodactylota liguritrix*, ventral view; 107, *Friseria cockerelli*, aedeagus; 108, *F. cockerelli*, ventral view of tegumen; 109, *F. cockerelli*, ventral view of vinculum and valvae; 110, *F. cockerelli*, lateral view of valva.



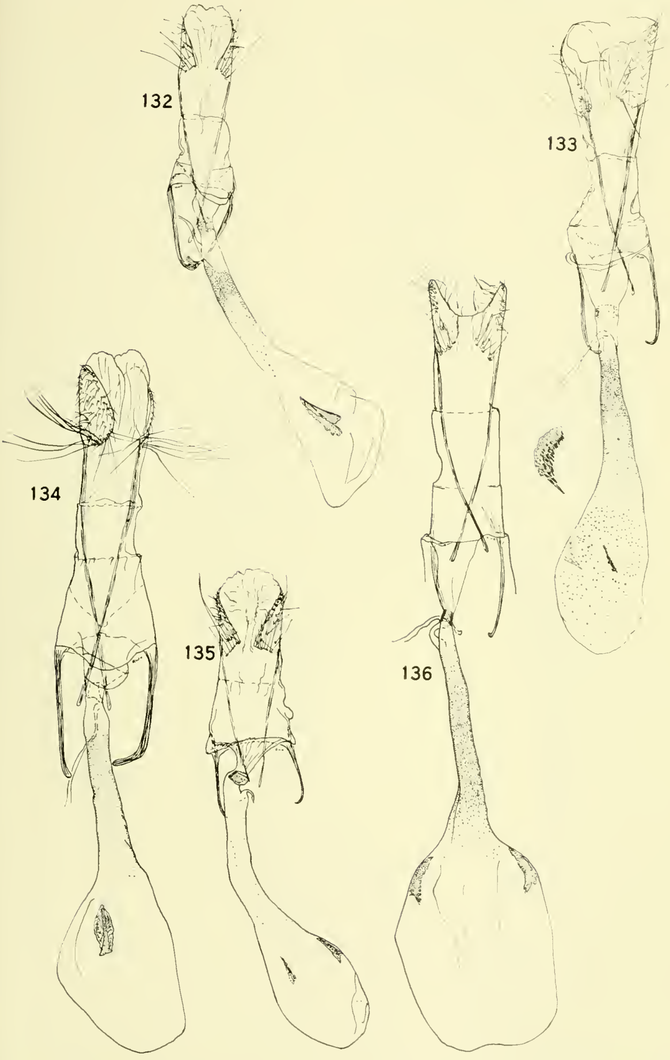
FIGURES 111–116.—Male genitalia: 111, *Friseria caieta*, ventral view of tegumen; 112, *F. nona*, ventral view of tegumen; 113, *F. caieta*, ventral view of vinculum and valvae; 114, *F. infracta*, ventral view of tegumen; 115, *F. infracta*, ventral view of vinculum and valvae; 116, *F. nona*, ventral view of vinculum and valvae.



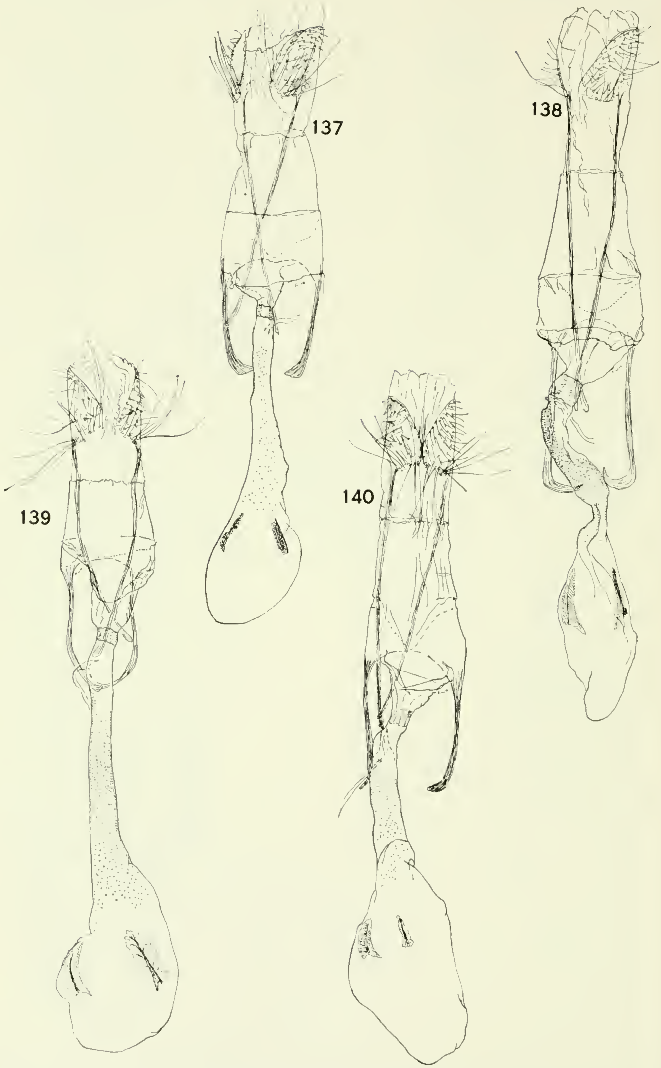
Figures 117–124.—Male genitalia: 117, *Friseria acaciella*, ventral view of vinculum and valvae; 118, *F. acaciella*, ventral view of tegumen; 119, *F. repentina*, ventral view of tegumen; 120, *F. lacticaput*, lateral view of valva; 121, *F. nona*, aedeagus; 122, *F. repentina*, lateral view of valva; 123, *F. repentina*, aedeagus; 124, *F. caieta*, aedeagus.



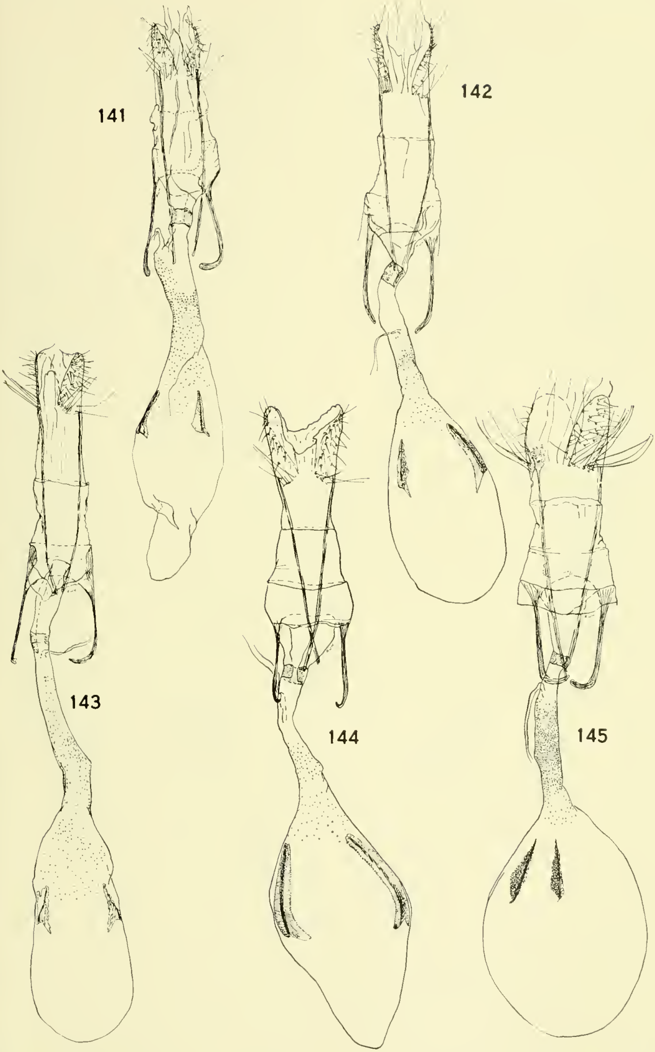
FIGURES 125–131.—Male genitalia: 125, *Friseria acaciella*, aedeagus; 126, *F. lacticaput*, aedeagus; 127, *Sriferia prorepta*, aedeagus; 128, *F. infracta*, aedeagus; 129, *Rifseria fuscotaeniaella*, ventral view; 130, *R. fuscotaeniaella*, aedeagus; 131, *S. prorepta*, ventral view.



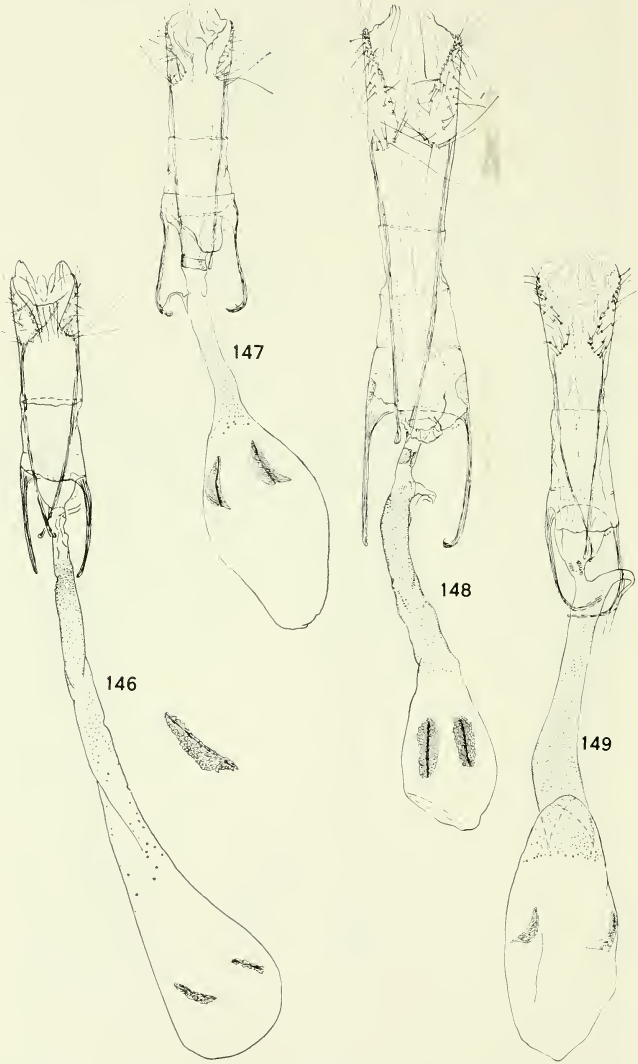
FIGURES 132–136.—Ventral view of female genitalia: 132, *Lita dialis;* 133, *L. maenadis;* 134, *L. invariabilis;* 135, *L. obnubila;* 136, *L. virgella.*



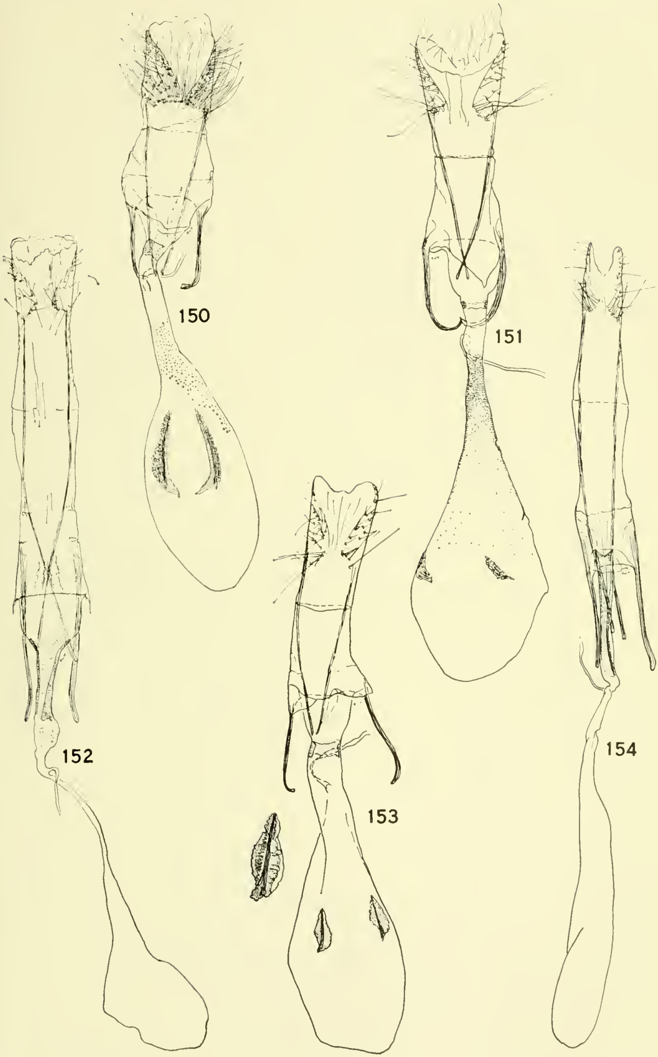
Figures 137–140.—Ventral view of female genitalia: 137, *Lita incicur;* 138, *L. nefrens;* 139, *L. barnesiella;* 140, *L. incicur.*



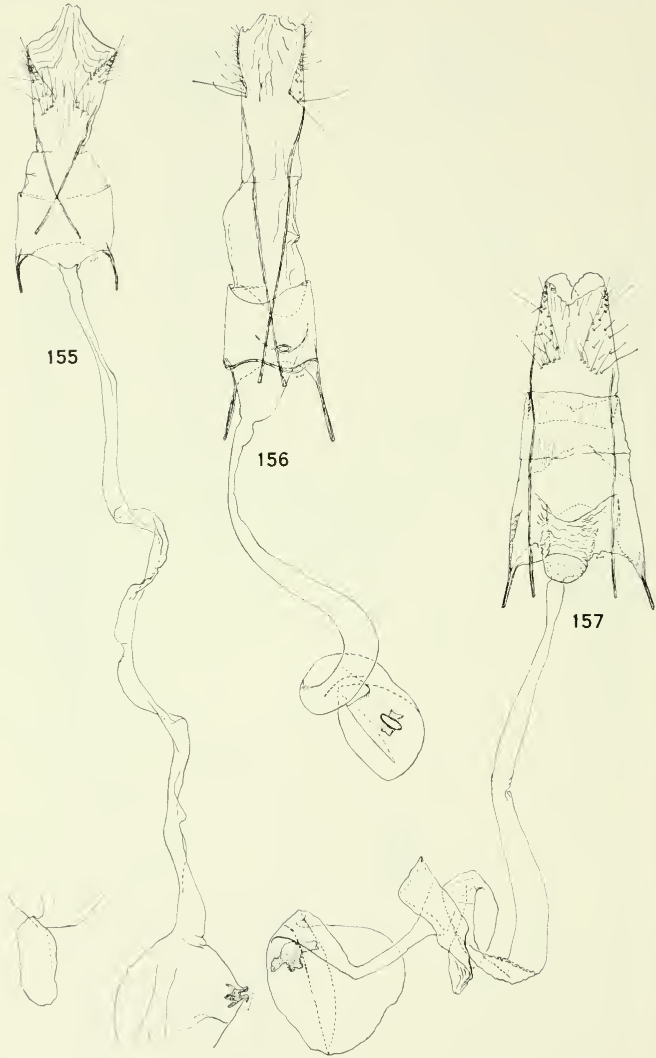
FIGURES 141–145.—Ventral view of female genitalia: 141, *Lita jubata;* 142, *L. sironae;* 143, *L. solutella;* 144, *L. rectistrigella;* 145, *L. pagella.*



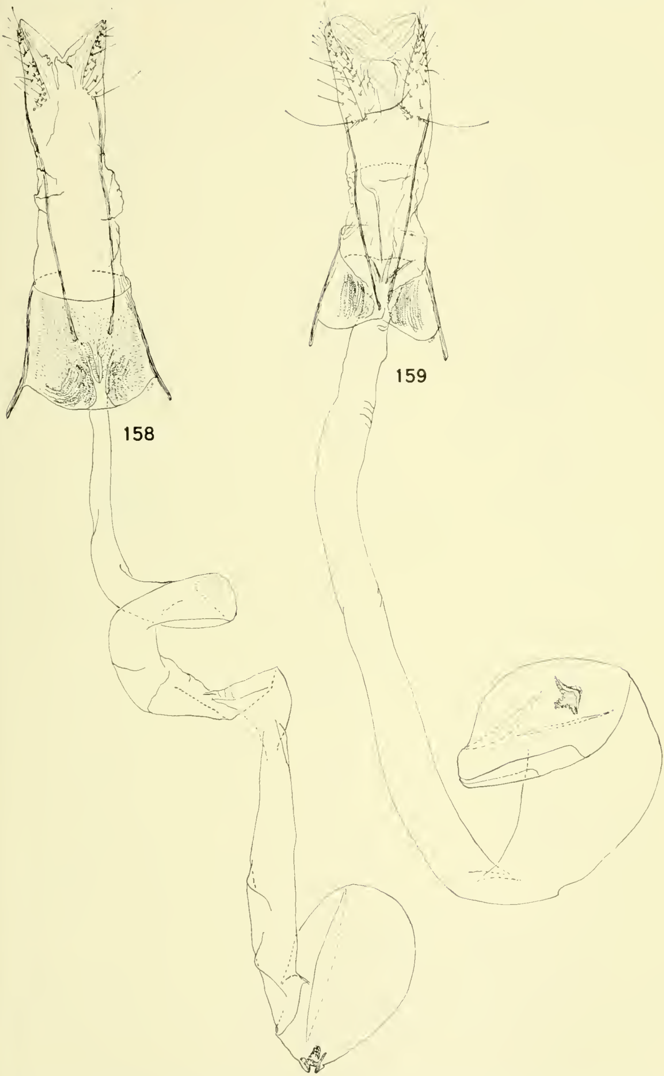
FIGURES 146-149.—Ventral view of female genitalia: 146, *Lita variabilis;* 147, *L. recens;* 148, *L. texanella;* 149, *L. puertella.*



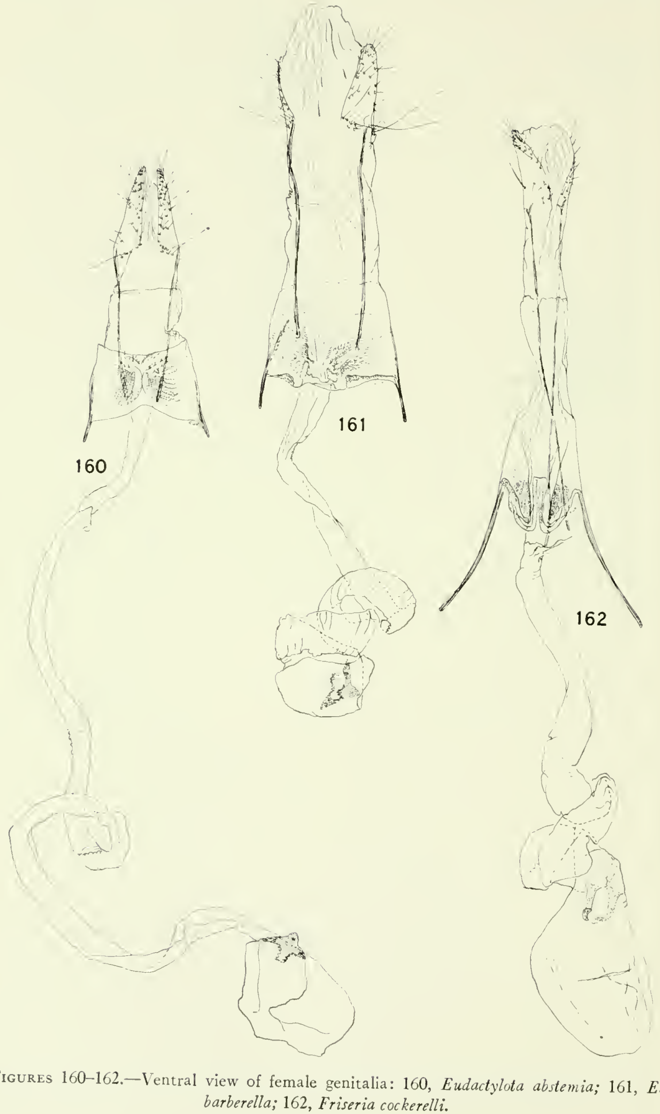
FIGURES 150–154.—Ventral view of female genitalia: 150, *Lita thaliae;* 151, *L. variabilis;* 152, *Arla tenuicornis;* 153, *L. princeps;* 154, *A. diversella.*



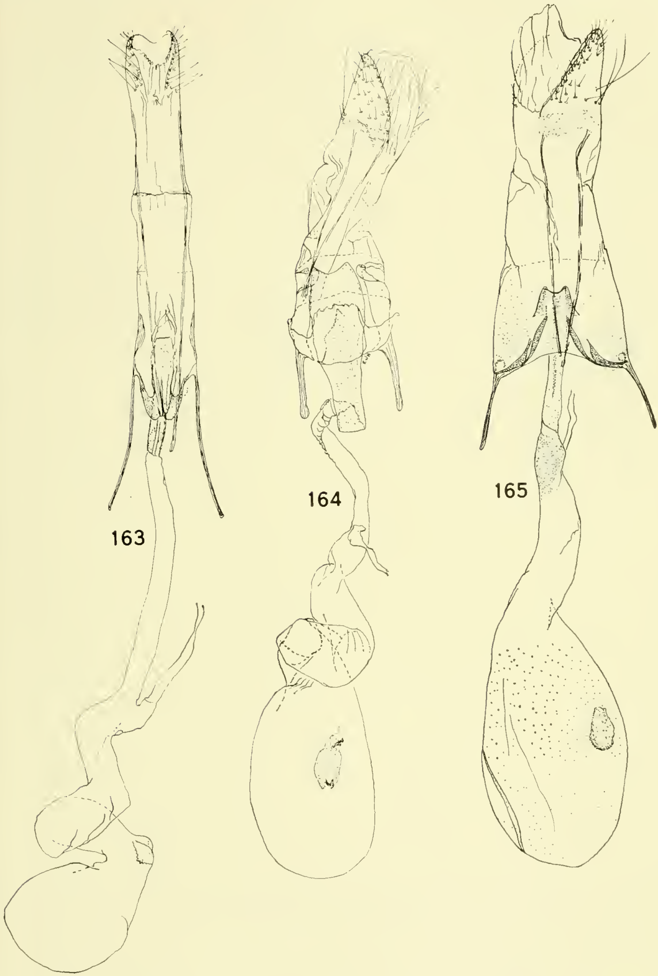
FIGURES 155–157.—Ventral view of female genitalia: 155, *Neodactylota snellenella;* 156, *N. egena;* 157, *N. basilica.*



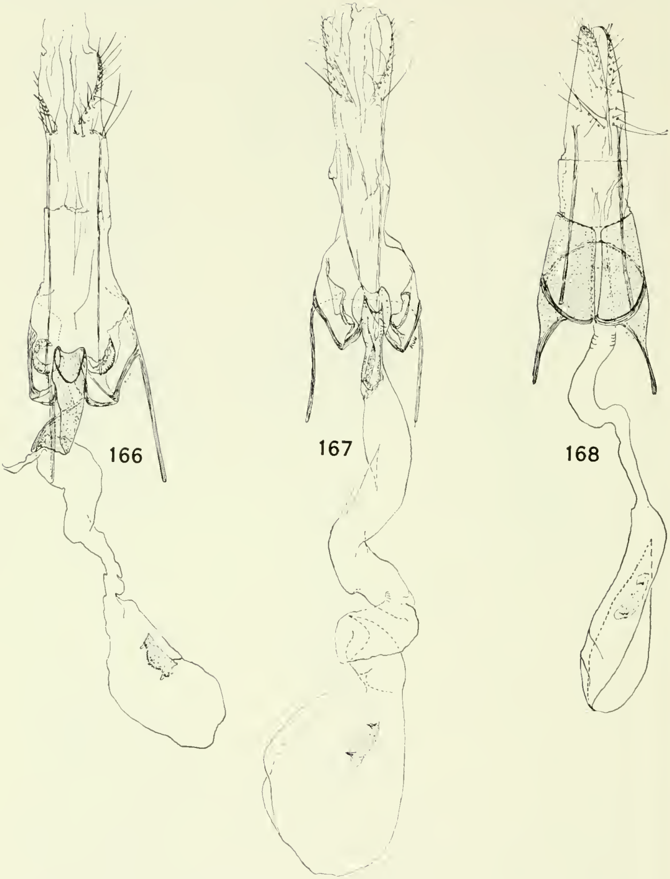
FIGURES 158–159.—Ventral view of female genitalia: 158, *Eudactylota iobapta;* 159, *E. diadota.*



FIGURES 160–162.—Ventral view of female genitalia: 160, *Eudactylota abstemia;* 161, *E. barberella;* 162, *Friseria cockerelli.*

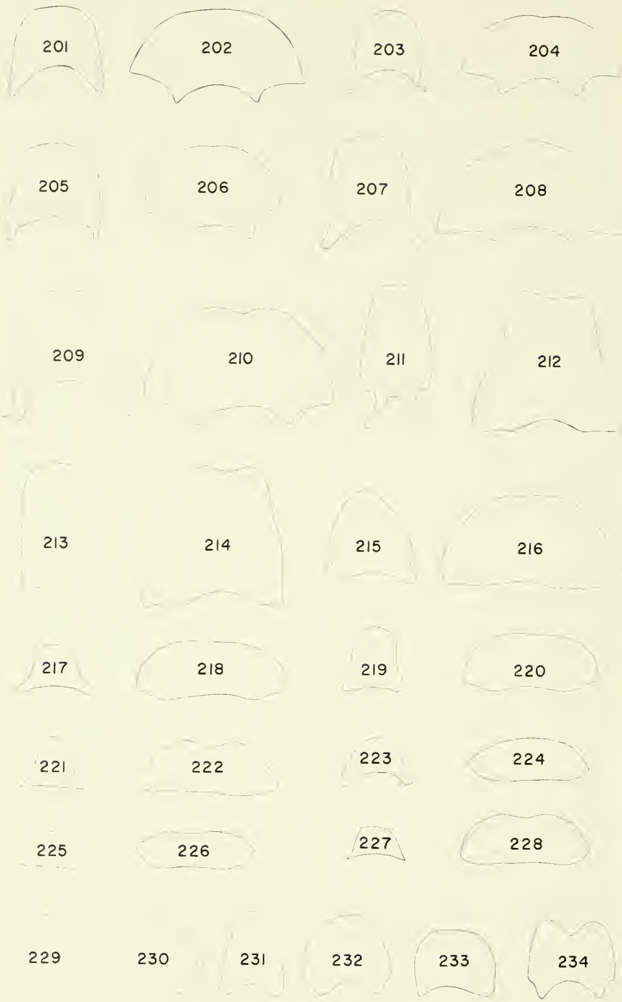


FIGURES 163–165.—Ventral view of female genitalia: 163, *Friseria caieta;* 164, *F. lacticaput;* 165, *F. acaciella.*



FIGURES 166–168.—Ventral view of female genitalia: 166, *Friseria nona;* 167, *F. repentina;* 168, *Rifseria fuscotaeniaella.*

FIGURES 169–200.—Eighth abdominal segment (odd numbers=terga, even numbers=sterna): 169, 170, *Lita virgella;* 171, 172, *L. solutella;* 173, 174, *L. variabilis;* 175, 176, *L. barnesiella;* 177, 178, *L. incicur;* 179, 180, *L. geniata;* 181, 182, *L. puertella;* 183, 184, *L. deoia;* 185, 186, *L. dialis;* 187, 188, *L. pagella;* 189, 190, *L. obnubila;* 191, 192, *L. veledae;* 193, 194, *L. rectistrigella;* 195, 196, *L. sironae;* 197, 198, *L. thaliae;* 199, 200, *L. texanella.*



FIGURES 201–234.—Eighth abdominal segment (odd numbers = terga, even numbers = sterna): 201, 202, *Lita recens;* 203, 204, *L. princeps;* 205, 206, *L. jubata;* 207, 208, *L. nefrens;* 209, 210, *L. invariabilis;* 211, 212, *Arla tenuicornis;* 213, 214, *A. diversella;* 215, 216, *Neodactylota snellenella;* 217, 218, *N. liguritrix;* 219, 220, *N. basilica;* 221, 222, *Eudactylota barberella;* 223, 224, *E. iobapta;* 225, 226, *E. diadota;* 227, 228, *E. abstemia;* 229, 230, *Friseria cockerelli;* 231, 232, *F. caieta;* 233, 234, *F. repentina.*

Figures 235–246.—Eighth abdominal segment (odd numbers = terga, even numbers = sterna): 235, 236, *Friseria nona;* 237, 238, *F. lacticaput;* 239, 240, *F. infracta;* 241, 242, *Rifseria fuscotaeniaella.*

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NOTES ON ARADIDAE IN THE U.S. NATIONAL MUSEUM, IV (HEMIPTERA: HETEROPTERA)[1]

By NICHOLAS A. KORMILEV[2]

For the privilege of studying the unidentified Aradidae in the collections of the U.S. National Museum, Smithsonian Institution, I wish to express my sincere appreciation to Dr. J. F. Gates Clarke, former Chairman and presently Senior Scientist of the Department of Entomology, to Dr. Richard C. Froeschner, Associate Curator in Charge, Division of Hemiptera, and to the late Dr. Carl J. Drake, Honorary Research Associate. The deposition of types of new species is stated with the descriptions.

In the descriptions, 25 units equal 1 mm. The order of the figures in the ratios follows the descriptive text leading to the ratios.

Subfamily Aradinae Amyot and Serville, 1843

Except for a few strong flying species of the *lugubris* group which occur in the Southern Hemisphere, the subfamily Aradinae is holarctic in distribution. The subfamily in North America was relatively

[1] Previous parts of this same series are: I, Kormilev, 1958, Proc. U.S. Nat. Mus., vol. 109, no. 3413, pp. 209–222; II, Kormilev, 1960, Journ. New York Ent. Soc., vol. 68, pp. 36–47; III, Kormilev, 1964, Proc. U.S. Nat. Mus., vol. 115, no. 3483, pp. 245–258.

[2] 365 Lincoln Place, Brooklyn, New York 11238.

well worked out in the first half of the century by various American entomologists, particularly by Van Duzee, Parshley, and Usinger. Parshley's (1921) key for the species of the genus *Aradus* Fabricius, though now more than forty years old, is still the basic aid for identification of American species. Nevertheless, even today new species are being found. Three of them are described herewith.

Genus *Aradus* Fabricius

Aradus Fabricius, 1803, Systema rhyngotorum, p. 116.

Aradus saileri, new species

FIGURE 1

MALE.—Elongate ovate, slightly widening backward; body finely granulate.

Head shorter than width across eyes (22:26); distance between eyes shorter than length of the head (17:22). Anterior process moderately long, slightly tapering anteriorly, tip rounded. Antenniferous tubercles short, robust, acute, parallel exteriorly, reaching middle of antennal segment I. Eyes subpedunculate, kidney-shaped, almost touching foreborder of pronotum. Lateral tooth of antenniferous tubercles absent. Preocular tubercles small, acute; postocular small, slightly blurred. Depressions of vertex deep, curved, connected posteriorly. Antennae robust, less than twice as long as length of head (40:22): antennal segment I cylindrical; II clavate; III cylindrical, as thick as tip of II; IV ovate, thinner than III; proportions of segments 6:15:11:8. Rostrum reaching foreborder of mesosternum.

Pronotum less than half as long as width across humeri (20:44). Anterior border slightly sinuate; anterolateral angles rounded; lateral borders very finely crenulate, strongly convex, rounded at humeri, very finely granulate, slightly sinuate anteriorly. Inner carinae strong, parallel, running from the foreborder to hindborder; middle carinae much thinner and lower, restricted to posterior two-thirds of disc, reaching hindborder; outer carinae blurred. Disc densely, finely granulate.

Scutellum much longer than width at base (27:19); lateral borders slightly convex, rounded, moderately raised. Apex narrowly rounded. Prebasal elevation of disc small. Disc finely granulate.

Hemelytra complete, distinctly wider than pronotum (50:44), apex of membrane reaching expanded border of genital capsule. Corium long, reaching hindborder of connexival segment V, its basolateral border expanded and reflexed; apical border convex exteriorly, sinuate interiorly; veins raised, finely granulate.

Abdomen longer than width across segment VI; connexivum wide, finely granulate; postero-exterior angles II to V not protruding, VI slightly protruding, VII produced backward, rounded apically.

Color.—Black; posterior borders of connexiva, inner borders of expanded genital lobes, and tips of femora, white or whitish; remainder of femora and the tibiae dark brown.

Measurements.—Total length 5.0 mm.; width of pronotum 1.76 mm.; width of abdomen 2.24 mm.

Holotype.—Male, Riverside Tanana R., Alaska, Lindroth collector, June 29, 1958. Bears label: "*Aradus* n.sp. nr *duzeei* det. R.I. Sailer" (USNM type 67580).

It is a pleasure to dedicate this species to Dr. Reece I. Sailer who first identified it as a new species.

Aradus saileri, new species, is related to *A. montanus* Bergroth but differs from it by the following characteristics: head is much shorter than its width across eyes; antenniferous tubercles without lateral tooth; connexivum bicolored; and size much smaller.

Aradus ovatus, new species

Figures 2, 3

Female.—Brachypterous; ovate, regularly tapering forward, less so backward; densely and finely granulate.

Head as long as width across eyes (25:25.5); distance between eyes longer than length of antennal segment II (17:12). Anterior process long, parallel-sided, reaching basal fourth of antennal segment II. Antenniferous tubercles conical, acute, directed a little downward; outer borders parallel, without tooth. Preocular tubercles rather obsolete, postocular absent; depressions of vertex shallow, wide, not connected posteriorly. Eyes globose, very prominent, but not stalked. Antennae short, less than one and a half times as long as head, (32:25), slightly narrower than fore-femora (4:5); antennal segment I ovate, II clavate, III tapering toward base, IV obovate; proportions of segments 5:12:8:7. Rostrum short, reaching front coxae.

Pronotum one-third as long as width across humeri (14:41). Anterior border deeply sinuate, finely crenulate; anterior angles rounded; lateral borders finely crenulate, slightly reflexed, straight and convergent anteriorly, arcuate posteriorly; hindborder deeply sinuate. Disc rather flat, densely granulate; inner carinae thin, finely granulate, slightly convergent backward; middle and outer carinae obsolete.

Scutellum triangular, slightly longer than width at base (20:18); lateral borders very slightly reflexed at apical half; apex narrowly rounded; disc uneven, densely granulate, slightly depressed at two-fifths its length and before tip.

Hemelytra abbreviated, wider than pronotum; membrane reduced to a narrow rim at tip of corium interiorly; clavus not discernible; exocorium strongly developed, outer border arcuate, finely crenulate; posterolateral borders of main corium simple, not crenulate.

Abdomen ovate, slightly longer than width across segment V (70:67). Lateral borders finely crenulate, widely rounded; postero-exterior angles II to V not protruding, VI slightly protruding, VII almost forming a right angle. Connexivum wide, densely granulate, its limit with tergum rather blurred. Tergum flat, slightly convex medially; limit between terga VII and VIII clearly defined medially, almost indistinguishable laterally. Lobes of VIII large, pincer-shaped, surrounding small tergum IX, but not contiguous at tips. Tergum IX reaches middle of lobes.

Color.—Testaceous; occiput, and postero-exterior angles of connexiva II to VII, pale reddish brown, almost whitish; outer borders of connexival segments in front of postero-exterior angles brown; head and pronotum ferruginous.

Measurements.—Total length 5.2 mm.; width of pronotum 1.64 mm.; width of abdomen 2.68 mm.

Holotype.—Female, Onaga, Kans., Crevecoeur collector (USNM type 67581).

Aradus ovatus, new species, is related to *A. montanus* Bergroth but may be separated by the following characteristics: antennal segment III two-thirds as long as II; middle and outer carinae of the pronotum obsolete; pronotum widest far behind middle; size much smaller; and by color.

Aradus barberi, new species

Figure 4

Male.—Elongate ovate, macropterous.

Head slightly longer than width across eyes (25:23); distance between the eyes less than length of antennal segment II (15:22.5). Anterior process long, slightly enlarged medially, produced beyond tip of antennal segment I. Antenniferous tubercles dentiform, acute, divergent, lateral tooth distinct. Eyes very prominent, kidney shaped. Preocular tubercles small, acute; postocular tubercles prominent, blunt. Depressions of vertex deep, slightly convergent backward, connected posteriorly. Antennae long, slender, less than twice as long as head (47:25). Proportions of antennal segments 5.5:22.5:9:10. Rostrum reaching to foreborder of mesosternum.

Pronotum less than half as long as width across humeri (19:43). Anterior border straight, anterolateral angles produced forward, subangular. Lateral borders sinuate and reflexed anteriorly, strongly convex, rounded posteriorly. Hindborder sinuate. Interlobal depression shallow, distinct; inner carinae thin, parallel between themselves; middle carinae convergent on forelobe, parallel on the hindlobe; outer carinae short, robust, parallel.

Scutellum triangular, longer than basal width (23:18). Lateral borders slightly arcuate, rimmed, reflexed; tip narrowly rounded; disc slightly raised medially, densely granulate anteriorly and around elevation.

Hemelytra reaching lobes of genital capsule; exterior border of corium slightly arcuate, almost straight; hemelytra as wide as pronotum; clavus longer than scutellum; corium reaching hindborder of connexival segment IV; membrane large.

Abdomen elongate ovate, longer than width across segment IV (63:46); lateral borders evenly, widely rounded; postero-exterior angles not protruding; VII forms an acute angle. Connexivum narrow anteriorly, widening posteriorly; lobes of genital capsule large, contiguous at their tips.

Color.—Greyish brown to sepia; corium and membrane variegated with whitish spots. Each lobe of genital capsule with a large, whitish spot. Antennae sepia, tips of segments II and III whitish.

Measurements.—Total length 5.32 mm.; width of pronotum 1.72 mm.; width of abdomen 1.84 mm.

Holotype.—Male, Evergreen, Colo., collector not known. Collected on *Pinus ponderosa*. Bears a label: "*Aradus* n.sp. near *marginatus* Uhl. det H. G. Barber" (USNM type 67582).

Paratypes.—Five males, deposited in the same collection and in the collection of the author.

This species is dedicated to the memory of the late Mr. H. G. Barber, an eminent American hemipterologist, who first identified it as a new species.

Aradus barberi, new species, runs in Parshley's key to *A. marginatus* Uhler, as Barber has indicated. It differs by having antennal segment II one and one-half times as long as the distance between eyes, while in *A. marginatus* these two measurements are equal.

Subfamily Calisiinae Stal, 1873

Genus *Calisiopsis* Champion

Calisiopsis Champion, 1898, *in* Godman and Salvin, Biologia Centrali-Americana, Rhynchota: Heteroptera, vol. 2, p. 67.

The genus *Calisiopsis* Champion has had only three species: two from Central America, and one from southeast Brazil. Among specimens examined was one from Finca Florida, Valle Tablones, Colombia, 1300 m. that belongs to *Calisiopsis*. Judging by the shape of the head and position of the eyes, it belongs to a new species; but because both of the taxonomically important antennae are missing, I prefer not to describe it.

Subfamily Aneurinae Douglas and Scott, 1865

Aneurinae contains only two genera: *Aneurus* Curtis, 1825, with a worldwide distribution, and *Aneuraptera* Usinger and Matsuda, 1959, with a single micropterous species from New Zealand. From the Western Hemisphere twenty species have been recorded. Two more are described herewith: one from Texas, the other from Guadeloupe.

Genus *Aneurus* Curtis

Aneurus Curtis, 1825, British Ent., vol. 2, pl. 86.

Aneurus pygmaeus, new species

FIGURES 5–7

MALE.—Elongate ovate, slightly widening backward. Head flat, almost as long as width across eyes (♂,11:12; ♀,12:13). Anterior process conical, rounded anteriorly, slightly produced over tip of antennal segment I. Antenniferous tubercles small, acute. Eyes moderately convex. Postocular tubercles blunt, slightly produced over outer border of eyes. Vertex with two (1+1) small, ovate callosities; surface finely, transversely rugose behind them. Antennae slender; first two segments obovate, last two cylindrical; proportions of segments ♂, 4:3:4:8; ♀, 4:3.5:4.5:9.

Pronotum trapezoidal, shorter than width across humeri (♂, 10:22.5; ♀, 10:25). Collar very fine, slightly sinuate in front; anterolateral angles rounded, slightly produced forward beyond collar; lateral borders of the forelobe straight, convergent; lateral borders of the hindlobe convex, rounded; both very finely crenulate; hindborder widely sinuate medially, convex at hindangles. Foredisc with two (1+1) round, callosities; hinddisc finely striated.

Scutellum semicircular, shorter than width at the base (♂, 9.5:14.5; ♀, 10:15); base slightly raised; disc concentrically striated.

Hemelytra long, reaching foreborder of tergum VII (♂), or almost to hindborder of tergum VII (♀). Corium reaching two-fifths of length of scutellum; membrane large, finely wrinkled. Hindwings reduced, reaching only to hindborder of tergum III.

Abdomen ovate, much longer than width across segment IV (♂, 43:32.5; ♀, 48:33). Exterior borders slightly convex, moreso posteriorly; postero-exterior angles not protruding. Connexiva very finely granulate at exterior borders. Each connexival segment from III to VI with two ovate, calloused spots; connexival segment VII with a single spot. Exterior borders of abdomen finely crenulate. Hypopygium small, ovate, slightly depressed, finely granulate; paratergites relatively large, flat, reaching tip of hypopygium. In females, tergum VII deeply sinuate posteriorly for reception of tergum VIII; segment IX very short and wide (1:5), straight posteriorly; paratergites small, rounded posteriorly, reaching to tip of segment IX. Spiracles II lateral; III to V ventral, not visible from above; VI and VII lateral, visible from above; VIII terminal.

Color.—Dark ferruginous, partially blackish; tergum and venter yellow brown; membrane white, transparent, brownish at the base.

Measurements.—Total length: ♂, 3.0 mm.; ♀, 3.28 mm.; width of pronotum; ♂, 0.9 mm.; ♀, 1.0 mm.; width of abdomen: ♂, 1.3 mm.; ♀, 1.32 mm.

Holotype.—Male, Aransas Co., Tex., Mar. 31, 1954, D. J. and J. N. Knull collectors, ex J. L. Lutz collection, USNM collection (USNM type 67583).

Allotype.—Female, collected with holotype; in the same collection.

Paratype.—One female, Mississippi, Jan. 9, 1946; deposited in the collection of author.

Aneurus pygmaeus, new species, is related to *A. minutus* Bergroth, from which it differs by the following: scutellum regularly semicircular, in *A. minutus* more narrowed at the tip, almost subtriangular; paratergites of male larger, and widened toward the tip, in *A. minutus* narrower, almost subcylindrical; whitish semitransparent membrane, in *A. minutus* brown and not transparent; dark ferruginous body, in *A. minutus* yellow brown (I hold the former color as distinctive); in the female, abdomen narrow and long, in *A. minutus* more ovate; paratergites are also different.

Aneurus nasutus, new species

Figures 8, 9

Male.—Elongate ovate, shiny; lateral borders of pronotum and abdomen with semiobliterated granulation.

Head as long as width across eyes (13:13.5); anterior process stout, tapering forward, rounded apically, reaching tip of antennal segment I. Antenniferous tubercles small, blunt, convex exteriorly. Eyes semiglobose, moderately protruding. Postocular tubercles small, blunt, not reaching outer border of the eyes. Mesad of the latter two (1+1) large, ovate, glabrous spots. Vertex roughly, transversely rugose. Antennae slender, less than twice as long as head (24:13); proportions of antennal segments 5:4:5:10.

Pronotum half as long as width across humeri (14:30). Collar thin, sinuate anteriorly. Anterolateral angles rounded, neither produced forward nor sideways; lateral borders of forelobe straight, strongly convergent; lateral borders of hindlobe parallel, rounded and convergent anteriorly. Hindborder sinuate medially. Foredisc with four (2+2) large, flat callosities. Hind-disc finely, transversely rugose; with two (1+1) large, transverse, elongate, glabrous spots mesad of humeri.

Scutellum short, wide at base (12:21), widely rounded apically; disc concentrically rugose.

Hemelytra almost reaching hindborder of tergum VII. Corium very short, reaching middle of scutellum. Membrane large, finely wrinkled.

Abdomen ovate, longer than width across segment IV (52:39). Outer borders of connexiva with semiobliterated granulation; hind-borders of connexival segments glabrous, shiny. Spiracles II lateral and visible from above; III to V sublateral, but not visible from above; VI and VII lateral and visible; VIII terminal. Paratergites small, strongly divergent, not reaching tip of hypopygium. Latter small, lateral borders convergent; tip rounded; disc moderately convex.

Femora moderately inflated, fusiform.

Color.—Dark brown; hindhalf of head, middle of pronotum, and base of scutellum, yellow brown; membrane black.

Measurements.—Total length 3.84 mm.; width of pronotum 1.2 mm.; width of adbomen 1.56 mm.

Holotype.—Male, Guadeloupe; deposited in Drake collection (USNM type 67584).

Aneurus nasutus, new species, is not particularly related to any of Central American species; it appears to be most like *A. subdipterous* Burmeister from southeastern Brazil, but is smaller. Antennae are similar to those of *A. tenuis* Champion but the shape of the head is quite different: antenniferous and postocular tubercles small, and blunt; scutellum of different shape; lateral borders of the pronotum and abdomen are smoother, not finely crenulate; hypopygium is larger; and color is different.

Subfamily Carventinae Usinger, 1950

Usinger (1950, p. 176) divided the Mezirinae into two tribes, Mezirini and Carventini. Later, Usinger and Matsuda (1959a, p. 56) elevated the latter to a subfamilial rank. All members of the Carventinae are tropical or subtropical, none occur in the holarctic region. Many of them are apterous or micropterous. The ivory-like incrustation on the body of some species, as in the genus *Proxius*, may accumulate on tufts of hair and produce projections which give the insect a bizarre appearance.

Genus *Proxius* Stal

Proxius Stal, 1873, Kongl. Svenska Vet.-Akad. Handl., vol. 11, p. 141.

Proxius has had six species which Usinger and Matsuda (1959, pp. 113–114) placed into three subgenera: two of these, *Proxius* Stal sensu stricto, with a single species and *Neoproxius* Usinger and Matsuda, with four species, are American; the third one, *Nesoproxius* Usinger and Matsuda, with a single species, is Sumatran. One new species, belonging to the subgenus *Neoproxius*, is described herewith.

Proxius (*Neoproxius*) *peruvianus*, new species

FIGURES 10, 11

FEMALE.—Elongate ovate; partially incrustated with an ivory-liked incrustation.

Head longer than width across eyes (20:16), as long as width across postocular projections (20:20). Anterior process long, parallel-sided, deeply cleft anteriorly; genae much longer than clypeus, cylindrical and truncate anteriorly, surpassing the tip of antennal segment I by one-fifth of their length. Antenniferous tubercles dentiform, slender, parallel-sided, reaching a little beyond middle of antennal segment I. Eyes small, semiglobose, moderately protruding. Postocular parts of head produced into large, partially punctured, triangular processes reaching far beyond outer border of eyes. Vertex with a punctured elliptical, flattened elevation running from clypeus to hindborder of head; head produced backward, forming a long "neck." Antennae, clypeus, and two (1+1) ovate, glabrous spots laterad of the elevated portion of vertex, rostral atrium, and rostrum, not incrustated; all other parts of head covered with thick, ivory-like, incrustations. Antennae long and slender, one and a half times as long as length of the head (32:20). Proportions of antennal segments 6:5:13.5:7.5. Rostrum short, reaching hindborder of narrow, deep, and short rostral groove; latter closed posteriorly. Rostral atrium closed.

Pronotum subrectangular, shorter than width across humeri (20:35). Forelobe almost as wide as hindlobe (32:35). Collar small, convex, foreborder straight. Anterior angles produced forward far beyond collar as two (1+1) lobes, these rounded interiorly and sinuate exteriorly. Anterolateral angles subrectangular; lateral borders of forelobe slightly sinuate, provided with a row of short, erect bristles projecting through incrustation. Interlobal notch deep and narrow. Lateral borders of hindlobe short, convex, deeply notched medially. Hindborder slightly convex medially, posterior angles angularly produced backward. Foredisc flat medially, with a small, relatively high, median ridge on posterior half of disc; strongly inflated laterally in a shape of an S with eight (4+4) dots on inner sides, deeply excavated laterad of these inflations. Collar, and two (1+1) round dots laterad of the median ridge, without incrustation; other parts of forelobe heavily incrusted. Hind-disc with two (1+1), L-shaped, high, transverse carinae medially, turned with their bases to each other, and with four (2+2) short, oblique ridges laterally. Latter produced over actual lateral border forming lateral teeth of the hindlobe. Hind-disc without incrustation, except along carinae.

Scutellum subtriangular, shorter than width at base (11:19), rounded posteriorly. Disc flat, without incrustation except on the two (1+1) lateral, high, hatchet-shaped ridges with their blades sideways.

Hemelytra reaching apical third of tergum VII. Corium very short, outer border carinate, incrusted; membrane transparent, finely corrugate.

Abdomen ovate, longer than width across segment IV (59:45). Lateral borders slightly, evenly convex. Connexival segments II and III fused, provided with two longitudinal ridges converging anteriorly. Other connexival segments rather flat, heavily incrusted; their outer borders slightly convex from II to IV, angularly produced on hindhalves from V to VII. Tergum incrusted laterally, posteriorly on tergum VII; outer margin of incrustation obliquely raised. Paratergites small, triangular, incrusted, reaching tip of segment IX. Latter subtruncate posteriorly. Spiracles very small, from II to IV ventral but progressively nearing margin; lateral and visible from above from V to VIII. Venter incrusted only laterally. Sternum incrusted along borders. Propleura incrusted.

Legs relatively long, slender; femora fusiform; tibiae cylindrical, slender. Tarsi with arolia.

Color.—Under incrustation and on free parts, yellow brown to brown; incrustation ivory.

Measurements.—Total length 4.44 mm.; width of pronotum 1.4 mm.; width of abdomen 2.36 mm.

Holotype.—Female, Satipo, Peru, P. Paprzycki collector, Apr. 26, 1941 (USNM type 67585).

Proxius peruvianus, new species, is related to *P. palliatus* Champion and may be separated from the latter by the following: genae produced beyond the tip of antennal segment I; absence of excavation on postocular lobes; median ridge of the pronotum reduced to a very short, thin carina on the hindhalf of forelobe; different shape of carinae on the hindlobe of pronotum and scutellum.

Genus *Kolpodaptera* Usinger and Matsuda

Kolpodaptera Usinger and Matsuda, 1959, Classification of the Aradidae, p. 144.

Kolpodaptera minuta, new species

Male.—Apterous; subovate; from metanotum to abdominal segment VI lateral borders parallel. Entire body covered with thick layer of greyish incrustation.

Head shorter than width across eyes (11:12.5). Anterior process short, robust, sides parallel; genae slightly produced beyond the tip of clypeus, not contiguous, forming a shallow notch. Antennal segment I produced by two-thirds its length over tip of anterior process. Antenniferous tubercles robust, subacute apically, outer borders subparallel. Eyes moderately protruding. Postocular borders convergent backward. Vertex with a thin, triple, longitudinal carina, laterally with two (1+1) oblique rugae. Antennae strong, almost twice as long as head (19.5:11); proportions of the antennal segments 7:3:4.5:5. Rostrum reaching hindborder of rostral groove; latter wide, shallow.

Pronotum much shorter than width across humeri (8:21). Collar slender. Anterolateral angles together with lateral borders form a regularly rounded arc. Disc with a median carina occupying posterior three-fifths of disc and running backward across meso- and metanotum and tergum I, progressively widening, becoming a double carina on metanotum and tergum I. Pronotum irregularly rugose laterad of median carina. Mesonotum wider than pronotum (24:21). Metanotum wider than mesonotum (25:24). Mesonotum laterad of median carina with four (2+2) larger, and two (1+1) smaller, flattened elevations separated from each other by fine sulci. Mesonotum rugose along lateral borders. Median carina of mesonotum fused posteriorly with median portion of metanotum; latter in turn fused posteriorly with tergum I; all together forming a longitudinally rugose triangular plate. Laterad of triangular plate metanotum has two (1+1) rugose elevations.

Abdomen subrectangular, slightly longer than width across segment II (27.5:26). Tergum I fused with metanotum anteriorly and with tergum II posteriorly; latter placed at a slightly lower level. Central dorsal plate consist of terga III to VI, limited by fine sulci. Median portion of central dorsal plate elevated, forming a median ridge, laterad of it with pattern of rugae and round callous spots. Tergum VII raised posteromedially for reception of hypopygium. Connexivum broad, segments II and III fused, others separated from each other by fine sulci; disc of each segment bearing round calloused spots with rugae around them; postero-exterior angles II to V not protruding; VI makes a step with VII; the latter produced backward as a triangular process, reaching to tip of hypopygium. Paratergites cylindrical, directed obliquely up and backward. Hypopygium dorsocaudal, flattened on disc, with an ovate median elevation on lower half. Spiracles II to VII lateral, visible from above; those of VIII terminal.

Color.—Yellow brown, partially darker.

Measurements.—Total length 2.36 mm.; width of pronotum 0.84 mm.; width of abdomen 1.04 mm.

Holotype.—Male, Livingston, Guatemala; deposited in Drake collection (USNM type 67586).

Kolpodaptera minuta, new species, is related to *K. panamensis* Usinger and Matsuda from which it may be separated by head shorter than width across the eyes; eyes less prominent; antenniferous tubercles relatively shorter; postero-exterior angle of connexival segment VII also relatively shorter; proportions of antennal segment 14:6:9:10, whereas in *K. panamensis* they are 15:9:10:14.

Kolpodaptera rugosa, new species

Female.—Apterous; ovate; thickly covered with greyish incrustation and accumulated dirt; under incrustation glabrous and shiny.

Head shorter than width across eyes (14:15.5). Anterior process short and robust, cleft anteriorly, genae longer than clypeus and pointed, reaching basal one-third of antennal segment I. Antenniferous tubercles short, robust, broad at base, subacute apically. Eyes moderately prominent, with convex facets. Postocular borders strongly convergent. Vertex with a short longitudinal ridge flanked by two (1+1) thin carinae, behind them with two (1+1) small, but prominent tubercles. Antennae strong, more than twice as long as head (29.5:14); proportions of antennal segments 10:5:7:7.5. Rostrum short, reaching hindborder of shallow, wide rostral groove.

Pronotum much shorter than width across humeri (8:28); mesonotum wider than pronotum (34:28); metanotum wider than mesonotum (39:34). Anterolateral angles of the pronotum rounded; lateral borders divergent backward. Collar thin, smooth. Median carina starts at middle of disc and fuses poteriorly with triangular plate formed by median portions of meso-, metanotum, and tergum I. Laterally pro-, meso-, and metanotum separated from each other by deep, transverse furrows. Median, triangular plate on meso-, and metanotum with a double median carina, roughly, longitudinally rugose laterally. Laterad of the median triangular plate, pro-, meso-, and metanotum roughly, irregularly rugose. Along lateral borders pro-, meso-, and metanotum roughly granulate.

Abdomen as long as width across segment IV (42:42.5). Tergum I completely fused with metanotum (median, triangular plate), and with tergum II; latter can be recognized only because it is at a slightly lower level. Central dorsal plate of the abdomen consists of terga III to VI, with a slightly elevated median line narrowed on tergum III, much wider on terga IV and V, and with a double longitudinal carina on tergum VI; laterad of the median elevation disc has a pattern of irregular rugae and round callous spots. Tergum VII convex medially, sloping laterally; VIII very short and wide. Connexivum wide; discs of connexival segments with a pattern of rough rugae and granules; exterior borders of each segment slightly convex, entire lateral border weakly festooned; postero-exterior angles from II to IV not protruding, V slightly protruding, VI forming an obtuse angle, and VII forming a right angle. Paratergites rounded, produced backward beyond tip of very short segment IX. Spiracles II to VIII lateral, visible from above.

Color.—Brown; lateral borders and central dorsal plate of the abdomen partially mottled with black.

Measurements.—Total length 3.24 mm.; width of pronotum 1.12 mm.; width of abdomen 1.56 mm.

Holotype.—Female, Cayamas, Cuba; deposited in the Drake collection (USNM type 67587).

Kolpodaptera rugosa, new species, is related to *K. prominens* Usinger and Matsuda and may be separated from it mainly by head shorter than width across the eyes; antennae relatively longer, more than twice as long as the head (less than twice in *K. prominens*); and different proportions of the antennal segments which are 20:10:14:15, whereas in *K. prominens* they are 25:11:16:17.

Subfamily Merizinae Oshanin, 1908

Mezirinae is the largest subfamily of the Aradidae. Previously, it was considered as a family under the name of Dysodiidae Reuter, but, as Usinger and Matsuda pointed out (1959, p. 54), that would distort the actual relationship between subfamilies so far included in Dysodiidae; therefore, they accepted Aradidae as a single family, consisting of eight subfamilies, including Mezirinae, and leaving only Termitaphididae as a second family in the superfamily Aradoidea.

Mezirinae has an almost worldwide distribution. It is absent from the frigid areas and develops the highest number of genera and species in the tropical and subtropical zones. Strange as it may seem, from the entire European and Siberian part of the Palaearctic region there is recorded only a single species of Mezirinae, *Mezira tremulae* (Germar), 1822. The Manchurian subregion of the Palaearctic region contains several genera and numerous species.

219-946—66——3

Genus *Miorrhynchus* Champion

Miorrhynchus Champion, 1898, *in* Godman and Salvin, Biologia Centrali-Americana, Rhynchota: Heteroptera, vol. 2, p. 75.

The genus *Miorrhynchus* Champion has contained ten species which may be separated into two groups: those with spiracles from VI to VIII lateral and visible from above; and those with only spiracles VII to VIII lateral and visible from above. Two new species belonging to the first group are described herewith.

Miorrhynchus angulatus, new species

Figures 16, 17

Male.—Elongate, widening backward, subtruncate posteriorly, partially covered with relatively long, incrusted, curled hairs.

Head longer than width across eyes (25:22). Anterior process long and moderately stout, covered with incrusted hairs which make it look stouter; reaching basal fourth of antennal segment I. Antenniferous tubercles parallel, directed forward. Eyes moderately large, semiglobose, protruding. Postocular borders straight; postocular tubercles placed far from eyes, dentiform, directed sideways. Vertex with two (1+1) rows of parallel, setigerous tubercles, running from base of clypeus to hindborder of head, two (1+1) pyriform callosities laterad of each row. Antennae very long, more than three times as long as head (81:25); first two segments covered with incrusted hairs, those on first segment longest; apical two segments except for a brush of erect bristles on tip of IV, naked. Proportions of the antennal segments: 29:12:30:10. Rostral groove long, deep, closed posteriorly; rostrum reaching hindborder of latter.

Pronotum much shorter than width across the humeri (32:50); forelobe much narrower than hindlobe (36:50); interlobal depression deep. Collar wide, with strongly sinuate foreborder. Anterolateral angles rounded, with a fringe of long, incrusted hairs; lateral borders slightly convex on the forelobe, more convex on the hindlobe; hindborder almost straight. Foredisc with two (1+1) round callosities; laterad of them with two (1+1) ridges covered with incrusted hairs; hinddisc rather flat, covered with remote granulations and short, incrusted hairs.

Scutellum shorter than width at base (20:28); carinate at all borders; lateral borders straight; tip pointed; disc rugose, with a low, median ridge, covered with long, curled, incrusted hairs.

Hemelytra reaching middle of tergum VII. Basolateral borders of corium reflexed; apical border convex exteriorly, sinuate interiorly; apical angle rounded, reaching hindborder of connexivum II. Membrane large, veins anastomosed.

Abdomen longer than width across segment VI (90:72.5); lateral borders feebly convex from II to V; angularly produced on VI and VII. Exterior borders of connexival segments II to V slightly convex, making lateral borders look festooned. Connexival segment VI trapezoidal, with postero-exterior angle rounded at tip; VII angularly produced backward as far as the tip of hypopygium. Paratergites flat, fusiform, reaching to tip of hypopygium. Latter subcordate, shorter than maximal width (15:19), divided by a transverse furrow in upper and lower lobes. Upper lobe subtriangular, with a relatively narrow median ridge; lower lobe semiglobose; both lobes covered with incrusted, curled hairs. Spiracles from II to V ventral, placed far from borders; VI to VIII lateral and visible from above.

Color.—Ferruginous; base of antennal segment I, antennal segment III, with exception of tip, and apical half of IV, yellow brown. Round calloused spots on connexival segments III to VII yellow.

Measurements.—Total length 6.8 mm.; width of pronotum 2.0 mm.; width of abdomen 2.9 mm.

Holotype.—Male, Callanga, Peru, 1300 m., F. Woytkowski collector, Feb. 13, 1953 (USNM type 67588).

Miorrhynchus angulatus, new species, is related to *M. longipes* Champion and may be separated from the latter by the angularly produced connexivum VI, which is rounded in *M. longipes*.

Miorrhynchus undulatus, new species

Figures 18, 19

Male.—Elongate ovate; partially covered with curled, incrusted hairs.

Head longer than width across eyes (25:21). Anterior process moderately stout, covered laterally with incrusted hairs; reaching basal fourth of antennal segment I. Antenniferous tubercles short, blunt, slightly divergent. Eyes semiglobose, protruding, but less than in preceding species. Postocular borders convex; postocular tubercles spiniform, placed far behind eyes, directed sideways and a little backward. Vertex with V-shaped row of setigerous tubercles, and laterad of them with two (1+1) ovate callous spots. Antennae long, more than three times as long as head (80:25); proportions of antennal segments 28:12.5:28:11.5. Rostrum reaching hindborder of rostral groove, latter closed posteriorly.

Pronotum shorter than width across humeri (35:53). Forelobe much narrower than hindlobe (36:53). Collar wide, slightly sinuate anteriorly. Anterolateral angles rounded; lateral borders convex on the forelobe, strongly convex on the hindlobe. Hindborder slightly convex in the middle. Foredisc with two (1+1) ovate calloused spots, laterad of them with two (1+1) longitudinal ridges, the latter covered with incrusted, curled hairs. Hind-disc partially rugose with half obliterated setigerous granules. Humeri raised.

Scutellum shorter than width at base (20:26). All borders carinate; lateral borders straight, tip pointed. Disc transversely rugose; median carina tapering backward, covered with dense, curled, incrustate hairs.

Hemelytra reaching apical third of tergum VII. Basolateral borders of corium reflected; apical border straight exteriorly, sinuate interiorly. Apical angle of corium pointed, reaching slightly over the hindborder of connexival segment II. Membrane large, with anastomosed veins, thickly covered with whitish incrustation.

Abdomen longer than width across segment IV (90:66); lateral borders moderately convex. Exterior borders of connexival segments II to V slightly convex; postero-exterior angles protruding, and rounded on connexival segments II to IV; subangular but not protruding on VI and VII; VI forms a slightly obtuse angle, with rounded tip; VII forms a slightly acute angle, directed backward and slightly sideways, tip rounded reaching to middle of paratergites. Paratergites small, clavate, reaching to middle of hypopygium; latter large, subcordate, with a moderately wide median ridge. Spiracles ventral on II to V; lateral and visible from above on VI to VIII.

Color.—Ferruginous to dark ferruginous; tibiae with a wide yellow-brown subbasal ring. Connexival segments III to VI each with two, connexival segment VII with one, round, yellow-brown, calloused spots.

Measurements.—Total length 6.84 mm.; width of pronotum 2.14 mm.; width of abdomen 2.64 mm.

Holotype.—Male, Callanga, Peru, 1300 m., F. Woytkowski collector, Feb. 13, 1953 (USNM type 67589).

Miorrhynchus undulatus, new species, is closely related to *M. championi* Kormilev but differs from it by the undulate lateral borders of abdomen which are not undulate in *M. championi*.

Genus *Placogenis* Usinger and Matsuda

Placogenis Usinger and Matsuda, 1959, Classification of the Aradidae, p. 352.
Diphyllonotus Kormilev, 1959, Proc. Ent. Soc. Washington, vol. 61, p. 61.

In a manuscript submitted for publication in 1955, the author originally proposed the name *Diphyllonotus* with the single included species *D. explanatus*. Unfortunately, the manuscript was lost by the printer. Thus the second species of the genus, *D. brachypterus*, was published in 1956 before the genus was validated. It was not until 1958 that the author learned the first manuscript was definitely lost; his redescription was printed in a different magazine in March 1959. Meanwhile, in January 1959, the genus was described by Usinger and Matsuda under the name of *Placogenis;* because the latter has priority, *Diphyllonotus* went into its synonymy.

The species of *Placogenis* are generally macropterous, but *P. brachyptera* (Kormilev) was recorded as both macropterous and brachypterous. The species may be best separated by the relative lengths of antennal segments.

Key to Species of *Placogenis*

1. Antennal segment I long, produced beyond apex of genae by at least two-fifths of its length; head much longer than width across the eyes 2
   Antennal segment I shorter, produced beyond apex of genae by at most one-fourth of its length; head as long as width across the eyes 3
2. Antennal segment I longer than IV (11: 9.2), and much shorter than III (11:14) . . . . **cockerelli** Usinger and Matsuda, 1959
   Antennal segment I as long as IV (11:11), and shorter than III (11:13). **explanata** (Kormilev), 1959
3. Antennal segment I as long as (10:10, brachypterous form), or slightly longer than IV (11:10, macropterous form), and shorter than III (10:13). **brachyptera** (Kormilev), 1956
   Antennal segment I shorter than IV (10:11), and much shorter than III (10:15) . . . . **clarkei,** new species

***Placogenis clarkei*, new species**

Figures 12, 13

Female.—Ovate; macropterous.

Head as long as width across eyes (21.5:22). Anterior process long, parallel-sided, anteriorly cleft; genae much longer than clypeus, reaching apical fourth of antennal segment I. Antenniferous tubercles acute, parallel-sided reaching basal fourth of antennal segment I. Eyes small, semiglobose, protruding. Postocular tubercles small, acute, reaching outer border of eyes; postocular borders oblique, converging backward. Vertex with V-shaped rows of small tubercles. Antennae long, strong, twice as long as head (44:21.5); proportions of antennal segments 10:8:15:11. Rostrum short, reaching hind-border of rostral groove, latter open posteriorly.

Pronotum trapezoidal, half as long as width across humeri (22:44). Collar thin, well separated from the disc. Anterolateral angles rounded, expanded, slightly reflexed; produced forward far beyond the collar; lateral borders parallel at hindlobe, convergent anteriorly. Lateral notch almost imperceptible. Hindborder feebly and widely sinuate. Foredisc with four (2+2) calloused spots, surrounded by a row of granules. Hind-disc roughly granulate.

Scutellum shorter than width at base (15:22). Lateral borders carinate, almost straight; tip rounded. Disc inflated, transversely rugose, provided with a stout median carina, tapering backward.

Hemelytra complete, reaching apical fourth of tergum VII. Corium short, not reaching hindborder of connexival segment II; basolateral border straight and reflexed, then flat and convex; apical border evenly sinuate; apical angle rounded.

Abdomen longer than width across segment IV (72:63). Lateral borders evenly convex; postero-exterior angles not protruding. Suture between connexival segments II and III not discernible. Tergum VII with a transverse carina along the hindborder, and a transverse sulcus in front of it. Paratergites large, triangular, reaching middle of segment IX; latter notched posteriorly. Spriacles II to V ventral, placed far from border; VI to VIII lateral and visible from above. Female with second valvula longer than second valvifer.

Color.—Ochraceous; lateral borders and apex of scutellum, antero-exterior angles of connexiva II to VII, spots on terga near joints of connexival segments III and IV, IV and V, V and VI, a spot in middle of hindborder of tergum VII, and the base of tergum VIII, fuscous to piceous.

Measurements.—Total length 5.28mm.; width of pronotum 1.76 mm.; width of abdomen 2.52 mm.

Holotype.—Female, Ciudad Universitaria, Tucuman, Argentina, J.F.G. Clarke collector, Feb. 19, 1959 (USNM type 67590).

It is a pleasure to dedicate this species to the collector, Dr. J. F. Gates Clarke, Senior Scientist in the Department of Entomology in the U.S. National Museum, Washington, D.C.

Placogenis clarkei, new species, is related to *P. brachyptera* (Kormilev) from which it may be separated at once by different proportions of antennal segments, particularly by the relatively longer segment III.

Genus *Notapictinus* Usinger and Matsuda

Notapictinus Usinger and Matsuda, 1959, Classification of the Aradidae, p. 361.

The genus *Notapictinus* was established by Usinger and Matsuda for reception of the American species lacking the stridulatory apparatus and previously referred to the genus *Pictinus* Stal, 1873.

Usinger and Matsuda originally referred six species to *Notapictinus* but the genus is much larger. In my key for separation of the species of the genus *Notapictinus* (1964) are included 25 species, three more are described herewith, and we may expect that further species will be described before long.

Notapictinus uruguayensis, new species

FIGURES 14, 15

FEMALE.—Elongate ovate, slightly widening backward; macropterous.

Head shorter than width across eyes (16:17.5). Anterior process moderately stout, reaching almost to apex of antennal segment I, sides slightly convex, tip deeply cleft; genae much longer than clypeus, with blunt tips. Antenniferous tubercles short, dentiform, divergent. Eyes large, protruding, their longitudinal diameter longer than antenniferous tubercles (5:4). Postocular tubercles slender, dentiform, reaching as far as, or a little beyond, the outer border of the eyes. Infraocular carinae low, finely granulate, converging from foreborder of eyes to union at middle of posterior border of head. Vertex with M-shaped row of granules, laterad of this with two (1+1) ovate callosities. Antennae moderately strong, more than one-and-a-half times as long as head (26:16); proportions of antennal segments, I to IV: 6:5:7.5:7.5. Rostrum reaches to hindborder of rostral groove, latter closed posteriorly.

Pronotum trapezoidal, much shorter than width across humeri (19:36). Forelobe narrower than hindlobe (27:36). Collar tiny, with a straight foreborder. Anterolateral angles slightly expanded, rounded, and reflexed, produced beyond the foreborder of collar. Lateral borders finely crenulate, straight and parallel at humeri, strongly converging anteriorly. Hindborder slightly convex medially and slightly sinuate mesad of hindangles. Foredisc with two (1+1) stout, granulate ridges, convergent anteriorly, laterad of them with two (1+1) lower, granulate inflations. Hind-disc roughly granulate.

Scutellum shorter than width at base (12:18). All sides carinate. Median carina T-shaped, moderately stout, granulate; disc also granulate.

Hemelytra complete, reaching apical fourth of tergum VII. Corium reaching middle of connexival segment III, basolateral border reflexed, forming a low carina, then slightly sinuate, receding, and not reflexed. Apical border bisinuate, shallowly exteriorly, and deeper interiorly. Membrane large and corrugate.

Abdomen longer than width across segment IV (60:45). Lateral borders evenly convex, rounded; postero-exterior angles barely protruding: VII forming a rounded lobe, reaching to the middle of tergum VIII. Posterior border of tergum VII carinate. Paratergites large, triangular, reaching apical fourth of segment IX. Latter tricuspidate; median portion acute, lateral (valves) rounded. Spiracles from II to VI ventral, placed far from border, VII and VIII lateral and visible from above.

Color.—Testaceous; head behind eyes, posterolateral angles of pronotum, lateral and basal carinae of scutellum, outer borders of connexiva, hindborder of tergum VII, entire terga VIII and IX, and two (1+1) large, dark spots on sterna III to V, infuscated. Hindborders of connexival segments II to VI yellow.

Measurements.—Total length 4.40 mm.; width of pronotum 1.44 mm.; width of abdomen 1.80 mm.

Holotype.—Female, Atlantide (Maldonado), Uruguay, H.L. Parker collector, Dec. 24, 1942; deposited in the Drake collection (USNM type 67591).

Notapictinus uruguayensis, new species, is related to *N. incaicus* Kormilev (1964, p. 473), from which it may be separated by the longer anterior process of the head; much shorter antennae; more produced anterolateral angles of the pronotum; granulate and not transversely rugose scutellum; and yellow hindborders of connexival segments.

Notapictinus platyceps, new species

Figures 20, 21

Male.—Elongate, with subparallel sides; macropterous.

Head shorter than width across eyes (15:17). Anterior process short, tapering forward, subtruncate anteriorly, reaching basal third of antennal segment I; genae as long as clypeus. Antenniferous tubercles short, dentiform, slightly divergent. Eyes relatively large, moderately prominent. Postocular borders rounded, without visible tubercle or tooth, not reaching outer border of eyes. Vertex with semiobliterated granulation. Entire upper surface of the head flattened. Antennae strong and long, more than twice as long as head (35:15). Proportions of the antennal segments 9:7:11:8. Rostrum reaching hindborder of rostral groove; latter wide, closed posteriorly.

Pronotum much shorter than width across humeri (20:37). Forelobe narrower than hindlobe (27:37). Collar sinuate anteriorly, rather indistinctly separated from the disc. Anterior angles produced forward far beyond the collar as rounded lobes. Lateral borders slightly convex, rounded on the forelobe; strongly convex on the hindlobe. Hindborder slightly convex in the middle. Interlobal sulcus thin but distinctly visible. Forelobe with two (1+1) almost obliterated callosities. Hindlobe granulate.

Scutellum shorter than width at base (12:18). All borders carinate; disc roughly, transversely rugose, with a moderately stout median carina.

Hemelytra reaching apical fourth of tergum VII. Basolateral border of corium reflexed forming a low carina. Apical angle produced into a long point, reaching to middle of connexival segment III. Apical border of corium deeply and widely sinuate.

Abdomen longer than width across segment V (59:42); sides subparallel. Connexival segment II short, triangular, semifused with III; latter very long, more than twice as long as II (15:7); other connexival segments normal. Postero-exterior angles not protruding on II to IV; slightly protruding on V and VI; rounded on VII. Hypopygium conical, almost as long as its width at base (9:10). Paratergites wide, flat, curved, tips reposing on the sides of hypopygium. Spiracles II to V ventral, placed far from border; VI to VIII lateral, visible from above.

Color.—Head, pronotum, with exception of anterior angles, scutellum, hindhalves of connexival segments III to VI, middle of tergum VII, and hypopygium, ferruginous. Antennae, anterior angles of pronotum, connexival segment II, and paratergites ochre brown. Forehalves of connexival segments III to VI and almost entire VII, yellow. Ventral side of the body ferruginous, with yellow spots on connexivum.

Measurements.—Total length 4.36 mm.; width of pronotum 1.48 mm.; width of abdomen 1.68 mm.

Holotype.—Male, Chapada, Brazil; September (USNM type 67592).

Notapictinus platyceps, new species, is related to *N. breviceps* (Champion) but is larger, has antennae with different proportions of segments; anterior angles of the pronotum produced forward as long lobes; and paratergites in the form of a hook.

Notapictinus ornatus, new species

Figures 22, 23

Male.—Elongate ovate, regularly widening backward, then narrowing; macropterous.

Head almost as long as width across the eyes (16:16.5). Anterior process long and slender, cleft anteriorly; genae much longer than clypeus, reaching apical two-fifths of antennal segment I. Antenniferous tubercles long, dentiform, slightly divergent, reaching basal fourth of antennal segment I. Eyes moderately large, protruding. Postocular tubercles small, dentiform, slightly produced beyond outer border of the eyes. Vertex with V-shaped row of granules, and laterad of this with two (1+1) callosites; latter each with a thin, longitudinal carina. Antennae strong, twice as long as head (31.5:16). Proportions of antennal segments 8:5.5:11:7. Rostrum reaching hindborder of rostral groove; latter wide, closed posteriorly.

Pronotum much shorter than width across humeri (19:36). Collar wide, slightly sinuate anteriorly, clearly separated from disc. Forelobe narrower than hindlobe (29:36). Anterior angles rounded, directed somewhat inward, produced beyond collar. Lateral borders of forelobe convex, rounded; those of hindlobe less convex, crenulate. Hindborder slightly convex medially and laterally. Foredisc with a deep median silcus, laterad with two (1+1) large, flat callosities. Inner borders of callosities carinate, discs each with two oblique carinae. Four (2+2) curved carinae between callosities and lateral borders. Hind-disc roughly granulate.

Scutellum shorter than width at base (12:19); all borders carinate; lateral borders sinuate medially. Median carina thin, but prominent; disc roughly, transversely rugose.

Hemelytra almost reaching hindborder of tergum VII. Basolateral border of corium reflexed; apical angle produced into a short point, reaching basal fourth of connexival segment III; apical border concave, forming two angles.

Abdomen longer than width across segment V (59:44). Connexival segments all of about the same length. Postero-exterior angles from IV to VI slightly protruding; on VII forming small rounded lobes. Paratergites small, clavate, reaching middle of hypopygium. Latter cordate, shorter than width at base (11:13.5); upper surface with a stout, subtriangular ridge not reaching hindborder of hypopygium. Spiracles II to V ventral; VI ventral but placed near margin; VII to VIII lateral.

Color.—Light ferruginous; connexival segments yellow brown, posterior borders yellow. Paratergites and tibiae ochre brown. Membrane light brown.

Measurements.—Total length 4.32 mm.; width of pronotum 1.44 mm.; width of abdomen 1.76 mm.

Holotype.—Male, Rio de Janeiro, Brazil; October (USNM type 67593).

Notapictinus ornatus, new species, is related to *N. kjellanderi* Kormilev (1964, p. 472) from Peru, but the anterior angles of the pronotum are directed forward and inward; lateral borders of the hindlobe are less convex; postero-exterior angle VII forms small, rounded lobes; hypopygium more elongate, with sinuate lateral borders; antennal segment II much shorter than I (5.5:8), whereas in *N. kjellanderi* it is as long as I.

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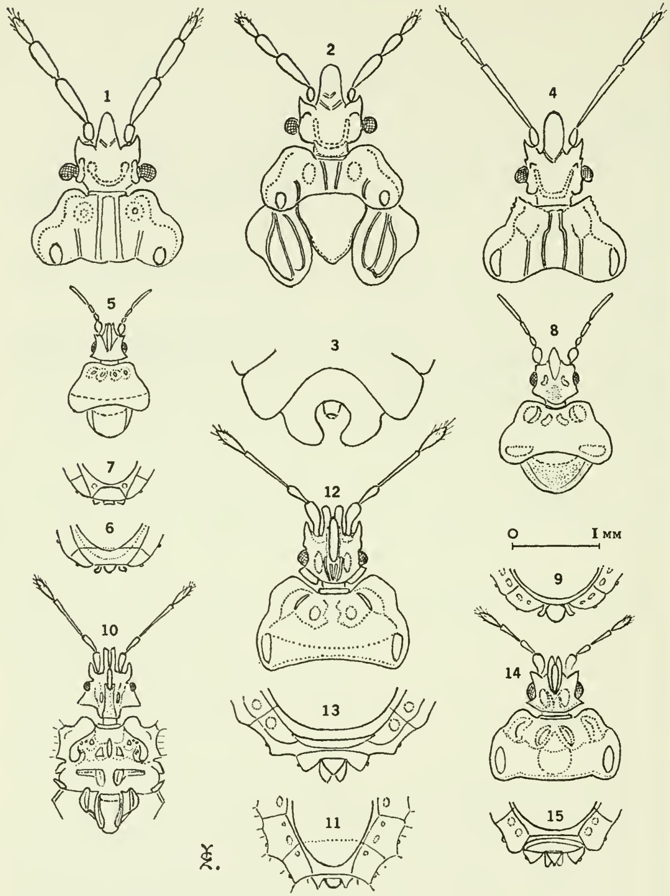
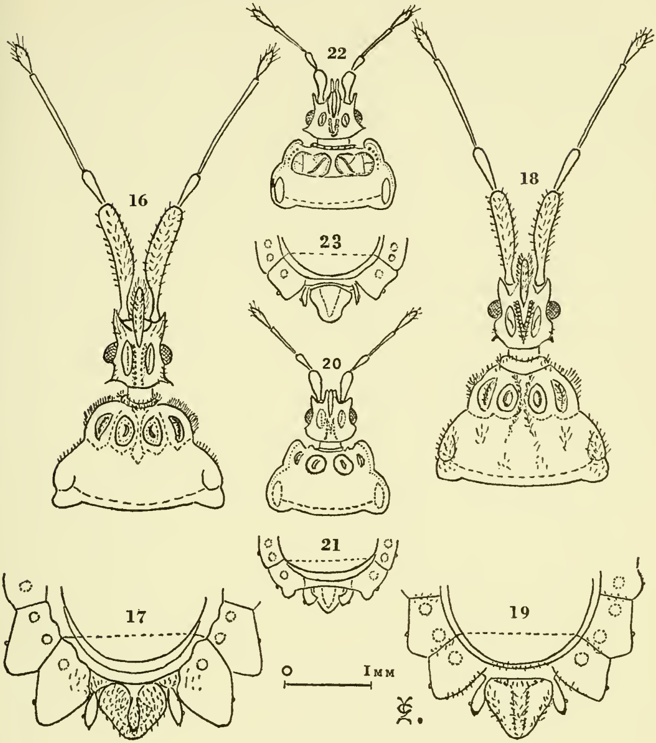


FIGURES 1–15.—New species: *Aradus saileri*, male: 1, head and pronotum. *A. ovatus*, female: 2, head and pronotum, 3, tip of abdomen. *A. barberi*, male: 4, head and pronotum. *Aneurus pygmaeus:* 5, male, head, pronotum, and scutellum; 6, male, tip of abdomen; 7, female, tip of abdomen. *A. nasutus*, male: 8, head, pronotum, and scutellum; 9, tip of abdomen. *Proxius peruvianus*, female: 10, head, pronotum and scutellum; 11, tip of abdomen. *Placogenis clarkei*, female: 12, head and pronotum; 13, tip of abdomen. *Notapictinus uruguayensis*, female: 14, head and pronotum; 15, tip of abdomen.



FIGURES 16–23.—New species, male: *Miorrhynchus angulatus:* 16, head and pronotum; 17, tip of abdomen. *M. undulatus:* 18, head and pronotum; 19, tip of abdomen. *Notapictinus platyceps:* 20, head and pronotum; 21, tip of abdomen. *N. ornatus:* 22, head and pronotum; 23, tip of abdomen.

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THE FREEZE-DRY PRESERVATION OF BIOLOGICAL SPECIMENS

By Rolland O. Hower [1]

Office of Exhibits

Introduction

Visitors today to the United States National Museum see specimens of small animals that accurately represent the form and color they possessed in life. This improved representation is the direct result of the new method of specimen preservation that has been brought about by the process of freeze-drying. By this process, the specimen retains most of its original characteristics without further need for preservation.

This new technique is based upon sublimation of frozen fluids. One of the earliest papers detailing the phenomenon of sublimation was delivered to the Royal Society of London in 1813 by William Hyde Wollaston, a physicist. Wollaston's commentary (1813) on water passing from the frozen to the gaseous state, apparently bypassing the liquid phase, discussed what was already a well-known phenomenon. It was not until the 1890's, however, that the removal

[1] As far as is known, Mr. Hower is the first to apply the freeze-dry process to museum work. Developing more sophisticated apparatus and establishing time schedules for the freezing of specimens, he is now investigating freeze-dry problems of color retention, fat stabilization, and the freezing of larger specimens.

of fluid from tissue by sublimation at low temperatures had been accomplished by Dr. Richard Altman of Leipzig (Glick, 1949, p. 4).

Only in recent years, with the advent of modern refrigeration and vacuum techniques and equipment that is widely available, has the process become practical for commercial or professional purposes. The process of freeze-drying, now greatly refined, is used currently for food processing and for the preservation of pharmaceuticals, human bone, tissue, and blood plasma.

The freeze-drying techniques utilized at the Smithsonian Institution for the preservation of biological specimens began in the late 1950's (Hower, 1962). There is now a well-established freeze-dry program to preserve many types of natural history specimens for exhibit. Current exhibits include freeze-dried rodents, reptiles, crustaceans, insects, and fishes.

Reflecting on events of past years that led to work on the freeze-dry process, I wish to express my gratitude to Dr. H. T. Meryman of the Biophysics Division of the Navy Medical Research Institute, who pioneered many of the techniques and has made himself always available for consultation.

Special thanks also are extended to James C. Nyce, who contributed invaluable aid in the preparation of this paper, to Mrs. Constance Minkin, for her writing contributions, and to John Hackmaster, who prepared the illustrations.

Principles of the Freeze-dry Concept

Freeze-drying consists bascially of dehydrating tissue while it is frozen. Whereas some tissue dried from a nonfrozen state becomes shrunken and consequently distorted in the process, tissue dried from a frozen state virtually retains its original appearance; thus, the process is not only valuable in preserving the quality of food but also in maintaining the appearance of museum specimens. An additional advantage is that the dehydrated tissue is not subject to decay.

Compared to other preservation methods, the shrinkage and distortion of freeze-dried museum specimens is minimal, but there is some distortion in certain types of animals, particularly some fishes. In most cases, however, the distortion is negligible or correctable. Furry or feathery specimens and those with exoskeletons appear completely natural when freeze-dried, provided they have been properly prepared. Such preparation includes the positioning of the specimen before dehydration, the actual dehydration, installation of artificial eyes, and the painting of mucous membranes or exoskeletons (mucous membranes become white after dehydration and crustaceans lose their coloration).

Sublimation.—If biological tissue is first frozen to give it mechanical rigidity and water is then removed by sublimation, most tissue can be dehydrated without apparent physical change.

Consider this process in terms of plain frozen water: ice. Each ice crystal is a geometrically sound structure, made up of myriads of water molecules that are retained in their positions by the gravitational field of the surrounding molecules. Within the restricting confines of this lattice, each molecule moves randomly, and there is a possibility that one of the motions of a surface molecule will be great enough to propel it out of the confines of the lattice. The greater the crystal mass, the greater the probability of such escapes. As temperature is increased and molecular motion becomes accelerated, the probability of escape becomes greater; thus, the average number of water molecules that will escape from a given mass at a given temperature can be statistically predicted. Ice within a biological specimen behaves in nearly an identical manner.

Sublimation begins at the outer surface of a specimen and continues at the boundary between the frozen and the dried tissue. This boundary recedes toward the center of the specimen as drying proceeds. As water molecules continue to escape from ice crystals on the boundary, they move about at high velocity, colliding constantly with other molecules and with the structure of the dried tissue surrounding them. (As they are buffeted from collision to collision, they are virtually independent of external forces.) There is a heavy concentration of water-vapor molecules at the sublimation boundary, due to the great number of molecules escaping; consequently, there are more collisions, which ricochet molecules along the line of least resistance toward the outer shell of the specimen. The force of the molecules' collisions following their escape from the ice crystals on the sublimation boundary supports their drive through the dried tissue of the specimen and into the atmosphere beyond its outer shell. For ice to sublime efficiently, the vapor pressure within the specimen chamber must be lower than the vapor pressure of ice within the specimen itself.

Vapor pressure.—If the temperature of a vacuum chamber containing ice is maintained at $-10°$ C., evacuated with a vacuum pump, and then valved off so that no external air can enter, molecules will begin to escape from the ice crystals within the chamber (fig. 1). Some of these molecules will ricochet about, colliding with one another and with the sides of the chamber, while others will relocate themselves upon other ice crystals.

As the concentration of the vapor formed by these free molecules reaches a specific point (which is dependent upon the temperatures of their atmosphere), the rate at which molecules return to the ice will become equal to the rate at which they depart, and the water vapor is then said to be in a state of equilibrium (fig. 1). The vapor pressure at which this equilibrium occurs is referred to as equilibrium vapor pressure. With the temperature of the chamber maintained at $-10°$ C., the pressure indicated on its vacuum gauge will be 1.950 mm. Hg. This is the equilibrium vapor pressure (consequently the vapor pressure) of water at $-10°$ C.

Water-vapor molecules may be removed from the area immediately surrounding the ice in a vacuum chamber, thereby upsetting the equilibrium and permitting more molecules to escape and allowing fewer to return. This principle applies to biological specimens as well as to ice.

The most effective method of continuously removing water-vapor molecules from a specimen chamber is to create a lower vapor pressure elsewhere. This can best be done by establishing a colder surface (condenser) nearby. Water vapor will diffuse to a colder surface and recondense to form new ice crystals.

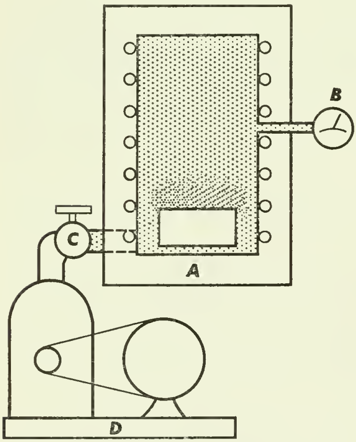

FIGURE 1.—Water-vapor equilibrium (A= refrigerated chamber; B= vacuum gauge; C= cut-off valve; D= vacuum pump).

A refrigerated condenser serving as an efficient water pump is employed for this purpose. As previously stated, when the temperature of a specimen chamber is $-10°$ C., the vapor pressure of ice within it is 1.950 mm. Hg. If the temperature of the nearby condensing surface is $-40°$ C., the vapor pressure is 96 micron Hg., creating a vapor-pressure differential of 1.854 mm. Hg. Water molecules will collect on the cold condenser surface. With this much vapor-pressure difference, the only limitation to the effectiveness of a condenser is the surface area (fig. 2).

Pressure reduction.—When vapor transfer occurs at atmospheric pressure, water molecules are impeded by collisions with air molecules. At atmospheric pressure, the mean free path (the average distance a vapor molecule can travel before colliding with another molecule) is approximately .005 microns (5×10^{-6} mm.). The mean free path of a water-vapor molecule with relation to pressure is as follows:

pressure	*mean free path*
10 mm. Hg.	0.0034 mm.
1 mm. Hg.	0.034 mm.
100 μ Hg.	0.34 mm.
10 μ Hg.	3.4 mm.
1 μ Hg.	34.0 mm.

The transfer of water molecules from an ice crystal to a condenser can be accelerated by increasing the length of their mean free paths; this can be done by reducing the pressure in the chamber with a

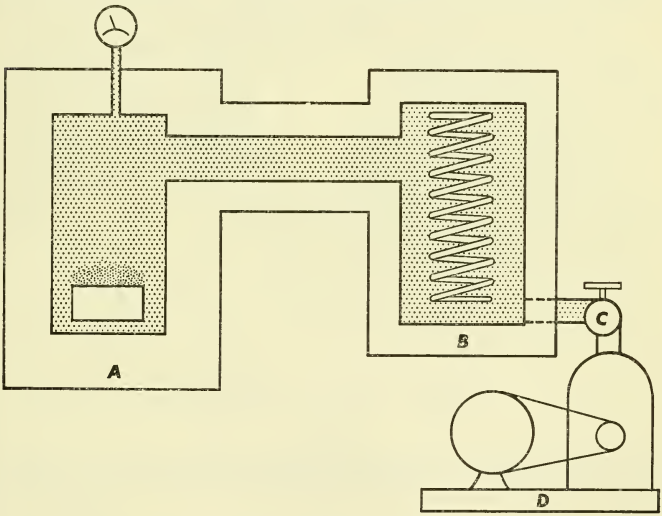

Figure 2.—Water-vapor differential (A=specimen chamber; B=condenser chamber; C=cut-off valve; D=vacuum pump.

vacuum pump. Not all vapors, however, are condensable; therefore, a pump must be used to remove these vapors so that chamber pressure will remain low enough to permit efficient removal of the water to its condenser.

Instrumentation of the Freeze-dry System

The basic equipment necessary to establish a freeze-dry apparatus consists of a specimen chamber, a condenser chamber, and a vacuum pump. The Smithsonian system also incorporates refrigeration control components that are very desirable for maintaining the dependability of the system.

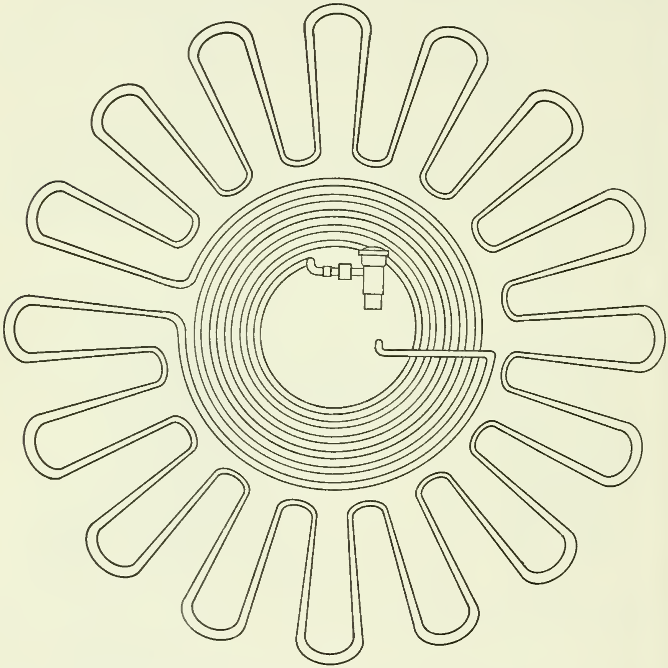

FIGURE 3.—Continuous copper tubing (⅝ in.) connected at alternate ends by return bends within the specimen chamber.

SPECIMEN CHAMBER.—The basic requirements for the specimen chamber are that (1) it must be vacuum tight; (2) it must be refrigerated; and (3) it must have a large access opening.

The ultimate vacuum within the chamber can be as low as 10 microns (1×10^{-2} mm. Hg.) of pressure, producing a differential between internal and external pressure of approximately 15 pounds per square inch. Sturdy construction is required if a chamber is to withstand such force.

At the Smithsonian, the structural requirements for the chambers were met by the selection of a 60-gallon paint-spray pressure tank for the specimen chamber and a 30-gallon tank for the condenser. These tanks required modification but proved both satisfactory and economical.

The Smithsonian specimen chamber was mounted horizontally on a base shaped to the contour of its walls, with allowance for the thickness of an insulated outer plastic shell. The door on the Smithsonian chamber is two feet in diameter and withstands a total external pressure of 6780 pounds. The chamber itself, two feet in diameter and 36 inches long, withstands a total external pressure of a little more than 20 tons.

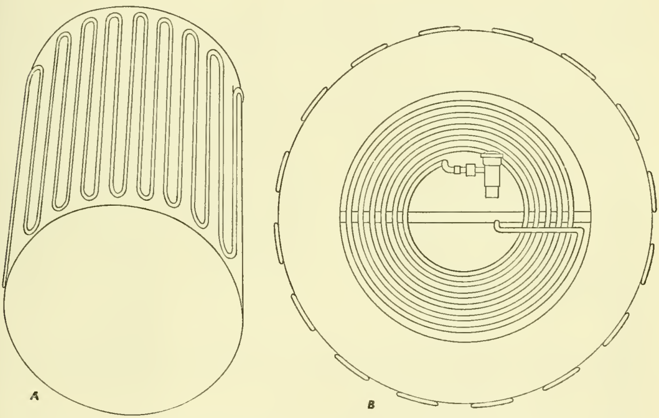

FIGURE 4.—Detachable refrigeration assembly: *A*, outside view; *B*, inside view.

The vapor line, a piece of steel tubing with an inside diameter of 3½ inches, was welded into a 3¾-inch hole midway down the side of the chamber.

The inside of the chamber was lined with ⅝-inch continuous copper refrigeration tubing, filling one end and running the length of the walls, where it was joined at alternate ends with 2-inch return bends. The tubing was soldered to the steel wall of the chamber, and a fillet of metallic plastic compound was added to improve heat conduction between wall and tubing (fig. 3).

Due to the difference in the coefficients of expansion of the two materials at operating temperatures, however, fracturing of the steel-to-copper attachments developed. To overcome this difficulty, the refrigeration line was soldered to the outer surface of a copper sleeve, negating the need for attachment between the copper tubing and the steel wall (fig. 4). This innovation not only solved the fracturing problem but also established the refrigeration line as a detachable unit within the system, allowing easy removal from the chamber for maintenance and repair.

Since the refrigeration line entered and left the chamber through two small openings in the rear of the tank, the openings around the tubing were sealed with soft solder. When installation of the refrigeration line was completed, the chamber was tested thoroughly for vacuum leaks.

Refrigeration of the specimen chamber.—Within an evacuated system, heat is transferred principally by radiation. Radiation travels in a line-of-sight path between a specimen and surrounding surfaces. There is no heat produced within the specimen chamber; therefore, the only appreciable load on the refrigeration system is ambient heat that leaks in through the insulation. This load can be calculated in BTU's per hour from the information given (p. 17).

Any refrigeration compressor (q.v.) serving the specimen chamber should be capable of producing controlled temperatures at the chamber walls of −15° to −30° C. (after heat leak has been taken into account).

When selecting a refrigeration compressor, it is desirable to double the calculated heat load (primarily heat leak) to allow a sufficient margin for error (table 1).

Table 1.—*Refrigeration compressor capacity in BTU's per hour* (based on a 90° F. ambient temperature; F–12 (freon-12)=Dichlorodifluoromethane; F–22 (freon-22)=Chlorotrifluoromethane)

Horsepower	Refrigerant	5° F	0° F.	−10° F.	−25° F.	−40° F.
0.25	F–12	1900	1700	1300	750	350
0.33	F–12	2275	2050	1550	950	445
0.50	F–12	3500	3175	2450	1550	1000
0.75	F–12	5100	4600	3550	2250	1400
1	F–12	7200	6500	5100	3350	2300
1	F–22		5590	4350	2890	1920

Condensing chamber.—The physical requirements for the condensing chamber are similar to those of the specimen chamber.

At the Smithsonian, a length of copper tubing, 3½ inches in diameter (later replaced with steel), was brazed into an opening, 3¾ inches in diameter, near the top of the 30-gallon tank. The opposite end of the tubing was connected to the specimen-chamber vapor line. At the base of the tank was an opening into which a 1½-inch steel pipe was welded, connecting it to the vacuum pump.

Inside the condensing chamber, a large complex of coils within coils was fashioned from 200 feet of copper refrigeration line ⅝ inches in diameter. The expansion valve was mounted inside the chamber and the refrigeration line was brought into and out of the chamber through openings in the side of the chamber, which were sealed with soft solder as in the specimen chamber (see fig. 4).

Refrigeration of the condenser.—The force underlying the motion of water vapor from the ice, through the specimen chamber to the refrigerated condenser, is the vapor-pressure difference. This force is produced by the difference in temperature between the ice crystals within the specimen and the refrigerated condenser. Table 2

Table 2.—*Relationship between temperature* (° C) *and vapor pressure* (mm. Hg.)

° C	Vp	° C	Vp	° C	Vp	° C	Vp
0	4. 579	−16	1. 132	−34	. 1873	−66	. 00349
−1	4. 217	−17	1. 031	−36	. 1507	−68	. 00261
−2	3. 880	−18	0. 939	−38	. 1209	−70	. 00194
−3	3. 568	−19	0. 854	−40	. 0966	−72	. 00143
−4	3. 280	−20	0. 776	−42	. 0768	−74	. 00105
−5	3. 013	−21	0. 705	−44	. 0609	−76	. 00077
−6	2. 765	−22	0. 640	−46	. 0481	−78	. 00056
−7	2. 537	−23	0. 580	−48	. 0378	−80	. 00040
−8	2. 326	−24	0. 526	−50	. 0295	−82	. 00029
−9	2. 131	−25	0. 476	−52	. 0230	−84	. 00020
−10	1. 950	−26	0. 430	−54	. 0178	−86	. 00014
−11	1. 785	−27	0. 389	−56	. 0138	−88	. 00010
−12	1. 632	−28	0. 351	−58	. 0106	−90	. 00007
−13	1. 490	−29	0. 317	−60	. 0080	−94	. 00003
−14	1. 361	−30	. 2859	−62	. 0061	−98	. 000015
−15	1. 241	−32	. 2318	−64	. 0046		

demonstrates the fixed relationship between temperature and the vapor pressure of water. The temperature difference between the specimen and the refrigerated condenser need not be extreme in order to produce a substantial difference in water-vapor pressure; however, it should be noted that lowering the condenser temperature produced less gain logarithmically in vapor pressure difference.

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It is clear, therefore, that any effort to produce extremely low condenser temperature is not economical since the cost per BTU of refrigeration increases rapidly as temperature is reduced, but the vapor-pressure differential increases only moderately. A temperature of −40° C. is satisfactory and is within the range of conventional freon-12 or freon-22 refrigeration units.

Another factor to be considered in designing a condenser is that the rate of water loss from the specimen will be very low and, thus, the heat load on the condenser's refrigeration unit will be slight.

The heat leak through the insulation of the condenser chamber should be calculated exactly, as for the specimen chamber.

Temperature Control: Temperature may be controlled by a simple mercury control switch with a 2- or 3-degree low-temperature differential. The control employed in the Smithsonian system is a sealed mercury switch, triggered by a vapor-pressure-actuated Bourbon tube. Exterior adjustments with visible settings over a calibrated dial are employed.

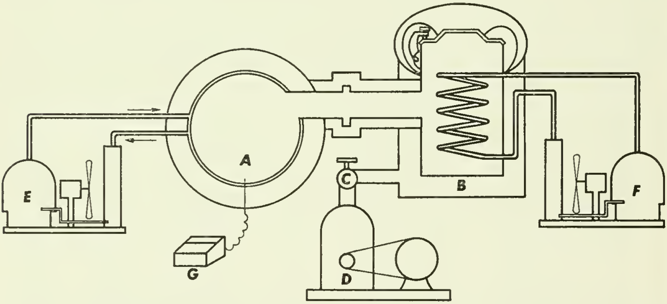


FIGURE 5.—Schematic of Smithsonian freeze-dry apparatus (A=specimen chamber; B=condensing chamber; C=recompression valve; D=vacuum pump; E, F=refrigeration compressors; G=vacuum gauge).

VACUUM PUMP.—The vacuum pump, very important to the freeze-dry system, should be selected with care. There are many suitable pumps available.

When a refrigerated condenser is employed as a vapor trap, the only function of the vacuum pump is to reduce air pressure mechanically within the chamber and evacuate the noncondensable gases released from the specimens during the drying process.

The capacity of a pump is described in terms of displacement. Displacement, expressed in liters per second or cubic feet per minute, is a measure of a pump's capability to produce a vacuum in a given time, as well as to keep the system evacuated as gases are released from volatile materials within the system. Pump displacement or pumping speed must be calculated according to the volume of the system and pressure desired. The time required to pump the system down to the ultimate pressure (about 10 to 100 microns Hg.) should be established. The pump-down chart (fig. 6) may be used to calculate

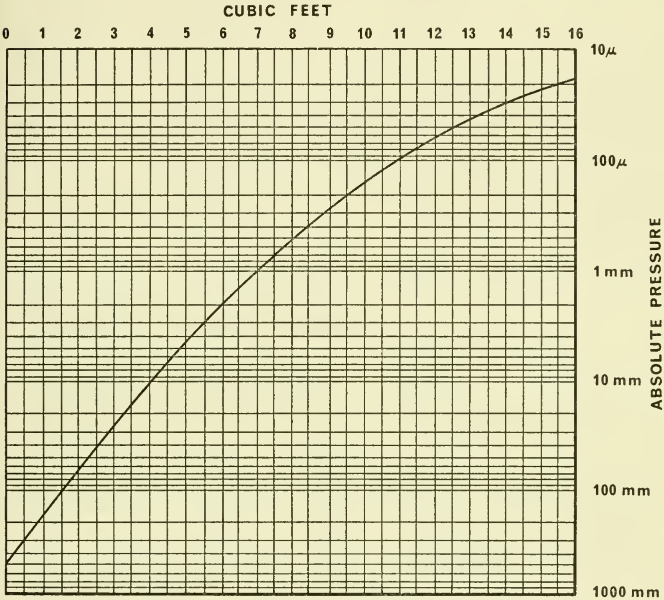


FIGURE 6.—Pump-down factor chart.

displacement requirements. By way of illustration, the following two examples are cited:

(1) To determine the required pumping displacement to evacuate a system with a total volume of 15 cubic feet to a pressure of 100 microns in 5 minutes, reference to the pump-down chart shows that at 100 microns the factor is 10.9. Multiply 10.9 by the volume (15 cu. ft.) to obtain the total number of cubic feet to be pumped (163.5). To determine the required pump displacement, divide this total by the number of minutes (5) allowed for the evacuation.

$$10.9 \times 15 = 163.5$$

$$\frac{163.5}{5} = 32.7 \text{ cu. ft./min. or } 55{,}563.6 \text{ liters/sec.}$$

(2) To determine how long it will take a pump with a displacement of 27 cubic feet per minute to evacuate a system with a volume of 160 cubic feet to a pressure of 200 microns (at 200 microns the factor is 9.50), calculate as follows:

$$9.50 \times 160 = 152$$

$$\frac{152}{27} = 56.29 \text{ min.}$$

Under certain conditions the refrigerated condenser can be eliminated and water vapor can be removed directly through the vacuum pump, provided the pump is capable of removing the vapor at a rate equal to its release from the specimen. To determine whether the condenser can be omitted, the approximate quantity of water vapor being released each minute by the specimens within the chamber must be computed.

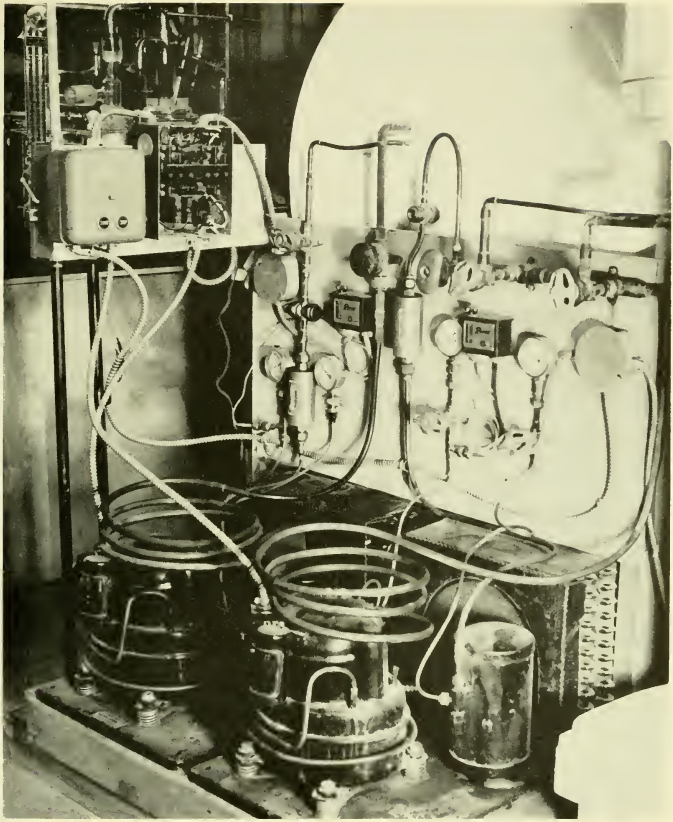
If, for example, a specimen chamber contains three squirrels, two flickers, a toad, and a garter snake (at various drying stages and all of average weight), the average daily release of water vapor will be approximately 12 grams.

If 150 microns of pressure were maintained within the chamber, it would be necessary to pump 200 cubic feet of water vapor for each gram of water removed from the system, or 2400 cubic feet per day (1.66 cu. ft./min.). If the vacuum pump cannot handle this volume of vapor, the pressure within the specimen chamber will slowly rise; and, as it rises, the volume occupied by a unit weight of water vapor decreases. At a pressure of 300 microns, two grams of water will occupy the same volume as would one gram at half that pressure. It is obvious, therefore, that overloading a chamber or providing an inadqeuate vacuum pump will cause an increase in operating pressure in the specimen chamber. To avoid this, a refrigerated condenser should be used.

Since the differential between the water-vapor pressure within the chamber and the vapor pressure of the ice within the specimen provides the driving force for the movement of water vapor through the system, an increase in pressure within the chamber causes a decrease in efficiency.

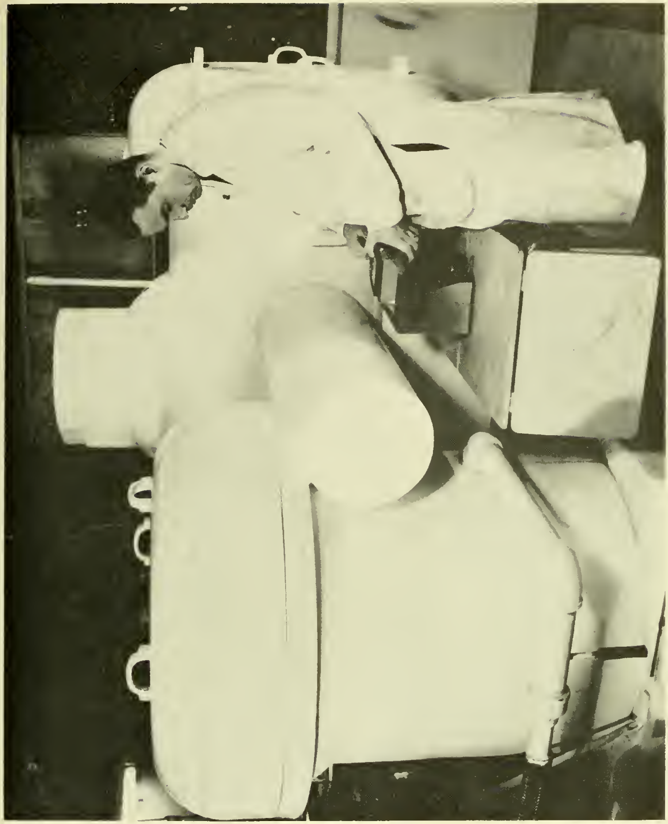
An increase in chamber pressure from 150 to 300 microns with a specimen temperature of $-10°$ C. would result in a vapor pressure differential of from 1.80 to 1.65 mm. Hg., or a reduction of a little more than 8 percent.

While this example demonstrates that increasing water-vapor load is not as deleterious as expected, it nevertheless establishes a relationship between water-vapor load and vacuum-pump capacity and



Refrigerating apparatus for the specimen and condenser chambers (Smithsonian photo).

Interior of the specimen chamber; dehydration is almost complete (Smithsonian photo).



Author checking the telethermometer of the apparatus (Smithsonian photo).

A specimen that has been freeze-dried (Smithsonian photo).

indicates that a vacuum-pump limitation can limit the number of specimens that can be produced in a reasonable span of time.

A 2-stage gas-ballast vacuum pump is recommended for all freeze-dry use. Gas ballast on the pump enables it to remove condensable vapors such as water vapor from a vacuum chamber with a minimum of internal condensation.

In the gas ballast, a valve provides a means for controlling the entry of air into the exhaust stage of the pump's operation. The ballast of air acts as a transporting medium carrying diluted vapors through the exhaust part to the atmosphere.

Such pumps are generally rated with ultimate pressure ranges from 1 to 10 microns; however, pumping speed usually begins to decrease at about 100 microns, which is considered a satisfactory pressure for freeze-drying.

Oil should be changed frequently in any pump used in a freeze-dry system. Even though the pump is gas-ballasted, a certain amount of water vapor will contaminate the oil and damage the pump.

TABLE 3.—*Vacuum table*

Terminology	Pressure Range
Ultrahigh vacuum	pressures below 1×10^{-6} mm. Hg. or .001 microns Hg.
High vacuum	$1 \times 10^{-3} - 1 \times 10^{-6}$ mm. Hg.
Fine vacuum	1 mm. Hg. 1×10^{-3} or 1 micron Hg.
Rough vacuum	760 mm. Hg. to 1 mm. Hg.
1 mm. Hg.	1000 microns
	.00132 atmosphere
	.01934 p.s.i.
	.0393 in. Hg.
1 micron	.001 mm. Hg.
	1×10^{-3} mm. Hg.
Atmospheric pressure	760 mm. Hg.
	14.7 p.s.i.
	29.921 in. Hg.

The possibility of future expansion of the freeze-dry system should also be considered when selecting a vacuum pump. Under certain conditions the addition of a second chamber may require doubled pumping capacity (see tables 3–5).

VACUUM-LINE DIMENSIONS.—The diameter of vacuum lines affects the efficiency of a freeze-dry system since a pump is effective only if the vacuum lines are large enough to handle the vapor transfer.

Conductance (the volume of flow of vapor through a line) is a well-investigated function, and there are a variety of ways to calcu-

Table 4.—*Metric conversion table*

1 in.	002.5400 cm.	025.4000 mm.
1 ft.	000.3048 m.	000.0304 cm.
1 in.^{2}	006.4520 cm.^{2}	645.2000 mm.^{2}
1 ft.^{2}	929.0000 cm.^{2}	
1 in.^{3}	016.3870 cm.^{3}	016.3870 ml.^{3}
1 ft.^{3}	000.0283 m.^{3}	000.2830 cm.
		.283 ml.
10 mm.	1 cm.	0.3937 in.
010 cm.	1 dm.	3.9370 in.
100 mm.^{2}	1 cm.^{2}	
100 cm.^{2}	1 dm.^{2}	
010 ml.	1 cl.	0.3380 fl. oz.
010 cl.	1 dl.	6.1025 cu. in.
010 dl.	1 l.	1.0567 fl. qt.
010 l.	2.64 gal.	

Table 5.—*Conversion multipliers* (e.g., liters per second times the factor equals cubic feet per minute)

From	To	Factor
liters per second	cubic feet per minute	02.1200
liters per minute	cubic feet per minute	00.0353
liters per second	liters per minute	60.0000
cubic centimeter per second	liters per second	00.0010
cubic feet per minute	liters per minute	28.3200

late the vacuum-line dimensions required to permit adequate conductance.

The flow of fluids (or vapors) within a vacuum system is usually either molecular flow or viscous flow. Molecular flow occurs at pressures at which the molecule's mean free path is greater than the average diameter of the tubing through which it flows.

Since the mean free path of a molecule does not approach the diameter of any large vacuum line at above 1-micron pressure, we are concerned only with viscous flow.

It should be noted that restriction of tubing to the viscous flow of vapors is significant only when the volumes to be moved are very large or the pressure differential is small. The law that expresses the viscous flow of fluids through a tube was first deduced by Jean L. M. Poiseuille, the French physicist (Daniels et al, 1949, p. 71). This law establishes relationships between the coefficient of viscosity (viscosity=poises/dyne sec./cm.^{2}), the volume of the fluid flowing through the whole section of the tube in unit time (seconds, as applied here), the pressure differential at each end of the tube, the radius, and the length of the tube.

V=Volume (cm.^{3}/sec.)
p=Pressure (dynes/cm.^{2})
r =Radius (in cm.)
L=Length (in cm.)

$$V=\frac{pr^4}{8_L}$$

The formula states that the volume of vapor transferred through a tube in a specific period of time is proportional to the fourth power of the tube radius. This means that a small increase in tube diameter will produce a considerable increase in vapor conductance.

To utilize the formula, it is necessary to know the coefficient of viscosity, which for air is approximately 1.7×10^{-4} poises at a pressure of 1 dyne/cm.^{2}=7.5×10^{-4} mm. Hg. 1.

For example, to calculate the conductance of vapor through a tube that is 193 cm. long, 7.62 cm. in diameter, and with a pressure differential between the specimen and the condensing surface of 2000 microns, the following values are:

V=cm.^{3}/sec.
p=2666.7 dynes/cm.^{2} (2000μ pressure differential)
r=3.81 cm.
L=193 cm.
$v=1.7\times10^{-4}$ poises

$$V=\frac{(3.14)(2666.7)(3.81)^4}{(8)(193)(.017)}=\frac{1737861.723}{26.248}$$

V=66209 cm.^{3}/sec.

Testing for leaks.—The overall system must be tested for vacuum leaks. Leaks in a vacuum system can be detected easily with a Peroni pressure gauge used in conjunction with acetone. The vapor pressure of acetone is so high that, when joints or surfaces are brushed with it, any leak will cause a marked increase of pressure within the system. The gauge head should be installed at a point near the vacuum pump and then watched for pressure increases after the system has been evacuated and tested.

Another test is to inject freon under slight pressure into the system and locate the leaks with a refrigeration leak detector. When the system is initially pumped down, the pressure in the system may be higher than anticipated due to gases being given off by zinc coating or other materials of high vapor pressure that may be inside the system. The pressure can be effectively reduced by allowing air to reenter the system and by pumping it down repeatedly until these vapors have been evacuated.

Repairs should be made while the system is evacuated because the vacuum helps a sealant penetrate a leak. Unless the pressure is unusually high when the pump is operating, it may be assumed that a leak is small and can be sealed with glyptol varnish or lacquer applied by brush. The instant that either material reaches the vacuum through a pinhole leak, it dries and plugs the leak. If the pressure remains high, the leak is large and should be plugged with soft solder.

Refrigeration compressors.—The major consideration in refrigeration is that constant temperature be maintained.

The hermetically sealed refrigeration unit is composed of a motor and compressor shaft of 1-piece construction. The motor (cooled by the flow of refrigerant gas) and compressor assembly are within a gas-tight housing that is welded shut. This method of construction eliminates the need for certain parts (pulley, belt, compressor flywheel, and compressor seal) found in an open unit and, of course, avoids the servicing and replacing of those parts.

One objection to this type of unit is that, under freeze-dry operating conditions, there is some danger of the motor's burning out because of the very small amount of refrigerant being circulated.

The Smithsonian's compressors, however, have not overheated despite continuous operation for several years in a room with an average temperature of about 90° F. If overheating should occur, it could be remedied by installing a water-cooled condenser in the discharge side of the compressor.

A second type, the air-cooled compressor, usually operates with a belt and pulley; the motor is in the open, where it is cooled by air circulating around it.

Operating characteristics of *both types* of refrigeration compressors are, otherwise, essentially the same.

The selection of a fractional-horsepower refrigeration compressor should be based upon calculation of heat load on thermal insulation (see p. 17 and also table 1).

Expansion valves.—For maximum vaporization of the refrigerant, it is important to select thermostatic expansion valves of correct capacity. It is equally important that the valves be installed at the proper locations, since both factors can influence the success or failure of the entire system.

The thermostatic expansion valve selected for the condensing chamber should be a type designed to control temperatures below −40° C.

Although the thermostatic expansion valves in either chamber may be mounted in any position, they should be installed as near the evaporator inlet as possible. The valves in the Smithsonian system are mounted inside the chambers, where maximum efficiency is gained.

Bulb Location: For satisfactory expansion-valve control, good thermal contact between the bulb and the suction line is essential. The bulb, which controls the expansion valve, should be fastened securely with two metal straps to a clean section of the suction line inside the chamber. The bulb should be located near the midpoint of the line around the coil. It should not be near the bottom of the line because a refrigerant-and-oil mixture is usually present there, which would result in incorrect control of the expansion valve.

Filter and Drier: These should be installed in the liquid line ahead of the thermostatic expansion valve.

Sight Glass: Further protection is easily and inexpensively provided with a sight glass through which the refrigerant level can be determined by the presence or absence of bubbles in the liquid line. Bubbles indicate that the refrigerant level is low.

Thermal insulation.—Insulation material is required to substantially reduce heat leak, which loads the refrigeration unit. This material may be glass wool, with a K factor of 0.29, rock wool, with a K factor of 0.26, compressed cork, with a K factor of 0.30, or other similar material. The Smithsonian freeze-dry apparatus is insulated with a foam-in-place plastic (polyurithane). Foam-in-place plastics range in density from 2 to 10 pounds per cubic foot; they offer K factors of from 0.02 to 0.24. These plastics can be used without great difficulty and can be made to conform to any contour. Such properties make plastic foam an ideal material to use as insulation.

Calculation for the determination of thermal impedence and heat load is as follows:

K=insulation factor (BTU/hr./sq. ft.)

S=surface area of insulation (sq. ft.)

A=Ambient temperature (difference between the inside and outside of chambers in °F)

IT=thickness of insulation (in.)

$$\frac{(K)\ (S)\ 2A}{IT}=\text{BTU/per hr.}$$

Temperature reading and recording.—Temperatures throughout the drying process should be carefully watched and accurately recorded. The record is indispensable for establishing drying times and for determining ideal temperatures for various types of specimen material. An automatic temperature-recording device is valuable for indicating the temperature variations as the refrigeration compressors are cycling, and it may also call attention to problems that would otherwise go unnoticed, such as a faulty temperature-control switch.

The system at the Smithsonian incorporates a telethermometer that utilizes a thermistor probe as a sensing element and provides temperature readings directly from a temperature scale. The telethermometer's range is from −40° to 150° C. Both surface and air probes are used and the probe leads are connected through a multiple-selector switch to permit convenient temperature reading at several places.

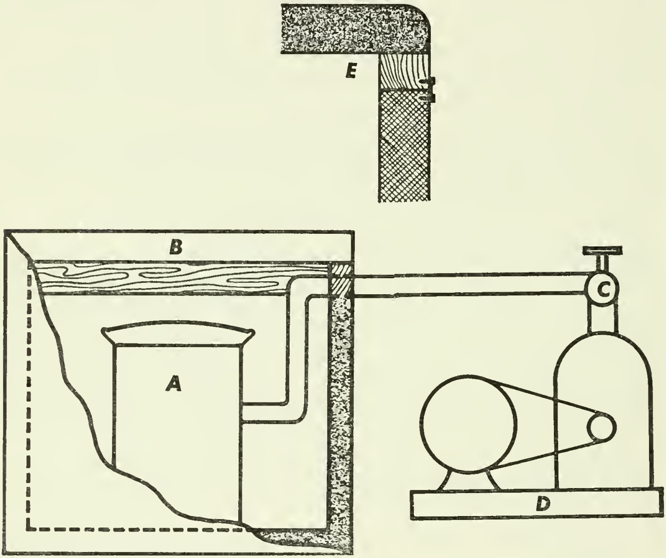


FIGURE 7.—Simple freeze-dry apparatus (A=specimen chamber; B=commercial deep-freeze; C=recompression valve; D=vacuum pump; E=wood-spacer insert).

RECORDER.—Any versatile general-purpose D.C. voltage and current recorder may be used to record temperatures continuously. One with a low-to-high-level range (200 microvolts to 500 volts and 200 millimicroamperes to 100 microamperes) is suitable for freeze-dry purposes. It is important that the recorder be compatible with the temperature device in scale range and voltage output.

Construction of a Freeze-dry System

The simplest apparatus suitable for freeze-drying consists of a commercial deep-freeze containing a small chamber connected to a gas-ballasted vacuum pump (fig. 7).

The main requirement for the deep-freeze chest is that it maintain a constant temperature of $-15°$ to $-20°$ C. The only alteration needed is removal of its hinges and latch and the insertion of a wood spacer between the chest and its lid to permit passage of a vapor line between them. The vapor line must pass *through* the wood spacer.

The hinges and latch should be relocated for the raised top; the thickness of the wood spacer is determined by the diameter of the vapor line that will pass through it.

A small specimen chamber may be made from a 5-gallon paint-spray pressure tank roughly 18 inches in diameter and 21 inches high. A hole must be cut in the side of the chamber for a vacuum line, which can be brazed into place.

The major consideration in selecting a gas-ballasted vacuum pump is the volume occupied by the water vapor at the temperature and pressure being used. Assuming that the chamber temperture is $-20°$ C., the vapor pressure is 0.8 mm. Hg. At a vapor pressure of 0.8 mm., one gram of water occupies a volume of 1200 litters. If the pressure gradient is approximately 0.6 mm., we find one gram of water will occupy approximately 1400 liters. A gas-ballasted vacuum pump with a 25-liter-per-minute capacity will take approximately one hour to pump one gram of water. A pump with a capacity of 79 liters per minute will remove approximately one gram of water in 18 minutes.

If the vapor line is 150 cm. (5 ft.) long, the diameter is calculated to be approximately 2.5 cm. or 1 inch. Tubing 1¼ inches in diameter will allow a sufficient operating margin when using the larger capacity pump.

The chamber must not be loaded beyond pumping capacity. In a system of this size, it is suggested that a single specimen be placed in the chamber and a second one added two or three days later, followed by a third specimen on the completion of the first, and so on, in this pattern. Observations of drying times during experimental drying cycles will determine the capacity of each individual system. The drying cycle can be interrupted, provided specimens are not permitted to thaw.

The apparatus described above is limited by two basic characteristics of its construction: the vapor-handling capacity and the size of the specimen chamber (fig. 8). As stated, the most efficient device for removing water vapor from the specimen chamber is a refrigerated condenser. If an external refrigerated condenser of sufficient size is used, the only limitation to the size of the specimen chamber is the size of the deep-freeze unit that holds the specimen chamber.

A refrigerated condenser can be constructed within a paint-spray pressure tank similar to the one used for the specimen chamber. The condensing surface may be a coil of ⅝-inch copper refrigeration tubing with an expansion valve mounted at the top or inlet side of the coil. The coil should have as many turns as space permits. A coil-within-a-coil arrangement is most desirable (fig. 9).

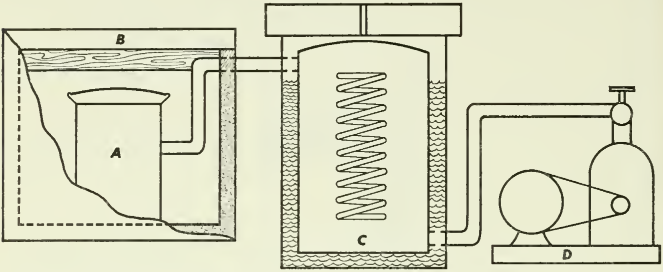


FIGURE 8.—Simple freeze-dry apparatus utilizing a condenser surface (A=specimen chamber; B=commercial deep freeze; C=condenser chamber; D=vacuum pump).

A vacuum-tight drain should be installed at the bottom of the condensing chamber to conveniently remove the condensation from the chamber during defrosting. The condensing chamber should be encased in an insulated box with openings in appropriate positions for vapor lines and refrigeration tubing.

An important requirement in any freeze-dry system is a valve (see fig. 5) that will permit atmospheric air to enter the system in order

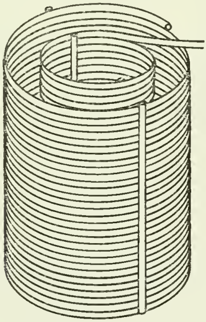


FIGURE 9.—Condensing coil.

that the chamber can be opened. This valve should be so located as to insure that the condensing chamber is situated between the valve and the specimen chamber, thereby assuring condensation of atmospheric moisture on the condensing coil rather than on the specimen. The valve must be vacuum tight when closed and need not be large; a ¼-inch intake is sufficient to shut down the system. It is recom-

TABLE 6.—*Freezing mixtures* (PS=primary substance and its proportion; SS=secondary substance and its proportion; TS=tertiary substance and its proportion; A=temperature (° C throughout) of substance before mixture; B=temperature of mixture; C=total reduced temperature; D=temperature when all snow is melted (when snow is used); E=heat absorbed (calories when A is grams); *=lowest temperature obtained. Table modified from "Smithsonian Physical Tables," 1959, 9th rev. ed., by W. E. Forsythe.

PS		SS	TS	A	B	C	D	E
$NaC_2H_3O_2^{(cr)}$	85	H_2O 100		10.7	4.7	15.4		
NH_4Cl	30	" "		13.3	−5.1	18.4		
$NaNO_3$	75	" "		13.2	−5.3	18.5		
$NaS_2O_3^{(cr)}$	110	" "		10.7	−8.0	18.7		
KI	140	" "		10.8	−11.7	22.5		
$CaCl_2^{(cr)}$	250	" "		10.8	−12.4	23.2		
NH_4NO_3	60	" "		13.6	−13.6	27.2		
$(NH_4)_2SO_4$	25	" 50	NH_4ND_3 25			26.0		
NH_4Cl	25	" "	" "			22.0		
$CaCl_2$	25	" "	" "			20.0		
KNO_3	25	" "	NH_4Cl 25			20.0		
$NaSO_4$	25	" "	" "			19.0		
$NaNO_3$	25	" "	" "			17.0		
K_2SO_4	10	snow 100		−1	−1.9	.9		
$NaCO_3^{(cr)}$	20	" "		−1	−2.0	1.0		
KNO_3	13	" "		−1	−2.85	1.85		
$CaCl_2$	30	" "		−1	−10.9	9.9		
NH_4Cl	25	" "		−1	−15.4	14.4		
NH_4NO_3	45	" "		−1	−16.75	15.75		
$NaNO_3$	50	" "		−1	−17.75	16.75		
NaCl	33	" "		−1	−21.3	20.3		
$H_2SO_4+H_2O$	1	" 1.097		−1	−37.0	36.0	−37.0	.0
(66.1% H_2SO)	1	" 1.26		−1	−36.0	35.0	−30.2	17.0
"	1	" 1.38		−1	−35.0	34.0	−25.0	27.0
"	1	" 2.52		−1	−30.0	29.0	−12.4	133.0
"	1	" 4.32		−1	−25.0	24.0	−7.0	273.0
"	1	" 7.92		−1	−20.0	19.0	−3.1	553.0
"	1	" 13.08		−1	−16.0	15.0	−2.1	967.0
$CaCl_2+6H_2O$	1	" .35		0			.0	52.1
"	1	" .49		0			−19.7	49.5
"	1	" .61		0			−39.0	40.3
"	1	" .70		0			−54.9*	30.0
"	1	" .81		0			−40.3	46.8
"	1	" 1.83		0			−21.5	88.5
"	1	" 2.46		0			−9.0	192.3
"	1	" 4.92		0			−4.0	392.3
Alcohol at 4° C	77	" 73		0	−30.0			
"		CO_2 solid			−72.0			
Chloroform		" "			−77.0			
Ether		" "			−77.0			
Liquid SO_2		" "			−82.0			
NH_4NO_3	1	H_2O .76		20	5.0			
"	1	" .94		20	−4.0			
"	1	" "		10	−4.0			
"	1	" "		5	−4.0			
"	1	snow "		0	−4.0			
NH_4NO_3	1	H_2O 1.20		10	−14.0			
"	1	snow "		0	−14.0			
"	1	H_2O 1.31		10	−17.5*			
"	1	snow "		0	−17.5*			
"	1	H_2O 3.61		10	−8.0			
"	1	snow "		0	−8.0			

mended that this valve be opened while the pump is still running to prevent atmospheric air from forcing the pump to run backward or forcing oil from the pump into the condensing chamber.

Figure 8 illustrates assembly of the modified apparatus using a refrigerated condenser.

Preparation of Specimens

The freeze-dry process will not improve a poor specimen. If a specimen is emaciated, slightly deteriorated, or otherwise inferior when it enters the chamber, it will be in no better condition when it leaves. Sagged tissue, however, can often be reshaped with subcutaneous injections of water, and sagged body cavities can be restored with cotton before freezing.

The art and skill of the taxidermist will help decide the success or failure of the freeze-dry technique. Many of the same tools and methods of conventional taxidermy can be employed advantageously in the freeze-dry process. Wires, supports, and other tricks of the trade are useful. Also rapid freezing with liquid nitrogen or freezing mixtures will hold a specimen in position.

Initial freezing of the specimen.—Of all compounds in animal tissue, water is the most abundant. For the average, it constitutes 70 percent of the animal's total weight. Water is found in cellular and vascular spaces, and, in small quanties, in protein and carbohydrates. Of the total liquid content, 20 percent is usually in extracellular fluid; approximately 25 percent of this extracellular fluid is plasma, and the remainder is interstitial fluid, mostly water. About 76 percent of muscle tissue is water. The Rowntree data (see Harrow, 1951) relating to the biochemistry of man is a good general guide to the distribution of tissue water in most mammals.

Water in tissue is found almost always in combination with naturally occurring salts; for this reason, freezing should be brought about in the shortest possible time. Slow freezing invariably leads to the formation of eutectics through the concentration of salts. As freezing water separates itself from a solution by the process of ion diffusion, the salts become more highly concentrated than they were in the original solution.

Eutectics have lower freezing points and lower vapor pressures than water; thus, their formation during the process slows down drying. Due to unfrozen saturated fluid in the tissue and resulting surface tension, shrinkage occurs. Rapid freezing, which reduces the formation of eutectics, can be accomplished by using the freezing mixtures listed in table 6, liquid nitrogen, or a freezing chest with a temperature of less than −25° C. Rapid freezing also creates smaller ice crystals, causing less tissue distortion during the process.

Techniques for faster drying.—The greatest amount of water is removed early in the drying cycle when a specimen's dried shell is thinnest and offers the least impedence to the escape of water vapor. The rate of weight loss due to the escape of vapor approaches zero with the completion of drying. If a specimen chamber is loaded with a great number of fresh specimens, the water-vapor atmosphere will be very great during the first few days, possibly exceeding the capacity of the system. If, however, specimens are introduced at spaced intervals, the same number of specimens can probably be processed without exceeding the system's vapor-removing capacity, and a constant level of water-vapor removal may be approached.

By drilling holes in the back or bottom portions of specimens, their drying surfaces are increased and the area of their epidermal layers is decreased, allowing water vapor to escape more rapidly. Skinning one side of a specimen serves a similar function in that it removes epidermal tissue that would otherwise act as a vapor barrier.

Evisceration of a specimen also reduces its water content considerably; however, the removal of water-laden organs requires incision, removal of the viscera, filling the body cavity with cotton or similar material, all of which requires time and involves some of the less desirable features of taxidermy.

A record should be maintained of each specimen's weight since observing the weight reduction (by removing the specimen from the chamber and weighing it) is the best method for determining when a specimen is completely dry. A specimen should be left in the chamber for one or two days after the loss of weight ceases to be apparent. This is especially true for rodents such as mice or rats with a scaly epidermis on their tails. The tails dry slowly and it is therefore advisable to perforate their undersides and keep the specimens in the chamber beyond their apparent drying times.

Conclusion

As technology advances, it becomes apparent that freeze-dry will be an ever-growing field. Plans are already underway for increasing the Smithsonian facilities. Theoretically, there is no limitation to the ultimate size or numbers of specimens that at one time could be processed in this manner. It is hoped that this paper will help to encourage the growth and exchange of further ideas on the freeze-drying process.

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CATALOG OF TYPE SPECIMENS OF THE DARTERS (PISCES, PERCIDAE, ETHEOSTOMATINI)[1]

By Bruce B. Collette and Leslie W. Knapp[2]

Introduction

The darters are a tribe of small freshwater fishes restricted to North America. Some 212 specific and subspecific names have been proposed for the approximately 100 valid described species. About a dozen species await description. As part of a long-term study of these fishes, we have prepared this catalog of type specimens. We hope that our efforts will be of value in furthering systematic research and stabilizing the nomenclature of this most fascinating group of North American fishes.

In preparing this catalog we have attempted to examine or at least to verify the location of the type specimens of all nominal forms of the three presently recognized genera of darters: *Percina*, *Ammocrypta*, and *Etheostoma*. By type specimens we mean holotypes, lectotypes, syntypes, paralectotypes, and paratypes. Each form is

[1] Fifth paper in a series on the systematics of the Percidae by the senior author.

[2] Collette: Assistant Laboratory Director, Bureau of Commercial Fisheries Ichthyological Laboratory, Division of Fishes, U.S. National Museum; Knapp: Supervisor in charge of vertebrates, Oceanographic Sorting Center, Smithsonian Institution.

listed in alphabetical order by the generic and specific name used in the original description. If subgeneric allocation was made in the original description, that name has been placed in parentheses between the genus and the species. Holotypes or lectotypes are listed before paratypes or paralectotypes.

The following data appear after each name: (1) citation of original description; (2) catalog number; (3) number of specimens and range in standard length in mm. are in parentheses; sex is given in a few cases; (4) locality; (5) collector; (6) date of collection; (7) determination of current status with reference to pertinent literature.

All original descriptions were consulted to help determine whether a collection was actually type material. The generic and subgeneric arrangement is modified from that presented by Bailey (*in* Bailey, Winn, and Smith, 1954, and *in* Bailey and Gosline, 1955). The use of the tribe Etheostomatini for the darters follows Collette (1963).

Lectotypes were selected in some instances in order to stabilize nomenclature. The following people have assisted in the selection of lectotypes: Dr. Charles F. Cole (subgenus *Boleosoma*); Mr. Donald A. Distler (*E. spectabile*); Dr. Robert V. Miller (*E. blennioides*); Dr. Edward C. Raney (*P. notogramma, P. crassa,* subgenus *Nothonotus*); Dr. William J. Richards (*E. swannanoa, E. thalassinum*); Dr. Chu-fa Tsai (*E. histrio, E. rupestre,* and *E. zonale*). Brief data are presented for each lectotype herein selected and the following abbreviations are used: D=dorsal spines (Roman numerals) and rays (Arabic numerals); A=anal spines (Roman) and rays (Arabic); LL=number of lateral line scales; POM=number of preoperculomandibular pores; and INF=number of infraorbital pores. If the lateral line is incomplete, the number of pored scales is given first, separated from the number of unpored scales by a plus sign; if the infraorbital canal is incomplete, the number of pores in the anterior portion is separated from the number in the posterior portion by a plus sign.

Five nominal species are replacement names. No original material was saved of the five species of darters described by Constantine Rafinesque. Type material of 21 nominal species could not be located. In instances where a type series was divided among several institutions, we usually located some of the specimens. However, when all of the types of a form were deposited in one institution we were occasionally unable to locate any specimens.

About 1860, a considerable number of darters, including types of 16 species described by Charles Girard, were sent from the U.S. National Museum to the Museum of Comparative Zoology at Harvard University for Frederick Putnam to study. Many of these were cataloged into the MCZ collection (table 1), and Jordan and others subsequently believed them lost. Representatives from a number of these series at the MCZ were later transferred to the University of Michigan Museum of Zoology by Carl L. Hubbs.

Another problem concerns the type material studied by Jordan at Indiana University. These specimens first received a lot number and

TABLE 1.—*Darter types transferred from USNM to MCZ*

USNM No.	First MCZ No.	Present MCZ No.	Species and describer	Locality
740	269	24599	*Pileoma carbonaria* Baird and Girard.	Tex., Río Salado
743	87	24625	*Diplesion fasciatus* Girard	Mex., Chihuahua R.
744	82	24575	*Boleosoma lepida* Baird and Girard.	Tex., Río Leona
745	84	24567	*Boleichthys elegans* Girard	Tex., Piedrapainte
748	83	24580	*Oligocephalus leonensis* Girard	Tex., Río Leona
1157	130	24546	*Hadropterus maculatus* Girard	Md., Potomac R.
1175	257	24636	*Pileoma zebra* Agassiz	Lake Superior
1179	1179	1179	*Aplesion potsii* Girard	Mex., Chihuahua R.
1182	85	24576	*Oligocephalus grahami* Girard	Tex., Devil's R.
1187	22	24652	*Catonotus fasciatus* Girard	N.Y., Grass R.
1188	101	24589	*Boleosoma fusiforme* Girard	Mass., Charles R.
1192	87	24625	*Diplesion fasciatus* Girard	Mex., Chihuahua R.
1197	122	24603	*Hadropterus nigrofasciatus* Agassiz.	Ala., near Mobile
1203	16	24634	*Oligocephalus humeralis* Girard	Va., James R.
1203	16	35975	*Oligocephalus humeralis* Girard	Va., James R.
1206	87	24625	*Diplesion fasciatus* Girard	Mex., Chihuahua R.
1283	93	24570	*Microperca punctulata* Putnam	Wis., Oconomowoc R.
1288	94	24690	*Microperca punctulata* Putnam	Mich., Pt. Huron
1294	96	24582	*Microperca punctulata* Putnam	Mich., Detroit R.
1303	129	24525	*Hadropterus maculatus* Girard	Md., Potomac R.
1311	270	24616	*Pleurolepis pellucidus* Agassiz	Ohio, Black R.
1327	----	32952	*Boleichthys warreni* Girard	N. Dak., Cannon Ball R.
1328	113	113	*Boleosoma gracile* Girard	Tex., Río Seco
1333	41	24569	*Boleichthys whipplii* Girard	Okla., Coal Cr.
1334	----	32950	*Oligocephalus pulchellus* Girard	Okla., Gypsum Cr.
1336	114	24728	*Boleichthys exilis* Girard	N. Dak., Little Muddy R.
1365	2	24658	*Catonotus Kennicotti* Putnam	Ill., Union Co.
1377	95	24566	*Microperca punctulata* Putnam	Ill., Calumet R.
1393	21	24656	*Catonotus fasciatus* Girard	N.Y., Grass R.
1801	1	24637	*Catonotus lineolatus* Agassiz	Ill., near Quincy
1801	1	24657	*Catonotus lineolatus* Agassiz	Ill., near Quincy
1811	37	24665	*Catonotus Kennicotti* Putnam	Ill., Union Co.
1865	237	24602	*Hyostoma Newmanii* Agassiz	Ala., Huntsville

later a regular catalog number. We have recorded both numbers. Some of these specimens are now at Stanford; many were transferred to the California Academy of Sciences. Later, some of the CAS types were transferred to the University of Michigan. However, a number are still missing.

In addition to listing the type specimens, we have compiled a list of the genus-group names proposed for the darters. The original description for each was verified. We have attempted to discover the first subsequent selection of type-species for those nominal genera which lacked originally designated type-species. The list is divided into available and unavailable genus-group names.

To facilitate using this catalog, we have also compiled an alphabetical index of nominal forms, using the original spelling. The author and the genus in which the species was originally described follow the specific name. Abbreviations of museums presently housing type material of each form are given following the name. Museums with the holotype, lectotype, or most syntypes are listed first. A museum abbreviation with a question mark indicates where the types were probably originally deposited even though we could not locate them. A question mark indicates we could not locate any types and do not know where they might be. An "X" is used when there was no type material, or it is almost certainly lost.

We express our deep appreciation to the curators and staffs of the museums and collections which house the type material of the darters. Type material is or has been in the collections listed below. Collections marked with an asterisk have been visited by one or both of the authors (BBC, LWK). Other initials represent those who kindly verified material in a few collections, with small holdings of darter types, which we were unable to visit.

*ANSP	Academy of Natural Sciences, Philadelphia. Dr. James E. Böhlke. [BBC, LWK.]
*BF	U.S. Bureau of Fisheries. Collection now merged with USNM.
*BMNH	British Museum (Natural History). Dr. P. H. Greenwood, Mr. Peter J. Whitehead. [BBC.]
*CAS	California Academy of Sciences, San Francisco. Mr. W. I. Follett, Mrs. Lillian Dempster. [BBC, LWK.]
*CM	Charleston Museum, S.C. Mr. E. Milby Burton. [BBC]
*CU	Cornell University, Ithaca, N.Y. Dr. Edward C. Raney, Mr. Timothy Zorach, Mr. Robert E. Jenkins. [BBC, LWK.]
*DU	Duke University, Durham, N.C. Dr. Joseph R. Bailey, Dr. Walter R. Courtenay, Jr. [BBC.]
*FMNH	Field Museum of Natural History, Chicago. Mrs. Marion Grey, Miss Pearl Sonoda. [BBC, LWK.]
*INHS	Illinois Natural History Survey, Urbana. Dr. Philip W. Smith [BBC, LWK.]
*ISC	Iowa State University, Ames. Dr. Kenneth D. Carlander. Type darters transferred to USNM. [BBC.]
*IU	Indiana University, Bloomington. Specimens now at CAS or UMMZ. [BBC, LWK.]
*KU	Kansas University, Lawrence. Dr. Frank B. Cross. [LWK, BBC].

*MCZ	Museum of Comparative Zoology, Harvard. Dr. Giles W. Mead, Mrs. Myvanwy Dick. [BBC, LWK.]
*MNHN	Muséum National d'Histoire Naturelle, Paris. Mme. M. L. Bauchot. [LWK, BBC.]
*NCSM	North Carolina State Museum, Raleigh. Mr. William M. Palmer. Darter types transferred to USNM. [BBC, LWK.]
OAM–OSU	Oklahoma Agricultural and Mechanical College, now Oklahoma State University, Stillwater. Dr. Rudolph J. Miller. [RJM.]
*OSM	Ohio State Museum, Columbus. Dr. Milton B. Trautman. [BBC, LWK.]
*SU	Stanford University, Division of Systematic Biology. Dr. George S. Myers, Dr. Warren C. Freihofer, Mr. Stewart Springer. [BBC, LWK.]
TAMC	Texas Agricultural and Mechanical University, College Station. Dr. Richard J. Baldauf. [RJB.]
TNHC	Texas Natural History Collections, University of Texas, Austin. Dr. Clark Hubbs. [CH.]
TU	Tulane University, New Orleans. Dr. Royal D. Suttkus, Dr. John S. Ramsey. [JSR.]
*TUC	Tulsa University Collections. Dr. Albert P. Blair. Darter types transferred to USNM. [BBC.]
UAIC	University of Alabama Ichthyological Collections. Mr. William M. Howell. [WMH.]
UG	University of Georgia, Athens. Dr. Donald C. Scott. Darter types transferred to CU. [Dr. William Richards, LWK.]
*UMMZ	University of Michigan, Museum of Zoology, Ann Arbor. Dr. Reeve M. Bailey, Dr. Robert R. Miller. [BBC, LWK.]
UOMZ	University of Oklahoma, Museum of Zoology, Norman. Dr. Carl D. Riggs. [CDR.]
UR	University of Richmond, Richmond, Va. Dr. William S. Woolcott. [WSW.]
*USNM	U.S. National Museum, Washington. [BBC, LWK.]
UW	University of Wisconsin, Milwaukee. Dr. Carroll R. Norden. [CRN.]
VPI	Virginia Polytechnic Institute, Blacksburg. Dr. William S. Woolcott. [WSW.]

In addition to those already mentioned who have selected lectotypes or who have permitted us to examine material housed in their institutions, we wish to thank Drs. Robert H. Gibbs, Jr., James A. Peters, and W. Ralph Taylor of the U.S. National Museum, for critically commenting upon the manuscript.

Available Genus-Group Names

Allohistium Bailey *in* Bailey and Gosline, 1955, Misc. Publ. Mus. Zool. Univ. Michigan, no. 93, p. 6. Type-species *Etheostoma cinerea* Storer, 1845, by original designation.

Alvordius Girard, 1859, Proc. Acad. Nat. Sci. Philadelphia, vol. 11, p. 68. Type-species *Alvordius maculatus* Girard, 1859, by monotypy.

Ammocrypta Jordan, 1877, U.S. Nat. Mus. Bull. 10, p. 5. Type-species *Ammocrypta beanii* Jordan, 1877, by original designation.

Anemoces Jordan, 1929, Manual of Vertebrates, 13th ed., p. 156. Type-species *Ulocentra gilberti* Evermann and Thoburn *in* Jordan and Evermann, 1896, by original designation.

Arlina Girard, 1859, Proc. Acad. Nat. Sci. Philadelphia, vol. 11, p. 64. Type-species *Arlina effulgens* Girard, 1859 (=*Etheostoma olmstedi* Storer, 1842), by monotypy.

Asproperca Heckel *in* Canestrini, 1860, Verh. Zool.-Bot. Wien, vol. 10, p. 311. Type-species "*Asproperca zebra* Heck." (=*Pileoma zebra* Agassiz, 1850), by monotypy.

Astatichthys Vaillant, 1873, Nouv. Arch. Mus. Hist. Nat. Paris, vol. 9, p. 106. Type-species *Etheostoma caeruleum* Storer, 1845, by original designation.

Austroperca Hubbs, 1936, Occ. Pap. Mus. Zool. Univ. Michigan, no. 341, p. 1. A replacement name for *Torrentaria* Jordan and Evermann, 1896, preoccupied by *Torrentaria* (Hodgson MS) Gray, 1863, Aves. Takes the same type-species as *Torrentaria* Jordan and Evermann, *Etheostoma australe* Jordan, 1884.

Belophlox Fowler, 1947, Not. Nat. Acad. Nat. Sci. Philadelphia, no. 191, p. 1. Type-species *Belophlox mariae* Fowler, 1947, by original designation.

Boleichthys Girard, 1859, Proc. Acad. Nat. Sci. Philadelphia, vol. 11, p. 103. Type-species *Boleichthys exilis* Girard, 1859, by original designation.

Boleosoma DeKay, 1842, Nat. Hist. New York Zool., vol. 4, p. 20. Type-species *Boleosoma tessellatum* DeKay, 1842 (=*Etheostoma olmstedi* Storer), by monotypy.

Catonotus Agassiz, 1854, Amer. Journ. Sci. and Arts, vol. 17, p. 305. Type-species *Catonotus lineolatus* Agassiz, 1854 (=*Etheostoma flabellaris* Rafinesque, 1819), by monotypy.

Claricola Jordan and Evermann, 1896, U.S. Nat. Mus. Bull. 47, p. 1093. Type-species *Etheostoma juliae* Meek, 1891, by original designation.

Copelandellus Jordan and Evermann, 1896, U.S. Nat. Mus. Bull. 47, p. 1100. Type-species *Poecilichthys quiescens* Jordan, 1884 (= *Boleosoma fusiforme* Girard, 1854), by original designation.

Cottogaster Putnam, 1863, Bull. Mus. Comp. Zool., vol. 1, p. 4 Type-species *Boleosoma tessellatum* Thompson, 1853, not of DeKay (= *Rheocrypta copelandi* Jordan, 1877), by monotypy.

Crystallaria Jordan and Gilbert *in* Jordan 1885, Ann. Rep. Comm. Fish and Fish. for 1885, p. 866. Type-species *Pleurolepis asprellus* Jordan, 1878, by original designation.

Diplesion Rafinesque, 1820, Ichthyologia Ohiensis, p. 37. Type-species *Etheostoma blennioides* Rafinesque, 1819, by subsequent designation of Girard, 1859, p. 101 and Jordan and Gilbert, 1877, p. 86.

Doration Jordan, 1929, Manual of the Vertebrates, 13th ed., p. 156. Type-species *Boleosoma stigmaeum* Jordan, 1877, by original designation.

Ericosma Jordan, 1877, U.S. Nat. Mus. Bull. 10, p. 8. Type-species *Alvordius evides* Jordan and Copeland, 1877, by original designation.

Estrella Girard, 1859, Proc. Acad. Nat. Sci. Philadelphia, vol. 11, p. 65. Type-species *Estrella atromaculata* Girard, 1859 (=*Etheostoma olmstedi* Storer, 1842), by monotypy.

Etheostoma Rafinesque, 1819, Journ. Phys., Chim., Hist. Nat., vol. 88, p. 419. Type-species *Etheostoma blennioides* Rafinesque, 1819, by subsequent designation of Agassiz (1854, p. 305). Verified by Opinion 14, Int. Comm. Zool. Nomen., 1910, Smithsonian Inst. Publ., 1938, pp. 25–27. Not *Etheostoma flabellaris* Rafinesque, 1819, as designated by Jordan and Gilbert, 1877, p. 85.

Hadropterus Agassiz, 1854, Amer. Journ. Sci. and Arts, vol. 17, p. 305. Type-species *Hadropterus nigrofasciatus* Agassiz, 1854, by monotypy.

Hololepis Agassiz *in* Putnam, 1863. Bull. Mus. Comp. Zool., vol. 1, p. 4. Type-species *Boleosoma Barratti* Holbrook, 1885 (=*Boleosoma fusiforme* Girard, 1854), by subsequent designation of Jordan and Gilbert, 1877, p. 93.

Hyostoma Agassiz, 1854, Amer. Journ. Sci. and Arts, vol. 17, p. 305. Type-species *Hyostoma Newmanii* Agassiz, 1854 (=*Etheostoma blennioides* Rafinesque, 1819), by monotypy.

Hypohomus Cope, 1870, Proc. Amer. Philos. Soc., vol. 11, p. 449. Type-species *Cottogaster aurantiacus* Cope, 1869, by monotypy.

Imostoma Jordan, 1877, Proc. Acad. Nat. Sci. Philadelphia, vol. 29, p. 49. Type-species *Hadropterus shumardi* Girard, 1859, by original designation.

Ioa Jordan and Brayton, 1878, U.S. Nat. Mus. Bull. 12, p. 88. Type-species *Poecilichthys vitreus* Cope, 1870, by original designation.

Litocara Bailey, 1948, Copeia, 1948, p. 79. Type-species *Poecilichthys sagitta* Jordan and Swain, 1883, by original designation.

Microperca Putnam, 1863, Bull. Mus. Comp. Zool., vol. 1, p. 4. Type-species *Microperca punctulata* Putnam, 1863 (=*Etheostoma microperca* Jordan and Gilbert, *in* Jordan 1888), by monotypy.

Nanostoma Putnam *in* Jordan, 1877, U.S. Nat. Mus. Bull. 10, p. 6. Type-species *Poecilichthys zonalis* Cope, 1868, by original designation.

Niviperca Whitley, 1951, Proc. Royal Zool. Soc. New South Wales, 1949–50, p. 68. A replacement name for *Nivicola* Jordan and Evermann preoccupied by *Nivicola* Hodgson, 1844, Aves. Takes the same type-species as *Nivicola* Jordan and Evermann, *Poecilichthys borealis* Jordan, 1844 (=*Boleichthys exilis* Girard, 1859).

Nothonotus Agassiz *in* Putnam, 1863, Bull. Mus. Comp. Zool., vol. 1, p. 3. Type-species *Etheostoma maculatum* Kirtland, 1840, by subsequent designation of Jordan and Gilbert 1877, p. 93.

Oligocephalus Girard, 1859, Proc. Acad. Nat. Sci. Philadelphia, vol. 11, p. 67. Type-species *Boleosoma lepida* Baird and Girard, 1853, by subsequent designation of Vaillant (1873, p. 90).

Percina Haldeman, 1842, Journ. Acad. Nat. Sci. Philadelphia, vol. 8, p. 330. Type-species *Perca nebulosa* Haldeman, 1842 (=*Sciaena caprodes* Rafinesque, 1818), by monotypy.

Pileoma DeKay, 1842, Nat. Hist. New York Zool., vol. 1, pt. 4, p. 16. Type-species *Pileoma semifasciata* DeKay, 1842 (=*Sciaena caprodes* Rafinesque, 1818), by monotypy.

Plesioperca Vaillant, 1873, Nouv. Arch. Mus. Hist. Nat. Paris, vol. 9, p. 36. Type-species *Plesioperca anceps* Vaillant, 1873 (=*Hadropterus nigrofasciatus* Agassiz, 1854), by monotypy.

Poecilichthys Agassiz, 1854, Amer. Journ. Sci. and Arts, vol. 7, p. 304. A replacement name for *Poecilosoma* Agassiz, 1850, preoccupied by *Poecilosoma* Huebner, 1819, Lepidoptera; *Poecilosoma* Stephens 1829, Hemiptera; *Poecilosoma* Newman, 1838, Coleoptera. Takes the same type-species as *Poecilosoma* Agassiz, *Etheostoma variatum* Kirtland, 1838.

Psychromaster Jordan and Evermann, 1896, U.S. Nat. Mus. Bull. 47, p. 1099. Type-species *Etheostoma tuscumbia* Gilbert and Swain, 1887, by original designation.

Rafinesquiellus Jordan and Evermann, 1896, U.S. Nat. Mus. Bull. 47, p. 1082. Type-species *Aplesion pottsii* Girard 1859, by original designation.

Rheocrypta Jordan, 1877, U.S. Nat. Mus. Bull. 10, p. 9. Type-species *Rheocrypta copelandi* Jordan, 1877, by monotypy.

Rhothoeca Jordan, 1885, Ann. Rept. Comm. Fish and Fish. for 1885, p. 868. Substitute name for *Nanostoma* Putnam erroneously regarded as preoccupied by *Nannostomus* Günther and taking the same type-species *Poecilichthys zonalis* Cope, 1869.

Richiella Coker, 1927, Copeia, no. 162, p. 18. Substitute name for *Richia* Coker preoccupied by *Richia* Grote, 1887, Lepidoptera. Takes the same type-species as *Richia* Coker, *Richia brevispina* Coker, 1926 (=*Etheostoma flabellaris* Rafinesque, 1819).

Serraria Gilbert, 1884, Proc. U.S. Nat. Mus. vol. 7, p. 205. Type-species *Hadropterus scierus* Swain, 1883, by original designation.

Swainia Jordan and Evermann, 1896, U.S. Nat. Mus. Bull. 47, p. 1040. Type-species *Etheostoma squamatus* Gilbert and Swain, 1887, by original designation.

Ulocentra Jordan, 1878, Manual of Vertebrates, 2nd ed., p. 223. Type-species *Arlina atripinnis* Jordan, 1877, by monotypy.

Vaillantia Jordan *in* Jordan and Brayton, 1878, U.S. Nat. Mus. Bull. 12, p. 89. Type-species *Boleosoma camurum* Forbes, 1878 (=*Vaillantia chlorosomum* Hay, 1880), by original designation.

Vigil Jordan, 1919, Proc. Acad. Nat. Sci. Philadelphia, vol. 70, p. 344. Substitute name for *Pleurolepis* Agassiz, 1863, preoccupied by *Pleurolepis* Quenstedt, 1852, Pisces. Takes the same type-species as *Pleurolepis* Agassiz, *Pleurolepis pellucidus* Agassiz *in* Putnam, 1863.

Villora Hubbs and Cannon, 1935, Misc. Publ. Univ. Michigan Mus. Zool., no. 30, p. 11. Type-species *Villora edwini* Hubbs and Cannon, 1935, by original designation.

Unavailable Genus-Group Names

Nivicola Jordan and Evermann, 1896, U.S. Nat. Mus. Bull. 47, p. 1082. Type-species *Poecilichthys borealis* Jordan 1884, (=*Boleichthys exilis* Girard, 1859), by original designation; preoccupied by *Nivicola* Hodgson, 1844, Aves.

Pleurolepis Agassiz *in* Putnam, 1863, Bull. Mus. Comp. Zool., vol. 1, p. 5. Type-species *Pleurolepis pellucidus* Agassiz *in* Putnam, 1863, by monotypy; preoccupied by *Pleurolepis* Quenstedt, 1852, Semionotidae.

Poecilisoma Agassiz, 1850, Lake Superior, p. 299. Type-species *Etheostoma variata* Kirtland, 1838, by subsequent designation of Agassiz, 1854, p. 306. Name preoccupied by *Poecilosoma* Huebner, 1819, Lepidoptera; *Poecilosoma* Stephens, 1829, Hemiptera; and *Poecilosoma* Newman, 1838, Coleoptera.

Richia Coker, 1926, Bull. Bur. Fish., vol. 42, p. 106. Type-species *Richia brevispina* Coker, 1926 (=*Etheostoma flabellaris* Rafinesque, 1819), by original designation; preoccupied by *Richia* Grote, 1887, Lepidoptera.

Torrentaria Jordan and Evermann, 1896, U.S. Nat. Mus. Bull. 47, p. 1080. Type-species *Etheostoma australe* Jordan, 1884, by original designation; preoccupied by *Torrentaria* (Hodgson MS) Gray, 1863, Aves.

Nominal Species

Alvarius fonticola Jordan and Gilbert, 1886, Proc. U.S. Nat. Mus., vol. 9, p. 23. Redescribed in more detail as "*Etheostoma* (*Alvarius*) *fonticola* Jordan and Gilbert, sp. nov." in Gilbert (1887, p. 63).

Lectotype: USNM 36523 (♂, 27), Texas, San Marcos R. at San Marcos; D. S. Jordan and C. H. Gilbert; September 1884; figured in Jordan and Evermann (1900, fig. 470); herein selected. D VII–10; A I, 6; LL 2+30=32; INF 3+1; POM 8; supratemporal canal interrupted; nape, cheeks, and breast naked; breeding tubercles on posterior anal rays.

Paralectotypes: USNM 198004 (3, 21–24), removed from USNM 36523.

=*Etheostoma* (*Microperca*) *fonticola* (Jordan and Gilbert).

Alvordius aspro Cope and Jordan *in* Jordan, 1877, Proc. Acad. Nat. Sci. Philadelphia, vol. 29, p. 51, based on the figure but not the description of "*Etheostoma blennioides*" in Kirtland, 1841, Boston Journ. Nat. Hist., p. 3, pl. 6, fig. 1.

Types: This name was proposed as "*Alvordius aspro*, Cope and Jordan, nom. sp. nov.," a replacement name for *Etheostoma blennioides* of Kirtland's figure. However, the name clearly applies to a new species based on Kirtland's misidentified figure. Cope and Jordan did not provide any description, did not mention any localities, and gave no indication of having any material before them. Therefore, the type of *A. aspro* must be the specimen from the Mahoning River, Ohio, from which Kirtland drew his figure. We have not been able to locate this specimen. However, there are two specimens collected by Jordan from the White River in Indiana. One, labeled "paratype," is USNM 20137, and the other, labeled "cotype," is BMNH 1880.1.21.84. In the same year that *A. aspro* was described, Jordan (1877, p. 375) listed *A. aspro* as "frequent" in collections made by Copeland and Jordan in the White River around Indianapolis. The USNM and BMNH specimens should not be considered as type material because the original description was based only on the references to Kirtland's figure.

=*Percina* (*Alvordius*) *maculata* (Girard).

Alvordius crassus Jordan and Brayton, 1878, U.S. Nat. Mus. Bull. 12(A), p. 12.

Lectotype: USNM 23459 (♂, 63), South Carolina, Saluda R., near Greenville; D. S. Jordan and A. B. Brayton; summer, 1877; labeled "drawn"; herein selected by Dr. Edward C. Raney. D XII–13; A II,10; LL 54, complete; cheeks and anterior portion of nape naked;

breast with one enlarged scale; another enlarged scale between pelvic fin bases; opercle covered with scales.

Paralectotypes: USNM 31111 (3, 46–50), same data as lectotype.

=*Percina* (*Ericosma*) *crassa crassa* (Jordan and Brayton).

Alvordius evides Jordan and Copeland *in* Jordan, 1877, Proc. Acad. Nat. Sci. Philadelphia, vol. 29, p. 51.

Lectotype: USNM 17872 (♂, 45), Indiana, Marion Co., White R., near Indianapolis; D. S. Jordan; 1874; herein selected. D XII–13; A II,9; LL 64; INF 8; POM 10; cheeks with a small patch of scales under junction of lateral and infraorbital canals; opercles scaly; nape with scattered scales; breast naked except for one modified scale at center; subocular bar present.

Paralectotypes?: MCZ 24399 (2 ♂, 42–46), same locality as lectotype. We are not certain that MCZ 24399 contains the other two syntypes on which the original description was based.

The original description was based on three specimens. Jordan and Copeland (in Jordan, 1877, p. 8) utilized additional specimens when they described *Ericosma* to contain the previously described *A. evides.* These additional specimens were incorrectly labeled as types: USNM 20119, MCZ 35957, and BMNH 1880.1.21.12–14.

=*Percina* (*Ericosma*) *evides* (Jordan and Copeland).

Alvordius maculatus Girard, 1859, Proc. Acad. Nat. Sci. Philadelphia, vol. 11, p. 68.

Syntypes: USNM 1346 (2, ?), Fort Gratiot on Lake Huron; Maj. B. Alvord; listed as thrown away in USNM catalog and we have been unable to find them.

=*Percina* (*Alvordius*) *maculata* (Girard).

Ammocrypta beanii Jordan, 1877, U.S. Nat. Mus. Bull. 10, p. 5.

Holotype: USNM 17833 (♂, 52), Louisiana, Notalbany R., near Tickfaw; T. H. Bean; December 1876.

=*Ammocrypta* (*Ammocrypta*) *beanii* Jordan.

Ammocrypta clara Jordan and Meek, 1885, Proc. U.S. Nat. Mus., vol. 8, p. 8.

Lectotype: USNM 35828 (1, 42), Iowa, Des Moines R. at Ottumwa; D. S. Jordan and S. E. Meek; August 1884. Jordan and Evermann (1896, p. 1063) listed USNM 35828, then containing four specimens, as "type." Linder (1959) selected one specimen as lectotype and removed the other three.

Paralectotypes: USNM 164166 (3, 33–51), out of USNM 35828. Linder overlooked paralectotypes SU 1500 (1, 46) and UMMZ 187510 (2, disintegrated), orig. IU 753, then IU 7323, that are also from the original type series.

The original description was based on the Ottumwa specimens and is followed by "specimens were *also* obtained in Red River at Fulton, Arkansas, and in the Sabine River at Longview, Texas" (italics ours). The Sabine River specimens (USNM 36488) and the Red River specimens (USNM 36337) were labeled paratypes in the USNM collection, but we do not feel they should be considered as such because they are listed in the fashion of "other material."

=*Ammocrypta* (*Ammocrypta*) *clara* Jordan and Meek. See Linder (1959).

Ammocrypta gelida Hay, 1881, Proc. U.S. Nat. Mus., vol. 3, p. 490.

Syntypes: USNM 27425 (2, 44–45), Mississippi, Clarke Co., Chickasawha R. at Enterprise; O. P. Hay; March–April 1880.

=*Ammocrypta* (*Ammocrypta*) *beanii* Jordan.

Ammocrypta vivax Hay, 1883, Bull. U.S. Fish Comm., vol. 2, p. 58.

Holotype: USNM 32213 (1, 39), Mississippi, Pearl R. at Jackson; O. P. Hay; summer, 1881.

=*Ammocrypta* (*Ammocrypta*) *vivax* Hay.

Aplesion potsii Girard, 1859, Proc. Acad. Nat. Sci. Philadelphia, vol. 11, p. 102; *potsii* a misprint for *pottsii*.

Holotype: MCZ 1179 (1, 50), Mexico, Chihuahua R. and tribs.; J. Potts; orig. USNM 1179.

=*Etheostoma* (*Oligocephalus*) *pottsii* (Girard).

Arlina atripinnis Jordan, 1877, U.S. Nat. Mus. Bull. 10, p. 10.

Holotype: USNM 20483 (♂, 56), Tennessee, trib. of Cumberland R., near Nashville; A. Winchell; in poor condition; frenum present, dorsal fin pattern clearly that of *Ulocentra*.

=*Etheostoma* (*Ulocentra*) *atripinne* (Jordan).

Arlina effulgens Girard, 1859, Proc. Acad. Nat. Sci. Philadelphia, vol. 11, p. 65.

Holotype: USNM 1253 (♂, 56), Washington, D.C., Rock Cr., trib. of Potomac R.; S. F. Baird; 1851.

=*Etheostoma* (*Boleosoma*) *olmstedi olmstedi* Storer. See Cole (1958).

Belophlox mariae Fowler, 1947, Notulae Naturae, no. 191, fig. 1.

Holotype: ANSP 71731 (♂, 55), North Carolina, Moore Co., trib. of outlet of Watson's Lake, about 3 mi. W. of Southern Pines, Little Pee Dee drainage; H. W. Fowler; Oct. 12, 1946.

=*Etheostoma* (*Oligocephalus*) *mariae* (Fowler).

Boleichthys elegans Girard, 1859, Proc. Acad. Nat. Sci. Philadelphia, vol. 11, p. 104.

Syntypes: MCZ 24567 (2, 35–40), Texas, Piedrapainte; J. H. Clark under Col. J. D. Graham; U.S. and Mexican Boundary Survey;

orig. USNM 745, then MCZ 84. The USNM catalog gives four for the number of specimens in USNM 745, but we have been unable to find any types other than MCZ 24567.

=*Etheostoma* (*Oligocephalus*) *grahami* (Girard).

Boleichthys eos Jordan *in* Nelson, 1876, Bull. Illinois Mus. Nat. Hist., no. 1, p. 35. Redescribed in more detail as "*Boleichthys eos*, Jordan and Copeland, n. s." *in* Jordan (1877, p. 46).

Syntypes: USNM 23460 (1, 42), Indiana, La Porte Co., Clear Lake; Jordan; summer, 1875. USNM 17848 (9, 27–42), Indiana, Wabash R.; Jordan. USNM 20117 (1, 34), Indiana, Wabash R.; Jordan; in very poor condition.

=*Etheostoma* (*Oligocephalus*) *exile* (Girard). See Hubbs (1926, p. 67).

Boleichthys exilis Girard, 1859, Proc. Acad. Nat. Sci. Philadelphia, vol. 11, p. 103.

Syntypes: USNM 1336 (24, 23–33), North Dakota, Little Muddy R., trib. of upper Missouri R.; G. C. Suckley. MCZ 24728 (6, 27–33), same data, all but the largest in poor condition; orig. USNM 1336, then MCZ 114. UMMZ 86492 (1, 31) out of MCZ 24728.

=*Etheostoma* (*Oligocephalus*) *exile* (Girard). See Hubbs (1926. pp. 64–68).

Boleichthys warreni Girard, 1859, Proc. Acad. Nat. Sci. Philadelphia, vol. 11, p. 104.

Holotype: MCZ 32952 (1, 42), North Dakota, Cannon Ball R., Hayden under Lt. G. K. Warren, exploration of the upper Missouri and Yellowstone; September 1856. The USNM catalog lists USNM 1327 as the type of *B. warreni*, but we have been unable to find a jar bearing this number. Jordan (1885, p. 869) and Hubbs (1926) wrote that the type was lost. The original description was based on only one specimen, and MCZ 32952 fits it very well.

=*Etheostoma* (*Oligocephalus*) *exile* (Girard). See Jordan (1885) and Hubbs (1926, p. 67).

Boleichthys whipplii Girard, 1859, Proc. Acad. Nat. Sci. Philadelphia, vol. 11, p. 103.

Syntypes: MCZ 24569 (1, 39), "Ark.," Coal Cr. [=trib. of Arkansas R. in E. Oklahoma, Hubbs and Black, 1941]; party under Lt. A. W. Whipple, Pacific Railroad Survey, orig. USNM 1333, then MCZ 41. USNM 1333 is listed in USNM catalog as containing two specimens, but we have been able to find only the specimen now cataloged as MCZ 24569.

=*Etheostoma* (*Oligocephalus*) *whipplii whipplii* (Girard). See Hubbs and Black (1941).

Boleosoma aesopus Cope, 1870, Proc. Amer. Philos. Soc., vol. 11, p. 270.

Syntypes: ANSP ?, Pennsylvania, Lycoming Co., Loyalsoc [now Loyalsock] Cr. in the Allegheny region; A. H. Smith. Types of other species described by Cope in this paper were deposited at ANSP, but Fowler (1907) did not mention types of this form, and we have not found them.

=*Etheostoma* (*Boleosoma*) *olmstedi olmstedi* Storer.

Boleosoma Barratti Holbrook, 1855, Journ. Acad. Nat. Sci. Philadelphia, ser. 3, vol. 2, p. 56, pl. 6, fig. 3.

Lectotype: MCZ 24571 (♂, 46), Florida, Holbrook; orig. MCZ 97; herein selected. D X–10; A II, 7; LL 26+24=50; INF 3+1; POM 9; interorbital, breast, and cheeks scaly.

Paralectotypes: MCZ 43090 (4, 37–40) and UMMZ 36598 (♂, 47), removed from MCZ 24571.

=*Etheostoma* (*Hololepis*) *fusiforme barratti* (Holbrook). See Hubbs and Cannon (1935) and Collette (1962).

Boleosoma camurum Forbes *in* Jordan, 1878, Bull. Illinois State Lab. Nat. Hist., vol. 1, no. 2, p. 40.

Syntypes: USNM 27894 (2 ♀, 39), Illinois, Peoria Lake; S. A. Forbes; Oct. 27, 1878. SU 1683 (♀, 44), Illinois. USNM 23455 (♀, 44), Illinois, Illinois R., figured in Jordan and Evermann (1898, fig. 452). MCZ 25053 (♀, 38), Illlinois, Peoria Lake. UMMZ 187505 (1, 39), Illinois, Pekin, orig. IU 506, then IU 4707. There were originally additional syntypes from "Cache R. and Clear Cr., Union Co.; Johnson Co." according to the original description, but we have not been able to locate them. Smith and Bridges (1960) reported that there were no syntypes in the collection of the Illinois Natural History Survey which inherited much of the material of the old Illinois State Laboratory of Natural History.

=*Etheostoma* (*Boleosoma*) *chlorosomum* (Hay) because *camurum* Forbes is preoccupied in *Etheostoma* by *Poecilichthys camurus* Cope.

Boleosoma fusiforme Girard, 1854, Proc. Boston. Soc. Nat. Hist., vol. 5, p. 41.

Lectotype: USNM 1188 (♀, 33), Massachusetts, trib. of Charles R. at Framingham; S. F. Baird; selected by Hubbs and Cannon (1935, p. 78).

Paralectotypes: USNM 94686 (25, 23–36); MCZ 24589 (4, 27–36); orig. USNM 1188, then MCZ 101. UMMZ 86582 (1, 37); out of MCZ 24589.

=*Etheostoma* (*Hololepis*) *fusiforme fusiforme* (Girard). See Hubbs and Cannon (1935) and Collette (1962).

Boleosoma gracile Girard, 1859, Proc. Acad. Nat. Sci. Philadelphia, 1859, p. 103.

Lectotype: USNM 1328 (♂, 35), Texas, Río Seco near Ft. Inge; C. B. Kennerly; selected by Hubbs and Cannon (1935, p. 44).

Paralectotypes: MCZ 113 (1, 36), orig. USNM 1328. USNM 1329 (1, 30), Texas, Río Leona near Ft. Inge; Kennerly.

=*Etheostoma* (*Hololepis*) *gracile* (Girard). See Hubbs and Cannon (1935) and Collette (1962).

Boleosoma lepida Baird and Girard, 1853, Proc. Acad. Nat. Sci. Philadelphia, vol. 6, p. 388.

Syntypes: USNM 744 (6, 32–45), Texas, Río Leona at Uvalde, trib. of Nueces R.; J. H. Clark. MCZ 24575 (3, 42–46), same data; orig. USNM 744, then MCZ 82. UMMZ 86335 (1, 41), out of MCZ 24575.

=*Etheostoma* (*Oligocephalus*) *lepidum* (Baird and Girard).

Boleosoma maculaticeps Cope, 1870, Proc. Amer. Philos. Soc., vol. 11, p. 269.

Lectotype: ANSP 13862 (♂, 45), North Carolina, upper waters of Catawba R.; E. D. Cope; selected and illustrated by Fowler (1907, p. 523, fig. 6). All 15 syntypes were still in the same bottle. The next to the largest specimen is closest (55.4 mm.) in total length to the size indicated by Fowler for the "type" (57.0 mm.), and it has the correct number of fin rays: D IX–13; A II,8. These are also the counts given by Cope in the original description. The lectotype has 43 lateral line scales, close to Fowler's figure which has about 45. This specimen herein confirmed as lectotype. INF 8; POM 10; pectoral rays 12–12.

Paralectotypes: ANSP 13863–76 (14, 23–48), same data as lectotype.

=*Etheostoma* (*Boleosoma*) *nigrum maculaticeps* (Cope). See Cole (1958).

Boleosoma maculatum Agassiz, 1850, Lake Superior, p. 305, pl. 4, fig. 3.

Lectotype: USNM 1840 (♂, 43), Ontario, Lake Superior, Ft. William and "the Pic" at the mouth of the Pic R.; L. Agassiz and party; July 13–20, 1848; herein selected by Dr. Charles F. Cole. D IX–13; A I,8; pectoral 12–13; LL 45+3=48; infraorbital pores 4+2; nape, cheeks, and breast naked; opercles partially scaled.

Paralectotype: USNM 197633 (♀, 41), removed from USNM 1840.

=*Etheostoma* (*Boleosoma*) *nigrum nigrum* Rafinesque.

Boleosoma mutatum Vaillant, 1873, Nouv. Arch. Mus. Hist. Nat. Paris, p. 88, a substitute name for *Boleosoma maculatum* Agassiz erroneously thought by Vaillant to be preoccupied in *Boleosoma* by *Etheostoma maculatum* Kirtland.

Types: The types of *B. mutatum* are the same as those of *Boleosoma maculatum* Agassiz.

=*Etheostoma* (*Boleosoma*) *nigrum nigrum* Rafinesque.

Boleosoma nigrum eulepis Hubbs and Greene, 1935, Trans. Wisconsin Acad. Sci., Arts, Lett., vol. 29, p. 96, pl. 3, figs. 1–3.

Holotype: UMMZ 77225 (1, 45), Wisconsin, Dodge Co., trib. of West Branch Rock R., 2 mi. N. of Atwater; C. W. Greene, Stuart, Creaser, and Griffin; Aug. 27, 1927.

Paratypes: UMMZ 100771 (79, 26–47), out of UMMZ 77225. USNM 74927 (2, 33–53), Wisconsin, Turtle Cr. at Delavan; N. Hollister; Oct. 11, 1910. USNM 117505 (3, 45–46), Wisconsin, Marquette Co., Welsh Cr.; Greene and H. S. Jones; Sept. 1, 1925; orig. UMMZ 73880. UMMZ 101528 (9, 25–52), Iowa, Dickinson Co., Spirit L.; J. C. Salyer; July 27, 1932. UMMZ 94832 (22, 26–48), Minnesota, Mississippi R. between Cass L. and Bemidji; Hubbs and Schultz; June 5, 1926. UMMZ 66681 (9, 24–28), Minnesota, Hubbard Co., L. Laselle and outlet; P. A. Moody; Aug. 11, 1925. UW 64 (17, 24–40), Wisconsin, Columbia Co.; Sand (Rock) Cr.; Greene and Jones; Aug. 18, 1925. UW 466 (5, 19–37), Wisconsin, Rock Co., Yahara R. at Indian Ford; G. Wagner; June 23, 1906. UW 467 (2, 40–41), Wisconsin, Walworth Co.; Geneva L.; Wagner; June 26, 1906. UW 473 (22, 24–59), Wisconsin; Manitowoc Co., Mud Cr. at Reedville; Wagner; July 17, 1906. UW 474 (18, 25–31), Wisconsin, Calumet Co., cr. at Brillion; Wagner; July 18, 1906. UW 479 (2, 38–43), Wisconsin, Vilas Co., Trout Lake Cr.; Wagner; July 10, 1907. UW 480 (3, 44–48), Wisconsin, Oneida Co., cr. between Squirrel L. and Diamond L.; Wagner; July 20, 1907.

The following paratypes are all UMMZ specimens from Wisconsin: 72370 (13, 29–54), Polk Co., Apple R., 2 mi. W. of Turtle L. on rt. 14; P. Okkelberg; Aug. 26, 1928. 72382 (13, 23–48), same data. 72414 (60, 25–57), Vilas Co., SE. side of Big Arbor Vitae L.; Metzelaar and Langlois; Sept. 19, 1925. 72447 (9, 36–50), Oneida Co., Kamaguesaga L., W. of Minoigua; Metzelaar and Langlois; Sept. 20, 1925. 72467 (2, 32–37), Vilas Co., Trout L.; Metzelaar and Langlois; Sept. 20, 1925. 72495 (14, 39–53), Vilas Co., Little Arbor Vitae L.; Metzelaar and Langlois; Sept. 21, 1925. 72502 (18, 32–52), Vilas Co., St. Germain L.; Metzelaar and Langlois; Sept. 21, 1925. 73442 (15, 30–49), Columbia Co., Fox R., 10 mi. E. of Portage on rt. 33; Greene and Jones; Aug. 18, 1925. 73458 (1, 42), Columbia Co., French Cr., below dam; Greene and Jones; Aug. 19, 1925. 73464 (35, 32–56), Columbia Co., French Cr., 1 mi. above mill pond; Greene and Jones; Aug. 19, 1925. 73472 (4, 46–56), Columbia Co., Spring Branch Cr., above co. rd.; Greene and Jones; Aug. 19, 1925. 73475 (3, 48–53), same data. 73563 (11, 31–51), Marquette Co., trib. of

Neenah Cr., 1.5 mi. from Neenah Cr.; Greene and Jones; Aug. 21, 1925. 73571 (5, 37–47), Columbia Co., outlet of Spring L., Pardeeville; Greene and Jones; Aug. 22, 1925. 73579 (28, 23–48), Columbia Co., old channel, below Park L. Dam; Greene and Jones; Aug. 22, 1925. 73586 (11, 34–45), Columbia Co., Park L.; Greene and Jones; Aug. 22, 1925. 73627 (89, 27–55), Marquette Co., Neenah Cr., 2 mi. NE. of Briggsville on rt. 23; Greene and Jones; Aug. 24, 1925. 73640 (2, 40–41), Columbia Co., trib. of Neenah Cr., 6 mi. E. of Briggsville; Greene and Jones; Aug. 24, 1925. 73670 (66, 30–48), Marquette Co., Belle Fountaine Cr., 4 mi. N. of Dalton; Greene and Jones; Aug. 25, 1925. 73683 (11, 31–49), Columbia Co., Neenah Cr., near mouth; Greene and Jones; Aug. 26, 1925. 73693 (33, 30–44), Columbia Co., French Cr. at mouth; Greene and Jones; Aug. 26, 1925. 73706 (7, 32–41), Columbia Co., Fox R., below mouth of French Cr.; Greene and Jones; Aug. 26, 1925. 73728 (4, 33–47), Columbia Co., Fox R., opposite Lock 25; Greene and Jones; Aug. 26, 1925. 73735 (6, 41–55), Columbia Co., Fox R. at Portage; Greene and Jones; Aug. 26, 1925. 73744 (47, 28–45), Fond du Lac Co., Grand R., above Fairwater Millpond; Greene and Jones; Aug. 5, 1925. 73810 (14, 34–49), Green Lake Co., Grand R., below Kingston Dam; Greene and Jones; Aug. 29, 1925. 73821 (4, 40–47), Greene Lake Co., Grand R. at Kingston; Greene and Jones; Aug. 29, 1925. 73831 (5, 27–44), Green Lake Co., trib. of Grand R., 4 mi. SW. of Uthey; Greene and Jones; Aug. 31, 1925. 73835 (85, 31–51), Fond du Lac Co., trib. of Grand R., 2 mi. S. of Fairwater; Greene and Jones; Aug. 31, 1925. 73862 (30, 39–51), Green Lake Co., Grand R., 3 mi. S. of Marquette; Greene and Jones; Sept. 1, 1925. 73874 (26, 27–48), Marquette Co., trib. of Grand R., 2 mi. W. of Kingston; Greene and Jones; Sept. 1, 1925. 73877 (8, 38–51), Marquette Co., trib. of Grand R., 1.5 mi. S. of Welsh Cr.; Greene and Jones; Sept. 1, 1925. 73888 (57, 28–55), Marquette Co., trib. of Grand R., Welsh Cr.; Greene and Jones; Sept. 1, 1925. 73955 (34, 26–54), Fond du Lac Co., Rush Cr., near Waupun; Greene and Cuchio; July 4, 1926. 77054 (33, 25–53), Columbia Co., Crawfish R., 2 mi. NW. of Fall R.; Greene and Stuart; Aug. 21, 1927. 77073 (35, 30–48), Dodge Co., Beaver Dam Cr., 5 mi. S. of Beaver Dam; Greene and Stuart; Aug. 21, 1927. 77082 (18, 32–53), Columbia Co., trib. of Crawfish R., 4 mi. NW. of Columbus; Greene and Stuart; Aug. 21, 1927. 77088 (15, 28–44), Columbia Co., trib. of Crawfish R. just N. of Columbus on rt. 16; Greene and Stuart; Aug. 22, 1927. 77096 (3, 33–40), Columbia Co., Crawfish R. at Columbus; Greene and Stuart; Aug. 22, 1927. 77110 (5, 32–39), Dodge Co., trib. of Crawfish R., 10 mi. W. of Watertown on rt. 19; Greene and Stuart; Aug. 23, 1927. 77125 (8, 31–46), Dodge Co., trib. of Beaver Dam Cr., 2 mi. E. of Lowell on rt. 16; Greene and

Stuart; Aug. 23, 1927. 77135 (6, 28–39), Dodge Co., W. Branch of Rock R., above millpond at Hustisford; Greene and Stuart; Aug. 27, 1927. 77153 (2, 37–41), Dodge Co., Beaver Dam Cr., below dam at Fox L.; Greene and Stuart; Aug. 26, 1927. 77165 (11, 32–45), Dodge Co., Crawfish R., 8 mi. N. of Watertown; Greene and Stuart; Aug. 26, 1927. 77208 (22, 27–44), Dodge Co., Old Mill Cr., 1 mi. S. of Atwater; Greene, Stuart, Creaser, Griffin; Aug. 27, 1927. 77232 (44, 25–49), Fond du Lac Co., W. Fk. of Upper W. Br. of Rock R., 4 mi. NW. of Waupun; Greene, Stuart, Creaser, Griffin; Aug. 29, 1927. 77592 (32, 21–44), Jefferson Co., Rock R., below Ft. Atkinson; Schultz and Tarzwell; Aug. 7, 1928. 77779 (30, 26–56), St. Croix Co., Apple R., above Somerset; Schultz and Tarzwell; Aug. 11, 1928. 78384 (6, 24–40), Rock Co., Rock R., 2.5 mi. N. of Beloit; Schultz and Tarzwell; Aug. 27, 1928. 78415 (43, 24–37), same data. 95933 (3, 26–49), Sawyer Co., Grindstone L., 10 mi. SE. of Haywood; Creaser and Jones; Sept. 2, 1928. 96111 (9, 24–48), Washburn Co., Trough L., 14 mi. SE. of Spooner on rt. 53; Creaser and Jones; Sept. 7, 1928. 96234 (15, 30–61), Polk Co., Apple R. at Amery; Creaser and Jones; Sept. 11, 1928. 96254 (13, 28–40), Polk Co., Balsam L. at Balsam City; Creaser and Jones; Sept. 12, 1928. 96570 (11, 43–52), Vilas Co., Trout L.; Wright; Aug. 6, 1927. 96573 (7, 20–48), Vilas Co., Trout L.; Wright; Aug. 4, 1927. 96703 (4, 43–47), Vilas Co,. Trout L.; Wright; Aug. 4, 1927. 100202 (2, 37–45), Vilas Co., Silver L.; Schneeberger; July 19, 1932.

=? *Etheostoma* (*Boleosoma*) *nigrum nigrum* Rafinesque. See Lagler and Bailey (1947) and Underhill (1963). We agree with Underhill that recognition of the scaly populations of *E. nigrum* as a subspecies does not aid in understanding the complex distributional pattern of the two morphological types present in the Great Lakes and upper Mississippi regions.

Boleosoma olmstedi var. *brevipinnis* Cope, 1868, Journ. Acad. Sci. Philadelphia, ser. 2, vol. 6, p. 214.

Lectotype: ANSP 22653 (♂, 46), Pennsylvania, Kiskiminitas R., trib. of Allegheny R.; E. D. Cope; number selected by Fowler (1907, p. 522 misprinted as "25,563 (type) to 22,567"), but all syntypes found still mixed together. Largest specimen herein selected as lectotype. D VIII–11; A I,9; LL 38+4=42; INF 4+3; pectoral rays 12–12; nape, preopercle, and breast naked; anterior part of belly naked.

Paralectotypes: ANSP 22654–67 (14, 34–40), same data as lectotype.

Cope mentioned two additional specimens of this form from the Holston River. Fowler did not list these as types. We feel it is best not to consider these specimens as paralectotypes and formally restrict the type locality to the Kiskiminitas River.

=*Etheostoma* (*Boleosoma*) *nigrum nigrum* Rafinesque.

Boleosoma perlongum Hubbs and Raney, 1946, Misc. Publ. Mus. Zool. Univ. Michigan, no. 65, p. 17, pl. 1, fig. 3.

Holotype: UMMZ 138475 (♂, 71), North Carolina, Columbus Co., N. shore of Lake Waccamaw; E. C. Raney, E. A. Lachner, and R. A. Pfeiffer; Mar. 30, 1941; orig. CU 9285.

Paratypes: UMMZ 138476 (16, 44–75), same data as holotype.

=*Etheostoma* (*Boleosoma*) *perlongum* (Hubbs and Raney). See Cole (1958).

Boleosoma phlox Cope, 1880, U.S. Nat. Mus. Bull. 17, p. 30.

Holotype: ANSP 20447 (1, 34), Texas, Trinity R. at Fort Worth; E. D. Cope. We have found no other type material and cannot determine if the original description was based on one or more specimens. The label says "type." Fowler (1907) referred to ANSP 20447 as "type," not cotype, so we assume this specimen is the holotype.

=*Etheostoma* (*Oligocephalus*) *lepidum* (Baird and Girard).

Boleosoma stigmaeum Jordan, 1877, Ann. New York Lyceum Nat. Hist., vol. 11, p. 311.

Lectotype: ANSP 20645 (♂, 39), Georgia, Floyd Co., Etowah R., trib. of Coosa R. near Rome; D. S. Jordan and C. H. Gilbert; summer, 1876; selected by Bailey, Winn, and Smith (1954, p. 142).

Paralectotypes: ANSP 20646–48 (3, 36–39), same data as lectotype. One syntype was figured by Fowler (1907, fig. 5).

Although labeled as a syntype of *B. stigmaeum*, USNM 31108 is a specimen of *Etheostoma* (*Ulocentra*) *coosae* (Fowler).

=*Etheostoma* (*Boleosoma*) *stigmaeum* (Jordan).

Boleosoma susanae Jordan and Swain, 1883, Proc. U.S. Nat. Mus., vol. 6, p. 249.

Lectotype: USNM 36501 (♂, 41), Kentucky, Whitley Co., trib. of Clear Fk., Cumberland R. near Pleasant View; D. S. Jordan and J. Swain; May 1883; herein selected by Dr. Charles F. Cole. D VIII–12; A I,9; pectoral 11–11; LL 40+4=44; infraorbital canal 4+2; preoperculomandibular pores 9; cheeks, opercles, nape, breast, and anterior half of belly naked.

Paralectotypes: USNM 197634 (7, 25–30), removed from USNM 36501.

=*Etheostoma* (*Boleosoma*) *nigrum susanae* (Jordan and Swain), apparently a valid subspecies.

Boleosoma tessellatum DeKay, 1842, Nat. Hist. New York Zool., vol. 1, pt. 4, p. 20, pl. 20, fig. 57.

Syntypes: Description and figure based on specimens then in New York State collection. Dr. E. M. Reilly, Curator of Zoology, has informed us that the types of this species are no longer present in the New York State Museum.

=*Etheostoma* (*Boleosoma*) *olmstedi olmstedi* Storer. See Cole (1958). Described after July 1, 1842, because that is the date on the preface to part 4, "Fishes," of the "Zoology of New York." Thus *Etheostoma olmstedi* Storer, January 1842 has priority.

Boleosoma vexillare Jordan, 1880, Proc. U.S. Nat. Mus., vol. 2, p. 235.

Holotype: ? (♂, 2½ in. TL), Virginia, Rappahannock R. at Warrenton. Jordan and Evermann (1896, p. 1058) wrote that the type was in the Charles Hallock collection. Cole was unable to find the type during the course of his thesis work on the subgenus *Boleosoma*, and we have also been unable to find it.

=*Etheostoma* (*Boleosoma*) *olmstedi vexillare* (Jordan). See Cole (1958).

Catonotus fasciatus Girard, 1859, Proc. Acad. Nat. Sci. Philadelphia, vol. 11, p. 68.

Lectotype: USNM 1345 (♂, 60), New York, Grass R., near Madrid; E. O. Dayton; 1852; herein selected. D VIII–14; A II,7; LL 32+21=53; INF 4+2; POM 9; supratemporal canal moderately interrupted; about 10 dark vertical bars on side of body.

Paralectotypes: USNM 197997 (♂, 53), removed from USNM 1345. USNM 1393 (4, 27–41), New York, Madrid; Dayton; 1852. MCZ 24652+24656 (6, 21–58), same locality; 1853. MCZ 24652 ("2") was originally USNM 1187, then MCZ 22. MCZ 24656 ("6") was originally USNM 1393, then MCZ 21.

=*Etheostoma* (*Catonotus*) *flabellare flabellare* Rafinesque.

Catonotus Kennicotti Putnam, 1863, Bull. Mus. Comp. Zool., vol. 1, p. 3.

Lectotype: USNM 1365 (♂, 35), Illinois; Union Co., a rocky brook; R. Kennicott; April 1857; herein selected. D VII–14; A II,7; LL 25+28=53; INF 4+2; POM 10; supratemporal canal moderately interrupted; cheeks, opercles, and breast naked; nape with few, scattered, imbedded scales; branchiostegal membranes moderately connected; tips of dorsal spines with bony knobs; about 10 horizontal lines on body.

Paralectotypes: USNM 198002 (20, 29–41), removed from USNM 1365. USNM 154713 (7, 27–42), same data; orig. USNM 1365, then Wesleyan Univ. 554; specimens badly dried out. MCZ 24658 (6, 29–50), same data; orig. USNM 1365, then MCZ 2. UMMZ 86347 (1, 42), out of MCZ 24658. MCZ 24665 (♂, 52; 3♀, 31–47), same locality; April–May 1856; orig. USNM 1811, then MCZ 37.

USNM 154784 (1, 42), same data; orig. USNM 1811, then Wesleyan Univ. 558.

=*Etheostoma* (*Catonotus*) *kennicotti* (Putnam).

Catonotus lineolatus Agassiz, 1854, Amer. Journ. Sci. and Arts, vol. 17, p. 305.

Lectotype: MCZ 24637+24657 (♂, 46), Illinois, small creeks near Quincy; L. Watson; 1853; orig. USNM 1801, then MCZ 1; herein selected. D VII–14; A II,8; LL 24+29=53; INF 4+2; POM 10; supratemporal canal incomplete; interorbital pores present; head and breast naked; humeral spot prominent; tips of dorsal spines widened; about seven rows of fine longitudinal stripes on the body above the lateral line; branchiostegal membranes broadly connected.

Paralectotypes: MCZ 43093 (5, 30–39) and UMMZ 86481 (2♂, 41–52) removed from MCZ 24637+24657. MNHN 2785 (♂, 43), same locality, orig. MCZ 859.

=*Etheostoma* (*Catonotus*) *flabellare lineolatum* (Agassiz).

Cottogaster aurantiacus Cope, 1868, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 6, p. 211, color pl. 24, fig. 6.

Lectotype: ANSP 13789 (1, 55), Virginia, N. Fork of Holston R.; E. D. Cope; 1867; number selected by Fowler (1907, p. 521); specimen herein selected. D XV–14; A II,10; LL 91.

Paralectotype: ANSP 13790 (1, 55), same data as lectotype.

=*Percina* (*Hypohomus*) *aurantiaca* (Cope).

Cottogaster cheneyi Evermann and Kendall, 1898, Bull. U.S. Fish Comm., vol. 17, p. 129, pl. 8, fig. 8.

Holotype: USNM 48781 (♂, 51), New York, St. Lawrence Co., Racket R. [now Raquette R.], near Norfolk; B. W. Evermann and B. A. Bean; July 18, 1894; figured in Jordan and Evermann (1900, fig. 445).

Paratypes: USNM 48782 (4, 39–47); USNM 126978 (4, 40–47), orig. BF 527; and SU 9048 (4, 40–49), orig. given as SU 5774; all with same data as holotype.

=*Percina* (*Cottogaster*) *copelandi* (Jordan).

Cottogaster putnami Jordan and Gilbert, 1883, U.S. Nat. Mus. Bull. 16, p. 498.

Lectotype: USNM 1314 (♂, 45), New York, Westport Br., Lake Champlain; S. F. Baird; September 1853; orig. no. 55; herein selected. D XI–12; A II,9; LL 48; INF 8; POM 10; cheeks naked; breast naked except for a large modified scale in the center and another between the bases of the pelvic fins; nape naked anteriorly; opercles scaly. This name was proposed as "nom. sp. nov." for *Boleosoma tessellatum* of Thompson (1853), Putnam (1863), and others, not of

DeKay. *Cottogaster putnami* was actually being proposed as the name of a new species and not as a substitute name, so the collection on which the description was based, USNM 1314, becomes the type material.

Paralectotypes: USNM 198000 (27, 35–49), removed from USNM 1314 + USNM 1193. USNM 1193, with the same locality and collector as USNM 1314, is now mixed with 1314 and may have been so at the time of the original description. All the specimens are the same species. At least one syntype of *C. putnami* out of USNM 1314 was included in a gift to the University of Cincinnati, dated Oct. 30, 1884.

=*Percina* (*Cottogaster*) *copelandi* (Jordan).

Diplesion fasciatus Girard, 1859, Proc. Acad. Nat. Sci. Philadelphia, vol. 11, p. 101.

Lectotype: MCZ 24625 (♂, 45), Mexico, Chihuahua R.; J. Potts; orig. USNM 743 (6)+USNM 1192 (3)+USNM 1206 (1), then MCZ 87; herein selected. D X–12; A I,7; LL 46+13=59; INF 9; POM about 10; interorbital, parietal, nape, cheeks, opercle, and breast naked; anal spine very strong.

Paralectotypes: MCZ 43092 (♂, 42; ♀, 42) and UMMZ 86349 (♀, 41), removed from MCZ 24625.

=*Etheostoma* (*Austroperca*) *australe* Jordan because *fasciatus* is preoccupied in *Etheostoma* by *Catonotus fasciatus* Girard.

Estrella atromaculata Girard, 1859, Proc. Acad. Nat. Sci. Philadelphia, vol. 11, p. 66.

Types: We have been unable to find type material of this form. During the course of his thesis work on the subgenus *Boleosoma*, Cole was also unable to locate any types. The original description was based on specimens from "the Potomac River, in the neighborhood of Washington."

=*Etheostoma* (*Boleosoma*) *olmstedi atromaculatum* (Girard). See Cole (1958).

Etheostoma (*Nothonotus*) *acuticeps* Bailey, 1959, Occ. Pap. Mus. Zool. Univ. Michigan, no. 603, pl. 1.

Holotype: UMMZ 159014 (♂, 58), Tennessee, Sullivan Co., S. Fork of Holston R., 0.5 mi. above S. Holston Dam, 7 mi. SE. of Bristol; R. M. Bailey, G. P. Cooper, and J. D. Kilby; June 23, 1949.

Paratypes: UMMZ 159013 (3, 49–51), same data as holotype. UMMZ 157585 (2, 45–52), same locality, R. M. Bailey, R. W. Eschmeyer, and J. Chance; Sept. 23, 1947.

=*Etheostoma* (*Nothonotus*) *acuticeps* Bailey.

Etheostoma arcus-celestis Crevecoeur, 1903, Trans. Kansas Acad. Sci., vol. 18, pp. 177–178.

Syntypes: USNM?, Kansas, Pottawatomie Co., French Cr., trib. of Vermillion R. near Onaga; F. F. Crevecoeur; April–May 1902. The types were sent to the U.S. National Museum in 1907 along with specimens of *Campostoma anomalum* and *Semotilus atromaculatus*. We have located the minnows (USNM 72474 and 70457) but have been unable to find the types of *E. arcus-celestis*.

=*Etheostoma* (*Oligocephalus*) *spectabile pulchellum* (Girard) according to Mr. Donald A. Distler (pers. comm.).

Etheostoma aubeenaubei Evermann, 1900, Rept. U.S. Fish Comm., vol. 25, p. 367, pl. 17.

Holotype: USNM 65248 (♀, 41), Indiana, Marshall Co., Aubeenaubee Cr., E. inlet of Lake Maxinkuckee; Evermann and Scovell; Aug. 23, 1899; erroneously given as USNM 49379 in original description.

Paratypes: All from Aubeenaubee Cr., Indiana. USNM 65255 (2, 38–39), Aug. 23, 1899. USNM 65258 (10, 34–40), Aug. 4, 1899. USNM 65260 (69, 35–40), Aug. 23, 1899. Two paratypes out of USNM 65260 were given to the Lebanon City Schools, Lebanon, Wis., Apr. 5, 1911. USNM 65249 (10, 25–30); Long Point; Aug. 11, 1899. USNM 65263 (5, 30–34), Aug. 8, 1899.

=*Etheostoma* (*Oligocephalus*) *exile* (Girard). See Hubbs (1926, p. 68).

Etheostoma (*Etheostoma*) *australe* Jordan, 1889, Proc. U.S. Nat. Mus. vol. 11, p. 362, replacement name for *Diplesion fasciatus* Girard, preoccupied in *Etheostoma* by *Catonotus fasciatus* Girard.

Lectotype: MCZ 24625 (♂, 45). See *Diplesion fasciatus*.

Paralectotypes: MCZ 43092 and UMMZ 86349.

=*Etheostoma* (*Austroperca*) *australe* Jordan.

Etheostoma blennioides Rafinesque, 1819, Journ. Phys., Chim., Hist. Nat., Arts, vol. 88, p. 419.

Types: As Call (1899) has noted, Rafinesque did not preserve any type material. Type locality Ohio River. Examination of a photograph of a sketch of this species from Rafinesque's notebook (fig. 1) confirms the attribution of the name *blennioides* to the species currently known by this name.

=*Etheostoma* (*Etheostoma*) *blennioides blennioides* Rafinesque. See Miller (1964).

Etheostoma (*Rhothoeca*) *blennius* Gilbert and Swain *in* Gilbert, 1887, Proc. U.S. Nat. Mus., vol. 10, p. 55.

Holotype: USNM 36187 (1, 60), Alabama, Cox's Cr., trib. of Tennessee R. near Florence; C. H. Gilbert and J. Swain; summer, 1884.

Paratype: SU 1955 (1, 47), Alabama, Shoal Cr., trib. of Tennessee R. near Florence; Gilbert and Swain; summer, 1884.

=*Etheostoma* (*Etheostoma*) *blennius* Gilbert and Swain. See Hubbs and Black (1940).

Etheostoma caerulea D. H. Storer, 1845, Proc. Boston Soc. Nat. Hist., vol. 2, p. 47. Original description repeated almost verbatim, with the addition of color changes in alcohol, in Storer (1846).

Holotype: MCZ 32949 (♀, 53), Illinois, Fox R.; S. C. Clark.

=*Etheostoma* (*Oligocephalus*) *caeruleum caeruleum* Storer. See Trautman (1930) and Knapp (1964).

Etheostoma cinerea D. H. Storer, 1845, Proc. Boston Soc. Nat. Hist., vol. 2, p. 49. Original description repeated almost verbatim in Storer (1846).

Syntypes: MCZ ?, Alabama, Florence; received from C. A. Hentz. We have been unable to find any types.

=*Etheostoma* (*Allohistium*) *cinereum* Storer. See Bailey and Gosline (1955).

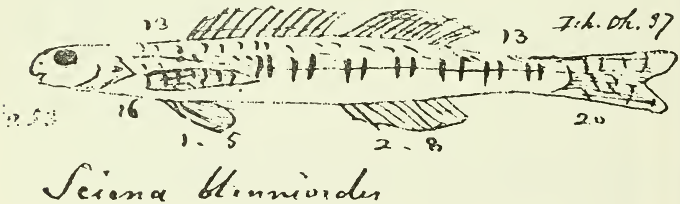

FIGURE 1.—*Etheostoma blennioides* Rafinesque (sketch from Rafinesque's notebook).

Etheostoma (*Hololepis*) *collis lepidinion* Collette, 1962, Tulane Stud. Zool., vol. 9, no. 4, p. 194, figs. 17, 18.

Holotype: USNM 179847 (♂, 40), Virginia, Charlotte Co., trib. of Horsepen Cr., 2.4 mi. NW. of Wyliesburg on Va. 907; B. B. Collette, C. F. Cole, J. G. New, E. C. Raney, C. R. Robins; Mar. 31, 1956.

Paratypes: CU 29992 (8, 30–38), same data as holotype. USNM 100215 (3, 29–31), Virginia, Charlotte Co., Wards Fork, trib. of Roanoke R., S. of Madisonville; S. Abraham; Apr. 23, 1935. USNM 101330 and 101334 (12, 22–29), Virginia, Charlotte Co., Wards Fork, Roanoke Cr., below mill dam between Madisonville and Cullen; G. S. Myers and Abraham; Sept. 15, 1935. CU 34544 (7, 29–40), Virginia, Charlotte Co., Wards Fork Cr., 6.7 mi. SSW. of Madisonville on Va. 47; Collette and J. S. Ramsey; Sept. 16, 1959. DU uncat. (♂, 38), North Carolina, Granville Co., Beech Cr., 3 mi. NNE. of Cornwall (now flooded by Kerr Dam); J. R. Bailey 52–7; spring, 1952. DU uncat. (5♀, 31–36), North Carolina, Durham Co., Lick Cr. on rt. 264, 4.5 mi. E. of Oak Grove; Bailey and Walter; Apr. 6, 1950. DU uncat. (♂, 36), North Carolina, Orange Co., Eno R., 2 mi. W. of Hillsboro; J. R. Bailey 49–9; Mar. 20, 1949. DU uncat. (♀, 38), North Carolina, Orange Co., Eno R. at ford N. of Hillsboro near Skipper Wright's; J. R. Bailey 55–3; Apr. 21, 1955.

=*Etheostoma* (*Hololepis*) *collis lepidinion* Collette.

Etheostoma cragini Gilbert, 1885, Bull. Washburn College Lab. Nat. Hist., vol. 1, no. 3, p. 99.

Lectotype: USNM 38320 (1, 33), Kansas, Finney Co., small brook leading from the "Lake" at Garden City to Arkansas R.; F. W. Cragin; March–April 1885; USNM 38320 listed by Jordan and Evermann (1896, p. 1092) as "type" then containing three specimens; lectotype herein selected. D IX–12; A II,6; LL 19+32=51; POM 10; INF 7 pores on right, 8 on left; supratemporal canal widely interrupted; cheeks and opercles naked; breast and prepectoral area with few, imbedded scales.

Paralectotypes: USNM 197994 (2, 29), removed from USNM 38320. USNM 125109 (1, 23), same data, orig. BF 309.

Additional syntypes from SU 2141 became mixed with SU 694 from Canon City, Colo. and so were not considered for selection of a lectotype.

=*Etheostoma* (*Oligocephalus*) *cragini* Gilbert.

Etheostoma cumberlandicum Jordan and Swain, 1883, Proc. U.S. Nat. Mus. vol. 6, p. 251.

Lectotype: USNM 36502 (♂, 41), Kentucky, Whitley Co., Wolf Cr., trib. of Clear Fork, Cumberland R., near Pleasant View; D. S. Jordan, J. Swain, C. H. Gilbert; May 1883; herein selected. This specimen was found alone in a bottle with three labels, each reading "type". Four additional specimens were found in another bottle, also labeled USNM 36502, *Etheostoma cumberlandicum.* The single specimen is in as good condition as the largest of the four, so it is selected lectotype. D VII–11; A II,7; LL 25+19=44; INF 4+1; POM 10; supratemporal canal interrupted; preopercle smooth; cheeks, opercles, nape, and breast naked.

Paralectotypes: USNM 197992 (4, 20–42), removed from USNM 36502.

=*Etheostoma* (*Catonotus*) *flabellare cumberlandicum* Jordan and Swain. See Ross and Carico (1963, p. 12).

Etheostoma (*Hadropterus*) *cymatotaenia* Gilbert and Meek *in* Gilbert, 1887, Proc. U.S. Nat. Mus., vol. 10, p. 51.

Lectotype: USNM 36215 (♂, 68, labeled "drawn"), Missouri, Niangua R., near Marshfield; C. H. Gilbert and S. E. Meek; summer, 1884; herein selected; (fig. 2). D XII–12; A II,10; LL 66; branchiostegal membranes slightly connected; opercles, cheeks, breast, and belly scaly; midventral belly scales slightly modified; thin flangelike midventral keel on lower edge of caudal peduncle near caudal base.

Paralectotypes: USNM 198090 (♂, 63), removed from USNM 36215. USNM 36260 (2 ♂, 63–68), Missouri, Osage Fork of Gasconade R., near Marshfield; Gilbert and Meek; summer, 1884; erroneously given as USNM 38260 in original description and in Jordan and Evermann (1896, p. 1042). USNM 36308 (5, 40–44), Missouri, Sac R., near Greenfield; Gilbert and Meek; summer, 1884. SU 2603 (4, 39–54), same data as USNM 36308.

Additional syntypes from SU 3949, with the same data as USNM 36215, became mixed with nontype specimens from Kentucky, collected by A. J. Woolman as a result of the 1906 earthquake.

=*Percina* (*Hypohomus*) *cymatotaenia* (Gilbert and Meek).

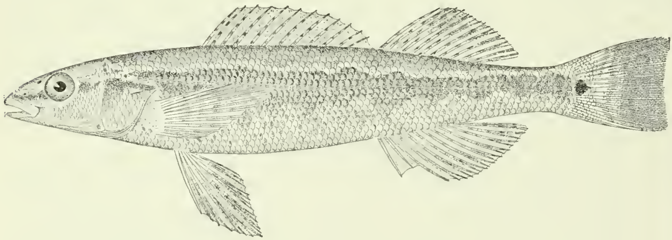

FIGURE 2.—*Etheostoma cymatotaenia* Gilbert and Meek (previously unpublished drawing of lectotype drawn in October 1884).

Etheostoma (*Ulocentra*) *davisoni* Hay, 1885, Proc. U.S. Nat. Mus., vol. 8, p. 554.

Holotype: USNM 37365 (1, 41), Florida, Santa Rosa Co., Yellow R., near Chaffin; H. T. Mann and D. M. Davison; April 1885.

=*Etheostoma* (*Boleosoma*) *davisoni* Hay. *Etheostoma davisoni* has long been considered a synonym of *E. stigmaeum*. However, *E. davisoni* has recently been recognized as a distinct species by Mr. William Mike Howell, who is presently studying the taxonomy and systematics of this group. His validation of *E. davisoni* will appear elsewhere.

Etheostoma (*Oligocephalus*) *ditrema* Ramsey and Suttkus, 1965, Tulane Stud. Zool., vol. 12, no. 3, p. 66, figs. 1–3.

Holotype: TU 35703 (♂, 34) Georgia, Chattooga Co., trib. to Mills Cr., trib. to Chattooga R., 4.3 airline mi. W. of Lyerly; July 18, 1962.

Paratypes: TU 29153 (21, 15–35), out of TU 35703. The following are all from the type locality. TU 26086 (8, 24–31), Apr. 19, 1962; TU 27566 (9, 18–34), May 30, 1962; TU 32762 (34, 19–42), June 1, 1964; TU 32981 (43, 20–39), June 23, 1964. Five paratypes out of TU 32981 were sent to each of the following institutions: USNM 198607 (29–32), MCZ 43123 (29–37), ANSP 101231 (26–32), CU 47872 (30–32), SU 62401 (27–36), and UMMZ 187501 (29–36). Also ANSP 20649 (1, 23), Georgia, Floyd Co., near Rome; summer, 1876; D. S. Jordan.

=*Etheostoma* (*Oligocephalus*) *ditrema* Ramsey and Suttkus.

Etheostoma duryi Henshall, 1889, Journ. Cincinnati Soc. Nat. Hist., vol. 11, p. 32.

Syntypes: Cincinnati Soc. Nat. Hist. (3 ♂, 2 ♀, 2–3 in.), Tennessee, small trib. of Tennessee R. at Whiteside on Memphis and Charleston RR.; C. Dury. We have been unable to locate any of the syntypes.

=*Etheostoma* (*Ulocentra*) *duryi* Henshall.

Etheostoma flabellaris Rafinesque, 1819, Journ. Phys., Chim., Hist. Nat., Arts, vol. 88, p. 419.

Types: As Call (1899) indicated, Rafinesque did not preserve any of his type material. Type locality—the Ohio R. The sketch of this species in Rafinesque's notebook (fig. 3) leaves no doubt as to the identity of what Rafinesque had before him.

=*Etheostoma* (*Catonotus*) *flabellare flabellare* Rafinesque.

Etheostoma fontinalis Rafinesque, 1820, Ichthyologia Ohiensis, p. 85.

Types: As Call (1899) noted, Rafinesque did not preserve types. Type locality—"in the springs and caves near Lexington."

=*Etheostoma* (*Catonotus*) *flabellare flabellare* Rafinesque according to Jordan and Evermann (1896, p. 1097).

Etheostoma formosa Henshall, 1889, Journ. Cincinnati Soc. Nat. Hist., vol. 11, p. 32.

Holotype: Cincinnati Soc. Nat. Hist. (1, 2½ in.), Tennessee, small trib. of Tennessee R. at Whiteside on Memphis and Charleston RR.; C. Dury. We have been unable to locate the type.

=*Etheostoma* (*Oligocephalus*) *caeruleum* ssp. See Knapp (1964).

Etheostoma fricksia Hildebrand, 1923, Bull. Bur. Fish., vol. 39, p. 7, fig. 1.

Holotype: USNM 82633 (♂, 44), Georgia, Richmond Co., Savannah Dr., small creek on Sanitary Dairy Farm near Augusta; S. F. Hildebrand; Mar. 26, 1918.

Paratypes: USNM 92818 (♂, 31; 2♀, 33–47), same data as holotype.

=*Etheostoma* (*Oligocephalus*) *fricksium* Hildebrand. See Bailey and Richards (1963).

Etheostoma güntheri Eigenmann and Eigenmann, 1892, Amer. Nat., vol. 26, p. 962. Description much enlarged in Eigenmann (1894).

Lectotype: BMNH 1892.12.30.151 (♂, 41), Canada, Manitoba, Red R. of the North at Winnipeg; C. H. Eigenmann; August–September 1892; herein selected. D IX–13; A II,10; LL 57; moderate frenum present; posterior rays of anal fin extending beyond posterior end of depressed second dorsal; black spot at anterior and posterior ends of first dorsal.

Paralectotypes: BMNH 1892.12.30.152–153 (2, 41–51), same data as lectotype.

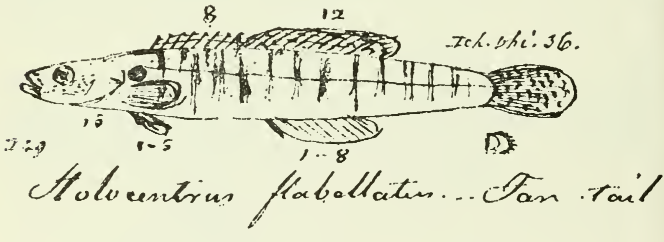

FIGURE 3.—*Etheostoma flabellare* Rafinesque (sketch from Rafinesque's notebook).

Three other specimens are mentioned, both in the original description and in the 1894 paper. We do not think that these should be considered as syntypes. USNM 45567 (♂, 42) and UMMZ 187522 (2, 31–42), orig. IU 1449, then IU 4506, Iowa, Cedar Rapids; S. E. Meek.

=*Percina* (*Imostoma*) *shumardi* (Girard). See Hubbs and Greene (1928, p. 384).

Etheostoma hildebrandti Evermann and Clark, 1910, Proc. Biol. Soc. Washington, vol. 23, p. 87, fig. 1.

Holotype: USNM 64616 (1, 43), Indiana, Fulton Co., Fletcher Lake, 12 mi. N. of Logansport near Cass Co. line; B. W. Evermann and H. W. Clark; Oct. 6, 1900.

=*Etheostoma* (*Oligocephalus*) *exile* (Girard).

Etheostoma (*Ulocentra*) *histrio* Jordan and Gilbert *in* Gilbert, 1887, Proc. U.S. Nat. Mus., vol. 10, p. 47.

Lectotype: USNM 36386 (♂, 42), Oklahoma, Poteau R., W. of Hackett City, Ark.; D. S. Jordan and C. H. Gilbert; summer, 1864; herein selected by Dr. Chu-fa Tsai. D IX–13; A II,7; LL 53; INF 4+3; POM 9; belly and breast naked; cheek with 6 imbedded scales; opercle with 2 scales; 6 dorsal blotches.

Paralectotypes: USNM 188972 (3, 24–33), removed from USNM 36386. SU 2682 (2, 33–35), same data. USNM 36409 (4, 24–35) and SU 569 (1, 32), Arkansas, Clark Co., Washita (Ouachita) R. at Arkadelphia; Jordan and Gilbert; summer, 1884. USNM 36448 (3, 30–34), Arkansas, Saline Co., Saline R. at Benton, just above railroad bridge; Jordan and Gilbert; summer, 1884.

=*Etheostoma* (*Etheostoma*) *histrio* Jordan and Gilbert.

Etheostoma (*Oligocephalus*) *hopkinsi binotatum* Bailey and Richards, 1963, Occ. Pap. Mus. Zool. Univ. Michigan, no. 630, pl. 1, B–C.

Holotype: CU 44157 (♂, 53), South Carolina, Abbeville Co., Calhoun Cr., 7.6 mi. E. of Calhoun Falls on S.C. 72; E. C. Raney, C. R. Robins, R. H. Backus, R. W. Crawford, J. N. Layne, and R. L. Wigley; ECR 1932; Mar. 27, 1951; orig. CU 19600.

Paratypes: CU 19600 (14, 37–55) and UMMZ 180075 (♂, 48; 3 ♀, 44–50), same data as holotype. Apparently the "additional specimens examined" by Bailey and Richards must also be considered as paratypes because they form part of the type-series as defined by Article 72b of the International Code of Zoological Nomenclature and were not referred to as variants, doubtfully associated with the nominal form, or expressly excluded from it. CU 48401 (1, 38), Georgia, Madison Co., S. Fork of Broad R., 2 mi. W. of Comer; Nov. 1, 1952, Ichthyology Class; orig. UG 269. CU 48399 (1, 33), Georgia, Madison Co., S. Fork of Broad R., 1–2 mi. S. of Carlton; Apr. 11, 1954; orig. UG 22E. CU 48400 (1, 46), Georgia, Madison Co., S. Fork of Broad R., 1–2 mi. S. of Carlton; Apr. 19, 1954; Ichthyology Class; orig. UG 22D. CU 48396 (5, 30–49), Georgia, Oglethorpe-Madison cos., S. Fork of Broad R., Anthony Shoals, near Carlton; Nov. 1, 1952; Ichthyology Class; orig. UG 22C. CU 43994 (♂, 48), Georgia, Madison Co., S. Fork of Broad R., Anthony Shoals, near Carlton; Sept. 3, 1950; W. J. Houck. UMMZ 133122 (3, 32–47), Georgia, Oglethorpe Co., Dry Fork Cr.; O. K. Fletcher; Nov. 3, 1940. UMMZ 133224 (8, 27–42), Georgia, Oglethorpe Co., Dry Fork Cr.; Fletcher; Feb. 8, 23, 1941. UMMZ 137773 (31, 27–43), Georgia, Oglethorpe-Wilkes cos., Dry Fork Cr., about 1 mi. N. of U.S. 78; Fletcher; Mar. 11, Apr. 13, 1941. CU 48398 (2, 38–46), Georgia, Oglethorpe Co., Buffalo Cr., 6 mi. E. of Lexington; Apr. 29, 1953; B. Martof; orig. UG 283. CU 48397 (2, 30–41), Georgia, Columbia Co., W. Fork of Cliatt Cr.; July 24, 1948; orig. UG 90. CU 48402 (15, 21–51), Georgia, Lincoln Co., Lloyds Cr.; July 23, 1948; Scott and Tyson; orig. UG 80. USNM 179063 (4, 37–49), South Carolina, Anderson Co., Twenty-three Mile Cr., 0.9 mi. NW. of Sandy Springs, 11.1 mi. NW. of Anderson on U.S. 76; Mar. 25, 1951; Raney, Robins, Backus, Crawford, Layne, Wigley; orig. CU 19604. CU 43515 (6, 23–39), South Carolina, Edgefield Co., 3 mi. E. of Edgefield Co. line on Ga. 23; Apr. 3, 1953; J. New.

=*Etheostoma* (*Oligocephalus*) *hopkinsi binotatum* Bailey and Richards.

Etheostoma iowae Jordan and Meek, 1885, Proc. U.S. Nat. Mus., vol. 8, p. 10.

Lectotype: SU 1457 (1, 36), Iowa, Chariton R. at Chariton; D. S. Jordan and S. E. Meek; July–September, 1884; herein selected; one specimen of *E. nigrum* removed and recataloged as SU 62430. D IX–10; A II, 7 or 8; LL 28+31=59, first anal spine much thicker than second; preopercle, opercle, nape, and belly scaled; breast naked.

Paralectotype: The original description was based on three specimens, but we have been unable to locate the third.

=*Etheostoma* (*Oligocephalus*) *exile* (Girard). See Hubbs (1926, p. 66).

Etheostoma (*Nothonotus*) *jordani* Gilbert, 1891, Bull. U.S. Fish Comm., vol. 9, p. 156, pl. 43, fig. 2.

Lectotype: USNM 125110 (♂, 48), Alabama, Calhoun Co., Choccolo Cr. trib. of Coosa R. at Oxford; P. H. Kirsch, W. M. Andrews, and E. O. Jones; May 23, 1889; herein selected. D X–11; A II, 8; LL (right side) 49; INF 8; POM 10; cheeks, prepectoral area, and breast naked; opercles, nape, and belly scaled; no regular longitudinal dark stripes along edges of scale rows.

Paralectotypes: USNM 198107 (8, 27–47), removed from USNM 125110. BMNH 1893.5.5.9–10 (2, 27–39), same data as lectotype. CAS 22854 (4, 24–38), and UMMZ 61706 (♀, 40), same data; orig. IU 4693; badly dried. We have not located the additional syntypes from Chestnut Cr., Verbena, Ala.

=*Etheostoma* (*Nothonotus*) *jordani* Gilbert. See Bailey (1959).

Etheostoma juliae Meek, 1891, Bull. U.S. Fish Comm., vol. 9, p. 130, pl. 42, fig. 2.

Syntypes: USNM 125116 (2 ♂, 41–49) and SU 1010 (♂, 37), Missouri, Greene Co., James R., trib. of White R., near Springfield; S. E. Meek, L. Rettger, and F. M. Drew; July 31, 1889; one of syntypes figured in Jordan and Evermann (1900, fig. 466).

Two topotypes of this species were found with *E. spectabile* (USNM 63366) that were collected with the types of *E. juliae*. They have recataloged as USNM 196750.

=*Etheostoma* (*Oligocephalus*) *juliae* Meek.

Etheostoma lepidogenys Evermann and Kendall, 1894, Bull. U.S. Fish Comm., vol. 12, p. 114, pl. 35.

Syntypes: USNM 44840 (2 ♂, 38–42), Texas, Comal Co., Guadalupe Drainage, Corral Cr. in the largest of the Comal Springs at New Braunfels; B. W. Evermann; Dec. 3, 1891.

=*Etheostoma* (*Oligocephalus*) *lepidum* (Girard).

Etheostoma Linsleyi H. R. Storer, 1851, Proc. Boston Soc. Nat. Hist., vol. 4, p. 37.

Syntypes: New York, Wayne Co., streams at Walcott [now Wolcott], near Lake Ontario; J. H. Linsley. We have been unable to find any type material of this nominal form.

=*Etheostoma* (*Catonotus*) *flabellare flabellare* Rafinesque.

Etheostoma (*Imostoma*) *longimana* Jordan, 1888, Proc. Acad. Nat. Sci. Philadelphia, vol. 40, p. 179.

Lectotype: MCZ 24619 (1, 53), Virginia, trib. of James R., S. F. Baird; about 1855; orig. USNM 1305, then MCZ 150; herein selected by Dr. Charles F. Cole. Anal spines II; LL 44; INF 8; POM 10; supratemporal canal complete; pectoral rays 13–12; scales above lateral line 4; scales below lateral line 8.

Paralectotypes: MCZ 43074 (2, 36–37), removed from MCZ 24619; 5 specimens of *E. nigrum* removed and recataloged as MCZ 42199. USNM 120258 (2, 42–44) and UMMZ 86603 (3, 33–47), same data; previously MCZ 24619; 1 specimen of *E. nigrum* removed from USNM 120258 and recataloged as USNM 197414.

=*Etheostoma* (*Boleosoma*) *longimanum* Jordan.

Etheostoma (*Etheostoma*) *luteovinctum* Gilbert and Swain *in* Gilbert, 1887, Proc. U.S. Nat. Mus., vol. 10, p. 58.

Lectotype: USNM 36139 (1, 37), Tennessee, Stone R., near Nashville; C. H. Gilbert and J. Swain; summer, 1884; herein selected. D IX–13; A II,7; LL 33+17=50; INF barely incomplete, 4+5; POM 10; supratemporal canal complete; cheeks, opercles, and nape fully scaled; breast partially scaled; 6 dorsal saddles.

Paralectotypes: USNM 198003 (2, 33–35), removed from USNM 36139, and SU 3945 (2, 39–40), same data as lectotype.

=*Etheostoma* (*Oligocephalus*) *luteovinctum* Gilbert and Swain.

Etheostoma lynceum Hay *in* Jordan, 1885, Ann. Rept. Comm. Fish and Fish. for 1884, p. 868, a substitute name for *Nanostoma elegans* Hay which is preoccupied in *Etheostoma* by *Boleichthys elegans* Girard.

Types: The types of *E. lynceum* are the same as those of *Nanostoma elegans*, USNM 27445, holotype and SU 627, paratype.

=*Etheostoma* (*Etheostoma*) *zonale lynceum* (Hay), a valid subspecies according to Dr. Chu-fa Tsai (pers. comm.).

Etheostoma macrocephalum Cope, 1869, Trans. Amer. Philos. Soc., new ser., vol. 13, p. 400.

Lectotype: ANSP 22626 (♂, 56), Pennsylvania, Youghiogheny R.; E. D. Cope. This specimen herein selected as the lectotype because it appears to be the only extant syntype. D XIV–12; A II,10; LL about 76; opercle naked; few small scales on cheek posterior to eye; snout long and pointed; eye length longer than snout length.

Fowler (1907) listed ANSP 22626 and 22628 as cotypes. ANSP 22628 (♂, 58) is not part of the type series but a *Percina maculata* with LL 62–64, cheek and opercle completely covered with scales, short blunt snout, eye about equal to snout length. The ANSP catalog lists this specimen as *Alvordius maculatus* from the Kiskiminitas River. Cope based his description on three syntypes, but we have been unable to locate the other two.

=*Percina* (*Alvordius*) *macrocephala* (Cope).

Etheostoma maculata Kirtland, 1841, Boston Journ. Nat. Hist., vol. 3, p. 276, pl. 2, fig. 3.

Types: We have not found any extant type material. Type locality—Mahoning R., Ohio.

=*Etheostoma* (*Nothonotus*) *maculatum maculatum* Kirtland. See Bailey (1959) and Raney and Zorach (MS).

Etheostoma microperca Jordan and Gilbert *in* Jordan, 1888, Manual of the Vertebrates, 5th ed., p. 134, a substitute name for *Microperca punctulatum* (Putnam), preoccupied in *Etheostoma*.

Types: The types of *E. microperca* are the same as those of *Microperca punctulatum* Putnam.

=*Etheostoma* (*Microperca*) *microperca* Jordan and Gilbert.

Etheostoma micropterus Gilbert, 1890, Proc. U.S. Nat. Mus., vol. 13, p. 289.

Holotype: USNM 38245 (♀, 40), Mexico, Chihuahua; E. Wilkinson; figured in Evermann and Kendall (1894, pl. 35) and Jordan and Evermann (1900, fig. 459).

=*Etheostoma* (*Oligocephalus*) *pottsii* (Girard).

Etheostoma (*Nothonotus*) *moorei* Raney and Suttkus, 1964, Copeia, no. 1, p. 131, fig. 1.

Holotype: CU 42883 (♂, 43), Arkansas, Cleburne Co., Devils Fork, 2.5 mi. SW. of Woodrow and 6 airline mi. W. of Drasco; L. W. Knapp and R. V. Miller; Apr. 26, 1962.

Paratypes: CU 41966 (15, 28–42), same data as holotype. USNM 188357 (108, 20–56) and UMMZ 181397 (15, 31–50), type locality; K. Strawn et al.; Aug. 21, 1962. TU 22697 (41, 26–57), Arkansas, Cleburne Co., Devils Fork between Stark and Edgemont on rt. 16; R. D. Suttkus, M. A. Wilkens, and B. I. Sundararaj; Oct. 23, 1959. TU 26227 (22, 27–50), Arkansas, Van Buren Co., Middle Fork at Shirley; Suttkus and W. T. Mason; Aug. 17, 1962. TU 26249 (21, 31–44), Arkansas, Van Buren Co., South Fork, 9 mi. SW. of Clinton on rt. 95; Suttkus and Mason; Aug. 17, 1962. KU 6652 (5, 20–36), Arkansas, Van Buren Co., South Fork of Little Red R. on Ark. 95, approx. 2.5 mi. SW. of Scotland; D. A. Distler and W. N. Berg; Sept. 3, 1960.

=*Etheostoma* (*Nothonotus*) *moorei* Raney and Suttkus.

Etheostoma nevisense Cope, 1870, Proc. Amer. Philos. Soc., vol. 11, p. 261.

Holotype: ANSP ?, (1, ?), North Carolina, falls of Neuse R., 8 mi. E. of Raleigh. Types of other species described by Cope in the 1870 paper were deposited at ANSP, but Fowler (1907) did not mention the type of this form, and we have been unable to find it.

=*Percina* (*Alvordius*) *peltata nevisense* (Cope) according to Dr. Edward C. Raney (pers. comm.).

Etheostoma (*Hadropterus*) *nianguae* Gilbert and Meek *in* Gilbert 1887, Proc. U.S. Nat. Mus., vol. 10, p. 52.

Lectotype: USNM 36214 (♂, 86), Missouri, Webster Co., headwaters of Niangua R., near Marshfield; C. H. Gilbert and S. E. Meek; summer, 1884; listed as type by Jordan and Evermann (1896, p. 1043); selection herein confirmed. D XII–14; A II,12; LL 73; caudal peduncle scale rows 12–2–13.

Paralectotype: SU 5299 (1, 82), same data as lectotype. The original description says deposited in museum of University of Cincinnati, but as Böhlke (1953, p. 73) noted, this specimen bears the proper data and the word "type."

=*Etheostoma* (*Oligocephalus*) *nianguae* Gilbert and Meek. See Kuehne and Bailey (1961).

Etheostoma (*Hadropterus*) *nianguae spilotum* Gilbert, 1887. Proc. U.S. Nat. Mus., vol. 10, p. 53.

Lectotype: USNM 38319 (1, 49), Kentucky, Owsley Co., Sturgeon Cr., trib. of Kentucky R. near Traveler's Rest; C. H. Gilbert; summer, 1884; listed as type by Jordan and Evermann (1896, p. 1044); selection herein confirmed. D X–13; A II,11; LL 50+10=60; caudal peduncle scale rows 10–2–10.

Paralectotypes: SU 4036 (6, 16–67), same data as lectotype; 3 specimens (17–20), apparently *Etheostoma* (*Boleosoma*) sp., removed and recataloged as SU 62429.

=*Etheostoma* (*Oligocephalus*) *sagitta spilotum* Gilbert. See Kuehne and Bailey (1961).

Etheostoma nigra Rafinesque, 1820, Ichthyologia Ohiensis, p. 37.

Types: The original description was based on material from the Green R., Kentucky. As Call (1899) noted, Rafinesque did not preserve any of his type material.

=*Etheostoma* (*Boleosoma*) *nigrum nigrum* Rafinesque.

Etheostoma nuchale Howell and Caldwell, 1965, Tulane Stud. Zool., vol. 12, no. 4, p. 101, fig. 1.

Holotype: UMMZ 187523 (♂, 39), Alabama, Jefferson Co., Glen Spring, Bessemer on Co. rt. 20; W. M. Howell and R. D. Caldwell; Mar. 24, 1964.

Paratypes: UMMZ 187524 (♀, 40, allotype), UMMZ 187525 (20, 27–45), USNM 259800–F 1 (20, 22–48), UAIC 1227 (9, 24–43), same collection as holotype. TU 34591 (20, 17–40), same locality; R. D. Suttkus, J. S. Ramsey, and F. Rose; Sept. 9, 1964.

=*Etheostoma* (*Oligocephalus*) *nuchale* Howell and Caldwell.

Etheostoma obeyense Kirsch, 1892, Bull. U.S. Fish. Comm., vol. 10, p. 292, fig.

Lectotype: USNM 45565 (♂, 52), Kentucky, Clinton Co., trib. of Cumberland R.; P. H. Kirsch; fall, 1889 or spring, 1890; selected and figured by Jordan and Evermann (1896, p. 1092 and 1900, fig. 463); selection herein confirmed.

Paralectotypes: Kirsch collected a total of 210 specimens from four Clinton Co. tributaries of the Cumberland in the fall of 1889 and spring of 1890: Indian Cr., 21; Spring Cr., 36; Smith Cr., 23; and Albany Branch, 130. We have been able to locate the following: SU 5116 (41, 28–51), Albany Branch, 2 *Etheostoma spectabile* removed by Knapp and recataloged as SU 62132. SU 1918 (38, 32–55), Spring Cr. This bottle was broken during the earthquake, which may account for the presence of two more specimens. All are *E. obeyense*, so perhaps Kirsch erred in his count of 36. BMNH 1892.12.30.136–139 (4, 35–41) Albany Branch, one small specimen of *E.* (*Oligocephalus*) *spectabile* removed and recataloged as BMNH 1892.12.30.140.

USNM 46207 (6, 28–43), Wayne Co., Beaver Cr., 1891 were labeled as types but were collected after the types and at a locality not mentioned in the original description and so are not types.

=*Etheostoma* (*Catonotus*) *obeyense* Kirsch.

Etheostoma olmstedi D. H. Storer, 1842, Journ. Boston Soc. Nat. Hist., vol. 4, p. 61, pl. 5, fig. 2.

Syntypes: MCZ 24781 (2♂, 46–64), Connecticut, Connecticut R. at Hartford; C. H. Olmsted; orig. MCZ 151.

=*Etheostoma* (*Boleosoma*) *olmstedi olmstedi* Storer. See Stone (1947) and Cole (1958, 1965). Described in January 1842 and so has priority over *Boleosoma tessellatum* DeKay, July 1842. See Storer (1843) and also summary of the meeting of Boston Society of Natural History for June 21, 1843 (Proc. Boston Soc. Nat. Hist., vol. 1, p. 120).

Etheostoma (*Hadropterus*) *ouachitae* Jordan and Gilbert *in* Gilbert, 1887, Proc. U.S. Nat. Mus., vol. 10, p. 49.

Syntypes: USNM 36449 (2♂, 40–43; ♀, 43), Arkansas, Saline Co., Saline R. at Benton; Jordan and Gilbert; summer, 1884. UMMZ 187509 (1, 42), same data, orig. IU 779, then IU 4958.

Böhlke (1953, p. 74) listed SU 552 [(3, 31–47), Arkansas, Ouachita R. at Arkadelphia; Jordan and Gilbert; summer, 1884] as paratypes, but we do not feel that they should be considered part of the type series because only the Saline River locality was listed, both in the original description and in an advance list (Jordan and Gilbert, 1886, p. 13) where *Hadropterus ouachitae* appeared as a *nomen nudum*.

=*Percina* (*Imostoma*) *uranidea* (Jordan and Gilbert). See Hubbs and Black (1940).

Etheostoma pagei Meek, 1894, Amer. Nat., vol. 27, p. 957.

Lectotype: USNM 45566 (♂, 50); Missouri, spring branch, trib. of Neosho R. at U.S. Fish Hatchery, Neosho; S. E. Meek; Apr. 15, 1893; figured in Jordan and Evermann (1900, fig. 464); herein selected. D IX–12; A II, 7; LL 13+40=53; INF 8; cheeks with small patch of scales; opercles naked; well-developed tubercles on the anal fin characteristic of *E. cragini* (see Collette, 1965).

Paralectotype: USNM 197969 (♀, 40), removed from USNM 45566.

=*Etheostoma* (*Oligocephalus*) *cragini* Gilbert.

Etheostoma (*Oligocephalus*) *pallididorsum* Distler and Metcalf, 1962, Copeia, no. 3, p. 556, fig. 1.

Holotype: KU 7144 (♂, 42), Arkansas, Montgomery Co., Caddo R., 8.5 mi. W. of Black Springs; Sec. 26, T3S, R27W; Distler and Metcalf; June 28, 1961.

Paratypes: KU 6921 (21, 20–42); CU 44004 (10, 23–43), transferred to CU after orig. description; UMMZ 178997 (10, 34–41); USNM 196547 (10, 33–46); same data as holotype. KU 6158 (18, 29–46), Arkansas, Montgomery Co., Caddo R., 1 mi. W. of Caddo

Gap; Distler and Metcalf; Apr. 6, 1961. KU 6922 (8, 32–36), Arkansas, Montgomery Co., trib. of Mill Cr., 2.5 mi. W. of Caddo Gap; Distler and Metcalf; June 29, 1961.

=*Etheostoma* (*Oligocephalus*) *pallididorsum* Distler and Metcalf.

Etheostoma (*Etheostoma*) *parvipinne* Gilbert and Swain *in* Gilbert, 1887, Proc. U.S. Nat. Mus., vol. 10, p. 59.

Holotype: USNM 36716 (1, 43), Alabama, small spring-branch trib. of Black Warrior R. at Tuscaloosa; C. H. Gilbert and J. Swain; summer, 1884.

=*Etheostoma* (*Oligocephalus*) *parvipinne* Gilbert and Swain. See Moore and Cross (1950).

Etheostoma peltatum Stauffer *in* Cope, 1864, Proc. Acad. Nat. Sci. Philadelphia, vol. 16, p. 233.

Holotype: ANSP 22627 (♂, 73), Pennsylvania, Lancaster Co., Conestoga Cr.; J. Stauffer.

=*Percina* (*Alvordius*) *peltata peltata* (Stauffer).

Etheostoma phoxocephalum Nelson, 1876, Bull. Illinois Mus. Nat. Hist., no. 1, p. 35.

Syntypes: UMMZ 187504 (2♂, 49–52), Illinois; S. A. Forbes; orig. IU 499, then IU 4702. Apparently syntypes but not labeled as such or listed in the IU catalog as types. No syntypes are in the collection of the Illinois Natural History Survey according to Smith and Bridges (1960).

=*Percina* (*Swainia*) *phoxocephala* (Nelson). See Bailey (1941).

Etheostoma (*Boleosoma*) *podostemone* Jordan and Jenkins *in* Jordan, 1889, Proc. U.S. Nat. Mus., vol. 11, p. 359, pl. 45, fig. 11.

Lectotype: USNM 39863 (♂, 45), Virginia, Roanoke R. at Allegheny Springs; Jordan and party; summer, 1888; herein selected by Dr. Charles F. Cole. D X–14; A II, 8; LL 38, complete; pectoral 12–12; infraorbital canal complete, 8 pores; preoperculomandibular pores 9; nape, cheeks, breast, and anterior part of belly naked; opercle partially scaled.

Paralectotypes: USNM 197635 (4, 40–45), removed from USNM 39863.

USNM 125477 (3, 26–42), Virginia, Roanoke R. at Roanoke and USNM 40305 (11, 24–41), Virginia, Roanoke R. are listed as paratypes in the U.S. National Museum catalog. Böhlke (1953, p. 74) considered SU 622 (8, 36–45), Virginia, Roanoke R. at Roanoke as paratypes. CAS 22857, formerly IU 7866 (12, 22–44), also from the Roanoke R. at Roanoke are labeled as paratypes. BMNH 1889.10.30.45 (1, 43), Roanoke R., U.S. Fish Comm. is labeled as "one of the types." However, Jordan and Jenkins designated USNM 39863, containing five specimens, as "type," and we believe this to be a designation of these specimens as syntypes from the type locality of Roanoke River at Allegheny Springs. The other specimens should then be considered as material examined and not part of the type series.

=*Etheostoma* (*Boleosoma*) *podostemone* Jordan and Jenkins. See Cole (1958).

Etheostoma quapella Eigenmann and Eigenmann, 1892, Amer. Nat., vol. 26, p. 963. Described in more detail in Eigenmann (1894).

Holotype: BMNH 1892.12.30.183 (♂, 36), Canada, Manitoba, Qu'Apelle R. at Fort Qu'Apelle, Red R. system; C. H. Eigenmann; August-September 1892.

=*Etheostoma* (*Oligocephalus*) *exile* (Girard). See Jordan and Evermann (1896) and Hubbs (1926, p. 68).

Etheostoma (*Percina*) *rex* Jordan and Evermann *in* Jordan, 1889, Proc. U.S. Nat. Mus., vol. 11, p. 357, pl. 45, fig. 9.

Holotype: USNM 39858 (♂, 122), Virginia, Roanoke R., near Roanoke; Jordan; summer, 1888.

Paratype: Jordan and Evermann mentioned a second smaller specimen taken with the type, but the whereabouts of this specimen is unknown.

=*Percina* (*Percina*) *rex* (Jordan and Evermann).

Etheostoma (*Hadropterus*) *roanoka* Jordan and Jenkins *in* Jordan, 1889, Proc. U.S. Nat. Mus., vol. 11, p. 358, pl. 45, fig. 10.

Lectotype: USNM 39866 (♂, 48), Virginia; Roanoke R. at Allegheny Springs; Jordan and party; summer, 1888. USNM 39866, then containing at least five specimens, given as "type" in original description; one specimen herein selected as lectotype by Dr. Edward C. Raney. D XI–12; A II,9; LL 47; cheeks naked; breast naked except for one large modified scale; nape naked anteriorly, with a few scales posteriorly; opercles with scales at least on upper portion; suborbital bar prominent; sides with 10 vertical bars tending to form a lateral band.

Paralectotypes: USNM 197774 (4 ♂, 43–48), removed from USNM 39866. MCZ 3106 (♂, 40); CU 46469 (3, 43–48); CU 46470 (1, 48), found with CU 46469 but probably out of MCZ 3106; SU 616 (9, 41–53), one specimen of *Percina peltata* removed; and UMMZ 187514 (7, 24–45), orig. IU 1143, then IU 5619, listed in old IU catalog as type, one specimen of *Etheostoma podostemone* removed and recataloged as UMMZ 187515; all from Roanoke R. at Roanoke.

In addition to the collections from the Roanoke River at Roanoke and Allegheny Springs listed above, specimens from two other rivers are mentioned in the original description. We feel that only the specimens from the Roanoke River should be considered as types, because Jordan and Jenkins designated a Roanoke series as "type," and because they specifically mentioned that the North Carolina specimens had larger scales than the Roanoke material. Therefore, we consider the following specimens from the Neuse and Tar rivers in North Carolina as other material, not as types. SU 17777 (1, 48), North Carolina, Neuse R. at Raleigh; listed by Böhlke (1953, p. 74) as a paratype. USNM 125359 (1, 42), same data; listed as a paratype in the USNM catalog. USNM 40367 (13, 29–48) and ANSP 70743–4 (2, 33–38), out of USNM 40367; same data, not listed as type in USNM catalog. UMMZ 187516 (♂, 59), orig. IU 1158, then IU 7998, part of the same series from the Neuse R.; not listed as type in IU catalog. UMMZ 187517 (1, 33), North Carolina, Tar R. at Rocky Mount; orig. IU 1144, then IU 7888, not listed as type in IU catalog; two specimens of *Percina peltata* removed and recataloged as UMMZ 187518.

=*Percina (Ericosma) crassa roanoka* (Jordan and Jenkins), according to Dr. Edward C. Raney (pers. comm.).

Etheostoma (*Rhothoeca*) *rupestre* Gilbert and Swain *in* Gilbert, 1887, Proc. U.S. Nat. Mus., vol. 10, p. 57.

Lectotype: USNM 36695 (♀, 32), Alabama, North R., trib. of Black Warrior R., near Tuscaloosa; C. H. Gilbert and J. Swain; summer, 1884; herein selected by Dr. Chu-fa Tsai. D XI–12; A II,7; LL 52; INF 4+3; POM 9; cheeks and breast naked; opercle with 2 imbedded scales; belly scaled anteriorly; 6 dorsal blotches.

Paralectotypes: USNM 188971 (17, 23–34), removed from USNM 36695.

=*Etheostoma* (*Etheostoma*) *rupestre* Gilbert and Swain.

Etheostoma sciotense Osburn and Williamson, 1898, Ann. Rept. Ohio State Acad. Sci., vol. 6, p. 17.

Lectotype: USNM 48846 (♂, 29), Ohio, Franklin Co., Big Walnut Cr., trib. of Scioto R., near Columbus; B. C. Osburn and E. B. Williamson; June 26, 1897; herein selected. D XII–12; A II,7; LL 27+19=46; anterior third of belly naked.

Paralectotypes: USNM 197995 (♂, 24), removed from USNM 48846. A third syntype was deposited in Jordan's collection, but we have been unable to find this specimen.

=*Etheostoma* (*Nothonotus*) *tippecanoe* Jordan and Evermann. See Osburn and Williamson (1899).

Etheostoma scovellii Woolman, 1892, Amer. Nat., vol. 26, p. 260.

Lectotype: USNM 44155 (1, 33), Mexico, Río de las Conchos, Chihuahua; A. J. Woolman; August 1891; herein selected. D XI–11;

A I,7; LL 44+15=59; INF 8; interorbital pores 2; cheeks, opercles, nape, and breast naked.

Paralectotypes: USNM 197970 (2, 27–34), out of USNM 44155. BMNH 1892.12.30.186–188 (3, 29–32), same data. CAS 22856 (3, 20–25), same data; orig. IU 4841.

=*Etheostoma* (*Austroperca*) *australe* Jordan. See Hubbs (1936).

Etheostoma (*Hadropterus*) *squamatus* Gilbert and Swain *in* Gilbert, 1887, Proc. U.S. Nat. Mus., vol. 10, p. 50.

Holotype: USNM 36652 (♂, 85), Tennessee, French Broad R. at mouth of Wolf Cr.; C. H. Gilbert and J. Swain; summer, 1884.

=*Percina (Swainia) squamata* (Gilbert and Swain).

Etheostoma squamiceps Jordan, 1877, U.S. Nat. Mus. Bull. 10, p. 11.

Lectotype: USNM 1145 (♂, 57), Kentucky, Logan Co., Russellville; Bebb; erroneously given as USNM 1345 in orig. description; herein selected. D IX–13; A II,7; LL 45+3=48; POM 10; INF incomplete; cheek and opercle covered with scales; small unpigmented fleshy bulbs around tips of first dorsal spines.

Paralectotype: USNM 197968 (♀, 54) removed from USNM 1145.

=*Etheostoma* (*Catonotus*) *squamiceps* Jordan. See Moore and Cross (1950, p. 145).

Etheostoma (*Nanostoma*) *swannanoa* Jordan and Evermann *in* Jordan, 1889, Proc. U.S. Nat. Mus., vol. 11, p. 360, pl. 45, fig. 13.

Lectotype: USNM 39861 (♀, 59), Virginia, S. Fork of Holston R. at Holstein Mills; D. S. Jordan and B. W. Evermann; summer, 1888; USNM 39861 given as type by Jordan and Evermann but then containing two specimens; lectotype herein selected by Dr. William J. Richards. D XII–12; A II,9; pectoral 16–16; LL 57; INF 8; POM 10; head, cheeks, opercles, and breast naked; vomerine teeth present; palatine teeth absent.

Paralectotypes: USNM 196777 (♀, 56), removed from USNM 39861. Jordan and Evermann designated USNM 39861 as "type," but they gave counts of the lateral line scales in 8 of the 10 specimens they had before them. Therefore, their description was apparently based on all their material, and the following are also considered paralectotypes. USNM 125490 (♀, 40), North Carolina, S. Fork of Swannanoa R. at Black Mountain; Jordan and Evermann; August 1888; orig. BF 772. SU 3507 (♀, 41), same locality as USNM 125490. Böhlke (1953, p. 74) gave the same data for SU 992 (2 ♂, 54–57) as for USNM 39861, but Jordan and Evermann reported only two specimens from this locality, so it seems likely that SU 992 is from Middle Fork of Holston R. at Marion or S. Fork of Swannanoa R. at Black Mountain. UMMZ uncat. (♂, 49), orig. IU 1169, then IU 8083. Locality in IU catalog for IU 8083 is N. Fork of Holston R. at Saltville, Va., but

Jordan and Evermann did not report this species from there. Locality in the IU catalog for 1169 is apparently S. Fork of Holston R. at Holstein Mills, Va. However, as with SU 992, this specimen must be from Middle Fork of Holston R. at Marion or S. Fork of Swannanoa R. at Black Mountain.

=*Etheostoma* (*Etheostoma*) *swannanoa* Jordan and Evermann.

Etheostoma tessellata D. H. Storer, 1845, Proc. Boston Soc. Nat. Hist., vol. 2, p. 48. Original description repeated almost verbatim in Storer (1846).

Syntypes: Alabama, Florence; received from C. A. Hentz. We have been unable to find any type material of this nominal form.

=?*Percina* (*Ericosma*) *evides* (Jordan and Copeland) according to Bailey (1959, p. 2). Although *E. tessellata* Storer is a senior synonym of *Alvordius evides* Jordan and Copeland, 1877, it is not available because *tessellata* is preoccupied in *Etheostoma* by *Boleosoma tessellatum* DeKay, 1842.

Etheostoma tippecanoe Jordan and Evermann, 1890, Proc. U.S. Nat. Mus., vol. 13, p. 3 [with fig. of *E. camurum*].

Lectotype: USNM 40080 (1, 29), Indiana, Tippecanoe R. at Marshland; B. W. Evermann; herein selected. D XII–13; A II, 8; LL 37+16=53; cheeks, prepectoral area, nape, and breast naked; opercle scaled; anterior part of belly naked along midline.

Paralectotype: USNM 197919 (1, 26), out of USNM 40080.

Four specimens are mentioned in the original description of *E. tippecanoe*. The two USNM specimens fit the original description and the current concept of *E. tippecanoe*. The other two syntypes apparently are UMMZ 187513 (2, 29–44), orig. IU 1194, then IU 4688. They have the belly completely scaled and lateral line scale counts of about 54+0=54 and 66+1=67. The larger one is a specimen of *E. camurum* and the smaller one probably is also. Jordan and Evermann (1896, p. 1090) wrote that the original description of *E. tippecanoe* was accompanied by a figure of *E. camurum* "by an error of printer." We believe that the specimen figured in Jordan and Evermann is the smaller specimen in UMMZ 187513. We count the same number of lateral line scales on the figure and the small specimen. The original drawing is labeled as a specimen 1⅞ in. long (total length) from no. 40080. This is equal to a standard length of about 29 mm. Three sets of comments are written on the original drawing. "The drawing is bad, but it was made from specimens sent to the National Museum as types of *E. tippecanoe*." "This is probably *E. camurum*. Certainly not *E. tippecanoe*. Anal fin very bad." "Fearful and not taken from our type."

=*Etheostoma* (*Nothonotus*) *tippecanoe* Jordan and Evermann. See Bailey (1959).

Etheostoma (*Psychromaster*) *trisella* Bailey and Richards, 1963, Occ. Pap. Mus. Zool. Univ. Michigan, no. 630, pl. 1, D–E.

Holotype: UMMZ 180073 (1, 35), Alabama, Cherokee Co., Cowans Cr., trib. of Spring Cr. which flows into Coosa R. at Jordans Farm on U.S. 411, 6.7 mi. SE. of Centre; E. A. Lachner and P. S. Handwerk; Sept. 13, 1947; orig. CU 18579.

=*Etheostoma* (*Psychromaster*) *trisella* Bailey and Richards.

Etheostoma (*Etheostoma*) *tuscumbia* Gilbert and Swain *in* Gilbert, 1887, Proc. U.S. Nat. Mus., vol. 10, p. 63.

Syntypes: SU 1003 (30, 25–48) and BMNH 1894.5.18.26–27 (2, 28–31), large spring at Tuscumbia flowing into Tennessee R.; C. H. Gilbert and J. Swain; summer, 1884; one of types figured by Jordan and Evermann (1900, fig. 467). Apparently UMMZ 187512 (44, 22–35), orig. IU 1380, then IU 5666, specimens almost completely disintegrated, are also syntypes, although they are not listed as types in the IU catalogs.

USNM 36154 with the same data also originally contained syntypes. This jar was found completely dried out in March 1937 and only fragments now remain. We believe that not many specimens were in the jar at that time because old correspondence of Barton Bean shows that at least 37 specimens from this series were sent out as "duplicate sets" to 37 high schools and other such institutions during the period Aug. 4, 1902 to Dec. 12, 1903. We assume that Bean was unaware that USNM 36154 contained types, for he certainly would not have sent type material to such institutions as the public schools of Kent, Wis.; Omaha, Nebr.; Windfall, Ind.; Galliopolis, Ohio; Helena, Mont.; Savanna, Ill.; Northwood, Iowa; Lovington, Ill.; Wiconisco, Pa.; the Free Public Library of Vinton, Iowa; the San Antonio Female College, Tex.; and the Ursuline Seminary, New Rochelle, N.Y.!

Böhlke (1953) and Bailey and Richards (1963) gave USNM 36154 as holotype. Böhlke listed SU 1003 as paratypes. From the number of specimens distributed out of USNM 36154, it is clear that all of the original type material should be listed as syntypes.

Böhlke erroneously listed SU 2683 (2, 27–28) as paratypes, but these specimens were collected at Florence, Ala., a locality not mentioned in the original description. Bailey and Richards (1963) listed USNM 43484 and 63115 and UMMZ 43484 as paratopotypes, but this material was collected by Kirsch in 1889, subsequent to the original description of *E. tuscumbia,* and so they are merely topotypes.

=*Etheostoma* (*Psychromaster*) *tuscumbia* Gilbert and Swain. See Bailey and Richards (1963).

Etheostoma (*Cottogaster*) *uranidea* Jordan and Gilbert *in* Gilbert, 1887, Proc. U.S. Nat. Mus., vol. 10, p. 48.

Syntypes: USNM 36413 (8, 31–46), Arkansas, Washita (Ouachita) R. at Arkadelphia; Jordan and Gilbert; summer, 1884. One specimen of *Etheostoma histrio* removed and recataloged as USNM 197419.

=*Percina* (*Imostoma*) *uranidea* (Jordan and Gilbert).

Etheostoma variata Kirtland, 1841, Boston Journ. Nat. Hist., vol. 3, p. 274, pl. 2, fig. 2.

Types: Type locality—Mahoning R., Ohio. We have been unable to find any extant type material.

=*Etheostoma* (*Etheostoma*) *variatum* Kirtland.

Etheostoma (*Ulocentra*) *verecundum* Jordan and Evermann *in* Jordan, 1889, Proc. U.S. Nat. Mus., vol. 11, p. 360, pl. 45, fig. 12.

Holotype: USNM 39862 (1, 44), Virginia, Middle Fork of Holston R., 5 mi. S. of Glade Spring; summer, 1888.

=*Etheostoma* (*Ulocentra*) *simoterum* (Cope).

Etheostoma (*Etheostoma*) *whipplei alabamae* Gilbert and Swain *in* Gilbert, 1887, Proc. U.S. Nat. Mus., vol. 10, p. 62.

Syntypes: USNM 36735 (6, 25–30), Alabama, Black Warrior R., near Morris; C. H. Gilbert and J. Swain; summer, 1884. USNM 36687 (2, 29–41), and SU 2318 (2, 35–41), Alabama, North R., trib. of Black Warrior R., near Tuscaloosa; Gilbert and Swain; summer, 1884.

=*Etheostoma* (*Oligocephalus*) *whipplii artesiae* (Hay). See Hubbs and Black (1941).

Etheostoma wrighti McCormick, 1892, Bull. Oberlin College Lab., no. 2, p. 30.

Holotype: Oberlin Coll. Mus. (1, 2⅝ in.), Ohio, Lorain Co., Vermillion R., trib. of Lake Erie; L. M. McCormick; Apr. 9, 1892. This specimen was not present in the Oberlin collection in mid-January 1931, according to Trautman (1957, p. 548), and has not been located.

=*Percina* (*Imostoma*) *shumardi* (Girard), according to Jordan and Evermann (1896, p. 1047) and Jordan, Evermann, and Clark (1930, p. 285). The type locality and original description support this conclusion, but Trautman (1957, p. 548) has suggested that *E. wrighti* may be a hybrid between *P. shumardi* and *P. caprodes* or *P. maculata*, or between *P. caprodes* and *P. maculata*.

Etheostoma zonale arcansanum Jordan and Gilbert, 1886, Proc. U.S. Nat. Mus., vol. 9, p. 5.

Lectotype: USNM 36410 (♀, 38), Arkansas, Washita (Ouachita) R. at Arkadelphia; D. S. Jordan and C. H. Gilbert; summer, 1884; herein selected by Dr. Chu-fa Tsai. D XI–11; A II,7; LL 56; INF 4+3; POM 10; cheeks, opercles, and belly completely covered with scales; a few scales on breast; 6 dorsal blotches.

Paralectotypes: USNM 188970 (25, 24–36), removed from USNM 36410. UMMZ 187506 (7, 25–36), orig. IU 777, then IU 4543, same data. USNM 36249 (2, 40–43), Missouri, Spring Fork of Neosho R., near Carthage; Gilbert and S. E. Meek. USNM 36275 (1, 41), Missouri, James Fork of White R., near Marshfield; Gilbert and Meek. USNM 36399 (2, 30–31), Oklahoma, Poteau R., W. of Hackett City, Ark.; Jordan and Gilbert; summer, 1884. USNM 36447 (15, 21–35), Arkansas; Saline R., near Benton, just above railroad bridge; Jordan and Gilbert; summer, 1884; six specimens of *Etheostoma r. radiosum* removed. UMMZ 187507 (4, 22–29), same locality, orig. IU 779, then IU 4546; one specimen of *E. histrio* removed and recataloged as UMMZ 187508.

=*Etheostoma* (*Etheostoma*) *zonale zonale* (Cope), according to Dr. Chu-fa Tsai (pers. comm.).

Hadropterus evermanni Moenkhaus, 1903, Bull. U.S. Fish Comm., vol. 22, p. 397, fig.

Holotype: Given as IU 9785 (1, 77), Indiana, Lake Tippecanoe in original description, but we have not located this specimen.

Paratypes: USNM 50834 (1, 48) and USNM 126919 (1, 48); 1899; orig. BF 2742; Lake Tippecanoe. We have not found the paratype originally cataloged as IU 9786 nor the specimen said to have been deposited at Stanford University. There appears to be no record of a paratype having been deposited in the British Museum, and Collette could find none among the type material or in the regular collections in October 1963.

=*Percina* (*Percina*) *caprodes semifasciata* (DeKay) × *Percina* (*Alvordius*) *maculatus* (Girard). See Hubbs (1926, p. 60). The two USNM specimens and the figure of the holotype appear to be intermediate between *P. caprodes* and *P. maculatus* in such characters as color pattern, number of lateral line scales, juncture of gill membranes, nape squamation, and snout shape. Trautman (1948) has also reported this natural hybrid combination from southwestern Lake Erie and tributaries that enter the lake in this region.

Hadropterus maculatus Girard, 1859, Proc. Acad. Nat. Sci. Philadelphia, vol. 11, p. 100.

Lectotype: USNM 1157 (♂, 69), Maryland, Anne Arundel Co., eastern trib. of Potomac R.; J. H. Clark; selected herein by Dr. Edward C. Raney. D XIV–12; A II,9; pectoral rays 14–13; LL 55;

scales above and below lateral line 7–10; caudal peduncle scales 21; cheeks sparsely scaled; opercles scaled; preopercles and nape naked; 11 enlarged scales on midline of belly. This specimen is also the type of *Hadropterus notogrammus* Raney and Hubbs.

Paralectotype: USNM 197773 (♂, 56) removed from USNM 1157.

MCZ 24525 (2 ♂, 60–64), originally USNM 1303, then MCZ 129, and MCZ 24546 (2 ♂, 54–55), originally USNM 1157, then MCZ 130, have the same data and were probably part of the original series; however, they were received from the USNM in 1853, but the description was not published until 1859, so it is doubtful if Girard had the specimens before him at the time of the original description. Therefore, the four specimens had best be considered only as topotypes, both of *H. maculatus* Girard and *H. notogrammus* Raney and Hubbs.

=*Percina* (*Alvordius*) *notogramma notogramma* (Raney and Hubbs) because *maculatus* is preoccupied by *Alvordius maculatus* Girard. See Hogarth and Woolcott (1966).

Hadropterus maxinkuckiensis Evermann, 1900, Rept. U.S. Fish Comm., vol. 25., p. 366, pl. 17.

Holotype: USNM 49378 (♂, 75), Indiana, Marshall Co., Aubeenaubee Cr., E. inlet of L. Maxinkuckee, 0.5 mi. from lake; Evermann and Scovell; Aug. 4, 1899.

=*Percina* (*Alvordius*) *maculata* (Girard). See Hubbs and Black (1954).

Hadropterus nasutus Bailey, 1941, Occ. Pap. Mus. Zool. Univ. Michigan, no. 440, figs. 1, 3.

Holotype: UMMZ 132898 (♂, 66), Arkansas, Searcy Co., Middle Fork, Little Red R., trib. of White R., near bridge on U.S. 65, 1.5 mi. SE. of Leslie; R. M. Bailey and M. E. Davis; Aug. 17, 1940.

Paratype: USNM 198146 (♀, 63), same data as holotype; orig. ISC 2.

=*Percina* (*Swainia*) *nasuta* (Bailey).

Hadropterus nigrofasciatus Agassiz, 1854, Amer. Journ. Sci. and Arts, ser. 2, vol. 17, p. 305.

Lectotype: MCZ 24603 (♂, 103), Alabama, near Mobile, A. Stein; orig. out of USNM 1197, then MCZ 122; herein selected. D XII–12; A II, 9; LL 50; preopercle without serrae; branchiostegal membranes slightly connected; nape, cheek, opercle, and breast completely scaled.

Paralectotypes: MCZ 43094 (11, 41–98) and UMMZ 86300 (3, 51–77), removed from MCZ 24603. USNM 1197 (♂, 74; ♀, 82), same data.

=*Percina* (*Hadropterus*) *nigrofasciata nigrofasciata* (Agassiz). See Crawford (1956).

Hadropterus nigrofasciatus westfalli Fowler, 1942, Notulae Naturae, no. 107, p. 9, fig. 9.

Holotype: ANSP 69980 (♂, 44), Florida, Wekiva R., trib. of St. Johns R.; M. J. Westfall, Jr.; Mar. 8, 1941.

=*Percina* (*Hadropterus*) *nigrofasciata nigrofasciata* (Agassiz). See Crawford (1956).

Hadropterus notogrammus Raney and Hubbs, 1948, Occ. Pap. Mus. Zool. Univ. Michigan, no. 512, pl. 1, figs. 1–2; pl. 2, figs. 1–2; a replacement name for *Hadropterus maculatus* Girard which was preoccupied.

Types: Raney and Hubbs designated UMMZ 144696 [(♂, 67), Virginia, Rockbridge Co., South R., 5 mi. E. of Lexington, L. C. Pettit; May 17, 1941; orig. CU 9719] as holotype; and USNM 40242; CU 8324, 9708, 10138, 4909; UMMZ 144697 and 95194 as paratypes. However, these designations are not valid because the type specimens for a new name must be the same as for the original name (Art. 72 d, Int. Code Zool. Nomencl.), in this case USNM 1157, lectotype and USNM 197773, paralectotype of *Hadropterus maculatus* Girard.

=*Percina* (*Alvordius*) *notogramma notogramma* (Raney and Hubbs). See Hogarth and Woolcott (1966).

Hadropterus oxyrhynchus Hubbs and Raney, 1939, Occ. Pap. Mus. Zool. Univ. Michigan, no. 396; pl. 1.

Holotype: UMMZ 118422 (♂, 80), West Virginia, Randolph Co., Cheat R. at Cheat Bridge; E. C. Raney; June 25, 1935.

Paratypes: USNM 56862 (♂, 63), West Virginia, Cheat R. at Raines; W. P. Hay; Sept. 12, 1899. UMMZ 118482 (4, 44–54), Virginia, Wythe Co., New R., above Jacksons Ferry; C. L. Hubbs and family; Aug. 21, 1936. UMMZ 119268 (7, 20–33), West Virginia, New R. at Prince; J. Addair; July 26, 1935. UMMZ 119246 (2, 30–31), West Virginia, New R., 2 mi. below Hinton; Addair; July 18, 1935.

=*Percina* (*Swainia*) *oxyrhyncha* (Hubbs and Raney). See Bailey (1941).

Hadropterus palmaris Bailey, 1940, Journ. Washington Acad. Sci., vol. 30, no. 12, p. 525, fig. 1.

Holotype: UMMZ 126179 (♂, 66), Georgia, Lumpkin Co., Etowah R., trib. of Coosa R., just above bridge on U.S. 19, 4 mi. SW. of Dahlonega; R. M. and M. K. Bailey; Aug. 25, 1939.

Paratypes: UMMZ 126180 (2, 45–67), USNM 117881 (2 ♂, 61–68) and USNM 198145 (♂, 63), orig. ISC 1, same data as holotype. UMMZ 111232 (1, 59) and UMMZ 111133 (22, 31–63), Alabama, Saugahatchee Cr., trib. of Tallapoosa R.; F. E. Guyton; Oct. 24,

1930. UMMZ 111234 (4), Alabama, Macon Co., 3 mi. E. of Tuskegee; Guyton; June 3, 1931; there is a note in the UMMZ card file that these specimens were not located during a check several years ago, and we were unable to find them in May 1964.

=*Percina* (*Ericosma*) *palmaris* (Bailey). See Crawford (1954).

Hadropterus pantherinus Moore and Reeves, 1955, Copeia, no. 2, p. 90, pl. 1.

Holotype: UMMZ 167120 (♀, 63), Oklahoma, Pushmataha Co., Little R., W. of Pickens, sec. 1, T. 2 S., R. 20 E.; G. A. Moore and J. D. Reeves; Mar. 25, 1951.

Paratypes: UMMZ 81185 (1, 59), Arkansas, Polk Co., trib. of Mountain Fork R.; June 29, 1927; Univ. Oklahoma Mus. Exped. OAM 2559 (1, 38), Oklahoma, McCurtain Co., Mountain Fork R., Beavers Bend State Park, sec. 10, T. 5 S., R. 25 E.; Moore and class; Aug. 21, 1948. UMMZ 167122 (3, 22–27), same locality as OAM 2559, Moore and F. B. Cross; May 30, 1948. USNM 198108 (1, 35), Oklahoma, LeFlore Co., Little R., S. of Honobia, sec. 30, T. 1 N., R. 22 E.; A. P. Blair; orig. TUC uncat. MCZ 38491 (1, 41), Oklahoma, McCurtain Co., Mountain Fork R. at Smithville, sec. 13, T. 1 S., R. 25 E.; Moore and C. C. Rigney; Aug. 17–19, 1948. UMMZ 167121 (6, 48–72), same locality as UMMZ 167120; Moore and Reeves; Mar. 25, 1951. OAM 4948 (1, 52), Oklahoma, McCurtain Co., Glover R. in sec. 13, T. 3 S., R. 22 E.; Moore and Reeves; Mar. 25, 1951.

=*Percina* (*Alvordius*) *pantherina* (Moore and Reeves).

Hadropterus scierus Swain, 1883, Proc. U.S. Nat. Mus., vol. 6, p. 252.

Lectotype: USNM 34350 (♂, 57), Indiana, Monroe Co., Bean Blossom Cr., trib. of White R., 6 mi. N. of Bloomington; D. S. Jordan and J. Swain; herein selected. D XIII–14; A II,10; LL complete, 71; preopercle serrate; branchiostegal membranes moderately joined.

Paralectotypes: Two specimens were mentioned in the original description, but we do not know if the second syntype is still in existence.

=*Percina* (*Hadropterus*) *sciera sciera* (Swain). See Hubbs and Black (1954).

Hadropterus scierus apristis Carl L. Hubbs and Clark Hubbs *in* Clark Hubbs, 1954, Amer. Mid. Nat., vol. 52, no. 1, p. 211.

Holotype: UMMZ 162377 (♂, 68), Texas, Caldwell-Guadalupe cos., San Marcos R., 0.5 mi. SE. of Prairie Lea; K. C. Jurgens and R. C. MacEwan; Feb. 11, 1950.

Paratypes: UMMZ 162378 (40, 46–74), same data as holotype. USNM 160628 (6 ♀, 48–61; 5 ♂, 57–83), Texas, Caldwell-Guadalupe cos., San Marcos R. at Stairtown; Jurgens and MacEwan; Feb. 18, 1950, orig. TNHC 255. USNM 160629 (11 ♀, 50–69, 1 ♂, 73), Texas, Caldwell-Guadalupe cos., San Marcos R., 0.5 mi. S. of Prairie Lea; Jurgens and W. Brown; Feb. 8, 1950; orig. TNHC 180. UMMZ 162374 (9, 41–72), Texas, Hays Co., San Marcos R., below cotton gin near State Fish Hatchery; C. Hubbs and Jurgens; Sept. 26, 1949; orig. TNHC 21. FMNH 46194 (13, 27–64), Texas, San Marcos R., 3 mi. SE. of State Fish Hatchery; Jurgens and Hubbs; Sept. 26, 1949; orig. TNHC 40; specimens partly dried out; erroneously given as FMNH 46195 in original description. OAM 4707 (8, 42–63), Texas, Caldwell-Guadalupe cos.; San Marcos R. at Fentress; Jurgens and Brown; Nov. 18, 1949. TNHC 90 (15, 28–56), Texas, Caldwell-Guadalupe cos.; San Marcos R., 0.5 mi. N. of Staples; Jurgens; Nov. 11, 1949. TNHC 501 (1, 75), Texas, Gonzales Co., Guadalupe R. at rt. 80, S. of Belmont; Hubbs; Apr. 6, 1950. TNHC 162 (1, 76), Texas, Gonzales Co., Guadalupe R., ¼ mi. SE. of Gonzales; Jurgens. TNHC 314 (1, 66), Texas, Comal Co., Guadalupe R. at Hunter; Jurgens and Brown; Mar. 22, 1950. SU 17311 (3), Texas, Caldwell-Guadalupe cos.; San Marcos R. at Stairtown; Mar. 25, 1950; Jurgens and W. Faber; orig. TNHC 333; specimens now completely disintegrated. TAMC 1F–13–g–10 (16, 35–78), Texas, Caldwell-Guadalupe cos., San Marcos R. at Martindale; Jurgens and Brown; Nov. 6, 1949. TAMC 1F–13–g–4 (1, ?), Texas, Gonzales Co., Guadalupe R., 0.5 mi. S. of Gonzales; F. T. Knapp; Nov. 26, 1950; dried out.

=*Percina* (*Hadropterus*) *sciera apristis* (Hubbs and Hubbs).

Hadropterus scierus serrula Jordan and Gilbert, 1886, Proc. U.S. Nat. Mus., vol. 9, p. 16.

Lectotype: USNM 36481 (♂, 50), Texas, Sabine R., 5 mi. S. of Longview; D. S. Jordan and C. H. Gilbert; summer, 1884; herein selected. D XII–14; A II,9; LL complete, 65; preopercular serrae 10–13.

Paralectotypes: USNM 198010 (5, 43–47), removed from USNM 36481.

Jordan and Gilbert had other material of their new variety from the Trinity River at Dallas, Tex. (USNM 36476) and from the Rio Lampasas at Belton, Tex. Evermann and Kendall (1894, pp. 88, 113) gave the type locality as the Sabine River at Longview. Jordan and Evermann (1896, p. 1038) gave the "type" as USNM 36481 and the type locality as the Red River at Fulton, Ark. Hubbs and Black (1954, p. 205) pointed out that Jordan and Evermann did not collect *serrula* in the Red River and no. 36481 is from the Sabine. Hubbs and Black designated USNM 36481 "as the sole lectotypes." We feel that Jordan and Evermann meant USNM 36481 to be the "types" in the first place, so Hubbs and Black's action was not necessary. Böhlke (1953, p. 74) listed SU 3934 from Rio Lampasas as paratypes and USNM 36481 as holotype. SU 3934 cannot be paratypes because USNM 36481 from the Sabine contains the entire type series as originally indicated by Jordan and Gilbert and confirmed by Evermann and Kendall (1894), Jordan and Evermann (1896), and Hubbs and Black (1954).

=*Percina* (*Hadropterus*) *sciera* ssp. Further study is necessary to determine whether or not *serrula* can be recognized as a valid subspecies. See Hubbs and Black (1954) and Hubbs (1954).

Hadropterus sellaris Radcliffe and Welsh, 1913, Bull. U.S. Bur. Fish., vol. 32, p. 31, pl. 18.

Holotype: USNM 74346 (♀, 39), Maryland, Harford Co., Swan Cr., near Havre de Grace; L. Radcliffe and W. W. Welsh; May 2, 1912.

Paratype: USNM 74347 (♀, 39), same data as holotype.

=*Etheostoma* (*Etheostoma*) *sellare* (Radcliffe and Welsh). See Hubbs and Black (1940) and Knapp et al. (1963).

Hadropterus shumardi Girard, 1859, Proc. Acad. Nat. Sci. Philadelphia, vol. 11, p. 100.

Holotype: USNM 1330 (♂, 48), Arkansas, Arkansas R., near Ft. Smith; G. C. Shumard.

=*Percina* (*Imostoma*) *shumardi* (Girard).

Hadropterus spillmani Hay, 1881, Proc. U.S. Nat. Mus., vol. 3, p. 491.

Lectotype: USNM 27432 (♂, 64), Mississippi, Clarke Co., Chickasawha R. at Enterprise; O. P. Hay; March–April 1880; listed as type by Jordan and Evermann (1896, p. 1039); selection herein confirmed. D XII–12; A II,9; pectoral 14–15; LL 54; scales above and below lateral line 6–11; cheeks, opercles, breast, and nape completely covered with scales; several serrations on preopercle.

Paralectotypes: The original description was based on "several specimens" of which some were placed "in Professor Jordan's collection" and the remainder in Butler University. These specimens are apparently no longer in existence.

=*Percina* (*Hadropterus*) *nigrofasciata nigrofasciata* (Agassiz). See Crawford (1956, p. 41).

Hadropterus tessellatus Jordan, 1877, U.S. Nat. Mus. Bull. 10, p. 7.

Lectotype: USNM 1199 (1, 47), Pennsylvania, Allegheny R. at Foxburg; S. F. Baird; herein selected. D XIII–12; A II,9; LL 51; pectoral rays 16; INF 8, fourth pore opening at the end of a dorsally directed tube beneath the eye; POM 10; four blackish dorsal saddles; cheeks naked; opercles and breast with few scales.

Paralectotype: USNM 197416 (1, 29), removed from USNM 1199. This smaller specimen was found in the bottle labeled USNM 1199. This might not be part of the type material because Jordan referred to "a specimen of an Etheostomoid" and "length of type 2½ inches" and so may have examined only the larger specimen. However, Jordan (1885, p. 163) mentioned two specimens as "the types of *Hadropterus tessellatus*."

=*Etheostoma* (*Etheostoma*) *variatum* Kirtland. See Jordan (1885) and Hubbs and Black (1941, p. 15).

Hololepis barratti appalachia J. R. Bailey, 1950, Copeia, no. 4., p. 312.

Holotype: UMMZ 156224 (♂, 37), North Carolina, Buncombe Co., pond S. of mouth of Bent Cr., 300 ft. W. of French Broad R., 7 mi. SSW. of Asheville; F. Cross and Y. Barber; July 14, 1947.

Paratypes: UMMZ 156225 (48, 13–42), same data as holotype. CU 18444 (3, 30–40), and DU uncat. (6♀, 19–40), same locality; June 7, 1949; J. R. Bailey.

=*Etheostoma* (*Hololepis*) *fusiforme barratti* (Holbrook). See Collette (1962).

Hololepis collis Hubbs and Cannon, 1935, Misc. Publ. Mus. Zool. Univ. Michigan, no. 30, p. 52, pl. 1, fig. 7.

Holotype: UMMZ 94560 (♂, 40), South Carolina, York Co., creek near York; D. Ameel; Nov. 11, 1931.

Paratypes: UMMZ 107085 (♀, 40), same data as holotype. UMMZ 94546 (♂, 36), South Carolina, York Co., Steel Cr., trib. of Catawba R. at Rock Hill; Ameel; Nov. 11, 1931.

=*Etheostoma* (*Hololepis*) *collis collis* (Hubbs and Cannon). See Collette (1962).

Hololepis erochrous Cope, 1864, Proc. Acad. Nat. Sci. Philadelphia, vol. 16, p. 233.

Lectotype: MNHN 4669 (1, 33), New Jersey, Delaware drainage, Brown's Mills; herein selected. D IX–10; A II, about 7; LL 17+31=48; cheeks, nape, breast scaly; interorbital naked. Fowler (1907), Hubbs and Cannon (1935), and Collette (1962) were unable to locate any types of this form at ANSP. Vaillant (1873, p. 134) wrote "L'exemplaire suivant envoyé à la collection du Muséum par cet auteur . . . ." with reference to its receipt from Cope in 1867. Figured in Vaillant, pl. 3, fig. 9.

=*Etheostoma* (*Hololepis*) *fusiforme fusiforme* (Girard). See Collette (1962).

Hololepis fusiformis atraquae Hubbs and Cannon, 1935, Misc. Publ. Mus. Zool. Univ. Michigan, no. 30, p. 68, pl. 1, fig. 11.

Holotype: UMMZ 107090 (♂, 31), Maryland, Prince Georges-Charles Co. line, Mattawoman Cr.; C. L. Hubbs, G. S. Myers, and E. D. Reid; May 21, 1933.

219-948—66——4

Paratypes: UMMZ 107089 (15, 27–32), USNM 117547 (2, 29–30), and USNM 92946 (4, 32–34), same data as holotype.

=*Etheostoma* (*Hololepis*) *fusiforme fusiforme* (Girard). See Collette (1962).

Hololepis fusiformis insulae Hubbs and Cannon, 1935, Misc. Publ. Mus. Zool. Univ. Michigan, no. 30, p. 83, pl. 1, fig. 15.

Holotype: MCZ 28274 (1, 24), Massachusetts, Nantucket Is., Gibbs Pond; H. Allen; "rec'd. Aug. 10, 1893."

Paratypes: UMMZ 86601 (2, 22–25) and MCZ 42078 (8, 16–26), same data as holotype. The latter was originally MCZ 33547, but because that number has also been used for a *Girardinus*, the paratypes have been recataloged.

=*Etheostoma* (*Hololepis*) *fusiforme fusiforme* (Girard). See Collette (1962).

Hololepis fusiformis metae-gadi Hubbs and Cannon, 1935, Misc. Publ. Mus. Zool. Univ. Michigan, no. 30, p. 81, pl. 1, fig. 14.

Holotype: USNM 77860 (♂, 32), Massachusetts, Barnstable Co., Osterville, Tempies Pond; V. Edwards; Nov. 12, 1902.

Paratypes: USNM 94683 (36, 27–43) and UMMZ 107093 (2, 31–38), same data as holotype.

=*Etheostoma* (*Hololepis*) *fusiforme fusiforme* (Girard). See Collette (1962).

Hololepis saludae Hubbs and Cannon, 1935, Misc. Publ. Mus. Zool. Univ. Michigan, no. 30, p. 50, pl. 1, fig. 6.

Holotype: UMMZ 107079 (1, 21), South Carolina, Saluda Co., Richland Cr., trib. of Lake Murray, 10 mi. SE. of Saluda; E. M. Burton; June 21, 1933.

Paratypes: UMMZ 107078 (2, 20–22), CM 33.149.1 (4, 16–22), and USNM 94685 (1, 21), same data as holotype. FMNH 38331 (1, 18), out of CM 33.149.1. UMMZ 107077 (4, 17–21) and CM 33.139.1 (4, 14–16), South Carolina, Saluda Co., Moore's Cr., trib. of Lake Murray, 6 mi. SE. of Saluda; Burton; June 21, 1933.

=*Etheostoma* (*Hololepis*) *saludae* (Hubbs and Cannon). See Collette (1962).

Hololepis serrifer Hubbs and Cannon, 1935, Misc. Publ. Mus. Zool. Univ. Michigan, no. 30, p. 31, pl. 1, fig. 2.

Holotype: UMMZ 107053 (♂, 53), North Carolina, Wake Co., Buffalo Cr. at Wendell; C. S. Brimley and Harris; Nov. 19, 1925.

Paratypes: The following are from North Carolina: USNM 93132 (♀, 45) and USNM 93133 (2♂, 43), Wilmington; W. P. Seal; March 1900. USNM 86163 (♀, 38), Wilmington; W. W. Welsh; Dec. 26, 1916. UMMZ 107056 (2, 33–36) and USNM 200333 (1, 34), Bertie

Co., Windsor; C. S. Brimley and W. B. Mabee; Oct. 21, 1924. UMMZ 107061 (1, 33), Martin Co., Williamston; Brimley; Oct. 23, 1924. UMMZ 107065 (♂, 40), Martin Co.; Jamesville; Brimley; Oct. 23, 1924. UMMZ 107054 (2, 34–38) and USNM 200335 (2, 38), Wake Co., Little R. at Wendell; Brimley and Mabee; Dec. 28, 1923. UMMZ 107064 (1, 33), same locality; Brimley and Harris; Nov. 19, 1925. UMMZ 94658 (2, 34–37), same locality; Brimley and Brady; Nov. 30, 1931. UMMZ 107060 (2, 37–43) and USNM 200330 (1, 38), Wake Co., Buffalo Cr. at Wendell; Brimley and Mabee; Nov. 30, 1923. UMMZ 107062 (♂, 37), same data; Mar. 30, 1925. UMMZ 107063 (5, 34–39) and USNM 200331 (5, 36–48), Johnston Co., Buffalo Cr., near Archer; Brimley and Mabee; Nov. 26, 1923. UMMZ 107066 (1, 37), Harnett Co., Black R. at Dunn; Brimley and Mabee; Nov. 19, 1923. UMMZ 107055 (3, 37–47) and USNM 200336 (4, 38–41), Johnston Co., Mingo Cr.; Brimley and Mabee; Nov. 19, 1923. UMMZ 107067 (3, 33–38) and USNM 200337 (3, 30–35), same data, Dec. 10, 1924. UMMZ 107059 (♂, 39) and USNM 200334 (2, 36–39), Harnett Co., Lillington; Brimley and Mabee; Dec. 11, 1923. UMMZ 107058 (1, 35), Harnett Co., Upper Little R. at Bunlevel; Brimley and Mabee; Dec. 11, 1923. UMMZ 107057 (1, 32) and USNM 200332 (1, 35), Sampson Co., Clinton; Brimley and Mabee; Nov. 20, 1923. UMMZ 70705 (1, 26), Moore Co., Lakeview; R. E. Coker; June 12, 1926. UMMZ 107073 (♀, 44), same data; Nov. 11, 1934. The following are from South Carolina: CM 34.215.1 (♂, 43), Marlboro Co., 6 mi. N. of Bennettsville; E. M. Burton; July 25, 1934. CM 33.260.1 (2, 32–34), Richland Co., Cedar Cr. on Leesville Rd.; Burton; Aug. 31, 1933. CM 33.264.1 (1, 32), Richland Co., old dam, near Wilson's Mill; Burton; Aug. 31, 1933. CM 34.179.1 (2, 33) and UMMZ 107075 (2, 32–33), Bamberg Co., Little Salkahatchie R., 3.5 mi. N. of Ehrhardt; Burton; July 11, 1934. CM 34.177.1 (2, 31–34) and UMMZ 107074 (2, 26–33), Colleton Co., Little Salkahatchie R., near Bell's Crossroads; Burton; July 11, 1934.

=*Etheostoma* (*Hololepis*) *serriferum* (Hubbs and Cannon). See Collette (1962).

Hololepis thermophilus Hubbs and Cannon, 1935, Misc. Publ. Mus. Zool. Univ. Michigan, no. 30, p. 63, pl. 1, fig. 10.

Holotype: UMMZ 107072 (♂, 32), North Carolina, Harnett Co., millpond at Kipling; C. S. Brimley and W. B. Mabee; Dec. 11, 1923.

Paratypes: UMMZ 107071 (2, 30) and USNM 200239 (2, 28–30), same data as holotype. UMMZ 107070 (♂, 31), North Carolina, Wake Co., Buffalo Cr. at Wendell; Brimley and Mabee; Nov. 26, 1923. UMMZ 107069 (1, 29), same data; Nov. 30, 1923. UMMZ

107068 (1, 29), North Carolina, Johnston Co., Big Swamp at Kenly; Brimley and Mabee; Nov. 26, 1923. USNM 52060 (8, 27–34) and USNM 52071 (6, 27–29), North Carolina, Wilmington; W. P. Seal. USNM 86165 (9, 26–30), North Carolina, ditch at Wilmington; W. W. Welsh; Dec. 29, 1916. USNM 86160 (2, 22–24), North Carolina, lake at Wilmington; "Grampus"; Jan. 3, 1917.

=*Etheostoma* (*Hololepis*) *fusiforme fusiforme* (Girard). See Bailey and Frey (1951) and Collette (1962).

Hololepis thermophilus oligoporus Bailey and Frey, 1951, Journ. Elisha Mitchell Sci. Soc., vol. 67, no. 2, p. 193, pl. 6, figs. 9–18; pl. 7, figs. 11–19; pl. 8, figs. 5–11.

Holotype: UMMZ 161969 (♂, 25), North Carolina, Bladen Co., Jones Lake; North Carolina lake survey; Sept. 10, 1947.

Paratypes: All from Bladen Co., N.C., collected by the North Carolina lake survey in 1947. Jones Lake: UMMZ 161968 (44, 15–27), same data as holotype. UMMZ 161970 (2, 21–23), June 17. UMMZ 161971 (3, 20–24), Aug. 26. UMMZ 161972 (38, 19–27), Aug. 28. DU uncat. (15, 21–25), Aug. 28. Salters Lake: UMMZ 161974 (46, 19–25), Sept. 9. UMMZ 161973 (2, 21), June 27. UMMZ 161975 (2, 18–20), July 4. Singletary Lake: UMMZ 161965 (2, 22–25), July 17. UMMZ 161966 (25, 17–27), Sept. 5. UMMZ 161967 (5, 22–25), Sept. 7.

=*Etheostoma* (*Hololepis*) *fusiforme fusiforme* (Girard). See Collette (1962).

Hololepis zonifer Hubbs and Cannon, 1935, Misc. Publ. Mus. Zool. Univ. Michigan, no. 30, p. 47, pl. 1, fig. 5.

Holotype: UMMZ 88803 (♀, 31), Alabama, Montgomery Co., pools of Catoma Cr., 5 mi. SW. of Montgomery; E. P. Creaser and H.R. Becker; Sept. 18, 1929.

Paratype: UMMZ 88822 (♀, 25), Alabama, Lowndes Co., Big Swamp Cr., 25 mi. SW. of Montgomery; Creaser and Becker; Sept. 18, 1929.

=*Etheostoma* (*Hololepis*) *zoniferum* (Hubbs and Cannon). See Collette (1962).

Hyostoma blennioperca Cope, 1868, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 6, p. 215.

Lectotype: ANSP 14026 (♂, 85), Virginia; Holston R.; E. D. Cope; October 1867. Fowler (1907, p. 522) designated number 14026 as "type" but left it mixed with the other syntypes in the bottle. However, he mentioned that "the type as here restricted is evidently the largest in the collection." Therefore, the largest specimen is herein confirmed as lectotype by Dr. Robert V. Miller. D XIV–13;

A II, 8; LL 74; pectoral rays 15–15; cheeks and opercle, completely covered with scales; snout blunt, not overhung.

Paralectotypes: ANSP 14027–35 (8, 47–60), same data as lectotype. ANSP 14004 (1, 54), Virginia, Wythe Co., trib. of Kanawha R.; Cope; 1867. ANSP 14006–08 (3, 51–61), Virginia, Wythe Co., Walker's Cr., trib. of Kanawha R.; Cope; 1867. ANSP 14020–25 (6, 54–66), Virginia, Sinking Cr., trib. of Kanawha R.; Cope; 1867.

By selecting ANSP 14026 as lectotype, Fowler made the name *H. blennioperca* Cope applicable to the Holston River population of *E. blennioides*. *H. blennioperca* thereby becomes a synonym of *E. b. newmanii*, according to Miller (1964). However, the Kanawha River specimens represent the upper Ohio River subspecies *E. b. blennioides*, according to Miller (1964).

=*Etheostoma* (*Etheostoma*) *blennioides newmanii* (Agassiz). See Miller (1964).

Hyostoma Newmanii Agassiz, 1854, Amer. Journ. Sci. and Arts, vol. 17 p. 305.

Lectotype: USNM 1865 (♂, 93), Alabama, near Huntsville; Newman; herein selected by Dr. Robert V. Miller. D XIV–12; A II, 7; pectoral rays 15–15; LL 71; cheeks, opercles, and belly completely covered with scales.

Paralectotypes: MCZ 24602 (5, 68–106), orig. out of USNM 1865, then MCZ 237. UMMZ 86764 (1, 106), out of MCZ 24602.

=*Etheostoma* (*Etheostoma*) *blennioides newmanii* (Agassiz). See Miller (1964).

Hyostoma simoterum Cope, 1868, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 6, p. 215, color pl. 24, fig. 5.

Syntypes: ANSP 14039–54 (16, 35–51), Virginia, Holston R.; E. D. Cope; October 1867. ANSP 14036–8 (3, 57–62); ANSP 14499–503 (5, 40–48); ANSP 5368–74 (7, 37–52); USNM 36604 (♂, 40); MNHN 4856 (1, 53), all with same data. Fowler (1907, p. 524) erroneously designated ANSP 14036 as lectotype and ANSP 14037–38 as paralectotypes of *Poecilichthys zonalis* Cope. These specimens are syntypes of *H. simoterum* as is clear from Fowler's figure 8 (see *P. zonalis*). With reference to the MNHN specimen, Vaillant (1873, p. 100) wrote "Cette espèce est représentée au Museum par un exemplaire type dû à l'obligeance de M. Cope."

=*Etheostoma* (*Ulocentra*) *simoterum* (Cope).

Ioa vigil Hay, 1882, Bull. U.S. Fish. Comm., vol. 2, p. 59.

Holotype: USNM 32201 (1, 23), Mississippi, Pearl R. at Jackson, O. P. Hay; July–August 1881.

=*Percina* sp. Perhaps *P.* (*Imostoma*) *uranidea* (Jordan and Gilbert). Not a species of *Ammocrypta* as has been presumed, but a species of *Percina* with a well-developed ctenoid caducous scale between the bases of the pelvic fins.

Microperca proeliaris Hay, 1881, Proc. U.S. Nat. Mus., vol. 3, p. 496.

Holotype: USNM 27418 (1, 26), Mississippi, Alcorn Co., trib. of Tuscumbia R. at Corinth; O. P. Hay; March–April 1880; in poor condition.

=*Etheostoma* (*Microperca*) *proeliare* (Hay).

Microperca punctulata Putnam, 1863, Bull. Mus. Comp. Zool., vol. 1, p. 4.

Syntypes: USNM 1377 (♂, 22; ♀, 24), Illinois, Calumet R., near Chicago; R. Kennicott. MCZ 24566 (2 ♀, 23–24); orig. out of USNM 1377, then MCZ 95. USNM 1283 (20, 23–30), Wisconsin, Oconomowac R., Lac la Belle; S. F. Baird; July 1853. MCZ 24570 (9, 24–31) and UMMZ 86457 (3, 24–31), orig. out of USNM 1283, then MCZ 93. USNM 1288 (28, 15–30), Michigan, Port Huron; Baird; August 1853. MCZ 24690 (11, 16–28) and UMMZ 86316 (3, 19–28), orig. out of USNM 1288, then MCZ 94; in poor condition. MCZ 24582 (1, 19), Michigan, Detroit R.; Baird; August, 1853; orig. USNM 1294, then MCZ 96; in poor condition. Also USNM 1276 (1, ?), Wisconsin, tribs. of Fox R., Vienna; Baird; August 1853; which we have been unable to locate.

=*Etheostoma* (*Microperca*) *microperca* Jordan and Gilbert because *punctulata* is preoccupied in *Etheostoma* by *Poecilichthys punctulatus* Agassiz.

Nanostoma elegans Hay, 1881, Proc. U.S. Nat. Mus., vol. 3, p. 493.

Lectotype: USNM 27445 (♂, 43), Mississippi, Clarke Co., shallow rocky branch of Chickasawha R. at Enterprise; O. P. Hay; March–April 1880; listed as type by Jordan and Evermann (1896, p. 1075); selection herein confirmed. D X–12; A II, 8; LL 42; branchiostegals 5–5; INF 7; POM 9; cheeks, opercles, and nape scaly; breast naked.

Paralectotype: SU 627 (1, 53), same data as lectotype.

=*Etheostoma* (*Etheostoma*) *zonale lynceum* (Hay) because *elegans* is preoccupied in *Etheostoma* by *Boleichthys elegans* Girard.

Nanostoma vinctipes Jordan, 1880, Proc. U.S. Nat. Mus., vol. 2, p. 236.

Lectotype: USNM 23454 (1, 47), Illinois, trib. of Illinois R. at Naperville; E. R. Copeland; listed as type by Jordan and Evermann (1896, p. 1075); selection herein confirmed. D XI–10; A II, 6; LL 46; branchiostegals 6–6; INF 7; POM 10; cheeks, opercles, breast, and nape scaly.

Paralectotypes: The whereabouts of the other four specimens from the type series is unknown.

=*Etheostoma* (*Etheostoma*) *zonale vinctipes* (Jordan), a valid subspecies according to Dr. Chu-fa Tsai (pers. comm.).

Nothonotus inscriptus Jordan and Brayton, 1878, U.S. Nat. Mus., Bull. 12(A), p. 34.

Lectotype: USNM 31145 (♀, 43), Georgia, Hall Co., Oconee R. at Sulphur Springs; D. S. Jordan and A. W. Brayton; summer, 1877; herein selected. D X–10; A II,8; LL 49; prevomerine teeth present; 6 dorsal blotches; cheeks, opercles, prepectoral area, and breast naked; nape completely scaled.

Paralectotype?: USNM 197439 (♂, 42), apparently same data as lectotype.

We select USNM 31145 as lectotype for the following reasons. The original description was based on two syntypes, male and female. USNM 31145 has the proper data and is labeled type, so it is clearly part of the type series. The male that we believe is the other syntype was discovered in the USNM collection labeled USNM 31132, *Etheostoma*, Etowah R., Georgia, Jordan and Brayton. *N. inscriptum* was reported only from the type locality in the original description, so it seems probable that this locality is in error. Under the species column in the USNM catalog we found the following entry for USNM 31132: "*Notropis stilbius Semotilus*, etc. (*Etheostoma*)," and for the locality "Etowah R., Rome, Ga. (chiefly)." It is apparent that the data for the specimen of *inscriptus* under USNM 31132 are totally confused. Therefore, in order to avoid further confusion should other specimens be found bearing this number, we recataloged this specimen as USNM 197439 and designate USNM 31145 as lectotype, because it is the specimen that we are certain is part of the type material.

=*Etheostoma* (*Etheostoma*) *inscriptum* (Jordan and Brayton).

Nothonotus thalassinus Jordan and Brayton, 1878, U.S. Nat. Mus. Bull. 12(A), p. 13.

Lectotype: USNM 31122 (♂, 40), South Carolina, Saluda R., near Greenville; D. S. Jordan and A. W. Brayton; summer, 1877; listed as type by Jordan and Evermann (1896, p. 1072); selection herein confirmed. D XII–12; A II,8; pectoral rays 15–14; LL 44; INF 8; POM 10; prevomerine teeth present; cheeks, opercles, prepectoral area, and breast naked; anterior portion of belly naked; nape scaled; 7 dorsal blotches.

Paralectotypes: SU 987 (♀, 46; 5 ♂, 37–49), South Carolina, Saluda R. at Farr's Mills, W. of Greenville; Jordan and Brayton; summer, 1877. MCZ 24397 (♂, 44), South Carolina, Saluda R. BMNH 1880.1.21.68 (♂, 52), South Carolina, Saluda R., Jordan.

=*Etheostoma* (*Etheostoma*) *thalassinum* (Jordan and Brayton).

Oligocephalus grahami Girard, 1859, Proc. Acad. Nat. Sci. Philadelphia, vol. 11, p. 102.

Holotype: MCZ 24576 (1, 33), Texas, Devil's R.; J. H. Clark under Col. J. D. Graham; orig. USNM 1182, then MCZ 85.

=*Etheostoma* (*Oligocephalus*) *grahami* (Girard).

Oligocephalus humeralis Girard, 1859, Proc. Acad. Nat. Sci. Philadelphia, vol. 11, p. 67.

Lectotype: USNM 1203 (♂, 42), Virginia, James R.; S. F. Baird; 1850; herein selected. D VII–13; A II,8: LL 36+11=47; INF 4+2; POM 10; supratemporal canal interrupted; cheeks, opercles, nape, and breast naked; about 11 vertical bars on body; tips of dorsal spines enlarged and slightly forked; branchiostegal membranes moderately joined.

Paralectotypes: USNM 198001 (45, 23–49), removed from USNM 1203. MCZ 24634 (10, 25–54), orig. out of USNM 1203, then MCZ 16. MCZ 35975 (2, 22–33), orig. out of USNM 1203.

=*Etheostoma* (*Catonotus*) *flabellare flabellare* Rafinesque.

Oligocephalus leonensis Girard, 1859, Proc. Acad. Nat. Sci. Philadelphia, vol. 11, p. 102.

Syntypes: MCZ 24580 (2 ♀, 34–37), Texas, Río Leona; J. H. Clark; badly dried; orig. USNM 748, then MCZ 83.

=?*Etheostoma* (*Oligocephalus*) *lepidum* (Baird and Girard). Although most characters suggest *E. lepidum*, there are well-developed ctenoid scales on the opercle, a character of *E. grahami* which is found in tributaries of the Rio Grande. The body appears to be more elongate than in either *E. lepidum* or *E. grahami*.

Oligocephalus pulchellus Girard, 1859, Proc. Acad. Nat. Sci. Philadelphia, vol. 11, p. 102.

Holotype: MCZ 32950 (1, 28), Oklahoma, trib. of Gypsum Cr., trib. of Canadian R.; Lt. A. W. Whipple and party, exploration of railroad route near 35th parallel; orig. USNM 1334.

=*Etheostoma* (*Oligocephalus*) *spectabile pulchellum* (Girard). See Hubbs and Ortenburger (1929).

Perca minima Haldeman, 1842, Journ. Acad. Nat. Sci. Philadelphia, vol. 8, p. 330.

Holotype: ANSP 13928 (1, about 47), Pennsylvania, Susquehanna R.; S. S. Haldeman; a skin preserved in alcohol and reported to be in poor condition by Fowler (1907).

=*Etheostoma* (*Boleosoma*) *olmstedi olmstedi* Storer. See Storer (1846, p. 271).

Perca (*Percina*) *nebulosa* Haldeman, 1842, Journ. Acad. Nat. Sci. Philadelphia, vol. 8, p. 330.

Holotype: ANSP 22652 (♂, 110), Pennsylvania, Susquehanna R., S. S. Haldeman; figured by Fowler (1945, fig. 202).
=*Percina* (*Percina*) *caprodes semifasciata* (DeKay).

Percina bimaculata Haldeman, 1844, Proc. Boston Soc. Nat. Hist., vol. 1, p. 157.

Types: USNM 1405, "*Percina*, Susquehanna River, S. S. Haldeman, *Percina* dried.—orig. of Haldeman" may be the type of *P. bimaculata*, but we have been unable to find this specimen.
=*Percina* (*Percina*) *caprodes semifasciata* (DeKay).

Percina caprodes burtoni Fowler, 1945, Acad. Nat. Sci. Philadelphia Monogr., no. 7, p. 134, figs. 218–219.

Holotype: ANSP 70701 (1, 134), North Carolina, Buncombe Co., Swannanoa R., near Oteen; E. M. Burton; Aug. 21, 1934.

Paratype: ANSP 13707 (1, 66), Virginia, Holston R.; E. D. Cope.
=*Percina* (*Percina*) *caprodes burtoni* (Fowler).

Percina (*Hadropterus*) *lenticula* Richards and Knapp, 1964, Copeia, no. 4, p. 695, fig. 1 A–C.

Holotype: CU 43592 (♂, 96), Alabama, Bibb Co., Cahaba R. on Ala. 27, 8.5 mi. N. of Centerville; R. D. and J. S. Suttkus; May 9, 1959.

Paratypes: CU 43593 (♀, 95), Alabama, Bibb Co., Cahaba R. on Ala. 5, 2.2 mi. N. of Centerville; Suttkus and party; July 8, 1958. TU 15291 (7 ♀, 77–92) and CU 43594 (♂, 86), same locality as CU 43593; Suttkus, R. J. and H. V. Miller, and J. de Abate; Mar. 17, 1957. UG 209 (3 ♂, 1 ♀, 48–63), CU 43435 (1 ♂, 1 ♀, 55–58), USNM 197491 (♂, 64), and UMMZ 180074 (♂, 60), Georgia, Cherokee Co., Etowah R. at the mouth of Canton Town Cr.; C. M. Tarzwell; Oct. 8, 1950.
=*Percina* (*Hadropterus*) *lenticula* Richards and Knapp.

Percina manitou Jordan, 1877, Proc. Acad. Nat. Sci. Philadelphia, vol. 29, p. 53.

Lectotype: USNM 23458 (♀, 68), Indiana, Fulton Co., Lake Manitou; D. S. Jordan; labeled "drawn"; herein selected. D XV–14; A II,11; LL 86; breast and nape naked; cheeks and opercles scaled; one enlarged ctenoid scale on midline of anterior part of belly.

Paralectotypes: The original description was based on three specimens in the Indiana State collections. One of these possessed and the other two lacked "enlarged, mucronate plates." We have not been able to locate the other two syntypes (one male and one female) and therefore designate the syntype we have found as lectotype.
=*Percina* (*Percina*) *caprodes semifasciata* (DeKay).

Percina nigrofasciata raneyi Crawford, 1956, Tulane Stud. Zool., vol. 4, no. 1, p. 49, fig. 10.

Holotype: CU 23344 (♂, 79), South Carolina, Abbeville Co., Calhoun Cr., trib. of Savannah R., 7.6 mi. E. of Calhoun Falls on rt. 72; E. C. Raney, R. W. Crawford, R. H. Backus, C. R. Robins, J. N. Layne, and R. L. Wigley; Mar. 27, 1951.

Paratypes: CU 19599 (37, 43–78) and USNM 188896 (2♂, 75–78; 2♀, 61–63), same data as holotype.

=*Percina (Hadropterus) nigrofasciata raneyi* Crawford.

Percina (*Alvordius*) *notogramma montuosa* Hogarth and Woolcott, 1966, Chesapeake Sci., vol. 7, no. 2, p. 101, fig. 2.

Holotype: USNM 199556 (♂, 51), Virginia, Campbell Co., Beaver Cr. 4 mi. E. of Lynchburg on US 460; W. T. Hogarth and E. Collins; Oct. 20, 1964.

Paratypes (all from Virginia): UR 2337 (3, 40–57), Albemarle Co., Hog Cr., at jct. with Rockfish R. at jct. of Co. rt. 602 and 722; Hogarth, C. Beirne, L. Kiss; Apr. 15, 1965. UMMZ 144697 (3, 47–49), Rockbridge Co., North R.; L. C. Pettit; May 17, 1941. UMMZ 175103 (5, 52–62), Alleghany Co., Potts Cr. above jct. with Jackson R.; C. R. Gilbert and D. G. Myer; Sept. 13, 1957. UR 2294 (6, 34–59), Albemarle Co., jct. with Rock Castle Cr. and Totier Cr. 1.2 mi. S. Scottsville on Co. rt. 726; W. S. Woolcott and Hogarth; Apr. 1, 1965. VPI 1006 (2, 51–64), Craig Co., Craig Cr. 6.8 mi. from New Castle on rt. 311; R. D. Ross, Wakeman, Cook; Aug. 19, 1958. CU 47322 (1, 48), Craig Co., Craig Cr. 0.25 river mi. downstream from Pinetop; R. E. Jenkins, J. E. Carico, R. L. Miles; June 6, 1963. VPI 1014 (1, 68), Rockbridge Co., South R. 4.9 air mi. E. of Lexington; Ross, Wakeman, Cook, Carroll, Handley; Aug. 21, 1958. VPI 981 (1, 52), Bath Co., Jackson R. 1.5 mi. N. of Greenwood; Ross, Wakeman, Cook; July 15, 1958. CU 47321 (2, 56–63), Bath Co., Jackson R., Hidden Valley Farm 4.3 mi. N. Mitchell Town; Ross, Jenkins; July 20, 1963. VPI 954 (2, 64–67), Bath Co., Cow Pasture R., 0.4 mi. NE. Nimrod Hall; Ross, Wakeman, Cook; July 3, 1958. UR 2350 (1, 52), Nelson Co., Owens Cr. 2.3 mi. SE. Buffalo Springs on Co. rt. 626; Hogarth, Beirne, Kiss; Apr. 15, 1965. UR 1797 (3, 53–62), Craig Co., John's Cr., Co. rt. 632, 2 mi. NE. jct. Co. rt. 632 and 658; Woolcott and Ichthyology Class; June 27, 1963. UR 2321 (12, 33–58), Amherst Co., Partridge Cr., Co. rt. 622 at jct. Co. rt. 624 near Stapleton; Hogarth, Beirne, Kiss; Apr. 15, 1965. VPI 963 (1, 47), Bath Co., Jackson Cr. 8.5 mi. S. Bacova on Co. rt. 603; Ross, Wakeman, Cook; July 2, 1958. VPI 1005 (1, 55), Craig Co., Craig Cr., 3 mi. SE. New Castle; Ross, Wakeman, Cook; Aug. 19, 1958. USNM 199557 (3, 44–62), Campbell Co., Beaver Cr. 4 mi. E. Lynchburg on U.S. 460; Hogarth and E. J. Collins; Oct. 20, 1964. UMMZ 175121 (1, 51), Alleghany Co., Potts Cr.; Gilbert and Myer; Sept. 13,

1957. UMMZ 95194 (1, 41), Alleghany Co., Dunlap Cr.; C. L. and L. C. Hubbs; Sept. 10, 1928.

=*Percina* (*Alvordius*) *notogramma montuosa* Hogarth and Woolcott.

Pileoma carbonaria Baird and Girard, 1853, Proc. Acad. Nat. Sci. Philadelphia, vol. 6, p. 387.

Lectotype: USNM 740 (♂, 85), Texas, Río Salado, 4 mi. from San Antonio; J. H. Clark; herein selected. D XV–15; A II, 11; LL 90; breast naked; cheeks, opercles, and nape completely covered with scales.

Paralectotypes: USNM 197999 (2 ♂, 75–87; ♀, 73), removed from USNM 740. MCZ 24599 (2 ♂, 88–108) and UMMZ 86594 (♂, 86), orig. out of USNM 740, then MCZ 269.

Jordan and Evermann (1896, p. 1027) also listed USNM 742 as "type." This specimen was taken by Kennerly in San Pedro Creek; there is no mention of either this locality or collector in the original description, so the specimen is not part of the type series.

= *Percina* (*Percina*) *caprodes carbonaria* (Baird and Girard).

Pileoma cymatogramma Abbott, 1860, Proc. Acad. Nat. Sci. Philadelphia, vol. 12, p. 327.

Holotype: ANSP 14009 (♀, 45), no locality.

= *Etheostoma* (*Etheostoma*) *blennioides blennioides* Rafinesque. See Miller (1964).

Pileoma semifasciatum DeKay, 1842, Nat. Hist. New York Zool., vol. 1, pt. 4, p. 16, pl. 50, fig. 162.

Syntypes: ?New York, Westport on Lake Champlain; J. E. DeKay; figure based on material then in the N.Y. State collection. Dr. E. M. Reilly, Curator of Zoology, has informed us that the types of this species are no longer present in the New York State Museum.

Topotypes are available: MCZ 24613 (5, 41–77), S. F. Baird.

= *Percina* (*Percina*) *caprodes semifasciata* (DeKay).

Pileoma zebra Agassiz, 1850, Lake Superior, p. 308, pl. 4, fig. 4.

Syntypes: MCZ 24636 (♂, 51; ♀, 60), Ontario, Lake Superior, "The Pic" at the mouth of the Pic R.; L. Agassiz; about July 13, 1848; orig. USNM 1175, then MCZ 257. UMMZ 86592 (1, 53) out of MCZ 24636.

= *Percina* (*Percina*) *caprodes semifasciata* (DeKay). See Hubbs and Brown (1929, p. 47).

Plesioperca anceps Vaillant, 1873, Nouv. Arch. Mus. Hist. Nat. Paris, vol. 9, p. 37, pl. 1, fig. 3.

Holotype: MNHN 2778 (♂, 86), locality unknown; donated by Agassiz; orig. MCZ 851.

= *Percina* (*Hadropterus*) *nigrofasciata nigrofasciata* (Agassiz).

See Jordan (1880, p. 225) and Crawford (1956).

Pleurolepis asprellus Jordan, 1878, Bull. Illinois State Lab. Nat. Hist., vol. 1, no. 2, p. 38.

Holotype: INHS uncat. (1, 90), Illinois, Hancock Co., small rocky trib. of Mississippi R.; C. K. Worthen.

Paratypes: ?(1, ?), same data as holotype. ? Illinois, Effingham Co., Little Wabash R.; S. A. Forbes; July 1877. We have been unable to find any paratypes of this species. The types were originally in the collection of the Illinois State Laboratory of Natural History. Smith and Bridges (1960, p. 254) did not list any type material of this species in the collections of the Illinois Natural History Survey which is the State Laboratory's successor, but Dr. Smith recently found the holotype for us.

= *Ammocrypta* (*Crystallaria*) *asprella* (Jordan).

Pleurolepis pellucidus Agassiz *in* Putnam, 1863, Bull. Mus. Comp. Zool., vol. 1, p. 5.

Lectotype: USNM 1311 (1, 50), Ohio, Black R., below falls at Elyria; S. F. Baird; August 1853; orig. no. 17. USNM 1311, then containing 21 specimens, was listed as type by Jordan and Evermann (1896, p. 1063); Linder (1959, p. 182) selected 1 specimen as lectotype.

Paralectotypes: USNM 164165 (20, 40–48) removed from USNM 1311 by Linder (1959). MCZ 24616 (9, 30–47) and UMMZ 86489 (3, 47–50) orig. out of USNM 1311, then MCZ 270. Although not mentioned by Jordan and Evermann or Linder, these collections are obviously part of the original material and come from the type locality and so must be considered parlectotypes.

There is no mention of any localities in the original description of *P. pellucidus*, but the following specimens were probably part of the original material. USNM 1289 (1, 49), Michigan, Port Huron; Baird; August 1853. USNM 1295 (1, 39), Mich., Detroit R.; Baird; August 1853. MCZ 24626 (4, 44–49) and UMMZ 86479 (1, 46), Ohio, Rockport; Kirtland.

=*Ammocrypta* (*Ammocrypta*) *pellucida* (Agassiz) not *A. pellucida* (Baird) as frequently given because the Baird name was listed as a synonym in Putnam and therefore has no status.

Poecilichthys artesiae Hay, 1881, Proc. U.S. Nat. Mus., vol. 3, p. 494.

Holotype: USNM 27434 (♂, 63), Mississippi, Lowndes Co., Catawba Cr., trib. of Tombigbee R. at Artesia; O. P. Hay; March–April 1880.

=*Etheostoma* (*Oligocephalus*) *whipplii artesiae* (Hay). See Hubbs and Black (1941).

Poecilichthys asprigenis Forbes *in* Jordan, 1878, Bull. Illinois State Lab. Nat. Hist., vol. 1 no. 2, p. 41.

Syntypes: SU 2201 (2, 38–39), Illinois, small creek near Pekin. The original description was based on 14 specimens from the type locality, but we have been unable to locate the other 12. Smith and Bridges (1960) did not report any type specimens of this species in the collections of the Illinois Natural History Survey which inherited the material of the Illinois State Laboratory.

MCZ 25051 (1, 45), Illinois, Peoria, 1880, is labeled as cotype but was collected after the original description was published and came from Peoria rather than from Pekin.

=*Etheostoma* (*Oligocephalus*) *asprigene* (Forbes).

Poecilichthys beani Jordan, 1884, Proc. U.S. Nat. Mus., vol. 7, p. 479.

Holotype: USNM 35754 (♀, 36), Missouri, Lafayette Co., Tabo Cr., trib. of Missouri R., near Lexington.

=*Etheostoma* (*Boleosoma*) *nigrum nigrum* Rafinesque. Jordan (1885, p. 548) admitted *P. beani* was a mutilated individual of *Boleosoma maculatum* (=*E. nigrum*).

Poecilichthys borealis Jordan, 1884, Proc. U.S. Nat. Mus., vol. 7, p. 477.

Lectotype: USNM 35747 (♂, 41), Canada, Montreal; T. J. Doran; herein selected. D IX–11; A II,7; LL 20+34=54; INF 8; POM 10; supratemporal canal widely interrupted; cheeks, opercles, nape, and belly covered with scales; few scattered scales on breast and prepectoral region.

Paralectotypes: USNM 197993 (3, 35–48), removed from USNM 35747. The fifth syntype mentioned in the original description is in SU 5447 but unfortunately became mixed with two specimens from Gravenhurst, Canada (SU 6261) during the earthquake.

=*Etheostoma* (*Oligocephalus*) *exile* (Girard). See Hubbs (1926, p. 67) and Richardson (1938).

Poecilichthys butlerianus Hay, 1883, Bull. U.S. Fish Comm., vol. 2, p. 61.

Holotype: USNM 32224 (1, 43), Mississippi, Yazoo Co., Big Black R., near Vaughn's Station; O. P. Hay; Aug. 20, 1881.

=*Etheostoma* (*Hololepis*) *gracile* (Girard). See Hubbs and Cannon (1935) and Collette (1962).

Poecilichthys camurus Cope, 1870, Proc. Amer. Philos. Soc., vol. 11, p. 265.

Lectotype: ANSP 13741 (1, 55), Tennesee, headwaters of Cumberland R.; herein selected by Dr. Edward C. Raney. D X–13; A II,9; LL 58.

Paralectotypes: ANSP 13742–44 (3, 49–56), same data as lectotype.

The types were found mixed in with the types of *Poecilichthys sanguifluus* Cope by Dr. Edward C. Raney.

=*Etheostoma* (*Nothonotus*) *camurum* (Cope). See Bailey (1959).

Poecilichthys coosae Fowler, 1945, Acad. Nat. Sci. Philadelphia, Monogr., no. 7, p. 356, figs. 226–228.

Holotype: ANSP 71189 (1, 38), Alabama, Cherokee Co., small cr., ¼ mi. NE. of Chesterfield, Coosa R. drainage; G. A. Coventry and C. B. Peterson; July 7, 1942.

Paratypes: All collected by Coventry and Peterson in Cherokee Co., Ala. ANSP 71190–91 (2, 34–35), same data as holotype. ANSP 71192–95 (4, 32–50), Cowan's Cr., Jordan's store; July 3, 1942. ANSP 71196 (♀, 39), cave on Lookout Mt., "Split Rock" at Little R. Gulch; July 1, 1942.

=*Etheostoma* (*Ulocentra*) *coosae* (Fowler).

Poecilichthys euzonus erizonus Hubbs and Black, 1940, Occ. Pap. Mus. Zool. Univ. Michigan, no. 416, p. 17, pl. 1, fig. 2.

Holotype: UMMZ 124597 (♂, 66), Missouri, Ripley Co., Current R. at "The Nook," T. 23 N., R. 2 E., sec. 9; A. H. Denney; Aug. 10, 1938.

Paratypes: UMMZ 124598 (5, 44–57), same data as holotype. UMMZ 124595 (8, 60–70), Missouri, Carter Co., Carter County Hunting and Fishing Club, T. 26 N., R. 1 E., sec. 11 and 12; Denney; July 25, 1938. UMMZ 124596 (2, 36–62), Missouri, Ripley Co., Doniphan Boat Landing, T. 23 N., R. 2 E., sec. 27; Denney; July 26, 1938. UMMZ 124599 (2, 58), Missouri, Carter Co., Current R., just above mouth of Pike Cr., T. 27 N., R. 1 W., sec. 23; Denney; Aug. 18, 1938.

=*Etheostoma* (*Etheostoma*) *euzonum erizonum* (Hubbs and Black.)

Poecilichthys euzonus euzonus Hubbs and Black, 1940, Occ. Pap. Mus. Zool. Univ. Michigan, no. 416, p. 23, pl. 1, fig. 3.

Holotype: UMMZ 123548 (♂, 61), Arkansas, Searcy Co., Buffalo R., 4 mi. SE. of St. Joe; J. D. and R. Y. Black; July 8, 1938.

Paratypes: UMMZ 124594 (4, 28–51), and USNM 117587 (1, 35), same data as holotype. UMMZ 123391 (2, 42–43), Arkansas, Madison Co., King's R., 3 mi. E. of Alabam at Denney Cave; J. D. and R. Y. Black; June 30, 1938. UMMZ 123504 (1, 45), Arkansas, Carroll Co., White R. near Busch; J. D. and R. Y. Black; July 8, 1938.

=*Etheostoma* (*Etheostoma*) *euzonum euzonum* (Hubbs and Black).

Poecilichthys gutselli Hildebrand, 1932, Journ. Elisha Mitchell Sci. Soc., vol. 48, no. 1, p. 78, pl. 3.

Holotype: USNM 92402 (♂, 71), North Carolina, Swain Co., Tuckaseegee R. at Ela; J. S. Gutsell; Aug. 26, 1930.

Paratypes: USNM 197411 (♀, 75), same data as holotype. USNM 92580 (♀, 37), North Carolina, Jackson Co., Tuckaseegee R., below Cullowhee; Gutsell; Aug. 29, 1930.

=*Etheostoma* (*Etheostoma*) *blennioides gutselli* (Hildebrand). See Miller (1964).

Poecilichthys hopkinsi Fowler, 1945, Acad. Nat. Sci. Philadelphia Monogr., no. 7, p. 249, fig. 206.

Holotype: ANSP 71548 (♀, 44), Georgia, Wilcox Co., Osewitchee Springs, 14 mi. N. of Fitzgerald; M. N. Hopkins, Jr.; Aug. 15, 1942.

Paratypes: ANSP 71567–69 (3, 25–45), same locality and collector as holotype; June 29, 1944.

=*Etheostoma* (*Oligocephalus*) *hopkinsi hopkinsi* (Fowler). See Bailey and Richards (1963).

Poecilichthys jessiae Jordan and Brayton *in* Jordan, 1878, Manual Vertebrates, 2nd ed., p. 227, and *in* Jordan and Brayton, 1878, U.S. Nat. Mus. Bull. 12(A), p. 59.

Syntypes: ? "sev. spec. each about 2″ long," Georgia, Chickamauga R. at Ringgold; D. S. Jordan and A. W. Brayton; summer, 1877. We have been unable to find any of the type material of this species. Figure 4 was found in the files of the Division of Fishes labeled as "*Poecilichthys jessiae*, Chickamauga River, Ga." We feel that it is probably based on one of the types and so reproduce it here.

=*Etheostoma* (*Boleosoma*) *jessiae* (Jordan and Brayton).

Poecilichthys kanawhae Raney, 1941, Occ. Pap. Mus. Zool. Univ. Michigan, no. 434, pl. 1.

Holotype: UMMZ 131837 (♂, 72), North Carolina, Ashe Co., N. Fork of New R. on rt. 16 at Crumpler; E. C. Raney, E. A. Lachner, and L. J. Kezer; Apr. 1, 1940.

Paratypes: UMMZ 131838 (7, 39–60) and CU 7663 (13, 39–57), same data as holotype. CU 7678 (2♂, 48–53), North Carolina, Ashe Co., N. Fork of New R., 1 mi. NNE. of Warrensville; Raney, Lachner, Kezer; Apr. 1, 1940. CU 7830 (3, 42–69) and UMMZ 131834 (2, 35), North Carolina, Ashe Co., N. Fork of New R., 1 mi. NNE. of Creston; Raney, Lachner, Kezer; Apr. 2, 1940. CU 7688 (5, 44–59) and UMMZ 131836 (2, 50–56), North Carolina, Ashe Co., S. Fork of New R. on rt. 16 at Index; Raney, Lachner, Kezer; Apr. 2, 1940. CU 7693 (3, 40–44) and UMMZ 131835 (2, 40–42), North Carolina, Ashe Co., S. Fork of New R., 1 mi. SW. of Fleetwood; Raney, Lachner, Kezer; Apr. 2, 1940. UMMZ 95371 (2, 30–44), Virginia, Carroll Co., Big Reed Island Cr.; C. L. Hubbs and E. P. Creaser; May 17, 1931. USNM 107679 (3, 46–59), Virginia, Carroll

Co., Crooked Cr., 4 mi. E. of Galax; L. P. Schultz and E. D. Reid; July 13, 1938.

=*Etheostoma* (*Etheostoma*) *kanawhae* (Raney).

Poecilichthys mesaeus Cope, 1864, Proc. Acad. Nat. Sci. Philadelphia, vol. 16, p. 232.

Lectotype: ANSP 13943 (♀, 49), Nebraska, Platte R., near Ft. Kearney; W. Hammond; selected and illustrated by Fowler (1907, p. 524, fig. 7).

Paralectotypes: ANSP 13944–46 (3), same data as lectotype. Fowler wrote "Type, No. 13,943, A.N.S.P." and did not mention these three specimens.

=*Etheostoma* (*Boleosoma*) *nigrum nigrum* Rafinesque.

Poecilichthys osburni Hubbs and Trautman, 1932, Ohio Journ. Sci., vol. 32, no. 1, p. 34, fig. 2.

Holotype: UMMZ 92409 (♂, 75), West Virginia, Pocohontas Co., Stony Cr., trib. of Greenbrier R.; J. Addair; June 2, 1931.

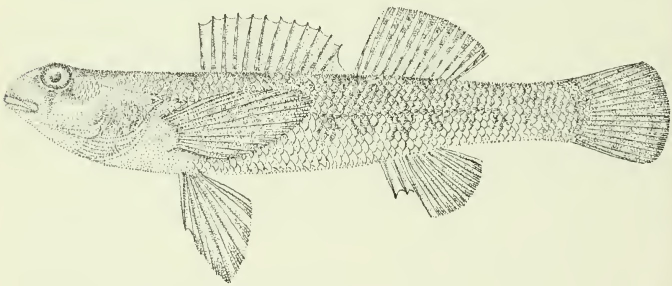

FIGURE 4.—*Poecilichthys jessiae* Jordan and Brayton, Chickamauga River, Ga. (previously unpublished drawing by Ernest Copeland that probably represents one of the lost syntypes).

Paratypes: UMMZ 92410 (5, 58–85), and OSM 12946 (4, 56–81), same data as holotype. USNM 39542 (♀, 56), Virginia, South Fork Reed's Cr.; M. McDonald. UMMZ 95370 (7, 49–57), and USNM 117588 (♀, 64), Virginia, Wythe Co., Reed Cr., trib. of New R., 2–3 mi. below Max Meadows; C. L. Hubbs and E. P. Creaser; May 17, 1931.

=*Etheostoma* (*Etheostoma*) *osburni* (Hubbs and Trautman). See Raney (1941).

Poecilichthys palustris Gilbert, 1884, Proc. U.S. Nat. Mus., vol. 7, p. 209.

Lectotype: USNM 34983 (♂, 30), Indiana, Greene Co., Switz City Swamp; C. H. Gilbert; August 1883; selected by Hubbs and Cannon (1935, p. 44).

Paralectotype: Gilbert mentioned a second specimen in his original description which has apparently been lost (Hubbs and Cannon, 1935, p. 44).

=*Etheostoma* (*Hololepis*) *gracile* (Girard). See Hubbs and Cannon (1935) and Collette (1962).

Poecilichthys punctulatus Agassiz, 1854, Amer. Journ. Sci. and Arts, vol. 17, p. 304.

Lectotype: MCZ 39 (1, 52), Missouri, Osage R.; G. Stolley; herein selected. D XII–14; A II, 8; LL 59+13=72; INF 8; POM 10; supratemporal canal widely incomplete; cheeks and opercles naked; color pattern completely faded.

Paralectotype: MCZ 43091 (1, 48), removed from MCZ 39.

=*Etheostoma* (*Oligocephalus*) *punctulatum* (Agassiz).

Poecilichthys quiescens Jordan, 1884, Proc. U.S. Nat. Mus., vol. 7, p. 478.

Holotype: USNM 28509 (♂, 36), Georgia, trib. of Altamaha R. [error for Alapaha R.], a branch of the Suwanee R. at Nashville; W. J. Taylor.

=*Etheostoma* (*Hololepis*) *fusiforme barratti* (Holbrook). See Hubbs and Cannon (1935) and Collette (1962).

Poecilichthys radiosus cyanorum Moore and Rigney, 1952, Copeia, no. 1, p. 10, pl. 1, figs. 3–4.

Holotype: UMMZ 161366 (♂, 68), Oklahoma, Johnston Co., Blue R., trib. of Red R., on U.S. 99, T. 1 S., R. 6 E.; G. A. Moore; Apr. 4, 1949; orig. OAM 2914.

Paratypes: All from the Blue R., Oklahoma, collected by G. A. Moore and students. OAM 2913 (96, 27–67), same data as holotype. UMMZ 161367 (77, 32–70), same locality; Apr. 5, 1947. MCZ 37204 (11, 33–53), Blue R., 10 mi. W. of Wapanucka, 3 mi. S. of rt. 7; Apr. 6, 1947; orig. OAM 1497. UOMZ 26154 (82, 28–53), Little Blue R., T. 1 N., R. 6 E., NW. sec. 36; Apr. 5, 1947. UOMZ 26155 (15, 39–49), Bryan Co., Cedar Cr., 7 mi. E. and 1 mi. S. of Durant; Apr. 15, 1949. USNM 153532 (49, 38–54), Pontotoc Co., Blue R., near source, SW. of Ada; orig. OAM 1587.

=*Etheostoma* (*Oligocephalus*) *radiosum cyanorum* (Moore and Rigney).

Poecilichthys radiosus paludosus Moore and Rigney, 1952, Copeia, no. 1, p. 11, pl. 2, figs. 3–4.

Holotype: UMMZ 161368 (♂, 47), Oklahoma, Pontotoc Co., Bois d'Arc Cr., trib. of Clear Boggy Cr., T. 2 N., R. 6 E.; E. Leonard, J. Stevenson, M. Chapman; Apr. 16, 1949; orig. OAM 2933.

Paratypes: All from Oklahoma. UMMZ 161369 (58, 30–45), same data as holotype. MCZ 37205 (41, 36–60), Pontotoc Co., Clear Boggy Cr.; Moore; Apr. 16, 1947; orig. OAM 1625. UOMZ 26156 (19, 28–39), Pontotoc Co., Jack Fork, Clear Boggy system, T. 2 N., R. 6 E.; J. M. McDowell, P. White, R. Loomis; Apr. 16, 1949. OAM 1703 (2, 36–41), Kiamichi R., S. of Talahina; Moore et al.; June 7, 1947. USNM 153533 (38, 27–39), Pushmataha Co., small trib., T. 2 N., R. 21 E., sec. 17; A. P. Blair and J. T. Herbelin; Apr. 16, 1949. UOMZ 26157 (36, 26–35), Latimer Co., Buffalo Cr., 21 mi. S. of Wilburton, T. 3 N., R. 19 E.; Blair and Herbelin; Apr. 17, 1949. USNM 198109 (27, 30–39), Pushmataha Co., Kiamichi R., SE. of Clayton, T. 1 N., R. 19 E., sec. 7; Blair and Herbelin; Apr. 16, 1949; orig. TUC uncat.

=*Etheostoma* (*Oligocephalus*) *radiosum paludosum* (Moore and Rigney).

Poecilichthys rufilineatus Cope, 1870, Proc. Amer. Philos. Soc., vol. 11, p. 267.

Lectotype: ANSP 13791 (1) North Carolina, Madison Co., Warm Springs Cr., trib. of French Broad R.; E. D. Cope. Selected and illustrated by Fowler (1907, p. 525, fig. 9). Still mixed with paralectotypes, a total of seven specimens (42–58).

Paralectotypes: ANSP 13792–97 (6), same data as holotype.

=*Etheostoma* (*Nothonotus*) *rufilineatum* (Cope). See Bailey (1959).

Poecilichthys sagitta Jordan and Swain, 1883, Proc. U.S. Nat. Mus. vol. 6, p. 250.

Holotype: ? (1, 2½ in. TL), Kentucky, Whitley Co., Wolf Cr., trib. of Clear Fork of Cumberland R., near Pleasant View; D. S. Jordan, J. Swain, et al.; May 1883. According to the original description, the type should be in the USNM collection, but we have been unable to find it here or elsewhere.

=*Etheostoma* (*Oligocephalus*) *sagitta sagitta* (Jordan and Swain). See Bailey (1948) and Kuehne and Bailey (1961).

Poecilichthys sanguifluus Cope, 1870, Proc. Amer. Philos. Soc., vol. 11, p. 264.

Lectotype: ANSP 13738 (1, 55), Tennessee, headwaters of South Fork of Cumberland R.; E. D. Cope; herein selected by Dr. Edward C. Raney.

Paralectotypes: ANSP 13739–40 (2, 48–50), same data as lectotype. Fowler (1907, p. 524) referred to seven syntypes of *P. sanguifluus*,

ANSP 13738 (type) to 13744. Three are types of *Poecilichthys camurus* Cope (q.v.).
=*Etheostoma* (*Nothonotus*) *maculatum sanguifluum* (Cope) according to Raney and Zorach (MS).

Poecilichthys saxatilis Hay, 1881, Proc. U.S. Nat. Mus. vol. 3, p. 495.
Holotype: USNM 27433 (1, 31), Mississippi, Clarke Co., trib. of Chickasawha R. at Enterprise; O. P. Hay; March-April 1880.
=*Etheostoma* (*Boleosoma*) *stigmaeum* (Jordan). See Bailey, Winn, and Smith (1954, p. 142).

Poecilichthys spectabilis Agassiz, 1854, Amer. Journ. Sci. and Arts, vol. 17, p. 304.
Lectotype: UMMZ 86340 (♂, 48), Missouri, Osage R., G. Stolley; out of MCZ 24503+24529+24722; herein selected by Mr. Donald A. Distler. D XI–13; A II, 6; LL 27+19=46; INF 4+3; pectoral rays 11; supratemporal canal complete.
Paralectotypes: UMMZ 179528 (6, 27–35), same data as lectotype; 1 specimen of *E. caeruleum* removed by Distler and recataloged as UMMZ 179529. MCZ 24503+24529+24722 (21, 27–40); 15 of the specimens in poor condition from drying; 3 specimens of *E. caeruleum* removed and recataloged as MCZ 42077. USNM 120284 (5, 32–48), out of MCZ 24503, 1 specimen of *E. caeruleum* removed and recataloged as USNM 196738.
=*Etheostoma* (*Oligocephalus*) *spectabile spectabile* (Agassiz). See Trautman (1930).

Poecilichthys swaini Jordan, 1884, Proc. U.S. Nat. Mus., vol. 7, p. 479.
Holotype: USNM 35308 (♂, 41), Mississippi, Lawrence Co., trib. of Pearl R. at Monticello.
=*Etheostoma* (*Oligocephalus*) *swaini* (Jordan).

Poecilichthys tetrazonus Hubbs and Black, 1940, Occ. Pap. Mus. Zool. Univ. Michigan, no. 416, p. 11, pl. 1, fig. 1.
Holotype: UMMZ 111330 (1, 33), Missouri, Dallas Co., Big Niangua R. at mouth of Greasy Cr., 6 mi. SE. of Buffalo; J. C. Salyer; Aug. 28, 1931.
Paratype: UMMZ 124600 (1, 22), same data as holotype.
=*Etheostoma* (*Etheostoma*) *tetrazonum* (Hubbs and Black).

Poecilichthys versicolor Agassiz, 1854, Amer. Journ. Sci. and Arts, vol. 17, p. 304.
Lectotype: USNM 1822 (♂, 42), Illinois, small creeks near Quincy; L. Watson; herein selected. D IX–14; A II, 7; LL 28+19=47; INF 4+3; POM 10; supratemporal canal complete.

Paralectotypes: USNM 197493 (5, 34–40), removed from USNM 1822; 1 specimen that is apparently an aberrant *spectabile* recataloged as USNM 197443.

USNM 1816, Missouri, Osage R.; G. Stolley is listed in the USNM catalog as type material, but these specimens have apparently been mixed with the paralectotypes of *Poecilichthys spectabilis* Agassiz in MCZ 24722.

=*Etheostoma* (*Oligocephalus*) *spectabile spectabile* (Agassiz).

Poecilichthys virgatus Jordan, 1880, Proc. U.S. Nat. Mus., vol. 2, p. 236.

Lectotype: USNM 23456 (1, 39), Kentucky, Rock Castle R. at Livingston; D. S. Jordan; selected by Jordan and Evermann (1896, p. 1093).

Paralectotypes: Of the "numerous typical examples" mentioned in the original description, we have been able to locate only one specimen other than the holotype. UMMZ 187511 (1, 41), same data, orig. IU 451, then IU 4748. A specimen was supposed to have been sent to the British Museum, but Collette could find no record of this having been done and could not find such a specimen in their collection in October 1963.

=*Etheostoma* (*Catonotus*) *virgatum* (Jordan).

Poecilichthys vitreus Cope, 1870, Proc. Amer. Philos. Soc., vol. 11, p. 263.

Holotype: ?, North Carolina, Wake Co., Walnut Cr., trib. of Neuse R.; E. D. Cope; late November. Types of other species described by Cope in the 1870 paper were deposited at ANSP, but Fowler (1907) did not mention the type (a female) of this species, and we have been unable to find it in several thorough searches.

=*Etheostoma* (*Ioa*) *vitreum* (Cope).

Poecilichthys vulneratus Cope, 1870, Proc. Amer. Philos. Soc., vol. 11, p. 266.

Holotype: ANSP 13798 (♂, 44), North Carolina, Madison Co., Warm Springs Cr., trib. of French Broad R. Found in bottle containing the types of *Poecilichthys rufilineatus* Cope by Dr. Edward C. Raney.

=*Etheostoma* (*Nothonotus*) *maculatum vulneratum* (Cope), according to Raney and Zorach (MS).

Poecilichthys whipplii montanus Hubbs and Black, 1941, Occ. Pap. Mus. Zool. Univ. Michigan, no. 429, p. 15, pl. 1, fig. 2.

Holotype: UMMZ 127777 (♂, 75), Arkansas, Washington Co., near head of Blue Hole Cr., trib. of Clear Cr., 1 mi. S. of Winslow; J. D. Black and J. Yerton; June 17, 1939.

Paratypes: USMM 117589 (7, 17–56), same locality as holotype; J. D. and R. Y. Black; Aug. 3, 1938; orig. UMMZ 123802. The remainder of the paratypes are all UMMZ specimens from Arkansas. 128678 (2, 24–48), Crawford Co., Schaberg Cr., trib. of Frog Bayou; Black, Mills, and Yerton; Aug. 17, 1939. 123806 (100, 16–72), Washington Co., Blue Hole Cr., Blue Hole, T. 13 N., R. 30 W.; Black and Yerton; Aug. 3, 1938. 123813 (107, 17–54), Washington Co., Railroad Cr., trib. of Frog Bayou, 1.5 mi. S. of Winslow; Black and Yerton; Aug. 4, 1938. 123821 (53, 17–64), Washington Co., Railroad Cr., below Cliff Hole, trib. of Frog Bayou, T. 13 N., R. 30 W.; Black and Yerton; Aug. 4, 1938. 123352 (1, 33), Crawford Co., Jones Cr., 1 mi. W. of Wintrey, T. 12 N., R. 29 W.; Black and Yerton; June 29, 1938. 123842 (2, 41), Crawford Co., Schaberg Cr., trib. of Frog Bayou, near Schaberg, T. 12 N., R. 30 W.; Black and party; Aug. 5, 1938. 127778 (7, 27–63), Washington Co., Blue Hole Cr., 1 mi. S. of Winslow; Black and Yerton; June 17, 1939. 123802 (220, 14–69), Washington Co., Blue Hole Cr., 1.5 mi. S. of Winslow, T. 13 N., R. 30 W.; Black and Yerton; Aug. 3, 1938.

=*Etheostoma* (*Oligocephalus*) *whipplii montanum* (Hubbs and Black).

Poecilichthys whipplii radiosus Hubbs and Black, 1941, Occ. Pap. Mus. Zool. Univ. Michigan, no. 429, p. 10, pl. 1, fig. 1.

Holotype: UMMZ 123080 (♂, 50), Arkansas, Hot Spring Co., Sugar Loaf Cr., trib. of Caddo R., Ouachita R. system; J. D. and R. Y. Black; June 19, 1938.

Paratypes: USNM 36419 (5, 22–30), Arkansas, Ouachita R. at Arkadelphia; D. S. Jordan and C. H. Gilbert. USNM 36442 (19, 22–46), Arkansas, Saline R. at Benton; Jordan and Gilbert. USNM 42766 (1, 27), Arkansas, Hot Springs; Meek.

The following paratypes are all UMMZ specimens from Oklahoma: 73056 (1, 45), Kiamichi R., 4 mi. E. of Tuskahoma. 81136 (1, 42), Le Flore Co., 8 mi. W. of Arkansas line; June 18, 1927. 109033 (2, 21–25), Pushmataha Co., Ten Mile Cr., trib. of Kiamichi R., 4 mi. NW. of Miller; June 26, 1929. 109036 (1, 47), Atoka Co., Little Boggy Cr., 5 mi. NE. of Atoka; June 28, 1928. 109448 (2, 45), Pushmataha Co., Walnut Cr., trib. of Kiamichi R., 1 mi. SW. of Albion; June 19, 1931. 110863 (3, 33–46), Le Flore Co., trib. of Big Cedar Cr., near NW. end of Rich Mt.; June 26, 1934. 129696 (1, 34), McCurtain Co., Glover R., one-fourth mi. W. of Glover; W. F. and P. F. Blair; June 16, 1938. 105393 (1, 27), Big Hell Cr., trib. of Ouachita R. at Mimoca, 7 mi. N. of Norman; Holloway; Mar. 25, 1937.

The following paratypes are all UMMZ specimens from Arkansas: 123067 (1, 21), Garland Co., Lake Hamilton, T. 3 S., R. 20 W.;

C. E. Burt; July 6, 1931. 123193 (3, 29–40), Hempstead Co., trib. of Terre Rouge Cr., 5.5 mi. NE. of Hope on U.S. 67; J. D. and R. Y. Black; June 22, 1938. 123230 (3, 28), Garland Co., Gulpha Cr. at jct. with Lake Hamilton, 10 mi. E. of Hot Springs; Black and Black; June 23, 1938. 127842 (8, 19–38), Lincoln Co., Caney Cr., 1 mi. N. of Star City; Black and Black; June 20, 1939. 127885 (1, 16), Bradley Co., Saline R., 5 mi. N. of Warren; Black and Black; June 20, 1939. 128060 (1, 16), Polk Co., trib. of Mountain Fk., 6 mi. SW. of Mena; Black and Black; July 6, 1939. 128106 (1, 36), Howard Co., Holly Cr., one-half mi. SE. of Dierks; Black and Black; July 7, 1939. 128138 (1, 32), Pike Co., Prairie Cr., Murfreesboro; Black and Black; July 7, 1939. 128247 (1, 23), Hempstead Co., Middle Fk. of Bois d'Arc Cr., 5.5 mi. NE. of Fulton; Black and Black; July 12, 1939. 128277 (4, 16–24), Garland Co., Gulpha Cr., 6 mi. SE. of Hot Springs; Black and Black; July 12, 1939.

=*Etheostoma* (*Oligocephalus*) *radiosum radiosum* (Hubbs and Black). See Moore and Rigney (1952).

Poecilichthys zonalis Cope, 1868, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 6, p. 212, color pl. 24, fig. 1.

Lectotype: ANSP 13799 (♂, 42), Virginia, Holston R.; E. D. Cope; herein selected by Dr. Chu-fa Tsai. D XI–11; A II,7; LL 55; INF 4 +3; POM 10; branchisotegals 5; chest naked; cheeks, opercles, and belly completely covered with scales; 6 dorsal blotches.

Paralectotypes: ANSP 13800–1 (♀, 38; ♂, 47), same locality data as lectotype.

Fowler (1907, p. 524) erroneously designated ANSP 14036 lectotype and ANSP 14037–38 paralectotypes. These specimens are not types of *P. zonalis* but are some of the syntypes of *Hyostoma simoterum* Cope. The color plate accompanying Cope's original description shows clearly that Cope had both *E. zonale* and *E. simoterum* from the Holston. Fowler's figure 8, which is labeled as the type of *P. zonalis*, represents a specimen of *Hyostoma simoterum*.

=*Etheostoma* (*Etheostoma*) *zonale zonale* (Cope).

Poecilosoma erythrogastrum Kirtland, 1854, Annals of Science, includ. Trans. Cleveland Acad. Nat. Sci., vol. 2, no. 1, p. 4.

Syntypes: USNM 1815 (?), Ohio, Rocky R., 7 mi. W. of Cleveland; J. P. Kirtland. We have been unable to locate this collection.

=*Etheostoma* (*Oligocephalus*) *caeruleum caeruleum* Storer. See Knapp (1964).

Poecilosoma transversum Abbott, 1860, Proc. Acad. Nat. Sci. Philadelphia, vol. 12, p. 326.

Lectotype: ANSP 13810 (1, 38), locality unknown; number selected by Fowler (1907, p. 525); specimen herein selected. D X–13; A II,7;

LL 31+15=46; INF 4+3; supratemporal canal complete. Abbott noted that there were no data with the specimens and assumed that they might have come from Lake Superior. This could not be so because *E. caeruleum* does not occur there.

Paralectotypes: ANSP 13811–19 (9, 28–42), same data as lectotype.

=*Etheostoma* (*Oligocephalus*) *caeruleum caeruleum* Storer. See Knapp (1964).

Rheocrypta copelandi Jordan, 1877, U.S. Nat. Mus. Bull. 10, p. 9.

Lectotype: USNM 20143 (♂, 43), Indiana, White R., 5 mi. N. of Indianapolis; Jordan and Copeland; herein selected. D XI–12; A II,9; LL 53; INF 8; POM 10; opercles scaled; cheeks naked. Jordan and Evermann (1896, p. 1046) listed USNM 20143, which contained two specimens, as type; herein further restricted.

Paralectotypes: USNM 197996 (♂, 43), removed from USNM 20143; USNM 23461 (♂, 44); MCZ 24392 (♂, 39), and BMNH 1880.1.21.36–37 (2 ♂, 43–45); all part of Jordan's material originally "some thirty in number" from the type locality.

=*Percina* (*Cottogaster*) *copelandi* (Jordan).

Richia brevispina Coker, 1926, Bull. Bur. Fish., vol. 42, p. 106, fig. 1.

Holotype: USNM 87411 (♂, 36), North Carolina, Burke Co., Paddy's Cr., just above head of Paddy's Cr. Lake, part of artificial Lake James system near Bridgewater, Catawba drainage; R. E. Coker; August 1922.

Paratypes: USNM 87412 (2, 27–36), same data as holotype.

=*Etheostoma* (*Catonotus*) *flabellare* ssp. See Hubbs (1927) and Myers (1927). [= *E.* (*C.*) *f. brevispina* (Coker) according to Ross and Carico (1963, p. 13)].

Sciaena caprodes Rafinesque, 1818, Amer. Month. Mag. and Critical Rev., vol. 3, no. 5, p. 354.

Types: Type locality—the Ohio River. As Call (1899) noted, Rafinesque did not preserve any of his type material. Examination of a sketch of this species in Rafinesque's notebook (fig. 5) shows that the name is correctly attributed.

=*Percina* (*Percina*) *caprodes caprodes* (Rafinesque).

Ulocentra gilberti Evermann and Thoburn *in* Jordan and Evermann, 1896, U.S. Nat. Mus. Bull. 47, p. 1049.

Holotype: USNM 47531 (1, 38), Tennessee, Clinch R. at Walker's Ford, near Tazewell; B. W. Evermann, J. T. Scovell, and R. R. Gurley; Oct. 12, 1893; figured in Jordan and Evermann (1900, fig. 446).

Paratypes: USNM 125373 (1, 36), orig. BF 285, and SU 1954 (2, 47), same data as holotype. The original description was supposedly based on three specimens, so there may have been an error in the original description. The SU bottle was broken during the 1906 earthquake, so there is also a possibility that another specimen of the same species became mixed with SU 1954.

=*Percina* (*Cottogaster*) *copelandi* (Jordan).

Ulocentra meadiae Jordan and Evermann, 1898, U.S. Nat. Mus. Bull. 47, p. 2852.

Holotype: USNM 48903 (♂, 46), Tennessee, Indian Cr., trib. of Powell R. at Cumberland Gap; R. R. Gurley; Oct. 17, 1893; figured by Jordan and Evermann (1900, fig. 447).

Paratypes: USNM 125623 (♂, 46), same data as holotype; orig. BF 711. The third paratype was sent to SU according to a U.S. Fish Comm. distribution list, but Böhlke (1953) did not list it among the Stanford types, and we were unable to find it there.

=*Etheostoma* (*Boleosoma*) *jessiae* (Jordan and Brayton).

Vaillantia chlorosoma Hay, 1881, Proc. U.S. Nat. Mus., vol. 3, p. 495.

Syntypes: USNM 27428, Mississippi, branch of Tuscumbia R. at Corinth; O. P. Hay; March–April 1880; completely disintegrated and dried by 1937. SU 726 (3 ♀, 37–41), Mississippi, Macon; Hay. Although not listed as types by Böhlke (1953), the data on the label, plus a label reading "cotypes," lead us to believe this is part of the

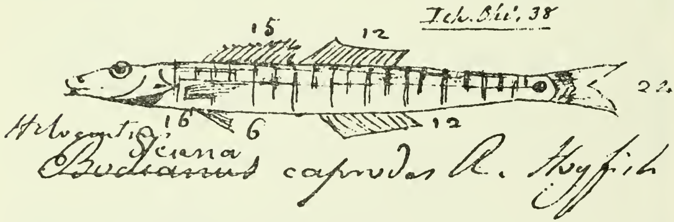

FIGURE 5.—*Sciaena caprodes* Rafinesque (sketch from Rafinesque's notebook).

original type material. The original description was based on specimens from the Tuscumbia R. at Corinth, Sandy Cr. at Artesia, and Horsehunter Cr. at Macon. Some of this material was placed in the U.S. National Museum, some in Jordan's collections, and the remainder in the Butler University collection. It seems likely that SU 726 represents material given to Jordan by Hay.

=*Etheostoma* (*Boleosoma*) *chlorosomum* (Hay).

Villora edwini Hubbs and Cannon, 1935, Misc. Publ. Mus. Zool. Univ. Michigan, no. 30, p. 13, pl. 1, fig. 1.

Holotype: UMMZ 87892 (♂, 37), Florida, Alachua-Columbia Co. line, Santa Fe R. at Poe Springs; E. T. Boardman; Feb. 8, 1928.

Paratypes: UMMZ 107047 (3, 30–35) and USNM 94684 (♀, 33), same data as holotype. UMMZ 101680 (2 ♀, 33–35), same locality; J. D. Kilby and A. F. Carr; Mar. 19, 1934. UMMZ 88685 (1, 25), Georgia, Early Co., trib. of Chattahoochee R., 2 mi. NW. of Jakin; E. P. Creaser and H. R. Becker; Sept. 15, 1929. MCZ 98 (1, ?), "Ga."; Barratt; no longer present in MCZ collection.

=*Etheostoma* (*Villora*) *edwini* (Hubbs and Cannon). See Collette and Yerger (1962).

Villora okaloosae Fowler, 1941, Proc. Acad. Nat. Sci. Philadelphia, vol. 92, p. 242, fig. 12.

Holotype: ANSP 69159 (♀, 24), Florida, Okaloosa Co., Little Rocky Cr., 7 mi. NE. of Niceville on rt. 218 (now Fla. 285); F. Harper; June 20, 1939. Holotype redescribed by Collette and Yerger (1962).

=*Etheostoma* (*Villora*) *okaloosae* (Fowler). See Yerger (1960) and Collette and Yerger (1962).

Checklist of Nominal Species

acuticeps Bailey, *Etheostoma*. (UMMZ)
aesopus Cope, *Boleosoma*. (ANSP?)
alabamae—see *whipplei alabamae*.
anceps Vaillant, *Plesioperca*. (MNHN)
appalachia—see *barratti appalachia*.
arcansanum—see *zonale arcansanum*.
arcus-celestis Crevecoeur, *Etheostoma*. (USNM?)
artesiae Hay, *Poecilichthys*. (USNM)
asprellus Jordan, *Pleurolepis*. (INHS)
asprigenis Forbes, *Poecilichthys*. (SU)
aspro Cope and Jordan, *Alvordius*. (X)
atraque—see *fusiformis atraque*.
atripinnis Jordan, *Arlina*. (USNM)
atromaculata Girard, *Estrella*. (?)
aubeenaubei Evermann, *Etheostoma*. (USNM)
aurantiacus Cope, *Cottogaster*. (ANSP)
australe Jordan, *Etheostoma*—see *fasciatus*, *Diplesion*.

Barratti Holbrook, *Boleosoma*. (MCZ, UMMZ)
barratti appalachia Bailey, *Hololepis*. (UMMZ, CU, DU)
beani Jordan, *Poecilichthys*. (USNM)
beanii Jordan, *Ammocrypta*. (USNM)
bimaculata Haldeman, *Percina*. (USNM?)
binotatum—see *hopkinsi binotatum*.

blennioides Rafinesque, *Etheostoma.* (X)
blennioperca Cope, *Hyostoma.* (ANSP)
blennius Gilbert and Swain, *Etheostoma.* (USNM, SU)
borealis Jordan, *Poecilichthys.* (USNM, SU)
brevipinnis—see *olmstedi brevipinnis.*
brevispina Coker, *Richia.* (USNM)
butlerianus Hay, *Poecilichthys.* (USNM)
burtoni—see *caprodes burtoni.*

caerulea Storer, *Etheostoma.* (MCZ)
camurum Forbes, *Boleosoma.* (USNM, SU, MCZ, UMMZ)
camurus Cope, *Poecilichthys.* (ANSP)
caprodes Rafinesque, *Sciaena.* (X)
caprodes burtoni Fowler, *Percina.* (ANSP)
carbonaria Baird and Girard, *Pileoma.* (USNM, MCZ, UMMZ)
cheneyi Evermann and Kendall, *Cottogaster.* (USNM, SU)
chlorosoma Hay, *Vaillantia.* (USNM, SU)
cinerea Storer, *Etheostoma.* (?)
clara Jordan and Meek, *Ammocrypta.* (USNM, SU, UMMZ)
collis Hubbs and Cannon, *Hololepis.* (UMMZ)
collis lepidinion Collette, *Etheostoma.* (USNM, CU, DU)
coosae Fowler, *Poecilichthys.* (ANSP)
copelandi Jordan, *Rheocrypta.* (USNM, MCZ, BMNH)
cragini Gilbert, *Etheostoma.* (USNM)
crassus Jordan and Brayton, *Alvordius.* (USNM)
cumberlandicum Jordan and Swain, *Etheostoma.* (USNM)
cyanorum—see *radiosus cyanorum.*
cymatogramma Abbott, *Pileoma.* (ANSP)
cymatotaenia Gilbert and Meek, *Etheostoma.* (USNM, SU)

davisoni Hay, *Etheostoma.* (USNM)
ditrema Ramsey and Suttkus, *Etheostoma.* (TU, USNM, MCZ, ANSP, CU, SU, UMMZ)
duryi Henshall, *Etheostoma.* (X)

edwini Hubbs and Cannon, *Villora.* (UMMZ, USNM, MCZ)
effulgens Girard, *Arlina.* (USNM)
elegans Girard, *Boleichthys.* (MCZ)
elegans Hay, *Nanostoma.* (USNM, SU)
eos Jordan, *Boleichthys.* (USNM)
erizonus—see *euzonus erizonus.*
erochrous Cope, *Hololepis.* (MNHN)
erythrogastrum Kirtland, *Poecilosoma.* (USNM?)
eulepis—see *nigrum eulepis.*
euzonus erizonus Hubbs and Black, *Poecilichthys.* (UMMZ)
euzonus euzonus Hubbs and Black, *Poecilichthys.* (UMMZ, USNM)

evermanni Moenkhaus, *Hadropterus.* (USNM)
evides Jordan and Copeland, *Alvoridus.* (USNM, MCZ)
exilis Girard, *Boleichthys.* (USNM, MCZ, UMMZ)

fasciatus Girard, *Catonotus.* (USNM, MCZ)
fasciatus Girard, *Diplesion.* (MCZ, UMMZ)
flabellaris Rafinesque, *Etheostoma.* (X)
fonticola Jordan and Gilbert, *Alvarius.* (USNM)
fontinalis Rafinesque, *Etheostoma.* (X)
formosa Henshall, *Etheostoma.* (?)
fricksia Hildebrand, *Etheostoma.* (USNM)
fusiforme Girard, *Boleosoma.* (USNM, MCZ, UMMZ)
fusiformis atraque Hubbs and Cannon, *Hololepis.* (UMMZ, USNM)
fusiformis insulae Hubbs and Cannon, *Hololepis.* (MCZ, UMMZ)
fusiformis metae-gadi Hubbs and Cannon, *Hololepis.* (USNM, UMMZ)

gelida Hay, *Ammocrypta.* (USNM)
gilberti Evermann and Thoburn, *Ulocentra.* (USNM, SU)
gracile Girard, *Boleosoma.* (USNM, MCZ)
grahami Girard, *Oligocephalus.* (MCZ)
güntheri Eigenmann and Eigenmann, *Etheostoma.* (BMNH)
gutselli Hildebrand, *Poecilichthys.* (USNM)

hildebrandti Evermann and Clark, *Etheostoma.* (USNM)
histrio Jordan and Gilbert, *Etheostoma.* (USNM, SU)
hopkinsi Fowler, *Poecilichthys.* (ANSP)
hopkinsi binotatum Bailey and Richards, *Etheostoma.* (CU, UMMZ, USNM)
humeralis Girard, *Oligocephalus.* (USNM, MCZ)

inscriptus Jordan and Brayton, *Nothonotus.* (USNM)
insulae—see *fusiformis insulae.*
iowae Jordan and Meek, *Etheostoma.* (SU)

jessiae Jordan and Brayton, *Poecilichthys.* (?)
jordani Gilbert, *Etheostoma.* (USNM, CAS, BMNH, UMMZ)
juliae Meek, *Etheostoma.* (USNM, SU)

kanawhae Raney, *Poecilichthys.* (UMMZ, CU, USNM)
Kennicotti Putnam, *Catonotus.* (USNM, MCZ, UMMZ)

lenticula Richards and Knapp, *Percina.* (CU, TU, USNM, UMMZ)
leonensis Girard, *Oligocephalus.* (MCZ)
lepida Baird and Girard, *Boleosoma.* (USNM, MCZ, UMMZ)
lepidinion—see *collis lepidinion.*
lepidogenys Evermann and Kendall, *Etheostoma.* (USNM)

lineolatus Agassiz, *Catonotus.* (MCZ, UMMZ, MNHN)
Linsleyi Storer, *Etheostoma.* (?)
longimana Jordan, *Etheostoma.* (MCZ, USNM, UMMZ)
luteovinctum Gilbert and Swain, *Etheostoma.* (USNM, SU)
lynceum Hay, *Etheostoma.* See *elegans, Nanostoma* for types.

macrocephalum Cope, *Etheostoma.* (ANSP)
maculata Kirtland, *Etheostoma.* (?)
maculaticeps Cope, *Boleosoma.* (ANSP)
maculatum Agassiz, *Boleosoma.* (USNM)
maculatus Girard, *Alvordius.* (USNM?)
maculatus Girard, *Hadropterus.* (USNM)
manitou Jordan, *Percina.* (USNM)
mariae Fowler, *Belophlox.* (ANSP)
maxinkuckiensis Evermann, *Hadropterus.* (USNM)
meadiae Jordan and Evermann, *Ulocentra.* (USNM)
mesaeus Cope, *Poecilichthys.* (ANSP)
metae-gadi—see *fusiformis metae-gadi.*
microperca Jordan and Gilbert, *Etheostoma.* See *punctulata, Microperca* for types.
micropterus Gilbert, *Etheostoma.* (USNM)
minima Haldeman, *Perca.* (ANSP)
montanus—see *whipplii montanus.*
montuosa—see *notogramma montuosa.*
moorei Raney and Suttkus, *Etheostoma.* (CU, TU, USNM, UMMZ, UK)
mutatum Vaillant, *Boleosoma.* See *maculatum, Boleosoma* for types.

nasutus Bailey, *Hadropterus.* (UMMZ, USNM)
nebulosa Haldeman, *Perca.* (ANSP)
nevisense Cope, *Etheostoma.* (ANSP?)
Newmanii Agassiz, *Hyostoma.* (USNM, MCZ, UMMZ)
nianguae Gilbert and Meek, *Etheostoma.* (USNM, SU)
nianguae spilotum Gilbert, *Etheostoma.* (USNM, SU)
nigra Rafinesque, *Etheostoma.* (X)
nigrofasciata raneyi Crawford, *Percina.* (CU, USNM)
nigrofasciatus Agassiz, *Hadropterus.* (MCZ, USNM, UMMZ)
nigrofasciatus westfalli Fowler, *Hadropterus.* (ANSP)
nigrum eulepis Hubbs and Greene, *Boleosoma.* (UMMZ, USNM, UW)
notogramma montuosa Hogarth and Woolcott, *Percina.* (USNM, UMMZ, CU, UR, VPI)
notogrammus Raney and Hubbs, *Hadropterus.* See *maculatus, Hadropterus* for types.
nuchale Howell and Caldwell, *Etheosoma.* (UMMZ, USNM, TU, UAIC)

obeyense Kirsch, *Etheostoma.* (USNM, SU, BMNH)
okaloosae Fowler, *Villora.* (ANSP)
oligoporus—see *thermophilus oligoporus.*
olmstedi Storer, *Etheostoma.* (MCZ)
olmstedi brevipinnis Cope, *Boleosoma.* (ANSP)
osburni Hubbs and Trautman, *Poecilichthys.* (UMMZ, USNM, OSM)
ouachitae Jordan and Gilbert, *Etheostoma.* (USNM, UMMZ)
oxyrhynchus Hubbs and Raney, *Hadropterus.* (UMMZ, USNM)

pagei Meek, *Etheostoma.* (USNM)
pallididorsum Distler and Metcalf, *Etheostoma.* (KU, USNM, UMMZ, CU)
palmaris Bailey, *Hadropterus.* (UMMZ, USNM)
paludosus—see *radiosus paludosus.*
palustris Gilbert, *Poecilichthys.* (USNM)
pantherinus Moore and Reeves, *Hadropterus.* (UMMZ, OAM, MCZ, USNM)
parvipinne Gilbert and Swain, *Etheostoma.* (USNM)
pellucidus Agassiz, *Pleurolepis.* (USNM, MCZ, UMMZ)
peltatum Stauffer, *Etheostoma.* (ANSP)
perlongum Hubbs and Raney, *Boleosoma.* (UMMZ)
phlox Cope, *Boleosoma.* (ANSP)
phoxocephalum Nelson, *Etheostoma.* (UMMZ)
podostemone Jordan and Jenkins, *Etheostoma.* (USNM)
potsii Girard, *Aplesion.* (MCZ)
proeliaris Hay, *Microperca.* (USNM)
pulchellus Girard, *Oligocephalus.* (MCZ)
punctulata Putnam, *Microperca.* (USNM, MCZ, UMMZ).
punctulatus Agassiz, *Poecilichthys.* (MCZ)
putnami Jordan and Gilbert, *Cottogaster.* (USNM)

quapella Eigenmann and Eigenmann, *Etheostoma.* (BMNH)
quiescens Jordan, *Poecilichthys.* (USNM)

radiosus—see *whipplii radiosus.*
radiosus cyanorum Moore and Rigney, *Poecilichthys.* (UMMZ, OAM, MCZ, USNM, UOMZ)
radiosus paludosus Moore and Rigney, *Poecilichthys.* (UMMZ, MCZ, UOMZ, OAM, USNM)
raneyi—see *nigrofasciata raneyi.*
rex Jordan and Evermann, *Etheostoma.* (USNM)
roanoka Jordan and Jenkins, *Etheostoma.* (USNM, SU, CU, MCZ)
rufilineatus Cope, *Poecilichthys.* (ANSP)
rupestre Gilbert and Swain, *Etheostoma.* (USNM)

sagitta Jordan and Swain, *Poecilichthys.* (USNM?)

saludae Hubbs and Cannon, *Hololepis.* (UMMZ, CM, FMNH)
sanguifluus Cope, *Poecilichthys.* (ANSP)
saxatilis Hay, *Poecilichthys.* (USNM)
scierus Swain, *Hadropterus.* (USNM)
scierus apristis Hubbs and Hubbs, *Hadropterus.* (UMMZ, USNM, TNHC, FMNH, OAM, TAMC, SU)
scierus serrula Jordan and Gilbert, *Hadropterus.* (USNM)
sciotense Osburn and Williamson, *Etheostoma.* (USNM)
scovellii Woolman, *Etheostoma.* (USNM, BMNH, CAS)
sellaris Radcliffe and Welsh, *Hadropterus.* (USNM)
semifasciatum DeKay, *Pileoma.* (?)
serrifer Hubbs and Cannon, *Hololepis.* (UMMZ, USNM, CM)
serrula—see *scierus serrula.*
shumardi Girard, *Hadropterus.* (USNM)
simoterum Cope, *Hyostoma.* (ANSP, USNM, MNHN)
spectabilis Agassiz, *Poecilichthys.* (UMMZ, MCZ, USNM)
spillmani Hay, *Hadropterus.* (USNM)
spilotum—see *nianguae spilotum.*
squamatus Gilbert and Swain, *Etheostoma.* (USNM)
squamiceps Jordan, *Etheostoma.* (USNM)
stigmaeum Jordan, *Boleosoma.* (ANSP)
susanae Jordan and Swain, *Boleosoma.*(USNM)
swaini Jordan, *Poecilichthys.* (USNM)
swannanoa Jordan and Evermann, *Etheostoma.* (USNM, SU, UMMZ)

tessellata Storer, *Etheostoma.* (?)
tessellatum DeKay, *Boleosoma.* (?)
tessellatus Jordan, *Hadropterus.* (USNM)
tetrazonus Hubbs and Black, *Poecilichthys.* (UMMZ)
thalassinus Jordan and Brayton, *Nothonotus.* (USNM, SU, MCZ, BMNH)
thermophilus Hubbs and Cannon, *Hololepis.* (UMMZ, USNM)
thermophilus oligoporus Bailey and Frey, *Hololepis.* (UMMZ, DU)
tippecanoe Jordan and Evermann, *Etheostoma.* (USNM)
transversum Abbott, *Poecilosoma.* (ANSP)
trisella Bailey and Richards, *Etheostoma.* (UMMZ)
tuscumbia Gilbert and Swain, *Etheostoma.* (SU, BMNH, UMMZ, USNM)

uranidea Jordan and Gilbert, *Etheostoma.* (USNM)

variata Kirtland, *Etheostoma.* (?)
verecundum Jordan and Evermann, *Etheostoma.* (USNM)
versicolor Agassiz, *Poecilichthys.* (USNM)
vexillare Jordan, *Boleosoma.* (?)
vigil Hay, *Ioa.* (USNM)

vinctipes Jordan, *Nanostoma.* (USNM)
virgatus Jordan, *Poecilichthys.* (USNM, UMMZ)
vitreus Cope, *Poecilichthys.* (ANSP?)
vivax Hay, *Ammocrypta.* (USNM)
vulneratus Cope, *Poecilichthys.* (ANSP)

warreni Girard, *Boleichthys.* (MCZ)
westfalli—see *nigrofasciatus westfalli.*
whipplei alabamae Gilbert and Swain, *Etheostoma.* (USNM, SU)
whipplii Girard, *Boleichthys.* (MCZ)
whipplii montanus Hubbs and Black, *Poecilichthys.* (UMMZ, USNM)
whipplii radiosus Hubbs and Black, *Poecilichthys.* (UMMZ, USNM)
wrighti McCormick, *Etheostoma.* (?)

zebra Agassiz, *Pileoma.* (MCZ, UMMZ)
zonale arcansanum Jordan and Gilbert, *Etheostoma.* (USNM, UMMZ)
zonalis Cope, *Poecilichthys.* (ANSP)
zonifer Hubbs and Cannon, *Hololepis.* (UMMZ)

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REVIEW OF NEW WORLD MOTHS OF GENUS EUCHROMIUS GUENÉE WITH DESCRIPTIONS OF TWO NEW SPECIES (LEPIDOPTERA: CRAMBIDAE)

By Hahn W. Capps[1]

The purpose of this paper is to provide a means for accurate identification of the species of *Euchromius* Guenée occurring in the Western Hemisphere and to provide names for two undescribed species, heretofore confused with *Euchromius ocelleus* (Haworth).

Delineations of genitalia were prepared by A. D. Cushman, scientific illustrator, Entomology Research Division, Agr. Res. Serv., U.S. Department of Agriculture, and are not drawn to scale. The male genitalia are in lateral view, with one harpe omitted and the aedeagus removed. The female genitalia are in ventral view. Photos of adults are by J. Scott, staff photographer, Smithsonian Institution, and are twice natural size.

[1] Entomology Research Division, Agricultural Research Service, U. S. Department of Agriculture. Retired September 26, 1964.

Keys to New World Species of *Euchromius*

Based on Color and Distribution

1. Forewing brownish from base to inner transverse postmedial band, with little or no irroration (pl. 1: fig. 1) . . . . . **galapagosalis,** new species
   Forewing ochreous white from base to inner transverse postmedial band, with fuscous irroration variable but distinct (pl. 1: figs. 2–4) 2
2. Forewing with whitish area adjacent to blackish terminal dots narrow; a fine ochreous line about midway between dots and termination of irrorated area (pl. 1: figs. 2, 3) 3
   Forewing with whitish area broader and with line much closer to termination of the irrorated area than to terminal dots (pl. 1: fig. 4).
   californicalis (Packard)
3. Forewing with two transverse postmedial bands straight or nearly so; thin line in whitish patch adjacent to blackish terminal dots somewhat sinouus and weakly denticulate; distribution Argentina (pl. 1: fig. 3).
   saltalis, new species
   Forewing with two transverse postmedial bands usually sinuate or bent inwardly; thin line in whitish patch adjacent to blackish terminal dots rather smooth (pl. 1: fig. 2); distribution otherwise . **ocelleus** (Haworth)

Based on Male Genitalia

1. Harpe conspicuously extenuated and narrowed distally, somewhat finger-like (fig. 3) . . . . **californicalis** (Packard)
   Harpe otherwise (figs. 1, 2, 4) 2
2. Aedeagus with two elongate patches of small, slender spinules basad of the large cornuti (figs. 1a, 2a) 3
   Aedeagus with but one elongate patch of small, slender spinules basad of the large cornuti (fig. 4a) . . . . **ocelleus** (Haworth)
3. Harpe broad, costal margin strongly serrate with basal production truncated distally, apices subequal (fig. 1) . . . . **saltalis,** new species
   Harpe narrower than above, serration of costal margin weak, the basal production rounded apically, with a single spine adjacent to apex (fig. 2).
   galapagosalis, new species

Based on Female Genitalia

1. With conspicuous hooklike sclerotizations laterad of the ostium (figs. 5, 7) 2
   Without such hooklike sclerotizations (figs. 6, 8) 3
2. Distance from ostium to origin of ductus seminalis much less than that from ductus seminalis to top of bursa copulatrix (fig. 7).
   californicalis (Packard)
   Distance from ostium to origin of ductus seminalis equal to or greater than that from ductus seminalis to tip of bursa copulatrix (fig. 5).
   saltalis, new species
3. Ventral margin of ostium rather broad and distinctly undulate; ductus bursae with some distinct spinulation between ostium and origin of ductus seminalis (fig. 6) . . . . **galapagosalis,** new species
   Ventral margin of ostium narrower than in above, and straight or nearly so; ductus bursae with conspicuous longitudinal grooves, without spinulation (fig. 8) . . . . **ocelleus** (Haworth)

Euchromius ocelleus (Haworth)

FIGURES 4, 8; PLATE 1 (FIG. 2)

Palparia ocellea Haworth, 1811, Lepidoptera Britannica, vol. 3, p. 486.
Eromene texana Robinson, 1870, Ann. Lyc. Nat. Hist. New York, vol. 9, p. 155.

MALE (pl. 1: fig. 2).—Alar expanse 18–24 mm. Forewing: Upper surface coloration somewhat variable; sordid white, ochreous white to pale brown, with brownish or fuscous irroration distinct; two ochreous transverse postmedial bands, sinuate or concave inwardly, margined with silvery white or gray; two short, oblique bars of similar color adjacent to apex; terminal dots blackish, margined outwardly with silvery metallic scales; a narrow whitish patch adjacent to terminal dots with a thin brownish line midway between the dots and termination of the irrorated area. Hind wing subhyaline, sordid white or with some pale ochreous brown suffusion, without markings, or with a thin testaceous terminal line.

Genitalia (fig. 4): Uncus rather slender, length about equal to that from receptacle to tip of the gnathos. Harpe broad; costa serrate, basal process triangular distally, hook from near base of the process. Aedeagus with a rather extensive series of short, stout, spinelike cornuti and basad an elongate patch of small, slender spines.

FEMALE.—Alar expanse 17–26 mm. Similar to male in color and maculation.

Genitalia (fig. 8): Ostium rather narrow, weakly scobinate, ventral margin straight or nearly so; ductus bursae long, with longitudinal grooves, spinulation inconspicuous; distance from ostium to origin of ductus bursae about equal that from ductus seminalis to tip of the bursa copulatrix; two subequal signa, elongate, scobinate, and ridgelike.

LARVA.—Arrangement of body setae typical of a crambid. Prothorax with two setae on prespiracular shield; group VI bisetose. Meso- and metathorax with group VI unisetose. Abdominal proleg-bearing segments (3–6) with seta IV approximate to V, on same pinaculum and under the spiracle. Ninth abdominal segment with paired setae II on same pinaculum; setae I approximate to seta III and on same pinaculum; setae IV and V absent, only seta VI of this group present. Crochets on abdominal prolegs in a complete ring, irregularly triordinal in length, weaker outwardly.

Mature larva 18–20 mm. long. Head: Pale amber with some brownish reticulation; ocellar pigmentation blackish, extending from ocellus I to ocellus V, posterior margin of pigmentation tangent to anterior margin of ocellus VI; without fuscous pigmentation at lateral incision of hind margin of head. Thorax: Prothoracic shield amber, with some brownish suffusion and a few dark fuscous patches, the most conspicuous one posterior to and slightly below level of base of seta Ib, the large one somewhat reniform and the other narrow, with long axis transverse. Body color sordid white, pinacula amber, rather large, round or nearly so and moderately sclerotized, except that on dorsum of ninth abdominal segment which is subrectangular. Spiracles: Rim black, central area sordid white; on abdominal segments 1–7, round or but slightly oval, small, with diameter but slightly larger than ring at base of the seta dorsad; on prothorax and abdominal segment 8, distinctly oval and much larger than on abdominal segments 1–7, three to four times larger. Anal shield broadly rounded, with a few inconspicuous brownish patches.

TYPE.—Male, in British Museum (Nat. Hist.), *ocelleus;* sex and location uncertain, *texana.*

TYPE LOCALITIES.—Near London, England, *ocelleus;* Texas, *texana.*

FOOD PLANT.—Corn and milo maize, on roots.

SPECIMENS EXAMINED.—167.

NEW WORLD DISTRIBUTION.—United States: Tennessee, Alabama, Texas, New Mexico, Colorado, Utah, Arizona, California, and Washington. Mexico: Sonora, Sinaloa, Durango, Federal District, and Vera Cruz. Panama: Corozal. French Guiana: Cayenne.

REMARKS.—*E. ocelleus* is of wide distribution, occurring in many parts of the world. The distribution cited herein is for the Western Hemisphere and is restricted to localities represented by material studied. For additional synonymy and distribution, see Bleszynski and Collins (1962).

Heretofore, *ocelleus* has been associated with stored products and dead vegetation (Beirne, 1952; Corbet and Tams, 1943; Hinton, 1943; Meyrick, 1928). The species is not a feeder on such material and doubtless its association with these was accidental.

Euchromius californicalis (Packard)

FIGURES 3, 7; PLATE 1 (FIG. 4)

Eromene californicalis Packard, 1873, Ann. Lyc. Nat. Hist. New York, vol. 10, p. 264.

MALE (pl. 1: fig. 4).—Alar expanse 20–23 mm. Resembling *ocelleus* in color and maculation but with the whitish patch adjacent to blackish terminal dots somewhat broader; and the thin brownish line within, closer to termination of irrorated area than to the terminal dots.

Genitalia (fig. 3): Uncus stout. Gnathos with lateral, flaplike production at base and two conspicuous, dorsal, toothlike productions at receptacle. Harpe much narrower distally, fingerlike; process from near base of costa hooklike. Aedeagus (fig. 3a) slender, with a few coarse distal cornuti and an elongate patch of weaker spinules somewhat basad.

FEMALE.—Alar expanse 14–22 mm. Similar to male in color and maculation.

Genitalia (fig. 7): Hooklike sclerotization laterad of ostium greatly expanded basally. Ductus bursae short; distance from ostium to origin of ductus seminalis about one-third that from ductus seminalis to tip of bursa copulatrix. Two subequal signa, narrow, ridgelike.

LECTOTYPE.—Male, in collection of Museum of Comparative Zoology, MCZ type no. 14297, present designation.

TYPE LOCALITY.—California.

FOOD PLANT.—Unknown.

SPECIMENS EXAMINED.—54.

DISTRIBUTION.—California, Washington, Idaho, Montana, Utah, and Colorado.

REMARKS.—*E. californicalis* was based on three males. Only two of the syntypes were located, both at the Museum of Comparative Zoology. One is without an abdomen; that with the abdomen is made lectotype of the species. The genitalia of the lectotype have been examined by brushing.

The illustration of Corbet and Tams (1943) of *californicalis* female genitalia does not agree with those of specimens in the U.S. National Museum. Their figure is definitely not of *californicalis* but of an abnormal specimen of *ocelleus* or of a species unknown to me.

Euchromius galapagosalis, new species

FIGURES 2, 6; PLATE 1 (FIG. 1)

Eromene ocellea (Haworth).—Schaus, 1923, Zool. Sci. Zoologica, vol. 5, no. 2, p. 29.

MALE.—Alar expanse 16–21 mm. Resembling *ocelleus*, but differing from it as follows: Facies somewhat darker. Upper surface of forewing smoother in appearance, the whitish ground color heavily overlaid with brown from base of wing to inner transverse postmedial band and with little or no irroration; irroration beyond outer transverse postmedial band more blackish and denser; the ochreous transverse postmedial bands straight or bent outwardly. Hind wing with subterminal line brownish and more diffuse.

Gentialia (fig. 2): Uncus moderately stout, somewhat dilated between base and tip. Harpe with costal serration weak; basal production of costa rounded at apex, the hooklike spine from below apex. Aedeagus (fig. 2a) with an elongate series of short, stout spines and two basal patches of small, slender spinules.

FEMALE (pl. 1: fig. 1).—Alar expanse 16–22 mm. Similar to male in color and maculation.

Genitalia (fig. 6): Ventral margin of ostium rather broad, undulate, strongly sclerotized, and finely spinulate. Ductus bursae long, longitudinal grooves weaker than in *ocelleus* but spinulation stronger. Two subequal signa, narrow, elongate, ridgelike.

Type.—Female, in collection of the U.S. National Museum, USNM type no. 67634, genitalia slide HWC 12,115.

Type locality.—South Seymour, Galápagos Islands.

Paratypes.—Galápagos Islands: Isla Santa Cruz, Academy Bay, Darwin Research Station 134♂, 178♀ (Jan. 22 to Feb. 27, 1964; R.O. Schuster and D.Q. Cavagnaro); Isla Santa Cruz, Bella Vista Trail 2♂ (Feb. 11, 1964; D.Q. Cavagnaro); Isla Pinzon, Summit and Upper Calderas Areas 10♂, 3♀ (Feb. 7, 1964; D.Q. Cavagnaro). Paratypes in collections of the U.S. National Museum and the California Academy of Sciences.

Food plant.—Unknown.

Remarks.—I am greatly indebted to Dr. C. Don MacNeill, Assistant Curator of Insects, Department of Entomology, California Academy of Sciences, for making available for study the large series collected by their representatives on a recent expedition to the Galápagos.

Efforts to locate the remainder of the series examined by Dr. Schaus were unsuccessful; however, in view of the absence of *ocelleus* in the extensive series of the California Academy of Sciences, it appears that *ocelleus* does not occur in the Galápagos and that *galapagosalis* is an endemic species, not occurring elsewhere.

Euchromius saltalis, new species

Figures 1, 5; Plate 1 (fig. 3)

Male (pl. 1: fig. 3).—Resembling *californicalis* in color and maculation but forewing more cream colored from base to inner transverse postmedial band; and whitish patch, adjacent to terminal blackish dots, with the thin line more ochreous and located midway between the dots and termination of the irrorated area.

Genitalia (fig. 1): Uncus moderately stout. Harpe with costa strongly serrate, basal production rather broad, straplike and truncate distally with apices subequal, one strong, hooklike and the other minute. Aedeagus (fig. 1a) with a series of short, stout spines and two elongate patches of slender spinules.

Female.—Alar expanse 20 mm. Similar to male in color and maculation.

Genitalia (fig. 5): Ostium with two lateral adzlike sclerotizations; ductus bursae long, somewhat longitudinally rugose and spinulation within rather coarse and conspicuous; origin of ductus seminalis about midway between ostium and tip of bursa copulatrix, two subequal signa, narrow, scobinate, ridgelike.

TYPE.—Male, in collection of the U.S. National Museum, USNM type no. 67635, genitalia slide HWC 12,110.

TYPE LOCALITY.—Salta, Argentina.

PARATYPE.—Female, in the U.S. National Museum.

FOOD PLANT.—Unknown.

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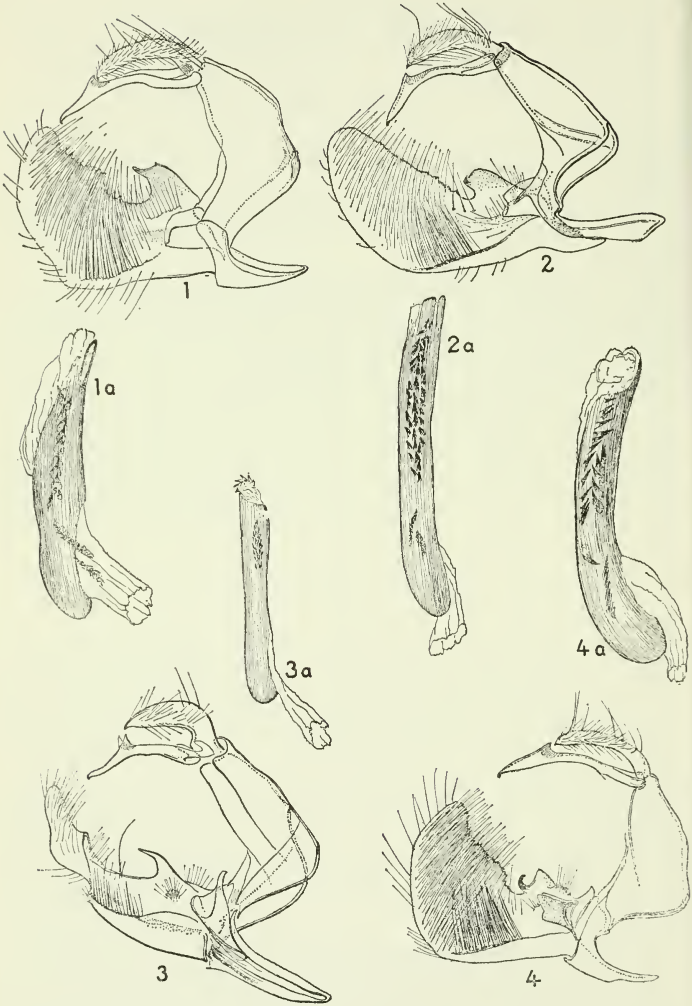
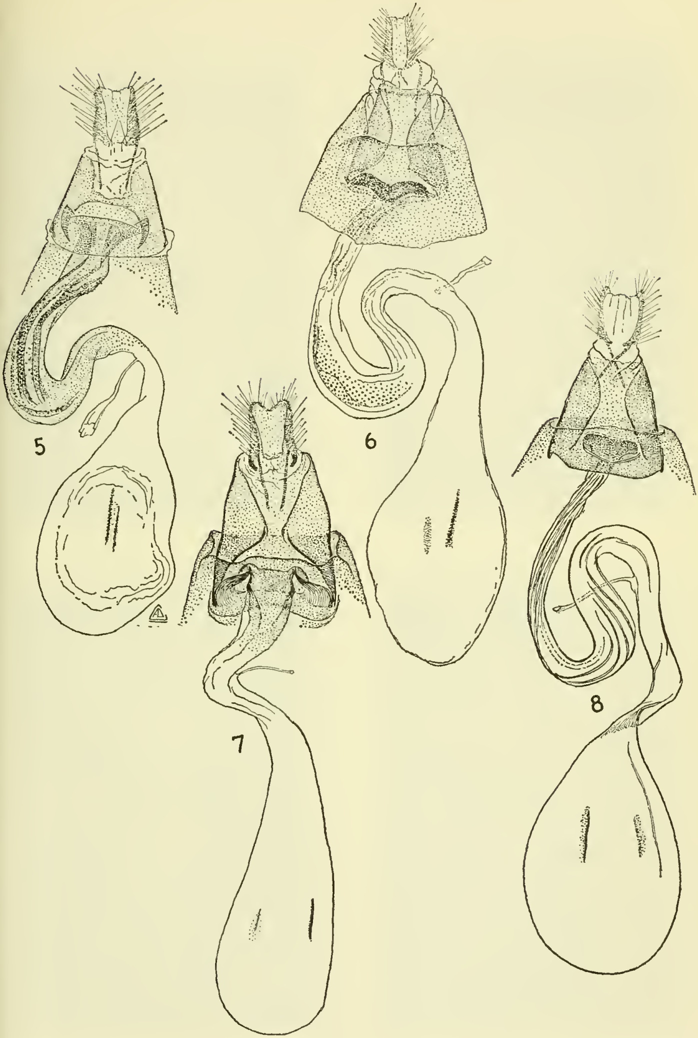
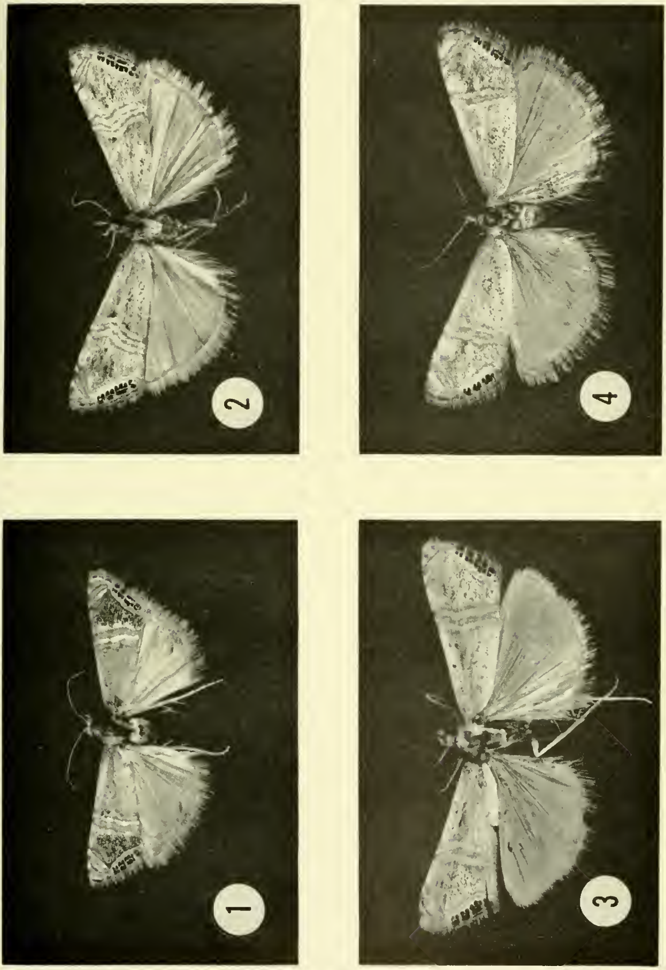


FIGURES 1–4.—*Euchromius*, male genitalia: 1, 1a, *saltalis*, new species; 2, 2a, *galapagosalis*, new species; 3, 3a, *californicalis* (Packard); 4, 4a, *ocelleus* (Haworth).



FIGURES 5–8.—*Euchromius*, female genitalia: 5, *saltalis*, new species; 6, *galapagosalis*, new species; 7, *californicalis* (Packard); 8, *ocelleus* (Haworth).

U.S. GOVERNMENT PRINTING OFFICE:1966



Euchromius, adults: 1, *galapagosalis*, new species; 2, *ocelleus* (Haworth); 3. *saltalis*, new species; 4, *californicalis* (Packard).

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PRELIMINARY REVISION OF BUTTERFLIES OF THE GENUS CALYCOPIS SCUDDER (LYCAENIDAE: THECLINAE)

By William D. Field
Associate Curator, Department of Entomology

The genus of butterflies treated in this paper contains 21 species, of which 6 are here described as new. Nineteen of these species are neotropical in distribution; one species is entirely nearctic and one is both nearctic and neotropical.

In *Calycopis* the forewings of the males lack scent pads. Upper surfaces of hindwings have some blue or purplish scales and sometimes these wings are almost entirely blue or purplish. Hindwings with tails at end of veins Cu_1 and Cu_2, the tail at end of Cu_2 being much the longest. Undersurface of hindwing with a submarginal ocellate spot below vein Cu_1 and sometimes with one or more of these spots above this vein. The area between the large blue lunule in interspace Cu_2 and the postmedian line is always darker than the ground color and is usually some shade of red.

In the male genitalia the uncus is divided dorsally into two lateral elements, often completely separated. Aedeagus usually with a single terminal, spinelike cornutus, very rarely with a small second terminal thornlike cornutus. The aedeagus lacks the ventral keel found in some Theclinae and is sometimes upturned distally. Harpes fused for more than one-half of their lengths from base and terminally truncate, or if bluntly pointed, with ends slightly upturned. Forearm of gnathos often with carina along inner surface, this carina sometimes laminate or dentate.

Female genitalia with ductus bursae a simple, lightly sclerotized tube, funnel-shaped at ostium bursae and with rounded or sharply pointed lobes above and posterior to ostium bursae. Bursa copulatrix with two large platelike signae, each ornamented with a centrally placed, rose-thorn shaped spine and with anterior margin deeply dentate.

On the basis of male genitalia characters the species of *Calycopis* are divided into five species groups. These groups are included in the key and are also separately treated in the body of this paper.

The figures were drawn by the author except figures 1, 4, 6, 9, 10, and 17, which were drawn by Mrs. Amy Awl. All photographs were made by Mr. Jack Scott, staff photographer, and are reproduced here (figs. 35-126) twice natural size.

Key to the Species of *Calycopis*

(Unless otherwise stated, all comparisons in this key pertain to the male genitalia in lateral view and to the female genitalia in ventral view.)

Males

1. Gnathos extending well beyond lower margin of lateral lobe of uncus; lower distal angle of this lobe not greatly expanded (figs. 1–9) . . 2
   Gnathos not extending beyond lower margin of lateral lobe of uncus; lower distal angle of this lobe greatly expanded (figs. 10–19), *partunda* group) 11

2. (1) Lateral lobe of uncus with distal margin concave or straight; ventral margin of uncus concave or straight in front of lower distal angle (figs. 1–8) 3
   Lateral lobe of uncus with distal margin convex; ventral margin of uncus convex in front of lower distal angle (fig. 9), (*cecrops* group) 10

3. (2) Fused harpes wide in ventral view, having a width that is more than two-thirds their length; distal end of aedeagus distinctly bent upward (figs. 7, 8) 4
   Fused harpes more narrow in ventral view, having a width that is not more than two-thirds their length, usually much less; aedeagus straight or only slightly upcurved distally (figs. 1–6), (*janeirica* group) 5

4 (3) Aedeagus in dorsal view sharply bent distally to the right and bifurcate; gnathos with dentate carina (fig. 7), (*torqueor* group). **C. torqueor**
   Aedeagus in dorsal view not as above; carina laminate (fig. 8), (*xeneta* group) . . . . **C. xeneta**

5. (3) Upper distal angle of lateral lobe of uncus greatly produced, forming a fingerlike process; basal end of aedeagus upturned (fig. 6) . **C. lerbela**

Upper distal angle of lateral lobe of uncus not so greatly produced, without fingerlike process; basal end of aedeagus slightly downturned or straight, not upturned (figs. 1–5) 6

6. (5) Harpes gradually tapered, forming long narrow apices; distal margin of lateral lobe of uncus straight or nearly so (fig. 1) . . . **C. bactra**

Harpes constricted before but expanded at apices; distal margin of lateral lobes of uncus concave (figs. 2–5) 7

7. (6) Aedeagus with two terminal cornuti; harpes fused for more than three-fourths their length (figs. 4, 5) 8

Aedeagus with a single terminal cornutus; harpes fused less than three-fourths their length (figs. 2, 3) 9

8. (7) Upperside of hindwing with a large area of blue and a much more narrow fuscus border; upper distal angle of lateral lobe of uncus slightly produced (fig. 4*c*) . . . . **C. janeirica**

Upperside of hindwing with a smaller area of blue and a broader border of fuscus; upper distal angle of lateral lobe of uncus more greatly produced (fig. 5*c*) . . . . **C. chacona**

9. (7) Eighth tergite of male abdomen with posterior concavity broader and proportionately more shallow and not grooved mesially (fig. 20*b*); blue disc on upperside of hindwing large and lustrous (fig. 114). **C. nicolayi**

Eighth tergite of male abdomen with posterior concavity narrow and deep and distinctly grooved mesially (fig. 20*c*); blue disc on upperside of hindwing smaller and not so lustrous (fig. 115) . **C. caulonia**

10. (2) Hindwing beneath having marginal ocellate spot in interspace Cu_1 with black center much larger than the red or gray lunule that partially surrounds it . . . . **C. cecrops**

Hindwing beneath having marginal ocellate spot in interspace Cu_1 with black center smaller than surrounding red lunule . **C. isobeon**

11. (1) Harpes fused for three-fourths or less their lengths (figs. 10, 11, 14) 12

Harpes fused for more than three-fourths their lengths (figs. 12, 13, 15–19) 14

12. (10) Lower margin of lateral lobe of uncus nearly straight, slightly concave anteriorly; forearm of gnathos without carina (fig. 10) . **C. susanna**

Lower margin of lateral lobe of uncus undulate; forearm of gnathos with laminate carina (figs. 11, 14) 13

13. (12) Saccus longer than harpes; aedeagus straight; harpes fused much less than three-fourths their length (fig. 11) . . . . **C. drusilla**

Saccus not as long as harpes; aedeagus upcurved; harpes fused nearly three-fourths their length (fig. 4) . . . . **C. bellera**

14. (11) Upper distal angle of lateral lobe of uncus greatly produced, forming an acute fingerlike process (figs. 16–19) 17

Upper distal angle of lateral lobe of uncus slightly produced but not as an acute fingerlike process (figs. 12–15) 15

15. (14) Forearm of gnathos without carina; dorsal surface of tegumen greatly uplifted; distal end of harpe bluntly rounded (fig. 15) . **C. partunda**

Forearm of gnathos with carina; dorsal surface of tegumen smoothly rounded; distal end of harpe slightly upturned (figs. 12, 13) . . 16

16. (15) Forearm of gnathos with sharply pointed dentate carina near apex; aedeagus nearly straight; distal margin of lateral lobe of uncus straight or slightly convex (fig. 13) . . . . **C. vitruvia**
Forearm of gnathos with dentate carina not sharply pointed and near middle in position; aedeagus in dorsal view sharply bent to the right; distal margin of lateral lobe of uncus slightly concave (fig. 12) . . . . **C. vibulena**
17. (14) Finger-like process at distal end of aedeagus directed upward (figs. 18, 19). 18
Finger-like process at distal end of aedeagus straight (figs. 16, 17) . 19
18. (17) Lateral lobes of uncus connected dorsally; upper distal angle of lateral lobe of uncus greatly produced; forearm of gnathos without carina; aedeagus very long, more than four times the length of harpe (fig. 19) . . . . **C. fractunda**
Lateral lobes of uncus entirely separate; upper distal angle of lateral lobe of uncus produced less than one-half as much as above; forearm of gnathos with carina; aedeagus shorter than above, less than four times the length of harpe (fig. 18) . . . . **C. anastasia**
19. (17) Lateral lobes of uncus narrowly connected dorsally; aedeagus with two cornuti, the larger one straight; dorsal margin of harpe greatly constricted before apex (fig. 17) . . . . **C. anfracta**
Lateral lobes of uncus entirely separate; aedeagus with a single large cornuti which is bent near middle; dorsal margin of harpe not as greatly constricted before apex as in species above (fig. 16) . **C. indigo**

Females

1. Length of ductus bursae plus bursa copulatrix less than 3½ times the width of ostium bursae (figs. 28, 31–33) 2
Length of ductus bursae plus bursa copulatrix 4 or more times the width of ostium bursae (figs. 22–27, 29, 30, 34) 6
2. (1) Posterior ostium bursae lobes sharply pointed 3
Posterior ostium bursae lobes rounded 5
3. (2) Posterior ostium bursae lobes large and spurlike; length of ductus bursae plus bursa copulatrix less than 2½ times the width of ostium bursae (fig. 33) 4
Posterior ostium bursae lobes small, not spurlike, forming two teeth; length of dultus bursae plus bursa copulatrix about 3 times the width of ostium bursae (fig. 32) . . . . **C. amplia**
4. (3) Hindwings beneath with reddistinct, not obscured with fuscous, particularly in the area between the large blue lunule in interspace Cu_2 and the postmedian line and with a submarginal red spot above vein Cu_1 . . . . **C. anfracta**
Hindwings beneath with red indistinct; obscured with fuscous, particularly in the area between the large blue lunule in interspace Cu_2 and the postmedian line and with a submarginal red spot lacking above vein Cu_1 . . . . **C. indigo**
5. (2) Ventral plate of ductus bursae at ostium bursae broadly rounded laterally (fig. 28) . . . . **C. drusilla**
Ventral plate of ductus bursae at ostium bursae sharply angled, not rounded laterally (fig. 31) . . . . **C. partunda**
6. (1) Forewing above with large shining purplish blue spot below cell . . 7
Forewing above without this spot, or if present it is pale blue in color, or forewing dark metallic blue over most of wing except outer margin 8

7. (6) Hindwing beneath with postmedian black line above vein Cu_2 bordered outwardly with white and inwardly with red; spurs of posterior ostium bursae lobes set close together (fig. 29) . . . . **C. vitruvia**
Hindwing beneath with postmedian black line lacking red inner border; spurs of posterior ostium bursae lobes set further apart than in *vitruvia* . . . . **C. fractunda**

8. (6) Forewing dark metallic blue except along outer margin . . **C. bellera**
Forewing not as above, dark brown sometimes with bright blue below 2dA and sometimes pale blue over cell and base of wing 9

9. (8) Total length of ductus bursae and bursa copulatrix 5 times the width of ostium bursae 10
Total length of ductus bursae and bursa copulatrix less than 5 times the width of ostium bursae 11

10. (9) Hindwing above with a wide brown border and with blue area more restricted (fig. 49) . . . . **C. chacona**
Hindwing above with brown border more narrow and with blue area larger (fig. 45) . . . . **C. janeirica**

11. (9) Total length of ductus bursae and bursa copulatrix 4½ mm. or slightly more 12
Total length of ductus bursae and bursa copulatrix 3¾ mm. or less . 13

12. (11) Inner red element of postmedian line on hindwing beneath broad, nearly 1 mm. in width . . . . **C. cecrops**
Inner red element of postmedian line on hindwing beneath not nearly as broad, about ½ mm. in width . . . . . **C. isobeon, C. susanna**

13. (11) Posterior ostium bursae lobes sharply pointed 14
Posterior ostium bursae lobes rounded . . . . **C. lerbela**

14. (13) Ductus bursae sharply bent ventrally just before attachment of ductus seminalis; area around the opening of ductus seminalis nonsclerotized **C. bactra**
Ductus bursae only gradually bent toward the left just before attachment of ductus seminalis; area around opening of ductus seminalis sclerotized . . . . **C. caulonia**

The *janeirica* Group

In this group the lower angle of uncus in lateral view is only slightly produced and much less so than the upper angle of uncus, (the ventral margin is not nearly as long as the distal or caudal margin). The aedeagus is fairly straight, ending distally in a straight or upward projected point. The fused harpes in ventral view are not nearly as wide as long.

The species in this group are all very closely related and most of them are usually more easily distinguished upon wing habitus and color characters, than by genitalic characters. In the male sex, *C. bactra* is distinguished at once from all the others in having a wider postmedian band on the wings underneath and in having the cell bar closer to it, being separated from it by less than twice the width of the band. *C. lerbela* is the only species in this group that has two black pupillated lunular spots on the outer margin of hindwing below. Of the remaining four species, *C. nicolayi* is the most distinct in having the blue color on the upperside of hindwing more lustrous and covering a larger area, and in having a dark gray ground color below. The remaining three species: *caulonia*, *janeirica*, and *chacona* are most closely related. They can be distinguished except for a few genital characters, only by color characters on the upper surfaces of the hindwings. *C. chacona* has a broad black outer border that completely obliterates the marginal black spots and consequently has a much smaller discal blue area; it has a marginal bluish white line in interspace Cu_2 only. *C. janeirica* has the outer border narrower, containing two large marginal black spots, nearly confluent but outlined by a trace of blue. Because of the narrow border there is a larger blue disc in *janeirica.* This species also has a marginal bluish-white line extending above vein Cu_1. *C. caulonia* has the marginal spots much smaller and more isolated than in *janeirica,* with marginal bluish-white line as in *janeirica.*

Calycopis bactra (Hewitson), new combination

FIGURES 1, 20*a*, 22, 35–42

Thecla bactra Hewitson, 1877, Illustrations of diurnal Lepidoptera: Lycaenidae, vol. 1, p. 194; vol. 2, pl. 77, figs. 619, 620.

Thecla beon (Cramer).—Godman and Salvin [not Cramer, a misidentification, in part], 1887, Biologia Centrali-Americana, Lepidoptera-Rhopalocera, vol. 2, pp. 74, 75.

MALE (figs. 35, 36).—Forewing above dark brown, nearly black, sometimes with a faint and dull bluish-purple irridescence over base; fringe paler brown. Hindwing above with costal and outer margin dark brown, nearly black; base and cell to outer dark border lustrous blue with a slight purplish tinge; abdominal margin below vein 2dA thickly covered in middle with pale grayish-purple scales; lobe of anal angle with a small orange-red spot, surrounded by the dark ground color; immediately above this on abdominal margin a small nearly triangular white spot; above anal angle along outer margin a pale bluish-white submarginal line between veins 2dA and M_3; tips of tails white; fringe at base of tail Cu_2 white. Undersides of both wings with ground color pale brown; with two very faint parallel bars slightly darker than ground color crossing the end of each discoidal cell, area between these bars dirty white and sometimes containing a few scattered red scales; fringe slightly darker than ground color and on hindwing containing a few bluish-white scales below vein Cu_1. Forewing above vein Cu_2 and hindwing with a narrow tricolored postmedian line or band; this band white along outside, black in middle and orange red along its inner side. Below vein Cu_1 this band has a W-shape; the V-shaped bar, present in some species of *Calycopis* in interspace M_3 and on vein Cu_1 is absent or only slightly indicated in *C. bactra.* Forewing underneath with costal margin orange red; outer margin slightly darker than ground color; a faint double row of slightly darker submarginal bars along outer margin above vein Cu_2. Hindwing beneath with anal lobe black; immediately inward from this on abdominal margin an orange-red bar; a few white scales between bar and anal lobe; a black or brown line extending from anal lobe around outer margin, becoming lighter brown near costal margin; inward from and adjacent to this line a white line fading into pale brown above vein M_3; interspace Cu_2 with a submarginal orange-red lunular marking, partially enclosing a small black spot along its outer edge; between the lunular marking and the anal lobe a submarginal dark brown lunular spot suffused with bluish-white scales; inward from this lunular spot and between middle elements of W-shaped portion of postmedian band an orange-red lunule; a double row of very faint and irregularly-shaped dirty white submarginal spots above vein Cu_1.

Length of forewing 11–12.5 mm.

Male genitalia, as illustrated by figure 1, with aedeagus short, under 3 mm. in length, nearly straight, slightly upturned distally and with base slightly downturned; lateral lobe of uncus with distal margin nearly straight and lower distal angle not greatly expanded, lower margin of uncus concave; harpes fused ventrally nearly seven-eights of their length, in lateral view gradually tapering and forming a long narrow apex. Eighth tergite (fig. 20*a*) with posterior concavity broad and shallow.

Female (figs. 37–42).—Wings on both surfaces much like the male, but frequently with some pale blue in base of forewing above and with blue of hindwing above much less brilliant; differing on the hindwing underneath in usually having a little orange red above Cu_1 next to the submarginal black pupillated lunule.

Length of forewing 11–12 mm.

Female genitalia, as illustrated by figure 22, with ductus bursae and bursa copulatrix relatively short, being about 3.5 mm. in length and just over 4 times the width of ostium bursae, posterior ostium bursae lobes sharply pointed.

Type-locality.—"Nicaragua."

Additional type data.—*C. bactra* was originally described from a single female specimen, the holotype, from the collection of W. C. Hewitson, now in the collection of the British Museum (Natural History) and labeled type number Rh. 915 with female genitalia preparation no. R. 1948–14 (N.H.B.).

Distribution.—Guatemala south through Central America, northern South America, Trinidad, northern Brazil and Peru.

GUATEMALA: Department of Quezaltenango, Volcán Santa Maria. HONDURAS: Department of Cortés, La Cumbre. NICARAGUA: no specific locality. PANAMA: Province of Panama, La Chorrera (May). CANAL ZONE: Culebra (Nov.); Ancón (May, June, October); New Culebra (February); Balboa (April, May); Taboga Island; La Boca (April); Barrow Colorado Island (March); La Cruces Trail, nr. Corozal (June). COLOMBIA: Department of Valle del Cauca, Cali District (3200 ft., February). PERU: no specific locality. VENEZUELA: State of Carabobo, Puerto Cabello. TRINIDAD: St. Andrew County, Matura (September), Oropuche (April); Coroni County, Gran Couva (April). SURINAM: District of Paramaribo, Paramaribo (March); District ?, Sint [sic] Barbara Plan [sic] (Surinam River, April). FRENCH GUIANA: Colonie de la Guyana, Cayenne, Mouth of Kourou River (July, December). BRAZIL: Territory of Rio Branco, Mt. Roraima (4200 ft., December).

MATERIAL STUDIED.—Eighteen males, 20 females, including their genitalia.

Calycopis nicolayi, new species

FIGURES 2, 20*b*, 113, 114

MALE (figs. 113, 114).—This species differs from all others in the *janeirica* group in having ground color of forewings and costal and outer borders of hindwings very much darker and purplish black in color. It is similar to *bactra* and thus differs from *caulonia*, *janeirica*, and *chacona* in having a very large blue disc on hindwing. This blue as in bactra is more lustrous than in the above-mentioned species and it lacks the purplish tinge found in *bactra*. The ground color underneath is very dark gray, not brown as in the other species. The markings below are as in *caulonia* and *janeirica* with postmedian red lunule of interspace Cu_2 slightly suffused with black and sometimes almost entirely black.

Length of forewing 10–12 mm.

Male genitalia, as illustrated by figure 2, with aedeagus about the length and shape of that found in *bactra*, somewhat more slender and less upturned at distal end; lateral lobe of uncus as in *janeirica;* harpes fused ventrally about as much as in *caulonia*, in vental view shaped about like that species and *bactra*, but in lateral view shaped like *caulonia* and *janeirica*. Eighth tergite (fig. 20*b*) with posterior concavity broader and proportionately more shallow than in any of the other species except *chacona*.

FEMALE.—Unknown.

TYPE-LOCALITY.—João Pessoa, State of Paraiba, Brazil.

ADDITIONAL TYPE DATA.—Described from the holotype, male (locality as given above; June 29, 1953; USNM type 34897; ex. S. S. Nicolay Collection; collected by Jorge Kesselring; male genitalia preparation WDF 5291, 1953), and two male paratypes from the same locality (taken June 21 and June 27, 1953).

LOCATION OF TYPES.—Holotype in United States National Museum, paratypes in the collection of Lt. Colonel Stanley S. Nicolay.

DISTRIBUTION.—Known only from the type-locality.

MATERIAL STUDIED.—Three males including their genitalia.

Calycopis caulonia (Hewitson), new combination

FIGURES 3, 20*c*, 23, 55, 56, 115, 116

Thecla caulonia Hewitson, 1877, Illustrations of diurnal Lepidoptera: Lycaenidae, vol. 1, p. 188; vol. 2, pl. 75, figs. (♀) 587, 588.

MALE (figs. 115, 116).—Very similar to *bactra* except that postmedian band on undersurfaces of wings contains less red along inner side and the bars at the end of the cell in both wings on this surface are separated by a greater distance from the postmedian bands. Very close to *janeirica* in this sex, hardly differing except in size.

Length of forewing 10–12 mm.

Male genitalia, as illustrated by figure 3, with aedeagus short as in *bactra*, being about 3 mm. in length, straight, not upturned distally and with distal end not prolonged as it is in *bactra* and not blunt as it is in *janeirica*; harpes and uncus about like *janeirica* but smaller. Eighth tergite (fig. 20*c*) similar to *janeirica* but with posterior concavity more narrow and proportionately deeper.

FEMALE.—Close to females of *bactra*, differing chiefly in having the blue on hindwing more restricted, being nearly absent in interspaces M_1 and M_2 opposite the end of cell. Wings below as in male with slightly less red along inner side of postmedian band and with cell bars further from this band than in *bactra*.

Length of forewing 10.5–11.5 mm.

Female genitalia, as illustrated by figure 23, with posterior ostium bursae lobes smaller and with spurs much closer together and nearer center of upper margin of ostium bursae than in *bactra*; with ductus bursae curving to left before entrance of ductus seminalis and with sclerotized area around opening of ductus seminalis (in *bactra* the area is nonsclerotized and the ductus bursae strongly and abruptly curved ventrally before nonsclerotized area).

TYPE-LOCALITY.—"Rio Janeiro" [Rio de Janeiro, Brazil].

ADDITIONAL TYPE DATA.—*Caulonia* was originally described from a single female specimen, the holotype, W. C. Hewitson collection, now in the collection of the British Museum (Natural History) and is labeled type number Rh. 916. According to Mr. D. S. Fletcher of the staff of that institution, this type lacks its abdomen. Another specimen, a topotype, was carefully compared with the holotype by Mr. Fletcher and upon being identified as that species was loaned to me for study. This specimen is the one illustrated in figures 23, 55, 56.

Distribution.—This species is found along the central eastern coast of Brazil from the State of Rio de Janeiro north to the state of Paraiba.

Brazil: State of Rio de Janeiro, Rio de Janeiro; State of Pernambuco, Recife (January), Santa Cruz (July), Bonita (January); State of Paraiba, João Pessoa (December, January, February).

Material studied.—Nine males and nine females including their genitalia.

Calycopis janeirica (C. Felder), new combination

Figures 4, 20*d*, 24, 43–46

"*Thecla beon* Cram. var. *janeirica*" C. Felder, 1862, Verh. Kais.-Königl. Zool.-bot. Ges. Wien, vol. 12, p. 474.

Thecla vibulena Hewitson [in part], 1877, Illustrations of diurnal Lepidoptera: Lycaenidae, vol. 2, figs. 599, 600 (only).

Male (figs. 43, 44).—Similar to *bactra*, differing in being slightly larger and in having dark borders of hindwings wider on the upper surface, especially so near apex. Forewing below differing from *bactra* in lacking the red along inner side of postmedian band. Hindwing below with less red along innerside of this band and with elements of this band forming three distinct, connected V-shaped bars below vein M_3.

Length of forewing 11–14 mm.

Male genitalia, as illustrated by figure 4, with aedeagus longer than in *bactra* or *caulonia*, usually nearly 4 mm. in length and nearly straight, the distal end similar to *caulonia*, not upturned as in *bactra*; lateral lobe of uncus with distal margin concave and lower distal angle not greatly expanded but slightly more so than in *bactra* or *caulonia*; lower margin concave. Harpes fused ventrally just barely over three-fourths of their length; in lateral view with apices slightly expanded, not long and tapering. Eighth tergite (fig. 20*d*) with posterior concavity narrow and much deeper than in *bactra* but not as narrow as in *caulonia*.

Female (figs. 45, 46).—Similar to the male, forewing above slightly bluish at the base. Hindwing above with border below vein Cu_1 more broken, with dark spots more isolated and with blue over disc not quite as brilliant. Wings underneath not different from those of the male and differing from *bactra* in the same ways that the male does.

Length of forewing 11–13 mm.

Female genitalia, as illustrated by figure 24, with ductus bursae and bursa copulatrix long, being about 5 mm. in length and just over 5 times the width of ostium bursae, with the pair of sharply pointed ostium bursae lobes similar to those of *caulonia*, but slightly larger, ductus bursae only slightly curved, or if greatly so, this curve near middle.

Type-locality.—"Rio" [Rio de Janeiro, Brazil].

Additional type data.—This species was described from the female sex and the number of specimens in the original series was not indicated. Although the C. Felder collection of Lepidoptera supposedly went to the British Museum (Natural History), the type of this species could not be located in that collection by Mr. D. S. Fletcher. I am not suggesting that a neotype be designated at present because of the possibility of the type being in some other European collection.

Distribution.—Widely distributed in Brazil from Amazonas and Pernambuco south to Santa Catarina.

Brazil: State of Amazonas, Manaos; State of Pernambuco, Espirito Santo, Recife; State of Baia, Tijuca; State of Rio de Janeiro, Petropolis, Rio de Janeiro, Nova Friburgo; State of Santa Catarina, Joinville (April, August, September).

Material studied.—Twelve males and 10 females, including their genitalia.

Calycopis chacona (Jörgensen), new combination

Figures 5, 20*e*, 21, 21*h–j*, 25, 47–52

Thecla poeas chacona Jorgensen, 1932, Deutsche Ent. Zeit. (Iris), vol. 46, pp. 44, 45.

Male (figs. 47–48, 51–52).—Closely allied to *janeirica*, differing in having the brilliant blue of hindwing covering a much smaller area and thus leaving a very much broader border on this wing. Differing from *janeirica* on the undersurfaces in having the ground color a warmer brown and with all red markings more of an orange red. The red of the postmedian band on the forewing below is frequently present but is very faint.

Length of forewing 11–14 mm.

Male genitalia (figs. 5, 21, 21*h–j*) with uncus, harpes and aedeagus in lateral view very much as in *janeirica*; lateral lobes of uncus in dorsal view further apart and more expanded, forming a deeper middle notch than in *janeirica* and harpes fused ventrally for a greater distance than in that species. Figures 21, 21*h–j* show variation of harpes in lateral view. Eighth tergite (fig. 20*e*) with posterior concavity as deep or deeper than in *janeirica* and much broader.

Female (figs. 49, 50).—Most specimens differ from *janeirica* in the same way that the males differ, in having a wider brown border with a smaller blue disc on the upper surfaces of the hindwings and in having the red of the postmedian band on the forewing below present but very faint. In *janeirica* this red is usually absent. I am unable to distinguish some female specimens from the state of Parana, Brazil from *janeirica;* however, all males I have seen from Parana are typical *chacona*.

Length of forewing 11–13 mm.

Female genitalia, as illustrated by figure 25, not separable from *janeirica.* Ductus bursae usually sharply curved immediately before ductus seminalis. Figures 24 and 24*a* of *janeirica* and figure 25 of *chacona* were not included to show differences between these two species. Both species have ductus bursae like figures 24*a* and 25 and, although I have not seen *chacona* like that of figure 24, I do not doubt that it occurs.

Type-locality.—"Formosa, Argentina."

Additional type data.—This species was originally described from a series of several specimens (=syntypes), the exact number not being stated. These syntypes are presumably in the Jörgensen collection in the Museo Argentino de Ciencias Naturales, Buenos Aires; however, a lectotype cannot be designated at the present time because I have been unable to obtain any information concerning these syntypes. My identification is based upon the original description, upon a topotype specimen and upon this being the southernmost species in the genus.

Distribution.—This species is found in the state of Parana in Brazil west and south through Paraguay to the provinces of Salta, Cordoba and Buenos Aires in Argentina.

Brazil: State of Parana, Castro, Londrina (April, September). Paraguay: Villarica (September). Argentina: Province of Misiones, Iguasu, Santa Maria; Province of Correntes, Corona near Goya; Province of Entre Rios, La Soledad, Gualeguaychu (March), Isla Los Cisnes (Parana delta); Province of Buenos Aires, Islas, Punta Lara, Buenos Aires; Territory of Formosa, Formosa; Province of Salta, Salta; Province of Tucuman, Tucuman (May); Province of La Rioja, La Rioja; Province of Cordoba, Cordoba, Cosquin.

Material studied.—Twenty-six males and 20 females, including their genitalia.

Calycopis lerbela, new species

Figures 6, 20*f*, 26, 57–60

Male (figs. 57–58).—Differing from *bactra* and related species in having the brilliant blue on hindwings above restricted to lower half of wing below cell. Anal lobe without red spot or at most with only a few red scales. Forewing below similar to *janeirica*, differing from that species on the hindwing in having a second submarginal black pupillated red spot, this spot in interspace M_3 and smaller than similar spot in interspace Cu_1.

Length of forewing 10.5–12.5 mm.

Male genitalia, as illustrated by figure 6, with lateral lobe of uncus having distal margin concave, with lower margin straight or nearly so and with upper distal angle produced, forming a short finger-like process; aedeagus very distinctive, having basal end upturned; harpe somewhat similar to *bactra* but slightly more blunt at apex. Eighth tergite (fig. 20*f*) very much as in *chacona* and slightly smaller.

FEMALE (figs. 59, 60).—Differing from the male by having a more extensive blue area in the base of the hindwing on the upper surfaces and in having the brown border on lower half of this wing more broken into isolated black spots. Similar to *bactra* female with blue somewhat brighter and extending over much of base of forewing. Wings underneath not differing from those of the male.

Length of forewing 11.5 mm.

Female genitalia, as illustrated by figure 26, with posterior ostium bursae lobes only slightly produced, rounded and lacking the pair of spurs usually present and thus very similar to *cecrops* and some specimens of *susanna*. It differs from the latter species in having a shorter ductus bursae and bursa copulatrix.

TYPE-LOCALITY.—Obidos, State of Amazonas, Brazil.

ADDITIONAL TYPE DATA.—Described from the holotype, male (locality as given above; USNM type 34898; E. A. Smyth Collection; male genitalia preparation WDF 2725, 1948); allotype, female (same locality; Oct.–Nov.; M. de Mathan; Rothschild bequest; female genitalia preparation WDF 3468, 1951) and from ten male paratypes from Obidos and from other localities in the state of Amazonas, Brazil.

LOCATION OF TYPES.—Holotype and two male paratypes in the United States National Museum. Allotype and eight male paratypes in the British Museum (Natural History).

DISTRIBUTION.—State of Amazonas in Brazil north into French Guiana and Surinam. Note: Material from French Guiana and Surinam was not included in the type series because of the remoteness of those countries from the type locality.

BRAZIL: State of Amazonas, Obidos (October–November), Itutuba to Obidos (January to April), Juhuity (April), Manaos. FRENCH GUIANA: Colonie de la Guyane, Cayenne. SURINAM: District?, Sint [sic] Barbara Plan [sic] (Suriname River, April).

MATERIAL STUDIED.—Fifteen males and one female, including their genitalia.

The *torqueor* Group

In this group the lower angle of uncus is about as in the *janeirica* group. The aedeagus is sharply upturned distally and curved to the right (in dorsal view), the distal portion of the aedeagus bifurcate in dorsal view, and bluntly pointed in lateral view. The fused harpes in ventral view are not nearly as wide as long. One species is assigned here.

Calycopis torqueor (Druce), new combination

FIGURES 7, 20*g*, 111, 112

Thecla torqueor Druce, 1907, Proc. Zool. Soc. London, 1907, p. 608.

MALE (figs. 111, 112).—Wings above similar to *indigo* with border on hindwing about the same as in that species but with two long brilliant blue rays on hind margin of forewing, one above and one below vein 2dA. Wings below hardly distinguishable from *anfracta* and as in that species with red markings more distinct than in *indigo* and with red lunule adjacent to postmedian band in interspace Cu_2 containing less fuscous than in *anfracta*.

Length of forewing 14 mm.

Male genitalia, as illustrated by figure 7, with aedeagus sharply bent upward and to the right at distal end; saccus as long as harpe; vinculum bent greatly to the rear; dorsal margin of tegumen (in lateral view) greatly produced in the middle; uncus with lateral elements similar to *bactra;* the lower margin short, with lower distal lobe small and distal margin nearly straight; harpes (in lateral view) of the common type, quite like *janeirica, partunda,* and several other species in the genus, with basal two-thirds fused (in ventral view), unusually broad near middle, narrowing rapidly toward apex and with free apical one-third widely separated; gnathos with a distinct tooth-like carina on inner surface of forearm.

FEMALE.—Unknown.

TYPE-LOCALITY.—"Carimang River [sic], British Guiana."

ADDITIONAL TYPE DATA.—Described from a series of males all from the type-locality. Druce designated a holotype as is indicated in the original description with the statements: "Type Mus. Godman," and "Whitely obtained a series of specimens which do not differ." The holotype, now in the collection of the British Museum (Natural History) is labeled type no. Rh 903 and its genitalia preparation number is 1951–489. Note: One of the paratypes was dissected and compared with the holotype by Mr. D. S. Fletcher and upon being found identical was loaned to me for study. This compared specimen is the one illustrated (figs. 7, 20*g*, 111, 112).

DISTRIBUTION.—

BRITISH GUIANA: Province of Essequibo, Caramang River.

MATERIAL STUDIED.—The only specimen available to me.

The *xeneta* Group

Uncus as in the *janeirica* and *torqueor* groups. The aedeagus is gradually upcurved distally, ending with a downward directed apex. One species is assigned here.

Calycopis xeneta (Hewitson), new combination

FIGURES 8, 20*h*, 107, 108, 117, 118

Thecla xeneta Hewitson, 1877, Illustrations of diurnal Lepidoptera: Lycaenidae, vol. 1, p. 193; vol. 2, pl. 77, figs. (♂) 611, 612.

Thecla devia Möschler, Schaus [not Möschler, a misidentification], 1920, Ent. News, vol. 31, p. 176.

MALE (figs. 107, 108, 117, 118).—Both forewing and hindwing with outer margins more nearly straight than in the other species of the genus. Forewing more distinctly purplish blue than in any other species and this blue lighter and more brilliant in color. Hindwing with a very narrow black outer border. Wings underneath much darker, being a smoky brown and with red markings very faint or lacking and red color replaced by dark brown or black. I divide this species into two subspecies (see below).

Length of forewing 9–14 mm.

Male genitalia, as illustrated by figure 8, with aedeagus distinctly curved upward before apex and with apex directed downward; both saccus and harpe in lateral view very short but with saccus over one-half length of aedeagus; vinculum bent greatly to the rear; elements of uncus quite similar to *bactra* and *torqueor* in having lower margin short with lower distal angle small and with distal margin nearly straight; harpes in lateral view blunt at apices, in ventral view very broad near middle, being almost as broad as long; gnathos with a short ridgelike carina on inner surface well forward from distal end.

FEMALE.—Unknown in both subspecies described below.

DISTRIBUTION.—Guatemala south into Costa Rica and French Guiana, British Guiana, Brazil, Peru, and Paraguay.

Calycopis xeneta xeneta (Hewitson)

FIGURES 8, 20*h*, 107, 108

MALE (figs. 107, 108).—This subspecies differs from *C. xeneta devia* (see below) in having the ground color a pale gray on the undersurfaces, with a dark cloudlike spot in the central area of both forewing and hindwing and a pale area above and below vein 2dA on forewing.

Length of forewing 12–14 mm.

Male genitalia as described above in the description of the species.

TYPE-LOCALITY.—Department of Chontales, Nicaragua.

ADDITIONAL TYPE DATA.—Described from at least two males as Hewitson mentions Brazil and Nicaragua for the range of his *xeneta*. The male labeled type in the Hewitson collection in the British Museum (Natural History) is the specimen from Nicaragua. It bears the labels "BM Type No. Rh. 899," and genitalia preparation number "BM 1951–491." I designate this specimen as the lectotype of *xeneta*.

A second syntype from Brazil belongs to *C. xeneta devia*. A topotypic male specimen apparently from the type lot was dissected and compared with the lectotype by Mr. D. S. Fletcher and upon being found identical was sent to me for study. This specimen is the basis for my identification of *xeneta*.

Distribution.—Guaala south into Costa Rica.

Guatemala: Department of Izabal, Cayuga (May). Nicaragua: Department of Chontales. Costa Rica: Province of Limón, La Florida (500 ft., March), Guápiles (800 ft., May).

Material studied.—Fifteen males, including their genitalia.

Calycopis xeneta devia (Möschler)

Figures 117, 118

Thecla devia Möschler, 1883, Verh. Kais.-Königl. Zool.-bot. Ges. Wien, vol. 32, p. 311, pl. 17, fig. 7.

Male (figs. 117, 118).—This subspecies differs from *C. xeneta xeneta* as described above. Specimens from Peru have the ground color of wings below slightly paler than specimens from other areas and have red markings faintly indicated on hindwings. These specimens are not here considered distinct enough to warrant separation.

Length of forewing 9–13 mm.

Male genitalia, not illustrated, not differing at all from some specimens of *C. xeneta xeneta* and differing from other specimens of that subspecies in having lateral elements of uncus in dorsal view slightly more produced and farther apart, forming a wider dorsal notch.

Type-locality.—"Surinam."

Additional type data.—Described from a single male, the holotype, and according to the original description, in the collection of the "Museum Stuttgart." I have no additional information on the type specimen; however, the original figure, original description, and type-locality indicate that *devia* is the subspecies of *xeneta* here described.

Distribution.—The Guianas south and west through Brazil to Peru and Paraguay.

French Guiana: Colony of Guyane, Cayene, Penintential Territory, St. Jean (Maroni River). British Guiana: Province of Essequibo, Kamakusa (November). Brazil: State of Pará, Igarapé-Açu. Peru: Department of Loreto, Achinamiza (January). Paraguay: Villarica, Sapucai.

Material studied.—Twelve males, including their genitalia.

The *cecrops* Group

Uncus in lateral view undulate on ventral margin; aedeagus and harpes as in the *janeirica* group. Two species are assigned to this group.

Calycopis cecrops (Fabricius)

FIGURES 9, 20*i*, 61–70

Hesperia cecrops Fabricius, 1793, Entomologia systematica emendata et aucta . . . , vol. 3, pt. 1, p. 270.

Rusticus poeas Hübner, 1811, Sammlung exotisher Schmetterlinge, vol. 1, pl. (101), figs. 1–4.—Scudder, 1876, Bull. Buffalo Soc. Nat. Sci., vol. 3, p. 108.

Strymon beon (Cramer).—Hübner [not Cramer, a misidentification], 1816, Verzeichniss bekannter Schmettlinge [sic], p. 75.

Polyommatus cecrops (Fabricius).—Godart, 1819, *in* Latreille and Godart, vol 9 *in* Encyclopedie méthodique, p. 636.

Thecla poeas (Hübner).—Boisduval and LeConte, 1833, Histoire Générale et iconographie des Lepidoptères et des chenilles de l'Amérique Septentrionale, pp. 111, 112, pl. 25, figs. 1–4.—Morris, 1860, Catalogue of the described Lepidoptera of North America, p. 103; 1862, Synopsis of the described Lepidoptera of North America, p. 103.—Kirby, 1871, Synonymic catalogue of diurnal Lepidoptera, p. 395.—Edwards, 1877, Trans. American Ent. Soc., vol. 6, p. 41; 1884, Trans. American Ent. Soc., vol. 11, p. 298.—French, 1886, Butterflies of the eastern United States, pp. 270, 271.

Thecla cecrops (Fabricius).—Westwood, 1857, *in* Doubleday and Westwood, Genera of the diurnal Lepidoptera, vol. 2, p. 485.—Kirby, 1871, Synonymic catalogue of diurnal Lepidoptera, p. 386.—Strecker, 1878, Butterflies and moths of North America: Complete synonymical catalogue . . . , pp. 86, 87, 185.—Skinner, 1898, Synonymic catalogue of the North American Rhopalocera, p. 48.—Holland, 1898, Butterfly book, pp. 246, 247, pl. 29, fig. 18, pl. 30, fig. 7.—Draudt, *in* Seitz, 1920, Die Gross-Schmetterlinge der Erde, vol. 5, p. 795, pl. 158, figs. b–1, b–2.—Holland, 1931, Butterfly book, rev., p. 239, pl. 30, fig. 7, pl. 29, fig. 18.

Tmolus cecrops (Fabricius).—Butler, 1869, Catalogue of diurnal Lepidoptera described by Fabricius in the collection of the British Museum, p. 189.

Thecla beon (Cramer).—Kirby [not Cramer, as a synonym of *T. cecrops*], 1871, Synonymic catalogue of diurnal Lepidoptera, p. 395.—Godman and Salvin [not Cramer], 1887, Biologia Centrali-Americana, Lepidoptera-Rhopalocera, vol. 2, p. 74.

Calycopis cecrops (Fabricius).—Scudder, 1876, Bull. Buffalo Soc. Nat. Sci., vol. 3, p. 108; 1889, Butterflies of the eastern United States and Canada with special reference to New England, vol. 3, pp. 1821, 1823.—Dyar, 1903, Bull. U.S. Nat. Mus., vol. 52, p. 38.—Comstock, J. H., and Comstock, A. B., 1917, How to know the butterflies, p. 231, pl. 34, figs. 10–12 [10=♀ not ♂, 11, 12=♂].—Field, 1940, Bull. Univ. Kansas, Biol. Ser., vol. 39, no. 10, p. 142; 1940, Bull. Brooklyn Ent. Soc., vol. 35, no. 4, pp. 134, 135; 1941, Journ. Kansas Ent. Soc., vol. 14, no. 2, pp. 66–68.—Clench, *in* Ehrlich, P. R., and A. H. Ehrlich, 1961, How to know the butterflies, p. 199.

Calycopis beon (Cramer).—Scudder [not Cramer, as a synonym of *C. cecrops*], 1876, Bull. Buffalo Soc. Nat. Sci., vol. 3, p. 108.

Thecla hugon (Godart).—Godman and Salvin [not Godart, a misidentification], 1887, Biologia Centrali-Americana, Lepidoptera-Rhopalocera, vol. 2, p. 75.

Strymon cecrops (Fabricius.—Barnes and McDunnough, 1917, Check list of the Lepidoptera of Boreal America, p. 14.—Barnes and Benjamin, 1926, Bull. So. California Acad. Sci., vol. 25, pt. 1, p. 17.—Clark, A. H., 1932, U.S. Nat. Mus. Bull. 157, p. 249, pl. 23, figs. 3, 4.—McDunnough, 1938, Check list of the Lepidoptera of Canada and the United States of America, 1: Macrolepidoptera, p. 24.—Hessel, 1948, Journ. New York Ent. Soc., vol. 56, pp. 243–244.—Rawson and Hessel, 1951, Bull. Brooklyn Ent. Soc., vol. 46, pp. 79–84, 5 figs. [of eggs, larvae, pupae].—Klots, 1951, Field guide to butterflies of North America east of the Great Plains, pp. 133, 144, plate 15 fig. 12.—Clark, A. H., and L. F. Clark, 1951, Smithsonian Misc. Coll., vol. 116, no. 7, pp. 78, 79, pl. 12 h.—dos Passos, 1964, Synonymic list of Nearctic Rhopalocera, p. 56.

Strymon cecrops ab. *gottschalki* Clark, A. H., and Clark, L. F., 1938, Proc. Biol. Soc. Washington, vol. 51, p. 3 (new synonymy); 1951, Smithsonian Misc. Coll., vol. 116, no. 7, p. 78, frontispiece fig. 7.

Male (figs. 61–64 [summer form], 67, 68 [spring form]).—Wings above usually entirely dark brown, sometimes with a small suffusion of blue in interspace Cu_1 and Cu_2 on hindwing; a pale submarginal bluish-white line below vein Cu_2 on hindwing, this line sometimes extending above through part of interspace Cu_1; anal lobe with a few red scales and a minute white bar at indentation above this lobe on abdominal margin. Wings below drab or hairbrown in color with markings similar to the other species of *Calycopis*; base of costal margin of forewing orange red, and with two parallel bars slightly darker than ground color crossing the end of each discoidal cell, these bars frequently red in color, and with area between these bars dirty white. *C. cecrops* differs from the other species, particularly in having the orange red along inner side of postmedian band much broader on the under surfaces of hindwing; in having the black pupillated submarginal spots in interspaces M_3 and Cu_1 gray, only rarely orange red; in having the lunule adjacent to outerside of W-shaped portion of postmedian band usually dark brownish gray, only rarely red or with a slight red suffusion and in having a larger black spot on the anal lobe.

Length of forewing 11–15 mm.

Male genitalia, as illustrated by figure 9, with distal margin of lateral lobe of uncus convex and with lower margin of lobe undulate, convex near base and concave before lower distal angle. Eighth tergite (figure 20*i*) very similar to that of *janeirica* and with posterior concavity slightly broader than in *isobeon*.

Female (figs. 65, 66, 69 [spring form], 70 [summer form]).—Wings above sometimes entirely like the male but usually differing in having a great deal of blue over disc of hindwing. Wings below quite like those of the male.

Length of forewing 11–14 mm.

Female genitalia, not illustrated, and not different from *C. susanna*, and as in that species having the posterior ostium bursae lobes either rounded or armed with two spines.

Variation.—Spring specimens of both sexes differ from summer specimens in having more blue on the wings above with smaller fuscous submarginal spots on the hindwing. On the undersurfaces the ground color in spring specimens is frequently darker and the black pupillated marginal lunules of the hindwing usually contain orange or red scales. One aberration has been described and named and is placed in the synonymy (ab. *gottschalki* Clark) as it is only an individual variant differing in having all red of undersurfaces replaced by yellow.

Type-localities.—The type-localities for *cecrops* and *poeas* are unknown, although they undoubtedly are both from one of the states along the eastern coast of the United States between Virginia and Georgia, and probably the latter. Fabricius states that *cecrops* is found "in Indiis"; however, this is entirely false. The type-locality for the synonym *gottschalki* is Fort Lewis Mt., Roanoke Co., Virginia.

Location of types.—I have been unable to locate either the types of *cecrops* or of *poeas*. The holotype of *C. cecrops* ab. *gottschalki* is in the United States National Museum, type 52256.

Distribution.—Eastern United States from Long Island south to Florida and west to Kansas and Texas.

New York: Long Island, East Marion (August). New Jersey: Cape May Co., Reeds Beach (August, September); Monmouth Co., Manasquan (June). Maryland: St. Mary Co., Pt. Lookout (August); Prince George Co., Beltsville (May). Virginia: Norfolk Co., Dismal Swamp (April); Nansemond Co., Suffolk (October); Princess Anne Co., Virginia Beach; Roanoke Co., Salem (April); Montgomery Co. (May); Bedford Co., Apple Orchard Mt. (4,000 ft.), Mons; Nelson Co.; Accomac Co., Dahl Swamp (July); King and Queen Co., Aylett (July); Highland Co., Buckeye (July). North Carolina: Henderson Co., Tucedo (August); Buncombe Co., Asheville (August); Bertie Co., Windsor (May, August). South Carolina: Charleston Co., Charleston (September); Clarendon Co. (September). Georgia: Okefenokee Swamp (July); White Co., Yonah Mt. Florida: Dade Co., Miami (March, May, June, July); Broward Co., Hollywood (March); Lee Co., Ft. Myers (April); Palm Beach Co., Palm Beach; Polk Co., Ft. Meade; Pasco Co., Dade City, Hudson (July); Seminole Co., Sanford; Valusia Co., De Land (August), Glenwood; Levy Co., Cedar Keys (July); Colombia Co., Lake City. West Virginia: Kanawha Co., Charleston (May). Tennessee: (no specific locality). Missouri: Barry Co., Roaring River (August). Kansas: Crawford Co. Arkansas: Carroll Co. (August, September). Louisiana: Caddo Co., Caddo Park (August). Texas: Bowie Co., Maud (June); Dallas Co., Dallas (August, September); Cameron Co., Brownsville, Esperanza Ranch.

Material studied.—Fifty-five males and 49 females, including the genitalia of 14 males and 14 females.

Calycopis isobeon (Butler and Druce), new combination

Figures 20*j*, 71–78

Tmolus isobeon Butler and Druce, 1872, Cistula entomologica, vol. 1, p. 108.—Butler, 1873, Lepidoptera exotica, p. 161, pl. 57, fig. 2.

Thecla beon (Cramer).—Godman and Salvin [not Cramer, a misidentification], 1887, Biologia Centrali-Americana, Lepidoptera-Rhopalocera, vol. 2, p. 75; ibid., vol. 3, pl. 57, figs. 4–6.—Draudt, 1920, *in* Seitz, Die Gross-Schmetterlinge der Erde, vol. 5, p. 795, pl. 158, figs. b3, b4.

Calycopis beon (Cramer).—Field [not Cramer, a misidentification], 1940, Bull. Univ. Kansas, Biol. Ser., vol. 39, no. 10, pp. 142–143; 1940, Bull. Brooklyn Ent. Soc., vol. 35, no. 4, pp. 134–135; 1941, Journ. Kansas Ent. Soc., vol. 14, no. 2, pp. 66, 68–69.—Clench, *in* Ehrlich, P.B., and Ehrlich, A. H., 1961, How to know the butterflies, p. 199.

Strymon beon (Cramer).—Klots [not Cramer, a misidentification], 1951, Field guide to butterflies of North America east of the Great Plains, p. 134.—dos Passos, 1964, Synonymic list of the Nearctic Rhopalocera, p. 56.

Male (figs. 71–74).—Ground color of wings above dark brown, sometimes dark metallic blue; differing from the summer form of *C. cecrops* on the hindwing in having a considerable amount of blue in lower half of wing below cell, occasionally with some blue in the cell and thus similar to the spring form of *cecrops*. On the undersurfaces it differs from both forms of *cecrops* by having the postmedian tricolored band of the hindwing very much narrower at its broadest point, being less than a millimeter in width and becoming even more narrow toward the costal margin; in the forewing the red element of this band is no wider than the black and white elements; on this surface of the hindwing the middle section of the W-shaped mark is more sharply angled than in *cecrops;* the black spot on anal lobe is smaller than in *cecrops* and the red above this spot is more distinct; the lunule adjacent to the W-shaped mark is always red in *isobeon* not dark gray as in *cecrops*, and the black pupillated submarginal spots in interspaces M_3 and Cu_1 are usually orange red (only rarely gray) with smaller black pupils.

Length of forewing 10–14 mm.

Male genitalia, not illustrated, hardly differing from *cecrops*, except for a slightly shorter aedeagus. In *isobeon* the average length of the aedeagus is 3.24 mm. with the extremes of 2.33 and 3.75 mm., while in *cecrops* this average is 3.75 mm. with the extremes of 3.50 and 4 mm. In *isobeon* the aedeagus becomes progressively shorter toward the southern limit of its distribution so that in Texas the average length is 3.37 mm., in Mexico 3.19 mm., in Costa Rica 3 mm. and in Panama 2.66 mm. Eighth tergite (fig. 20*j*) with posterior concavity usually more narrow than in *cecrops*.

Female (figs. 75–78).—Differing from the male in having more blue on wings above, the blue extending through discal cell of hindwing and on base of forewing. On the undersurfaces it differs from *cecrops* females in the same way that the males differ from that species.

Length of forewing 10–13 mm.

Female genitalia, not illustrated, not different from either *cecrops* or *susanna*

Type-locality.—"Cartago, Costa Rica."

Additional type data.—Originally described from both sexes, and although the number of specimens was not stated, only two specimens in the collection of the British Museum (Natural History) can be positively identified as belonging to the original series. The male labeled BM type no. Rh. 913 with the abdomen lacking is hereby designated the lectotype. Mr. D. S. Fletcher of that institution kindly compared it with a male from Irazú, Costa Rica (near the type locality) and this male is the basis for the identification of *C. isobeon* in the present work. The female type was dissected and studied by Mr. Fletcher and is the female of quite another species not belonging in the genus *Calycopis*.

Distribution.—Texas south through Mexico and Central America into Panama.

United States: texas: Bowie Co., Maud; Dallas Co., Dallas (September); McLennon Co., Waco (March), Kerr Co., Kerrville; Uvalde Co., Concan; Neuces Co., (March); Guadalupe Co., Sequin; Bexar Co., San Antonio (March, April, June); Hidalgo Co., Donna (October), Progresso; Cameron Co., Brownsville (May, June, July, October), San Benito (May, June July), Esperanza Ranch. Mexico: State of Nuevo Leon, Monterey (April, 1800 ft.); State of San Luis Potosi, Huichihuáyan (September), Tamazunchale (April); State of Vera Cruz, Jalapa, Presidio, Vera Cruz (June), Cordoba, Orizaba (June, 2000 ft.), Portin (June, 1600 ft.), Ojo de Agua (1600 ft.), Coatepec (May); State of Oaxaca, San Geronimo (June). Guatemala: Department of Retalhuleu, San Sebastian; Department of Guatemala, Guatemala City (October); Department of Zacapa, Zacapa (October). Costa Rica: Province of Cartago, Cartago (5000 ft.), Volcán Irazú (6–7000 ft.). Panama: Province of Chiriqui, El Volcán Chiriqui (February).

Material studied.—Sixty-four males and 51 females including the genitalia of 32 males and 29 females.

The *partunda* Group

Uncus in lateral view with lower angle greatly produced and with ventral margin greater than, equaling, or nearly equaling length of distal margin. Aedeagus fairly straight, ending distally in a straight or upward projected point. One species (*C. vibulena*), with genitalia characters somewhat resembling *C. torqueor* (see the *torqueor* group), has the aedeagus sharply curved to the right (in dorsal view) but with the distal end of aedeagus not bifurcate and also with an uncus typical of the *partunda* group.

***Calycopis susanna*, new species**

Figures 10, 20*k*, 21*e–g*, 27, 83-90

Male (figs. 83–86).—Wings above indistinguishable from *C. isobeon*. Undersurfaces of wings of some specimens indistinguishable from *C. isobeon* but usually with red of tricolored postmedian band on forewing a little less distinct. Specimens found in the northern part of the range (Mexico to Costa Rica) tend to have a second submarginal black pupillated red spot on the hindwing below; however, this also occurs in some southern specimens.

Length of forewing 11–14 mm.

Male genitalia, as illustrated by figure 10, with upper distal angle of lateral lobe of uncus rounded, lower distal angle also rounded and somewhat produced (often greatly so), causing distal margin to be concave. Variation in the unci of a single species is unusual in *Calycopis* and at first two species were thought to be represented here. One showing a greatly extended lower distal angle (fig. 21*f*) is particularly common in Costa Rica but also occurs in Mexico, Guatemala, Honduras, British Honduras and Panama. The other with this angle not greatly extended (fig. 21*e*) is also common in Costa Rica and is found as well in Mexico, Honduras and French Guiana. Intermediates (fig. 10) have not been found in the northern part of its range but do occur in the Canal Zone, Panama, Colombia and Venezuela. Because of the presence of intermediates and because of the fact that there is no correlation between these differences in the unci and the slight habitus differences reported above, I treat these forms as variations of a single species. Eighth tergite (fig. 20*k*) with posterior concavity more narrow and deeper than in *C. isobeon.*

Female (figs. 87–90).—Not distinguishable from females of *isobeon.* This sex can be identified only by association with males.

Length of forewing 9–13 mm.

Female genitalia, as illustrated by figures 27*a–d*, very variable and not differing from *isobeon* or *cecrops.*

Type-locality.—Territory of Guyane, Cayenne, French Guina.

Additional type data.—Described from the holotype, male (locality as given above; USNM type 34899; William Schaus Collection; male genitalia preparation WDF 2712, 1948), allotype, female (same data as the holotype; female genitalia preparation WDF 2707, 1948) and from five male and two female paratypes from Cayenne and from Maroni River, French Guiana. Note: Many additional specimens of both sexes were studied but not included in the paratype series because of the variation in the genitalia. The association of the allotype and two female paratypes with the French Guiana males is thought to be accurate because *isobeon* is not known to occur in French Guiana.

Location of types: Holotype, allotype, three male and one female paratypes in the United States National Museum. One male paratype and one female paratype in the British Museum (Natural History). One male paratype in the American Museum of Natural History.

Distribution.—Mexico south through Central America to Ecuador, Colombia, Venezuela, and French Guiana.

Mexico: State of San Luis Potosi, El Bonito (June), El Pujol (July); State of Vera Cruz, Jalapa, Santa Rosa (April), Presidio (April, June); State of Nayarit, Compostela (October); State of Colima, Colima (February, March, April, December); State of Yucatan. GUATEMALA: Department of Retalhuleu, San Sebastian. BRITISH HONDURAS: District of Toledo, Rio Grande (June). HONDURAS: Department of Atlántida, La Ceiba (November). COSTA RICA: Province of Limón, La Florida (May), Guápiles (March), Puerto Limón (January, May), Santa Clara; Province of Cartago, Turrialba (May), Tuis; Province of San Jose, El Rodeo (June). CANAL ZONE: Ancon (June, August), Empire (September), Balboa (May, July), Barro Colorado Island (January), La Cruces Trail near Corozal (June), Corozal (February), La Boca (January), Culebra (December). COLOMBIA: Department of Cundinamarca, Bogotá; Department of Caldas; Department of Valle del Cauca, Cali District (February, 3260 ft.), Hormiguero (January, 3260 ft.). ECUADOR: Province of Bolivar, Balzapamba (700 meters, June). VENEZUELA: State of Carabobo, Puerto Cabello (April), San Esteban (September); State of Yaracuy, Aroa. FRENCH GUIANA: Territory of Guyane, Cayenne; Territory of L'Inini, 60 miles up Maroni River. Note: One specimen labeled "Ponce, Porto Rico" is probably mislabeled, as no member of *Calycopis* is known from the West Indies.

MATERIAL STUDIED.—One hundred five males and 98 females, including their genitalia.

Calycopis drusilla, new species

FIGURES 11, 20*l*, 28, 81, 82, 91, 92

MALE (figs. 81–82).—Wings above most similar to *C. janeirica* with forewing darker and with a dull metallic bluish-purple iridescence over base and remainder of wing except along outer margin. Hindwing above with bluish purple more brilliant and with outer border not or seldom breaking up into individual black spots below vein Cu_1. Wings underneath similar to *janeirica* but hindwing always with two (instead of one) submarginal black pupillated lunular-shaped red spots, one below vein Cu_1 and the second, smaller, adjacent to this and below vein M_3.

Length of forewing 13–14 mm.

Male genitalia, as illustrated by figure 11, with saccus extremely long, longer than harpes, and with foreward bend in vinculum extremely elevated, lateral lobe of uncus with distal margin concave, lower margin convex in the middle and with upper distal angle greatly produced; inner surface of gnathos arm with carina long and ridgelike. Eighth tergite (fig. 20*l*) with posterior concavity very shallow and broad.

FEMALE (figs. 91, 92).—Wings above dark brown with blue ray on hind margin of forewing and with hindwing blue in the cell and below vein M_3, the blue similar to *caulonia* in its placement but more brilliant in tone being nearly as much so as in *drusilla* males. Wings below quite like those of the male.

Length of forewing 11–12.5 mm.

Female genitalia, as illustrated by figure 28, with combined length of ductus bursae and bursa copulatrix less than 3½ times the width of ostium bursae; posterior ostium bursae lobes rounded, without spurs.

TYPE-LOCALITY.—Province of Limón, La Florida, Costa Rica.

ADDITIONAL TYPE DATA.—Described from the holotype, male (locality as given above, elevation 500 feet; March; Collection William Schaus; USNM type 34900; male genitalia preparation WDF 2731, 1948), allotype, female (Cabima, Panama; May; August Busck, female genitalia preparation WDF 2820, 1948) and from five male and six female paratypes from various localities in Costa Rica, Mexico, and the Panama Canal Zone.

LOCATION OF TYPES.—Holotype, allotype and three male paratypes in the United States National Museum, two male and six female paratypes in the American Museum of Natural History, New York City.

DISTRIBUTION.—Mexico south through Central America into the Panama Canal Zone.

MEXICO: State of Vera Cruz, Santa Rosa (August), Misantla (June, September); State of Durango, Presidio (April). COSTA RICA: Province of Limón, La Florida (500 feet, March); Guápiles (December). CANAL ZONE: Barro Colorado Island (March), Ancon Hill (February), Empire (June), Cabima (May).

MATERIAL STUDIED.—Six males and seven females, including their genitalia.

Calycopis vibulena (Hewitson), new combination

FIGURES 12, 20*m*, 93, 94

Thecla vibulena Hewitson, 1877, Illustrations of diurnal Lepidoptera: Lycaenidae, vol. 1, p. 190; vol. 2, pl. 76, figs. (♂) 601, 603.

MALE (figs. 93, 94).—Similar to *C. drusilla* with entire forewing, except for a narrow black border, dull and dark metallic bluish purple and with hindwing having costal and outer borders very dark and wider than in *C. drusilla*. In *C. vibulena* the brilliant bluish purple is restricted to a smaller area in base of wing. Hindwings underneath darker smoky brown than in *C. drusilla* and lacking the red along innerside of postmedian band, lunule adjacent to outerside of W-shaped portion of postmedian band in interspace Cu_2, fuscous not red in color but sometimes with a few scattered red scales. A second submarginal, black pupillated, lunular-shaped red spot absent or sometimes barely indicated by a little red in interspace M_3; this red never with a distinct black pupil.

Length of forewing 11–13 mm.

Male genitalia, as illustrated by figure 12, with aedeagus in dorsal view sharply bent to the right at distal end; with saccus short, much shorter than harpe; with foreward bend of vinculum lower than in *drusilla.* Lateral lobe of uncus with distal margin slightly concave and lower margin slightly concave near base; with upper and lower distal angles not greatly produced, lower angle less produced than in *drusilla* and *vitruvia;* inner surface of gnathos with pointed carina. Eighth tergite (fig. 20*m*) similar to *drusilla,* somewhat more cordate in shape.

Female.—Unknown.

Type-locality.—Belém ("Pará"), State of Pará, Brazil.

Additional type data.—This was described from both sexes from "Brazil, the Amazon (Pará), and New Granada" and the total number of specimens in the series was not stated in the original description. According to Mr. D. S. Fletcher of the British Museum (Natural History) "there are eight specimens from Hewitson's original series in the collection" (in litt.). A study of these specimens reveals that there are three or possibly four species in addition to *vibulena* in this series. Two males are *partunda,* one male and two females are *janeirica,* one male is *lerbela* and the male with missing abdomen is probably *susanna.* Only one of these *vibulena* specimens was given a type number and I designate this specimen the lectotype. It is labeled "Para, Brazil" and "BM Type No. Rh. 912." Mr. Fletcher dissected this lectotype and compared with it a topotype which was then lent to me. This compared topotype is the basis for the identification of *C. vibulena* in this paper and is the one illustrated (figs. 12, 20*m*, 93, 94).

Remarks.—Three of the five figures included by Hewitson in his original description (1877) are of species other than *vibulena* as follows: figure 599 is of a male *C. janeirica,* figure 600 is of a male *C. lerbela* and figure 602 is of a female, probably *C. janeirica* although it looks more like female *susanna.*

Distribution.—Known only from the State of Pará in Brazil.

Brazil: State of Pará, Belém, Igarapé-Açu.

Material studied.—Five males, including their genitalia.

Calycopis vitruvia (Hewitson), new combination

Figures 13, 20*n*, 29, 109, 110, 119, 120

Thecla vitruvia Hewitson, 1877, Illustrations of diurnal Lepidoptera: Lycaenidae, vol. 1, p. 193; vol. 2, pl. 77, fig. (♂) 613 (two figures).
Thecla fortuna Druce, 1907, Proc. Zool. Soc. London, 1907, p. 608.

Male (figs. 109, 110).—Wings above dull metallic bluish purple in color, similar to those of *C. vibulena,* with the dark borders on costal and outer margins more narrow, with brilliant blue color of forewing extending over base, below the cell and vein Cu_2 and with a streak of blue in lower half of the cell. Wings below similar to *vibulena*, not as dark brown in ground color and with red along inner side of postmedian band absent as in that species but with the lunular marking adjacent to outer side of W-shaped portion of postmedian band in interspace Cu_2 dark red with very little fuscous.

Length of forewing 11.5–12 mm.

Male genitalia, as illustrated by figure 13, with aedeagus nearly straight, slightly upturned at distal end; saccus not as long as harpe; foreward bend of vinculum below middle; lateral lobe of uncus with distal margin nearly straight, only slightly convex and shortened, being about same length as lower margin and forming nearly a right angle with lower margin, which is slightly concave; inner surface of gnathos arm with carina pointed and much nearer distal end than in *vibulena*. Eighth tergite (fig. 20*n*) with posterior margin undulate with a very shallow posterior concavity.

Female (figs. 119, 120).—Wings above similar to male, the blue color almost as brilliant and restricted in hindwing to the base, the cell, and area below vein M_3; the blue in the forewing, as in the male, covering base of wing below cell and vein Cu_2 with a few scattered blue scales in lower half of cell and in interspace Cu_1 near cell; hindwing with a submarginal white to bluish-white line below vein M_3 (this line absent in the male); dark border broken into three individual spots below vein M_3. Wings beneath similar to male with red markings larger.

Length of forewing 12 mm.

Female genitalia, as illustrated by figure 29, with combined length of ductus bursae and bursa copulatrix five times the width of ostium bursae, the posterior ostium bursae lobes forming spurs that are closer to one another than in *C. fractunda;* ductus seminalis from near middle of combined ductus bursae and bursa copulatrix.

Type-localities.—For *vitruvia*: Belém ("Pará"), State of Pará, Brazil. For *fortuna:* "Yurimaguas," Department of Loreta, Peru.

Additional type data.—*Vitruvia* was apparently originally described from a single male, the holotype (locality as given above; Hewitson Collection; British Museum (Natural History) type No. Rh. 900; genitalia preparation number NHB 1951 484.) *Fortuna* was apparently described from at least two male specimens as the localities given in the original description are "Yurimaguas, Peru" and "Topajos, Amazona." The specimen from Peru bears a type label and the British Museum (Natural History) type number Rh. 902. I designate this specimen the lectotype.

Note on synonymy.—Mr. D. S. Fletcher dissected and compared the types of both *vitruvia* and of *fortuna* and found the latter to be a synonym. A third specimen compared with these types and found to be identical was sent to me for study. This is the specimen illustrated in figures 13, 20*n*, 109, 110.

Distribution.—Brazil and Peru.

Brazil: State of Pará, Belém, (Pará). Peru: Department of Loreto, Yurimaguas, Iquitos, Department ?, Achinamiza.

Material studied.—Two males and one female, including their genitalia.

Calycopis bellera (Hewitson), new combination

Figures 14, 20*o*, 30, 79, 80, 95, 96

Thecla bellera Hewitson, 1877, Illustrations of diurnal Lepidoptera: Lycaenidae, vol. 1, p. 194; vol. 2, pl. 77, fig. (♀) 618.

Thecla origo Godman and Salvin, 1887, Biologia Centrali-Americana, vol. 37 Lepidoptera-Rhopalocera, vol. 2, p. 73; ibid., vol. 3, pl. 56, figs. 32, 33.

Male (figs. 95, 96).—Wings above most similar to *drusilla*, differing by the broader outer margin above vein Cu_1 which gradually broadens toward costa. Wings below most similar to *vibulena* but with a small amount of red along inner side of postmedian band on hindwing.

Length of forewing 13.5 mm.

Male genitalia, as illustrated by figure 14, with aedeagus bent downward at base and slightly and gradually upturned distally; saccus relatively short, much shorter than harpe; foreward bend of vinculum prominent and low (much below middle); lateral lobe of uncus with distal margin strongly concave, lower distal angle as prominent as upper distal angle, lower margin slightly undulate; inner surface of gnathos arm with carina ridgelike and pointed; harpe in lateral view broad at base, gradually tapering and suddenly expanding before apex and spatula-like in shape; harpes, in ventral view, with apices widely separated. Eighth tergite (fig. 20*o*) not cordate in shape with posterior concavity broad and deep.

Female (figs. 79, 80).—Wings above darker than the females of most other species in the genus, the forewing, except outer border, dull metallic blue and hind margin below vein 2dA, brilliant blue; hindwing with base of wing, cell, and area below vein M_3 of same brilliant blue; a blue submarginal line between vein M_3 and the black anal lobe, and immediately inward from this line a series of three black lunular-shaped marks. Wings below similar to those of male, with ground color slightly paler brown or gray brown; hindwing with red along inner side of postmedian band more distinct and red markings in lower half of wing slightly larger.

Length of forewing 10–12.5 mm.

Female genitalia, is illustrated by figure 30, with combined length of ductus bursae and bursa copulatrix slightly over four times the width of ostium bursae and with lobes posterior to ostium bursae only slightly pointed; ductus seminalis distinctly beyond middle of combined length of ductus bursae and bursa copulatrix.

Type-locality.—For *bellera:* "The Amazon." For *origo:* Belém ("Pará"), State of Pará, Brazil.

Additional type data.—*C. bellera* was described from both sexes although the number of specimens was not stated. I designate as the lectotype, the female specimen which is labeled type number Rh. 914 in the collection of the British Museum (Natural History). The male is apparently lost. *C. origo* was evidently described from at least three male specimens since the localities given in the original description are Chiriqui, Panama, Panama City, and the "Amazons Valley." The specimen labeled "Amazon, Para," is the one that bears a red type label and the British Museum type number Rh. 909. I designate this specimen the lectotype. A topotype compared by Mr. D. S. Fletcher with the lectotype of *origo* and found to be a perfect match in both maculation and color as well as the genitalia is the basis both for identification and for synonymizing with *C. bellera.* This is the male illustrated in figures 14, 20*o*, 95, 96.

Distribution.—Brazil and Bolivia.

Brazil: State of Pará, Belém (Pará). State ?: "Amazon." Bolivia: Department ?, Guanay (1300 ft., April).

Material studied.—One male and two females, including their genitalia.

Calycopis partunda (Hewitson), new combination

Figures 15, 21*a*, 31, 97, 98

Thecla partunda Hewitson, 1877, Illustrations of diurnal Lepidoptera: Lycaenidae, vol. 1, p. 206; vol. 2, pl. 82, figs. (♂) 685, 686.

Male (figs. 97, 98).—Forewings above similar to those of *bellera* in the ground color with a decidedly dull metallic purplish sheen; differing from *bellera* in having a small ray of bright purplish blue in base of forewing below 2dA and in having the dark border of hindwing very wide throughout and thus restricting more to the base the bright purplish blue; wings below as in *vitruvia* entirely lacking the red usually found along inner side of postmedian band. The two syntypes of *C. partunda* were compared by Mr. D. S. Fletcher of the staff of the British Museum (Natural History) with Hewitson's figure of the undersurface (fig. 686). Mr. Fletcher reports that "the area between the elements of the postmedian arch below vein Cu_1 should be rusty red in this figure" (in litt.).

Length of forewing 13 mm.

Male genitalia, as illustrated by figure 15, with aedeagus nearly straight; saccus shorter than harpe; dorsal margin of tegumen (in lateral view) terminating abruptly; lateral lobe of uncus with lower and distal margins concave, upper distal angle produced, lower distal angle rounded; inner surface of gnathos arm without carina; harpe in lateral view with apex blunt; harpes in ventral view with apices not widely separated. Eighth tergite (fig. 21*a*) cordate in shape and similar to that of *torqueor* except for the posterior concavity being more like that of *drusilla.*

Female.—Not illustrated. Similar to *bellera* on both surfaces of wings, differing only in having the ground color a slightly darker blue above and darker gray below.

Length of forewing 11.5 mm.

Female genitalia, as illustrated by figure 31, with combined length of ductus bursae and bursa copulatrix between three and three and one-half times width of ostium bursae; posterior ostium bursae lobes rounded, and thus very similar to *drusilla,* but with these lobes more flat than in that species. Ductus seminalis from near middle of combined ductus bursae and bursa copulatrix.

Type locality.—"The Amazon."

Additional type data.—*Partunda* was described from two males from Bolivia and the Amazon in the collection of W. C. Hewitson now in the British Museum (Natural History). I designate the male specimen bearing the type label number Rh. 910 as the lectotype. This is the specimen from the Amazon. Mr. D. S. Fletcher, who reports that this specimen lacks its abdomen, has kindly compared with it a specimen labeled "Amazonas" which he found to be identical. This compared specimen is the basis for the identification of the name *C. partunda* in this paper and is the male illustrated in figures 15, 21 A, 95, 96.

Distribution.—French Guiana, Brazil and Bolivia.

French Guiana: Territory of Guyane, Cayenne. Brazil: State ?, the Amazon; State of Pará, Pará; State of Paraiba, João Pessoa (June). Bolivia: no specific locality.

Material studied.—Four males and one female, including their genitalia.

Calycopis amplia (Hewitson), new combination

Figures 32, 121, 122

Thecla amplia Hewitson, 1877, Illustrations of diurnal Lepidoptera: Lycaenidae vol. 1, pl. 195; vol. 2, pl. 77, figs. (♀) 621, 622.—Godman and Salvin, 1887 Biologia Centrali-Americana, Lepidoptera-Rhopalocera, vol. 2, p. 75; ibid., vol. 3, pl. 57, figs. [female not male] 7, 8.

Male.—Unknown.

Female (figs. 121, 122).—Wings above most similar to those of *bellera* and *indigo,* but with less blue on hindwing than in *bellera* and with this color indistinct and confined entirely to area near base; wings below differing from all of its known relatives in having a crescent-shaped bar below vein Cu_2 on forewing placed inward from postmedian line; otherwise similar to *indigo* except that the light markings are orange not red and with orange lunule adjacent to postmedian line in interspace Cu_2 much obscured with fuscous; in addition to the submarginal black pupillated orange lunule in interspace Cu_1 there is a similar but smaller lunule in interspace M_3 and sometimes a trace of a third one in interspace M_2.

Length of forewing 10.5–11 mm.

Female genitalia, as illustrated by figure 32, with combined length of ductus bursae and bursa copulatrix much the shortest of any species in the genus, being more than two and one-half and just under three times the width of ostium bursae; bursa copulatrix shorter than ductus bursae plus ostium bursae lobes; teeth on posterior ostium bursae lobes very short.

Type-locality.—"Nicaragua (Chontales)."

Additional type data.—Described from a single female, the holotype (locality as given above, Hewitson Collection, British Museum (National History) type No. Rh. 917). The abdomen being missing from this type, Mr. D.S. Fletcher compared two topotypes (including one figured by Godman and Salvin in the "Biologia") and four other specimens with the holotype. Finding these specimens to be conspecific with *amplia* they were loaned to me and are the basis for the identification of that name in this paper.

Distribution.—Nicaragua, Costa Rica, Columbia and Ecuador.

Nicaragua: Department of Chontales. Costa Rica: Province of Limón, Guápiles (March, July). Columbia: State of Cundinamarca, Cananche (September). Ecuador: Province ?, Paramba (April).

Material studied.—Six males including their genitalia.

Calycopis indigo (Druce), new combination

Figures 16, 21*b*, 33, 105, 106, 123, 124

Thecla indigo Druce, 1907, Proc. Zool. Soc. London, 1907, pp. 608, 609.

Male (figs. 105, 106).—Wings above quite similar to those of *partunda* in having a much narrower border on hindwing than in most species and in having a longer ray of brilliant blue below 2dA of forewing. Wings below hardly distinguishable from *partunda* differing only in having a smaller submarginal black pupillated lunule below vein Cu_1 on hindwing.

Length of forewing 12 mm.

Male genitalia, as illustrated by figure 16, with aedeagus nearly straight, the base slightly bent downward; saccus nearly as long as harpes; lateral element of uncus with distal margin concave just before upper distal angle, which is greatly produced in lateral view, almost spurlike, and with lower margin nearly straight, or only slightly concave; lower distal angle of uncus only slightly rounded; arm of gnathos with a small ridgelike carina on inner surface; apices of harpes in lateral view slightly pointed and in ventral view close together. Eighth tergite (fig. 21*b*) most like *C. bactra* in shape with posterior concavity very shallow.

Female (figs. 123, 124).—Wings above dark brown with a slight dull purplish-blue sheen in base of hindwing. Wings below like the male except that the ground color is lighter.

Length of forewing 12 mm.

Female genitalia, as illustrated by figure 33, with combined length of ductus bursae and bursa copulatrix less than two and one-half times the width of ostium bursae and with a pair of prominent spurlike teeth on posterior ostium bursae lobes; ductus seminalis near middle of combined ductus bursae and bursa copulatrix.

Type-locality.—"Chapada Campo,"=Plain near Serra da Chapada, "Brazil."

Additional type data.—Originally described from a single male, the holotype (locality as given above; H. H. Smith; British Museum (Natural History) type No. Rh. 901; genitalia preparation number NHB 1951–485). This holotype was compared by Mr. D. S. Fletcher with a specimen from Mato Grosso, Brazil and found to be conspecific. This compared specimen is the basis for the identification of the name *indigo* in this paper and is the one illustrated in figures 16, 21*b*, 105, and 106.

Distribution.—Brazil and Argentina.

Brazil: State of Mato Grosso, Serra da Chapada (January); State ?, Amazon· Argentina: Territory of Misiones, Puerto Aquirre.

Material studied.—Two males and two females, including their genitalia.

Calycopis anfracta (Druce), new combination

Figures 17, 21*c* 53, 54, 101, 102

Thecla anfracta Druce, 1907, Proc. Zool. Soc. London, 1907, p. 609.

Male (figs. 101, 102).—Wings above with dark border slightly broader than in *indigo* but not nearly as broad as in *C. partunda*. Forewing with ground color having more of a purplish-blue sheen, sometimes with a greenish overcast and with brilliant blue ray below vein 2dA shorter, confined to base. Wings beneath similar to those of *C. indigo*, differing only in the red markings on hindwing being more distinctly red.

Length of forewing 12.5–13 mm.

Male genitalia, as illustrated by figure 17, with aedeagus nearly straight and with base less downward bent than in *indigo;* saccus distinctly shorter than harpes; lateral lobe of uncus with distal and lower margins concave; upper distal angle of uncus greatly produced, more so than in *indigo;* lower distal angle broadly rounded; gnathos arm with more distinct carina than in *indigo;* harpe in lateral view distinctly constricted before apex forming a small apical lobe. Eighth tergite (fig. 21*c*) much broader than that of *indigo* but otherwise similar.

Female (figs. 53, 54).—Wings above quite similar to *indigo*, below paler than in the male and as in that sex with markings more distinctly red than in *indigo*. Red lunule next to postmedian line below vein Cu_2 on undersurface of hindwing less obscured with fuscous.

Length of forewing 10.5 mm.

Female genitalia, not illustrated, not different from *indigo*.

Type-locality.—"Chancamayo,"=Chanchamayo, "Peru."

Additional type data.—Originally described from a single male, the holotype (locality as given above; H. Whitely; British Museum (Natural History) type No. Rh. 908; male genitalia preparation number NHB 1949 150). Mr. D. S. Fletcher sent me a topotype specimen that he compared with the holotype and found to be conspecific. This compared specimen is the basis for the identification of the name *anfracta* in this paper.

Distribution.—Colombia, Peru and Bolivia.

Colombia: Department of Cundinamarca, Bogotá. Peru: Department of Junin, Chanchamayo; Satipo. Bolivia: Department of Santa Cruz, near Santa Cruz.

Material studied.—Nine males and one female, including their genitalia.

Calycopis anastasia, new species

Figures 18, 99, 100

Male (figs. 99, 100).—Wings above similar to those of *anfracta* except that the borders on the hindwings are wide as in *partunda;* wings underneath with slightly darker ground color than in *anfracta* but with markings almost exactly as in that species.

Length of forewing 11.5 mm.

Male genitalia, as illustrated by figure 18, with aedeagus nearly straight, base slightly bent downward and with distal end elongated, upcurved, and fingerlike; saccus distinctly shorter than harpes; lateral lobe of uncus with distal margin concave and with lower margin much more concave than in *anfracta;* upper distal angle of uncus greatly produced as in *anfracta;* lower distal angle somewhat truncate; gnathos arm with carina placed further back from distal end than in *anfracta*; harpe in lateral view gradually narrowed to apex which is rounded forming a lobe that is not as distinct as in *anfracta*. Eighth tergite not illustrated and shaped about as in *partunda* (fig. 21*a*).

FEMALE.—Unknown.

TYPE-LOCALITY.—Province of Chapare, Department of Beni, Bolivia.

ADDITIONAL TYPE DATA.—Originally described from the holotype, male (locality as given above; USNM type 34901; male genitalia preparation WDF 3432, 1951) and two male paratypes from Santiago del Estero and Santa Cruz de la Sierra, both in the department of Santa Cruz de la Sierra, Bolivia.

LOCATION OF TYPES.—Holotype and one paratype in United States National Museum, one paratype in British Museum (Natural History).

DISTRIBUTION.—Known only from Bolivia.

MATERIAL STUDIED.—Three males, including their genitalia.

Calycopis fractunda, new species

FIGURES 19, 21*d*, 34, 103, 104, 125, 126

MALE (figs. 103, 104).—Wings above similar to those of *indigo* with brilliant blue on the hindwing decidedly purplish and with forewing a dull metallic bluish purple except along outer margin where the color is dark brown; wings below not different from *partunda* and as in that species with the bars of postmedian band in interspaces M_3 and Cu_1 nearly straight.

Length of forewing 14 mm.

Male genitalia, as illustrated by figure 19, with aedeagus nearly straight, distal end fingerlike, upcurved, and greatly elongated, much more so than in *anastasia;* saccus nearly as long as harpes; lateral lobes of uncus connected across the top and in lateral view with distal and lower margins concave; upper distal angle of uncus greatly prolonged, much more so than in any other species of *Calycopis;* lower distal angle broadly rounded and similar to that of *anfracta;* gnathos arm without carina; harpe in lateral view similar to *anfracta*, in ventral view similar to *anastasia*. Eighth tergite (fig. 21*d*) similar to that of *anfracta*, slightly more cordate in shape.

FEMALE (figs. 125, 126).—Wings above and below very similar to those of *vitruvia*, differing only in the hindwing underneath having a smaller black pupil in submarginal red lunule of interspace Cu_1, in having the bars of postmedian band in interspaces M_3 and Cu_1 nearly straight and with postmedian black line above Cu_2 lacking red inner border.

Length of forewing 10.5 mm.

Female genitalia, as illustrated in figure 34, differing from *vitruvia* in having spurs of ostium bursae lobes set further apart and with base of these lobes more produced medially.

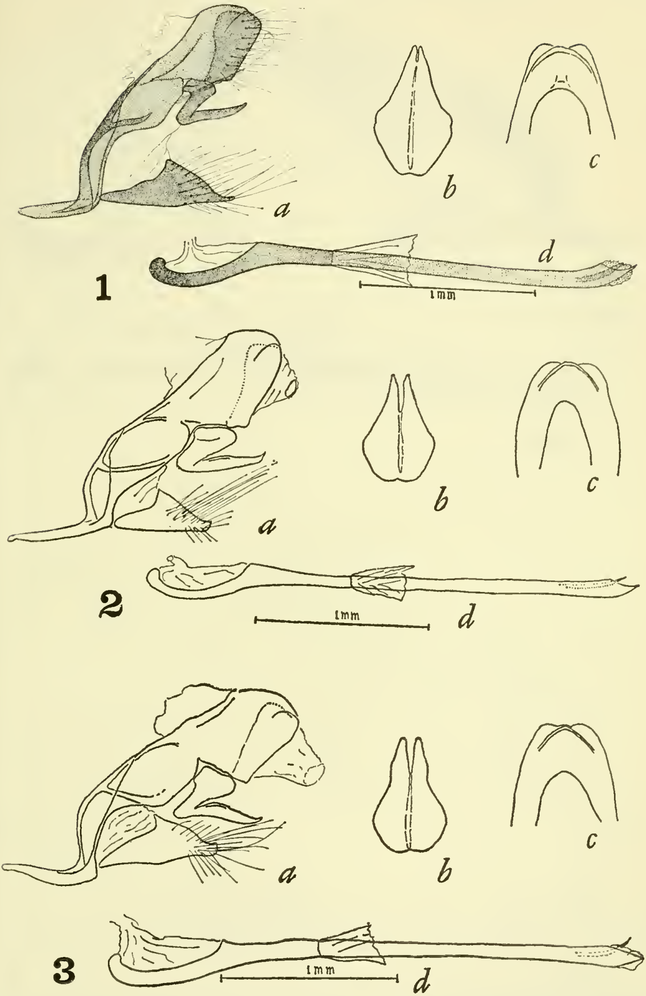
TYPE-LOCALITY.—Achinamiza (Department of Loreto), Peru.

ADDITIONAL TYPE DATA.—Described from the holotype, male (locality as given above; September; H. Bassler Collection; male genitalia preparation WDF 3443, 1951) and from the allotype, female (Iquitos, Department of Loreto, Peru; October; collection of E. I. Huntington; female genitalia preparation WDF 5069, 1951).

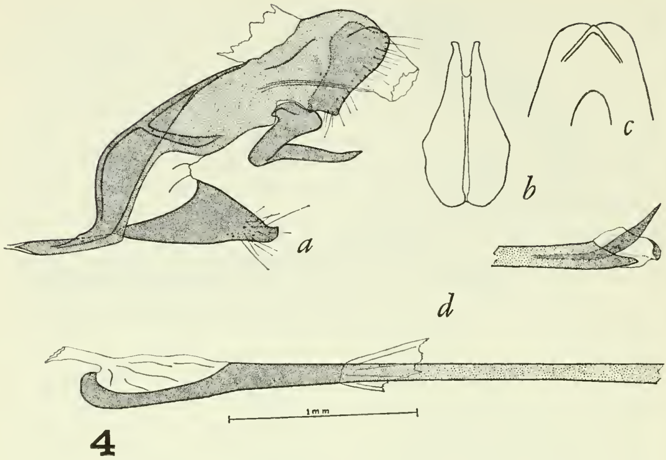
LOCATION OF TYPES.—Holotype and allotype in American Museum of Natural History, New York City.

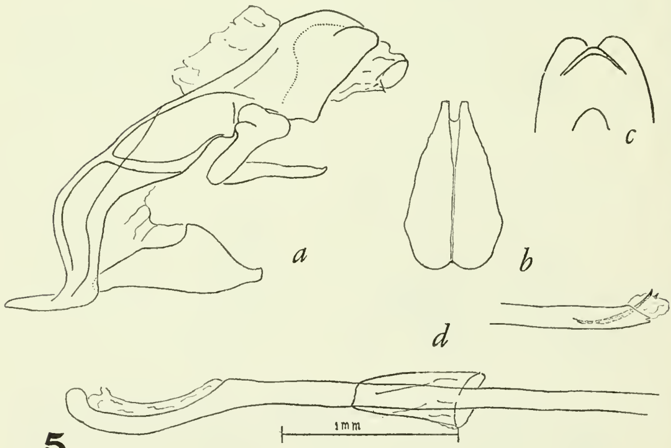
DISTRIBUTION.—Known only from Peru.

MATERIAL STUDIED.—One male and one female.

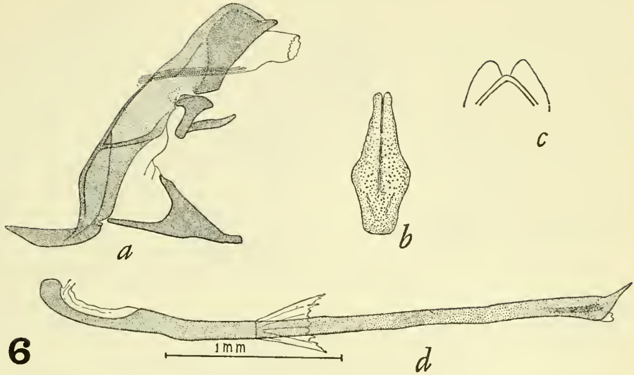


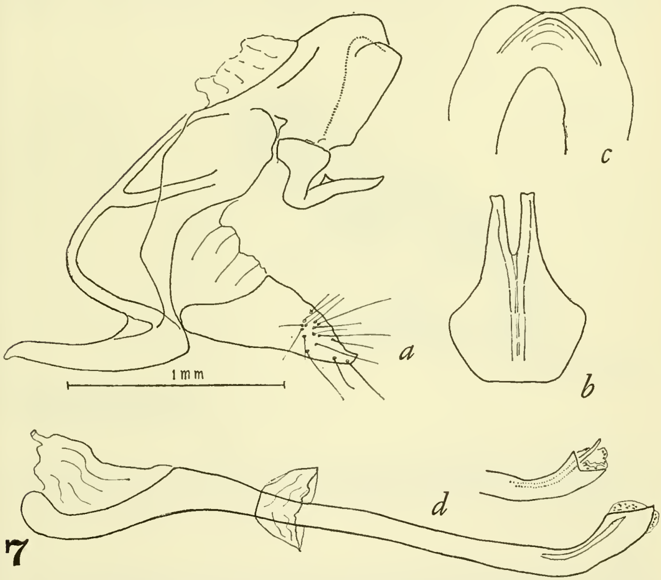
FIGURES 1–3.—Male genitalia (*a*=harpe, tegumen, uncus, vinculum, saccus and gnathos in lateral view; *b*,=fused harpes in ventral view; *c*=uncus and tegumen in dorsal view; *d*,=aedeagus in lateral view): 1, *Calycopis bactra* (Hewitson), from preparation 2887 (WDF); 2, *C. nicolayi* Field, holotype; 3, *C. caulonia* (Hewitson), from preparation 5310 (WDF).



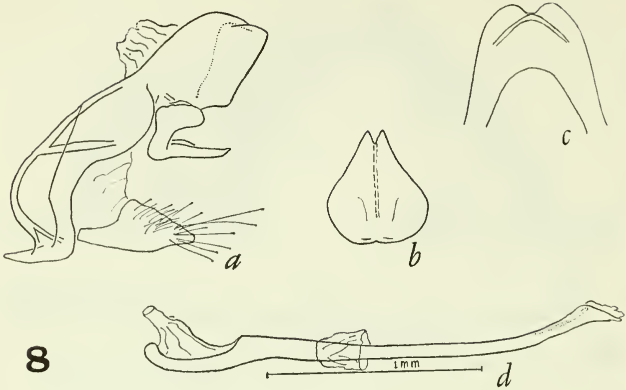


FIGURES 4–5.—Male genitalia (see figs. 1–3 for key): 4, *C. janeirica* (C. Felder), from preparation 2697 (WDF); 5, *C. chacona* (Jörgensen), from preparation 2696 (WDF).





FIGURES 6–7.—Male genitalia (see figs. 1–3 for key): 6, *C. lerbela* Field, holotype; 7, *C. torqueor* Druce, from preparaion BM 1951 490.



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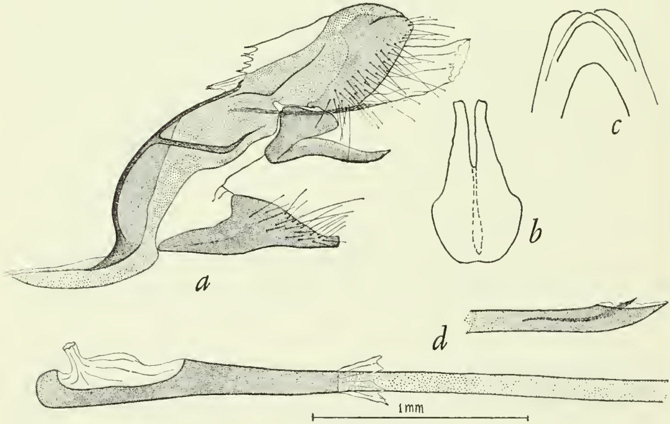

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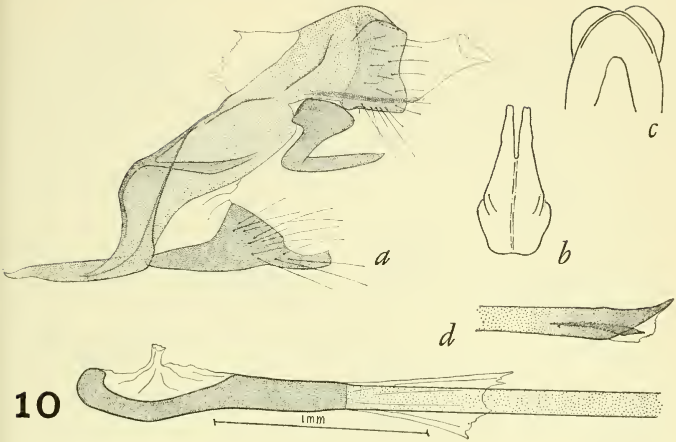
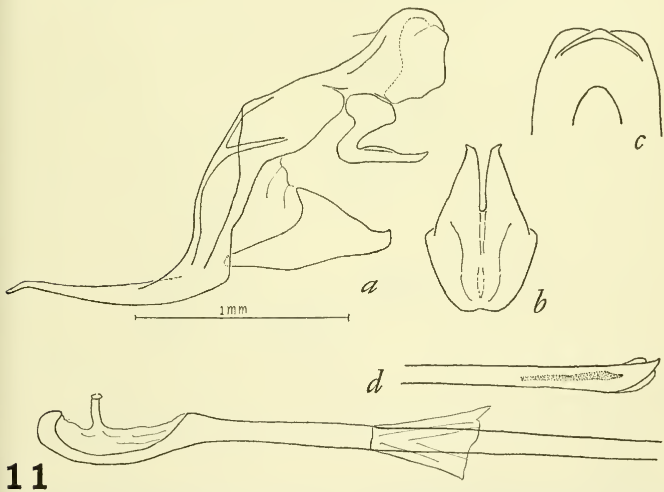
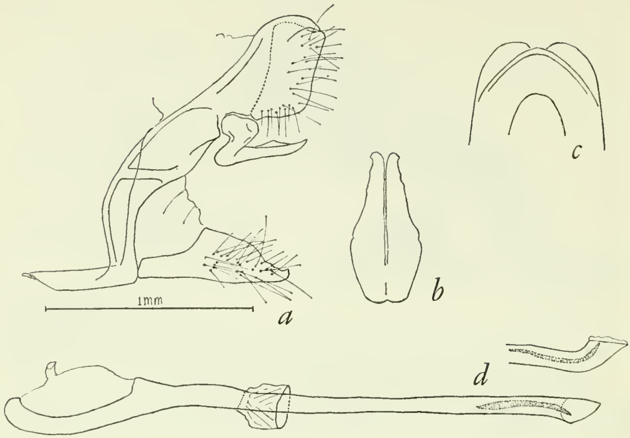
FIGURES 8–9.—Male genitalia (see figs. 1–3 for key): 8, *C. xeneta* (Hewitson), from preparation BM 1951 492; 9, *C. cecrops* (Fabricius), from preparation 2729 (WDF).





FIGURES 10–11.—Male genitalia (see figs. 1–3 for key): 10, *C. susanna* Field, from preparation 2683 (WDF); 11, *C. drusilla* Field, holotype.



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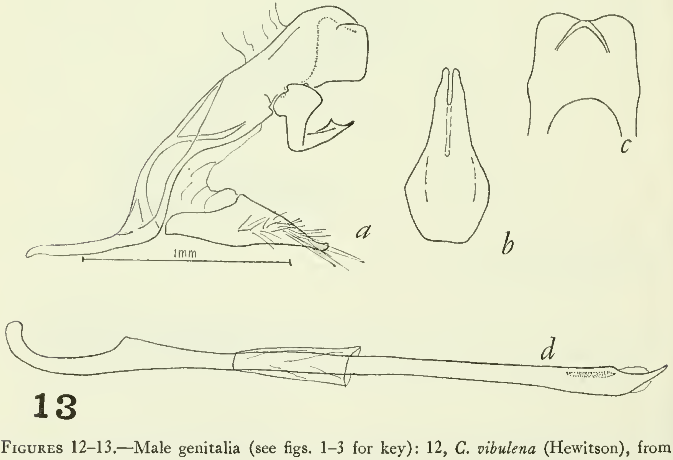

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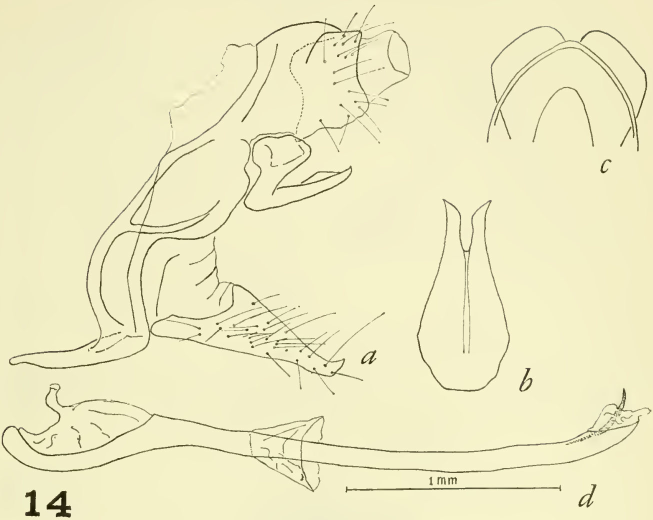
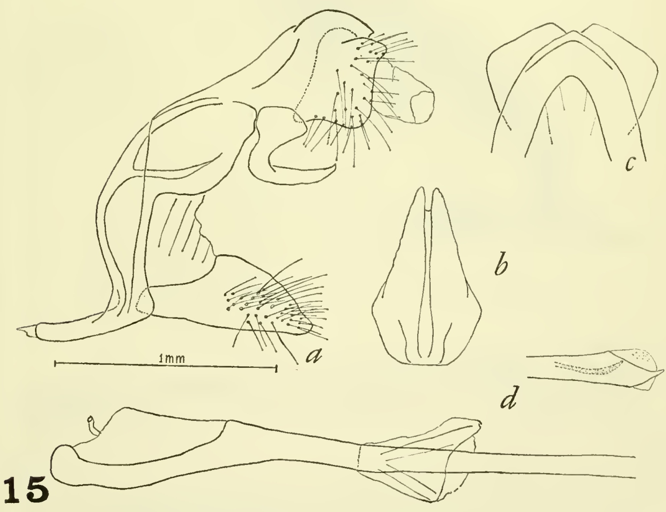
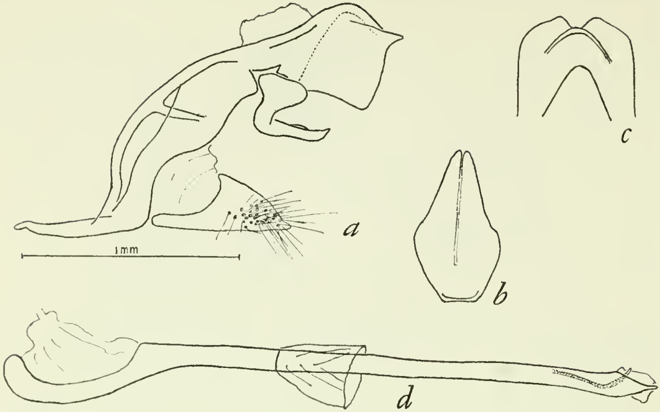
FIGURES 12–13.—Male genitalia (see figs. 1–3 for key): 12, *C. vibulena* (Hewitson), from preparation BM 1949 165 A; 13, *C. vitruvia* (Hewitson), from preparation BM 1951 488.





FIGURES 14–15.—Male genitalia (see figs. 1–3 for key): 14, *C. bellera* (Hewitson), from preparation BM 1949 147; 15, *C. partunda* (Hewitson), from preparation BM 1949 148.



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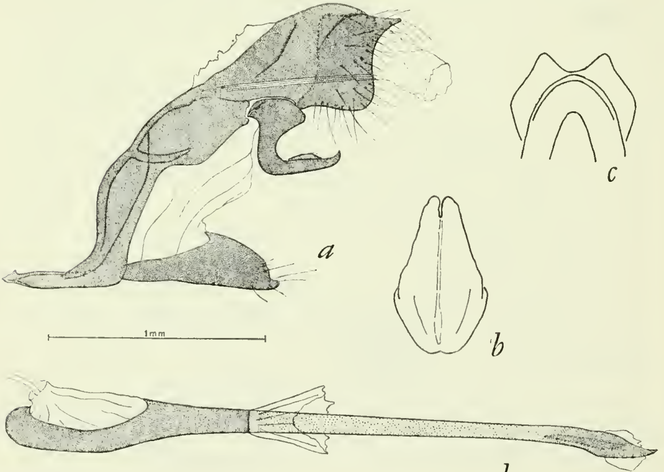

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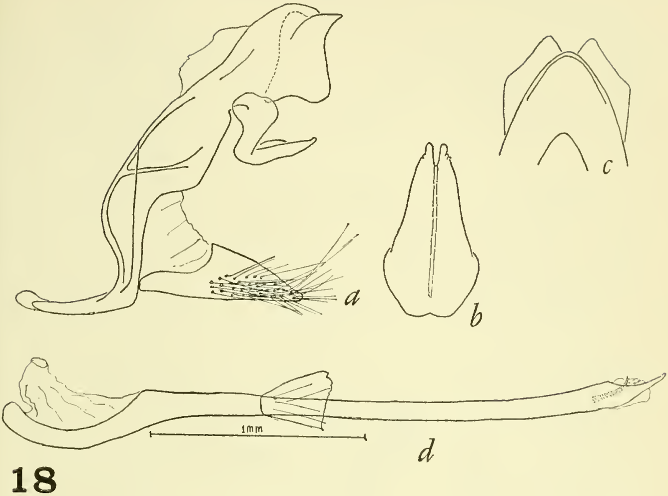
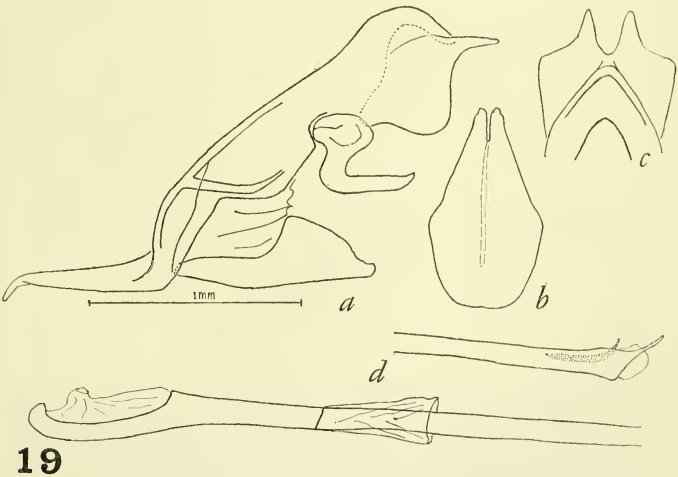
FIGURES 16–17.—Male genitalia (see figs. 1–3 for key): 16, *C. indigo* (Druce), from preparation BM 1951 497; 17, *C. anfracta* (Druce), from preparation 2700 (WDF).





FIGURES 18–19.—Male genitalia (see figs. 1–3 for key): 18, *C. anastasia* Field, holotype; 19, *C. fractunda* Field, holotype.

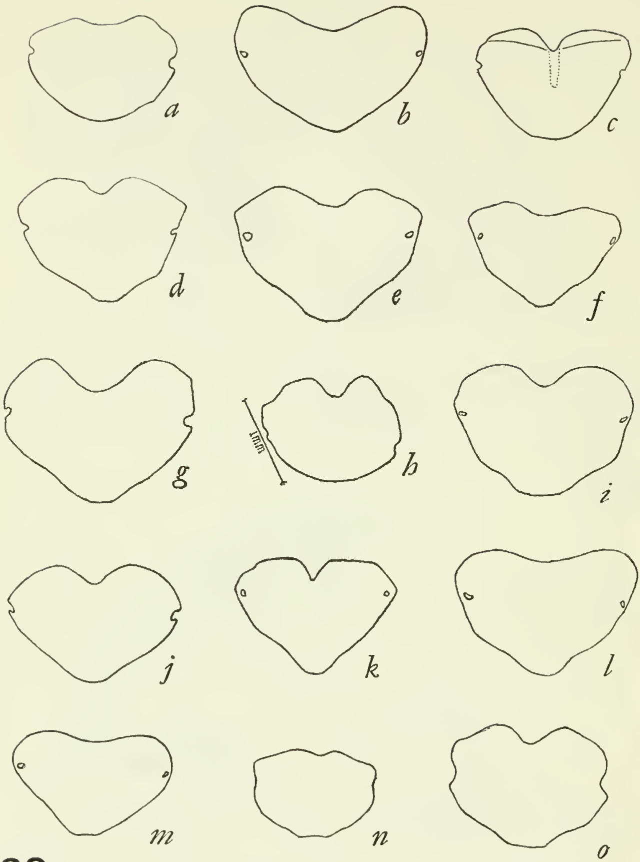


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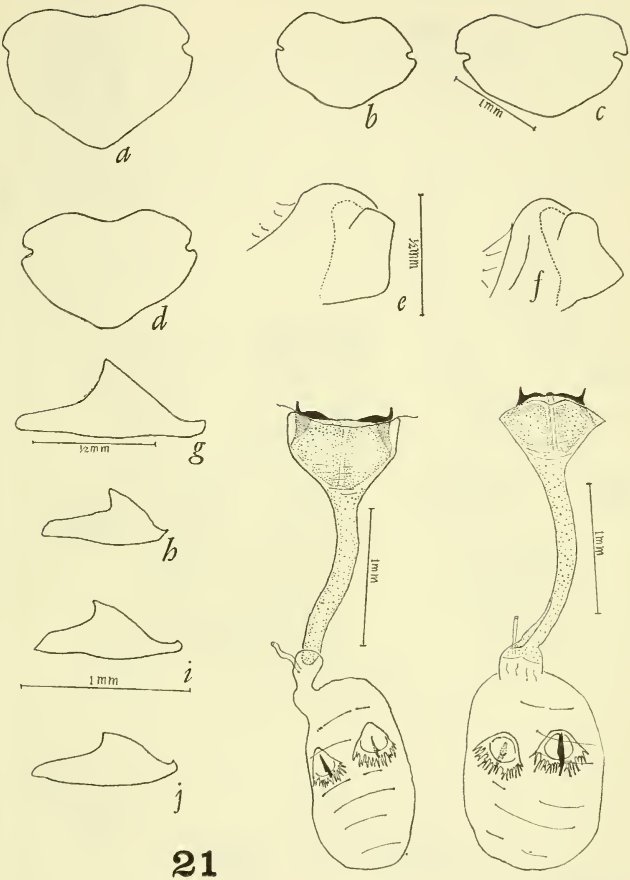
FIGURE 20.—Eighth tergite of male abdomen (scale in fig. *h*): *a*, *C. bactra* (Hewitson), from preparation 2887 (WDF); *b*, *C. nicolayi* Field, holotype; *c*, *C. caulonia* (Hewitson), from preparation 5310 (WDF); *d*, *C. janeirica* (C. Felder), from preparation 2697 (WDF); *e*, *C. chacona* (Jörgensen), from preparation 2696 (WDF); *f*, *C. lerbela* Field, holotype; *g*, *C. torqueor* (Druce), from preparation BM 1951 490; *h*, *C. xeneta* (Hewitson), from preparation BM 1951 492; *i*, *C. cecrops* (Fabricius), from preparation 2729 (WDF); *j*, *C. isobeon* (Butler and Druce), from preparation 2839 (WDF); *k*, *C. susanna* Field, holotype; *l*, *C. drusilla* Field, holotype; *m*, *C. vibulena* (Hewitson), from preparation 3436 (WDF); *n*, *C. vitruvia* (Hewitson), from preparation BM 1951 488; *o*, *C. bellera* (Hewitson), from preparation BM 1949 147.



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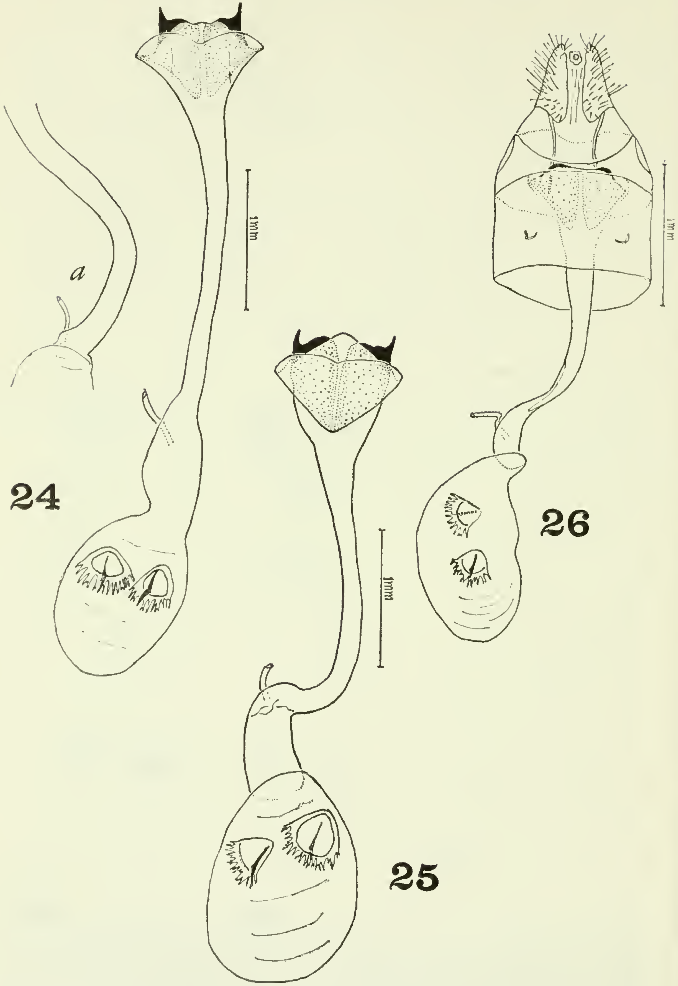
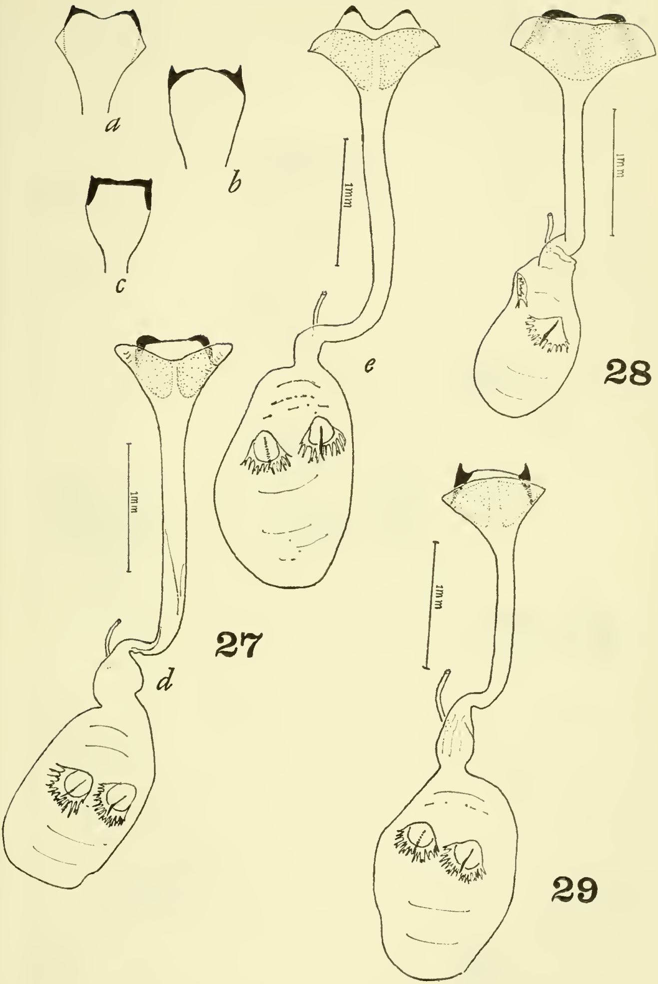
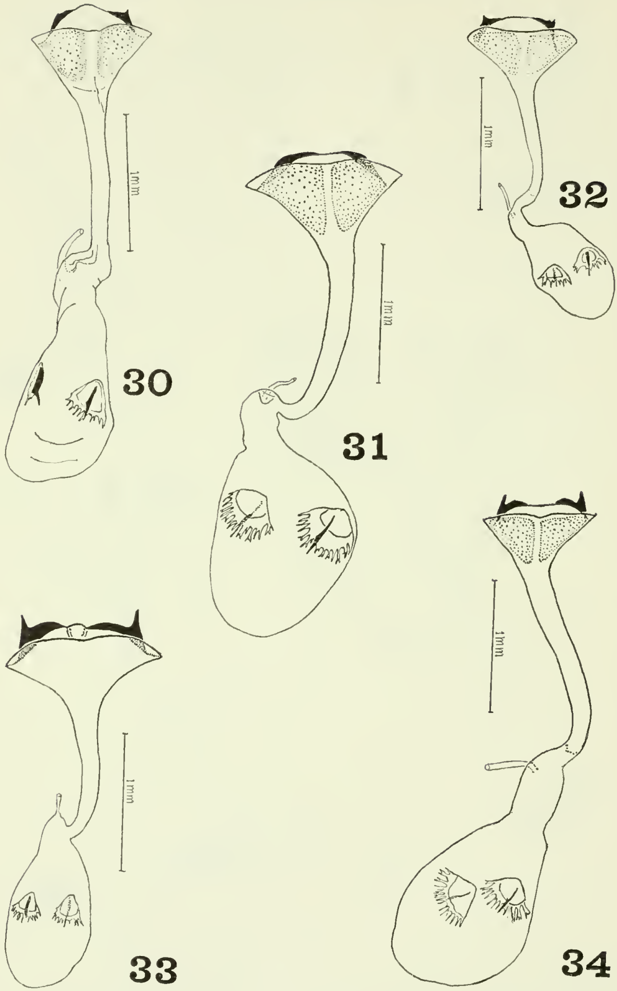
FIGURES 21–23.—Eighth tergite of male abdomen: 21*a*, *C. partunda* (Hewitson), from preparation BM 1949 148; *b*, *C. indigo* (Druce), from preparation BM 1951 497; *c*, *C. anfracta* (Druce), from preparation 2700 (WDF); *d*, *C. fractunda* Field, from holotype. Lateral views of unci and harpe showing variations in *C. susanna* Field: 21*e*, from preparation 2833 (WDF); *f*, from preparation 2681 (WDF); *g*, from preparation 2681. Lateral views of harpes showing variations in *C. chacona* (Jörgensen): 21*h*, from preparation 2923 (WDF); *i*, from preparation 2925 (WDF); *j*, from preparation 2920 (WDF). Female genitalia in ventral view: 22, *C. bactra* (Hewitson), holotype; 23, *C. caulonia* (Hewitson), from preparation BM 1949 145.



Figures 24–26.—Female genitalia in ventral view (except 24*a*, which shows portion of bursa copulatrix and ductus bursae in lateral view): 24, *C. janeirica* (C. Felder), from preparation 2765 (WDF); 25, *C. chacona* (Jörgensen), from preparation 2766 (WDF); 26, *C. lerbela* Field, allotype.



FIGURES 27–29.—Female genitalia in ventral view: 27*a*, *C. susanna* Field, from preparation 2780 (WDF); *b*, from preparation 2792 (WDF); *c*, from preparation 3467 (WDF); *d*, allotype; *e*, from preparation 2896 (WDF); 28, *C. drusilla* Field, allotype; 29, *C. vitruvia* (Hewitson), from preparation 5070 (WDF).



FIGURES 30–34.—Female genitalia in ventral view: 30, *C. bellera* (Hewitson), holotype; 31, *C. partunda* (Hewitson), from preparation 5319 (WDF); 32, *C. amplia* (Hewitson), from preparation 5091 (WDF); 33, *C. indigo* (Druce), from preparation 3185 (WDF); 34, *C. fractunda* Field, allotype.

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Plates

(Figures 35–126)

FIGURES 35–50

C. bactra (Hewitson)

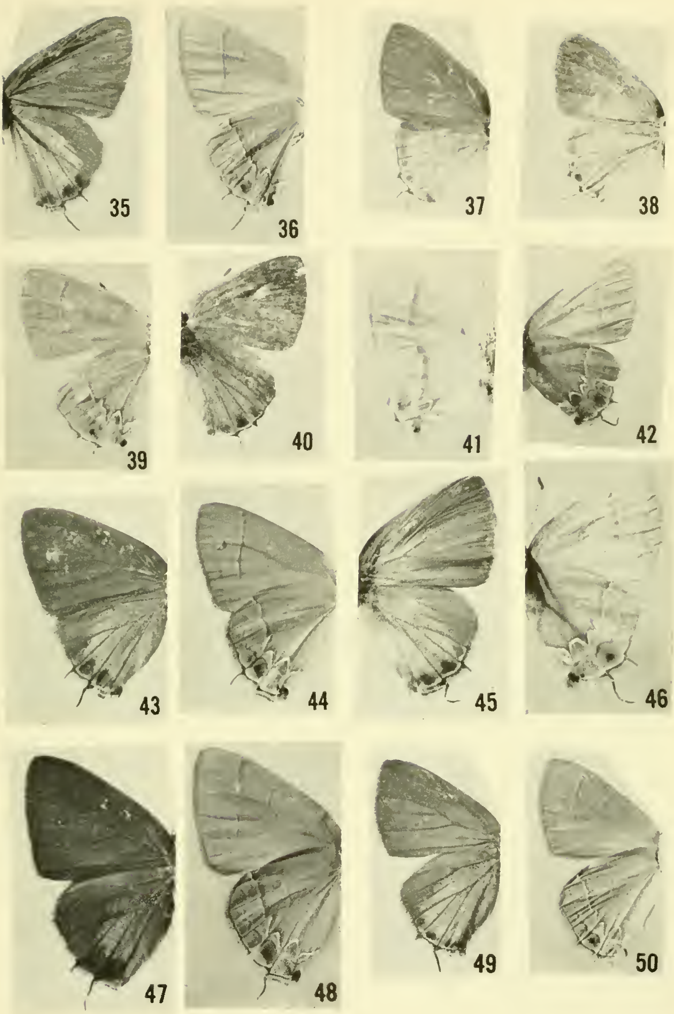
35. Male, upper surface, Ancon, C.Z., Panama.
36. Lower surface of 35.
37. Female, upper surface, Balboa, C.Z., Panama.
38. Female, upper surface, La Cumbre, Honduras, compared with holotype.
39. Female, lower surface, Cauca Valley, Cali District, Colombia.
40. Upper surface of 39.
41. Lower surface of 37.
42. Lower surface of 38.

C. janeirica (C. Felder)

43. Male, upper surface, Rio de Janeiro, Brazil.
44. Lower surface of 43.
45. Female, upper surface, Rio de Janeiro, Brazil.
46. Lower surface of 45.

C. chacona (Jörgensen)

47. Male, upper surface, Castro, Parana, Brazil.
48. Lower surface of 47.
49. Female, upper surface, Castro, Parana, Brazil.
50. Lower surface of 49.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Figures 51–66

C. chacona (Jörgensen)

51. Male, upper surface, Villarica, Paraguay.
52. Lower surface of 51.

C. anfracta (Druce)

53. Female, upper surface, Puerto Aquirre, Missones, Argentina.
54. Lower surface of 53.

C. caulonia (Hewitson)

55. Female, upper surface, Santa Cruz, Brazil, compared with holotype.
56. Lower surface of 55.

C. lerbela Field

57. Male, upper surface, holotype.
58. Lower surface of 57.
59. Female, upper surface, allotype.
60. Lower surface of 59.

C. cecrops (Fabricius)

61. Male, upper surface, Salem, Va.
62. Lower surface of 61.
63. Male, upper surface, Miami, Fla.
64. Lower surface of 63.
65. Female, upper surface, Montgomery Co., Va.
66. Lower surface of 65.


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Figures 67–82

C. cecrops (Fabricius)

67. Male, upper surface, Dismal Swamp, near Suffolk, Va.
68. Lower surface of 67.
69. Female, upper surface, Montgomery Co., Va.
70. Female, upper surface, Miami, Fla.

C. isobeon (Bulter and Druce)

71. Male, upper surface, San Benito, Tex.
72. Lower surface of 71.
73. Male, upper surface, Vulcan Irazú, Costa Rica, compared with lectotype.
74. Lower surface of 73.
75. Female, upper surface, San Benito, Tex.
76. Lower surface of 75.
77. Female, upper surface, San Benito, Tex.
78. Lower surface of 77.

C. bellera (Hewitson)

79. Female, upper surface, Belém, Brazil, compared with lectotype.
80. Lower surface of 79.

C. drusilla Field

81. Male, upper surface, holotype.
82. Under surface of 81.


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Figures 83–98

C. susanna Field

83. Male, upper surface, holotype.
84. Lower surface of 83.
85. Male, upper surface, Port Limon, Costa Rica.
86. Lower surface of 85.
87. Female, upper surface, allotype.
88. Lower surface of 87.
89. Female, upper surface, Guápiles, Costa Rica.
90. Lower surface of 89.

C. drusilla Field

91. Female, upper surface, allotype.
92. Lower surface of 91.

C. vibulena (Hewitson)

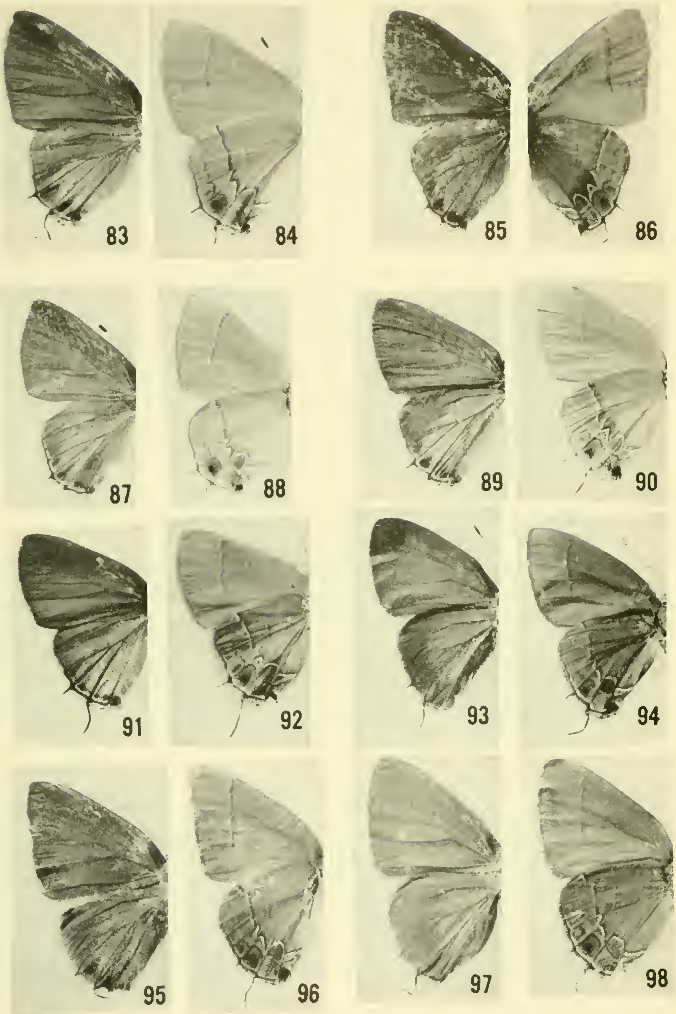
93. Male, upper surface, Belém, Pará, Brazil, compared with lectotype.
94. Lower surface of 93.

C. bellera (Hewitson)

95. Male, upper surface, Belém, Pará, Brazil, compared with lectotype of the synonym *origo* (Godman and Salvin).
96. Lower surface of 95.

C. partunda (Hewitson)

97. Male, upper surface, Amazonas, Brazil, compared with lectotype.
98. Lower surface of 97.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Figures 99–114

C. anastasia Field

99. Male, upper surface, holotype.
100. Lower surface of 99.

C. anfracta (Druce)

101. Male, upper surface, Chanchamayo, Peru, compared with holotype.
102. Lower surface of 101.

C. fractunda Field

103. Male, lower surface, holotype.
104. Upper surface of 103.

C. indigo (Druce)

105. Male, upper surface, Mato Grosso, Brazil, compared with holotype.
106. Lower surface of 105.

C. xeneta xeneta (Hewitson)

107. Male, lower surface, Nicaragua, compared with lectotype.
108. Upper surface of 107.

C. vitruvia (Hewitson)

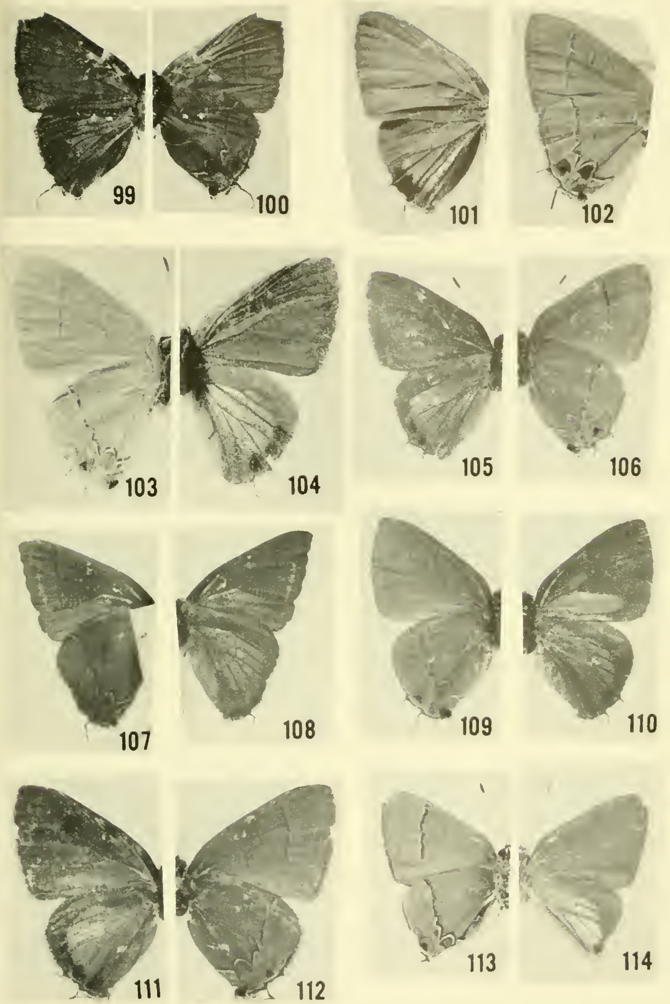
109. Male, lower surface, Iquitos, Peru, compared with holotype of *vitruvia* and lectotype of *fortuna* (Druce).
110. Upper surface of 109.

C. torqueor (Druce)

111. Male, upper surface, Caramang River, British Guiana, a paratype compared with holotype.
112. Lower surface of 111.

C. nicolayi Field

113. Male, lower surface, holotype.
114. Upper surface of 113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Figures 115–126

C. caulonia (Hewitson)

115. Male, upper surface, João Pessoa, Brazil.
116. Lower surface of 115.

C. xeneta devia (Moschler)

117. Male, upper surface, St. Jean, Maroni, French Guiana.
118. Lower surface of 117.

C. vitruvia (Hewitson)

119. Female, upper surface, Achinamiza, Peru.
120. Lower surface of 119.

C. amplia (Hewitson)

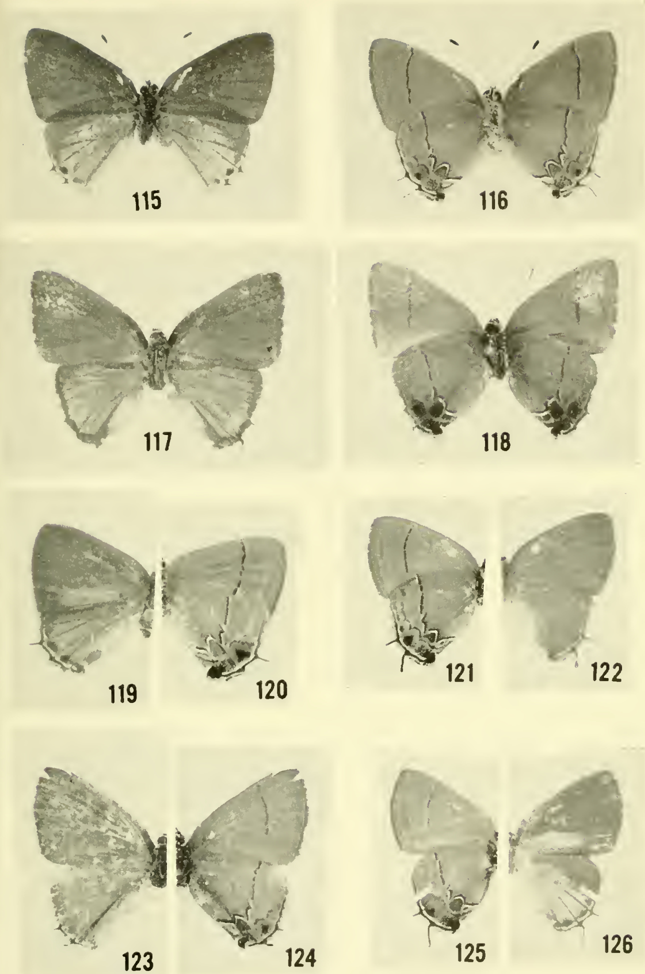
121. Female, lower surface, Guápiles, Costa Rica.
122. Upper surface of 121.

C. indigo (Druce)

123. Female, upper surface, Puerto Aquirre, Missones, Argentina.
124. Lower surface of 123.

C. fractunda Field

125. Female, lower surface, allotype.
126. Upper surface of 125.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TYPE-SPECIMENS OF POLYCHAETES DESCRIBED BY EDITH AND CYRIL BERKELEY (1923-1964)

By Marian H. Pettibone
Associate Curator, Division of Worms

The late Edith Berkeley, working as a volunteer investigator at the Pacific Biological Station at Nanaimo, British Columbia, published some 11 papers between 1923 and 1961, chiefly on the polychaetes from the Nanaimo district. In these publications 1 new genus, 15 new species, and 8 new varieties (some subsequently raised to species) were described, and 1 new name was proposed. Edith Berkeley was later joined by her husband Cyril in her polychaete studies, and they jointly published 34 papers between 1932 and 1964. In addition to material from British Columbia, their collection included specimens from Alaska, the Bering Sea, the western Canadian Arctic, southern California, the west coasts of Mexico and Panama, Peru, Hudson Bay, and the east coast of Canada. These studies resulted in the erection of 4 new genera, 43 new species, 1 new subspecies, 7 new varieties, and 1 new name. Cyril Berkeley alone published two short papers dealing with polychaetes (1942, 1956). "Canadian Pacific Fauna" includes two papers by the Berkeleys: "Polychaeta Errantia" (1948) and "Polychaeta Sedentaria" (1952a). Their publications serve as the primary source for information on the polychaetes of western Canada and nearby areas.

In 1964, Cyril Berkeley kindly donated the Berkeley polychaete collection to the Smithsonian Institution. I went to Nanaimo to help in the transfer of the collection. Some type material of the Berkeley species had been set apart from the general collection. However, a good deal of type material, including syntypes and paratypes, was not so segregated.

The purpose of this paper is to indicate the change in the location of the Berkeleys' material from their private collection to that of the U.S. National Museum and to provide some pertinent information on the type material.

For each of the species described by the Berkeleys, I have given the original reference; subsequent references to that species by the Berkeleys are also listed. I have also included selected references to publications of other authors, in which additional figures or descriptions may be given, or in which the Berkeley species are referred to other genera or species. The type material is documented by the Museum Catalog Number (USNM), the locality, and number of specimens. In extracting type material from the general collection, I have been guided by the date and information given in the original reference. Type material was found for all but two species, *Prionospio multibranchiata* E. Berkeley, 1927, and *Caulleriella viridis* var. *pacifica* E. Berkeley, 1929. Dr. R. W. Sims of the Annelid Section at the British Museum (Natural History) kindly furnished me with the list of polychaetes given to the British Museum by Edith Berkeley. The syntypes and paratypes (referred to as cotypes) of the Berkeley species that are deposited in the British Museum are so indicated (BMNH).

A complete list of the papers dealing with polychaetes by Edith Berkeley, by Edith and Cyril Berkeley, and by Cyril Berkeley is included, together with a list of the new taxa described in each paper.

I wish to express my appreciation to Mr. Cyril Berkeley for his gift of the Berkeley collection to the Smithsonian Institution and for his help in making what might have been a rather tedious task of transferring a large collection, such a pleasant one. My sister Mrs. Katherine Swanson was particularly helpful, far beyond the call of duty, in serving as typist and general helper.

Family Polynoidae

Lepidasthenia longicirrata E. Berkeley

Lepidasthenia longicirrata E. Berkeley, 1923, p. 214, figs. 8–13.—Pettibone, 1953, p. 51, pl. 26, figs. 229–236.

Lepidametria longicirrata (E. Berkeley).—E. and C. Berkeley, 1948, p. 18, fig. 22.

Type material: Holotype, USNM 32853, off Jesse Island, British Columbia, from sponge-bed, 15 fms., June 9, 1920 (middle piece and posterior piece with regenerating posterior end, anterior end missing). Metatype, USNM 32852, Port Albion, Ucluelet, British Columbia, July 12, 1945, Barraclough, collector (selected as type material by E. Berkeley). Metatype, USNM 32851, Deep Bay, Maple Point, British Columbia, 20 fms., August 1934, commensal form (specimen in 2 pieces, selected as type material by E. Berkeley).

Malmgrenia nigralba E. Berkeley

Malmgrenia nigralba E. Berkeley, 1923, p. 213, figs. 5–7.—E. and C. Berkeley, 1948, p. 10.
Malmgrenia lunulata (Delle Chiaje).—Pettibone, 1953, p. 25, pls. 10, 11.

Type material: Syntypes, USNM 32875 and 32876, Piper's Lagoon, Vancouver Island, British Columbia, sand bed, very low tide, June 20, 1920, 3 specimens (anterior piece of 17 segments and posterior piece of 22 segments; 2 anterior pieces of 14 and 16 segments and 2 middle pieces of 9 and 19 segments). Syntypes, BMNH 1935. 12.19.33/35, Piper's Lagoon, Vancouver Island, British Columbia.

Family Pareulepidae

Eulepethus mexicanus E. and C. Berkeley

Eulepethus mexicanus E. and C. Berkeley, 1939, p. 328, figs. 4–7.
Pareulepis fimbriata (Treadwell).—Hartman, 1959, p. 123.
Mexieulepis mexicanus (E. and C. Berkeley).—Rioja, 1961, p. 237.

Type material: Holotype, USNM 32893, Isle Grande Bay, Mexico, 6 fms., fine sand, Apr. 8, 1937, W. Williams, collector, M. S. *Stranger*.

Family Sigalionidae

Sigalion lewisii E. and C. Berkeley

Sigalion lewisii E. and C. Berkeley, 1939, p. 326, figs. 2, 3.
Eusigalion lewisii (E. and C. Berkeley).—Hartman, 1944a, p. 13.
Thalanessa lewisii (E. and C. Berkeley).—Hartman, 1959, pp. 119, 122.

Type material: Holotype, USNM 32896, Espiritu Santo Island, Gulf of California, 24°22′ N., 11°11′ W., 11 fms., bottom of coralline algae, coral and shell, Apr. 18, 1937, F. E. Lewis, collector, M. S. *Stranger* (specimen in 2 pieces). Paratype, BMNH 1938. 11.29.4, Espiritu Santo Island, Gulf of California.

Sthenelanella atypica E. and C. Berkeley

Sthenelanella atypica E. and C. Berkeley, 1941, p. 26, pl. 5, figs. 1–3.

Type material: Syntypes, USNM 32849 and 32850, off Corona del Mar, Calif., 12–17 fms., July 21, 1937, G. E. MacGinitie, collector, 2 specimens (1 complete, 1 incomplete posteriorly, with pharynx extended). Syntypes, USNM 32848, off Balboa, Calif., November and December 1932 and February 1933, G. E. MacGinitie, collector, 33 specimens.

Remarks: Hartman (1961, p. 54) questionably referred *S. atypica* to *Sthenelanella uniformis* Moore, 1910.

Family Amphinomidae

***Eurythoe complanata* var. *mexicana* E. and C. Berkeley**

Eurythoe complanata (Pallas).—E. and C. Berkeley, 1939, p. 323, fig. 1 (part).
Eurythoe complanata var. *mexicana* E. and C. Berkeley, 1960a, p. 358.

Type material: Holotype, USNM 32884, Espiritu Santo Island, Gulf of California, littoral, 1937, F. E. Lewis, collector. Paratypes, USNM 32883, San Carlos Bay, Gulf of California, Sept. 5, 1959, H. Arai, collector, 2 specimens (anterior and posterior portions).

Family Tomopteridae

***Tomopteris elegans* E. Berkeley**

Tomopteris elegans E. Berkeley, 1924a, p. 289, pl. 1, figs. 1, 2. (Not Chun, 1888.)
Tomopteris renata E. Berkeley, 1930, p. 76. [New name for *T. elegans* E. Berkeley, 1924, preoccupied.]—E. and C. Berkeley, 1948, p. 26, figs. 31, 32.
Tomopteris (*Johnstonella*) *renata* E. Berkeley.—Uschakov, 1952, p. 106, figs. 3–5.—E. and C. Berkeley, 1957, p. 576; 1960b, p. 791.

Type material: Holotype, USNM 32879, west of Entrance Island, British Columbia, 200 fms., July 13, 1915, C. M. Fraser, collector. Paratypes, USNM 32880, north of Five Fingers, British Columbia, 200 fms., July 10, 1915, C. M. Fraser, collector, 4 specimens. Paratypes, BMNH 1938. 11.29.6/8, Gulf of Georgia, British Columbia.

Remarks: Dales (1955, p. 440; 1957, p. 141) referred *T. renata* to *T.* (*Johnstonella*) *pacifica* Izuka, 1914. Hartman (1959, p. 182) indicated that *T. renata* is perhaps the same as *T. pacifica*. The Berkeleys (1957) consider the two species to be distinct.

Family Pilargidae

***Ancistrosyllis longicirrata* E. and C. Berkeley**

Ancistrosyllis longicirrata E. and C. Berkeley, 1961, p. 658, figs. 5–7.
Podarmus ploa Chamberlin, 1919.—Pettibone, 1966, p. 199, figs. 24–26. [Family Polynoidae.]

Type material: Holotype, USNM 30990, South Pacific off Peru, 5°55′ S., 82°02′ W., from plankton, P. N. Sund, collector.

***Loandalia fauveli* E. and C. Berkeley**

Loandalia fauveli E. and C. Berkeley, 1941, p. 30, pl. 5, figs. 4–6.—Hartman, 1960, p. 89.—Pettibone, 1966, p. 196, figs. 22, 23.

Type material: Holotype, USNM 32891, Newport Bay, Calif., mud flats, Mar. 3, 1935, G. M. MacGinitie, collector (specimen in 3 pieces).

Family Syllidae

***Amblyosyllis lineata* var. *alba* E. Berkeley**

Amblyosyllis lineata Grube var. *alba* E. Berkeley, 1923, p. 208.—E. and C. Berkeley, 1948, p. 81, fig. 121.

Type material: Syntypes, USNM 32860, 32861, 32862, Jesse to Newcastle Island, Nanaimo region, British Columbia, 20 to 25 fms., in cavities of siliceous sponges, Sept. 4, 1919, 4 specimens (in 12 pieces: anterior end of 5 setigerous segments, middle piece with 7 segments, posterior piece with 1 setigerous and 1 achaetous segment; anterior end with 5 segments, middle piece of 2 segments, posterior piece with 6 setigerous and 1 achaetous segments; 2 anterior ends each with 5 segments, 4 middle pieces consisting of 3, 2, and 2 segments, and single parapodium).

Autolytus magnus E. Berkeley

Autolytus magnus E. Berkeley, 1923, p. 210, pl. 1, figs. 3, 4.—E. and C. Berkeley, 1938a, p. 47; 1945, p. 318; 1948, p. 70.—Hartman, 1948, p. 24.—Imajima and Hartman, 1964, p. 93, pl. 18, figs. a–c.

Type material: Holotype, USNM 32897, Departure Bay, Nanaimo, British Columbia, Feb. 23, 1920, swarming at station float, sacconereis phase.

Autolytus trilineatus E. and C. Berkeley

Autolytus aurantiacus.—E. and C. Berkeley, 1938a, p. 48. [Not Claparède, 1868.]

Autolytus trilineatus E. and C. Berkeley, 1945, p. 318, fig. 1; 1948, p. 69, fig. 100.

Autolytus prismaticus (Fabricius).—Pettibone, 1954, p. 249, fig. 29, a, b.

Type material: Syntypes, USNM 32881 and 32882, Newcastle Island, Nanaimo, British Columbia, June 18, 1943, 5 specimens (complete specimen showing characteristic color markings, head of bud indicated between setigerous segments 13 and 14; complete specimen, 2 anterior ends, 3 middle pieces, and 3 posterior ends).

Exogone lourei E. and C. Berkeley

Exogone lourei E. and C. Berkeley, 1938a, p. 44, figs. 6–12; 1948, p. 79, fig. 117

Exogone dispar (Webster).—Pettibone, 1954, p. 259, fig. 28, k.

Type material: Holotype, USNM 32895, False Narrows, Nanaimo, British Columbia, May 21, 1936.

Odontosyllis parva E. Berkeley

Odontosyllis parva E. Berkeley, 1923, p. 208, pl. 1, figs. 1, 2.—E. and C. Berkeley, 1941, p. 30; 1948, p. 83, fig. 123.

Type material: Holotype, USNM 32892, False Narrows, Nanaimo, British Columbia, on bryozoan, May 30, 1919 (specimen in 3 pieces, anterior end of 15 segments, 2 middle pieces each with 6 segments).

Odontosyllis phosphorea var. _nanaimoensis_ E. Berkeley

Odontosyllis phosphorea Moore var. *nanaimoensis* E. Berkeley, 1923, p. 206; 1961, p. 1321.—E. and C. Berkeley, 1942, p. 191; 1948, p. 82, fig. 122.

Type material: Syntypes, USNM 32857 and 32859, Departure Bay, Nanaimo, British Columbia, swarming from end of July to end of November, 32 specimens. Syntypes, USNM 32858, Departure Bay, Nanaimo, British Columbia, swarming, Aug. 13, 1918, 15 specimens. Syntypes, BMNH 1935. 12.19.39/42, Departure Bay, Nanaimo, British Columbia.

Syllis harti E. and C. Berkeley

Syllis harti E. and C. Berkeley, 1938a, p. 35, fig. 2; 1942, p. 190; 1945, p. 317; 1948, p. 77, fig. 114.
Typosyllis harti (E. and C. Berkeley).—Hartman, 1959, pp. 227, 234.

Type material: Holotype, USNM 32671, off Nootka light, west coast Vancouver Island, British Columbia, about 45 fms., E. G. Hart, collector (pharynx is loose in vial). Paratype, BMNH 1938. 11.29.-10, Princess Louise Inlet, British Columbia, 25 fms., J. F. L. Hart, collector.

Syllis pulchra E. and C. Berkeley

Syllis pulchra E. and C. Berkeley, 1938a, p. 34, fig. 1; 1948, p. 73, fig. 105.
Typosyllis pulchra (E. and C. Berkeley).—Hartman, 1944b, p. 250; 1948, p. 22.

Type material: Holotype, USNM 32847, False Narrows, Nanaimo, British Columbia, May 30, 1919. Paratypes, USNM 32846, between Jesse Island and Five Fingers, Nanaimo, British Columbia, 8 fms., July 17, 1918, 8 specimens. Paratypes, USNM 32845, Newcastle, Nanaimo, British Columbia, July 9, 1919, 4 specimens. Paratypes, BMNH 1938. 11.29.9, Departure Bay, British Columbia.

Syllis spenceri E. and C. Berkeley

Syllis spenceri E. and C. Berkeley, 1938a, p. 38, fig. 4; 1948, p. 75, fig. 112.
Typosyllis adamanteus (Treadwell).—Imajima and Hartman, 1964, p. 132.

Type material: Holotype, USNM 32872, Departure Bay, Nanaimo, British Columbia, May 24, 1925, G. J. Spencer, collector. Paratypes, USNM 32871, Departure Bay, Nanaimo, British Columbia, May 24, 1925, G. J. Spencer, collector, 20 specimens. Paratypes, BMNH 1938. 11.29.11/14, Departure Bay, Nanaimo, British Columbia.

Syllis stewarti E. and C. Berkeley

Syllis stewarti E. and C. Berkeley, 1942, p. 191; 1948, p. 72.
Typosyllis stewarti (E. and C. Berkeley).—Hartman, 1948, p. 22.

Type material: Holotype, USNM 32899, Estevan Point, west coast Vancouver Island, British Columbia, littoral, 1934, E. G. Hart, collector, *William J. Stewart.*

Family Nereidae

Micronereis nanaimoensis E. and C. Berkeley

Micronereis variegata.—Ramsay, 1914, p. 243, figs. 2–5, 7.—E. Berkeley, 1924a, p. 290.—E. and C. Berkeley, 1948, p. 60, fig. 89. [Not Claparède, 1863.]
Micronereis nanaimoensis E. and C. Berkeley, 1953a, p. 85, pls. 1, 2.

Type material: Syntypes, USNM 32854, 32855, and 32856, Departure Bay, British Columbia, Apr. 23 to May 23, 1947, 41 specimens.

Nereis (Ceratonereis) scotiae E. and C. Berkeley

Nereis (Ceratonereis) scotiae E. and C. Berkeley, 1956a, p. 267, figs. 1, 2.
Ceratonereis scotiae (E. and C. Berkeley).—Hartman, 1959, pp. 239, 256.

Type material: Holotype, USNM 32889, Mitchell Bay, Nova Scotia, July 18, 1939, littoral, W. S. Hoar, collector. Paratypes, USNM 32890, Mitchell Bay, Nova Scotia, July 18, 1939, littoral, W. S. Hoar, collector, 2 specimens.

Nereis (Eunereis) wailesi E. and C. Berkeley

Nereis (Eunereis) wailesi E. and C. Berkeley, 1954a, p. 456, figs. 1, 2.
Eunereis wailesi (E. and C. Berkeley).—Hartman, 1959, p. 241.

Type material: Holotype, USNM 32894, Cachalot, west coast Vancouver Island, British Columbia, G. H. Wailes, collector.

Nereis (Neanthes) mancorae E. and C. Berkeley

Nereis (Neanthes) mancorae E. and C. Berkeley, 1961, p. 656, figs. 1–4.

Type material: Holotype, USNM 32887, Mancora, Peru, intertidal, W. L. Klawe, collector. Paratypes, USNM 32888, Mancora, Peru, intertidal, W. L. Klawe, collector, 5 specimens.

Nicon peruviana E. and C. Berkeley

Nicon peruviana E. and C. Berkeley, 1964, p. 128, figs. 1, 2.

Type material: Holotype, USNM 32822, South Pacific off Peru, approximately 5° S., 81° W., Apr. 10, 1959, at night-light, P. N. Sund, collector (male heteronereid). Paratype, USNM 32821, South Pacific off Peru, approximately 5° S., 81° W., Apr. 10, 1959, at night-light, P. N. Sund, collector (male herteronereid).

Family Nephtyidae

Nephthys cornuta E. and C. Berkeley

Nephthys sp.? Weese, 1933, p. 20.
Nephthys cornuta E. and C. Berkeley, 1945, p. 328, figs. 2–4; 1948, p. 50, figs. 72, 73.
Nephtys cornuta.—Hartman, 1959, p. 106.—Clark, 1955, p. 547; 1958, p. 206.

Type material: Holotype, USNM 32873, Fishing Bay, East Sound, Orcas Island, Washington, 11–14 fms., soft mud, 1929, A. O. Weese, collector. Paratype, USNM 32874, Princess Louise Inlet, British Columbia, 20 fms., May 13, 1929. Paratypes, Fishing Bay, East Sound, Orcas Island, Washington. 11–14 fms., soft mud, 1929, A. O. Weese, collector, 4 specimens (in collection of R. B. Clark, University of Bristol, sectioned and stained for histological purposes; dissected for anatomical work on brain structure).

Family Sphaerodoridae

Sphaerodorum biserialis E. and C. Berkeley

Sphaerodorum biserialis E. and C. Berkeley, 1944, p. 3, figs. 1–3.

Type material: Holotype, USNM 32867, Dease Strait, western Canadian Arctic, 69° N., 106°25′ W., 45 fms., 1936–37, H. A. Larsen, collector, R.C.M.P. *St. Roch.* Paratype, USNM 32868, Dease Strait, western Canadian Arctic, 69° N., 106°25′ W., 45 fms., 1936–37, H. A. Larsen, collector, R.C.M.P. *St. Roch.*

Remarks: According to the revision by Pettibone (1963, p. 208), *S. biserialis* should be referred to *Ephesiella* Chamberlin, thus becoming *Ephesiella biserialis* (E. and C. Berkeley).

Family Goniadidae

Glycinde picta E. Berkeley

Glycinde picta E. Berkeley, 1927a, p. 412.—E. and C. Berkeley, 1942, p. 194; 1948, p. 35, fig. 48.—Hartman, 1948, p. 29.

Type material: Holotype, USNM 32870, False Narrows, British Columbia, May 20, 1920. Paratypes, USNM 32879, False Narrows, May 20, 1920; Piper's Lagoon, Apr. 20, 1920; Departure Bay Beach, June 27, 1918, low tide; 6 specimens. Paratypes, BMNH 1938. 11.29.18/19, Departure Bay, British Columbia.

Family Onuphidae

Onuphis eremita var. _parva_ E. and C. Berkeley

Onuphis eremita Audouin and Milne-Edwards var. *parva* E. and C. Berkeley, 1941, p. 35.

Type material: Holotype, USNM 32886, off Corona del Mar, Calif., 12–17 fms., G. E. MacGinitie, collector. Paratype, USNM 32885, off Corona del Mar, Calif., 12–17 fms., G. E. MacGinitie, collector.

Onuphis zebra E. and C. Berkeley

Onuphis zebra E. and C. Berkeley, 1939, p. 337, figs. 9–10.—Hartman, 1944c, p. 71, pl. 3, figs. 55–60.

Type material: Holotype, USNM 32898, Punta Gorda, Lower California, 23°04′ N., 109°35′ W., 14 fms., fine sand, Apr. 24, 1937, W. Williams, collector, M. S. *Stranger*.

Rhamphobrachium longisetosum E. and C. Berkeley

Rhamphobrachium longisetosum E. and C. Berkeley, 1938b, p. 428, figs. 1–8.—Hartman, 1944c, p. 48, pl. 1, figs. 1–8.

Type material: Syntype, USNM 32865, off mouth of Santa Ana River, southern California, 17 fms., G. E. MacGinitie, collector (anterior end of 9 segments showing characteristic long anterior setae). Syntypes, USNM 32866, off Balboa, southern California, 33 fms., May 19, 1933, G. E. MacGinitie, collector, 2 specimens (nearly complete specimen of 34 segments and middle fragment of 18 segments, also portion of tube).

Family Lumbrineridae

Lumbrinereis ligulata E. and C. Berkeley

Lumbrinereis ligulata E. and C. Berkeley, 1941, p. 38.
Lumbrineris ligulata.—Hartman, 1959, p. 335.

Type material: Syntypes, USNM 32877 and 32878, off Corona del Mar, southern California, 12–17 fms., July 21, 1937, G. E. MacGinitie, collector, 9 specimens (9 anterior ends, 2 middle pieces, 1 posterior end, plus jaws dissected out in small vial).

Lumbrinereis luti E. and C. Berkeley

Lumbrinereis luti E. and C. Berkeley, 1945, p. 332, fig. 6; 1948, p. 100, fig. 159.
Lumbrineris luti.—Hartman, 1959, p. 335.

Type material: Holotype USNM 32864, Northumberland Channel, British Columbia, 10–20 fms., dense mud, Apr. 16, 1937 (specimen in 2 pieces, anterior and middle). Paratypes, USNM 32863, Nanoose Bay, British Columbia, Aug. 28, 1918; Northumberland Channel, Apr. 16, 1937; east coast Vancouver Island, 10–20 fms., dense mud; head of Seymour Inlet, 36 fms.; 31 specimens (31 anterior ends, 25 middle pieces).

Family Dorvilleidae

Dorvillea pseudorubrovittata E. Berkeley

Dorvillea pseudorubrovittata E. Berkeley, 1927a, p. 409.—E. and C. Berkeley, 1948, p. 87.—Hartman, 1948, p. 29.

Type material: Syntypes, USNM 32674 and 32675, Round Island to Mudge Island, east coast Vancouver Island, British Columbia, 25 fms., June 11, 1920, 7 specimens. Syntypes, USNM 32676, between Jesse and Russel Islands, east coast Vancouver Island, British Columbia, June 5, 1924, 8 specimens.

Family Orbiniidae

Aricia macginitii E. and C. Berkeley

Aricia macginitii E. and C. Berkeley, 1941, p. 40, pl. 5, figs. 7–10.
Phylo ornatus (Verrill).—Hartman, 1957, p. 265, pl. 24, figs. 1–10.

Type material: Holotype, USNM 32717, Newport Bay, southern California, mud flats, Dec. 26, 1932, G. E. MacGinitie, collector.

Family Paraonidae

Aricidea longicornuta E. and C. Berkeley

Aricidea longicornuta E. and C. Berkeley, 1950, p. 53, fig. 2; 1952a, p. 38, figs. 68, 69.

Aricidea uschakovi Zachs.—Hartman, 1957, p. 321, pl. 43, fig. 5.

Type material: Holotype, USNM 32721, Pender Island, Malaspina Channel, Nanaimo, British Columbia, 75 fms., Jan. 19, 1929 (specimen in 2 pieces, posterior end missing). Paratypes, USNM 32720, Deep Hole, outside Departure Bay, Nanaimo, British Columbia, 230 fms., 2 specimens (in 4 pieces, posterior ends missing).

Aricidea lopezi E. and C. Berkeley

Aricidea lopezi E. and C. Berkeley, 1956*b*, p. 542, figs. 1–3.

Type material: Holotype, USNM 32718, off Upright Head, Lopez Island, San Juan Archipelago, Washington, 12 fms., Aug. 23, 1955, R. I. Smith, collector (complete specimen). Paratypes, USNM 32719, off Upright Head, Lopez Island, San Juan Archipelago, Washington, 12 fms., Aug. 23, 1955, R. I. Smith, collector, 2 specimens (1 complete, 1 in 2 pieces, posterior end missing).

Family Spionidae

Boccardia columbiana E. Berkeley

Boccardia columbiana E. Berkeley, 1927a, p. 416, pl. 1, figs. 4–8.—Woodwick, 1963a, p. 132, fig. 1.

Polydora (*Boccardia*) *columbiana* (E. Berkeley).—E. and C. Berkeley, 1952a, p. 16, figs. 22, 23.

Type material: Holotype, USNM 32714, Newcastle Island, Nanaimo, British Columbia, Aug. 3, 1918, boring in shaly rock (in 6 pieces). Paratypes, USNM 32713, Newcastle Island, Nanaimo, British Columbia, Aug. 3, 1918, boring in shaly rock; off Round Island, Aug. 19, 1918; in old wood of old float, Nov. 10, 1919; Piper's Lagoon, in shaly rock, May 4, 1923, 9 specimens (1 complete, 8 anterior ends, 5 middle pieces, 4 posterior ends). Paratypes, BMNH 1938. 29.29. Departure Bay, British Columbia.

Boccardia uncata E. Berkeley

Boccardia uncata E. Berkeley, 1927a, p. 418, pl. 1, figs. 9–13.

Polydora (*Boccardia*) *uncata* (E. Berkeley).—Okuda, 1937, p. 238, figs. 16, 17.—E. and C. Berkeley, 1952a, p. 14, figs. 18–21.

Type material: Holotype, USNM 32712, Piper's Lagoon, British Columbia, in frail sandy tube, May 4, 1923. Paratypes, USNM 32711, Piper's Lagoon, British Columbia, in frail sandy tubes, May 4, 1923, 3 specimens (3 anterior ends and 2 middle pieces). Paratypes, BMNH 1938. 11.29.27/28, Piper's Lagoon, British Columbia.

Neopygospio E. and C. Berkeley

Neopygospio laminifera E. and C. Berkeley

Neopygospio laminifera E. and C. Berkeley, 1954a, p. 462, figs. 6, 7.

Type material: Holotype, USNM 32715, Rathtrevor Beach, Nanaimo, British Columbia, in small sandy tube, July 1951. Paratypes USNM 32716, Rathtrevor Beach, Nanaimo, British Columbia, in small sandy tubes, July 1951, 3 specimens (2 complete, one with posterior end missing).

Polydora caeca var. *magna* E. Berkeley

Polydora caeca (Oersted) var. *magna* E. Berkeley, 1927a, p. 419.
Polydora magna E. Berkeley.—E. and C. Berkeley, 1936, p. 473; 1952a, p. 21.

Type material: Holotype, USNM 32710, False Narrows, Nanaimo, British Columbia, low tide (specimen in 2 pieces, anterior and posterior ends). Paratypes, BMNH 1938. 11.29.24, Rocky Bay, British Columbia.

Polydora cardalia E. Berkeley

Polydora cardalia E. Berkeley, 1927a, p. 418, pl. 1, fig. 14.—E. and C. Berkeley, 1952a, p. 21, figs. 38, 39.

Type material: Holotype, USNM 32709, Cardale Point, Nanaimo, British Columbia, July 6, 1921. Paratypes, USNM 32708, Cardale Point, Nanaimo, British Columbia, July 6, 1921; dredged off Round Island, Aug. 19, 1920; False Narrows, May 20, 1920; Rocky Bay, May 16, 1920; 21 specimens (2 complete, 19 anterior ends, 9 middle pieces, and 6 posterior ends). Paratypes, BMNH 1938. 11.29.25, Departure Bay, British Columbia.

Polydora ciliata var. *spongicola* E. and C. Berkeley

Polydora ciliata (Johnston) var. *spongicola* E. and C. Berkeley, 1950, p. 52, fig. 1; 1952a, p. 20, fig. 35.
Polydora spongicola E. and C. Berkeley.—Woodwick, 1963b, p. 212, fig. 2.

Type material: Holotype, USNM 32706, False Narrows, Nanaimo, British Columbia, in sponge encrusting rock of "reef" (specimen with anterior end only). Paratypes, USNM 32707, Northumberland Channel, British Columbia, in sponge on shells of *Pecten hindsi*, July 1943, 48 specimens (23 complete, 25 anterior ends, 3 middle pieces, 4 posterior ends).

Polydora socialis plena E. and C. Berkeley

Polydora socialis (Schmarda) subsp. *plena* E. and C. Berkeley, 1936. p. 468; 1952a, p. 22.

Type material: Holotype, USNM 32705, Departure Bay, Nanaimo, British Columbia, clean sand beds, littoral, May 1, 1935. Paratypes, USNM 32704, Departure Bay and Piper's Lagoon, Nanaimo, British

Columbia, clean sand beds, littoral, May 1 and 20, 1935, 28 specimens (15 complete, 13 anterior ends, 1 posterior end).

Paraprionospio tribranchiata **E. Berkeley**

Paraprionospio tribranchiata E. Berkeley, 1927a, p. 415, pl. 1, figs. 2, 3.—Weese, 1933, p. 19.—E. and C. Berkeley, 1936, p. 476.

Prionospio pinnata Ehlers.—E. and C. Berkeley, 1941, p. 42; 1942, p. 196; 1952a, p. 30, figs. 56, 57; 1963b, p. 149.

Type material: Holotype, USNM 32701, Nanoose Bay, Nanaimo, British Columbia, Aug. 28, 1918 (anterior end only; has been dry). Paratypes, USNM 32702, Nanoose Bay, Nanaimo, British Columbia, Aug. 28, 1918, 2 specimens (anterior ends; have been dry). Paratypes, USNM 32703, Nanoose Bay, Nanaimo, British Columbia, Sept. 6, 1918, 2 specimens (anterior ends, with proboscis everted). Paratypes, BMNH 1938. 11.29.30, Comox Spit, Vancouver Island, British Columbia.

Prionospio multibranchiata **E. Berkeley**

Prionospio multibranchiata E. Berkeley, 1927a, p. 414, pl. 1, fig. 1.

Prionospio cirrifera Wirén.—E. and C. Berkeley, 1942, p. 196; 1952a, p. 28, figs. 52, 53.

Type material: No type material was found in the collection. Type locality: Station Flat, Nanaimo, British Columbia, low tide.

Prionospio ornata **E. and C. Berkeley**

Prionospio ornata E. and C. Berkeley, 1961, p. 660, figs. 8–12; 1963b, p. 149; 1964, p. 132.

Type material: Holotype, USNM 32698, South Pacific off Peru, 8°17′ S., 79°09′ W., from plankton, 0 to 15 m., Sept. 25, 1958, P. N. Sund, collector, larva. Paratypes, USNM 32697, South Pacific off Peru, 8°17′ S., 79°09′ W., from plankton, 0 to 15 m., Sept. 25, 1958, P. N. Sund, collector, 35 larvae.

Spio butleri **E. and C. Berkeley**

Spio butleri E. and C. Berkeley, 1954a, p. 461, figs. 3, 4.

Type material: Holotype, USNM 32695, McIntyre Bay, Queen Charlotte Islands, British Columbia, swimming in tide-pool on sandy beach, May 27, 1953, T. H. Butler, collector. Paratypes, USNM 32696, McIntyre Bay, Queen Charlotte Islands, British Columbia, swimming in tide-pool on sandy beach, May 27, 1953, T. H. Butler, collector, 6 specimens (one complete, 5 anterior ends, 3 middle pieces, 1 posterior end).

Spio martinensis **var.** ***pacifica*** **E. Berkeley**

Spio martinensis Mesnil var. *pacifica* E. Berkeley, 1927a, p. 413.

Spio filicornis (Müller) var. *pacifica* E. Berkeley.—E. and C. Berkeley, 1936, p. 475; 1952a, p. 25.

Spio filicornis (Müller).—Hartman, 1948, p. 36. (Includes *S. martinensis*, var. *pacifica*.)

Type material: Holotype, USNM 32700, False Narrows, Nanaimo, British Columbia, May 30, 1919. Paratypes, USNM 32699, Nanaimo district, British Columbia; Horsewell Point, May 3, 1923; between Horsewell and Plantas, May 22, 1924; end of Newcastle, May 30, 1923; False Narrows, May 30, 1919; Cardale Point, July 6, 1921; 53 specimens (32 complete, 21 anterior ends, 1 middle piece, 1 posterior end).

Family Chaetopteridae

Leptochaetopterus E. Berkeley

Leptochaetopterus pottsi E. Berkeley

Leptochaetopterus pottsi E. Berkeley, 1927b, p. 441, figs. 1–3.
Telepsavus costarum Claparède.—Monro, 1933, p. 1052—E. and C. Berkeley, 1942, p. 196; 1952a, p. 63, figs. 127–130.

Type material: Syntypes, USNM 32691 and 32693, Piper's Lagoon, Nanaimo, British Columbia, Apr. 20, 1920, 17 specimens (17 anterior ends, 5 middle pieces). Syntypes, USNM 32692, Departure Bay Beach, Nanaimo, British Columbia, Apr. 20, 1920, 7 specimens (7 anterior ends, 2 middle pieces). Syntypes, USNM 32694, off Mudge Island, Nanaimo, British Columbia, 25 fms., in the crevices of a rotten piece of wood, June 11, 1920, 2 specimens (anterior ends).

Mesochaetopterus rickettsii E. and C. Berkeley

Mesochaetopterus rickettsii E. and C. Berkeley, 1941, p. 43, pl. 5, figs. 15, 16.

Type material: Holotype, USNM 32686, Newport Bay, southern California, G. E. MacGinitie, collector (anterior end). Paratypes, USNM 32685, Newport Bay, southern California, Jan. 19, 1932, E. F. Ricketts, collector, 8 specimens (have been dry). Paratype, 32684, Newport Bay, southern California, Mar. 22, 1933, G. E. MacGinitie, collector, 1 specimen (in 13 pieces).

Family Cirratulidae

Caulleriella viridis var. *pacifica* E. Berkeley

Caulleriella viridis (Langerhans) var. *pacifica* E. Berkeley, 1929, p. 307.
Caulleriella alata (Southern).—E. and C. Berkeley, 1950, p. 57; 1952a, p. 36; 1958a, p. 405.—Hartman, 1961, p. 108.

Type material: No type material was found in the collection. Type locality: False Narrows, Nanaimo, British Columbia.

Chaetozone spinosa var. *corona* E. and C. Berkeley

Chaetozone spinosa Moore var. *corona* E. and C. Berkeley, 1941, p. 45.
Chaetozone corona E. and C. Berkeley.—Hartman, 1961, p. 109.

Type material: Syntypes, USNM 32689 and 32690, off Corona del Mar, Calif., 12–17 fms., July 21, 1937, G. E. MacGinitie, collector, 4 specimens (one complete).

Dodecaceria fewkesi E. and C. Berkeley, new name

Sabella pacifica Fewkes, 1889, p. 132, pl. 7, figs. 1, 2. [Not Grube, 1859.]
Dodecaceria pacifica (Fewkes).—E. Berkeley, 1929, p. 308.—E. and C. Berkeley, 1932b, p. 314; 1941, p. 46; 1942, p. 197; 1952a, p. 33.
Dodecaceria fistulicola Ehlers (1901).—Reish, 1952, p. 103, pl. 20.
Dodecaceria fewkesi E. and C. Berkeley, 1954b, p. 326, figs. 1–7; 1956, p. 544. [New name for *Sabella pacifica* Fewkes, preoccupied.]

Remarks: According to Reish (1952), *Sabella pacifica* Fewkes (1889) (preoccupied by Grube, 1859) from Santa Barbara, Calif. is identical with *D. fistulicola* Ehlers (1901) from Chile. If so, *D. fewkesi* E. and C. Berkeley, a new name for *Sabella pacifica* Fewkes, should also be referred to *D. fistulicola*. Hartman (1959, p. 408) lists both *D. fewkesi* and *D. fistulicola* as valid names.

Tharyx multifilis var. _parvus_ E. Berkeley

Tharyx multifilis Moore var. *parvus* E. Berkeley, 1929, p. 307.—E. and C. Berkeley, 1952a, p. 35.
Tharyx parvus E. Berkeley.—Hartman, 1961, p. 113.

Type material: Holotype, USNM 32687, Piper's Lagoon, Nanaimo, British Columbia, May 31, 1923. Paratypes, USNM 32688, Piper's Lagoon, Nanaimo, British Columbia, May 31, 1923, 10 specimens (have been dry).

Family Flabelligeridae

Stylarioides negligens E. and C. Berkeley

Stylarioides eruca.—E. Berkeley, 1930, p. 69. [Not Claparède, 1870.]
Stylarioides negligens E. and C. Berkeley, 1950, p. 58, fig. 4; 1952a, p. 10, fig. 10.
Pherusa negligens (E. and C. Berkeley).—Hartman, 1959, pp. 418, 421.

Type material: Holotype, USNM 32683, Mitlenatch Island, Gulf of Georgia, British Columbia, 100 fms., D. Williamson, collector (specimen in 2 pieces).

Family Capitellidae

Heteromastus filobranchus E. and C. Berkeley

Heteromastus filobranchus E. and C. Berkeley, 1932a, p. 671, figs. 5–7; 1952a, p. 103, figs. 211, 212.—Hartman, 1947, p. 428, pl. 53, figs. 1–4.

Type material: Holotype, USNM 32682, Nanoose Bay, Nanaimo, British Columbia, 15–25 fms., Feb. 16, 1929 (specimen in 5 pieces has been dry). Paratypes, USNM 32681, Ship Bay, Rosario Inlet, Washington, 5–6 fms., sandy mud, A. O. Weese, collector, 6 specimens (in 17 pieces). Paratypes, BMNH 1938. 11.29.32, Saanich Inlet, Vancouver Island, British Columbia.

***Notomastus pallidior* var. *parvus* E. Berkeley**

Notomastus pallidior Chamberlin var. *parvus* E. Berkeley, 1929, p. 312.
Notomastus parvus E. Berkeley.—Hartman, 1959, p. 445.

Type material: Syntypes, USNM 32679 and 32680, north end Newcastle Island, Departure Bay, British Columbia, May 21, 1923, 7 specimens (9 pieces, one complete).

Remarks: *N. pallidior*, var. *parvus* is not included in E. and C. Berkeley, 1952a; a label added to the type material indicates that it was considered later by the Berkeleys to be the young of *Notomastus tenuis* Moore.

***Notomastus variegatus* E. and C. Berkeley**

Notomastus pallidior.—E. and C. Berkeley, 1942, p. 198. [Not Chamberlin, 1918.]
Notomastus variegatus E. and C. Berkeley, 1950, p. 59; 1952a, p. 103.

Type material: Syntypes, USNM 32677 and 32678, Estevan Point, west coast Vancouver Island, 45 fms., E. G. Hart, collector, 11 specimens (17 pieces).

Family Arenicolidae

***Arenicola glasselli* E. and C. Berkeley**

Arenicola glasselli E. and C. Berkeley, 1939, p. 340—Wells, 1962, p. 344.

Type material: Holotype, USNM 32835, San Felipe, Gulf of California, littoral, June 18, 1936, S. A. Glassell, collector. Paratypes, USNM 32844, San Felipe, Gulf of California, littoral, June 18, 1936, S. A. Glassell, collector, 6 specimens. Paratypes, BMNH 1938. 11.29.34/37, San Felipe, Gulf of California.

Protocapitella E. and C. Berkeley

***Protocapitella simplex* E. and C. Berkeley**

Protocapitella simplex E. and C. Berkeley, 1932a, p. 669, figs. 1–4.
Branchiomaldane vincenti Langerhans.—E. and C. Berkeley, 1950, p. 60; 1952a, p. 99, figs. 203–205.

Type material: Holotype, USNM 32808, Wreck Bay, west coast Vancouver Island, British Columbia, 1921 (specimen on slide). Paratypes, BMNH 1938. 11.29.33, Wreck Bay, west coast Vancouver Island, British Columbia.

Family Maldanidae

***Axiothella rubrocincta* var. *complexa* E. and C. Berkeley**

Axiothella rubrocincta (Johnson) var. *complexa* E. and C. Berkeley, 1941, p. 49.

Type material: Holotype, USNM 32818, Newport Bay, southern California, mud flats, November 1933, G. E. MacGinitie, collector. Paratypes, USNM 32819, Newport Bay, southern California, mud flats, November 1933, G. E. MacGinitie, collector, 2 specimens (in 3 pieces). Paratypes, USNM 32820, Newport Bay, southern California, mud flats, November 1933, G. E. MacGinitie, collector, 4 specimens (in 6 pieces).

Clymene (Euclymene) grossa var. _newporti_ E. and C. Berkeley

Clymene (Euclymene) grossa Baird var. *newporti* E. and C. Berkeley, 1941, p. 49; 1960a, p. 360.
Euclymene grossa (Baird) var. *newporti* (E. and C. Berkeley).—Hartman, 1959, pp. 453, 456.

Type material: Holotype, USNM 32826, Newport Bay, southern California, Nov. 12, 1936, G. E. MacGinitie, collector. Paratype, USNM 32827, LaJolla, southern California, Jan. 13, 1938, rocky shore with coarse sand beneath, G. E. MacGinitie, collector, 1 specimen (anterior and posterior ends).

Clymene (Euclymene) papillata E. and C. Berkeley

Clymene (Euclymene) papillata E. and C. Berkeley, 1939, p. 340, figs. 11, 12.
Euclymene papillata (E. and C. Berkeley).—Hartman, 1959, pp. 453, 457.

Type material: Holotype, USNM 32839, Punta Peñasco, Sonora, Mexico, S. A. Glassell, collector (specimen in 2 pieces, anterior and posterior ends). Paratype, BMNH 1938. 11.29.38, Punta Peñasco, Sonora, Mexico.

Leiochone columbiana E. Berkeley

Leiochone columbiana E. Berkeley, 1929, p. 315, pl. 1, figs. 1–9.—E. and C. Berkeley, 1952a, p. 44, figs. 81–84.
Clymenura columbiana (E. Berkeley).—Hartman, 1959, pp. 456, 458.

Type material: Holotype, USNM 32837, Departure Bay, Nanaimo, British Columbia, 8–10 fms. Paratype, BMNH 1938. 11.29.42, Departure Bay, Nanaimo, British Columbia.

Praxillella affinis var. _pacifica_ E. Berkeley

Praxillella affinis (Sars) var. *pacifica* E. Berkeley, 1929, p. 313.—E. and C. Berkeley, 1942, p. 198; 1952a, p. 49, figs. 97–100.

Type material: Syntypes, USNM 32832 and 32833, Nanoose Bay, British Columbia, Aug. 28, 1918, 10–15 fms., 4 specimens (1 complete, 3 anterior ends—1 with regenerating head, 1 middle piece, 2 posterior ends).

Family Ampharetidae

Pseudosabellides E. and C. Berkeley

Pseudosabellides lineata E. and C. Berkeley

Sabellides octocirrata.—E. and C. Berkeley, 1942, p. 201. (Not Sars, 1835.)
Pseudosabellides lineata E. and C. Berkeley, 1943, p. 131; 1944, p. 3; 1952a, p. 71, fig. 147.

Asabellides sibirica (Wirén).—Pettibone, 1954, p. 318, fig. 36, e.
Asabellides lineata (E. and C. Berkeley).—E. and C. Berkeley, 1956c, p. 241.

Type material: Syntypes, USNM 32809 and 32813, Nanoose Bay, British Columbia, 25 fms., Aug. 28, 1918, 3 specimens. Syntypes, USNM 32812, Nanoose Bay, British Columbia, sponge bed, Jan. 11, 1931, 3 specimens. Syntypes, USNM 32811, Port Burwell, Ungava, Hudson Bay, 10–15 fms., sandy mud, Sept. 16, 1927, 2 specimens. Syntypes, USNM 32810, Nash Harbour, Nunivak Island and Spiriden Bay, Kodiak Island, Alaska, 8–12 fms., 7 specimens.

***Pseudosabellides littoralis* E. and C. Berkeley**

Pseudosabellides littoralis E. and C. Berkeley, 1943, p. 131; 1952a, p. 72.

Type material: Holotype, USNM 32817, Departure Bay, Nanaimo, British Columbia, littoral, Apr. 21, 1929. Paratypes, USNM 32815, Departure Bay, Nanaimo, British Columbia, littoral, Apr. 21, 1929 and Apr. 5, 1934, 3 specimens. Paratypes, USNM 32816, Portage Lagoon, Nanaimo, British Columbia, littoral, May 4, 1935, 9 specimens. Paratypes, USNM 32814, Diana Bay, Hudson Bay, littoral, Aug. 4, 1928, 18 specimens.

Remarks: *Pseudosabellides littoralis* should be referred to *Asabellides* Annenkova, thus becoming *Asabellides littoralis* (E. and C. Berkeley).

Family Terebellidae

***Novobranchus* E. and C. Berkeley**

***Novobranchus pacificus* E. and C. Berkeley**

Novobranchus pacificus E. and C. Berkeley, 1954a, p. 465, figs. 8–13.

Type material: Holotype, USNM 32838, Buccaneer Bay, British Columbia, 25 fms., Sept. 20, 1918.

***Pista moorei* E. and C. Berkeley**

Pista moorei E. and C. Berkeley, 1942, p. 204, figs. 4, 5; 1952a, p. 81, fig. 166.

Type material: Holotype, USNM 32925, Trincomali Channel, British Columbia, 25–30 fms., August 1934. Paratypes, USNM 32824, Malaspina Channel, Pender Island, British Columbia, 25 fms., Jan. 1, 1929, 2 specimens. Paratype, USNM 32822, Departure Bay, British Columbia, July 11, 1940. G. E. MacGinitie, collector, 1 specimen.

***Pista pacifica* E. and C. Berkeley**

Pista elongata.—E. and C. Berkeley, 1935, p. 773. (Not Moore, 1909.)
Pista pacifica E. and C. Berkeley, 1942, p. 202, figs. 1–3; 1952a, p. 80, figs. 163–165.—Hartman, 1944b, p. 273, pl. 22, figs. 37–41, pl. 25, figs. 61, 62.

Type material: Syntypes, USNM 32841 and 32843, west coast Vancouver Island, British Columbia, June 27, 1934, 5 specimens (anterior ends and portion of tube). Syntypes, USNM 32834, Elkhorn Slough, southern California, G. E. MacGinitie, collector, 2 specimens (anterior ends and middle piece).

***Scionella estevanica* E. and C. Berkeley**

Scionella estevanica E. and C. Berkeley, 1942, p. 205; 1943, p. 130; 1952a, p. 87.

Type material: Holotype, USNM 32831, Estevan Point, west coast Vancouver Island, 76 fms., 1934, E. G. Hart, collector (anterior end). Paratype, USNM 32820, Estevan Point, west coast Vancouver Island, 76 fms., 1934, E. G. Hart, collector (anterior fragment, gills missing).

Family Sabellidae

***Branchiomma burrardum* E. Berkeley**

Branchiomma burrardum E. Berkeley, 1930, p. 71, fig. 1, A–E.—E. and C. Berkeley, 1941, p. 55; 1942, p. 201; 1952a, p. 110, figs. 227–229.
Megalomma splendida (Moore).—Hartman, 1956, p. 298.

Type material: Holotype, USNM 32828, Burrard Inlet, British Columbia, dredged, Sept. 15, 1928 (specimen in two pieces). Paratypes, USNM 32829, off Five Fingers, British Columbia, taken on setline, June 5, 1929, 2 specimens. Paratypes, BMNH 1935. 12.19.106, Dodd's Narrows, Vancouver Island, British Columbia.

***Distylia volutacornis* var. *pacifica* E. and C. Berkeley**

Distylia volutacornis (Montagu) var. *pacifica* E. and C. Berkeley, 1954a, p. 468, fig. 16.
Bispira volutacornis (Montagu) var. *pacifica* (E. and C. Berkeley).—Hartman, 1959, pp. 537, 542.

Type material: Holotype, USNM 32840, off Clarke Rock, Gulf of Georgia (specimen in 2 pieces, with tube).

***Fabricia minuta* E. and C. Berkeley**

Fabricia minuta E. and C. Berkeley, 1932b, p. 315, fig. 1, A–E; 1952a, p. 120, figs. 245, 246.
Oridia minuta (E. and C. Berkeley).—Hartman, 1951, p. 390.
Oriopsis? *minuta* (E. and C. Berkeley).—Banse, 1957, p. 88.

Type material: Syntypes, USNM 32806, Long Bay, west coast Vancouver Island, British Columbia, among algae, 1931, 2 specimens (on slide).

***Fabricia pacifica* E. and C. Berkeley**

Fabricia sabella (Ehrenberg).—E. Berkeley, 1930, p. 73, fig. 1, H (part).
Fabricia pacifica E. and C. Berkeley, 1950, p. 66; 1952a, p. 121, fig. 249.
Fabriciola berkeleyi Banse, 1956, p. 429.

Type material: Holotype, USNM 32807, Newcastle Island, Departure Bay, Nanaimo, British Columbia, on stones at low tide, Aug. 8, 1918 (specimen on slide). Paratypes, USNM 32836, Newcastle

Island, Departure Bay, Nanaimo, British Columbia, on stones at low tide, Aug. 8, 1918, 7 specimens.

Publications on Polychaetes by Edith and/or Cyril Berkeley with New Taxa Described

BERKELEY, EDITH

1923. Polychaetous annelids from the Nanaimo district, 1: Syllidae to Sigalionidae. Contr. Canadian Biol., n.s., vol. 1, pp. 203–218, 1 pl. [*Odontosyllis phosphorea* var. *nanaimoensis; Odontosyllis parva; Amblyosyllis lineata* var. *alba; Autolytus magnus, Malmgrenia nigralba; Lepidasthenia longicirrata.*]

1924a. Polychaetous annelids from the Nanaimo district, 2: Phyllodocidae to Nereidae. Contr. Canadian Biol., n.s., vol. 2, pp. 285–294, 1 pl. [*Tomopteris elegans.*]

1924b. On a new case of commensalism between echinoderm and annelid. Canadian Field-Nat., vol. 38, p. 193.

1927a. Polychaetous annelids from the Nanaimo district, 3: Leodicidae to Spionidae. Contr. Canadian Biol., n.s., vol. 3, pp. 407–422, 1 pl. [*Dorvillea pseudorubrovittata; Glycinde picta; Spio martinensis* var. *pacifica; Prionospio multibranchiata; Paraprionospio tribranchiata; Boccardia columbiana; Boccardia uncata; Polydora cardalia; Polydora caeca* var. *magna.*]

1927b. A new genus of Chaetopteridae from the N.E. Pacific: With some remarks on allied genera. Proc. Zool. Soc. London, pp. 441–445, 3 figs. [*Leptochaetopterus; Leptochaetopterus pottsi.*]

1929. Polychaetous annelids from the Nanaimo district, 4: Chaetopteridae to Maldanidae. Contr. Canadian Biol., n.s., vol. 4, pp. 305–316, 1 pl. [*Tharyx multifilis* var. *parvus; Caulleriella viridis* var. *pacifica; Notomastus pallidior* var. *parvus; Praxillella affinis* var. *pacifica; Leiochone columbiana.*]

1930. Polychaetous annelids from the Nanaimo district, 5: Ammocharidae to Myzostomidae (Appendix: Some pelagic forms from the Straits of Georgia and the west coast of Vancouver Island). Contr. Canadian Biol., n.s., vol. 6, pp. 65–77, 8 figs. [*Branchiomma burrardum; Tomopteris renata* (new name).]

1935. Swarming of *Odontosyllis phosphorea* Moore, and of other Polychaeta near Nanaimo, B.C. Nature, vol. 136, p. 1029.

1936a. Plankton of the Bermuda oceanographic expeditions, 3: Notes on Polychaeta. Zoologica, vol. 21, pp. 85–87.

1936b. Occurrence of *Saccocirrus* in western Canada. Nature, vol. 137, p. 1075.

1961. Swarming of the polychaete *Odontosyllis phosphorea* Moore, var. *nanaimoensis* Berkeley, near Nanaimo, B.C. Nature, vol. 191, p. 1321.

BERKELEY, EDITH, and BERKELEY, CYRIL

1932a. Some Capitellidae (Polychaeta) from the N.E. Pacific: With a description of a new genus. Proc. Zool. Soc. London, pp. 669–675. [*Protocapitella; Protocapitella simplex; Heteromastus filobranchus.*]

1932b. On a collection of littoral Polychaeta from the west coast of Vancouver Island. Contr. Canadian Biol., n.s., vol. 7, pp. 309–318. [*Fabricia minuta.*]

1935. Some notes on the polychaetous annelids of Elkhorn Slough, Monterey Bay, California. Amer. Midl. Nat., vol. 16, pp. 766–775.

1936. Notes on Polychaeta from the coast of western Canada, 1: Spionidae. Ann. Mag. Nat. Hist., ser. 10, vol. 18, pp. 468–477, 1 fig. [*Polydora socialis plena; Polydora magna.*]

1938a. Notes on Polychaeta from the coast of western Canada, 2: Syllidae. Ann. Mag. Nat. Hist., ser. 11, vol. 1, pp. 33–49, 12 figs. [*Syllis pulchra; Syllis harti; Syllis spenceri; Exogone lourei.*]

1938b. *Rhamphobrachium longisetosum*, n. sp., with some observations on the regeneration of the specialized anterior setae. Ann. Mag. Nat. Hist., ser. 11, vol. 1, pp. 428–435, 8 figs. [*Rhamphobrachium longisetosum.*]

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