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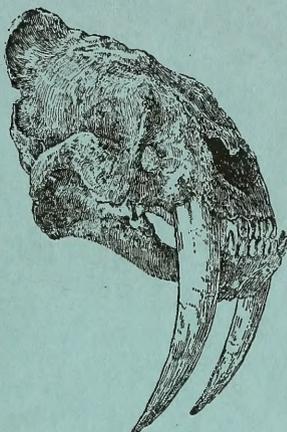
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BULLETIN OF THE Southern California Academy of Sciences

LOS ANGELES, CALIFORNIA

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VOL. 58

JANUARY-APRIL, 1959

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**MAMMAL FOOTPRINTS FROM THE AVAWATZ
FORMATION, CALIFORNIA**

By RAYMOND M. ALF^o

INTRODUCTION

The Avawatz formation and its Tertiary mammals in the Avawatz Mountains were described in 1939 by Paul C. Henshaw and Robert W. Wilson.

During a field trip to the Avawatz Mountains, northwest of Baker, California, Robert Baum of the Webb School discovered mammal footprints high on the wall of a small canyon. Two later trips were made with equipment necessary for removal and preservation of the tracks, which are the first to be reported from the Mojave Desert.

My sincere thanks are extended to the many Webb School boys who participated in the field trips. I am grateful to Sanford Gifford and William Webb, also of the Webb School, for their assistance in the difficult task of removing the footprints. Gratitude is also expressed to Malcolm McKenna and Richard H. Tedford of the University of California, Berkeley, for their help in identifying mammal teeth and bones closely associated with the ichnites. Thankfulness is extended to A. O. Wiidford for criticizing this manuscript.

LOCATION

The locality lies in the southeasternmost flank of the Avawatz Mountains, ten miles by road northwesterly from the town of Silver Lake, which is eight miles north of Baker, California.

It is in the southeast part of the northwest quarter of sec. 9, R. 7E., T. 15N., Baker Quadrangle, San Bernardino Co., California.

STRATIGRAPHY

The upper Tertiary formation consists of sediments which lie to the south and west of the eastern end of the Avawatz Mountains and is divided by Henshaw into four members: (1) a coarse conglomerate (fanglomerate), (2) green and brown clays, (3) resistant breccia, and (4) arkosic sands and tuffs, with a total thickness estimated at several thousand feet.

^oWebb School of California, Claremont, California.

The upper member of the series approximately a thousand feet in thickness and reflecting the dominant structure consisting of a series of broadly to closely folded anticlines and synclines is fossiliferous. The sediments of the uppermost member of the Avawatz formation are characterized by a predominance of arenaceous material that is relatively soft and friable. There are several persistent layers, a few feet thick, of pure white volcanic ash and also several of punky gray volcanic ash. The bulk of the material seems to have been laid down under flood-plain conditions.

Where the footprints were first located the sediments consist of alternating friable sandstone a few inches thick and clay about a quarter of an inch thick. On weathered surfaces the clay has been removed, and the footprints are not so clear as on the freshly exposed clay surface. At other localities natural casts of footprints have been found in very hard sandstone.

FOOTPRINTS

The footprints (Plate 1) were made by large and small camels, an antelope, and carnivores in random fashion with no trail relation, indicating the possibility of a water hole previous to the influx of the overlying sands.

The large camel footprints (Plate 2, top) have an average length of about 14 cm. and a maximum width of about 13 cm. while the smaller ones (Plate 3) average approximately 9.8 cm. in length and 7.6 cm. in width. Teeth and bones identified as *Procamelus*, collected in the formation nearby, indicate that the smaller camel footprints were made by camels of that genus. The larger camel footprints could have been made by *Alticamelus*, though no teeth or bones referable to that genus have been found at Avawatz.

The carnivore footprints seem to be of three types. One print of a pes 13 cm. in length and a width of 8 cm. across the toes has a well developed heel (Plate 2; bottom). This plantigrade print has associated with it a manus digitigrade print 8.5 cm. in length with a maximum width of 8 cm. This type of print could have been made by a bear-dog, and *Osteoborus* remains have been identified from the formation.

The largest of the digitigrade carnivore footprints has a length of 10 cm. and width of the same dimension and the pad is as broad as the toe width. The smallest of this type of carnivore prints has a maximum length of 8.5 cm. and a width of 7.3 cm. The pad is noticeably narrower than the toe spread.



PLATE 1

Large slab of sandstone showing footprints of camel, carnivore, and antelope.

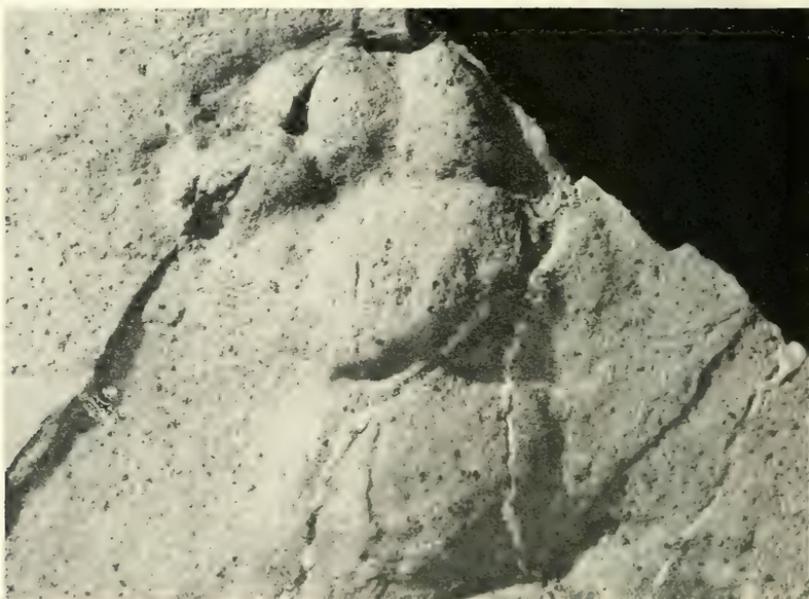


PLATE 2

Upper: Footprint of large camel with faint footprints of antelope.
Lower: Natural cast of "bear-dog" footprint showing well developed heel.

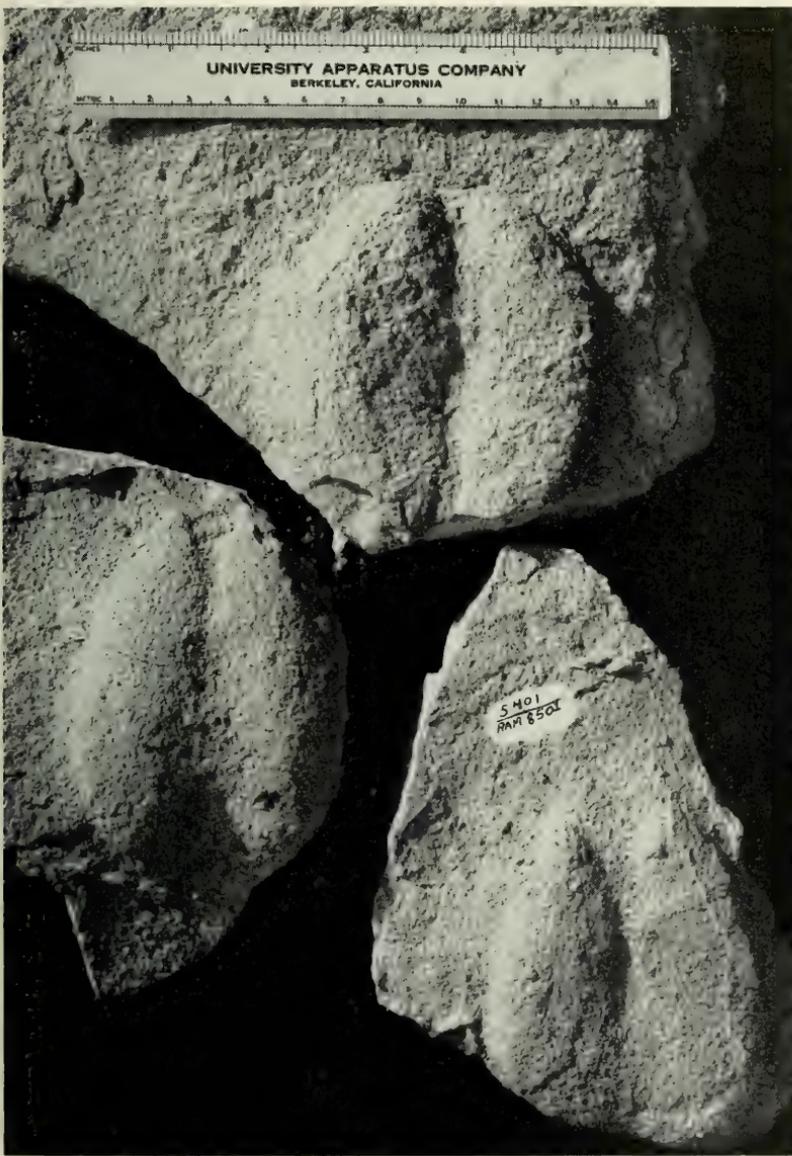


PLATE 3

Natural casts of small camel, *Procamelus*?



PLATE 4

Footprint of "bear-dog" on clay surface.

The occurrence of Tertiary mammal footprints is either very rare or has received so little consideration from collectors in the field that few specimens have been recorded. Robert G. Chaffee has reported mammal footprints from the White River Oligocene of Wyoming and Tertiary mammal tracks have been reported from Oklahoma (Hesse, Curtis J.) and Kansas (Robertson, G. M. and Sternberg).

Curry states that the Copper Canyon upper Tertiary beds of Death Valley have yielded hundreds of well preserved tracks of mammals and birds. Included in his collection are at least eight kinds of carnivores, three horses, a proboscidian, three or more camelids, a number of other artiodactyls, several web-footed, and numerous large and small wading birds.

The search for additional footprints from the Avawatz formation is continuing with the hope that more light can be gained concerning the life habits of the animals, the climate and the ecology of the Mojave Desert during upper Tertiary time.

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A NEW SPECIES OF SEA HARE FROM
CALIFORNIA WATERS

By LINDSAY R. WINKLER*

During a study of Aplysiids in the collection of the Allan Hancock Foundation, University of Southern California, two specimens were found which represent a new species with close affinities to the common *Aplysia californica* Cooper. According to the station number regularly deposited in the bottles, the specimens were collected at the mouth of Topanga Canyon, Malibu, California, December 18, 1945 by members of the Foundation staff, Dr. E. Yale Dawson and Dr. Floyd Durham.

During the initial study of the collections these were thought to be specimens of *A. vaccaria* Winkler, (1954) because of their superficial resemblance to that species occasioned by persistently black body color. When routine check of the number of stomach teeth was made, however, it became apparent that the affinities were not with *A. vaccaria* belonging to the subgenus *Tullia* (Preuvot-Fol, 1933), but with the very different *A. californica* of the subgenus *Neaplysia* Cooper 1863). As noted in the description, other anatomical features distinguish it from this latter species.

Aplysia (*Neaplysia*) *nettiae*, n. sp.

Description: Form and body size are as for the subgenus (Plate 5). The parapodial lobes are free to the union with the foot, where they are separated by about one-fourth the distance of separation at the anterior ends. The posterior margins extend caudad as small flaps on either side of the pseudosiphon, a small rounded orifice between the parapodial lobes posteriorly serving as an auxiliary excurrent siphon in the subgenus *Neaplysia*. The diameter of the mantle foramen approximates one-fifth of its distance posterior to the shell margin. The opaline gland is of the alveolar type. The shell shows an obtuse auxiliary plate in the plane of the nucleus as characteristic of the subgenus, and a pronounced apical membrane. The nucleus is present in the auxiliary plate as is the case also in *A. californica* (Winkler, 1958). There is no noticeable calcareous layer.

The color of the type specimen is deep black in alcohol preservative, into which quantities of olive green pigment diffuse from the specimens. The midlateral radular teeth possess very

*School of Tropical and Preventive Medicine, Loma Linda, California.



PLATE 5

Photograph of a preserved specimen of *Aplysia nettiae*.

long pointed median cusps with many sharp lateral spines and a basal cusp, serrate on its outer margin. The jaws have weak transverse ridges.

TYPE SPECIMEN: Holotype, No. 991, Paratype, No. 992, deposited in the collection of the Allan Hancock Foundation, University of Southern California.

TYPE LOCALITY: Mouth of Topanga Canyon, Malibu, California.

Remarks: This species differs from *A. californica* in that the foramen leading to the mantle cavity is not formed into a minute tube as is always the case in the latter species. In the type specimens the orifice is approximately 3 mm. in diameter. The parapodial lobes are weaker and much more finely frilled on the margins. In *A. californica* the parapodial lobes are united at the point of union with the foot, while in this species their points of union with the foot are well separated. Small flaps extend caudad just above their union with the foot, which is not the case in *A. californica*. The shell bears considerable resemblance to that of *A. californica*. The apical membrane is more

fully developed and more acute. The shell is veined with black forming a network, probably due to the heavy supply of pigmentation and is more convex than the variable forms from *A. californica*, (Winkler, in press). The phallus is similar to that of *A. californica*, except that it is black rather than white. The dominant foods found in the type specimens were *Chondria nidifica* and *Hypnea*, sp., algal identification by Dr. E. Yale Dawson, probably *H. esperi*. In addition both *Centrocerus clavulatum* and a species of *Lophosiphonia* were abundant in the crop contents. If a heavy pigmentation is due only to the food eaten (Winkler, 1959) rather than metabolic species differences from *A. californica*, it would seem that *Chondria nidifica* would have to be the responsible sea weed since the writer has observed the color pattern of numerous specimens of *A. californica* eating dominantly all the other algae noted above. These latter animals did not demonstrate any black pigmentation nor the diffusion of pigment into the alcohol preservative. The species is named after the writer's small daughter, who has a very special interest in sea hares.

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NEW SPECIES OF SPIONIDÆ (ANNELIDA, POLYCHAETA)
FROM SOUTHERN CALIFORNIA¹

By DONALD J. REISH

Department of Biology and the Allan Hancock
Foundation, University of Southern California

While studying the ecology of the polychætous annelids in Newport Bay, California, the author encountered one new species and one new subspecies belonging to Family Spionidæ. These specimens were collected from the bottom of the bay with size one Hayward orange-peel bucket (Reish, 1955). The author is indebted to Mr. Richard Linsley for the use of his boat, and to Dr. J. Laurens Barnard and Dr. Keith H. Woodwick for assistance in collecting the material.

***Spiophanes pigmentata* n. sp.**
Plate 6, Figures 1 to 4

This new species of *Spiophanes* was taken from many different stations in Newport Bay in 1951 and 1954. The holotype, of about 80 setigerous segments, is 15 mm. in length and 1.5 mm. in width.

ANTERIOR END.—The prostomium (Pl. 6, fig. 1) is longer than broad with its ridge extending to the posterior limits of the first setigerous segment. At the anterior margin the prostomium is broadly rounded with no indication of lateral extensions or frontal horns. A large brown pigmented area is located about a third of the way back on the prostomium. The palpi arise from the lateral posterior margins of the prostomium; they are thick at their base and extend to segment 15. Two pairs of eyes, in trapezoidal arrangement, are located in the posterior half of the prostomium. The anterior pair is set farther apart than the posterior pair. There is no median antenna.

The first segment has slender capillary setæ in both the notopodium and the neuropodium. There is a brown pigmented area at the dorsal and ventral margin of the neuropodium of this segment.

The dorsal cirrus is well developed beginning with the second segment. It is filiform in shape and is directed back along the dorsum.

¹Contribution number 236 from the Allan Hancock Foundation, University of Southern California. Present address: Dept. of Biological Sciences, Long Beach State College.

SETÆ.—The hooded hooks (Pl. 6, fig. 2) first appear at segment 12 and are present to the posterior end. They are quinquedentate with two larger and three smaller teeth. The smaller teeth are in triangular arrangement with the single tooth at the apex of the hook. These setæ are accompanied with capillary ones.

The posterior parapodia (Pl. 6, fig. 3) bear well-developed dorsal cirri, notopodial and neuropodial lobes. The capillary setæ in the notopodium project beyond the dorsal cirrus. Both the hooded hooks and capillary setæ of the neuropodium extend beyond its lobe.

The pygidium (Pl. 6, fig. 4) terminates in a pair of dorsal, thick, long papillæ and a pair of ventral, thick, short papillæ.

PIGMENTATION.—This species is strongly pigmented; the pigmentation persisting in the preserved condition. Typically the pigmented areas occur on the prostomium and segment one as described above (Pl. 6, fig. 1). However, some variation was found to exist in smaller specimens. A pigmented patch was located on either side of the prostomium on the peristomium instead of the single pigmented area on the prostomium. The pigmentation of the dorsal margin of the neuropodium extends to segments four to six in the larger specimens and to segments 10 to 12 in the smaller ones. A dorso-median patch of brown begins with the second setigerous segment and extends to segments 6 to 12 in the different specimens. In addition some of the smaller specimens may have pigmentation just lateral to the dorso-median patch; it may appear as a solid pigment or as a ring.

Spiophanes pigmentata lives in a fine membrane tube which is composed of a small particles and a few sand grains. The tube consists of a tan region and a rust region.

DISCUSSION.—*Spiophanes pigmentata* differs from the other known species of the genus by the possession of:

- (1) unique pigmentation pattern in anterior segments,
- (2) quinquedentate hooded hooks which first appear at segment 12, (3) posterior parapodial lobes with extending dorsal cirri, notopodial and neuropodial lobes, and setæ, and (4) pygidium with a pair of longer, dorsal papillæ and a pair of shorter, ventral papillæ.

Four other species of the genus have been reported from the eastern Pacific. They are characterized as follows:

Spiophanes missioniensis Hartman (1941)

- (1) lateral extension to prostomium
- (2) a curved spine in the first neuropodium
- (3) tridentate hooded hooks appearing in the neuropodium of segment 15

- (4) pygidium with two dorsal cirri and one ventral cirrus
- (5) reported from only southern California

Spiophanes fimbriata Moore. (1923)

- (1) rounded prostomium
- (2) median antenna
- (3) lateral interparapodial pouches after segment 15
- (4) hooded hooks appearing in the neuropodium of segment 15
- (5) reported from only California

Spiophanes bombyx (Claparède). (Berkeley and Berkeley, 1952)

- (1) frontal horns
- (2) bidentate hooded hooks appearing in the neuropodium of segment 15
- (3) a curved spine in the first neuropodium
- (4) pygidium with a dorsal cleft and two ventral cirri
- (5) cosmopolitan in distribution

Spiophanes cirrata Sars (Berkeley and Berkeley, 1952)

- (1) lateral extension to prostomium
- (2) median antenna
- (3) tridentate naked hooks appearing in the neuropodium of segment 15
- (4) pygidium with 6 to 12 cirri, some of which may be dichotomously branched
- (5) reported from cold waters of the Northern Hemisphere

TYPE MATERIALS.—The holotype, 11 paratypes, and additional specimens have been deposited in the annelid collections of the Allan Hancock Foundation, University of Southern California.

TYPE LOCALITY.—Newport Bay, California, from substrate composed of mud, muddy sand, or sand and shell fragments.

***Prionospio heterobranchia newportensis* n. subsp.**

Plate 6, Figure 5

A total of 188 specimens from 39 stations were collected from the benthos of Newport Bay, California. The holotype of 82 setigerous segments measures 20 mm. in length and 1.0 mm. in width. Other complete specimens range from 15 to 25 mm. in length.

Anterior end.—The prostomium is rounded in front and bears a pair of smaller eyes anterior to a pair of larger ones. The caruncle extends to the posterior limits of the second setigerous segment. There is no median antenna.

The first setigerous segment is abranchiata. Branchiæ are present from setigerous segment two to six. The first, fourth, and fifth pairs are plumose, and the second and third pairs are filiform.

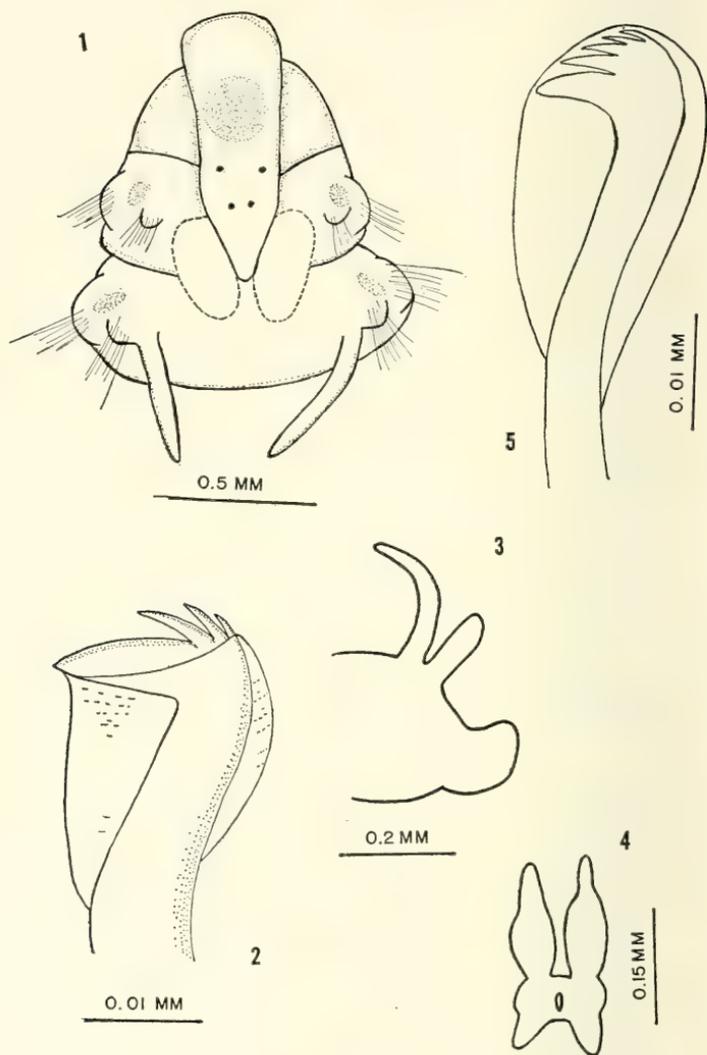


PLATE 6

Spiophanes pigmentata n. sp. Fig. 1 to 4

Fig. 1. Anterior end, dorsal view. Dotted lines indicate origin of palpi.

Fig. 2. Hooded hook from anterior neuropodium.

Fig. 3. Posterior parapodium showing extending dorsal cirrus, notopodial and neuropodial lobes.

Fig. 4. Pygidium in end view showing the anus, the longer, dorsal papillae, and shorter, ventral papillae.

Prionospio heterobranchia Newportensis n. subsp. Fig. 5

Fig. 5. Hooded hook from anterior neuropodium.

SETÆ.—The notopodia and neuropodia of the first 13 setigerous segments bear only two simple capillary setæ. Hooded hooks (Pl. 6, fig. 5) are first present in the neuropodium of segment 14. The hooks are composed of one larger and four smaller teeth which are surrounded by a hood. Similar hooded hooks begin in the notopodium from setigerous segment 42 to 55. Capillary setæ accompany the hooks in both the notopodium and neuropodium throughout the length of the animal.

POSTERIOR END.—The pygidium is characterized by a single, longer, dorso-median cirrus and two shorter, lateral cirri.

DISCUSSION.—The stem species *Prionospio heterobranchia* Moore (1907), and the two subspecies, *P. h. texana* Hartman (1951) and *P. h. newportensis* n. subsp., are the only species of the genus characterized by having five pairs of branchiæ. These three may be separated as follows:

Prionospio heterobranchia Moore (1907)

Eyes: One pair

Appearance of hooks: Neuropodial segment 15
Notopodial segment 40

Distribution: Massachusetts

Prionospio heterobranchia texana Hartman (1951)

Eyes: Two pairs

Appearance of hooks: Neuropodial segment 14

Appearance of hooks: Neuropodial segment 14
Notopodial segments 42 to 55

Distribution: Southern California

TYPE MATERIAL.—The holotype and 22 paratypes have been deposited in the polychæte collections of the Allan Hancock Foundation, University of Southern California.

TYPE LOCALITY.—Newport Bay, California, from shallow depths.

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THE NUMBER OF SPECIES OF GAMMARIDEAN AMPHIPODA (CRUSTACEA)*

By J. Laurens Barnard

No precise figures on the number of species of gammaridean Amphipoda have been published, to the knowledge of the writer. The Gammaridea comprise the largest suborder of the Amphipoda and are familiar inhabitants of the marine intertidal and benthos, streams and lakes, and sandy beaches (sand-hoppers). The group has been catalogued in my recent "Index to the Families, Genera and Species of Gammaridean Amphipoda" (Barnard 1958, Hancock Foundation Occ. Pap. 19) which is the first resume since Stebbing's treatise (1906, *Das Tierreich* 21).

The following table illustrates the composition of the suborder in comparison to that of 50 years ago.

| | Stebbing 1906 | Barnard 1958 (through 1956) |
|----------|---------------|--------------------------------|
| Families | 42 | 57 |
| Genera | 330 | 605 |
| Species | 1242 | 3146 |

The following compilation provides data on the distribution of the Gammaridea according to habitat, through 1956.

| | |
|-----------------------------|------|
| Marine and brackish species | 2376 |
| Stream and lake species | 400 |
| Lake Baikal species | 232 |
| Terrestrial species | 88 |
| Subterranean species | 50 |

*Contribution No. 226 from the Allan Hancock Foundation, University of Southern California

PLIOCENE MARINE DEPOSITS IN NORTHWESTERN BAJA CALIFORNIA, MEXICO, WITH THE DESCRIPTION OF A NEW SPECIES OF *ACANTHINA* (GASTROPODA)†

By LEO G. HERTLEIN* AND EDWIN C. ALLISON**

Pliocene sediments with marine invertebrate fossils occur at several locations in northwestern Baja California. They have been mentioned only incidentally in the literature dealing with that region except for one brief account (Santillán and Barrera, 1930, pp. 20-25). Recent studies of the geology and Pliocene paleontology of southwestern San Diego County, California (Hertlein and Grant, 1944) reveal, by comparison, the dearth of information concerning contemporary faunas in immediately adjacent portions of the State of Baja California, Mexico. To supply information concerning this area we have prepared the present paper presenting the results of recent field work together with a compilation of the findings of Santillán and Barrera, published and unpublished.

The previously unpublished descriptions of fossil localities collected by Santillán and Barrera, University of California Museum of Paleontology localities A-433 through A-470, are exceedingly brief and not in complete agreement with plotted positions on a reconnaissance map presumably prepared from notes of these collectors. Localities from which collections of fossils have been obtained recently are located on the sketch map (Plate 7) with greater precision.

The writers wish to acknowledge the aid of several individuals who assisted in the field work or who contributed information which has aided in the preparation of this paper. These include: Dr. W. K. Emerson, A. Allanson, J. A. Van Couvering, F. H. Kilmer, and R. H. Tedford. All have participated in this work as students or employees of the University of California. Mr. Ira E. Cornwall, Victoria, British Columbia, kindly identified the species of barnacle cited in this paper.

GEOLOGICAL SETTING

EDWIN C. ALLISON

North of the Vizcaíno Bay and Peninsula (Beal, 1948; Mina, 1956, 1957), marine Pliocene deposits along the west coast of Baja California are generally limited to thin, flat-lying, discontinuously distributed, near-shore deposits resting on a variety

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of older rocks. Santillán and Barrera (1930, pp. 20-25) noted the occurrence of some of the marine, fossil-bearing, Pliocene deposits between El Rosario and San Antonio del Mar and designated them the Cantil Costero formation, noting occurrences especially in the area between El Rosario and San Ramón (east of San Quintín Bay). That area would provide, by inference, the type locality (or typical occurrence) for the Cantil Costero formation. Beal (1948, pp. 77-81) interpreted the Salada formation of Heim (1922, pp. 544-546) broadly to include all marine Pliocene rocks of the Baja California Peninsula, including those described by Santillán and Barrera. The Salada formation, as the name was used originally by Heim, pertained only to exposures in Arroyo Salada, near Magdalena Bay. Santillán and Barrera's Cantil Costero formation applies most appropriately to marine Pliocene deposits now known in western Baja California from El Rosario northward.

The Cantil Costero lithology is dominated by varying proportions of conglomerate and sandstone, generally poorly sorted and friable. Clasts have been derived mainly from volcanic and intrusive rocks of the Cretaceous Alisitos formation and associated plutons (Table 1). Thickness of the Cantil Costero formation is not known to exceed 5 meters. Exposures usually occur at elevations greater than 100 meters and at distances of a few kilometers inland from the present shore line.

Post-Pliocene marine deposits (Emerson, 1956, pp. 323-324) generally occur at lower elevations than do fossiliferous beds of the Cantil Costero formation. Topographically highest marine deposits which are demonstrably Pleistocene are located on the north side of Cabo Colnett (University of California Museum of Paleontology localities V-5123, V-5686, V-5728, and B-3080) where both marine invertebrates (*Dendroaster excentricus*) and terrestrial vertebrates (deer, ground sloths, antilocaprids, and caballine horses) occur at an estimated elevation of 50 meters¹.

Rocks varying greatly in age underlie the Cantil Costero formation, usually without marked discordance. Fossiliferous Pliocene arenaceous sediments lie conformably on late Tertiary basalts at one of the more northern localities, B-3066. Southward, in the vicinity of El Rosario, Pliocene deposits rest on the late Cretaceous Rosario formation. The Cantil Costero formation overlies variegated reddish and greenish colored beds east of San Quintín Bay, in the central part of the area containing outcrops of Pliocene deposits. These variegated beds represent

¹Vertebrate fossils collected by A. Allanson, J. A. Van Couvering, F. H. Kilmer, and E. C. Allison have been examined by R. H. Tedford of the University of California Museum of Paleontology. His report states that the assemblage is clearly Pleistocene in age, but that a more refined age determination is at present impossible.

nonmarine deposition during part of the interval of time extending from late Cretaceous through Tertiary. Similar nonmarine sediments contain large fossil reptiles west of El Rosario but north of Cabo Colnett these lie stratigraphically between a thin marine Paleocene formation and Pleistocene deposits.

Table 1. GENERALIZED STRATIGRAPHY OF WESTERN BAJA CALIFORNIA BETWEEN ENSENADA AND EL ROSARIO

| Rock Unit | Lithology | Maximum Thickness | Age |
|----------------|--|-------------------|---------------------------|
| | Marine and nonmarine coarse sediments (usually terrace deposits) | 20 meters | Pleistocene |
| Cantil Costero | Marine coarse sediments | 5 meters | Pliocene |
| | Basic volcanic rocks | 20 meters | ? Miocene-Pleistocene |
| | Nonmarine sediments | 100 meters | Cenozoic undifferentiated |
| Sepultura | Marine sediments with local algal limestones* | 20 meters | Paleocene |
| Rosario | Marine sediments | 300 meters | late Upper Cretaceous |
| | Nonmarine sediments | 200 meters | Upper Cretaceous |
| | Nonmarine clastic and pyroclastic rocks | 150 meters | ? late Lower Cretaceous |
| Alisitos | Marine volcanic and immediately derived sedimentary rocks with interbedded biohermal and bio-clastic limestones | 5000 meters | late Lower Cretaceous |
| | Plutons of the peninsula range Batholith (intrude Alisitos rocks; truncated by Rosario sediments) Upper Cretaceous | | |

PALEONTOLOGY

LEO G. HERTLEIN AND EDWIN C. ALLISON

The fossils from Pliocene strata in northwestern Baja California, discussed in the present paper, are few in number and, in general, poorly preserved. Their occurrence is of interest because they clearly indicate the presence of discontinuous patches of strata of Pliocene age in the region between San Diego, California, (the fauna of the San Diego formation of Pliocene age is now receiving special study) and the fossiliferous beds of Pliocene age described at Turtle Bay, Baja California, by E. K. Jordan and Hertlein (1926), by Hertlein (1933), by Chace (1956), and by Mina (1956, 1957). Several species in the present list of fossils also occur in Pliocene strata of the region to the north or to the south.

*Algal limestones here cited may be of Eocene age.

The fossils discussed here were collected by Manuel Santillán and Tomás Barrera (1930), and by field parties from the department of paleontology, University of California, Berkeley, chiefly by William K. Emerson and Edwin C. Allison. One lot of oysters was collected by E. K. Jordan and L. G. Hertlein near San Antonio del Mar. The specimens considered, with the exception of a paratype of the new species described herein and the oysters collected by Jordan and Hertlein (which are in the collections of the California Academy of Sciences), are in collections of the University of California Museum of Paleontology.

The localities from which Pliocene fossils were collected in northwestern Baja California follow.

Loc. A-433 (Univ. Calif. Mus. Paleo.). North of El Rosario on mesa; M. Santillán and T. Barrera, colls.; field No. 20. [No fossils from this locality seen by present authors.]

Loc. A-434 (Univ. Calif. Mus. Paleo.). ?Near Loc. A-433 (U.C.), north of El Rosario; M. Santillán and T. Barrera, colls.; field No. 21. [No fossils from this locality seen by present authors.]

Loc. A-449 (Univ. Calif. Mus. Paleo.). Border of mesa northeast of El Rosario; M. Santillán and T. Barrera, colls.; field No. 35. [No fossils from this locality seen by present authors.]

Loc. A-450 (Univ. Calif. Mus. Paleo.). ?Near Loc. A-449 (U.C.); M. Santillán and T. Barrera, colls.; field No. 21. This locality bears the same field number as that at Loc. A-434 (U.C.) and therefore is similarly questionable. [No fossils from this locality seen by present authors.]

The four preceding collecting stations appear to be situated near the summit of the mesa northeast of El Rosario: apparently the Pliocene sediments overlie late Cretaceous strata of the Rosario formation.

Loc. 456 (Univ. Calif. Mus. Paleo.). Terrace east of San Quintín, between San Simón and Agua Chiquita; M. Santillán and T. Barrera, colls.; field No. 47.

Loc. 459 (Univ. Calif. Mus. Paleo.). Same horizon as that at Loc. A-456 (U.C.), north of Agua Chiquita; M. Santillán and T. Barrera, colls.; field No. 48.

Loc. 470 (Univ. Calif. Mus. Paleo.). Three miles (4.8 km.) above mouth of Covotitos Creek [San Antonio del Mar]; M. Santillán and T. Barrera, colls.; field No. 63.

Fossils from localities A-456 (Univ. Calif. Mus. Paleo.) and A-459 (Univ. Calif. Mus. Paleo.) probably were collected near the summit of the mesa east of San Quintín Bay where the Cantil Costero formation overlies nonmarine strata of late Cretaceous or Tertiary age.

Loc. A-6522 (Univ. Calif. Mus. Paleo.). 8.2 miles (13.2 km.) south of Socorro; R. A. Stirton, coll., 1947. [The Cantil Costero formation probably overlies late Cretaceous strata of the Rosario formation at this locality.]

Loc. B-1404 (Univ. Calif. Mus. Paleo.). Sparsely fossiliferous sandstone and conglomerate exposed near top of bluffs about six miles (9.7 km.) east of San Quintín; Pliocene beds rest upon variegated reddish and greenish nonmarine sediments of late Cretaceous or Tertiary age; E. C. Allison, coll., 1951.

Loc. B-3066 (Univ. Calif. Mus. Paleo.). Shallow road metal quarry on west side of Ensenada-San Quintín highway, near kilometer marker 258; fossils occur in whitish friable sandstone which rests upon Tertiary basalt; W. K. Emerson and E. C. Allison, colls., 1956.

Loc. B-4300 (Univ. Calif. Mus. Paleo.). Near highway at Arroyo Amargo, north of El Rosario; beds probably overlying late Cretaceous sediments; T. Lawrence, coll., 1956.

Loc. 31785 (Calif. Acad. Sci.). Oysters near road on top of Colnett

Mesa, about three miles south of San Antonio del Mar; E. K. Jordan and L. G. Hertlein, colls., 1926.

List of species of Pliocene age from localities in northwestern Baja California. Locality numbers are arranged from north to south. The species accompanied by the symbol * indicates that specimens were seen by the present authors.

| | North to South | | | | | | | | |
|---|----------------|----------------|--------|-------|-------|--------|--------|--------|---|
| | A-470 | 31785 (C.A.S.) | B-3066 | A-459 | A-456 | B-1404 | A-6522 | B-4300 | Listed by Santillán and Barrera. Localities not differentiated by Identifications by B. L. Clark. Nomenclature that of current usage. |
| Echinoidea | | | | | | | | | |
| <i>Dendraster ashleyi</i> Arnold..... | | | | | | | | | X X |
| " <i>Dendraster</i> cf. <i>ashleyi</i> Kew"..... | | | | | | | | | X X |
| Pelecypoda | | | | | | | | | |
| * <i>Anomia</i> sp. | | | X | | | | | | |
| <i>Arca</i> sp. | | | | X | | | | | |
| <i>Hinnites multirugosus</i> Gale | | | | X | | | | | |
| * <i>Mytilus</i> sp. (large) | | | | X | | | | | |
| <i>Ostrea</i> sp. | | | | | | | | | |
| <i>Ostrea vespertina</i> Conrad | | | | | | X | X | X | |
| * <i>Ostrea vespertina veatchii</i> Gabb..... | X | X | | | | | | | |
| * <i>Pecten bellus</i> Conrad | | | | | | | X | | |
| <i>Pecten circularis</i> Sowerby | | | | | | | | X | |
| * <i>Pecten</i> cf. <i>P. gallegosi</i> E. K. Jordan & Hertlein | | | | X | | | | | |
| * <i>Pecten ethegoini</i> Anderson | | | X | | | | | | |
| * <i>Pecten</i> sp. | | | | | X | X | | | |
| <i>Phacoides</i> , sp. | | | | | | | | | X X X |
| <i>Phacoides</i> sp. | | | | | | | | | X X X |
| <i>Pholadidea</i> sp. | | | | | | | | | X X X |
| * <i>Spisula</i> cf. <i>S. hemphilli</i> Dall (cast) | | | | X | | | | | |
| Gastropoda | | | | | | | | | |
| * <i>Acanthina emersoni</i> Hertlein & Allison, n. sp. [cited as " <i>Acanthina</i> n. sp." by Santillán and Barrera].... | | X | X | X | | | | | X X |
| " <i>Alectrion californica</i> var." | | | | | | | | | X X |
| * <i>Cancellaria</i> cf. <i>C. crawfordiana</i> Dall | | | | | | | | X | |
| * <i>Forreria</i> cf. <i>F. wrighti</i> E. K. Jordan & Hertlein | | X | | | | | | | |
| <i>Polinices</i> sp. | | | | | | | | | X |
| * <i>Thais</i> aff. <i>T. ethegoinensis</i> Arnold | X | X | | | | | | | |
| * <i>Thais</i> cf. <i>T. haemastoma biserialis</i> Blainville | | | | | | | X | | |

| | North to South | | | | | | |
|--|----------------|-----|---|---|--|--|---|
| | A-470 | | | | | | |
| | 31785 (C.A.S.) | | | | | | |
| | B-3066 | x | | | | | |
| | A-459 | | | | | | |
| | A-456 | | | | | | |
| | B-1404 | | | | | | |
| | A-6522 | | | x | | | |
| | B-4300 | | | | | | |
| | | | | | | | Listed by Santillán and Barrera. Localities not differentiated. Identifications by B. L. Clark. Nomenclature that of current usage. |
| ° <i>Thais trancosana</i> Arnold | | | | | | | |
| <i>Trophon</i> sp..... | | | | | | | |
| <i>Turritella vanlecki</i> Arnold | | | | | | | x x |
| ° <i>Turritella</i> sp. | | | | | | | |
| Cirripedia | | | | | | | |
| ° <i>Balanus tintinabulum</i> Linnaeus | | x | | | | | |
| Shark teeth ["Diente de Tiburón"]..... | | x x | | | | | |
| Skate "teeth" ["Diente de liza"]..... | | | x | | | | |
| | | | | | | | x x |

The fossils cited in the foregoing list, when considered as a whole or from each locality, are indicative of Pliocene age. Among the species definitely identified, *Dendraster ashleyi*, *Ostrea vespertina*, *Ostrea vespertina veatchii* Gabb, and *Pecten bellus* Conrad, all occur both in the beds of Pliocene age at Turtle Bay, Baja California, and in the San Diego formation in southwestern San Diego County, California. These species and, in addition, *Pecten etchegoini* and *Turritella vanlecki* are extinct. All these (with the possible exception of *Pecten bellus*) are known to occur only in beds of Pliocene age. Among the doubtfully identified species, *Spisula* cf. *S. hemphilli* is comparable to *S. hemphilli* occurring in the San Diego formation and *Pecten* cf. *P. gallegosi* and *Forreria* cf. *F. wrighti* are comparable to species which occur in Pliocene strata at Turtle Bay.

The occurrences of the species cited above suggest that the beds containing them in northwestern Baja California are comparable in age to those occurring in the San Diego area, California, and at Turtle Bay, Baja California, and are of late Pliocene age.

Descriptions of Species
 Family Thaididae
 Genus *Acanthina* Fischer de Waldheim
Acanthina emersoni Hertlein & Allison, new species

Plate 8, Figure 1

Shell of medium size, thick, whorls gently rounded (apex lacking); body whorl sculptured with about 18 low, flattish spiral ribs, separated by much narrower spiral grooves, some of the ribs bear a faint medial groove; the four anterior ribs are separated from the others by a well developed spiral groove which

represents the growth stages of a small tooth present at the edge of the outer lip; the penultimate whorl is sculptured with about 6 spiral ribs; all the ribs are crossed by fine, fairly even lines of growth; a deep anterior notch at the base of the aperture and a well developed siphonal fasciole present; about 5 or 6 spiral ribs are present on the interior of the outer lip; the inner lip consists of smooth callus. Height (apex lacking), 27.3 mm.; maximum diameter, 16.8 mm.; height of aperture, 20 mm.

Holotype (Univ. Calif. Acad. Mus. Paleo. Type Coll.), and paratype (Calif. Acad. Dept. Geol. Type Coll.), from Loc. A-459 (Univ. Calif. Mus. Paleo.), terrace north of Agua Chiquita, Baja California, Mexico; M Santillán and T. Barrera, colls., 1930 [their Loc. 48]; Pliocene. One specimen was collected at Loc. A-456, also one at Loc. B-3066 (Univ. Calif. Mus. Paleo.), in a quarry near kilometer marker 258 on the west side of the Ensenada-San Quintín highway, Baja California.

This new species bears a general resemblance to specimens of the Recent west American *Acanthina spirata* Blainville², especially those on which the whorls are rounded anteriorly. The fossil form here described possesses much more rounded whorls, the spiral ribs are much broader, occasionally bear a medial groove, and are separated by much narrower interspaces, the whole crossed by fine fairly even lines of growth which do not divide the interspaces into squarish pits as do those on the Recent species.

Acanthina emersoni, new species, appears to be more closely related to *Acanthina spirata* than it is to the South American species described as *Monoceros imbricatum* Lamarck or to the species with much wider ribs which occurs in Pliocene strata in Chile which was described under the name *Monoceros tenuis* Sowerby.

The general appearance of the exterior of this species is somewhat similar to that of worn specimens of *Thais lima* Gmelin, but the presence of a tooth on the anterior portion of the inner lip readily serves to separate this new fossil form from the species described by Gmelin.

This new species is named for Dr. William K. Emerson, Assistant Curator, Department of Mollusks, American Museum of Natural History, in recognition of his contributions to the knowledge of the Pleistocene invertebrate fauna of Baja California, Mexico.

²P[URPURA]. *spirata* Blainville, Nouv. Ann. Mus. d'Hist. Nat. Paris, Vol. 1, p. 252, pl. 12, fig. 8, 1832. "Des îles Sandwich, d'où elle été rapportée par M.P.E. Botta." [This locality is erroneous. It is a west American species ranging from Mendocino County, California, to Cape San Lucas, Lower California, Mexico. Socorro Island (Dall).]—Kiener, Spéc. Gén. Icon. Coq. Viv., Fam. Purpurifères, Pourpre, p. 121, pl. 38, fig. 90, 1836. Original locality cited.

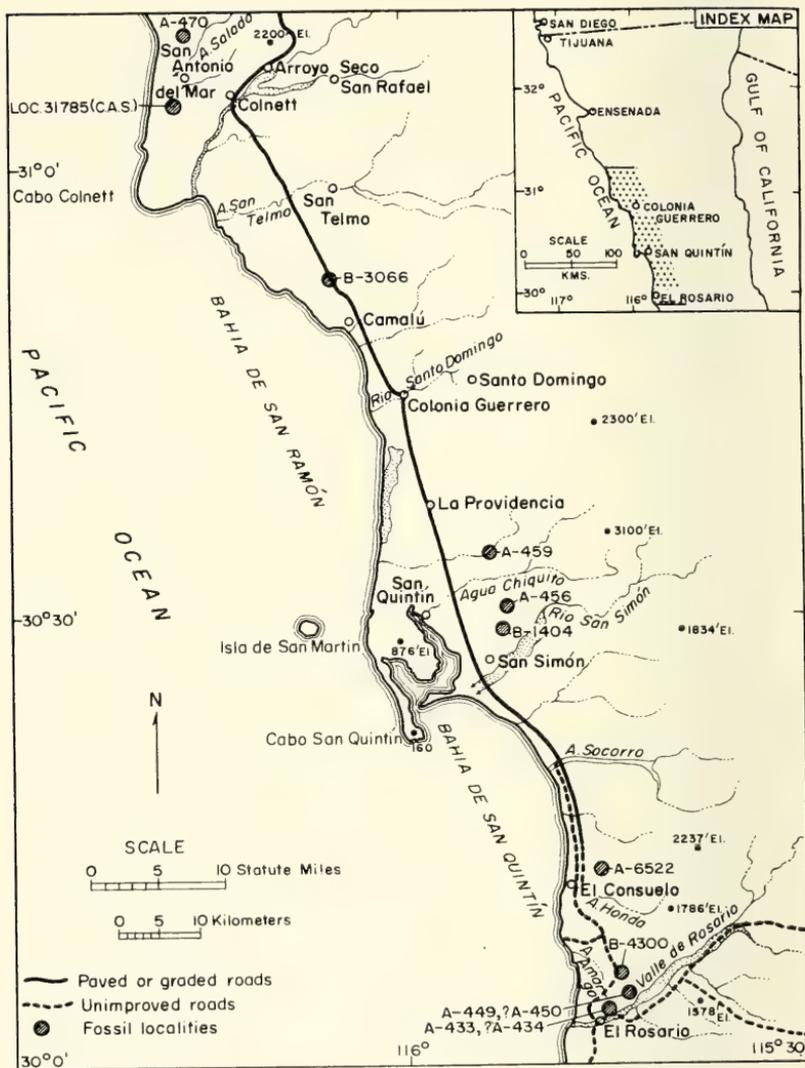


PLATE 7

Map of northwestern Baja California showing collecting stations and points of elevation. Adapted from United States Air Force Preliminary Base, Ensenada (472B), 1946 [revised 1954]. Scale 1:500,000.

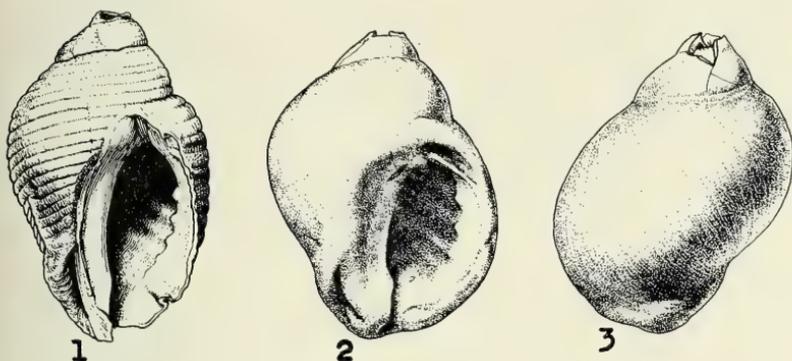


PLATE 8

Fig. 1. *Acanthina emersoni* Hertlein & Allison, new species. Holotype. Height, 27.3 mm.

Figs. 2 and 3. *Thais trancosana* Arnold. Hypotype. Height, 25 mm. Fig. 2. Apertural view. Fig. 3. View of opposite side of specimen shown in Fig. 2.

Thais trancosana Arnold

Plate 8, Figures 2 and 3

Thais trancosana Arnold, Proc. U. S. Nat. Museum, Vol. 34, No. 1617, p. 388, pl. 36, fig. 3, August 8, 1908.—Arnold, in Branner, Newsome and Arnold, U. S. Geol. Surv., Folio 163, p. 6, illustr., sheet II, fig. 74, 1909.

TYPE LOCALITY: "Santa Cruz Quadrangle, Santa Cruz County, locality No. 21, ditch between Feld [Felt] Lake and Los Trancos Creek, 2½ miles south-southwest of Stanford University." "Merced formation, upper Pliocene."

REMARKS: Two well preserved specimens of *Thais* and three imperfect ones were collected by W. K. Emerson and E. C. Allison at Loc. B-3066 (Univ. Calif. Mus. Paleo.), in a shallow quarry near kilometer marker 258 on the west side of the Ensenada-San Quintín highway, Baja California.

The larger specimens, only slightly decorticated at the apex, are about 25 mm. in height. We have compared these with casts of the type specimen of *Thais trancosana* Arnold and find that they agree in all observable details.

Characters of the shell which serve to aid in the separation of this species from the Recent *Thais lamellosa* Gmelin and *Thais ethegoensis* Arnold, a Pliocene species, are the lower spire,

the very rapidly enlarging whorls which are only slightly convex, and the very thick shell.

We have seen specimens of this species from various localities in the Merced formation in central California.

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THE LARVAL HABITS OF PLINTHOCOELIUM
SUAVEOLENS PLICATUM (LeCONTE)

(Coleoptera: Cerambycidae)

By E. G. Linsley and P. D. Hurd, Jr.

University of California, Berkeley

Although the longicorn tribe Callichromini consists predominantly of large, brilliantly colored beetles, remarkably little has been recorded of the habits for the majority of the species. Biologically, the best known species in the group is the European musk beetle, *Aromia moschata* (Linnæus), the habits of which have been summarized by Duffy (1949, 1953). Considerable information is also available for some of the Asiatic species, especially those which attack citrus [cf. Kalshoven (1936, 1955), Beeson and Bhatia (1939), Gressitt (1942), Pruthi and Mani (1945), Lieu (1947), Linsley (1958), etc.]. Duffy (1957) has summarized what little is known of the African forms and Costa Lima (1936, 1955) has given host plant data for some of the South American species.

Two species in this tribe are now recognized in America north of Mexico. *Plinthocoelium schwarzi* (Fisher) is known only from southeastern Texas. Its host plant has not been established with certainty but Vogt (1949) reports that adults are frequent on flowers of lote, *Condalia obtusiflora* (Hook.), and of *Cissus incisa* (Nutt.) from late April through May. When disturbed they emit a milky white volatile material having a fragrance similar to butyraldehyde. The second species, *Plinthocoelium suaveolens* (Linnæus) is more widely distributed. *P. suaveolens suaveolens*, the best known subspecies, ranges through the humid southeastern states from Florida to Delaware and west to eastern Texas and Missouri. Hamilton (1892) has recorded it breeding in the trunk and immense roots of the gum elastic tree, *Nyssa uniflora* Walt., in the southern swamps of Alabama, and Riley (1880) records it from the same or a related tree in eastern Texas (recorded as gum elastic tree, a specis of *Nyssa*). Craighead (1923)

¹The writers wish to express their appreciation to M. A. Cazier, Director, Southwestern Research Station, American Museum of Natural History, Portal, Arizona, for guiding us to the site where these observations were made and for aid in this and a number of related projects.



PLATE 9

Figure 1 (upper): view of *Plinthocoelium*-infested *Bumelia* tree growing in dry wash. Figure 2 (lower): base of infested tree showing adult emergence hole six inches above ground level! (photographs by the authors).

partially characterized the larva from two badly preserved specimens collected in *Morus* at Savannah, Georgia. The more westerly subspecies, *P. suaveolens plicatum* (Le Conte) (Plate 11, fig. 1) occurs in the drier areas from central Texas to southeastern Arizona, and the only prior record we can find of its habits is the statement of Hamilton (1892) that according to a friend (not an entomologist), this form breeds in old cactus, a conclusion that hardly seems likely in view of the observations reported here.

The locality where the observations here reported were made is the Miller Ranch situated in the Peloncillo Mountains some 7 miles southeast of Rodeo, Hidalgo County, New Mexico. The host plant of *Plinthocoelium* in this area is Chicle, *Bumelia lanuginosa* (Michx.) var. *rigida* Gray, a large shrub or small tree with spiny branches and obovate-cuneate leaves, mostly fascicled on the branches. Most of the plants are from 8 to 10 feet in height but some individuals attained 12 feet or more. They were growing in a gravelly wash facing and draining to the west. Below the surface gravel the soil was sandy. Generally the shrubs were grouped into small thickets or were scattered among mesquites (*Prosopis juliflora*) and false mesquite (*Calliandra eriophylla*). Nearly every *Bumelia* plant with a stem diameter of more than 2.5 inches had been attacked by the beetle (Plate 9, fig. 1).

Bumelia blooms in June and July, at which time the plants bear fragrant flowers. The adults are active at this time, being found during the day on the trunk, at the base of the plant or on the blossoms. Thus on July 18, 19, 20, 1955 more than 300 adult beetles were collected by J. D. Hood, W. J. Gertsch, E. Ordway, R. J. and W. C. Miller, Jr., whereas on August 21, 1958, only 3 males and one female were found by more than a dozen entomologists collecting in the area.

The adults oviposit at the base of the tree and when the eggs hatch the larvae work down into the roots (Plate 11, fig. 3). They construct long, straight tunnels, running with the grain of the wood. The burrows are kept clear by the larvae pushing the sawdust-like frass out of openings at the ground level or on the upper surface of the roots (Plate 10b). These holes for frass ejection are oval and about $\frac{1}{4}$ inch by $\frac{5}{32}$ inches in diameter (Plate 11, fig. 2). Indications are that the larvae require more than one year to complete their development. Emergence holes are about $\frac{1}{2}$ inch by $\frac{3}{8}$ inches in diameter and were to be found from 1 to 8 inches above the ground level, but mostly below 2 inches (Plate 9, fig. 2; Pl. 10a).

Apparently several seasons are necessary for the beetles to kill the plant. Thus a dead shrub had 7 emergence holes and no active frass openings, a tree estimated at 80 per cent dead, 8 emergence holes and one active frass hole, one 60 per cent dead, 4 emergence holes and two active frass holes, one 10 per cent dead, 2 emergence holes and one frass hole, and living green trees over 2.5 inches in diameter, from 1 to 3 emergence holes and 2 or 3 frass holes at or above the ground level. A few plants with a basal diameter of less than 2.5 inches also exhibited active frass holes.

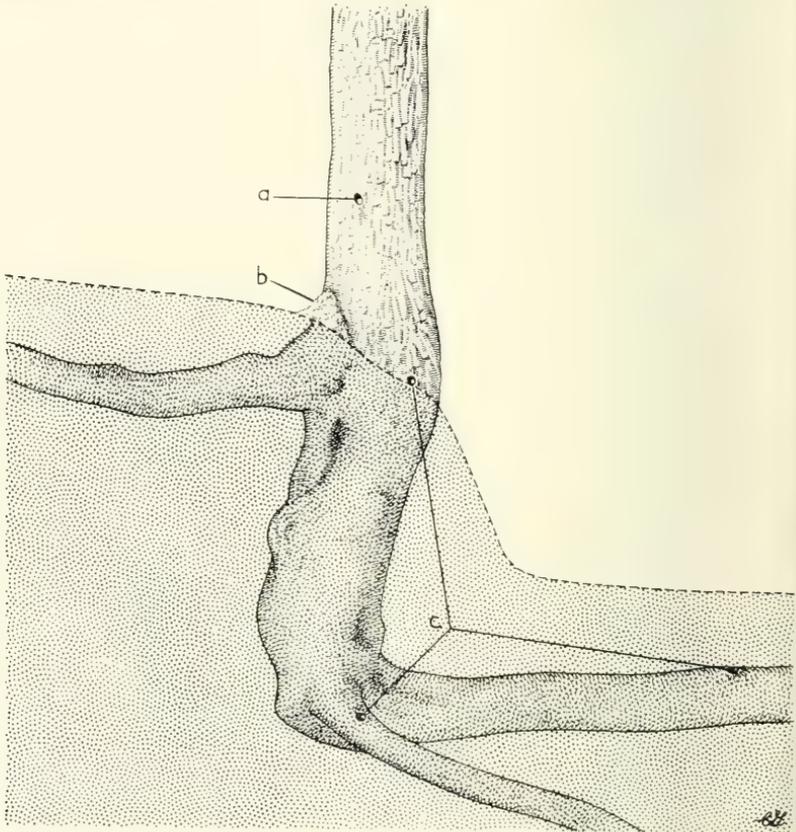


PLATE 10

Schematic representation of the *Plinthocoelium*-infested tree shown in Plate 10, indicating the location of (a) an adult emergence hole, (b) a larval frass pile, and (c) frass ejection holes utilized by larvae. (The shaded area lies below the ground level.) (Celeste Green, del.)

In two cases scarab larvae were present in the roots, in one instance associated with an adult scarab, *Phileurus illatus* LeConte, which had worked its way up a burrow in a root and destroyed a larva of *Plinthocoelium*. Burrows of an unidentified buprestid beetle were also found higher up in the stem of the dead plants and one example of *Neoclytus mucronatus vogti* Linsley was taken on the bark by Paul Opler. This latter subspecies occurs near the southern boundary of the United States from the Baboquivari and Rincon Mountains of Arizona to the Lower Rio Grande Valley of Texas and adjacent areas in northern Mexico. It has been associated previously with *Celtis*, *Ulmus* and *Parkinsonia* (Linsley, 1957).

Although the above observations are too fragmentary to permit generalizations, they do lend support to the conclusion that the two known subspecies of *Plinthocoelium suaveolens* (Linnæus) not only differ in host plant, but occupy quite different habitats, at least at the extremes of their geographic ranges.

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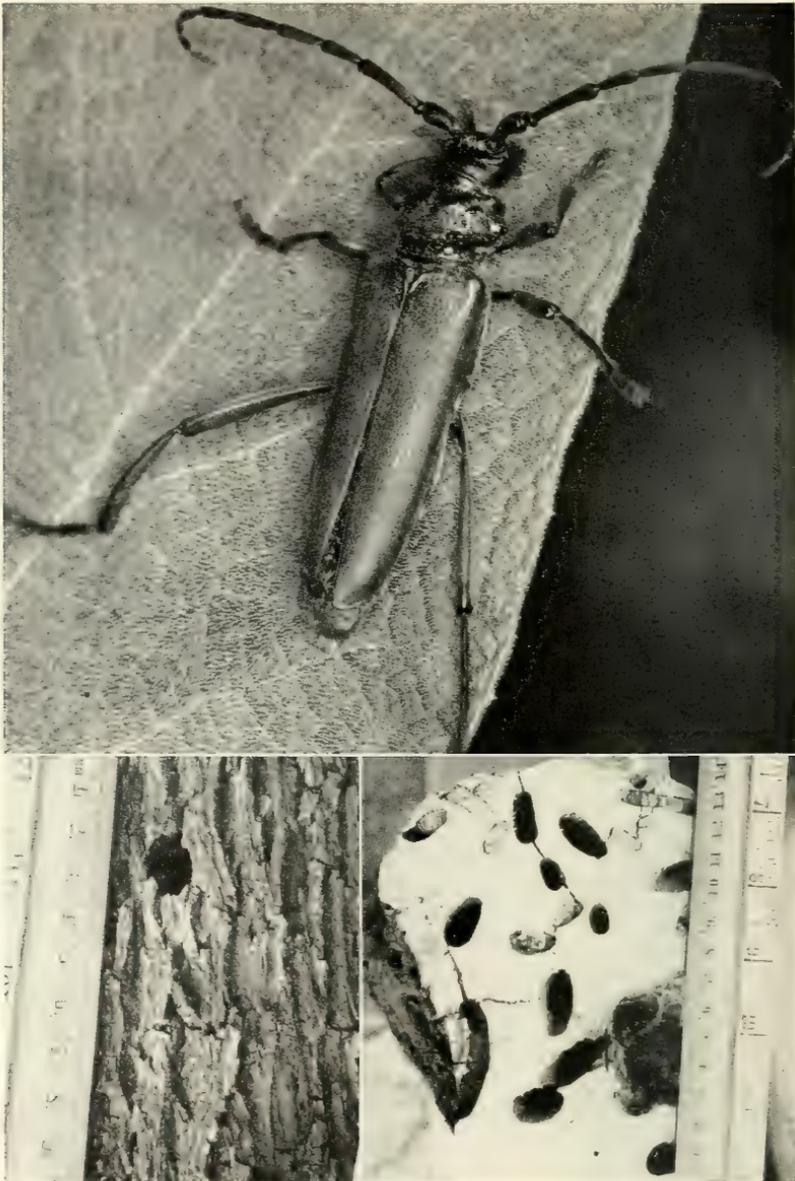


PLATE 11

Figure 1 (upper). Adult female of *Plinthocoelium suaveolens plicatum* (LeConte) (photograph by G. Bradt, courtesy of M. A. Cazier). Figure 2 (lower left): frass ejection hole utilized by larva (photograph by Robert M. Chew). Figure 3 (lower right): cross section of larval burrows in *Bumelia* plant killed by *Plinthocoelium* (photograph by Robert M. Chew).

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AN ALTERNATING, SEXUAL GENERATION IN
 THE GALL WASP *CALLIRHYTIS*
POMIFORMIS (ASHM.)
 (Hymenoptera, Cynipidae)

By ROBERT J. LYON¹
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One of the most conspicuous of the oak galls in California is the large "oak apple" produced by the cynipid wasp *Callirhytis pomiformis* (Ashm.) The galls are quite common on the oaks *Quercus agrifolia* Nee and *Quercus wislizenii* A. DC. and since they are not deciduous formations they may be seen on these oaks for years after the emergence of the original inhabitants. The wasps were first described by H. F. Bassett (1881:74) but William Ashmead (1885:295) was the first investigator to use a valid name. No males have previously been known for this species and until the present time, all descriptions have been based upon studies of the parthenogenetic females. The term "agamic" used to designate the parthenogenetic females, is well-entrenched in the literature however, since agamic, by strict definition, means reproduction not involving gametes, it is avoided here.

The existence of alternating generations among the Pacific Slope members of the *Cynipidæ* has never been proven by controlled experimentation although circumstantial evidence indicates the existence of such a generation for several species. This evidence consists of observations showing the presence of the related galls on the same tree at different times of the year

¹The writer wishes to express his appreciation for helpful assistance in the preparation of this paper, to Dr. John N. Belkin of the Entomology Department at U.C.L.A., to Mr. Lewis H. Weld of Arlington, Virginia and to Mr. Gerhard Bakker, L.A.C.C., who made the drawings.

plus similarities in the morphology of the insects. Experimentation in Europe and other areas indicate that alternating generations are usual rather than uncommon in the *Cynipidæ*. In these areas parthenogenetic and sexual generations had often been described as separate species and in certain instances had been placed in separate genera. After the life histories had been studied, generic concepts were, of necessity, revised. Since no complete life history is known for any species on the Pacific Slope, detailed studies for this and other species would seem to be worthwhile.

During the months of February through early April of the years 1955-1958 large numbers of the parthenogenetic female *Callirhytis pomiformis* (Ashm.) were reared from galls on the native trees and from galls brought into the laboratory. These females were placed in cloth-mesh rearing bags which were tied on the new growth of *Quercus agrifolia* Nee, both native trees and young trees growing in five-gallon containers. Bags were placed on young leaf buds, new stem growth and on the young staminate flowers. The female wasps showed a decided preference for the young leaf buds and quickly oviposited into this tissue often to such an extent as to kill the developing bud. Wasps were also seen ovipositing into other tissues, however there was no subsequent gall growth from these. Shortly after the new leaves unrolled, a toadstool-shaped gall, Plate 12, fig. a & b, began to develop on the undersurfaces of the leaves instead of the large, apple-shaped structure, Plate 12, fig. c, that is typically associated with *Callirhytis pomiformis* (Ashm.) This toadstool gall was known to other workers and had been listed as an undescribed species under Lewis Weld's field No. 1742. A photograph of it appears in "Cynipid Galls of the Pacific Slope," 1957, fig. 121. Adult specimens proved to be exceedingly difficult to rear because approximately 75% were parasitized by chalcids and another 24% were inhabited by the inquiline *Synergus agrifoliae* (Ashm.) which is probably a parasite of the gall-maker. This may be the reason why the toadstool gall-maker had never been described although the gall itself is not uncommon. At the present time, twelve specimens, seven females and five males have been reared. One female was located by Mr. Lewis Weld in the collection of the U. S. National Museum. It had been reared many years ago in Los Angeles and bore Koebele No. 319. As a single specimen it had never been described nor associated with the species *Callirhytis pomiformis* (Ashm.). Detailed examination showed the sexual females to be remarkably similar to the parthenogenetic females. Such similarity is not necessarily found in alternating generations of the *Cynipidæ*.

SEXUAL FEMALE: Similar to the parthenogenetic females with the following differences: Antennæ with 13-14 segments, rather uniform yellowish-brown with a ratio of 1.8 to 2.2 unlike the parthenogenetic females whose antennæ are 14-15 segmented and

darker, especially distally, with a ratio of 2.4. All the legs of the sexual females are yellowish-brown whereas the metathoracic legs of the parthenogenetic females are dark-brown like the abdomen. The mesoscutum and scutellum of the parthenogenetic females are more densely pubescent than in the sexual females. The sexual females show only two tergites on the dorsal margin of the abdomen and some specimens are smooth whereas in the parthenogenetic females, all the abdominal tergites are visible from above and are punctate. Length of the sexual females, 2.3-3.1 mm. Average of seven females 2.9 mm. Length of the parthenogenetic females 3-4 mm.

MALES: Very similar to the sexual females except that they are smaller; antennæ with 15 segments, reddish-brown except the

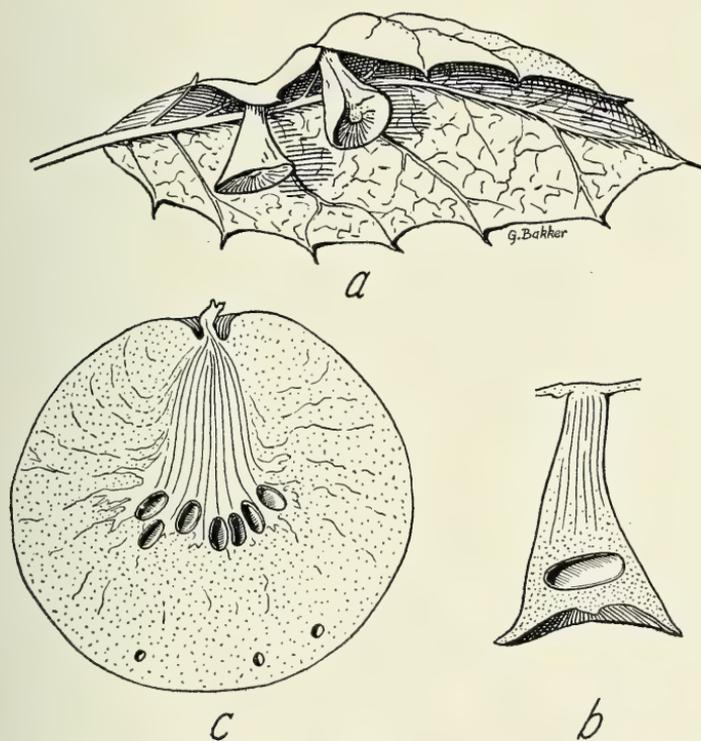


PLATE 12

Fig. a. Leaf of *Quercus agrifolia* Nee showing the typical toadstool galls produced by the sexual generation of *Callirhytis pomiformis* (Ashm.)

Fig. b. A single gall of the same showing the position of the larval cell.

Fig. c. Large, polythalamous, stem gall produced by the parthenogenetic generation of *Callirhytis pomiformis* (Ashm.) on *Quercus agrifolia* Nee.

two basal segments which are yellowish. Mesoscutum only sparsely pubescent. Length 2.1-2.6 mm. Average length of five specimens 2.36 mm.

It does not seem to be necessary to use a variety or form name to differentiate the sexual generation from the parthenogenetic generation as advocated by Kinsey in 1920. Specimens in the series are here designated as *Callirhytis pomiformis* (Ashm.), sexual generation and each insect bears Weld No. 1742. Parthenogenetic females bear Weld No. 1621. A male and a female each have been designated as types of the sexual generation and these together with an additional male and female have been placed in the collection of the U. S. National Museum. One female and a male are in the collection at U.C.L.A. and a female and a male are in the collection of the California Academy of Sciences.

GALL: A toadstool-shaped gall arising singly or occasionally in groups of two or three from the lamina of the undersurfaces of the leaves of *Quercus agrifolia* Nee and *Quercus Wislizenii* A.DC. The galls appear as tiny, bright-green buttons as early as February or March, however most of the young galls make their appearance during the latter part of March and early April. The galls appear ten days to two weeks after the eggs are laid into the growing buds. Many of the galls are tinged with rose or pink when young although most are light-green in color. Growth is quite rapid and unparasitized galls reach a length of 0.8 to 0.9 cm. in May and yield adult insects of both sexes from May 15 through the first week of June. Mature galls are monothalms with the single cell occupying the space below the flared top of the gall. The elongated stem of the gall is solid.

Temperature experiments in the laboratory showed that the parthenogenetic females were very sensitive to elevated temperatures and emerged from the galls when the temperature was elevated to the high 70's F. and low 80's F. Galls that were collected too far in advance of the early months of the year, yielded few insects and sometimes none at all. This temperature sensitivity would seem to indicate that temperature plays a critical role in correlating the emergence of the insects with the early growth of the host oaks. These oaks must reach a stage that is susceptible to attack otherwise the young galls will not develop. During January and February in Southern California, temperatures in the above ranges are not uncommon. As indicated above, gall growth has been noted on the new leaves in late February and early March.

Preliminary work indicates that some of the emerging parthenogenetic females lay eggs which produce only sexual females while others lay eggs that give rise to the males. Since only twelve specimens have been obtained at this time it is not possible

now, to present information to confirm this. In other species of the *Cynipidæ* that produce a sexual generation from a polythalamous gall, galls produced by some females yield only males whereas other galls, produced by other females, yield only female insects.

The biological relationships involving gall-makers, inquilines and parasites in *Callirhytis pomiformis* (Ashm.) are most interesting and complex. Studies of these relationships are still in progress and the results will be published at a later date.

SUMMARY: An alternating, sexual generation exists in the gall wasp *Callirhytis pomiformis* previously known from parthenogenetic females only. The gall produced by the sexual generation is a monothalamous, toadstool-shaped, leaf gall that develops when the parthenogenetic females oviposit into the young leaf buds of *Quercus agrifolia* Nee. Temperature apparently plays a vital role in coordinating the emergence of the parthenogenetic females with the early growth of the host oaks.

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BRIEF NOTES ON FOUR ARIZONA MOTHS

By JOHN ADAMS COMSTOCK

In July of 1955, while collecting lepidopterous larvæ in Madera Canyon, Santa Rita Mountains, Arizona, two interesting species of pyralids were found feeding on a native Coral tree, *Erythrina flabelliformis* Kearney.

These turned out to be *Agathodes monstralis* Guenee, and *Terastia meticulosalis* Guenee.

The following brief field notes were made on July 29, '55:

Agathodes monstralis

Several mature larvae were found, each in a protective chamber formed of a folded leaf, sealed along its edge with silk strands.

MATURE LARVA. Length, 22 mm.; greatest width at fourth segment, 4.5 mm. In shape it is cylindrical, tapering to a narrow head and cauda.

Head; width 2.3 mm. Color, yellow-brown. The two ocelli on the outer edge of the circle are white, and the remainder, black. The mouth parts are tinged with brown. Clypeus, white. Antennae; proximal portion white and distal elements black.

The head is sparsely covered with long white setae.

Body; ground color, dull green, shading to a yellow-green laterally.

The first segment is flesh-colored, and bears numerous round black dots. The second segment has a pair of medium sized black papillae, one each side of the median space. The remaining segments, from second to tenth, have two large papillae each side of the median space. These papillae resemble volcanic peaks with furrows running down their sides, but they lack craters. Each bears a long seta at its tip.

On the caudal segments these papillae grow progressively smaller.

Lateral to the above described rows of papilliform spots is a longitudinal white line. Inferior thereto is a wide yellow-green space, along the center of which occurs a row of raised papillae (one to a segment), each topped by a black point bearing a long seta, and each rimmed at the base by a black circle. Inferior to these there is a poorly defined light longitudinal line, on which is placed the spiracles. The latter are yellow, and relatively small.

The ventral surface is light green. The legs are black, with light green edges at the segmental junctures. The prolegs are concolorous with the abdomen, and the anal prolegs are tinged with pink on the terminal segment.

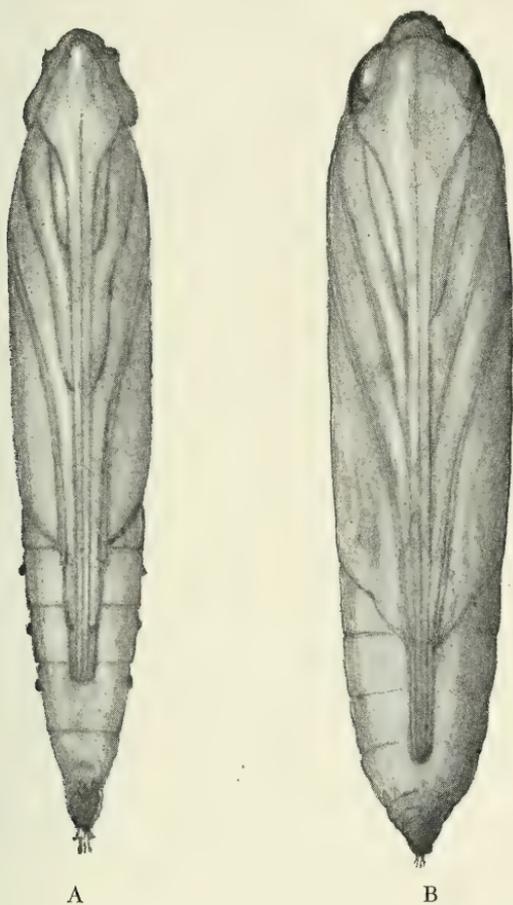


PLATE 13

a. Pupa of *Agathodes monstrialis*, ventral surface, enlarged $\times 6\frac{1}{2}$.

b. Pupa of *Terastia meticulosalia*, ventral surface, enlarged $\times 5$.

Reproduced from drawing by the author.

Pupation occurred in the folded leaf chamber, between August 1 and 5.

PUPA. Length, 16 mm.; greatest width, 2.6 mm.

The shape is fusiform, long and narrow, tapering regularly towards head and cauda, as will be noted on Plate 13, fig. A. The color is yellow-brown, shading to a darker brown on the head, cremaster, and the tips of maxillae and antennae. The maxillae extend 2.75 mm. beyond the wing margins, the antennae being considerably shorter.

The spiracles are dark brown, and slightly protruding. The segmental lines are dark brown and narrow.

The cremasteric hooks are in two series, the longest being .25 mm. and the shortest, .12 mm. Other structural features are shown in the illustration.

The first imago emerged August 15, 1955.

Holland, in his "Moth Book", 1908, Plate XLVIII, Figure 3, illustrates the moth, and gives its range as "Florida to the Rio de la Plata in South America". To this may now be added southern Arizona.

We have not been able to locate descriptions or illustrations of the larva or pupa in the literature.

Terastia meticulosalis

The few larvae of this species which we collected were feeding in the seed pods of *Erythrina flabelliformis*. They dropped to the floor of the rearing cage and began spinning cocoons before a description of the larva could be made. The cocoon is constructed of two layers of silk,—the outer covered with soil granules, and the inner firm but thin, through which the pupa could be plainly discerned. However, the mature larva was described by Dyar in 1901¹, from Florida examples taken on *Erythrina herbacea*. His description of the feeding habits differs from our observation. He states that "the larva is an internal feeder, boring in the younger stems which it completely hollows out, killing them." (See also Proc. Ent. Soc. Wash. 4, 463. 1901).

Five pupae were secured, which made possible the following notes, and accompanying illustration:

PUPA. Length, 22 mm. Greatest width through shoulders, 4.2 mm.

The form is cylindrical, with a small rounded head and somewhat prominent eyes, and a regularly tapering cauda. The color is straw, shading to brown on the head, thorax and cauda. All segmental lines are narrow, and light brown. The maxillae reach well beyond the wing margins to within 3 mm. from cauda, whereas the antennae terminate at the wing margins.

The cremasteric hooks are minute, and light yellow.

¹Journ. N. Y. Ent. Soc. 9 (1), pp. 21-22

The spiracles are only slightly darker than the body, and are not raised or protruding.

Other structural features not specifically mentioned are shown on Plate 13, figure B.

The pupae gave forth imagines between August 21 and 24, 1955.

Dyar, 1902² gives the range of the species as Florida, the West Indies, Ceylon, Java and the Philippine Islands. We can add Arizona.

E. Graywood Smyth collected it in Peru.

Costa Lima, 1950³ shows a poor figure of the imago.

McDunnough in his List of 1939 includes two synonyms, i.e., *subjectalis* Lea., and *coeligenalis* Hlst., the latter described in Trans. Am. Ent. Soc. 13, 156: 1886.

There is one other pyralid listed for the United States, which feeds on *Erythrina*, namely *Agathodes designalis* Guenee, originally described in Spec. Gen. 8, 204: 1854, of which Hulst's *Stenurgis floridalis* published in 1886⁴ is a synonym.

The mature larva of this species was described by Dyar in 1901 from examples taken in southern Florida, and for which *Asclepias*, *Salix*, and *Erythrina herbacea* were recorded as food plants. Costa Lima, 1950³ gives *Erythrina cristagalli* for the same species.

Stenocharis permagnaria Grossb.

One of the results of field work in Pinery Canyon, Chiricahua Mountains, Arizona, during the summer of 1956, was the capture of gravid females of certain moths, the life histories of which were unknown. Eggs were obtained from these, notes and drawings were made in the field, and where possible, the species was reared to maturity.

Several, however, could be carried only to the first instar, and, refusing to accept any of the various plants offered, starved to death.

One such example was *Stenocharis permagnaria*, a female of which came to light July 6, 1956. Eggs were laid on successive days, in compact single-layered patches.

EGG. 1 mm. tall \times .6 mm. wide. Elongate-oval, with a circlet of 20 nodules at the top, and a slightly depressed area internal thereto.

The oval stands on end, with the large area at the top, and the restricted and flattened end at the bottom. The micropylar area is granular and pitted, and the remaining surface granular.

²List of N. Am. Lepid. p. 380. #4327

³Insectos do Brasil, pt. 2, p. 42

⁴Trans. Am. Ent. Soc. 13, 156



PLATE 14

Egg of *Stenocharis permagnaria*, enlarged $\times 40$.

Reproduced from drawing by the author.

The color of the egg is dull olive except for the pearly-white nodules and circlet. See Plate 14.

The first eggs hatched July 20, 1956. Egress was from the top, and the shell was left intact.

The young larvæ were offered Pine (three species), Cypress, oak, willow, wild walnut, *Prunus*, *Rhus*, *Ceanothus*, *Eriogonum* and various grasses, all to no avail. Brief notes were made before they had succumbed.

NEWLY EMERGED LARVA. .

Length, approximately 3 mm. Head about twice the width of the first segment; light yellow-brown. The ocelli are black.

The body is cylindrical. A broad black band covers the dorsal surface. Substigmatically there is a longitudinal light yellow stripe. Below this, the entire abdominal surface is black. The legs are black on their proximal segments and translucent straw on the distal elements. The single pair of prolegs are dark on the proximal segments and translucent straw distally. The anal prolegs are translucent straw, and are held wide apart, at right angles to the long axis of the body.

Minute colorless hairs occur sparingly on the body.

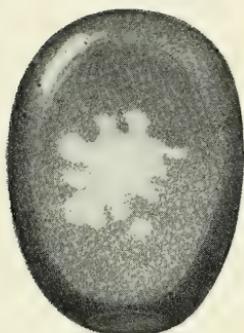


PLATE 15

Egg of *Melittia gloriosa* viewed from the side (upper figure), end and top (lower figure). Enlarged $\times 20$.

Reproduced from drawing by the author.

Melittia gloriosa Hy. Edw.

The largest and most handsome of the Clear-wing moths of the family *Aegeriidae* in North America is *Melittia gloriosa*. The species was originally described in 1880¹ by Henry Edwards. It is widely distributed in the Pacific Coast and southwestern states but may be taken only in areas where its foodplants, members of the *Cucurbitaceae* occur.

No complete records of its life history have been published, and adequate illustrations are still lacking.

Dr. Riley, in 1888² first recorded the pupal case and erroneously listed the food plant as the "roots of *Rhus laurina*".

¹ Bull. Bklyn. Ent. Soc. 3, p. 71.

² Proc. Ent. Soc. Wash. 1, p. 85

Beutenmuller correctly recorded it in 1900³ as a borer in the roots of "Big-root", and in 1901⁴ gave a colored illustration of the female.

Francis X. Williams published an excellent account of its habits in 1913⁵ and illustrated the pupal case.

Engelhardt's bulletin on the "North American Clear-wing Moths of the Family Aegeriidae"⁶ gives the most complete accounts of its range, habits, variations and food plants thus far published. Both sexes of the moth are illustrated in color on Plate 31, figs. 178-179.

During July of 1955, while collecting in Madera Canyon, Santa Rita Mountains, southern Arizona, the writer observed *M. gloriosa* on the wing in fair numbers, hovering over fields of "Man-root", or sunning themselves in the early morning on the leaves of this cucurbit plant. Females were seen in the act of ovipositing, and many eggs were collected. It was noted that numbers of these were laid on the vine stems at considerable distance from the plant root. Examination was made at various times of the stems, and also of the man-sized roots, but no larvæ were found.

Notes and drawings of the egg were made in the field on July 21, 1955, as here recorded.

EGG. Length, approximately 2 mm; width, 1.1 mm. Height .5 mm.

In form, it is navicular, with the 'bow' and 'stern' rounded, the base flat, and the top slightly cupped or depressed. There is a suggestion of a flange immediately above the base on some examples.

The micropyle is a circular, slightly depressed area, placed at the 'bow' end. It is slightly lighter in color than the remainder of the egg surface.

The color of the egg is blackish-brown, mottled with soiled white patches, the latter being most noticeable on the flattened superior surface.

The texture appears to be granular, but on higher magnification is seen to be covered by a network of lines outlining irregular hexagonal cells. In the mottled areas, the walls of these cells are black and the enclosed areas white.

Plate 15 illustrates the egg in three aspects.

The recorded food plants of *M. gloriosa* are: *Echinocystis fabacea* Naud. (Man-root or Big-root); *Cucurbita foetidissima* H.B.K. (Cabazilla) and *Cucurbita palmata* Wats. (Coyote Melon). It will probably be found on other cucurbitaceous plants.

³ Can Ent. 32, p. 303

⁴ Mem. Am. Mus. Nat. Hist. VI. Pl. XXIX, fig. 3

⁵ Kans. Univ. Science Bull. VIII, No. 5, pp. 217-220. Pl. XXXI, fig. 6.

⁶ Bull. 190, U. S. Nat. Mus. 1946.

NOTES ON *Trypanosoma* AND *Grahamella* IN RODENTS FROM MAUI, TERRITORY OF HAWAII

Discovery of a trypanosome in the blood of a trapped Alexandrine rat which nightly devoured corks from stored bottles led the author to survey other rodents for possible blood parasites on the Island of Maui, Territory of Hawaii. Blood samples were obtained mostly from rats brought to the Kahului Plague Laboratory. Most of the smears were made from droplets from auricles of excised hearts or scalpels used to open the heart during examination of freshly killed animals for plague studies. Sometimes clotted blood was drawn quickly over the slide. When possible, tissue contact preparations were made from internal organs, especially liver when the heart was not available. One animal was sampled in January, 230 in February and 4 in June of 1945.

Examinations of blood and tissue samples from 112 Alexandrine rats, *Rattus rattus alexandrinus*, 112 Hawaiian rats, *Rattus hawaiiensis*, and 2 black rats, *Rattus rattus rattus*, revealed 92 or 39% infected with parasites of the genera *Trypanosoma* and *Grahamella* and a *Hepatozoön*-like organism. The occurrence of *Trypanosoma* and *Grahamella* in rats from Maui is similar to that reported by Kartman (1954, J. Parasitol. 40: 571-579) for the Kaunamano Gulch, Hamakua District, Island of Hawaii.

One hundred and twelve Alexandrine rats, 52 adult and 3 immature males, 56 adult and 1 immature females, examined revealed 19 (12 ♂, 7 ♀) naturally infected with *Trypanosoma lewisi* and 1 male with a *Hepatozoön*-like organism. Trypanosome infected Alexandrine rats were trapped near Kahului; Kokomo; 2 miles north of Kihei; Kuiaha near Haiku; ½ mile northwest and north, ½ mile east, 2 miles southwest and 2 miles west of Makawao; and near Spreckelsville for an infection percentage of 16.9 as compared with 22.2 for Kaunamano Gulch. The male Alexandrine rat with the *Hepatozoön*-like parasite was trapped 3 miles south of Puunene and only one parasite was found in a liver tissue contact preparation.

One hundred twenty-one Hawaiian rats, 64 adult and 3 immature males, 51 adult and 3 immature females, examined revealed 60 (29 ad., 3 imm. ♂; 27 ad., 1 imm. ♀) infected with *Trypanosoma lewisi*, 5 (2 ♂, 3 ♀) infected with *Grahamella* sp., 6 (4 ♂, 2 ♀) harboring both *Trypanosoma lewisi* and *Grahamella*, and 1 male with a *Hepatozoön*-like parasite. The trypanosome infected Hawaiian rats were trapped ½ mile east, ½ and 3 miles south, 1 and 3 miles southwest, 2 miles west, ½ and 3 miles northwest and ½ mile north of Makawao, and Paia Sugar Mill, Paia. The *Grahamella* infected rats were collected ½

mile east, 3 miles south, west and northwest of Makawao, and at Paia Sugar Mill. The male Hawaiian rat with a *Hepatozoön*-like parasite was trapped $\frac{1}{2}$ mile south of Makawao.

Kartman (1954) was able to work with live trapped animals on the Island of Hawaii in contrast to dead animals used here. However, some idea of the relative trypanosome parasitemias can be obtained by comparing counts where the smears are thin enough. Kartman's monthly infection rates for *Trypanosoma lewisi* show the highest parasitemias in February on Hawaii and most of the Maui blood samples were obtained in February. The largest number of parasitemias for Hawaiian rats was in the 0 to 19,000 class per 10,000 white blood cells. Counts made here per 1,000 white blood cells are multiplied by 10 for comparative purposes. Counts from 3 adult female Alexandrine rats collected 3 miles north of Kihei revealed 2270, 0, and 770 parasites, respectively; from 1 adult male taken near Kokomo, 5240; and from 1 adult male trapped $1\frac{1}{2}$ miles north of Makawao, 6860. In using white blood cells for numerical comparisons, one must remember that a lymphocytosis is characteristic of certain phases of trypanosome infections so that it would be necessary to know the day after initial infection and the rate of increase of lymphocytes to accurately correlate the number of parasites.

Parasite counts made here from 4 Hawaiian rats harboring *Grahamella* revealed the following: one immature male collected 5 miles south of Makawao showed 7 parasitized cells per 100 microscopic fields using 10X oculars and a 95X objective and the number of parasites in 6 unbroken red blood corpuscles was 20, 31, 23, 20, 27 and 14; one adult male showed 6 per 100 and the number of parasites in 4 intact red blood corpuscles was 14, 20, 18 and 18; one adult female showed 2 per 100 and 16 and 26, respectively; and another adult female showed 20 per 100 plus parasite counts averaging 19.2, range 12 to 29, per unbroken corpuscle. Using double the above figures to compare with Kartman's counts, the average number of parasitized red blood corpuscles per 200 fields was 17.5, range 4 to 40, as compared to 10 for Kaunamano Gulch. The average number of parasites per corpuscle here was 20, range 19.5 to 27.5, as compared to 17 for Kaunamano Gulch.

The writer wishes to thank Frank Clifton and Jack D. Williams for technical assistance in collecting blood samples, and Ed S. C. Mau, Supervising Rodent Control Inspector, Department of Health, Territory of Hawaii, for permission to take blood and tissue samples at the Kahului Plague Laboratory. The opinions expressed here are those of the writer and do not represent the views of the Navy Department.—Sherwin F. Wood, Life Sciences Department, Los Angeles City College, Los Angeles 29, California.

FOSSIL INSECTS FROM MONTANA

I. A NEW FOSSIL NEMOPTERID (NEUROPTERA)

By W. DWIGHT PIERCE AND RUTH A. KIRKBY

Photography by Edwin N. Horne

It is our good fortune to be able to add the second known fossil insect in the rare Neuropterous family, Nemopteridæ.

The family Nemopteridæ was monographed by Longinas Navas in 1912 in *Genera Insectorum* No. 136, with key to genera, list of all species, and colored illustrations of each genus.

However Navas overlooked a short note in *Science*, vol. 36, p.446 (Oct. 4, 1907) by T. D. A. Cockerell, giving a brief description of a fossil Nemopterid, *Halter americana* Cockerell, from the Miocene of Florissant, Colorado.

This is a small family, but the species are sparsely scattered in Europe, Asia, Africa, Australia and South America. The existence in ancient times of two fossil species in the Rocky Mountain area of the United States is therefore of considerable interest.

Dr. Cockerell's note is rather unsatisfactory as a description, but he says enough to prove that he had a different insect from the one which we will describe. We quote his entire note:

"*Halter americana* new species".

"A wonderfully preserved example with the wings spread, from Station 13B (S. A. Rohwer) (Florissant, Colorado). The anterior wings are clear hyaline, 31mm. long, with the venation as usual in the genus (*Halter*); hind wings (as in all of the Nemopteridæ to which family it belongs) very long and narrow, length 46mm. with an apical fiddle shaped expansion which is dark colored. The Nemopteridæ are today confined to the Old World, except a single species of *Stenorhachus* found in Chile. The Florissant insect is not of the Chilean genus but belongs to that section of *Halter* which includes the Persian *H. extensa* (Oliv.). In *H. extensa* the black area of the hind wings is broken into two, whereas in the fossil it is solid and continuous. The persistence of such an extremely peculiar type through such a long time and such migrations indicates a remarkable degree of stability".

Navas took *H. extensa* out of *Halter*, and based his new genus *Olivierina* on it, dividing it off from *Halter* on the very basis of this division of the hind wing apical enlargement into two



PLATE 16

Fossil Nemopterid, *Olivierina metzeli*, Pierce and Kirkby.

expansions. *Chasmoptera hutti* Wood of Australia also has the paddle divided into two parts but the stem is much shorter in proportion.

Our new species is separable in the same way from *Halter americana* Cockerell, and we therefore place it on the basis of the generic description in *Olivierina* and name it in honor of Elvyn Metzels, the original discoverer of the Montana fossil insect deposit located at the South end of Ruby Reservoir, South and West of Alder, Montana, in 1928.

The site has been mentioned in literature as follows:

"Ancient Wings in the Rocks" by Henry P. Zuidema, *Natural History magazine*, (1953, vol. 62, pp. 32-37, with 10 figures). The deposit is stated to be Miocene in Montana near the headwaters of the Missouri, but is not more definitely located.

A report in "Earth Science" (Sept.-Oct., 1955, pp. 14-18, with 9 figures) by Henry Zuidema, under the title "Ancient Wings in the Rocks". He reports that his material was collected in 1947, but in this brief popular article he does not more closely locate the source, than the state of Montana.

The Junior author and husband, Sam Kirkby, visited this site at various times since 1955, and collected a number of fossil insects which will be treated in subsequent papers in this series. The type specimen was collected by Elvyn Metzels. When received the right hind wing was only visible in one half its length. By use of a fine scalpel, and with the aid of Xylol to show the underlying color, the Senior author was able to expose the entire wing. The fore wings are only fragmentary in detail, but typically Nemopterid.

Order *NEUROPTERA*

Superfamily *NEMOPTEROIDEA*

Family *NEMOPTERIDÆ*

Subfamily *NEMOPTERINÆ*

Genus *OLIVIERINA* Navas 1912

New species *Olivierina metzelsi*, Pierce and Kirkby

Holotype: Specimen in private museum of Samuel E. and Ruth E. Kirkby, Riverside, California. Specimen #2747, from Oligocene shales near Alder, Montana.

Description of specimen: Overall length of body 13mm., only six abdominal segments visible, measuring 6mm. in length. Head transverse. Antennæ elongate, linear, filiform, measuring 5mm. in length. Legs simple and slender. Anterior legs: femur equal to tibia, tarsus about $\frac{1}{3}$ as long as tibia. Middle legs slightly longer than anterior. Hind legs considerable longer;

femur not greatly dilated, tibia about 1-½ times as long as femur. Forewings very much broken, measuring approximately 30 mm. long by 9 mm. wide; Those portions visible showing clearly Nemopterid venation. Hind wings measure 48 mm. in length; stem with three veins in basal third beyond which the middle vein branches, so there are four veins running into the beginning of the paddle. The paddle or widened area of hind wing is 5 mm. long and 3-¾ mm. wide and has the margin strongly outlined, with three parallel central veins to apex; from the outer two of these three veins, there are many diagonal veins to the margin, some of which are branched near base, near middle, or near apex, veins laterally dissimilar. This leaf like arrangement narrows for a short distance and widens again to a narrow inflation with diagonal veins. This apical portion is not complete in the type specimen.

The only known living species in this genus is *Olivierina expansa* (Olivier) Navas which occurs in Persia, Syria and the Caucasus.

This is the first fossil species in the genus and the second fossil species in the family. It is very close in appearance to the type, but differs by having the second or apical portion of the expansion narrower than in the type. No doubt if we could know what the head and thorax looked like, it would differ materially from the type species. But there is such a gap in time and distribution between the two that we feel warranted in giving the fossil a name.



PROCEEDINGS OF THE ACADEMY

November 21, 1958

The Section on Anthropology, with Russell Belous, Chairman, sponsored the November meeting of the Academy held at the Los Angeles County Museum. No dinner was held before the meeting. Miss Ruth DeEtte Simpson, Associate Curator of Anthropology at the Southwest Museum gave a summary account of her recent trip to Europe visiting various Museums and important sites of early man.

ABSTRACT OF ADDRESS

"Impressions Derived from an Archeological Tour of Western Europe"

Ruth DeEtte Simpson

At the suggestion of European prehistorians, the speaker spent 3½ months studying significant Lower Paleolithic sites and collections, and talking with field archeologists in England, France, Spain, Denmark and Switzerland. Information derived from this investigation will aid materially in the undersanding of archeological projects being directed by the speaker in the western American deserts.

European scientists agreed that the specimens brought from America were man-made, were different and probably older than any American material they had seen previously. The consensus of opinion was that, until stratigraphic relationships can be established for the desert lithic material, no age determination should be attempted; that it should be considered in its own right as a separate American industry with Lower Paleolithic-like attributes. The speaker therefore now designates the Mojave Desert hand axes and related implements as the Manix lithic assemblage, in recognition of the type site: Pleistocene Lake Manix.

In Western Europe, it was apparent that archeological data and interpretations are changing very rapidly, that many adjustments are being made in the classification of Paleolithic material. For example: the *Pebble Industry* is now restricted only to very early implement assemblages devoid of even rudimentary hand axes; the *Abbevillian* is the term now assigned to the early phases of the hand-ax culture; the phases previously called Abbevillian (or Chellean) are now included as early phases of the classic Acheulean period.

Scientists working the Dordogne area of France are especially active in breaking down the larger classifications of the Upper Paleolithic. It is now considered best to speak of the Perigordian (Chatelperron) as preceding the Aurignacian; to limit the Aurignacian to a very specific culture complex and to follow it with a later aspect of the Perigordian. Even the Magdalenian is now extensively sub-divided. It also appears that excavations presently under way will establish the presence of a complex between the Mousterian and Perigordian.

Most important sites visited by the speaker were those in central and southern Spain where, for the first time in European prehistory, the Pebble Industry has been found in place beneath the Acheulean and Abbevillian. Spanish archeological progress was extremely impressive.

Outstanding among the museums visited were the British Museum of Natural History in London (for its exhibit related to the evolution of Man), the Musée de l'Homme in Paris (for its unequalled study collections of lithic material) and the Musée des Beaux Arts in Pau (for its collection of African Lower Paleolithic material determined to be of pre-Gunz age).

Certainly a major impression derived from this period of study was that the European scientists demonstrated an excellent attitude of generous cooperation, interest and fellowship. These men are extremely eager to establish an exchange of information with American scientists.

December 12, 1958

The December meeting was held one week in advance of the usual meeting time because of the approaching Christmas holidays. The program was sponsored by the Section of Botany, with Miss Bonnie C. Templeton, Chairman. A summary of the lecture of the evening by Dr. Kenneth E. Baker, Professor of Plant Pathology, University of California at Los Angeles, follows:

Dynamics of Plant Disease

Kenneth F. Baker

There has been close parallel development of disease-control practices in plants and animals. Both have progressed from superstitious practices, through the use of antiseptics (on animals) and sprays (on plants), to aseptic procedures, to use of antibiotics (on animals and plants) and retardant or antagonistic organisms in soil. A plant disease is the result of the interaction between a *variable plant* and an *unpredictable environment*, and usually an *adaptable pathogen* is also involved; frequently a *mobile vector*, such as an insect, carries the pathogen.

Modern plant pathology aims at controlling disease by altering one or more of these four factors. *Environment* may be selected or altered so as to favor the host but not the pathogen. The *plant* used may be resistant, or rotation practiced to break the pathogen cycle. The two ultimate sources of *pathogens*, the soil and the host, may be eliminated by heat or chemical treatment of soil and the use of pathogen-free planting material. Sanitation must be practiced to prevent recontamination. As a last resort, sprays may be used. The *vector* may be eliminated by selection of areas unfavorable to the insect, or the use of sprays.

The control of plant disease is desirable for several reasons beyond the elimination of crop loss. The tolerance of the plant to climatic variation is often greatly broadened, and culture thus made less tedious and expensive. Sometimes only after controlling pathogens (*e.g.*, damping-off fungi) is it possible to apply controls for some other problem (*e.g.*, leaching to reduce salinity). Only healthy plants can yield valid data on effectiveness of cultural practices, and thus enable growers to learn from experience. Elimination of disease is essential for scheduled and mechanized production of plants, a present economic necessity.

Pathogens cause disease by weakening plants by robbing them of nutrients, interfering with water movement (vascular parasites), increasing water loss (rusts), rotting all or part of a plant (*Botrytis* gray mold, bacterial soft rot), reducing root area and effectiveness, and by formation of toxins. They gain entry into a plant through dead or dying parts (*Botrytis*), directly through the epidermis (powdery mildew, *Rhizoctonia*, *Verticillium*), through stomata (rusts, bacteria) or lenticels (potato scab), or through wounds (crown gall). They develop on the surface of the plant (powdery mildews), in the vascular elements (*Verticillium*, *Fusarium*, bacteria), or in other tissues where decay is produced.

Pathogens reproduce by dry air-borne spores formed on aerial structures (*Botrytis*), by thick-walled resting spores formed in rotted tissues (water-mold root rots), by slimy, water-borne spores produced in sac-like structures (*Septoria*), by air-borne spores forcibly ejected from cup-shaped structures (*Sclerotinia*), and by thick-walled clumps of mycelium (*Rhizoctonia*). These structures are carried about by air, water, soil, planting material, containers, rubbish, insects, and man. When these bodies come into contact with another suitable plant they infect in the ways mentioned, develop in the plant, and again sporulate, completing the cycle.

January 16, 1959

The January program was held under the sponsorship of the Earth Sciences Section, with Dr. Theodore Downs as Acting Chairman. Professor Daniel I. Axelrod of the University of California at Los Angeles presented a discussion on "Changing Climates in the Tertiary of the Sierra Nevada." The lecture was especially rewarding in that Dr. Axelrod gave an excellent review of the history of ancient floras leading to the occurrence of those of the later Tertiary of the Sierra Nevada area. The methods of analysis of paleobotanical evidence were reviewed, with particular emphasis on the comparison of fossil plants with their living counterparts in distant parts of the continent, and the ecologic relationships involved. On the basis of fossil evidence of plant associations of the Pliocene and Pleistocene of Nevada and eastern California, Dr. Axelrod presented estimates of past altitudes of the Sierra Nevada mountain region. The major uplift of the Sierra Nevada range, which caused the present widespread desert environment to the eastward, was thus interpreted as having occurred in late Pliocene to middle Pleistocene time.

Board of Directors

A meeting of the Board of Directors and Advisory Board was held immediately following the program in January. The following committees were appointed by the President, Dr. Hildegard Howard:

Committee on nominations for Directors and Advisory Board, 1959-1960

Dr. Fred S. Truxal, Chairman

Mrs. Dorothy Martin

Dr. Charles Burch

Committee on nomination of Fellows

Dr. Theodore Downs, Chairman

Dr. John Garth

Miss Ruth D. Simpson

Committee on awarding of A.A.A.S. research grants

Miss Gretchen Sibley

Dr. W. Dwight Pierce

Dr. Sherwin F. Wood

A set of 52 charts presented to the Academy by Mr. O. A. Angelillo, concerning his investigations for water on the Mohave desert property of Mr. N. K. Mendelsohn of the California City Development Company, were reviewed by the Board. The obvious promotional nature of the project was discussed and scientific fallacies inherent in the charts were pointed out. It was, therefore, resolved to return the charts to Mr. Angelillo; it was further resolved that a letter explaining the action of the Board be sent to Mr. Angelillo.

New Members

The following have been accepted for unlimited membership since the publication of the membership list in the 1958-1959 Program: Ed. N. Harrison, 1134 Glendon Ave., Los Angeles (Ornithology); Charles L. Hogue, 4986½ Floristan Ave., Los Angeles (Entomology); William Lumsden, Long Beach State College (Paleontology); Dr. Joseph F. Shea, 8709 Rincon Ave., Sun Valley (Archaeology); Lloyd Mason Smith, Orange Coast College, Costa Mesa (Biology); Howard Stien, 314 Lime St., Inglewood (Biology); Rudolph G. Strong, Dept. of Entomology, University of California, Riverside (Entomology). Two were accepted for limited membership: Mrs. Freddie Curtis, 433 Ross St., Glendale (Archaeology); and Dr. Ethel R. Harrington, 963 - 4th Ave., Los Angeles (Medicine).

SCIENTIFIC NOTES

Dalcerides ingenita (Hy. Edw.)

During August of 1954, while collecting lepidoptera in Madera Canyon, Santa Rita Mountains, Arizona, a gravid female of the little yellow "Flannel-moth", *Dalcerides ingenita* came to light.

A number of eggs were laid, which hatched on August 29.

We had no information on the food plant at the time, and the young larvae died shortly after hatching, but not before we made brief notes, as given below.

This species was first described by Henry Edwards in *Papilio*, Volume 2, page 12, 1882, under the name *Artaxa ingenita*, with the type locality given as Prescott, Arizona.

It is the only species in the Genus and in the Family that occurs in the United States.

We have not been able to locate any references to its life history, other than the brief note by Dyar on the cocoon, published in *Insectur Inscitiae Menstruus*, 13, p. 46, 1925.

The eggs were oval in shape, and yellow in color like the moth. They were laid in flat single-layered clusters, each separated by a narrow space.

The newly emerged larvae were slug-like, and yellow.

JOHN A. COMSTOCK

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The 1922 issues are: Vol. XXI, No. 1, March; Vol. XXI, No. 2, September.

The 1923 issues are: Vol. XXII, No. 1, March; No. 2, July.

The 1924 issues are: Vol. XXIII, No. 1, January-February; No. 2, March-April; No. 3, May-June; No. 4, July-August; No. 5, September-October; No. 6, November-December.

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VOL. 58

MAY-AUGUST, 1959

PART 2

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LIFE CYCLE STUDIES OF THE BRACHYURA
OF WESTERN NORTH AMERICA, II. THE
LIFE CYCLE OF *LOPHOPANOPEUS*
BELLUS DIEGENSIS RATHBUN

By JENS W. KNUDSEN

Assistant Professor, Department of Biology
Pacific Lutheran College, Parkland, Washington

INTRODUCTION

This paper is the second part in a series of larval studies of western North American Brachyura, and extends our knowledge to another xanthid crab, *Lophopanopeus bellus diegensis* Rathbun. Along the west coast of the United States the genus *Lophopanopeus* is represented by two species, *Lophopanopeus leucomanus* and *Lophopanopeus bellus*, each with two distinct subspecies (recombination by Menzies, 1946). Part I (Knudsen, 1958) of this series gave the life history of *Lophopanopeus leucomanus leucomanus* (Lockington). Hart (1935) recorded the larval development of *Lophopanopeus bellus bellus* (Stimpson) and the present paper covers the second subspecies of this combination, *Lophopanopeus bellus diegensis*. Thus, only *Lophopanopeus leucomanus haethi* Rathbun remains to be worked out before our knowledge of the larval forms of this genus is complete.

Lophopanopeus bellus diegensis has a life cycle that is typical of other xanthid crabs which have been studied in that there is a prezoaea, four zoeal stages, and a megalops. The particular group of larvae used in this study metamorphosed to the first zoeal stage so rapidly after hatching that too few prezoaea were obtained for a complete study of their anatomy. Thus, this paper is lacking in the description of this stage. It may be mentioned here, however, that the prezoaea that were observed resemble *Lophopanopeus leucomanus leucomanus* (Knudsen, 1958) very closely.

The work involved in this paper was completed at the Allan Hancock Foundation, University of Southern California, Los Angeles, California. The writer is grateful to Dr. John S. Garth and Dr. Norman T. Mattox for their guidance in this study.

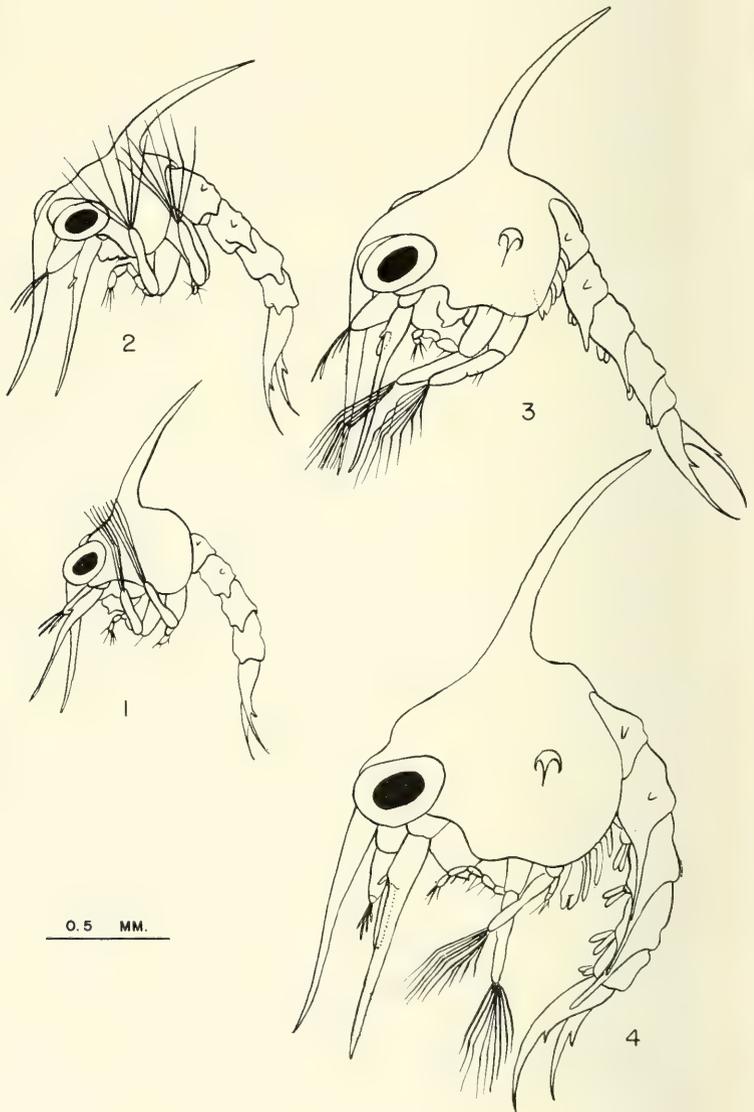


PLATE 17

Lophopanopeus bellus diegensis Rathbun: fig. 1, first zoea; fig. 2, second zoea; fig. 3, third zoea; fig. 4, fourth zoea.

LOPHOPANOPEUS BELLUS DIEGENSIS RATHBUN

Ovigerous specimens were collected for this study at the Newport Channel cable crossing, Corona Del Mar, California, on June 22, 1955. This genus has the longest breeding season of any of the California xanthid crabs, ovigerous females being found from February through October. The extreme northern range of *Lophopanopeus bellus bellus* may well be correlated with this extended breeding period and the extremes in water temperature during this period. Female *Lophopanopeus bellus diegensis* become mature at a size ranging from 8.5 mm. to 9.0 mm. carapace width. The number of eggs per female ranges from 1,000 to 6,400 with an average of about 3,500. One female may produce two or three broods per year. Eggs are purple-brown when first deposited but turn to a light gray prior to hatching. Under the microscope the eggs appear hyaline except for the eye pigment and melanophores which give the grayish appearance. The larval period is completed in about five weeks' time. The culture methods outlined in Part I of this series were employed in this study.

FIRST ZOEAE (Plate 17 and 18). Measurements: Body 1.37 mm. long from front of head to tip of telson. Dorsal spine 0.60 mm.; rostral spine 0.60 mm., distance from tip of dorsal spine to end of rostral spine 1.50 mm., antenna equal in length to rostral spine.

DESCRIPTION: Carapace smooth, with all spines present; spines unarmed and smooth.

ANTENNULE (Plate 18, Figure 5) conical, with two long aesthetes and three setae. Antennal protopodite (Plate 18, Figure 4) swollen at base, tapering to a point, with a short unarmed, smooth exopodite. Mandibles and maxillae not dissected or diagnosed.

First maxilliped (Plate 18, Figure 6) with one, two, one, two and five "hairs" on five segmented endopodite, and four plumed natatory "hairs" on exopodite. Second maxilliped (Plate 18, Figure 7) with one, two, and three "hairs" on the three segmented endopodite, and four natatory "hairs" on the exopodite. Other thoracic appendages not evident.

Abdomen five-segmented, with spinelike projections on the mid-lateral surfaces of segments two and three, and posterolateral projections on segments three to five.

Telson (Plate 18, Figure 3) forked, with two very small, inconspicuous lateral spines, one normal dorsal spine and three medial spines per fork. The first medial spine with nine or ten long "hairs" about one third the spine length from base.

SECOND ZOEAE (Plate 17, Figure 2). Measurements: Body length 1.68 mm.; dorsal spine 0.65 mm.; rostral spine 0.73 mm.;

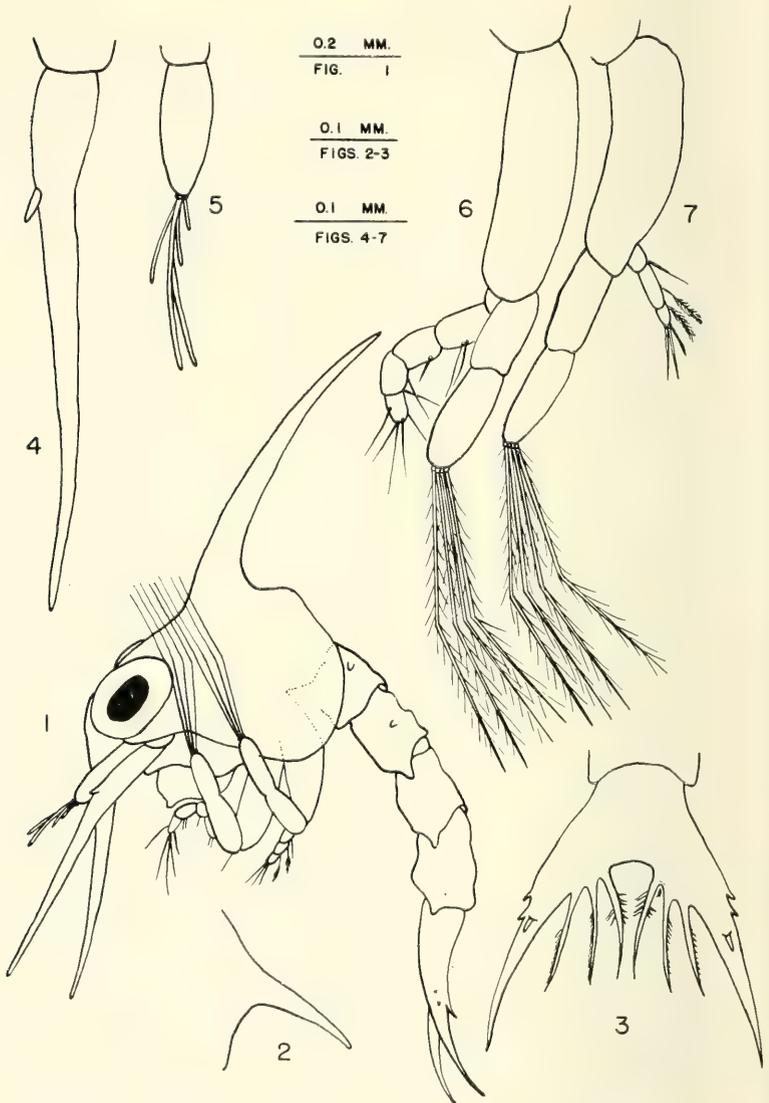


PLATE 18

Lophopanopeus bellus diegensis Rathbun first zoea: fig. 1, first zoea, lateral view; fig. 2, lateral spine; fig. 3, telson; fig. 4, antenna; fig. 5, antennule; fig. 6, first maxilliped; fig. 7, second maxilliped.

distance from dorsal spine tip to end of rostral spine 1.73 mm.; antenna equal to rostral spine.

DESCRIPTION: All carapace spines present and smooth. A prominent protuberance before the dorsal spine.

Antennule conical, with four aesthetes at tip. Antenna smooth, with a short exopodite, without an endopodite. Mandibles and maxillæ not diagnosed.

First maxilliped with six terminal natatory "hairs," second with seven natatory "hairs." The third maxillipeds, chelæ, and pereopods appear as small buds behind the second maxilliped.

Abdomen five-segmented and armed as in the first zoeal stage. Lateral telson spines present, but inconspicuous.

THIRD ZOEAL (Plate 17, Figure 3). Measurements: Body length 2.10 mm.; dorsal spine 0.86 mm.; rostral spine 8.60 mm.; distance from tip of dorsal spine to end of rostral spine 2.03 mm.; antenna as long as rostral spine.

DESCRIPTION: Carapace smooth, with marginal "hairs," and a prominent protuberance before the dorsal spine; with all spines present and smooth.

Antennule conical, with two long aesthetes and several short setæ. Antenna with the exopodite unchanged, with a short (0.09 mm.) endopodite.

First maxilliped with eight natatory "hairs." Second maxilliped with nine natatory "hairs." Chelæ and pereopods elongated and conspicuous.

Abdomen with a new, unarmed sixth segment; armature unchanged. Rudimentary pereopods and uropods present. Telson without lateral spines, with an additional pair of short median spines, otherwise normal.

FOURTH ZOEAL (Plate 18, Figure 4). Measurements: Body length 2.76 mm. from front of head to tip of telson. Dorsal spine 1.00 mm.; rostral spine 0.90 mm.; distance from tip of dorsal spine to end of rostral spine 2.43 mm.; antennal endopodite 0.35 mm.

DESCRIPTION: Carapace smooth, with marginal "hairs" and a prominent protuberance before the dorsal spine, with all spines present.

Antennule conical, with a short endopodite visible only from a superior or median view. Antennal exopodite unchanged, endopodite one-third length of protopodite.

First maxilliped with nine natatory "hairs"; the second maxilliped with ten natatory "hairs." Third maxillipeds fingerlike. Chelæ and pereopods well developed but not functional.

Abdomen with normal armature, rudimentary pereopods on segments two to five and uropods on the sixth segment. The

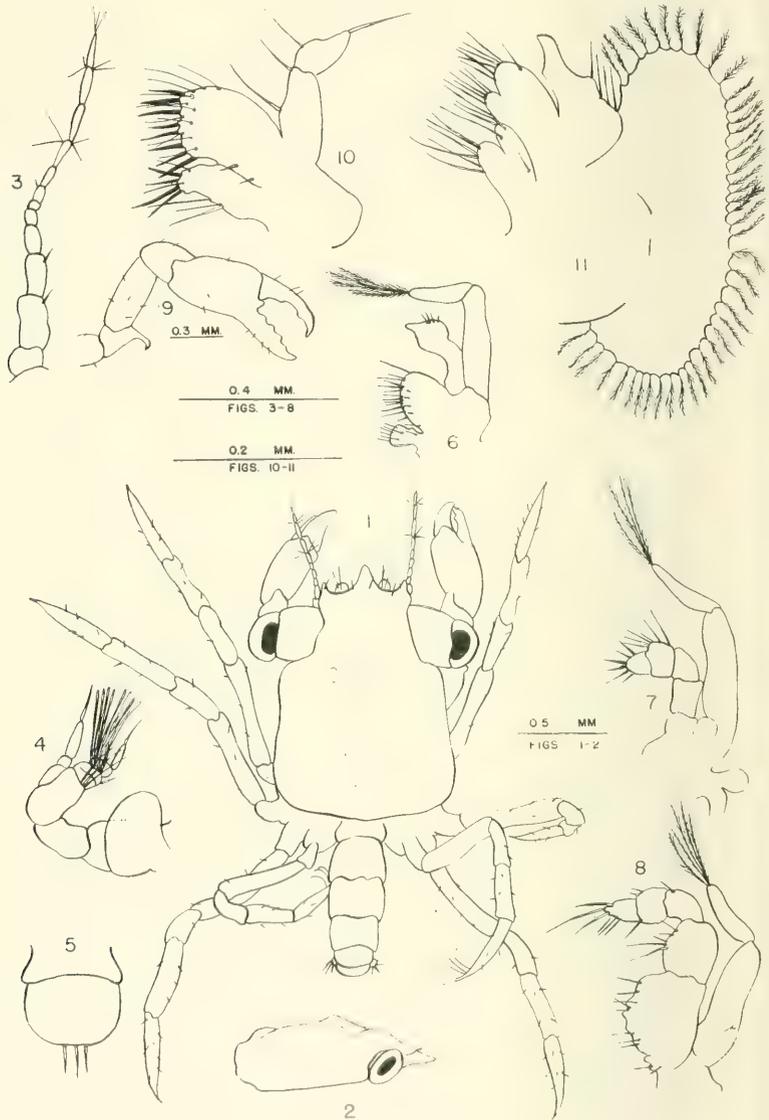


PLATE 19

Lophopanopeus bellus diegensis Rathbun megalops: fig. 1, megalops, dorsal view; fig. 2, lateral view of carapace; fig. 3, antenna; fig. 4, antennule; fig. 5, telson; fig. 6, first maxilliped; fig. 7, maxilliped; fig. 8, third maxilliped; fig. 9, chela; fig. 10, first maxilla; fig. 11, second maxilla.

fourth pair of median telson-spines is only one-third the length of surrounding spines.

MEGALOPS (Plate 19). Description: Carapace smooth, "hairs" in the anterior portion and setæ on margins. Front wide, with a broad, rectangular projection on the anterolateral corners of the carapace; projection forming a tooth in the anterior corner. Rostrum exceeds frontolateral teeth, is rounded and projected downward. Carapace with five setæ between rostrum and teeth. Greatest distance across carapace less than distance between tips of eyes. A conspicuous mid-dorsal protuberance (Plate 19, Figure 2); two midlateral protuberances; and one postero-mid-dorsal protuberance.

Antennule (Plate 19, Figure 4) composed of a peduncle and two flagella; first segment swollen laterally to accommodate statocyst; second segment bare; third segment with a short two-segmented flagellum bearing subterminal and one terminal "hair," and a second flagellum of three short segments bearing æsthetes, terminating with a long segment and a terminal bristle. Antenna (Plate 19, Figure 3) of eleven segments; segments eight and ten with cluster of "hair." First maxilla (Plate 19, Figure 10): endopodite two-segmented, with two setæ on first segment and one lateral and one terminal seta on the second segment; exopodite with eight stout spines and eleven terminal setæ; endite with four stout spines and five terminal setæ. Second maxilla (Plate 19, Figure 11); exopodite with about fifty marginal, plumose "hairs"; endopodite with only four lateral, plumose "hairs"; second endite bilobed, with seven and six setæ; first endite bilobed with four and six setæ.

First maxilliped (Plate 19, Figure 6): exopodite two-segmented with four terminal plumose "hairs"; endopodite degenerate and mono-segmented, with four distal setæ; second endite with thirteen marginal and four submarginal setæ; first endite with ten setæ. Second maxilliped (Plate 19, Figure 7) with two-segmented exopodite bearing four terminal, plumose "hairs"; endopodite with four free segments, with two, zero, six and six bristles from merus to dactylus. Third maxilliped (Plate 19, Figure 8); exopodite two-segmented with five terminal "hairs"; endopodite with two, eight, five, one and three "hairs" from basis to propodus and three setæ and three spines on dactylus. Cheliped (Plate 19, Figure 9) with a prominent ischial spine. Pereiopods "hairy," dactylus with three long setæ.

Abdomen of six segments and a telson. Pleopods on segment two to five and uropods with nine plumose setæ on sixth segment. Telson (Plate 19, Figure 5), with three terminal bristles.

REMARKS. *Lophopanopeus bellus diegensis* is easily distinguished from *Lophopanopeus l. leucomanus* by the absence of

spinelets on the antennal protopodite, and from *L. B. bellus* (see Hart 1935) by the presence of two lateral telson-spines.

It is interesting to note that larval studies of *Lophopanopeus* corroborate the revision of this genus by Menzies (1946) in that the larvæ of the new combination of subspecies, *L. b. bellus* and *L. bellus diegensis* are almost identical in appearance but differ from the larvæ of *L. l. leucomanus* to a much greater degree.

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A NEW SPECIES OF FOSSIL TURTLE FROM THE PLIOCENE OF OREGON, WITH NOTES ON OTHER FOSSIL *CLEMMYS* FROM WESTERN NORTH AMERICA

By BAYARD H. BRATTSTROM AND ANN STURN*

The genus *Clemmys* has an interesting geographical distribution with species in southern Europe, southeast Asia, northeastern North America, and one species in western North America. In contrast to many Cenozoic reptile groups, there are a number of fossil forms known. It is the purpose of this paper to discuss new and previously described fossil *Clemmys* from the Pacific Coast of North America.

Most of the material referred to below comes from the collections of the Los Angeles County Museum, including the recently acquired California Institute of Technology collection (L.A.C.M. and C.I.T.) and the Museum of Paleontology of the University of California, Berkeley (U.C.M.P.) and was studied through the courtesy of Dr Theodore Downs and Dr. R. A. Stirton, respectively.

Hay (1908) lists the following species of fossil *Clemmys* from western North America: *C. morrisiæ* (Bridger Eocene), *C. saxea* (Upper Miocene Mascall beds of Oregon), and *C. hesperia* (Pliocene, Rattlesnake beds of Oregon). Several specimens of Pleistocene *Clemmys marmorata* have been recorded (Brattstrom, 1953a, 1953b, 1955, 1958). The oldest known member of the genus is *C. bockmani* from the Paleocene of Saskatchewan.

Clemmys owyheensis new species

TYPE: L.A.C.M. (C.I.T.) no. 5123, an entoplastron.

TYPE LOCALITY AND HORIZON: C.I.T. Loc. 62, Owyhee, Hemphillian Pliocene, near Rome, Malheur County, Oregon. It was found along the east side of Dry Creek, a tributary of Crooked Creek.

DIAGNOSIS: The specimen is a large emydid turtle with the humeral-pectoral sulcus crossing the entoplastron, gular-humeral sulci forming an acute angle with the mid-line of 33 degrees or less. The entoplastron is curved posteriorly and laterally, but is tapered anterior-laterally with a prominent anterior knob.

DESCRIPTION OF TYPE: The type consists of an entoplastron 33.5 mm. long and 36.0 mm. wide (Plate 21) with the humeral-pectoral sulcus crossing it, and with the humeral-gular sulcus forming an angle of about 28 degrees with the mid-line (or the two sulci forming an acute angle of 65 degrees or less). The

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entoplastron is curved posteriorly and laterally: anterior-lateral edges are strongly tapered towards the mid-line, but turn anteriorly about 8-10 mm. from the anterior tip to form a large knob (12 mm. wide at its base). The knob is slightly pointed and has the forks of the gular sulci upon it. The intergular sulcus start about 3.5 mm. anterior of the gular sulcus fork on the right gular-humeral sulcus.

PARATYPES: Four bones, all of the plastron, are designated paratypes. They all come from the same locality as the type and include another entoplastron, L.A.C.M. (C.I.T.) no. 5127, Fig. 21; and three epiplastrons, L.A.C.M. (C.I.T.) no. 5124-5126. The entoplastron is the same general size and shape as the type (length and width respectively: 33.0 and 33.5 mm.). It is somewhat more worn than the type and chips have broken off its ventral surface. The anterior knob is wider than in the type (14 instead of 12 mm.) and the humeral-gular sulcus angle with the mid-line is 33 degrees. The intergular sulcus starts 5 mm. anterior of the gular sulci fork on the left gular-humeral sulcus.

The left epiplastron (5126) is 51.0 mm. long (greatest length) and 30.0 mm. wide with a relatively strong gular-humeral sulcus. The right epiplastron (5124) apparently comes from another individual as it is 42 mm. long and 28 mm. wide. The third epiplastron (5125) is partly broken and worn. All three have a medial indentation for articulation with the knob of the entoplastron.

REFERRED MATERIAL: In addition to the type and paratypes, there are 14 marginal bones from the same locality and one marginal from another locality on Dry Creek. These marginals all appear emyidine and are referred here to *Clemmys owyheensis*.

RELATIONSHIPS: *C. owyheensis* differs from all recent and fossil *Clemmys* in the shape of the entoplastron, especially as to its anterior knob and gular sulci angle. *C. owyheensis* appears more closely related to *C. morrisiæ* of the Bridger Eocene than to any other fossil or Recent *Clemmys*. It differs from "hesperia" and *morrisiæ* by being larger, having the anterior knob more developed, and having a smaller angle to the gular sulci. The Miocene *C. saxea* from the Mascall beds of Oregon is known only from a pygal bone and its relationship to *owyheensis* is unknown. Some of these relationships are diagrammed in Plate 22.

Clemmys marmorata

This living species is known from several Pleistocene localities, some of which are already recorded in the literature. Some fossil *Clemmys* from Pliocene deposits prove to be *C. marmorata*. *C. hesperia* described by Hay (1903), without comparison with

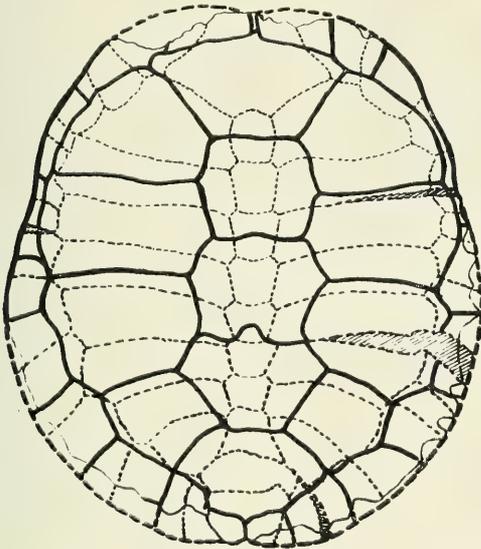


PLATE 20

Dorsal view of carapace of fossil *Clemmys marmorata*, L.A.C.M. 3647, L.A. Brickyard locality no. 3, San Pedro Fm., Los Angeles Co., California. Pleistocene.

marmorata, falls within the variation shown by Recent *C. marmorata*. The material will be discussed by locality:

PLEISTOCENE

Rancho La Brea, Los Angeles County, California, Late Pleistocene. Brattstrom (1953a, 1958) records *C. marmorata* from the La Brea Tar Pits.

McKittrick Asphalt, Kern County, California, Late Pleistocene. Recorded by Brattstrom (1953b).

Carpinteria Asphalt, Santa Barbara County, California, Late Pleistocene. Material from this deposit (including a record of *marmorata* from an archeological site in Santa Barbara County) is reported by Brattstrom (1955).

Potter Creek Cave, Shasta County, California, Late Pleistocene. Referred to by Brattstrom (1955).

San Francisco Bay, Irvingtonian Pleistocene. An emydid (U.C.M.P. no. 39062) recorded by Savage (1951) is probably *C. marmorata*.

Tranquility, Fresno County, California, Pleistocene. (SW $\frac{1}{4}$ of SE $\frac{1}{4}$ of NE $\frac{1}{4}$, Sec. 29, T14S, R16E, Jameson Quad., 2 $\frac{1}{2}$ mi. S. by W. of Jameson and 2 $\frac{1}{2}$ mi. N. by E. of Tranquility). This

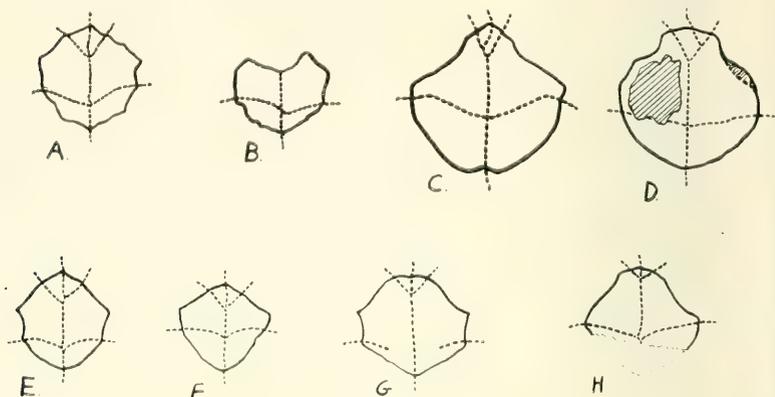


PLATE 21

Ventral views of entoplastra of *Clemmys marmorata* and *C. owyheensis* n. sp. A. *C. marmorata*, L.A.C.M. 3648, L.A. Brickyard, Pleistocene. B. *C. marmorata*, L.A.C.M. 3650, L.A. Brickyard, Pleistocene. C. *C. owyheensis* n. sp. Type: L.A.C.M. (C.I.T.) 5123. D. *C. owyheensis* n. sp. Paratype: L.A.C.M. (C.I.T.) 5127. E. and F. *C. marmorata*, Recent, Los Angeles Co., California. G. and H. "*C. hesperia*" (= *C. marmorata*), Redrawn from Hay.

sandy clay fossil deposit (U.C.M.P. Loc. 4401) contains fragments of *Clemmys* (no. 37705) which do not differ from recent *C. marmorata*.

White Bluffs, Washington, Early Pleistocene, C.I.T. Locality YE 36, Bluffs 1 mi. N. Werhl Ranch, opposite town of White Bluffs, Washington. From this locality there are 17 fragments of bones, mostly marginals, that are referred to *C. marmorata*.

San Pedro Formation, Los Angeles County, California, Pleistocene. C.I.T. locality 186, 100 ft. N.E. of corner of N. Pacific and Olive Sts., San Pedro, Los Angeles County, California. There is one left hypoplastron and inguinal buttress, one right epiplastron, and one costal of *C. marmorata* from this deposit.

U.C.M.P. locality 2407, Upper San Pedro Formation. Material from this locality includes one right hypoplastron and inguinal buttress, one right xiphoplastron, one right costal, two marginals, and fragments of a right hypoplastron. From the same locality are 1 *Pituophis catenifer*, 6 *Lampropeltis*, and 6 *Crotalis viridis* vertebrae in the University of California, Museum of Paleontology collections.

L.A.C.M. locality: L.A. Brickyard, locality no. 3, Mission Road and Daily Street, San Pedro, Los Angeles County, California. The following *Clemmys marmorata* material is found associated with *Equus*, camel, ground sloth, mastodon, and mammoth:

| | |
|-------------|---|
| RECENT | MARMORATA |
| PLEISTOCENE | MARMORATA |
| PLIOCENE | MARMORATA (HESPERIA) |
| MIOCENE | SAXEA |
| OLIGOCENE | EASTERN NORTH AMERICAN SPECIES |
| EOCENE | MORRISIAE ? ASIAN AND EUROPEAN SPECIES ? |
| PALEOCENE | BOCKMANI ? |

PLATE 22

Suggested relationships of the species of *Clemmys* of western North America.

A. One complete carapace (L.A.C.M. no. 3647), 13.6 cm. long and 11.9 cm. wide (Plate 20). The carapace appears to be similar to Recent *C. marmorata* except in minor details which may be attributed to individual variation, *i.e.* the small nodule which is found on the anterior portion of the fourth central scute. Variation of this type may also be found in some Recent specimens of *C. marmorata*. The central line of the fossil carapace is depressed, probably the result of pressure during fossilization.

B. A right two-thirds of a second carapace (L.A.C.M. no. 3649) showing all but the last few posterior centrals. The estimated length of this carapace is 13.5 and 12.6 cm. respectively.

C. The left one-third of a third carapace (L.A.C.M. no. 3651) showing portions of the lateral scutes and their accompanying marginals.

D. An entire, though badly damaged shell (L.A.C.M. no. 3650) with the anterior and posterior portion of the plastron lost. The shell is distorted and fractured. A portion of the entoplastron is illustrated in Plate 21, figure B.

E. An anterior portion of a plastron (L.A.C.M. no. 3648), the entoplastron of which is illustrated in Figure 2a.

F. There are also six additional fragments (L.A.C.M. nos. 3652-3657) which are probably *C. marmorata*.

PLIOCENE

Hungry Valley, Los Angeles, California, Upper Pliocene. C.I.T. Locality 459, Hungry Valley Fm. SE $\frac{1}{4}$, Sec. 21, T8N, R18W, Ft. Tejon Quad. There is a fragment of the anterior end of a carapace from this locality referable to *C. marmorata*. The

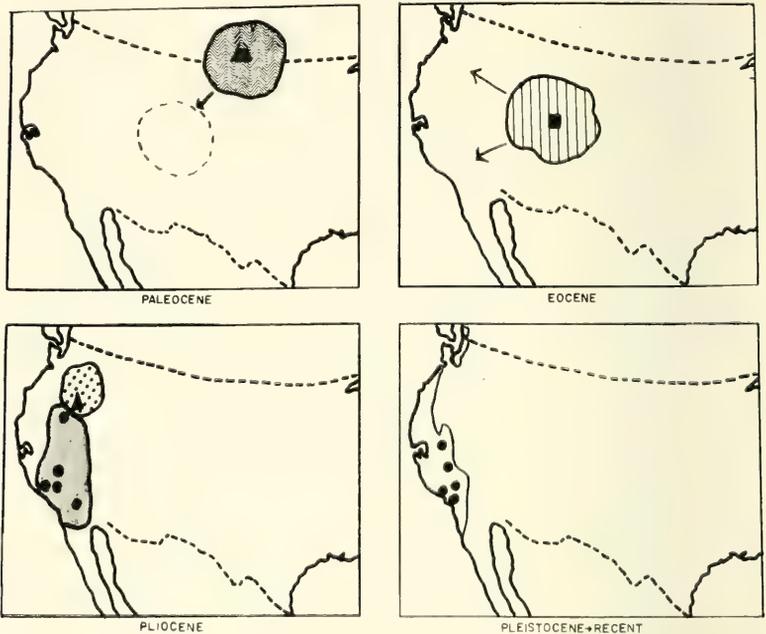


PLATE 23

Maps showing changes in distribution of the genus *Clemmys* in western North America.

precentral scute is 8.3 mm. long and 2.9 mm. wide; the first central scute is approximately 31.3 mm. wide and the length and width of the proneural bone is 29.0 and 38.8 mm. respectively.

Mt. Eden, L.A.C.M. locality 1118, Mt. Eden Fm., Riverside County, California. A pygal collected by T. Downs from this locality in 1953 does not differ from Recent *C. marmorata*.

Ricardo Formation, Kern County, California, Pliocene. A fragment of a turtle from U.C.M.P. locality 1083, no. 29280, is indistinguishable from *C. marmorata*.

Oregon: *C. hesperia*; Hay (1903) described *C. hesperia* from the Pliocene Rattlesnake beds of Rattlesnake Creek, Oregon on the basis of hyoplastral characters. We have found that these characters are not distinct (contrary to the remarks by Brattstrom, 1953a), but fall within the individual variation found in both Recent and Pleistocene *C. marmorata*. Further, we have found no basic difference between a reconstruction of the entoplastron of *C. hesperia* (a reconstruction made from the already reconstructed anterior plastron of *C. hesperia* by Hay, 1903)

and the entoplastron of Recent *Clemmys marmorata* (See Plate 21). *C. hesperia* must therefore be placed into the synonymy of *C. marmorata*.

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FOSSIL ARTHROPODS OF CALIFORNIA.
No. 22. A PROGRESS REPORT
ON THE NODULE STUDIES

By W. DWIGHT PIERCE

One of the most astonishing fields in paleoentomology was opened by Drs. Allison R. Palmer, and Allen M. Bassett, in their preliminary statement in *Science* (1954, vol. 120 (8):228) concerning silicified insects in calcareous petroliferous nodules; and Dr. Palmer's later report (*Miocene Arthropods from the Mojave Desert, California. Geol. Surv. Paper 294-G; pp. 237-280, figs. 83-101, pl. 30-34*) published early in 1958, revealed the scope of their findings.

The present writer began active study of the Calico Mountains nodules in 1956, stimulated by the independent discoveries of Mr. and Mrs. John H. Rouse; and has worked continuously on the material since then, basing studies on four great collections of nodules, which now total 17,203. The first report on this material was No. 21 in this series, on the termites (*Bull. So. Cal. Acad. Sci. 57 (1): 13-24, pl. 5-7*).

Since then the field has enlarged beyond the Calico Mountains, and nodules of similar types are now at hand from Ventura, Kern, and San Bernardino Counties.

In the Calico Mountains of San Bernardino County, in the area of a Middle Miocene fresh water lake, which was surrounded by volcanoes, there occur two distinct series of fossil-insect-bearing nodules. The upper series, just under the volcanic lava cap, consists of bluish gray to bluish black nodules, mostly now found in the tailings dumps of the borax mines, because the mines have been sealed. The lower series, in great thickness, consists of white, pinkish, yellowish, grayish, greenish, or other types of light-colored nodules found in many stratigraphic layers. Dr. Thane McCulloh of Riverside, Calif., who has studied the stratigraphy of the Calico Mountains, assured me verbally that the blue nodules are younger than the white. This is corroborated by the large percentage of blue nodules containing unsilicified insects.

Due to the tilting of the mountain strata the stratigraphic correlations must yet be made; but nodules are now at hand from altitudes of 2300 to 3000 feet in eleven quarter sections ($\frac{1}{2}$ miles square each) on the western and northern sides of the southeastern mountain mass in the Calico Mountains, enclosed by Mule Cañon Drive, and sites have been reported to us by Dr. McCulloh in the southern and southeast sectors, so that it is

safe to say that the nodule-bearing strata lie under this entire mountain mass.

The southeastern portions of Mount Pinos, of the Frazier Mts., in Ventura County, also yield pale bluish nodules that are associated with the borax mines near the lava cap; and these nodules contain fossil insects preserved in the same manners as those from the Calico Mountains. Below the blue nodules, Samuel Kirkby has found a deposit of white nodules.

John and Marie Carr found in Horse Cañon of the Tehachapi Mts., of Kern County, east of Monolith, white nodules of the usual type; and published descriptions of the boron deposits in Los Angeles and Inyo Counties lead me to expect to find similar nodules in these counties also.

Bob Godsey has found a different kind of fossil-bearing nodule on the hill at Lenwood, south of Barstow, in San Bernardino County.

The exciting fact regarding the insects found in the nodules is that many of them are silicified, three dimensional, with every evidence that they were killed and preserved instantly, for they are clearly outlined, with even some internal organs preserved, and the hairs on the appendages silicified. The outlines are so perfect that only colloidal silica replacement can explain their preservation.

Often however, when the insect had died and begun to disintegrate, or is represented by a cast skin, the silica replacement is crystalline and not colloidal, showing that there were two phases of silicification.

Some of the fossil insects have been preserved in other ways, such as by calcium, or strontium. Still other insects completely disintegrated and left a tell-tale cavity to prove their existence. These cavities are so perfect that by means of latex cast we can obtain the exact form of the insect.

Our research with the nodules has revealed a number of forms of beautifully preserved silicified algae. Among the fossil arthropods so far disclosed are many eggs, larvae, pupae, and adults of Heleidae (Ceratopogonidae), midges whose larvae feed upon algae. We also find multitudes of Dytiscid larvae, which feed upon the Heleids. And the fairy shrimps (Anostraca), a very small species, were also present. They probably fed upon the detritus on the bottom.

Paleoentomology usually has to deal with crushed insects, but these nodules contain perfect three-dimensional fossils. This fact suggests that death must have been sudden, presumably caused by the very materials which preserved the bodies in original form.

Dr. Palmer's (1958) cross section of a cliff showing three great nodule-bearing zones, in which were 13 nodule-bearing series, immediately suggests that the catastrophe of insect death did not occur annually, but rather epochally, in some cases after hundreds of years intermission. Measurements of the dark and light pairs of varves, considered by geologists as two-season annual layers, in the matrix surrounding nodules, gives an average of 25 years to the inch. The Palmer section of 88 ft., could then possibly account for a time of 26,400 years. The great intervals between nodule zones could at this rate be 4050 and 6750 years.

METHODS OF PROCEDURE.

Dr. Palmer (1958) has described his methods of collecting, preparing and studying the nodules. Mine are similar but should be outlined. Each collecting area is given a site number (I now have 102 sites in the Calico Mts.); and it is noted whether the specimens were floats, drifts, from mine dump, or found in matrix (horizontal or anticline), and also if in mine caves. An aneroid barometer reading is used to check with the topographic maps. In most cases of matrix collection, samples of the matrix are also collected. This is important because the matrix rocks in the different areas are very distinct, and will ultimately be of value in the stratigraphic correlation. And likewise we are finding numerous insect evidences in the matrix also.

A total of 37 different people have participated in the collecting of these nodules. Every nodule is numbered in India ink, so that the collector, source, altitude, etc. can always be associated. Before putting away, each nodule is carefully examined under a 3-power head binocular, and those with external specimens are given specimen number and put aside.

George Kanakoff, of the Los Angeles County Museum, has accompanied me on three of the expeditions. Rudolph C. Pesci was on one trip, and has been of great assistance in working out the methods of recovery.

For acid work, I prefer 20% formic acid rather than acetic acid, but sometimes use dilute hydrochloric acid, and occasionally dilute nitric acid. For calcareous fossils on the outside of the nodules, I use hydrogen peroxide, which is very slow in action, but does not destroy the specimens.

Only one nodule is extracted per jar, and this is weighed, measured and sketched, and a page record shows whether petroleum was present; whether the rods which Palmer called coprolites were present; and finally the results of the microscopic examination, with respective numbers of the specimens mounted.

The acid takes from a day or week to a month to break down the nodule. But usually at the end of a week the sludge is filtered, and the nodule cracked and more acid added. By this method I have multitudes of proofs that the silicified insects are in all parts of the nodule, and not only in the center. A discussion of the different types of nodules will be taken up in a separate report.

After filtration the sludge is washed into petri dishes, and washed over and over until all solubles are removed. Then the product is removed by fine brushes to alcohol, and examined under binocular microscope. All specimens are lifted by fine brush to xylol. Sometimes I use terpineol to clear a specimen. It is then mounted in balsam, under cover glass, and if necessary pieces of glass are used to take the cover glass weight from the specimens, for they are exceedingly delicate and easily broken.

At present writing 2340 microscope slides have been mounted for the Los Angeles County Museum collection.

Mrs. Ruth Weissman has assisted in this work for the past year, and her son Albert has helped in some of the drawings.

At Riverside, my collaborators, Samuel and Ruth Kirby, are using a method superior to mine because they have running hot water at hand. They use two knitting rings over which is stretched fine rayon or nylon cloth, and pour the sludge onto this cloth, and run hot water through it; then they reverse and by means of water, deposit the contents in a flat dish. Thus they have done away with brushes and filter paper.

THE DEVELOPING MIOCENE PICTURE

The biological complex of that ancient day over 20,000,000 years ago, in this region of lake and volcanoes, is continuously growing. The following summary includes all forms previously recorded by Dr. Palmer (1958), Dr. Thomas Snyder (1955. Proc. Ent. Soc. Wash. 57 (2): 79-80, The University of California at Riverside (Life Magazine, June 24, 1957), and myself (1958), and those that I am now able to add from my studies at the Los Angeles County Museum, and those collected by Mrs. Rouse, and the Kirkbys. Detail studies, group by group will be published later.

MOLLUSCA: One impression of a *Lymnaea* in white nodule (L. A. Mus.)

OSTRACODA: In nodules at three sites in Calico Mts., and abundant at Lynwood (L. A. M.)

ANOSTRACA: Fairy shrimp evidences have been found in numbers by Palmer, Pierce and the Kirkbys. One specimen of adult female found by Tal Morash had a cluster of eggs,

which will be described. Three whole fairy shrimp, Kirkby collection.

ARANEIDA: One spider described by Alexander Petrunkevitch in Palmer report. Pierce (L. A. M.) and the Kirkbys have found specimens.

ACARINA: One species of water mite described by D. R. Cook in Palmer report. Mites also found by Pierce (L. A. M.), and Kirkbys. A different mite from Frazier Mts. (L. A. M.)

CHELONETHIDA: One chelate pseudoscorpion claw, Pierce (L. A. M.)

SCORPIONIDA: One chelate leg, Kirkby.

MYRIAPODA: Two fragments of a centipede, Pierce (L.A.M.)

COLLEMBOLA: A beautiful specimen, Kirkby.

ODONATA: Palmer reported on one Libellulid. Mrs. Rouse has found numerous dragon flies and one damsel fly, and we have numerous other evidences, especially a fine pupa petrified on the outside of a nodule, found by Mrs. Weissman (L.A.M.)

ORTHOPTERA: Part of grasshopper body, Rouse (L. A. M.)

PLECOPTERA: A young nymph, Kirkby.

ISOPTERA: In my report No. 21 of this series, I reported five species of termites from the Calico Mts. Mr. Samuel Kirkby has found a silicified head, and a silicified wing portion. Dr. Thomas Snyder (1955) reported another termite species from the Frazier Mts.

HEMIPTERA: Palmer's report covers descriptions by R. I. Sailee, and J. C. M. Carvalho of two Lygaeids and one Mirid. Mrs. Kirkby has recovered one of the Lygaeids. Several Noto-nectidae and Saldidae are to be added, Rouse and Pierce (L. A. M.)

HOMOPTERA: Palmer described a beautiful leaf hopper. This has been recovered by Mrs. Kirkby. Another species has been found, Pierce. (L. A. M.)

APHIDOPTERA: One specimen, University of Calif., Riverside (Life Mag.)

ALEUROOPTERA: One specimen, Rouse.

THYSANOPTERA: Kelly O'Neill reports three species in Palmer report. Many others have been found, Kirkby, Pierce. (L.A.M.) Thrips have been found in Frazier Mts, nodules (U.C.L.A.)

LEPIDOPTERA: One moth, Mrs. Rouse (L.A.M.)

COLEOPTERA: Palmer reports one Dytiscid, one Staphylinid, one Cybocephalid. We have on hand many larvae, and three or four different adult species of Dytiscidae, and one Hydrophilidae, Pierce, Rouse. (L. A. M.) Dytiscid larvae also from Frazier Mts., Pierce (L.A.M.)

HYMENOPTERA: One ant, Univ. Riverside (Life Mag.), another ant, Kirkby. A wasp, Tal Morash collection.

DIPTERA: Palmer describes three Heleidae, and one Tendi-pedidae. We have seven types of Heleid pupae, two types of eggs, numerous adults, Rouse, Pierce (L. A. M.), and Kirkby. Heleid pupae from Frazier Mts., Weissman, Pierce (L.A.M.)

In addition to the arthropods, other forms of life are in the nodules as follows:

PISCES: Two fish skeletons in nodules, one found by H. G. Kirkpatrick of Yermo, Calif., one by Mrs. W. Keegan, Martinez, Calif. In addition 26 silicified eggs of fish, showing various stages of embryonic development, from nodules found in three quarter sections of Calico Mts. (L. A. M.)

AVES: Three nodules with impressions of feathers, Rouse (one in L. A. M.); two silicified feathers, Kirkby.

MAMMALIA: Many silicified hairs of mammals, some with roots, Pierce (L. A. M.) Miss Gretchen Sibley will report on these.

PLANTS: The plant material includes algae, mosses, stems and leaf of higher plants. Kirkby, and L. A. M.

Thus it can be seen that we already know of the existence in and around that ancient lake of 22 orders, 35 families of invertebrates; fish, birds, mammals, and all great groups of plants. Thus we have a stimulus for continued research.

BRIEF STATISTICAL SUMMARY TO DATE

I present the following statistical data to stimulate my associates and collaborators. Results in this kind of work take patience and care, but they are worth while.

The following counts are based on 11,785 nodules, collected in many lots, at 48 sites, in 11 quarter sections of the Yermo Quadrangle, all in the southeastern mass of the Calico Mts., enclosed by Mule Cañon Drive. Findings north of this drive will be reported at a later time. The altitudes range from 2300 to 3000 ft.

An average of 1.9% of all nodules have evidence of insects externally, either as petrifications or impressions. By use of latex we can make excellent casts from the impressions.

Petroleum was noted in 50.5% of the nodules.

By acid treatment of 849 nodules we have recovered: 926 Anostraca mandibles and antennae from 84 nodules; 455 Heleid stages (egg, larvae, pupa, adult) from 208 nodules; 516 Dytiscidae (larvae, adults) from 227 nodules; and 23 Thysanoptera from 23 nodules.

By cracking, Odonata have been recovered from 38 nodules,

although in several of these, part of the body was visible externally.

Rods occurred in 48.2% of 334 nodules. While Dr. Palmer calls these rods coprolites of fairy shrimp (*Anostraca*), we must enter a reasonable doubt as to all being coprolites. There are silicified rods, crystal clear; other rods which look like algae, and finally dark rods conceivably coprolites; all about the same size. Of the nodules showing "coprolites", only 14 out of 161 contained evidences of fairy shrimp; of the nodules showing fairy shrimp, only 13 out of 44 showed "coprolites". The fairy shrimp remains are usually mandibles and second antennae; and the mandibles are of several instar sizes; so that I conceive that broods of fairy shrimp molted in colony, and that would account for an average of 11.4 individuals per nodule containing them. Some nodules are almost solid masses of these rods, and Mrs. Kirkby and I feel that we are dealing with algae. Often matrix shales are full of these rods.

Succeeding papers in this series will take up the findings group by group.

The report on the fish eggs cannot rightly be numbered in this series, but is presented in the following paper.



SILICIFIED EGGS OF VERTEBRATES FROM CALICO MTS. NODULES

W. DWIGHT PIERCE

An important result of the work of acid digestion of Calico Mts. nodules for silicified insects, has been the finding of 26 silicified eggs of vertebrates in nodules collected in three quarter sections along Mule Cañon Drive on the northern side of the southeastern mountain mass.

The nodules found in SW quarter of Section 18, Yermo Quadrangle, were from "Blue Dump" Cañon joining Mule Cañon Drive about 2000 ft. west of Tin Can Alley, all collected as floats on the road side.

The one nodule from NW quarter of Section 24 is from the same road, higher up.

The two nodules from NE quarter Section were collected in Switchback Cañon: No. 294 from matrix in the Rouse anticline (site 10), cited in my previous paper on the termites from the nodules (Bull. So. Cal. Acad. Sci. 57 (1):13-24); and nodule 4421 is from matrix in a hole (Site 25) above the Rouse anticline.

The following table gives the data on the fossil eggs found in the nodules.

It will be noted that the largest and the smallest eggs were both in Nodule 83, which contained ten eggs.

The nodules in which these eggs were found were all white, mostly of irregular form, only four being normal types of regular shape; and all were rather small, weighing an average of about 5 to 10 grams. Nodule 21 weighed 4.7 gr.; No. 83, 13.5 gr.; No. 294, 37.4 gr.

The eggs were in different stages of embryonic development, some being solid, undifferentiated; others had 2 cells, 4 cells, up to complete embryo showing the typical forms of vertebrate embryos. The drawings presented (Plate 24, figs. A-F) were made by careful microscopic study by Albert Weissman, student at University of Southern California.

In view of the absence of amnion, I consider these eggs and the separated embryo to be fish.

This supposition is strengthened by the fact that two nodules containing fish skeletons, possibly Cyprinodont, have been found in Mule Cañon Drive between the entrances of the two contributing cañons. The first of them was found by H. G. Kirkpatrick of Yermo, Calif., near the entrance of Tin Can Alley, and measured (incomplete) 32.7 mm. (probable length 34 or 35 mm.); thickness of body 9.9 mm. (Plate 25) The second was

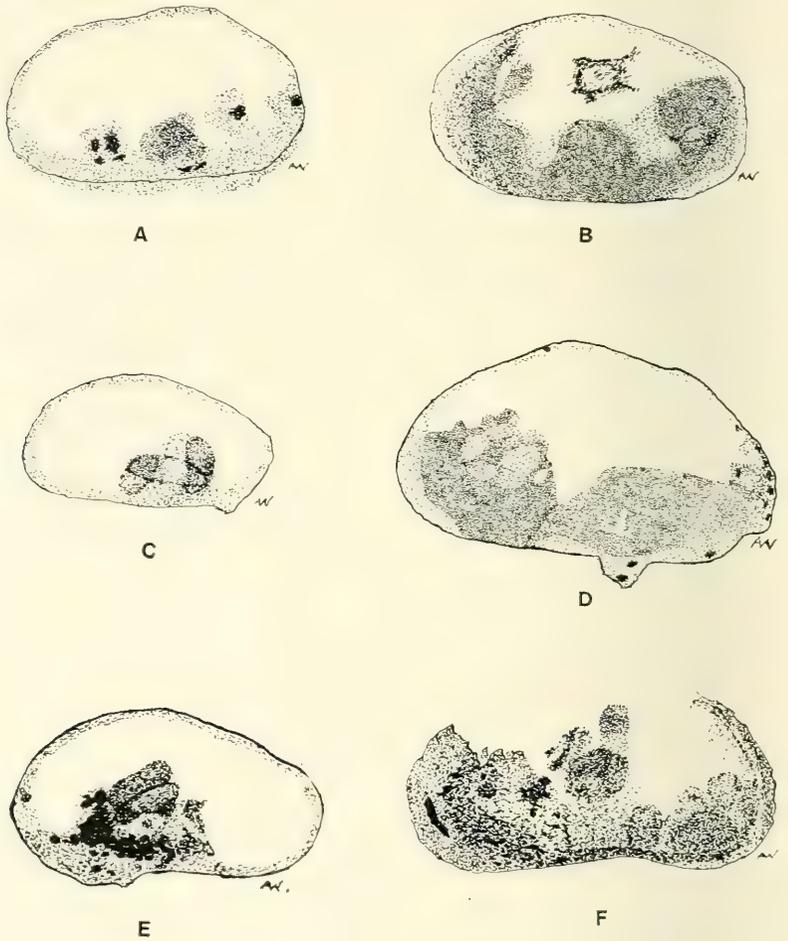


PLATE 24

Petrified eggs showing embryos. drawn by Albert Weissman.

a. Specimen 193a.

d. Specimen 274d.

b. Specimen 114c.

e. Specimen 225e.

c. Specimen 193c.

f. Specimen 113f.



PLATE 25

Petrified fish found by H. G. Kirkpatrick, photo by George Brauer.

found by Mrs. W. Keegan of Martinez, Calif. at about the same site. Half of the nodule containing this was lost.

October 28, 1958

Data on the silicified eggs.

| Quarter section | Nodule | Specimen | Egg measurements | | Condition | Embryo | Collector |
|-----------------|-----------------|----------|------------------|-----------|--------------|------------|----------------|
| | | | length mm. | width mm. | | | |
| SW 18 | 1 | 8 | 0.905 | 0.46 | bruised | solid | W. D. Pierce |
| | | 9 | 1.000 | 0.46 | broken | solid | |
| | | 10 | 0.846 | 0.48 | broken | solid | |
| | | 34a | 0.76 | 0.48 | good | solid | |
| | | 34b | 0.96 | 0.57 | good | solid | |
| SW 18 | 10 & 30 | 113 | 1.07 | 0.57 | embryo alone | complete | J. Hotchkiss |
| | | 114a | 1.01 | 0.57 | good | solid | |
| | | 114b | 0.98 | 0.57 | good | solid | |
| | | 114c | 0.94 | 0.56 | good | developing | |
| SW 18 | 17, 25, 52 & 57 | 193a | 0.88 | 0.50 | good | developing | G. P. Kanakoff |
| | | 193b | 0.86 | 0.53 | good | developing | |
| | | 193c | 0.75 | 0.38 | good | developing | |
| SW 18 | 83 | 274a | 0.96 | 0.53 | good | indistinct | J. Hotchkiss |
| | | 274b | 0.90 | 0.51 | good | developing | |
| | | 274c | 1.05 | 0.61 | good | developing | |
| | | 274d | 1.11 | 0.63 | good | developing | |
| | | 274e | 1.07 | 0.46 | good | developing | |
| | | 274f | 0.67 | 0.34 | good | developing | |
| | | 274g | 0.96 | 0.53 | good | developing | |
| | | 274h | 0.96 | 0.51 | good | developing | |
| | | 274i | 0.96 | 0.50 | good | developing | |
| | | 274j | 0.73 | 0.42 | good | developing | |
| | | SW 18 | 21 | 2298 | 0.76 | 0.42 |  |  | J. Hotchkiss |
| SW 18 | 24 | 2075 | | | broken | gone | G. P. Kanakoff |
| NW 24 | 274a | 197 | 0.88 | 0.50 | | | G. P. Kanakoff |
| NE 19 | 294 | 225 | 0.76 | 0.42 | | | W. D. Pierce |
| NE 19 | 4421 | 1772 | | | broken | | John Carr |
| Maximum | | | 1.11 | 0.63 | | | |
| Minimum | | | 0.67 | 0.34 | | | |
| Mean | | | 0.908 | 0.50 | | | |



PLATE 26

Petrified fish found by Mrs. W. Keegan, who furnished photo.

NOTES ON CERAMBYCID BEETLES FROM
THE SOUTHWEST UNITED STATES
AND MEXICO

(Notes on North-American Coleoptera, No. 5)

By CHARLES S. PAPP

University of California, Riverside.¹

The material here discussed was collected mostly by Dr. John Adams Comstock in the Santa Rita Mountains in southern Arizona, during the latter part of July and the first part of August 1954 and 1955, and is housed in the author's collection. Further notes of faunistic importance are given on certain Cerambycidae from the collections of the Los Angeles County Museum, Department of Entomology, which were made available through the kind assistance of Dr. Fred S. Truxal and Mr. Lloyd Martin. Some of the dates are also recorded from specimens in the author's collection, and the collections of Mr. Robert H. Crandall (Altadena, Calif.) and Mr. George P. Mackenzie² (San Marino, Calif.). The numbers preceding each species are those of the Leng's Catalogue of the Coleoptera of America, North of Mexico.

14071 *Archodontes melanopus* v. *serrulatus* LeC. This moderately shining-brown form known from Arizona to Texas. Two specimens taken by Dr. Comstock in Madera Canyon in the Santa Rita Mts., July 19 to 30 in 1954 and 1955. Prior to these dates a single specimen from the Huachuca Mts., Arizona, was in my collection, with a date, "August." Four specimens in the Mackenzie collection are from Ehrenberg, Ariz., 6.24.1943 (by Grassman), and one from Wickenburg, Ariz. collected by Mackenzie in 8.31.1941.

14072 *Archodontes arizonicus* Csy. Three specimens collected by Dr. Comstock in Madera Canyon, Santa Rita Mts., Ariz. on 7.30.1954.

14073 *Stenodontes molarius* (Bates) ? I have one specimen from Prescott, Ariz. A subtropical form, known from Lower California southward to northern South America. Very similar to *S. lobigenis* (Bates), but somewhat longer, and differing in the broad metapisterna. Further research is needed for a final decision. Otherwise *S. lobigenis* is well known from Texas and southern California, western Mexico (Oaxaca to Sonora), Gulf of California and Baja California.

14078 *Ergates spiculatus* LeC. One of our largest cerambycids, distributed throughout the Pacific States. Specimens

¹Publication No. 1124, University of California, Citrus Experiment Station, Department of Entomology, Riverside.

known from British Columbia, to southern California. Those in my collection were taken by Mr. Arnold Menke in Snow Valley, San Bernardino County (9.6.1953), myself in Altadena, Calif., and in the Angeles National Forest (August 1954 and 1955), and by Mr. G. P. Mackenzie at Glacier Lodge, Inyo County, Calif. (8.20.1946). Specimens also in the Mackenzie collections are from Lake Arrowhead (8.1.1939) male and female, one male taken by K. M. Fender in McMinville, Oregon (8.22.1941).

Dr. J. A. Comstock collected two specimens, a male and a female, in Madera Canyon, Santa Rita Mts., Arizona (7.30.1955) which differ in many ways from the typical form. These unusual specimens (Plate 27, fig. 1 and 2.) judged by Dr. G. L. Linsley from the original color paintings, are the ssp. *neomexicanus* Casey (= *marmoratus* Cockerell), a Rocky Mountain subspecies which ranges southward to New Mexico, Arizona and northern Mexico. A junior collector, Dick Watson, mentioned one other pair after seeing my two specimens, which he collected in the same location in 1955, from which also one specimen is now in the writer's collection.

14083a *Derobrachus geminatus* ssp. *forreri* Bates. One specimen from Madera Canyon, Santa Rita Mts., Ariz. (Dr. Comstock). Several specimens were also collected by Mr. R. H. Crandall in Tucson, Ariz. (8.10.1939). Other specimens of this fairly large beetle are in the collection of the Los Angeles County Museum, taken also from the Santa Rita Mts. by Dr. F. S. Truxal and L. Martin on various dates. The typical form, which is well known from Arizona, is much longer and darker brown. Specimens are well represented in collections.

14086 *Prionus californicus* Motsch. Known from California and Oregon. Two specimens from Madera Canyon, Santa Rita Mts., Ariz. taken by Dr. Comstock (7.20.1955). One other specimen is in my collection, taken by R. J. Lyon on Mount Palomar (9.6.1954). A dozen specimens from other parts of California (Lake Arrowhead, Altadena, Little Rock) and one from Prescott, Ariz. (by G. F. Maughmer) are also in the author's collection. In the Mackenzie collection there are specimens from the above localities and also from San Marino, Calif.

14088 *Prionus heroicus* Semen. A typical Arizona species. Three specimens taken by Dr. Comstock in Madera Canyon, Santa Rita Mts., Ariz. (7.19.1955), one of which is an unusually small specimen.

14097 *Tragosoma desparium* Lin. One specimen from the Huachuca Mts., Ariz. collected by Dr. Comstock (8.16. or

²While this manuscript was in preparation there came the tragic news of the death of Mr. George P. Mackenzie. A note on the life of the deceased, a pioneer of western entomology, will be given later in the "Bulletin".

17.1954). Sporadically known from all parts of North-America, but more frequently found in the forest regions of central and western Europe and also in Siberia.

14171 *Achryson surinamum* (Lin.). Four specimens collected by R. H. Crandall in Arizona: one in Tucson (9.30.1937), one in Phoenix (in 1934) and two in Sells (4.20.1937). A widely distributed species, known also from Texas, and far south through the Americas to Argentina and the West Indies.

14173 *Atylostagma glabrum* Schffr. Known from Arizona. One specimen taken by Dr. Comstock in Ramsay Canyon, Huachuca Mts., Ariz. (8.16.1954). The Mackenzie collection has four specimens from Globe, Ariz., collected by Parker (9.2.1935).

20051 *Anoplocuris conatae* Fisher. Eight specimens collected by R. H. Crandall in Tucson, Ariz. (8.8.1937).

20038 *Aneflus sonoranus* Csy. Twenty specimens from Madera Canyon, bearing various dates, and two from Ramsay Canyon in the Huachuca Mts., Arizona, taken by Dr. Comstock. Three specimens collected in 7.22.1941 in Globe, Ariz. by R. H. Crandall. Two specimens from Prescott, Ariz. (by G. F. Maughmer) in the Mackenzie Collection.

— *Aneflomorpha unispinosa* Csy. New for the United States. Known before from Mexico. Seven typical specimens collected by Dr. Comstock in Madera Canyon, Santa Rita Mts., Arizona (7.20.1955), and four specimens from Globe, Ariz. in the G. P. Mackenzie collection, collected by Parker (6.24.1953). Three additional specimens collected by Dr. Comstock in the same location (7.26.1954) and one also taken by him at San Simon, Baja California, Mexico (9.9.1955) are noticeably smaller and slightly paler in color. Two others also from Madera Canyon (by Comstock) are more slender and darker in color.

14198 *Romaleum hispicorne* (L.). Eleven specimens collected by Dr. Comstock, all from Madera Canyon in July 1954 and 1955, including one very small male, which is about half of the normal size. Another female specimen in my collection comes from Brownsville, Texas (5.27.1951), also some larger females from the same location, and one from Little Butte, Colorado; finally, three others from Hope, Arkansas. The specimens from Madera Canyon seem to be generally larger, and darker, and the yellowish pubescence on most of the specimens is greatly reduced. The Madera Canyon specimens have more granulated prothoraces, the female rough, the male smoother. The longitudinal short stria in the rear middle of the prothorax more sulcate on the Maderan males, and definitely costate on males from other localities. The center portion of

the granulate female prothorax in both cases is distinctly costate and smooth. The elytra of all Maderan specimens is slightly canaliculate near the scutellum and toward and parallel with the sutura for not more than one sixth of the whole length. The abdomen of the Maderan specimens is slightly pubescent, shining in the medial portion. The others have yellowish pubescence. The species abundance in New Mexico is questionable.

14207 *Hypermallus incertus* (Newn.). 13 specimens collected by Dr. Comstock in Madera Canyon, Santa Rita Mts., Arizona (7.20.1955) and in Ramsay Canyon, Huachuca Mts., Arizona (8.16.1954) of which eight are males. Various sizes. Known as an eastern species, distributed to the west as far as Texas. Three specimens in the G. P. Mackenzie collection are from Overland, Mo., collected by J. Heyes (7.20.1940) and one from Aayne County, Grosse Ile, Michigan, collected by Geo. Steyskall (7.25.1948).

It is my personal opinion that the genus *Hypermallus* Lac. (1869) is not synonymous with *Romaleum* White (see Blackwelder's "Checklist", part 4, p. 564). The genus *Hypermallus* Bates (1880) is a synonym of *Elaphidion* Serv. (1834).

—*Elaphidion lanuginosum* Bates. Another new record: 8 specimens were collected by E. C. Welling in Chichén Itza, Yucatan, México during June and July 1954. It was known before from Guatemala. It was fairly common in 1954, and was associated with *Eburia rotundicollis* Bates of which Mr. Welling also sent me 10 specimens. Both of the species were collected in a bushy area at late afternoon.

14236 *Aneflus protensis* LeC. Two specimens from Dr. Comstock's material from Madera Canyon, Santa Rita Mts., Arizona (19.20.1955). One very typical specimen with dark brown ground color is a male, the other with slightly lighter brown, a female. One specimen in the Mackenzie collection came from Wickenburg, Arizona (8.21.1944 by G. P. Mackenzie).

14600 *Callichroma plicatum* LeC. This beautiful iridescent blue and green Cerambycid with reddish-brown abdomen and femura, and with black tibiae and tarsi was described and known from Texas. I have one specimen from Elk Horn Ranch, Arizona, collected by R. J. Ford (8.27.1949). Others from the same location are in the Ford collection.

14651 *Phymatodes nitidus* LeC. A widely distributed species along the West Coast, from Washington to northern California. There are specimens in my collection from Humboldt County (one), Sonora (one), Camina (two) taken by F. T. Scott in June 1933, Placer County (two, June 1933) from

California locations, and one specimen from Salmon Arm collected by H. B. Leech (6.5.1929). Other British Columbia specimens are in the Mackenzie collections.

14660 *Megacyllene antennatus* (White). Two specimens from the Comstock material, taken in the Santa Rita Mts., Madera Canyon. Known from Arizona and southern California, where it is common mainly in the desert areas and along the Colorado River. Seven other specimens in the writer's collection from Cathedral City, Calif. collected in February 1932.

14753 *Rhopalophora rugicollis* LeC. A southwestern species. One small specimen from Ramsay Canyon, Huachuca Mts., Arizona, collected by Dr. Comstock (8.16 or 17.1954).

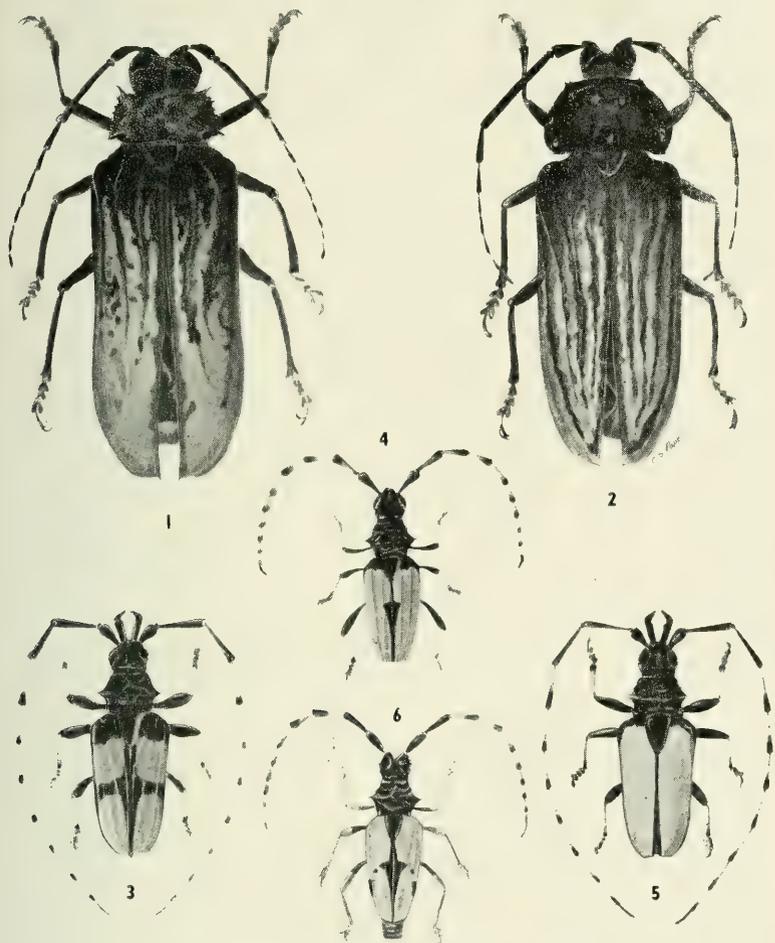
14784 *Stenaspis solitaria* (Say). Commonly reported from Kansas to Mexico and seems to be a fairly common species in the Santa Rita Mts., Arizona: Six specimens collected by Dr. Comstock (7.20.1955); two specimens in the writer's collection, same locality, collected by Mr. R. Sobott (8.28.1954); and a series taken by Dr. Truxal and L. Martin, same locality, now in the Los Angeles County Museum collection. Twenty-nine specimens collected by R. H. Crandall from the following localities: Tucson (9.4.1934 and 7.4.1939), Sabino Canyon (10.4.1937) in Arizona. Anthony (7.10.1941) from New Mexico and Guyamas (9.10.1938) from México.

14802 *Aethecerinus latecinctus* Horn. An Arizona species. Several specimens collected by D. K. Duncan in Globe, Ariz. (July). Three other specimens in my collection are also from Tucson (2) and Phoenix (1). The R. H. Crandall collection has one specimen, a very unusual color variation: the dark brown post-scutellar band reduced to two small macula, one close to the sutura, the other just behind the shoulder. According to Crandall, this is the only specimen of this color variation he ever collected.

14808 *Schizax senex* LeC. A rare and moldy looking species and known only from Arizona. Six specimens collected by R. H. Crandall in Phoenix (5.2.1932).

14810 *Tylosis maculata* LeC. Known from Texas and Arizona. Three specimens collected by Dr. Comstock in Santa Rita Mts., Madera Canyon (7.20.1955), one unusually small male and two females. Seventy-four specimens in my collection came from Prescott, Arizona, which is purchased material with no collecting date supplied. The color variations are illustrated on Plate 28. One in the R. H. Crandall collection came from Sierra Blanca, Texas (7.5.1941) and four others from Arizona.

14810a *Tylosis maculata* v. *sellata* LeC. Known from New Mexico. One small specimen in my collection is from Mesilla



TEXT TO THE ILLUSTRATIONS

PLATE 27

1. *Ergates spiculatus* ssp. *neomexicanus* Casey, male, 2. female.
 3. *Dendrobias mandibularis* Serv. male. 4.-6. *Dendrobias reductus* Casey.
 Note color variation. — All specimens from Arizona. (Reproduced from
 painting by the author.)

Park, N. M., collected by Merrill (10.12.1922). Several specimens in my collection from Prescott, Arizona, have the same elytral markings, but the maculation of the prochorax is entirely different.

14826 *Crossidius longipennis* Csy. Described from New Mexico. Two specimens from Santa Rita Mts., Madera Canyon, Arizona, collected by Dr. Comstock (8.16 or 17, 1954) are in the author's collection.

14828a *Crossidius wickhami* ssp. *rhodopus* Linsley. Several specimens from Linsley's original type series (Paratypes) in the G. P. Mackenzie collection, taken by Mackenzie near Convict Lake, California (9.15.1945), from which the following collections received each one specimen: Los Angeles County Museum, Department of Entomology, the R. H. Crandall Collection and that of the author.

14838 *Crossidius blandi* Csy. Several specimens collected by Crandall in Douglas, Arizona. Previously known from Utah. One specimen in the author's collection also from Douglas.

14841 *Sphaenothecus suturalis* LeC. Three specimens in my collection: two collected by Dr. Comstock in Ramsay Canyon, Huachuca Mts., Arizona (8.16.1954, male and female), another male from Douglas, Arizona, collected by A. E. Lewis (8.2.1954). The male from the Huachuca Mts. more reddish-brown than that from Douglas. It is easy to recognize by the white sutura and long antennae. R. H. Crandall collected 25 specimens in Arizona: Tucson (9.6.1938, 5.28.1939, and 6.18.1941), in Phoenix (9.2.1939); in New Mexico: Anthony (7.15.1941). Also two specimens from Phoenix, Ariz. and one from New Mexico are in the author's collection.

14844 *Sphaenothecus bivittatus* Dup. A widely distributed species: from Mexico through southern California (Indio), Arizona and Texas. Twenty-three specimens collected by R. H. Crandall in Arizona: Phoenix (9.15.1933), Tucson (9.15. and 9.24.1938), Sabino Canyon (10.4.1934), in the Baboquivari Mts. (9.15.1935); in México: Guaymas (9.10.1938). Two specimens in the writer's collection came from Arizona (Phoenix) and old México (Guaymas).

14863 *Dendrobias reductus* Csy. A beautiful male specimen in my collection from Blythe, Calif., collected in June 1951 (coll. R. J. Lyon). Not recorded elsewhere than southern California.

14864 *Dendrobias madibularis* Serv. A typical Arizona beetle. Commonly reported from the Santa Rita Mts. and many specimens are to be found in collections. Series collected by

R. H. Crandall, F. S. Truxal and L. Martin. Dr. Comstock sent me one very beautiful specimen from Madera Canyon, Santa Rita Mts. (7.30.1955) with absolutely perfect maculation. Very commonly the black markings are reduced, occasionally the elytra light brown. It is also frequently reported from the willow-covered Colorado River area at Yuma, Arizona, flying at early evenings in July. (H. C. Fall). R. J. Lyon gave me two specimens from this area taken at late afternoon. Also known from Baja California and other parts of México. The genus *Dendrobias* (mostly Central American) is commonly found in Guatemala and Nicaragua, from which the *D. mandibularis* has the widest range of all species. Specimens with great color variations have been collected as far south as Colombia. (Plate 27, fig. 3.)

— *Ptychodes punctatus* Dillon & Dillon. Described from a male specimen from Santa Rosa, Vera Cruz, México. I have a specimen collected by Mr. E. C. Welling (August 1954) in Palengue Chiapas, Yucatan, México. The surprisingly beautiful Monochamnini, supposed to be very rare in this area, according to Welling, is the only specimen he ever saw during years of collecting in the Yucatan peninsula.

14898 *Monochamus maculosus* Hald. A male and female taken by Dr. Comstock in Ramsay Canyon, Huachuca Mts., Arizona (8.16.1954). Also four specimens in the G. P. Mackenzie collection from Williams, Ariz. (7.5.1942, by H. L. Schunk). Known from Arizona, Colorado and New Mexico.

14928 *Synaphaeta guexi* LeC. Known from Vancouver B.C. to southern California. This species was collected by Dr. Comstock in Madera Canyon, Santa Rita Mts., Arizona (7.30.1954) at light, as the first specimen reported from Arizona. More common in the northwestern states. The Los Angeles County Museum, Department of Entomology has several specimens from the Sequoia National Forest, Calif., some are the same size as the Comstock specimens, but four specimens from the High Sierra are far larger and more of a light gray color. (see also Papp: Entom. News, 1955, 66:219).

14940 *Coenopoëus palmeri* LeC. Widely distributed, from Arizona to México (including Baja California) and frequently collected in southern California. Breeds in *Opuntia*. Four specimens in the Comstock material from Madera Canyon, Santa Rita Mts., Arizona, collected at light (7.30.1954), of which one is blacker, with very reduced white markings. Mr. R. H. Crandall collected series in various years in Tucson, Arizona, during the months from July to September.

15037 *Dectes spinosus* Say. From Massachusetts to Louisiana, Colorado and Indiana is its territory. Horn (Calif. Acad. Sci., Proc. 1895:228) reported it from Baja California, and Linsley (loc. cit. 1942:74) gives as hosts *Ambrosia*, *Eupatorium* and *Xanthium* after Leng and Hamilton 1896, and Craighead 1923. The Crandall collection has twenty-one specimens, all collected by Crandall in Arizona: Tucson (9.4.1939), Nogales (8.24.1939), Huachuca Mts. (9.20.1940), Chiricahua Mts. (8.29.1939), Naco (8.27.1939) and Douglas (8.27.1939). One specimen in the Crandall collection from Edgebrook, Illinois, collected by R. Wentzel (7.21.1934). Specimens in the writer's collection are also from Douglas and from the Chiricahua Mountains.

15082 *Oncideres pustulata* LeC. Known from Texas, all over the state; most common in the south. As reported by Dillon and Dillon (Onciderini, Part 2, 1946, p. 364-365) on *Vachellia farnesiana*, *Acacia berlandieri*, *A. nesiana* and on citrus trees. Two specimens were collected by Dr. Comstock in Ramsay Canyon, Huachuca Mts., Arizona (8.16.1954). Two other specimens from Rio Grande Canyon, south of Tacos, New Mexico (8.12.1932) and three from Santa Fé, New Mexico, are in the author's collection.

15084 *Oncideres rhodosticta* Bates. Formerly known from Texas. Dillon and Dillon (op. cit. p. 382-383) mentioned first from all over Arizona (on mesquite, *Prosopis julifera*), then New Mexico: Organ Mts. (8.29.1940, by Dillon and J. N. Knull), also from the central and western parts of Texas. The R. H. Crandall collection has fifty-four specimens from Tucson, Arizona (9.28.1937). Four specimens from this material in the writer's collection.

15085 *Oncideres quercus* Skinner (?). Two specimens from Madera Canyon, Santa Rita Mts., Arizona, collected by Dr. Comstock (7.20.1955). Differs from the original description (Ent. News, 1905, 16:291) and from that of Dillon and Dillon (op.cit. p. 383-385, plate XV, fig. 6).

15088 *Oncideres cingulata* Say. Usually in collections labeled as *O. texanus* Horn (not Herrick). Dillon and Dillon (op. cit. p. 387-388) gives date on its distribution, and I would like to add the state of Arizona with one specimen in the collection of R. H. Crandall, taken by Crandall, from Tucson. This species is found also in México and in California, on *Eucalyptus*.

15123 *Saperda concolor* LeC. Known from New Mexico and Arizona. 15 specimens (seen by J. N. Knull) are in the Crandall

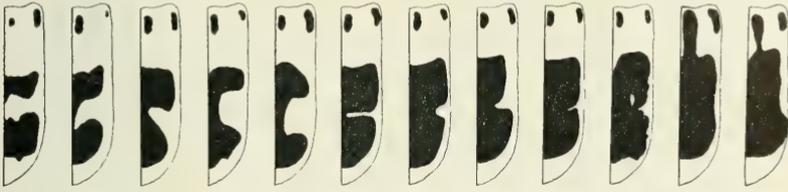


PLATE 28

Color and pattern variations of *Tylosis maculata* LeC. from Arizona.

collection from Elmwood, Illinois, collected by E. Dluhy. Knull reported the species also from Ohio (Columbus), breeding in living branches of poplar and willow (see Knull: Ohio Biol. Survey, Bull. 39, 1946:273-274).

15159 *Tetraopes discoideus* LeC. Known from Texas and Idaho. Seventy-six specimens in the Crandall collection from Tucson, Ariz., and Phoenix, Ariz., collected by Crandall from July to October in various years. One specimen in this collection from Sabino Canyon, Arizona (10.11.1934): only the apical portion of the elytra is gray, otherwise the entire beetle is red. Several specimens in the writer's collection, also from Arizona.

15182b *Tetraopes femorata* v. *basalis* LeC. Known from Utah. R. H. Crandall collected thirty-one specimens in Chico Valley, Arizona (8.19 and 20.1939) from which eight specimens are now in my collection.

The beetles collected by Dr. John Adams Comstock on his 1954-1955 trips to the Santa Rita Mountains in Arizona were only occasional. This relatively small amount of Cerambycidae represented in his shipments of several hundreds of specimens of other families, gives us very interesting additions to our knowledge of the zoogeographical relationship of the southern Arizona mountains and that of the Mexican and more southern territories. I wish to express my sincere thanks to Dr. and Mrs. Comstock for their generous interest in the beetles and for the time taken away from his specialty, the Lepidoptera.

A report concerning other coleopterous families will be forthcoming as soon as identifications are completed.

In the following few chapters I wish to give some faunistic notes on Cerambycidae which were recently called to my attention while comparing material in the Los Angeles County Museum. The specimens, if not otherwise noted, are in the museum's collections:

14868 *Ipochus hispidus* Csy. Two specimens of this small

Cerambycid-beetle collected by L. J. Muchmore in Arch Beach, Calif. (7.2 to 11, 1925). Not uncommon under bark of *Rhus*: larvae taken from the wood of *Rhus integrifolia* (in Coronado, by Blaisdell) and *Rhus laurina* (in Poway, also by Blaisdell).

14869 *Ipochus pubescens* Csy. Rare in collections. One specimen taken by L. J. Muchmore in Arch Beach, Orange County California, July 2 to 11, 1925.

14873 *Ipochus fasciatus* LeC. Here two dates and from high altitudes: Camp Baldy, southern California, 6.13.1921, collected on oak. Other specimens from Santa Susanna Pass, taken by L. J. Muchmore, 9.13.1928.

14880 *Moneilema appressa* LeC. A brownish, well developed specimen without data. This species is known from Texas and New Mexico.

14882 *Moneilema laevigata* Bland. One specimen, taken by Dr. A. Fényes in Santa Fé, New Mexico.

14883 *Moneilema gigas* LeC. Usually associated with *M. gigas* v. *spinicollis* Csy. Several specimens collected by Dr. F. S. Truxal and Lloyd Martin in the Santa Rita Mts. in southern Arizona. Also Dr. Comstock sent me one specimen from the same location (7.20.1955). Large series in the Crandall collection, all from Arizona: Tucson (11.29.1935, 10.8.1937 and 9.4.1939) and also from the Santa Rita Mts. (9.27.1939). One other specimen in the Museum's collection came from Burro Canyon, Arizona (4.4.1924).

14889 *Moneilema subrugosa* Bland. Lindsley (Proc. Calif. Acad. Sci. 1942, 24:65-66) mentions that this species from Lower California is to be found on *Lophocereus australis*. An additional new locality, I should mention one specimen in the collection of the Museum from Magdalena Island, collected on *Opuntia* cactus.

NOTES ON THE EARLY STAGES OF THREE
SOUTHWESTERN MOTHS

By JOHN ADAMS COMSTOCK

Panthea pallescens centralis McD.

During the summer of 1956 a group of entomologists with whom I was associated had the opportunity of collecting in the area near Kohl's Camp, Gila County, Arizona. On July 2, the junior member of our party, Billy Martin, brought me a large caterpillar which he found on the ground near pine and oak, and which proved later to be *Panthea pallescens centralis*.

As the larva showed signs of preparing for pupation, hasty notes were immediately made of the specimen.

MATURE LARVA: Length, 35 mm. The body is robust, and is covered by numerous black hair-pencils and bunches of black and white bristles. The ground color ranges from brown to gray-brown. There is a middorsal longitudinal soiled white stripe which expands at each segmental juncture. Lateral to this is a longitudinal row of bunched spicules, paired on each segment. These are placed on a ground of light russet-brown.

Lateral thereto is a row of black pencils, one to each segment. Latero-inferior to these is another row of bunched spicules. Below each one of these is the spiracle, orange centered and black rimmed. Anterior to each spiracle is a small nodule bearing spicules.

Infrastigmally there occurs a soiled white longitudinal band which forms the 'overlap'.

The head is obscured by a transverse row of black hair-pencils and thickly placed bunches of black and white spicules.

Anterior to each segmental juncture there are white bands, bisected by black dashes. These fade out over the dorsum.

Legs, black, with red-brown terminal segments. Prolegs colorous with the body. Crochets, brown.

The head is black, and is thickly studded with small black nodules.

The larva began spinning a fragile cocoon on July 3, 1956, and pupated July 8.

PUPA: Length, 21 mm. Greatest width through center, 8 mm. Fusiform; plump, with the head evenly rounded and the eyes closely approximate. The antennae and maxillae extend to within 2 mm. of the edge of wing cases.

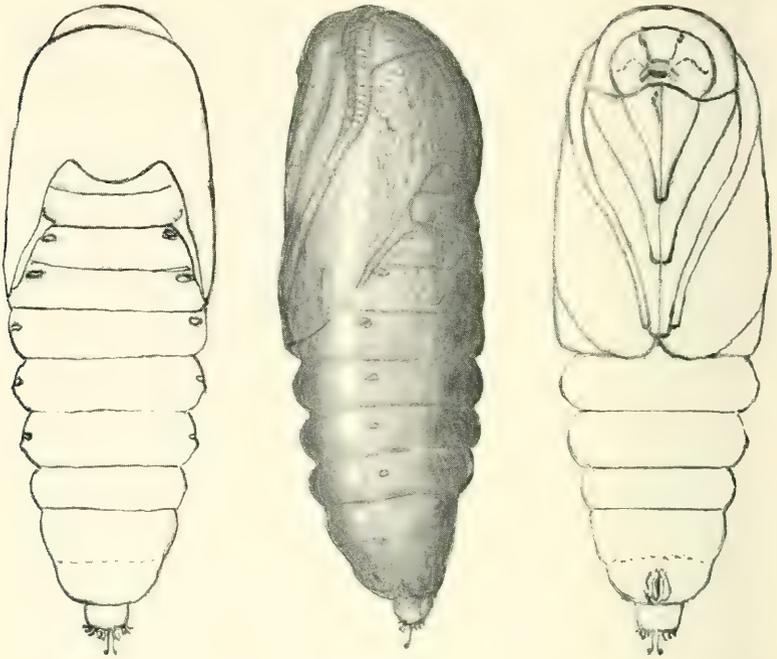


PLATE 29

Pupa of *Panthea pallescens centralis*, McD. shown in dorsal, lateral, and ventral aspects, Enlarged $\times 4$. Drawing by the author.

The surface texture of the wing cases and thorax, including appendages, is rugose or finely striated. The abdominal segments are smooth and glistening on the venter, and finely granular on the dorsum.

The spiracles are oval, and slightly darker than the body.

The cremaster terminates in a pair of relatively long recurved light brown spines, and a cluster of small hooklets.

The body color is rich red-brown, slightly darker over the dorsum.

The pupa is illustrated on Plate 29.

Our determination of the species was made by William A. Rees and Robert H. Reid, working with material in the Los Angeles County Museum collection. Since *Panthea pallescens centralis* was described from Canadian material, it is possible that our Arizona specimens may be a race of the *pallescens* complex.

Acronycta perditia Grt.

Late in August of 1956 William A. Rees supplied me with a few larvae of *Acronycta perditia*, from which two examples were reared to maturity. Notes were made of the last instar larva, and pupa, with an illustration of the latter.

Subsequently Mr. Rees, in a letter dated September 28, 1956, recorded some details of the earlier instars, which are here quoted prior to my notes on the mature larva and pupa.

"The (young) larva hatched on July 31, 1956 and proceeded to eat the shell. After three days (Aug. 2d) it was about 4 mm. long, each segment having about 10 or 12 hairs on it. The head and first segment were brownish, being rather transparent. The third segment being of a clear color, while the next three were brownish, with the next clear and the last two brownish. The whole appearance of the larva having a transparent look, very hairy, resembling an Arctiid larva more than a Noctuid."

"Aug. 6th, the insect was now in its second instar, being hairy as before if not more so. The coloring is now deepening, the brownish colored segments now being almost black while the clear segments have become more of a brownish clouded color. The head is of a cream, with speckling of blackish-brown."

"Aug. 17th, general markings about the same as before, much more hairy than before, about 35 to 40 hairs on each segment, and being in the 3rd instar. The larva is now about 7 mm. long."

"Aug. 24th, ground color of larva is now black, the hairs being of a yellow orange, some black hairs on 3rd segment, an orange stripe on either side, head being of an orange color, anal tuft black, larva now about one-half inch long."

"The insect did go through a 5th and 6th instar but since I had no time on my hands, I failed to make any notes. Just before pupation the larva was about an inch and a half long, the general coloring was of a reddish brown and black, with a very prominent silver stripe on each side. There were also two orange stripes on the back or top side, running the full length of the insect."

"It was pupated on Sept. 10th, 1956. It has built a cocoon of silk and hair, along with several leaves. It fed on a species of hedge that I have in my yard. It will also feed on Sumac and Manzanita."

W. A. R.

I supplement Mr. Rees' brief notes on the final instar as follows

MATURE LARVA: Length, 30 mm. Ground color of both

head and body a rich velvety black. This is somewhat obscured by a large number of warty nodules, each bearing a brush of hair, (verrucae).

Head; width, 35 mm. Glistening black throughout, the only color being in the middle segment of the antenna, which is a dark maroon.

The most conspicuous feature of this larva is a longitudinal band of silvery white crescents, placed substigmatally, each crescent being interrupted at the tips by a dull yellow nodule topped with a brush of light brown hairs.

The verrucae tend to run transversely across the middle of each segment, and also to some extent in longitudinal rows. The brushes on the third and tenth segments are the longest.

The longitudinally placed verrucae on each side of the mid-dorsal line are yellow except those on the first three thoracic and last three caudal, which are nearly black. The yellow verrucae are topped with dull yellow and black setae.

The two rows of verrucae that occupy the dorso-lateral area are dull maroon and bear both black and dull yellow setae. The substigmatal verrucae are black, and are topped with light tan setae.

Spiracles, yellow-centered. Legs, glistening black. The four pairs of prolegs are black, with their terminal segments slightly tinged with maroon, as are also the anal prolegs.

The larvae were reared on sumac (*Rhus laurina*) and willow.

S. E. Crumb¹ has described the larva from a single inflated example which apparently had lost most of its color.

The recorded range of this species is from western Canada to Idaho and California. Pennsylvania is also included, which suggests a widespread and unrecorded eastward extension.

The cocoon is spun on the ground among twigs, leaves and gravel, which are incorporated in it. Our largest example measured 35 mm. long by 18 mm. wide. It is a stout and compact oval. Our first specimen pupated in mid September, and the second on October 3, 1956.

PUPA: Length, 22.5 mm. Greatest width, 7 mm. Color; brownish black on head, thorax and wings, the abdominal segments having a slightly lighter chestnut or dark maroon tinge.

The tip of the head protrudes forward as a rugose hemispherical nodule. The eyes are relatively small and closely approximated. The mesothoracic legs extend nearly to the margin of the wings and near their tips are folded over the maxillae. The latter reach slightly beyond the wing margins.

¹The larvae of the Phalaenidae; Techn. Bull. No. 1135, U.S.D.A. p. 35. 1956.

The antennae also terminate at or near the wing margins, their tips being obscured by the mesothoracic legs.

All of the surfaces of the head, thorax and wing cases are rugose. The abdominal segments are smooth, except for the anterior edges of each segment which are pitted.

The spiracles are conspicuous, and slightly darker than adjacent areas.

The cremaster terminates in two brushes, made up of short spicules with recurved tips, all of approximately equal length. These two brushes are so closely approximated that they appear as a single bundle.

Our illustration of the pupa, Plate 30, obviates the necessity of further description.

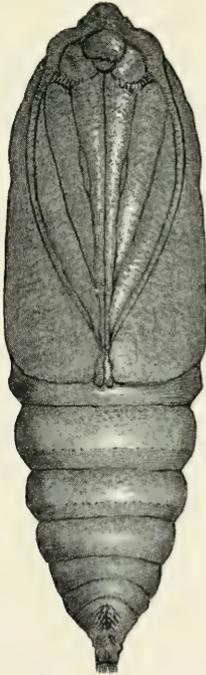


PLATE 30

Pupa of *Acronycta perditia* Grt., ventral aspect, enlarged $\times 4$. Drawing by the author.

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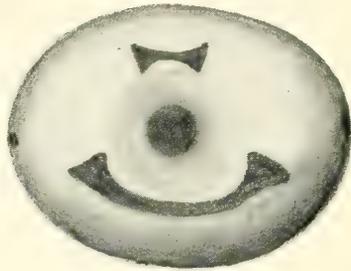


PLATE 31

Egg of *Epicnaptera americana*, "Lappet Moth". Enlarged $\times 24$. Drawing by the author.

Epicnaptera americana Harris

The "Lappet Moth"

Several eggs of this common moth were turned over to me by Noel McFarland.

The larva of this species has been described by numerous authors, and the egg has occasionally been mentioned, but apparently no illustration of it occurs in the literature.

The most complete description was published by H. H. Lyman in the *Canadian Entomologist*, Vol. 6, p. 158, 1874, from Canadian examples. From this it appears that there is a slight difference in the markings of northern examples as compared with those from the southwestern United States.

Eggs laid April 29, 1958 hatched May 10, 1958. All were remarkably uniform in their markings.

Egg: Oval, with two flattened surfaces; length, 1.6 mm.; width, 1.2 mm. Ground color, ivory-white.

In the center of each flattened surface there is a round black spot, surrounded by an areola of blue-gray. Where this occurs, the surface of the egg is depressed. Lateral to this depressed area there is a long crescentic band of black with expanded ends, and opposite this on the other margin of the depressed area, a similar, but much smaller black figure. These markings are repeated on the reverse surface of the egg.

At each end there is a small round black spot which is not depressed.

The accompanying illustration, Plate 31, obviates the need of further description.

Several subspecies and forms of *Epicnaptera americana* have

been named. The example that produced the eggs here described is either the race *carpinifolia* Bvd., or the form *californica* Pack.

NOTES ON THE EARLY STAGES OF
PHÆOURA CRISTIFERA HULST
(Lepidoptera; Geometridae)

By JOHN ADAMS COMSTOCK

During a field trip to Pinery Canyon, Chiricahua Mountains, Arizona, in July of 1956, in association with Lloyd Martin of the Los Angeles County Museum, and a group of lepidopterists, we took a gravid female of a Geometrid which we tentatively identified as *Nacophora quernaria* A. & S.

A number of eggs were laid on July 5 and 6, which hatched July 15-17, 1956.

The newly emerged larvæ were tried on a number of local plants, from which they selected oak and willow. They seemed to prefer willow, and the few examples that were carried to maturity were reared on willow.

When emergence of the imagines occurred, we were dumfounded to find three males of what we identified as *Phæoura cristifera* Hlst.

This led me to conclude that eggs of *P. cristifera* had been inadvertently introduced in the process of feeding. Our notes and drawings of the egg, larva and pupa were therefore held in reserve pending further study.

In examining the long series of *cristifera* from Arizona, in the Los Angeles Museum collection, it was noted that they were all males, whereas all of the supposed *N. quernaria* from Arizona were females.

Mr. Martin had occasion to mention this to Carl Kirkwood of Summerland, California, who expressed the opinion that our so-called *quernaria* from Arizona were actually females of *Phæoura cristifera* and advised sending a series to Dr. Rindge of the American Museum of Natural History.

On hearing this, I mailed the specimens that I had reared, including the original female that gave us eggs, to Dr. Rindge.

In his reply, dated May 27, 1959, he has solved the problem by the following statement. "—as a matter of fact, I have already written both these species for my forthcoming revision. It seems that *quernaria* is a strictly eastern species, and *cristifera* is to be found in the southern Rocky Mountains. The females of the two are quite similar in appearance, and things are usually complicated by a great scarcity of this sex in *cristifera*. The specimens

that you sent in are all representatives of what I am calling *Phæoura cristifera* Hulst."

On the basis of this information, I am now justified in publishing the following notes and illustrations.

Phæoura cristifera

EGG: .75 mm. tall by .55 mm. wide; sub-ovoid, the large arc of the ovoid upward, and the smaller end downward and flat.

The top or crown is separated from the sides by a circlet of 15 pearly-white nodules. Internal to these the convex cap continues the arc of the oval.

The cap and sides are smooth and lustrous silvery olive-green, the cap being of a slightly darker shade than the area below the nodules. The latter have a slight suggestion of a beginning ridge below them, but there is no continuation of ridges down the sides. See Plate 32.

As the egg matures it takes on a yellow-brown color, with a large olive-black spot on one side. The pearly-white nodules remain unchanged.

FIRST INSTAR LARVA: Length, approximately 2.5 mm. The newly emerged larvæ show their typical "looper" affinities. When first hatched they are colonial in habit, and immediately start weaving a fragile mesh of silk.

Head; burnt orange in color, and more than twice the width of the largest body segment. Ocelli, black. Mouth parts edged with brown.

Body; uniformly cylindrical. A broad black longitudinal band covers the dorsum. Stigmata there is a whitish discontinuous band, interrupted at the segmental junctures.

Abdomen (venter), black. Legs ringed with black and translucent yellow. Prolegs (a single pair) light yellow, darker proximally. Anal prolegs, light yellow. Crochets, black, and held wide apart.

Moderately long white setæ are sparsely scattered over the body.

Owing to the large number of life histories that were being run concurrently with this, the second instar larva was not recorded.

THIRD INSTAR LARVA: Length approximately 8 mm.

Head, subquadrate, slightly wider than first thoracic segment, the lobes rising to a pair of rounded pyramids, each topped by a short black hair. The face is mottled dark and light brown, the upper half predominantly brown and the lower half lighter. The front is light brown, the upper portion depressed. Clypeus, white.



PLATE 32

Egg of *Phaeoura cristifera* enlarged $\times 62$. Reproduced from painting by the author.

Ocelli, black. The proximal segment of the antenna is white, and the distal segments are brown.

Body, mottled gray, brown and black; subcylindrical, and bearing numerous warty prominences.

The first segment is mottled brown dorsally, and gray laterally. The second segment is crossed transversely by raised ridges, with two pairs of tubercles placed dorso-laterally, the first pair being black and the second brownish black. The third segment is mottled, and the fourth segment bears a large black triangular tubercle mid-dorsally, the remainder of the segment being mottled light and dark brown and gray. The fifth segment has a wide transverse mottled black band, a pair of black tubercles dorso-laterally, and another pair of red-brown tubercles placed stig-matally. There is also a yellow-brown tubercle mid-dorsally in front of the black band, which is formed by the fusion of three warty prominences. The sixth to ninth segments are mottled dark and light brown, the dark elements having a tendency to form longitudinal wavy lines. Each segment bears a warty tubercle substigmatally. The tenth and eleventh segments bear a large black patch on each side. The twelfth segment has a prominent transverse ridge, topped by four dark tubercles.

The venter is mottled black and dark brown, and is marked mid-ventrally on the sixth segment by a large raised warty black patch.

Legs: The proximal two segments are gray, and the distal segments, black.

From this point on the larvae apparently showed little change



PLATE 33

Larva of *Phaeoura cristifera* (penultimate instar), on a sprig of willow. Enlarged $\times 4$. Reproduced from painting by the author.

in color and form, except for growth. The rate of mortality was high, and it was deemed best not to disturb them. A drawing was made of the penultimate instar, which is reproduced on Plate 33.

The head width of this was 3 mm, and the total length of the larva was 48 mm. The posture of the larva when at rest simulated a crooked twig.

By September 12, 1956 the five surviving larvae had pupated on the floor of the rearing cage, in loosely woven cocoons, into which ground litter was incorporated.

PUPA: Length, 21 mm. Greatest width through center, 7mm. The thorax, head and wings are heavily rugose. The antennae terminate at the margins of the wings. They are ridged longitudinally and striated transversely.

The abdominal segments are pitted along their anterior margins and relatively smooth on the movable portions of each segment.

The cremaster is subtriangulate and is tipped by two long spines which extend caudally and are slightly recurved laterally. There are three small recurved hooklets near the base of each long spine, the positions and relative sizes of which are shown on the illustration, Plate 34.

The color of the chrysalis is blackish brown. When the drawing was made the abdominal portion was elongated, but it gradually became shorter and more robust.

In the spring of 1957 three males and one female emerged.



PLATE 34

Pupa of *Phaeoura cristifera*, ventral aspect. Enlarged $\times 3\frac{1}{2}$. Reproduced from painting by the author.

THREE NEW WATER-STRIDERS FROM BRAZIL

(Hemiptera)

By CARL J. DRAKE
Smithsonian Institution

The present paper contains the descriptions of one new species of the genus *Ovatametra* (Gerridæ) and two new species of *Rhagovelia* (Veliidæ). The types are in the Drake Collection (USNM).

The American genus *Ovatametra* Kenaga is represented in Neotropical Americas by eight species, including the new one described below from Brazil. The members of this genus are: *O. amnica* Drake (1957) from Panama; *O. bella* Drake (1957) from Bolivia; *O. fusca* Kenaga (1942) from Brazil; *O. parvula* (Drake & Harris) (1935) from Brazil; *O. minima* Kenaga (1942) from Peru; *O. obesa* Kenaga (1942) from Brazil; and *O. thaumana*, n. sp., which is characterized below.

***Ovatametra thaumana*, n. sp. (Plate 35)**

APTEROUS MALE: Small, oblong, velvety black with an inverted, U-shaped mark in front of eyes and the posterior margin behind vertex of head, two broad longitudinal stripes (one on each of median part of pro- and mesonotum), and the posterior margin of last three or four dorsal tergites of abdomen yellowish brown; mesa- and metapleura with longitudinal, black stripe near the upper margin; abdomen beneath deep black with hind margin of seventh tergite and genital segments testaceous; thorax and head beneath testaceous with a slight tinge of orange; pleura and thorax beneath with a little silvery lustre, also the outer parts of the dorsal abdominal tergites; labium with the first, second and basal half of third segments testaceous, the distal half of third and last segment blackish fuscous and shining. Anterior legs testaceous with the posterior face of femora blackish fuscous, tibiæ brownish testaceous, tarsi dark fuscous. Intermediate and hind legs brownish. Female differs slightly from the male in having the abdomen beneath almost entirely testaceous and both metanotum and second dorsal tergite marked with a pair of large, flavotestaceous spot (one on each side). The rest of the markings are nearly the same as those in the male.

Length 2.50 mm. (male), and 2.85 mm. (female); width 0.92 mm. (male) and 1.24 mm. (female).

HOLOTYPE (male) and **ALLOTYPE** (female), Caioba, Parana, Brazil, XI.1958, F. Plaumann. One paratype and several nymphs were also taken with the type.

The color markings as illustrated (Plate 35, type) and anten-

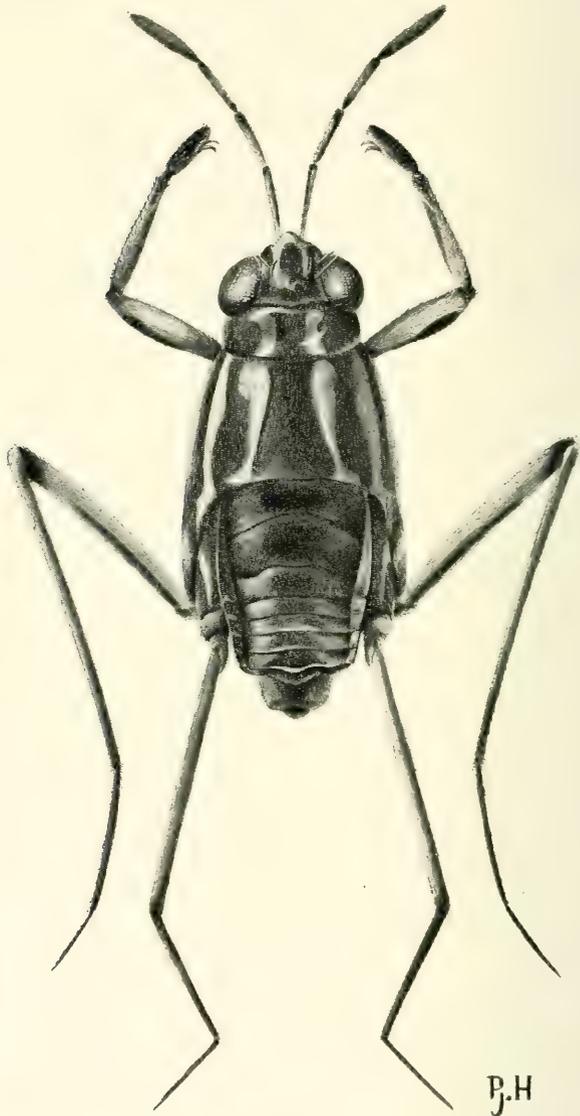


PLATE 35

Ovatametra thaumana, drawn from type by Patricia Hogue. Enlarged $\times 50$.

nal segments distinguish this species from other members of this genus.

Rhagovelia occulcata, n. sp.

BRACHYPTEROUS FORM: Small, blackish with the subapical, transverse, yellowish orange band of pronotum interrupted at middle and not wider than the posterior part of vertex, quite bluish beneath, a spot on last dorsal tergite of abdomen, median part of last segment of venter, and outer margins of connexiva shining black. Legs entirely shining black, including acetabula, coxæ and trochanters. Antennæ with the narrow, basal part of first segment testaceous. Female with the shining black margins of connexiva much wider beyond apical half than in the male.

Length 3.00 mm. (male), and 3.20 mm. (female); width 1.25 mm. (male) and 1.35 mm. (female).

APTEROUS MALE: Head with usual median, longitudinal, black line and basal impressions. Antennæ 2.58 mm. long, with the usual blackish bristly hairs on basal segments, measurements of segments: I, 78; II, 48; III, 42; IV, 38. Pronotum very short, not longer than an eye. Mesonotum wider across humeral angles than median length (94:80), covering most of metanotum. Abdomen gradually narrowed posteriorly, about two and one-half times wider at base than at apex; connexiva with lateral sides slowly converging posteriorly, with the last three segments more sharply narrowed than others, termination apically in an acute angle opposite apex of last abdominal tergite. Abdomen beneath without spines, ridges or furrows. All coxæ and trochanters unarmed. Legs long, slender, femora slender. Anterior tibiæ subcylindrical, 1.35 mm. long, slightly longer than femora, feebly flattened beneath on apical fourth. Middle legs very long, femora 2.25 mm. long tibiae 1.50 mm. long, tarsal II and III nearly subequal (74:72). Hind femora slender, at thickest part smaller than the base of middle femora, 1.60 mm. long, armed a little beyond the middle with a moderately long, slender, posteriorly-leaning spine, thence without spines; tibiæ 1.80 mm. long, straight, unarmed.

APTEROUS FEMALE: Slightly stouter than male, antennal measurements: Segment I, 77; II, 53; III, 42; IV, 35. Mesonotum strongly extended posteriorly, rounded apically, with apex covering all of median parts at metanotum. Connexiva wider than in male, nearly upright, with apical half slightly inflated, gradually converging posteriorly, with apices not quite touching each other, narrowly truncate behind. Abdomen more convergent posteriorly than in male. Posterior femora slender and unarmed; tibiæ straight, also without spines.

MACROPTEROUS FORMS: Very similar in general aspect in both sexes. Hemelytra blackish fuscous, extending beyond apex of

abdomen and not entirely covering connexival segments in repose. Pronotum pentagonal, wider across humeri than median length, not produced behind in female. Length 3.85 mm. (including wings), width 1.50 mm.

HOLOTYPE (male) and **ALLOTYPE** (female), both apterous, Morretes, Parana, Brazil. *Paratypes*: 26 specimens, all taken with type, in the same school in the ripples of a small river.

This species has slender hind femora (scarcely as thick as base of middle femora), which are armed beneath (just behind the middle) with only a single spine in male and unarmed in female. The hind tibiae are unarmed in both sexes. On the ventral side of the hind femora, there is a thin row of eight or nine long, black hairs on the apical three-fourths in the male and five or six such hairs on the distal half in the female.

Rhagovelia zela, n. sp.

APTEROUS FORM: Small, blackish, provided with grayish, recumbent pubescence, beneath bluish pruinose, pronotum with the subapical, transverse, yellowish orange band divided at the middle and not wider than base of vertex. Antennae fuscous-black, furnished with the usual, long, bristly hairs on first two segments, basal part of first segment testaceous. Labium shining black. Legs deep black, shining, with inferior margins of all acetabula, and the coxae and trochanters of front and hind legs testaceous, those of middle legs shining black. Genital segments of both sexes and a median spot of last genital segment beneath shining black, also the last dorsal tergite of the abdomen. Length 2.60 mm. (male) and 3.20 mm. (female), width 1.10 mm. (male) and 1.35 mm. (female).

MALE: Head with the usual median longitudinal line and basal impressions. Antennae 1.92 mm. long, segmental measurements: I, 54; II, 35; III, 32; IV, 32. Pronotum short, scarcely as long as an eye; mesonotum finely, deeply punctate, wider across humeri than median length (85:60), sharply and slightly convexly narrowed on lateral sides behind humeral angles, with apex rather wide and slightly convex; metanotum narrowly exposed behind mesonotum, a little more exposed along lateral sides of mesonotum. Abdominal tergites slowly evenly tapering apically, with seventh segment less than half as wide as basal one; connexiva feebly convexly narrowed apically, terminating in an acute angle opposite hind margin of last tergite of abdomen; venter without spines, furrows or median ridge. Coxae and trochanters unarmed. Legs slender, moderately long; forelegs with tibiae slightly longer than femora, only slightly enlarged apically, slightly flattened beneath on apical third. Middle legs very long, femora 1.62 mm. long, tibiae 1.00 mm. long, tarsal segments I and

II long, subequal in length. Posterior femora 1.10 mm. long, at their widest point (large near spine) not as thick as the base of middle femora, armed just behind the middle beneath with a fairly large, sharp, posteriorly-leaning spine, thence to apex with six or seven much smaller spines that gradually decrease in size; tibiae 1.00 mm. long, straight, unarmed.

FEMALE: More robust than, but with color, markings, and the size and armature of hind femora as in male. Antennae 1.92 mm. long, measurements of segments: I, 58; II, 28; III, 34; IV, 34. Middle and hind femora scarcely reaching apex of abdomen. Hind femora with armature as in male. Connexiva wider than in male, upright, narrowed apically, slightly more narrowed on last three segments, with apices truncate and widely separated from each other. Length 3.20 mm., width 1.35 mm.

MACROPTEROUS FORMS: Male and female very similar in general aspect. Pronotum pentagonal, strongly convex across humeral angles. Hemelytra blackish fuscous, extending considerably beyond tip of abdomen, not entirely covering connexival segments in repose. Length 4.00 mm.

HOLOTYPE (male) and ALLOTYPE (female), both apterous, XII, 1958, Guaramirim, Santa Catarina, Brazil. *Paratypes*: 5 specimens, all taken in the same school with type.

Closely related to *R. modesta* Bacon and *R. occulcata*, n. sp., and separated from them by the male parameres, the antennal measurements, armature of hind femora in both sexes, and the female connexival segments. The armature of femora of both sexes distinguishes *R. zela* from *R. occulcata*.



A NEW PROSTIGMATID MITE (ACARINA; CALIGONELLIDÆ)

By E. A. MCGREGOR

In 1935 the writer collected a mite occurring on the native fan palm at Indio, California. This acarid was entirely new to the author who, at that time, sent it to E. W. Baker for his opinion of its identity. He replied that it appeared to be a new genus and new species in the Stigmæidæ. The matter was put aside until recently when, after an interval of 24 years, Baker was again approached for his latest opinion of the mite. He replied that it is now referable to the genus *Molothrognathus*, erected by Summers and Schlinger (1955), and that the mite probably is an undescribed species. Upon comparing the mite with the three known species in the genus, the writer became convinced of its uniqueness.

Molothrognathus washingtonia, new species

MALE. GNATHOSOMA. Stylophore conical, narrowing anteriorly to form long acuminate digits. Peritremata originating immediately behind basal sclerites of movable digits, extending posteriorly, closely straddling the median axis of stylophore, turning abruptly outward near anterior margin of idiosoma and curving in reducing caliber around the caudo-lateral angle of stylophore. Rostrum split apically into two blunt tips, reaching to base of palp-tibia. Palpus of average thickness, reaching to middle of tibia I. Claw strong, acute, about equalling palp-tarsus which is equipped as follows: A tiny spindle-shaped sensillum on outer surface subterminally; three acicular setæ; a terminal whorl of 4 stout, arched setæ with bulbous tips.

IDIOSOMA. Narrowly ovate, widest in humeral region, almost twice as long as greatest width. (Six males averaged 0.285 mm. long by 0.155 mm. wide.) Dorsum without plates, but striated throughout; anterior two-thirds of integument with longitudinal striæ, posterior third with transverse striæ. Two adjacent eyes each side. Eleven pairs of dorsal setæ (excluding pair of short ventro-caudal setæ); all shortish except the long scapulars. A linear structure (ma) is visible axially on venter, extending from near anterior end of idiosoma cauded to a point even with coxæ IV, remotely bordered each side by three widely spaced setæ; this is probably the median apodeme. Legs relatively small; coxal groups well separated. Sensory setæ on leg I include a small, spindle-shaped sensillum on genu, two adjacent sensilla on tibiæ, and a spindle-shaped sensillum on tarsus (all sensilla situated as described by Summers and Schlinger (1955) for *Molothrognathus leptostylus*). Tarsus II also bearing a small spindle-shaped

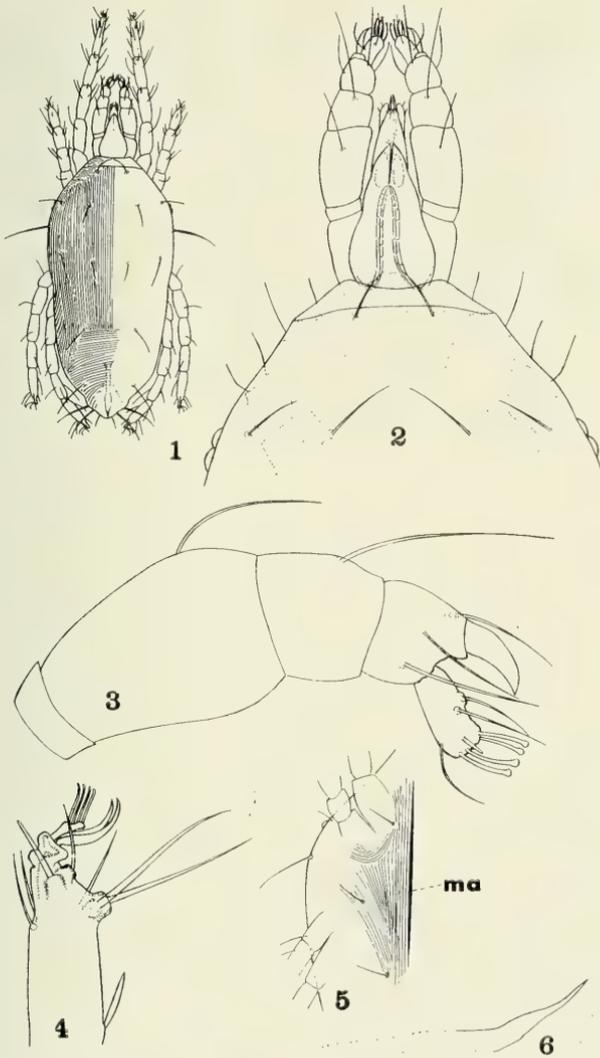


PLATE 36

Molothrognathus washingtonia

EXPLANATION OF FIGURES

- Fig. 1. Dorsal view of male.
 Fig. 2. Dorsal view of gnathosoma and anterior portion of idiosoma.
 Fig. 3. Lateral view of right palpus.
 Fig. 4. Tip of tarsus I, lateral view.
 Fig. 5. Anterior portion of idiosoma, right side, viewed ventrally (ma, median apodeme).
 Fig. 6. Lateral view of aedeagus.

sensillum dorsally on distal third of segment. Tarsi each with two strong claws; between them a fingerlike empodium bearing two pairs of capitate tenent hairs. Aedeagus in lateral outline roughly resembling a boomerang, the shaft daggerlike, narrowing to a sharp tip.

HOLOTYPE. Six males on one slide, Indio, California, Sept. 12, 1935 (E. A. McGregor), *ex* native fan palm (*Washingtonia filifera*). U. S. National Museum No. 2524. (Four mites in the genus *Schizotetranychus* are also present on this slide.)

The present writer had no opportunity to observe the feeding habits of the present mite. Summers and Schlinger stated that there is evidence to indicate that mites of his genus feed on eggs of the brown mite (*Bryobia prætiosa* Koch).

REFERENCE CITED

- Summers, F. M., and Schlinger E. I.
1955. Mites of the family Caligonellidae (Acarina). *Hilgardia* 23 (12): 539-561.

HATCHING TIME AND FIRST FEEDING INTERVAL FOR FIRST INSTAR *Triatoma protracta* AND *rubida* NYMPHS UNDER FIELD CONDITIONS

Single, adult female *Triatoma protracta protracta* and *Triatoma rubida uhleri* were closely watched for eggs which were isolated as soon as laid at the San Joaquin Experimental Range headquarters laboratory building during the summer of 1951. This is an adobe brick building with uniform indoor temperatures located at 1,000 feet elevation in the foothills of the Sierra Nevada near O'Neals, 25 miles east of Fresno, California (Wood, 1951, *Bull. So. Calif. Acad. Sci.* 50:106-112). Twenty *protracta* eggs were from adults collected in Griffith Park, Los Angeles, and 13 eggs were from adults taken near O'Neals, California. All the *rubida* eggs were from laboratory raised adults originally from Cottonwood, Arizona.

The average number of days for hatching of 33 *protracta* eggs was 18.2, range 16 to 20, with minimum temperatures between 56.9 and 60.1° F and maximum temperatures between 93.7 and 99.1° F for the time interval involved. The mean average temperature was 78.3, varying from 75.4 to 79.8. The average for 29 *rubida uhleri* eggs was 14.9 days, range 13 to 18, with minima between 51.2 and 59.5 and maxima between 86.5 and 96.6. The mean was 78, varying from 75.5 to 80.3 for the time interval involved.

The average number of hours before voluntary first feeding

of 27 *protracta* which fed to repletion was 65.3, range 46.5 to 78, at minimum temperatures between 51.2 and 59.5 and maximum temperatures between 86.5 and 96.6 for the time interval involved. The mean average temperature was 73.2, varying from 68.7 to 77.3. The average for 20 *rubida uhleri* was 61.9 hours, range 47.5 to 90.5, at minima between 52.3 and 58.3 and maxima between 88 and 95. The mean temperature was 72.9, varying from 70 to 76.

The writer wishes to thank: Fred Douthitt for many courtesies extended during this investigation and Lisle R. Green for the weather data, Superintendent and Range Conservationist, respectively, California Forest and Range Experiment Station; the Division of Zoology of the University of California at Davis; and Dr. Walter E. Howard under whose immediate supervision this work was completed.—Sherwin F. Wood, Life Sciences Department, Los Angeles City College, Los Angeles 29, California.

BODY WEIGHT AND BLOOD MEAL SIZE IN CONENOSE
BUGS, *Triatoma* AND *Paratriatoma*

Adult and nymphal *Triatoma protracta protracta* from Elizabeth Lake Canyon, Los Angeles and O'Neals in California, *Triatoma rubida uhleri* from Continental, Cottonwood, Sahuaro and Tonto National Monuments in Arizona, *Triatoma recurva* from Rancho Guirocoba, Sonora, Mexico and *Paratriatoma hirsuta* from Brenda and Gila Bend, Arizona, and Palms Canyon Wash, Borrego, California, were fed mostly on guinea pigs and weighed before and after to determine meal size during August and September, 1953, from cultures at Los Angeles City College. The bugs were placed in a 45 × 20 × 20 mm Cargile plastic box which had been balanced on an analytical chemical scale. Where possible, single specimens were isolated and weighed before and after feeding but in some instances all bugs of one feeding group were weighed together.

Thirteen unfed 1st instar *protracta* nymphs averaged 0.61 milligrams before feeding and 8 of these which fed to capacity as judged by maximum distension of the abdomen averaged 4.75 mg after their first blood meal on a mouse. This is a meal equivalent to 6.7 times their own body weight in the first feeding of their life cycle.

One 4th instar *protracta* weighed 44 mg before and 108 mg after feeding on a guinea pig for a 64 mg blood meal. However, this was after release of one fecal dropping by the bug.

One 55 mg 5th instar *protracta* fed to capacity weighed 187 mg after for a 132 mg blood meal. Seven other 5th instars filled to capacity averaged 210 mg blood meals, range 180 to 257.

Three other 5th only partially engorged revealed before and after weights of 60-150, 52-150, and 32-113. All fed on guinea pigs except the last mentioned which fed on a mouse.

Seven engorged adult male *protracta* averaged 68.7 mg before feeding, range 50-95, and 137 mg after, range 108-179. Eight engorged adult female *protracta* averaged 66.5 mg before feeding, range 52-92, and 140 mg after, range 120-170. The blood meals for the males averaged 68.7, range 30-87, and for the females 73.7, range 57-115. All were fed on guinea pigs.

One set of 13 fertile *rubida* eggs averaged 1 mg per egg while another set of 11 averaged 1.27 mg per egg for an average of 1.12 mg for the 24 eggs all of which hatched.

Twenty-eight unfed 1st instar *rubida* averaged 0.67 mg before first feeding. Six of these 1st which fed to capacity on a guinea pig averaged 5 mg each or a blood meal 7.4 times their own body weight!

One 2nd instar *rubida* weighed 4 mg before and 15 mg after feeding on a guinea pig.

Six 3rd instar *rubida* fed to capacity on a mouse were weighed together before feeding averaging 7.5 mg each and after feeding 44.3 mg each. Two engorged 3rd instars fed separately on a mouse and a guinea pig revealed before and after weights of 13-87 and 20-119 or 74 and 99 mg meals, respectively.

Twelve 4th instar *rubida* weighed together before feeding averaged 12.58 mg. Eight of these bugs fully engorged averaged 125.25 mg, range 88-186. Four recorded as half full averaged 63 mg, range 57-73. All were fed on one guinea pig.

Ten 5th instar *rubida* weighed together before feeding averaged 62.5 mg, range 45-77. Five of these bugs fed to capacity averaged 376.8 mg, range 291-468. Thus, for average weights this is a blood meal 6 times their own body weight. The other five 5th recorded as $\frac{1}{2}$ to $\frac{2}{3}$ full revealed weights of 110, 158, 183, 193, and 225 mg after feeding. Two additional partially fed 5th showed before and after weights of 53-122 and 90-163. All were fed on guinea pigs. If we use the average weight for the 10 unfed 5th above, 62.5 mg, in relation to the heaviest engorgement recorded here as 468 mg, the weight gain is 7.4 times as noted also for the 1st instars above. This tremendous capacity for blood is very important to *Triatoma* in survival under natural conditions since it permits them to wait months for a second blood meal.

Ten male *rubida* fed on a guinea pig averaged 73.4 mg, range 48-120, before engorgement and 112.5 mg, range 82-155, after feeding. Only two of these bugs "appeared" filled to capacity as judged by body distension with 55 and 64 mg meals, respectively. This small blood meal capacity reveals why these adults must feed more frequently in nature and therefore are probably

much more important in disease transmission during the warmer periods of the year.

Twelve female *rubida* fed on a guinea pig averaged 115 mg, range 91-162, before feeding and 214.3 mg, range 172-292, after feeding. The average blood meal here was 99.3 mg, range 67-135. It is not always apparent whether the female is completely filled but the 5 noted here so classified averaged 115 mg blood meals, range 96-135. The other 7 were recorded as partially full. The additional average weight of 42.6 mg before and 101.8 mg after feeding reflects the larger size and blood capacity of the female over the male.

One male *recurva* (*longipes*) fed 14-VIII-53 on a guinea pig revealed a before and after weight of 252-347 mg but on 4-IX-53 after feeding on a mouse revealed weights of 224-418. Thus, the first meal was 95 mg and the second 194, apparently having metabolized the first meal in 20 days under summer temperatures. One female *recurva* revealed 556-575 before and after body weights for a 19 mg blood meal.

One fully engorged 5th instar *Paratriatoma hirsuta* nymph revealed before and after feeding weights of 27-107 for an 80 mg blood meal on a mouse. One engorged male *hirsuta* revealed before and after weights of 21-45 for a 24 mg meal on mouse blood. Three separate engorged female *hirsuta* averaged 42.6 mg, range 32-60, before feeding and 87 mg, range 65-112, after feeding with meals averaging 44.3 mg, range 29-52. The 29 mg meal was from a guinea pig, the 52 mg meals from mice. The two females which fed to capacity each took 52 mg blood meals with before and after weights of 32-84 and 60-112.

In relation to maintenance of Chagas' trypanosome, *Trypanosoma cruzi*, in nature, meal size is very important since it increases the chance of the bug picking up parasites from lightly infected hosts. The larger meal size of 1st instar and adult *Triatoma rubida uhleri* would favor this bug in maintenance and transmission of Chagas' trypanosome under natural conditions in addition to the advantages previously cited by Wood (1952, Pan-Pacific Ento. 28:147-153).

The author thanks J. B. Dixon and O. G. Graves, Cottonwood, Supt. C. C. Sharp, Tonto National Monument, and G. E. Steele, Sahuaro National Monument, for *rubida* specimens and K. E. Stager, Los Angeles County Museum, for the Mexico *recurva*.—Sherwin F. Wood, Life Sciences Department, Los Angeles City College, Los Angeles 29, California.

ERRATE

(in Bulletin Vol. 58, Part 1)

Page 15, from line 23, the text should read as follows:

Appearance of hooks: Neuropodial segment 12
Notopodial segment 35

Distribution: Texas

Prionospio heterobranchia newportensis n. subsp.

Eyes: Two pairs

Appearance of hooks: Neuropodial segment 14
Notopodial segment 42 to 55

Distribution: Southern California

Dryocosmus bicornis

In the January issue of the Annals of the Entomological Society of America, Dr. Richard L. Doutt, Dept. of Biological Control, University of California presents conclusive evidence proving that *Dryocosmus bicornis* (McC. & Egb.) is actually the parthenogenetic generation of *Dryocosmus dubiosus* (Fullaway) which was described in 1909 from both males and females. This is a most important contribution to our knowledge of the Pacific Slope Cynipidæ.

R. J. Lyon

PROCEEDINGS OF THE ACADEMY

February 20, 1959

Under the sponsorship of the Section on Vertebrate Zoology, with Dr. Charles A McLaughlin Chairman. Dr. Rudolph Ruibal presented a lecture on "Speciation in Frogs." Dr. Ruibal is Assistant Professor of Zoology at the University of California, Riverside.

March 20, 1959

Dr. Paul Saltman, Assistant Professor of Biochemistry, School of Medicine, University of Southern California, discussed the biological effects of atomic radiation, under the title "Atom and Eve." The program was sponsored by the Section on Medical Science, with Dr. John D. Soule, Chairman.

April 17, 1959

A representative of the Jet Propulsion Laboratory of the California Institute of Technology presented a summary of the work of the laboratory on "Space Satellites," showing a motion picture and models. The meeting was then opened for questions regarding the program. Dr. Joseph B. Ficklen, III, Chairman of the Section on Physical Sciences, introduced the speaker.

May 15, 1959

The annual dinner meeting was sponsored by the Committee on Special Events with Henry Anson Wylde Chairman, in cooperation with the Hospitality Committee (Russell Belous Chairman) which arranged for the use of the University of Southern California Town and Gown Foyer for the dinner.

Annual reports were presented by the Secretary, the Treasurer (with Auditor's report by Mr. Allen Steuart), and the Editor (see below). Members of the newly elected Board of Directors and Advisory Board were announced, as follows:

Board of Directors: Thomas Clements, John A. Comstock, Theodore Downs, Hildegard Howard, Richard Loomis, Lloyd Martin, W. Dwight Pierce, Gretchen Sibley, Kenneth E. Stager, Fred S. Truxal and Sherwin F. Wood.

Advisory Board: A. Weir Bell, J. Stanley Brode, Charles Burch, Howard R. Hill, Dorothy Martin, Theodore Payne, Richard Swift, Louis C. Wheeler, John A. White.

The following were awarded the degree of Fellow: Dr. E. Yale Dawson, Dr. E. Gorton Linsley and Dr. Richard H. Merriam. The research grant from the American Association for the Advancement of Science was awarded to Thomas Emmet.

The address of the evening was presented by Clayton G. Loosli, M.D., Dean of the School of Medicine, University of Southern California. Dr. Loosli's subject was "New Horizons in Medicine."

June 12, 1959

About 60 members and guests assembled on the third floor of the Los Angeles County Museum for the last monthly meeting of the year. Officers and Section Chairmen for the fiscal year 1959-1960 were announced, and the meeting was turned over to the new president, Dr. Fred S. Truxal. Under the title, "Science in the Museum," Dr. Hildegard Howard, retiring president, reviewed the work in the Science Division of the Los Angeles County Museum, of which she is Chief Curator. Her talk was complete with an introduction of the curatorial staff, and a 45-minute period was then devoted to "open house" in the various curatorial offices and laboratories.

Meetings of the Board of Directors

The Board of Directors for 1958-59 met following the monthly programs of February 20, March 20, and April 17, 1959. Organizational meetings of the newly elected Board for 1959-1960 were held on May 1 and June 12, 1959.

At the February meeting, nominations for Board of Directors and Advisory Board as prepared by the Nominating Committee were approved for mailing to the membership. A Committee to study needs for changes in the By-Laws was appointed, as follows: Fred S. Truxal, Chairman, Gretchen Sibley, W. Dwight Pierce and Sherwin F. Wood. Dr. Truxal reported at both the March and April meetings concerning the work of this Committee; the items to be considered include primarily revisions in qualifications for Junior Members, and selection of the Board of Directors and Advisory Board; the Committee requested more time for careful study of these matters. The Committee on selection of Fellows presented a report which was unanimously accepted; those to be granted this honor were announced at the Annual Meeting (see report above). The Committee on awarding of the A.A.A.S. research grant reported five applicants; a choice was made later and announced at the Annual Meeting (above).

The newly elected Board of Directors and Advisory Board met in special session on the first Friday in May to hear reports and elect officers for 1959-1960. Condensed versions of the reports are given below. Officers are as follows: President, Fred S. Truxal; first Vice President, Theodore Downs; second Vice President, Richard Loomis; Secretary, Gretchen Sibley; Assistant to the Secretary, Lloyd M. Martin; Treasurer, W. Dwight Pierce; Editor, John A. Comstock.

Secretary's Report: The Southern California Academy of Sciences met nine times during the fiscal year, 1958-1959, with an average attendance

of about seventy-five. Seven meetings were held at the Los Angeles County Museum; one (in October) was held at the Stuart Pharmaceutical Products Company in Pasadena, and the Annual Meeting at the University of Southern California. Dinner meetings were discontinued for the months of November, December, January and February, while the museum cafeteria was being renovated. Membership for the year totalled 200, of which 28 were new; subscribers to the Bulletin, another 51. Deceased during the year were: Dr. Frank Peabody, Mr. O. C. Smith, and Mr. Stuart Peck.

Editor's Report: The customary three issues of the Bulletin were edited and issued in 1958, and the first issue for 1959 was published. The three 1958 issues contained a total of 37 papers, 182 pages, and 49 illustrations.

Treasurer's Report: General Fund—balance in bank May 1, 1958, \$366.63; receipts \$4924.06; disbursements \$4487.65; cash on hand May 1, 1959, \$82.50; balance in bank May, 1959, \$720.54. Memorial Fund—balance in bank May 1, 1958, \$879.60; receipts, including repayment from general fund, \$309.70; disbursement (loan to general fund) \$200; balance in bank April 27, 1959, \$989.30. Securities market value May 1, 1959, \$64,803.53; bulletins and memoirs in stock, \$13,600; bulletins in press \$650.00; other property \$407.00; total value inventory \$14,657.00. Total assets May 1, 1958: general fund, memorial fund, postage on hand, accounts receivable, interest receivable, securities and inventory—\$81,338.93.

Section Chairmen met with the 1959-1960 Board of Directors on June 12, to set up the monthly programs for the coming fiscal year.

New Members

The following have been accepted for membership since March, 1959: Dr. M. Dale Arvey, 6903 Harvey Way, Lakewood (Ornithology); Marsha Brenton, 4328 Saint Claire Ave., Studio City (Zoology); Dr. Carl L. Hubbs, Scripps Institution (Zoology); Jack Hudson, 3937 Verdugo View Drive, Los Angeles (Physiology-Ecology); Edward D. Mitchell, Jr., 409 Cypress Ave., Los Angeles (Vertebrate Zoology); Dr. Rodolfo Ruibal, 2826 Iron Hills Way, Riverside (Zoology); Robert C. Stephens, 2104 Santa Fe Ave., Torrance (Zoology); Dr. Peter P. Vaughn, 6286½ Commodore Sloat Drive, Los Angeles (Paleontology); William G. Waldron, 800 Selkirk Street, Pasadena (Entomology); Patrick H. Wells, 5505 Arbor Dell Place, Los Angeles (Biology); Joseph Wilcox, P. O. Box 70, Whittier, Calif. (Entomology).

Earth Sciences Section Meetings

Six meetings of the Earth Sciences Section of the Academy were held in the fiscal year 1958-1959. The first (on October 3, 1958) was reported in the Bulletin for December, 1958 (vol. 57, part 3, p. 179).

The second meeting occurred at the University of California, Riverside, on December 19, 1958, with a dozen members in attendance. Rodolfo Ruibal led a discussion on "The Biology and Evolution of a Population of *Rana pipiens* from the Salton Sink, Colorado Desert." Of particular interest was his evidence for the probable natural selection for low salinity water sources by the desert frog population.

The group met at Occidental College on March 6, 1959, with seventeen members and visitors present. William Morris presented a lively discussion on "The Use of Horse Astragali in Determining Faunal Horizons, and Some Aspects of Miocene Horse Taxonomy." His data confirmed previous stratigraphic interpretations, and he emphasized the great need for correlation of skeletal anatomy and dental characters to derive a more taxonomic picture in the Equidae.

On April 24, the section members were guests of Webb School at Claremont, where approximately 25 people listened to a guest speaker from the Museum of Paleontology at Berkeley, Dr. Malcolm C. McKenna. He presented a thorough discussion on "New Fossil Evidence Concerning Insecti-

vore Interrelationships." It was gratifying to learn that the many new finds (specimens hidden in museums and those taken recently from screenings at old Cretaceous localities) are contributing much toward the better understanding of many early mammalian groups that were heretofore lost in the Insectivora "wastebasket" category.

William Lumsden presented a very complete survey of "The Use of Ostracods in Paleontology," at the May 29 meeting at Long Beach State College. There were about 22 in attendance. Lumsden stressed that although the ostracods are poorly known as living or fossil forms (due to lack of study), they have great potential, particularly as regards sources for ecologic interpretations. John White arranged for an awe-inspiring tour of the new science wing at Long Beach State College. This was the last scheduled meeting for the year.

A special meeting was held at the Los Angeles County Museum on June 26 with sixteen in attendance. Dr. Bjorn Kurtén, a visitor from the Geological Institute of Helsingfors University, Finland, presented an extremely interesting discourse on "Faunal Evolution and Chronology of the Cromerian (Middle Pleistocene) in Europe." Using evidence based on radio-carbon and potassium-argon dates, and on faunal analyses which included species of bears, weasels, microtine rodents and proboscideans, Dr. Kurtén correlated the glacial and interglacial stages of Europe with "cold" and "warm" faunas, and noted the effects of those cyclical, climatic changes on the evolution of the various species.

The work of the Southern California Academy of Sciences is carried on entirely through the generosity of private citizens, who are sufficiently interested in the advancement of education and cultural endeavor to donate funds or make bequests to the Academy. As a guide, in the matter of bequests, for those who plan to further this program, the following forms are suggested:

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To be used when it is desired to leave the Academy any personal property, such as money, stocks, bonds, works of art, or other objects of value.

I give and bequeath unto "Southern California Academy of Sciences," of the City of Los Angeles, the sum of..... Dollars: To have and possess the same unto the said "Southern California Academy of Sciences," its successors and assigns, to the uses, dispositions and benefits thereof forever.

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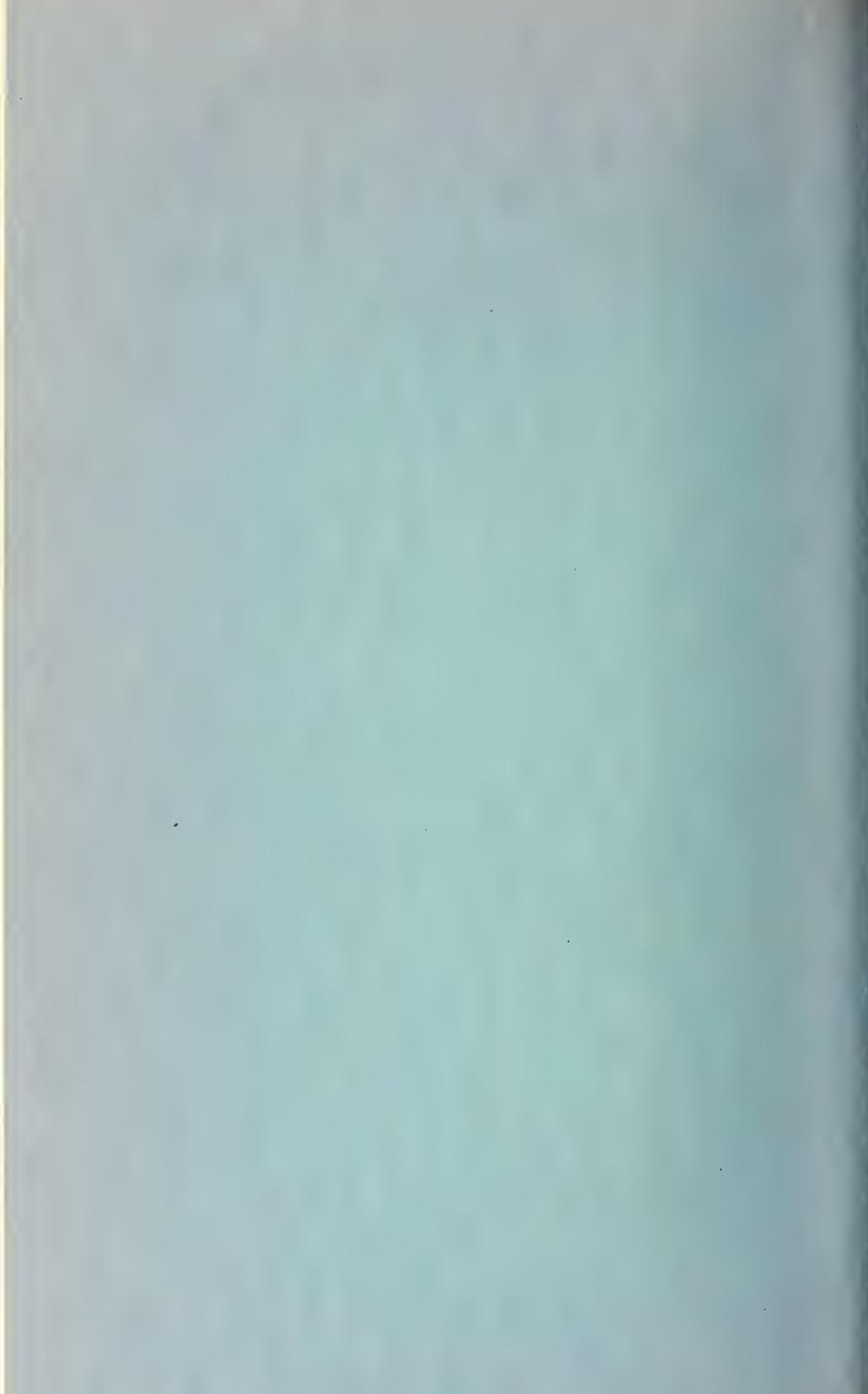
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VOL. 58

SEPTEMBER-DECEMBER, 1959

PART 3

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Issued January 15, 1960

Southern California Academy of Sciences

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TAPOCHOERUS, A UINTAN DICHOBUNID
ARTIODACTYL FROM THE SESPE FORMATION
OF CALIFORNIA

By MALCOLM C. MCKENNA

(A contribution from the University of California Museum of Paleontology)

ABSTRACT

Hyopsodus egressus Stock, 1934b, from the Uintan (late Eocene) Tapo Ranch faunule, Sespe formation, Southern California, is not a hyopsodont condylarth. The species is here made the type of *Tapochoerus*, new genus, a dichobunid artiodactyl. A hypocone and non-hypertrophied metaconule on the upper molars and the lack of a metaconid on P_3 , combined with presence of a metaconid on P_4 , a paraconid on M_1 and M_2 , and the nature of the lower molar hypoconulids, indicate affinity with the most primitive members of the dichobunid subfamily Homacodontinae. The recently proposed dichobunid subfamily Antiacodontinae Gazin, 1958, is rejected and its members returned to the Homacodontinae.

Among the fossil mammal remains collected by the California Institute of Technology at Locality 180 on the Tapo Ranch in Simi Valley, Southern California, are half a dozen jaws and more than a dozen teeth of a Uintan (late Eocene) mammal which Chester Stock (1934b) named as a new species of the condylarth genus *Hyopsodus*, *H. egressus*. In his paper Stock did not make comparisons with remains of any dichobunid artiodactyl. Recent clarifications of dichobunid interrelationships by C. L. Gazin (1952, 1955, 1958) have made it increasingly apparent to the author that *Hyopsodus egressus* Stock, 1934b, is not a hyopsodont condylarth but rather is a dichobunid artiodactyl related to *Microsus*, *Hexacodus*, *Antiacodon*, and *Auxontodon*. "*H. egressus*" possesses a combination of characters which indicates that it represents a Uintan member of a primitive homacodont dichobunid lineage that may have been isolated in California west of Mohavia throughout most of the Eocene. By Uintan time the lineage had become generically distinct from its closest dichobunid allies.

I wish to thank Drs. D. E. Savage and C. L. Gazin and Mr. W. A. Clemens for reading the manuscript and for criticism. Dr. Theodore Downs and Mr. William Otto were also of considerable assistance. The illustrations were drawn by Howard Hamman (Plate 37, fig. a, c) and Owen J. Poe (Plate 37, fig. b.).

FAMILY DICHOBUNIDAE GILL, 1872

SUBFAMILY HOMACODONTINAE PETERSON, 1919a

Tapochoerus, NEW GENUS

ETYMOLOGY: TAPO, Tapo Ranch, Simi Valley, Southern California; *choerus*, Gr. *choiros*, pig, with reference to the bunodont dentition.

TYPE: *Hyopsodus egressus* Stock, 1934b.

TYPE OF *H. Egressus*: Calif. Inst. Technology¹. No. 1590, fragmentary right lower jaw with P₄ - M₃, figured by Stock, 1934b, Plate I, figs. 3, 3a.

PARATYPES OF *H. egressus*: Calif. Inst. Technology Nos. 1596, left M³, 1597, right M¹ or M², and 1598, right M¹ or M². Paratypes figured by Stock, 1943b, Plate I, figs 4, 5, and 6, respectively. C. I. T. No. 1598 refigured, this paper, fig. 1, b.

HYPODIGM: Type, paratypes, and the following specimens: C.I.T. Nos. 1292, two sections of a right lower jaw with M₂ - M₃, P₃ - P₄, and roots of P₂, figured by Stock, 1934b, Plate I, figs. 7, 7a, 7b, 7c; 1587, fragmentary right lower jaw with M₁ - M₃; 1588, fragmentary right lower jaw with P₄ - M₂, this paper, fig. 1, c; 1589, fragmentary left lower jaw with M₁ - M₃; 5224, fragmentary right lower jaw with two molars; 5225, right M³; 5226, right M¹ or M²; 5227, right M³; 5228, ½ upper molar; 5229, fragmentary left upper molar; 5230, associated left ?M² and M³, this paper, fig. 1, a; 5231, left lower molar; 5232, left lower molar; 5233, anterior, caniniform tooth, probably from the upper dentition and probably this species, though this is not proven; 5234, left P₄.

TYPE LOCALITY OF *Tapochoerus egressus*: Tapo Ranch, Calif. Inst. Technology Locality 180, Uintan part of Sespe formation, progressive grid coordinates 1,227,475 - 1,250,500, elevation 1425 feet m. s. l., Santa Susana Quadrangle (1943; 1:62,500), north side of Simi Valley, Ventura County, California.

AGE: Late Uintan (approximately "Uinta C"), assigned to late Eocene.

DISTRIBUTION: Type Locality only.

¹. All fossil mammal specimens formerly in the collections of the California Institute of Technology are now the property of the Los Angeles County Museum.

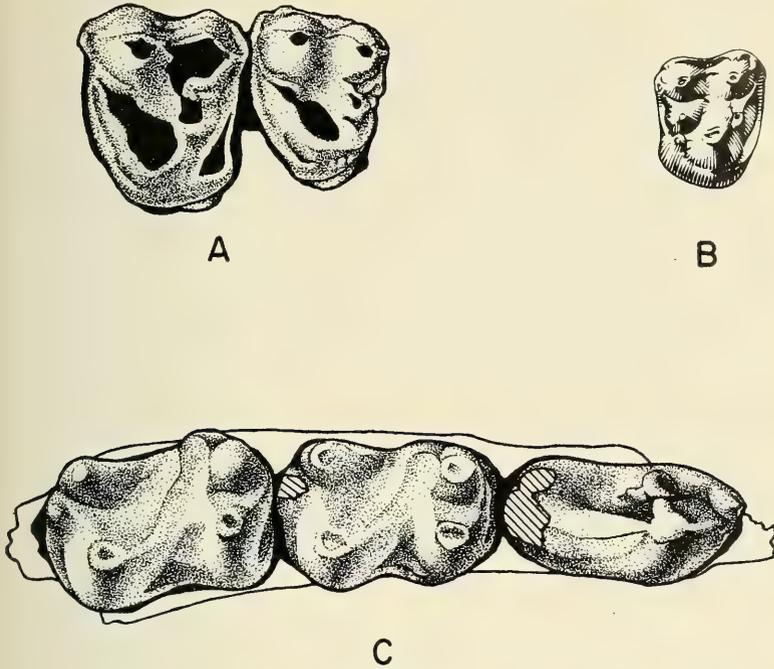


PLATE 37

Tapochoerus egressus (Stock, 1934b). A: C. I. T. No. 5230, associated left ?M² and M², x3. B: C. I. T. No. 1598, right ?M² (Stock, 1934b, Plate I, fig. 6. Photograph poorly retouched in region of hypocone), x2. C: C. I. T. No. 1588, right lower jaw fragment with P₄ - M₃, x3. A and C, by Howard Hamman; B by Owen J. Poe.

GENERIC DIAGNOSIS: Primitive dichobunid artiodactyl in which the teeth are more bunodont than selenodont; the hypocone is retained on M¹ and/or M², the metaconules are large but are neither hypertrophied nor markedly displaced and, when unworn, possess five posterior crests; there is neither a mesostyle nor ectoloph ribbing on M¹ and/or M², strong diastemata isolate the double-rooted P₂; P₃ is trenchant and lacks a metaconid; P₄ is also trenchant but possesses a distinct entoconid and a metaconid which separates from the protoconid high on the crown; M₁ has a strong paraconid separated from the metaconid but not as widely separated as in *Antiacodon* or *Auxontodon*, M₂ has a variably separated paraconid, and M₃ has a fused single lingual trigonid cusp; all the lower molars are elongate, with hypoconulids closely similar to those of *Hexacodus*.

REVISED DIAGNOSIS AND DESCRIPTION OF *TAPOCHOERUS EGRESSUS*

M¹ and/or M² with high, conical paracone possessing anterior and posterior crests, a basal connection to the weak posterior wing of the protoconule, and slight fluting labially in the area where the labial cingulum is interrupted; metacone also with anterior and posterior crests, but without marked basal connection to metaconule; protocone conical, but connected to protoconule by strong ridge; protoconule strong, with strong antero-labial wing to anterior cingulum at base of paracone and very weak labially directed posterior wing joining small basal projection from paracone; metaconule very strong, conical, and with a weak anterolabial wing, a moderately strong posterolabial wing terminating anterolingual to the metastyle, and four additional flutings or minor crests placed diagonally on the posterior slope; the most lingual of these accessory crests faces a cuspule on the posterior cingulum labial to the hypocone; almost the whole circumference of the tooth bears a robust and crenulated cingulum which is interrupted only briefly at the labial base of the paracone (where there is generally a small notch just posterior to the interruption) and at the lingual base of the protocone, but even these gaps are filled with small crenulations at the proper site; the hypocone is merely a moderately large cuspule on the cingulum and does not approach the size of the metaconule, though the cusp is at least present, in contrast to members of the Helohyinae and Diacodexinae. (See Sinclair (1914a, p. 290, etc.). Gazin (1952, p. 73) mentions a hypocone in some molars referred to *Bunophorus*, stating that the cusp is approximately equivalent in size to the protoconule and metaconule.)

M³ triangular, with high, conical paracone and smaller metacone linked by crests forming a stronger ectoloph than that of M¹ and/or M²; an incipient mesostylar rib strengthens the ectoloph at its mid-point; the protocone is approximately the size of the metacone and is linked to the protoconule as in M¹ and/or M²; the protoconule is as in the other molars; the metaconule is large, with moderately well developed antero- and posterolabial wings, a few specimens with a crest to the protocone, and in unworn teeth four additional, minor crests on the posterior slope lingual to the posterolabial wing; the tooth is almost surrounded by a highly cuspidate cingulum, the principal interruptions occurring at the bases of the protocone and occasionally the metacone; a hypocone is generally not indicated, but a small cuspule is located in the appropriate position on Calif. Inst. Technology No. 1596 (Stock, 1934b, plate 1, fig. 4.).

Lower jaw with diastemata both anterior and posterior to the roots of P₂. (Stock identified these roots as belonging to a single-rooted C and P₁, respectively, and was forced by his ideas

of hypsodont affinity to conclude that the posterior diastema was possibly the former site of a P_2 lost during life, although he admitted that "no very clear, if any, external indication of the former presence of alveoli can be determined."). Large mental foramen beneath P_2 ; another, small foramen below posterior root of P_3 . Symphysis extending to beneath posterior root of P_2 .

P_2 double-rooted, strong.

P_3 trenchant, typically dichobunid and not closely similar to P_3 of hypsodonts; no crest from protoconid to entoconid and no metaconid (in contrast to *Antiacodon* and *Auxontodon*); main crest to heel as in *Wasatchia*, *Hexacodus*, *Leptoreodon*, etc., in that it seems to stand up as a sharp ridge above the deeply concave posterior face of the protoconid.

P_4 elongate, but not as thin and trenchant as P_3 ; paraconid low, distinct, somewhat lingually placed, and with a short cingulum extending basoposterolabially for a short distance; protoconid high, with an anterior crest curving from the apex to the posterolabial base of the paraconid and a sharp ridge running posterobasally from the apex as in P_3 ; metaconid separating from high on protoconid and a weak metastylid developing high on metaconid, creating a sharp groove between itself and the main posterior ridge of the protoconid (The high metaconid differs from that of *Hexacodus*, *Microsus*, *Antiacodon*, or *Auxontodon*, the only other American dichobunids exhibiting the cusp on P_4 . *Antiacodon* and *Microsus* have well separated, low metaconids, evidently derived from the condition seen in *Hexacodus*, in which a weak, low metaconid is developed at the base of the protoconid of a tooth which is otherwise similar to P_4 of *Diacodexis* and *Protodichobune*. *Auxontodon* has a high metaconid, but the cusp is well separated and is evidently derived from that of *Antiacodon*.); the metastylid does not extend to the base of the metaconid; entoconid present, though the cusp is generally absent in American dichobunids (present only in *Hexacodus*, *Antiacodon*, *Auxontodon*, and weakly in *Diacodexis robustus*.).

M_1 with paraconid and metaconid not well separated, in agreement with *Microsus* (Gazin, 1955, p. 23), but in disagreement with *Homacodon*, in which there is a single lingual trigonid cusp, and with *Antiacodon* and *Auxontodon*, in which the paraconid and metaconid are very well separated; paraconid larger than metaconid in agreement with *Auxontodon*; anterior cingulum and parts of labial cingulum heavy in contrast to most members of the Diacodexinae; looping paralophid as in *Homacodon* and *Microsus*, but also similar to that of hypsodont condylarths; metaconid and hypoconid apices connected by notched metalophid; strong hypoconid connected to hypoconulid as in *Hexacodus* (Gazin, 1952, p. 75).

M_2 as in M_1 except larger, with paraconid subordinate to metaconid and easily obliterated by wear as in *Microsus* (Gazin, 1955, p. 23); several tiny crenulations on anterior crest of entoconid.

M_3 narrower than M_2 , with paraconid completely engulfed in incomplete paralophid loop as is usually the case in *Microsus* (Gazin, 1955, p. 23); hypoconulid large, but not narrowly projecting as in *Wasatchia*, *Diacodexis*, *Homacodon*, etc.; hypoconulid variably connected to other posterior talonid cusps, but most frequently connected to hypoconid; additional crests directly connecting the entoconid to the hypoconid may be present.

DISCUSSION:

Stock (1934b) compared *Tapochoerus egressus* with advanced hypsodont condylarths but did not mention dichobunid artiodactyls. One is thus led to assume that the dichobunids were overlooked as possible relatives of *Tapochoerus*. Had these additional comparisons been made I believe that Stock would not have placed *Tapochoerus egressus* in the Hyopsodontidae. Certain similarities to *Haplomyilus* and *Hyopsodus*, such as looping paralophids and weakly separated paraconids on the lower molars, a metaconid on P_1 , bunodont crowns, and a small hypocone on the anterior upper molars, also support dichobunid relationships. Considered in detail, the similarity to the dichobunids is always greater. In addition, the presence of diastemata, the placement of the lower molar hypoconulids, and the trenchant nature of the premolars indicate artiodactyl affinities.

Possession of a hypocone is a distinctive feature of *Tapochoerus*. American dichobunids differ from their European counterparts in that the hypocone is either not present (Helo-hyinae, Diacodexinae, except possibly some specimens of *Bunophorus*) or if so, it is generally reduced in conjunction with progressive hypertrophy of the metaconule (advanced homacodonts). In *Antiacodon*, which together with *Auxontodon* represents a distinctive but minor side branch of the homacodont complex, the hypocone is present on M^1 and M^2 but the metaconule is not hypertrophied. Although the premolars remove *Antiacodon* from the ancestry of all later homacodonts except *Auxontodon*, the molars probably do not differ greatly from the primitive homacodont condition. *Tapochoerus* is in agreement with *Antiacodon*, in that the metaconule is not hypertrophied. Unfortunately, the upper molars of *Hexacodus* are not yet known.

Lower molars of *Tapochoerus* resemble those of the presumably primitive homacodont genus *Microsus* in the presence of a distinct paraconid on M_1 , variable paraconid on M_2 , and loss of the paraconid on M_3 (present in some specimens of *Microsus*). Other homacodonts depart widely from this condition. *Homacodon* itself has only one lingual trigonid cusp on each

lower molar. In *Antiacodon* the paraconid and metaconid are much more widely separated than in *Tapochoerus*. In the one preserved molar (M_1) of *Auxontodon* the paraconid and metaconid are widely separated, but the paraconid is the larger cusp as in *Tapochoerus*.

The lower premolars also ally *Tapochoerus* with the homacodonts. Among American dichobunids, only in members of the Homacodontinae is a metaconid found on P_4 . Curiously enough, however, *Homacodon* itself lacks the cusp. The P_4 metaconid of *Tapochoerus* is more closely appressed to the protoconid than in other homacodonts, but the cusp is variable within the group. Presence of a P_4 entoconid also suggests the Homacodontinae, though this cusp is easily acquired phylogenetically, as seems to be the case with *Diacodexis*.

Several minor lineages among the homacodonts do not lead toward *Tapochoerus*. *Homacodon* itself has already lost one of the lingual trigonid cusps of the lower molars, lacks a metaconid on P_4 , and already shows hypertrophy of the metaconule of the upper molars, notably M^3 . *Homacodon* was already too advanced to have given rise to *Tapochoerus*. *Antiacodon* and its probable descendant, *Auxontodon*, possess highly characteristic P_3 and P_1 , each tooth bearing a metaconid. This cusp is unknown in P_3 of other American dichobunids and gives P_3 a distinctive "triconodont" aspect in this lineage. The lineage apparently arose from a *Hexacodus*-like primitive homacodont stock during the Wasatchian and carried on to the late Uintan genus *Auxontodon*. Gazin (1958, p. 2) created a new subfamily, Antiacodontinae, for the two genera, but the two forms are closely similar to each other in comparable details and together are not more distinctive than other vertical branches of the homacodonts (e.g., *Homacodon* itself or *Mesomeryx*), though the inferred caniniform P_1 of *Auxontodon* was considered important by Gazin. *Bunomeryx*, a Uintan homacodont, possesses an enlarged P_1 (Peterson, 1919a, p. 67). This part of the jaw is almost completely unknown in middle and early Eocene homacodonts. The distribution of enlarged and presumably caniniform first premolars within the homacodonts is therefore too poorly understood for taxonomic use at present. At this time, therefore, recognition of the antiacodont lineage as a distinct subfamily does not seem to me to be justified. While distinct, the antiacodonts are just one minor lineage within a complex of equally distinctive lineages, all of which fit conveniently into one useful subfamily, the Homacodontinae.

Tapochoerus appears to be related to the primitive homacodonts and on the basis of available evidence is closely related especially to *Hexacodus* and *Microsus*. Four homacodont lineages therefore existed during the middle Eocene in North

America: *Homacodon* itself, leaving no known descendants; *Antiacodon*, leading to the late Eocene *Auxontodon*; *Microsus*, leading to advanced late Eocene homacodonts; and the ancestry of *Tapochoerus*, presumably restricted to the West Coast and undergoing little significant modification from the early Eocene onward.

Measurements (mm.)

| | |
|--|---------------------------|
| ?M ² (C.I.T. No. 1598) ectoloph length: | |
| maximum width | 7.7 : 9.3 |
| M ³ ectoloph length: | |
| maximum width | 6.0-6.4 : 7.4-7.8 |
| Depth of lower jaw (C.I.T. No. 1292) at | |
| diastema between P ₁ and P ₂ | est. 9.0 |
| Depth of lower jaw beneath M ₂ , lingually | 12.5-13.2 |
| | (10.6 in one young adult) |
| Length of diastema (C.I.T. No. 1292) | |
| between P ₁ and P ₂ | est. 4.0 |
| Length of cheek tooth series from ante- | |
| rior margin of first alveolus of P ₂ | |
| to posterior margin of M ₃ | est. 50.0 |
| Length of lower molar series, M ₁ -M ₃ , | |
| inclusive | 22.5-est. 23.0 |
| P ₃ , length: greatest width (C.I.T. No. 1292) | 7.4 : 3.2 |
| P ₄ , length: greatest width (C.I.T. No. 1292) | 8.3-8.8 : 4.0-4.8 |
| M ₁ , length: greatest width (C.I.T. No. 1292) | 7.1-7.3 : 4.7-4.9 |
| M ₂ , length: greatest width (C.I.T. No. 1292) | 7.4-8.0 : 5.1-5.3 |
| M ₃ , length: greatest width (C.I.T. No. 1292) | 7.3-7.9 : 4.5-5.1 |

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REVIEW OF THE HEAD MUSCLES OF SALAMANDERS

Part I.

By WILLIM A. HILTON

PROTEIDAE

In a *Necturus* larva of 34 mm, the two slides of the M. levator mandibulae are widely separated, with a small and a larger superficial portion which may be seen from above. In the adult the superficial portion has become very thick, the two parts showing above meet on the middle line, between the eyes and back of them. After the removal of the two superficial portions three divisions may be seen in the profundus and two in the ptergoid with some overlapping and intermingling of fibers. In adult *PROTEUS*, this muscle as a whole is not so heavy. Two parts may be recognized from the surface with some separation between the two sides. Underneath some profundus and ptergoid fibers may be found but they are not well separated from the superficial parts.

The M. levator externus is large in *Necturus* adult and nearly two-lobed towards its insertion. It is quite elongate in *Proteus*.

An intermandibularis anterior or submentalis is not present in either genus.

In *Necturus*, a lateral genio-hyal was seen but not in *Proteus*. Fibers from the dorso-laryngeus are attached to the tracheal regions laterally in *Necturus* and *Proteus*. A constrictor laryngeus is not evident in either genus.

The ceratohyoideus externus is large in *Necturus*, but especially so in *Proteus*. The ceratohyoideus internus is very small in *Proteus*.

A small muscle, the protractor arcus ultimi (Hoffman '78, Wilder '91) which runs forward from the base of the last ceratobranchial to the posterior side of the second hypobranchial, is said to be present in *Proteus*.

The subarcuales obliqui is very slender, of one strand in *Proteus*, but much larger in *Necturus*.

The subarcualis rectus muscles have origins on the third arch with only two insertions.

The levator arcuum muscles are well developed in both genera; four or more parts are easily seen in *Necturus* larvae and adults. In *Proteus* they are well formed but weaker.

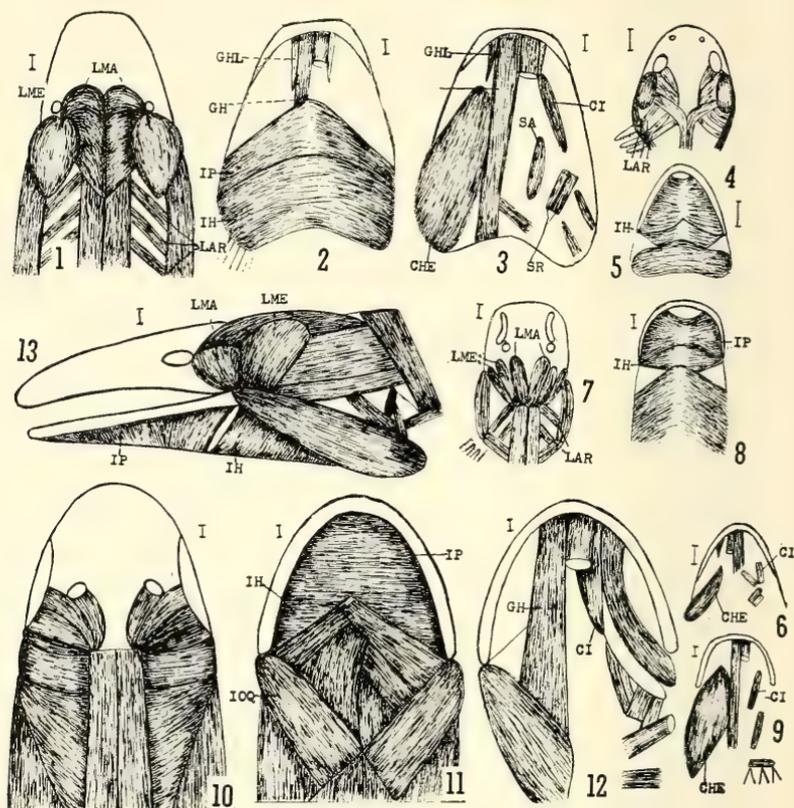


Plate 38

Muscles of the head of Proteidae, 1-9; Amphiumidae 10-13. 1. *Necturus* adult, head above. 2. Same throat, below, deeper muscles partly shown. 4-6 *Necturus* larvae of 34 mm, above, below and deep throat. 7-9. *Proteus*, above, below and deep throat muscles. 10. *Amphiuma*, above. 11. Superficial throat. 12. Deep throat. 13. Side View.

Scale equals 1 mm.

CHE, Ceratohyoideus externus; CM, Ceratomandibularis; Di, Dialator laryngus; Dm, Depressor mandibulae; GG, Genioglossus; GH, Geioohyoideus; GHl, Geioohyoideus lateralis; IA, Intermandibularis anterior or submentalis; IH, Interhyoideus; IP, Intermandibularis posterior; LAR, Levatores arcuum branchiarum; LMA, Levator mandibulae externus; SA, Subarcualis obliqui; SR, Subarcuales Recti.

The omo-arcualis is well developed in *Necturus* and much weaker in *Proteus*.

In *Necturus* the six eye muscles are quite typical, but the bulbi muscles are not well developed. In *Proteus* only slight indications were found of the recti muscles.

SIRENIDAE

In a young siren of 122 mm length the superficial part of the *M. levator mandibulae* is in two sections; the forward one near the eyes is larger than usual. The two sides of the external part of this muscle are quite widely separated. Underneath, a profundus portion and a pterygoid were recognized. The depressor mandibulae as usual is of two parts, one portion from the tip of the ceratohyal. Druner, '01 and '04, calls this cerato-hyomandibularis.

I found no lateral geniohyoideus, A.M. protractor arcus ultime was recognized by Hoffman '78 and Wilder '91.

The omo-arcualis is well developed and quite characteristic.

The first levator arcus is from fascia near the depressor mandibula and is very broad; the second is much smaller and the fourth is broad and fan-shaped.

In *PSEUDOBANCHUS*, the *M. levator mandibulae* muscles are well separated externally with two divisions on each side. A profundus and a pterygoid may be seen.

The mandibularis externus has two heads, the more forward is very small but is a distinct filament.

The ceratohyoideus externus is well developed, the internus especially small.

The subarcuales obliqui are very small but similar in their position to those of *Siren*.

The levatores arcuum are similar to those of *Siren*, but very small.

There is a small omo-arcualis present.

AMPHIUMIDAE

The *M. levator mandibulae* is of two divisions on the surface, the anterior part is quite large. The posterior portion is of two parts, the more lateral of which has a strong tendon. The more medial covers the lateral part. There is a profundus portion, said to be of two parts by Eaton, '36, but not clear to me. A pterygoid portion may be found under the superficial muscle.

The mandibularis externus has two origins and two parts. The depressor mandibulae of each side have two divisions, but none from the ceratohyal, that is no ceratomandibularis. The geniohyoideus is very broad with no geniohyoideus lateralis and no anterior intermandibularis.

The ceratohyoideus internus is quite large. The subarcuales obliqui are well developed, but are not oblique in position. They take origin from the first branchial arch, not from fascia on central muscles.

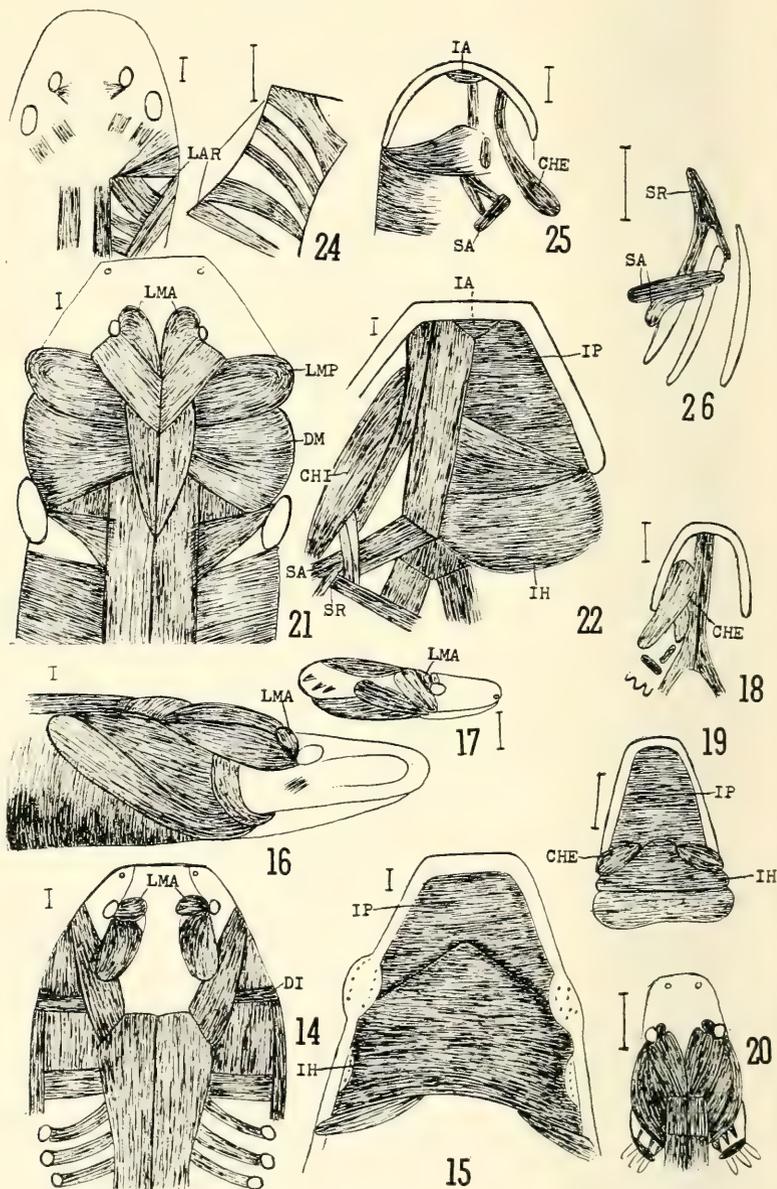


Plate 39

CRYPTOBRANCHIDAE

In a larva of 35 mm, the *M. levator mandibulae* externally forms one side of a wide V. It has a posterior superficial portion and a small fan-shaped part just below each eye.

In the adult, this muscle externally seems to be of three parts on each side. The profundus portion is well developed, but the pterygoid part seems to be lacking.

The depressor mandibulae although of two parts is not connected with the ceratobranchial.

The intermandibularis anterior is well formed in both the larvae and the adult.

There is quite a large geniohyoideus lateralis on each side in the adult.

The ceratohyoideus internus is well developed.

The subarcuales obliqui and recti muscles are about the same in larva and adult, but differ in proportion and somewhat in position.

Megalobatrachus, it is reported, loses the 3rd and 4th arch in the adult and two muscles are inserted on the second arch. It loses all traces of the subarcualis rectus Iv in the adult. *Cryptobranchus* loses the first levator in the adult. *Megalobatrachus*, having lost the last two gill arches at transformation also loses the last levators. The first three join the transversalis ventralis to make the dorso-pharyngeus, according to Drüner '04.

The levators and depressores branchiarum of the larvae are lost in the adult when the gills are lost.

In *Cryptobranchus*, the eye muscles are not marked, the retractor bulbi and levator bulbae seem to be mostly connective tissue. In a larva of 36 mm, the six main muscles are well formed, the retractor bulbi is present as a few fibers. In addition a small slip from the levator mandibulae runs along the inner side of the eyeball, closely associated with the eye region.

A Bibliography is given in other publications of this series.

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25. Throat muscles of a 37 mm *Cryptobranchus* larva, some of the deeper muscles shown on one side. 26. Subarcuales recti muscles and oblique muscles of a 37 mm *Cryptobranchus* larva, enlarged to show relation of muscle to gill clefts.

LIFE CYCLE STUDIES OF THE BRACHYURA
OF WESTERN NORTH AMERICA, III
THE LIFE CYCLE OF
PARAXANTHIAS TAYLORI (STIMPSON)

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INTRODUCTION

This paper is the third in a series of larval studies of western North American Brachyura, and extends our knowledge to another xanthid crab, *Paraxanthias taylori* (Stimpson). The larvae were reared in the laboratory at the Allan Hancock Foundation, University of Southern California, Los Angeles, California. The writer is grateful to Dr. Norman T. Mattox and Dr. John S. Garth for their guidance in this work.

PARAXANTHIAS TAYLORI (STIMPSON)

Ovigerous specimens were collected for this study at Lunada Bay, Palos Verdes, California, on June 26, 1955, and June 29, 1955. Ovigerous females were abundant in the lower intertidal zone from April through September. The breeding season of this genus is the second longest of the California Xanthidae, but is notably shorter than the breeding of *Lophopanopeus*. Females mature at a size ranging from 11.5 mm. to 13.5 mm. carapace width. Females of this species produce an average of 21,000 eggs at a time and may produce one or two sets of eggs per year. Newly deposited eggs are a dark garnet-brown, changing to an orange-brown prior to hatching. Larvae are orange-brown and hyaline. The larval period lasts from five to six weeks. The culture methods outlined in Part I (Knudsen, 1958) of this series were employed for this species.

PREZOEA (Plate 40). Figure One shows the prezoea just after hatching, before the appendages have been extended. Figure Two illustrates the true *Paraxanthias* prezoea prior to metamorphosis into the first zoeal stage.

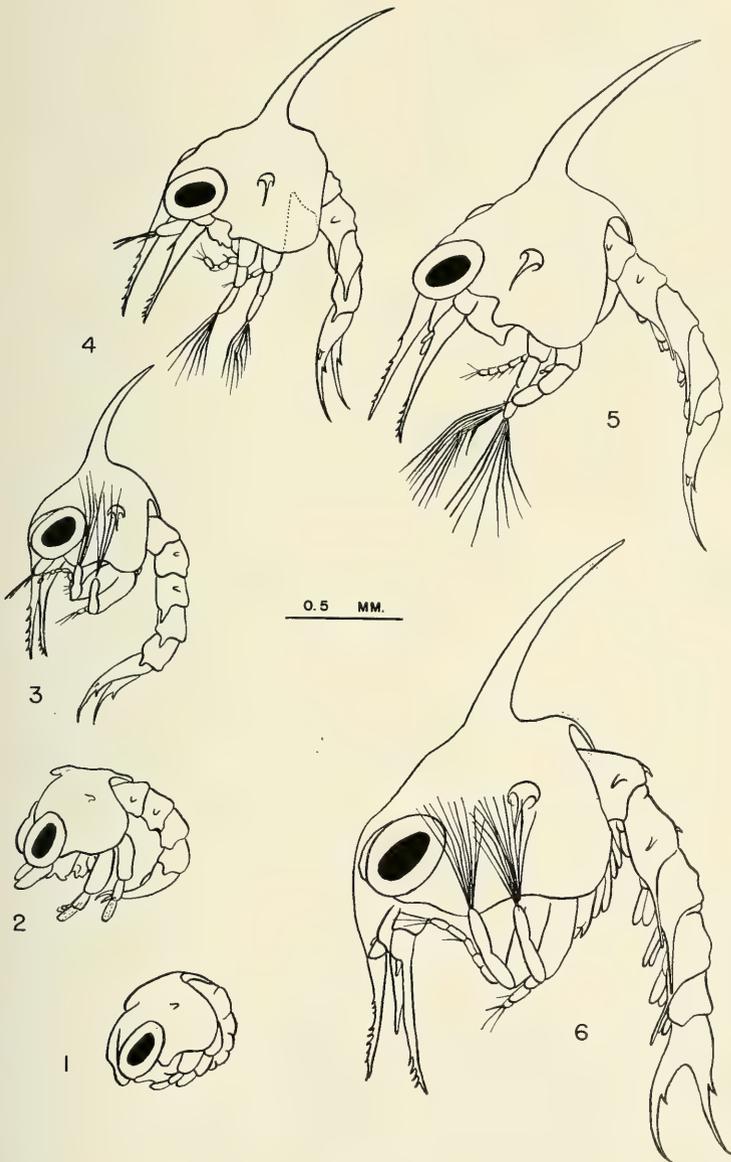


PLATE 40

Paraxanthias taylori (Stimpson): fig. 1, prezoa after hatching; fig. 2, prezoa partly expanded; fig. 3, first zoea; fig. 4, second zoea; fig. 5, third zoea; fig. 6, fourth zoea.

DESCRIPTION: Body length 1.46 mm. Carapace, 0.51 mm. long by 0.36 mm. high, with all spines flattened.

Antennules and antennae telescoped, finger-like. Mandibles and maxillae rudimentary, lacking definite form.

First and second maxillipeds with natatory "hairs" enclosed in the exopodites.

Abdomen five-segmented and with telson; short, spinelike projections on segments two and three; and posterolateral spines on segments three, four and five. Telson telescoped, not extended.

FIRST ZOEAE (Plates 40 and 41). Measurements: Body 1.82 mm. from front of head to tip of telson. Dorsal spine 0.61 mm.; rostral spine 0.55 mm.; total distance from tip of dorsal spine to end of rostral spine 1.54 mm. Antenna equal in length to rostral spine.

DESCRIPTION: Carapace with all spines present, dorsal spine smooth, lateral spines (Plate 2, figure 6) armed with three spinelets on dorsal margin, (the first and third spinelet may be less conspicuous) swollen ventrally about one-third of distance from base. Rostral spine (Plate 41, figure 3) armed anteriorly on distal half.

Antennule (Plate 41, figure 5) typical of family, conical, with two long and two short aesthetes at tip. Antennal protopodite (Plate 41, figure 4) swollen at base and tapering to a point; with a short exopodite, and armed on the distal third. Mandibles and maxillae not dissected or diagnosed.

First maxilliped; protopodite with median "hairs"; exopodite with four natatory "hairs" at tip; endopodite with three, two, zero, one, and four "hairs" on the five segments. Second maxilliped normal; exopodite with four natatory "hairs"; endopodite with one, one, and three "hairs" on its three segments.

Abdomen five-segmented, with midlateral, spinelike projections on segments two and three, and posterolateral spines on segments three, four, and five.

Telson (Plate 41, figure 2) forked; with one major and one minor lateral spine, one dorsal spine, and three median, barbed spines.

SECOND ZOEAE (Plate 40). Body 1.84 mm. long from front of head to tip of telson. Dorsal spine 0.80 mm.; rostral spine 0.60 mm.; and 1.70 mm. from tip of dorsal spine to the end of rostral spine. Antenna as long as rostral spine.

DESCRIPTION: Carapace with all spines present, with a mid-dorsal protuberance before dorsal spine. Dorsal spine recurved, appearing smooth, but with microscopic lumps. Lateral spine superficially smooth, and three spinelets now inconspicuous. Rostral spine shorter than dorsal spine, armed anteriorly on distal half.

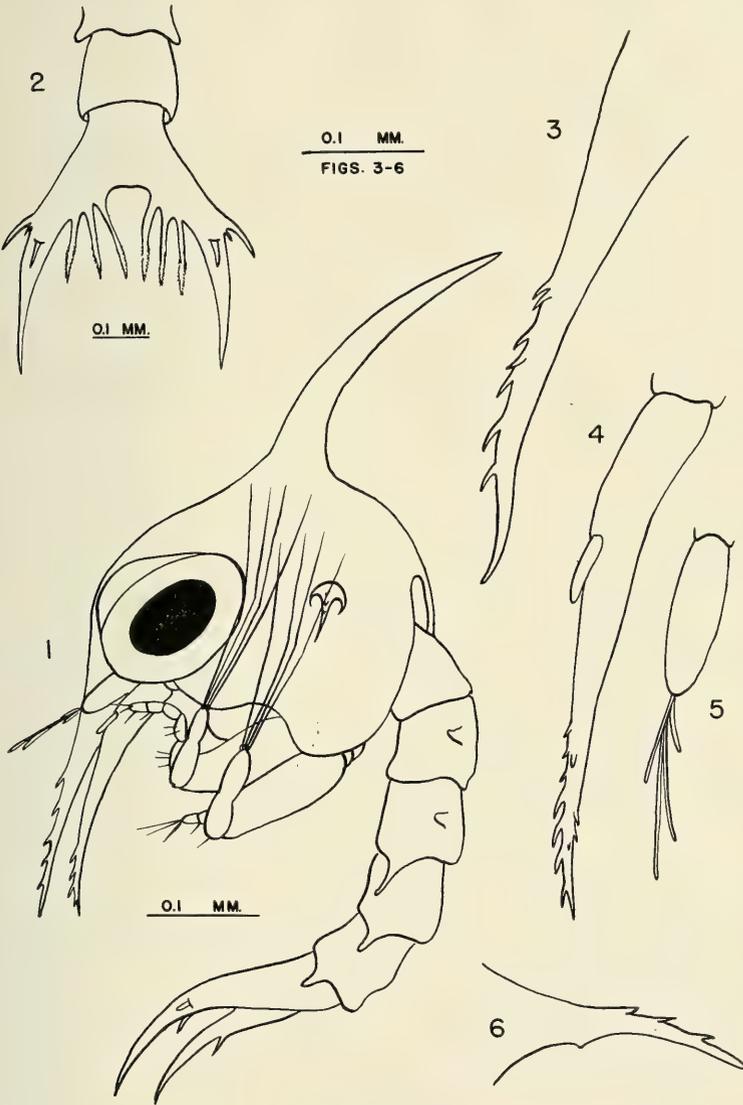


PLATE 41

Paraxanthias taylori (Stimpson) first zoea: fig. 1, first zoea lateral view; fig. 2, telson; fig. 3, rostral spine; fig. 4, antenna; fig. 5, antennule; fig. 6, lateral spine.

Antennule conical, with long aesthetes at tip. Antenna with a short exopodite, armed with long spinelets on distal third. Mandible dentate posteriorly.

First maxilliped with six natatory "hairs"; second maxilliped with seven.

Abdomen five-segmented, armed as in first zoea; all spines proportionately longer. Telson armature unchanged; secondary lateral spine less conspicuous than in first zoeal stage.

THIRD ZOEA (Plate 40). Measurements: Body 2.35 mm. from front of head to tip of telson. Dorsal spine 1.01 mm.; rostral spine 0.75 mm.; and 2.34 mm. from tip of dorsal spine to end of rostral spine. Antennae equal to, or slightly longer than, rostral spine.

DESCRIPTION: Carapace with all spines present. Dorsal spine with minute pointed protuberances on distal half. Lateral spines apparently smooth, decurved. Rostral spine one third shorter than dorsal spine, armed on distal half.

Antennule unchanged, conical, with long aesthetes at tip. Antennal protopodite swollen distally to base of exopodite, there narrowing sharply, and then tapering gradually to the tip, armed on distal fourth; exopodite, rounded at tip. Mandibles and maxillae not diagnosed.

First maxilliped normal, with eight natatory "hairs". Second maxilliped with nine natatory "hairs." Other thoracic appendages, if present, inconspicuous.

Abdomen six-segmented, with a new terminal segment before telson. Rudimentary pleopods present. Armature unchanged, proportionately longer. Minor lateral spine on telson fork reduced to an inconspicuous protuberance; other armature unchanged.

FOURTH ZOEA (Plate 40). Measurements: Body 3.00 mm. long; dorsal spine 1.28 mm.; rostral spine 0.77 mm.; and distance from tip of dorsal spine to end of rostral spine 2.73 mm. Antennal endopodite 0.40 mm.

DESCRIPTION: Carapace with all spines present. Dorsal spine with minute lumps on distal two-thirds. Lateral spines smooth. Rostral spine two-fifths as long as dorsal spine, armed on distal third. Antennule conical, with swollen, two-segmented protopodite, and a minute endopodite. Antennal protopodite as long as rostral spine, with a short exopodite and a long endopodite, and with five or six spinelets on distal third.

First maxilliped normal, with two, one, two, two and four "hairs" on five-segmented endopodite and nine natatory "hairs" on exopodite. Second maxilliped with ten natatory "hairs."

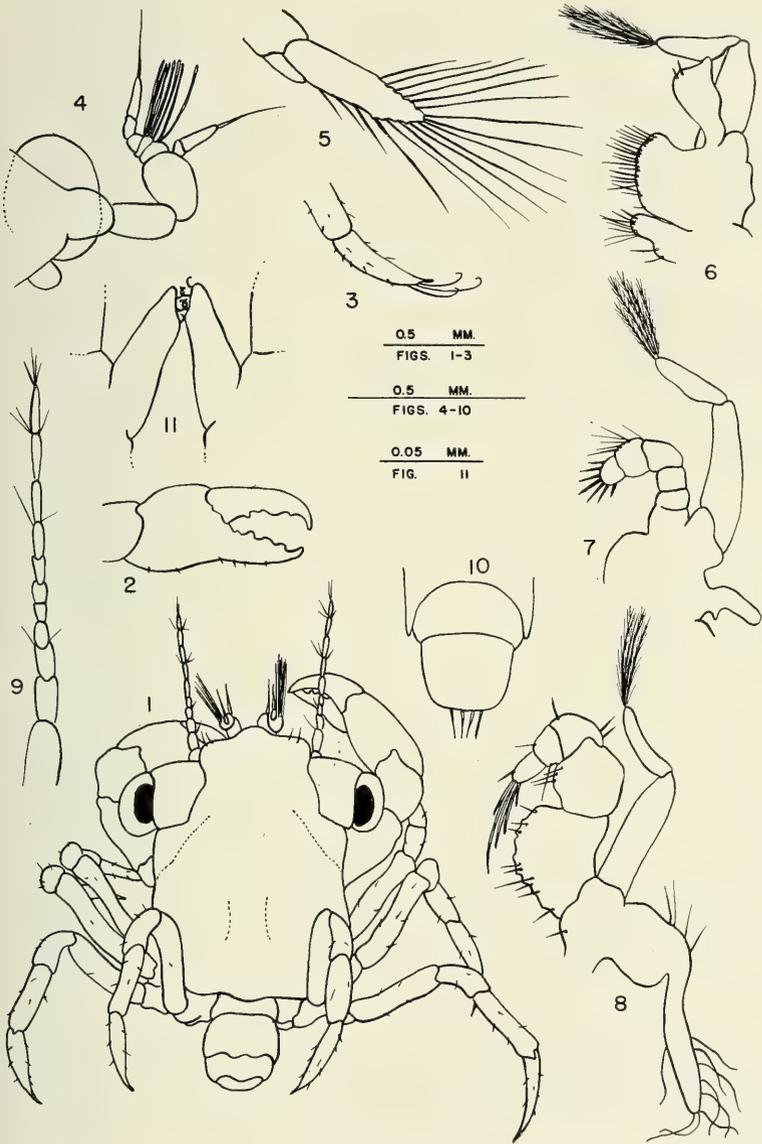


PLATE 42

Paraxanthias taylori (Stimpson) megalops: fig. 1, megalops, dorsal view; fig. 2, chela; fig. 3, dactylus of pereopod five; fig. 4, antennule; fig. 5, pleopod four; fig. 6, first maxilliped; fig. 7, second maxilliped; fig. 8, third maxilliped; fig. 9, antenna; fig. 10, telson; fig. 11, endopodites of pleopods, second pair.

Chelipeds extended, with well developed chelae. Pereiopods extended as fingerlike processes.

Six-segmented abdomen with spinelike projection on segment two and three, long (0.37 mm.) spines on posterolateral margins of segments three, four, and five, pereiopods extended on the posteroventral margins of segments two, three, four, and five, and rudimentary uropods posteroventrally on segment six. Telson armed as in third zoeal stage.

MEGALOPS (Plate 42). Measurements: Body 2.30 mm. from rostrum to tip of telson. Carapace 1.40 mm. long and 1.00 mm. wide

DESCRIPTION: Carapace surface smooth, with "hairs" sparsely dispersed on surface. Front broad, frontolateral corner well rounded, not rectangular, without teeth. Rostrum bent sharply downward, bluntly rounded.

Antennule (Plate 42, figure 4) with two flagella on the third segment; ventral flagellum two-segmented with a terminal bristle; dorsal flagellum five-segmented, segments one, two and three with long aesthetes, five with a terminal bristle. Antenna (Plate 3, figure 9) of eleven segments with conspicuous setae on segments, three, eight and ten, with a terminal tuft.

First maxilliped (Plate 42, figure 6) with five plumose "hairs" on a two-segmented exopodite, with two setae distally located on the endopodite, and with nineteen and ten setae on endites two and one. Second maxilliped (Plate 42, figure 7) with five terminal "hairs" on exopodite, and one and five setae on carapace and propodus of endopodite, with seven spines on dactylus. Third maxilliped (Plate 42, figure 8) with four plumose "hairs" on exopodite, and one, ten, three, three, two, and one setae from basis to dactylus, with five long terminal spines on dactylus. Cheliped with ischial spine very short or absent. Three specialized "hairs" on dactylus (Plate 42, figure 3), of last pereiopod. All pereiopods "hairy."

Abdomen of six segments and a telson. Endopodite of all pleopods (Plate 42, figure 11) with three median hooks used to hold pleopods together. First pleopod with nineteen plumose setae on exopodite. Telson with four terminal setae. (Plate 42, figure 10).

REMARKS. The first zoeae of *Paraxanthias taylora* resemble those of *Cycloxanthops novemdentatus* in color and spination. However, they differ from *Cycloxanthops novemdentatus* in that they have only three small spinelets on the dorsal edge of the lateral spines, and that the third, median, telson spine is not

broadened distally. The first zoeae of *Paraxanthias taylori* are quickly separated from those of the genus *Lophopanopeus* (Hart, 1935; Knudsen, 1958) in that their lateral and rostral spines are armed.

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NONMARINE MOLLUSCAN REMAINS
FROM RECENT SEDIMENTS IN
MATTY CANYON, PIMA COUNTY, ARIZONA

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ABSTRACT. Three hundred and fifty molluscan shells from 14 sediment samples from recent deposits in Matty Canyon, south-eastern Pima County, Arizona, were studied as to abundance of shells, proportion of each form or general taxonomic type, and the implied environmental conditions under which they had lived. Mollusks from 13 of the 14 samples gave indications of some shallow water (pond, marsh, and/or slow moving stream) habitat. Landsnail material in 12 of the 14 samples gave indication of probable grassland and/or moderate vegetation cover. In the molluscan material there was no indication of forms common to heavy vegetation cover or rushing rivers. In general, the mollusks reflected conditions akin to modern ones, prior to the present arroyo cutting situation. The period covered by the sediment samples represented ca. 3250 years before the present.

INTRODUCTION

In November 1957, 14 sediment samples (including nonmarine gastropod and pelecypod remains) were submitted by Frank W. Eddy then of the University of Arizona Department of Anthropology. They had been collected from Recent deposits in Matty Canyon, Pima County, Arizona (see Plate 43), the previous September by Mr. Eddy and M. E. Cooley; Mr. Eddy had made his studies in the Matty Canyon area under the auspices of the Comin's Fellowship Fund. A report on environmental conditions under which the mollusk shells had existed as parts of living animals, was requested. Thanks are given Mr. Eddy for the opportunity to study this type of molluscan material in connection with his own study of past land use in Matty Canyon by man. Through the courtesy of Paul S. Martin, a trip was made in February 1958 to Matty Canyon so current conditions there could be observed. University of Arizona department heads Emil W. Haury (Anthropology) and Albert R. Mead (Zoology) offered encouragement and provided the opportunity to study the materials.

*Mr. Drake is currently carrying out a field and museum study of the nonmarine mollusks of Southwestern British Columbia under the auspices of the National Museum of Canada; his headquarters is at the Department of Zoology of The University of British Columbia.

PROCEDURE

Each sample was weighed; it was roughly measured for volume in large glass cylinders graduated in cubic centimeters. These measurements are given in Table I.

TABLE I
MEASUREMENTS AND SERIAL NUMBERS FOR 14 SAMPLES

| Eddy-Cooley Sample Nos. | Sample Study Nos. | Geologic Units | UAIM Nos. | | Wt. In Grams | Volume as in Cubic Centimeters | No. of Shells |
|-------------------------|-------------------|------------------------|-----------|----|--------------|--------------------------------|---------------|
| 1 | 2771 | 1 | 360 | to | 161 | 110 | 15 |
| | | | 367 | | | | |
| 2 | 2772 | 2-soil zone | 368 | to | 1349 | 1000 | 30 |
| | | | 381 | | | | |
| 5 | 2775 | 2-soil zone | 382 | to | 190 | 30 | 25 |
| | | | 387 | | | | |
| 3 | 2773 | 3 | 388 | to | 125 | 50 | 36 |
| | | | 392 | | | | |
| 7 | 2777 | 3 | 393 | | 60 | 15 | 12 |
| 4 | 2774 | 3, "M" zone | 394 | to | 712 | 760 | 142 |
| | | | 400 | | | | |
| 14 | 2784 | 3B, MC-5 "K" soil zone | 401 | to | 565 | 600 | 12 |
| | | | 403 | | | | |
| 13 | 2783 | 3C MC-5 | 404 | | 152 | 50 | 2 |
| 11 | 2781 | 3D, MC-5 | 405 | to | 450 | 490 | 9 |
| | | | 408 | | | | |
| 12 | 2782 | 3E, MC-5 | 409 | | 55 | 15 | 1 |
| 9 | 2779 | 4-"X" zone | 410 | to | 137 | 100 | 16 |
| | | | 413 | | | | |
| 10 | 2780 | 4-lower cienega zone | 414, | | 162 | 75 | 28 |
| | | | 415 | | | | |
| 8 | 2778 | 5 | 416 | to | 45 | 25 | 14 |
| | | | 419 | | | | |
| 6 | 2776 | 7 | 420 | to | 89 | 20 | 8 |
| | | | 422 | | | | |
| (Totals:) | | | | | 4252 | 3340 | 350 |

In general, the shells in the sediment samples were fragile; the only practical way to recover them for study was to pick them out of the matrix. Each sample was picked over on two separate occasions, and, although there perhaps remain undetected shells and fragments, it is felt that the forms and gross numbers of those forms given here are representative of the samples.

Plastic trays, as well as the glass cylinders used for volume measurements, were washed well before and after the individual samples were processed in them. In the event that the samples would be used later for pH determination or study of other contained organic items such as diatoms, fungus hyphae, ostracods, etc., the trays and glass cylinders were rinsed in distilled water before and after washing.

Each sample was given a study number (2771 to 2784). Forms of mollusks found within a sample were deposited in the University of Arizona Invertebrate Museum (UAIM) and given serial numbers 360 to 422; however, there were more numbers than forms in some samples as unique, photographed, or illustrated individual shells (as the specimen of *Helisoma* sp. of Plate 44) were assigned separate numbers. The sediment samples were deposited in the University of Arizona Geochronology Laboratories.

The forms in a sample were identified if possible usually to genus. In the case of the numerous specimens of the terrestrial gastropod family Succineidae, determination to genus was not attempted as from what little is known of genera diagnostics in this family in the Southwest, genera currently cannot be distinguished from shells only. Landsnails of the family Pupillidae were often too fragmentary or fragile when whole to permit sufficiently detailed examination to assign them to genera. Information concerning the molluscan remains in the 14 samples is presented in Table II.

TABLE II
MOLLUSCAN REMAINS IN 14 SAMPLES

Abbreviations: L = land form(s)
FW = freshwater form(s)

| GEOLOGIC UNIT | UAIM NO. | NO. OF SHELLS | IDENTIFICATION AND /OR REMARKS |
|---------------|----------|---------------|--|
| 1 | 360 | 1 | L, <i>Hawaiiia</i> sp.; Pl. 44. |
| 1 | 361 | 4 | L, <i>Hawaiiia</i> sp. |
| 1 | 362 | 3 | FW, <i>Pisidium</i> sp.; 3 valves. |
| 1 | 363 | 3 | L, succineid snail shells. |
| 1 | 364 | 1 | L or FW, basal portion of snail shell. |
| 1 | 365 | 1 | L, basal portion of pupillid snail shell. |
| 1 | 366 | 1 | FW, <i>Helisoma</i> sp. |
| 1 | 367 | 1 | FW, <i>Pisidium</i> sp.; 1 valve; Pl. 44. |
| 2 | 368 | 1 | FW, <i>Physa</i> sp.; Pl. 44. |
| 2 | 369 | 3 | FW, <i>Physa</i> sp. |
| 2 | 370 | 1 | FW, amnicolid snail shell; Pl. 44. |
| 2 | 371 | 1 | FW, amnicolid snail shell. |
| 2 | 372 | 1 | L, small discoid snail shell. |
| 2 | 373 | 1 | FW, <i>Pisidium</i> sp.; 1 articulated clam. |
| 2 | 374 | 5 | FW, <i>Pisidium</i> sp.; 5 valves. |

| | | | |
|---|-----|----|---|
| 2 | 375 | 9 | L, succineid snail shells. |
| 2 | 376 | 2 | FW, <i>Helisoma</i> sp. |
| 2 | 377 | 1 | FW, <i>Lymnaea</i> sp.; Pl. 44. |
| 2 | 378 | 2 | FW, <i>Lymnaea</i> sp. |
| 2 | 379 | 1 | L, <i>Vertigo</i> sp. |
| 2 | 380 | 1 | L, <i>Gastrocopta</i> sp.; Pl. 44. |
| 2 | 381 | 1 | FW, <i>Helisoma</i> sp.; Pl. 44. |
| 2 | 382 | 7 | FW, <i>Helisoma</i> sp. |
| 2 | 383 | 8 | L, succineid snail shells. |
| 2 | 384 | 3 | FW, <i>Pisidium</i> sp.; 3 valves. |
| 2 | 385 | 3 | FW, <i>Physa</i> sp. |
| 2 | 386 | 1 | L or FW, basal portion of snail shell. |
| 2 | 387 | 3 | L, <i>Hawaia</i> sp. |
| 3 | 388 | 2 | FW, <i>Helisoma</i> sp. |
| 3 | 389 | 31 | L, succineid snail shells. |
| 3 | 390 | 1 | L, succineid snail shells. |
| 3 | 391 | 1 | L, <i>Gastrocopta</i> sp. |
| 3 | 392 | 1 | L, succineid snail shell; Pl. 44. |
| 3 | 393 | 12 | L, succineid snail shells. |
| 3 | 394 | 23 | L, succineid snail shells. |
| 3 | 395 | 40 | L, <i>Hawaia</i> sp. |
| 3 | 396 | 75 | L, pupillid snail shells: <i>Pupilla</i> , <i>Gastrocopta</i> , and <i>Vertigo</i> ; mostly fragments. |
| 3 | 397 | 1 | FW, lymnaeid snail shell. |
| 3 | 398 | 1 | L, <i>Gastrocopta</i> sp. |
| 3 | 399 | 1 | L, <i>Vertigo</i> sp. |
| 3 | 400 | 1 | L, <i>Vertigo</i> sp.; Pl. 44. |
| 3 | 401 | 7 | L, succineid snail shells. |
| 3 | 402 | 4 | L, <i>Hawaia</i> sp. |
| 3 | 403 | 1 | L, pupillid snail shell. |
| 3 | 404 | 2 | L, <i>Hawaia</i> sp. |
| 3 | 405 | 4 | L, succineid snail shells. |
| 3 | 406 | 1 | FW, <i>Pisidium</i> sp.; articulated clam. |
| 3 | 407 | 3 | FW, <i>Pisidium</i> sp.; 3 valves. |
| 3 | 408 | 1 | L, <i>Gastrocopta</i> sp. |
| 3 | 409 | 1 | L, succineid snail shell. |
| 4 | 410 | 7 | L, succineid snail shells. |
| 4 | 411 | 7 | L, <i>Gastrocopta</i> sp. |
| 4 | 412 | 1 | L, <i>Gastrocopta</i> , sp. |
| 4 | 413 | 1 | L, <i>Gastrocopta</i> , sp. |
| 4 | 414 | 25 | L, succineid snail shells. |
| 4 | 415 | 3 | L, pupillids. |
| 5 | 416 | 11 | L, succineid snail shells. |
| 5 | 417 | 1 | FW, <i>Pisidium</i> sp.; 1 valve. |
| 5 | 418 | 1 | L, <i>Cionella</i> sp.; Pl. 44. |
| 5 | 419 | 1 | L, basal portion of snail shell. |
| 7 | 420 | 6 | L, succineid snail shells. |
| 7 | 421 | 1 | L, <i>Gastrocopta</i> sp. |
| 7 | 422 | 1 | L, <i>Pupoides</i> sp. |

PALEOENVIRONMENTAL RECONSTRUCTIONS

In the current Southwest, none of the 5 types of freshwater forms (*Pisidium*, *Physa*, *Helisoma*, lymnaeids, and annicolids) would normally be found living in deep and swift rivers. They

would, however, sometimes be found under swampy conditions or in shallow ponds at the edges of lakes, meandering creeks, and rivers.

Freshwater forms were contained in 5 samples but 13 of the 14 samples contained succineid landsnails. The succineids are *almost* amphibious and are usually considered so because they have generally been found alive in the damp, wet zone on the substratum at the edge of bodies of water.

The one sample (Eddy-Cooley sample 13—study number 2783, from geologic unit 3C, -MC-5), containing *no* aquatic forms or succineids, contains only 2 landshells for its weight of 152 grams and a volume of roughly 50 cc.

Regardless of small numbers of individuals and small sample size, the mere presence of the freshwater forms and succineids indicated that some ponds or swampy conditions existed during (or before, if by redeposition) the time that 13 of the 14 sediment samples were deposited.

Other than the succineids, the landsnail remains represent members of three families of minute forms: The discoid Zonitidae (*Hawaiiia*), tall Cionellidae (*Cionella*), and the usually toothed and sculptured Pupillidae (*Vertigo*, *Gastrocopta*, *Pupilla*, and *Pupoides*). Species of these genera now occur in southeastern Arizona in a thoroughly unstudied variety of elevations and habitats. Their numerical strength in the sediment samples (of several different weights and volumes) does not necessarily indicate heavy vegetation; rather, grasslands or moderate arboreal vegetation would harbour such small numbers.

CONCLUSIONS FROM INTERDISCIPLINARY INFORMATION AND NEGATIVE EVIDENCE

Eddy (1958) has given a study of Matty Canyon and its history from ca. 1300 B.C. to 1958 A.D. While archaeology was his primary pursuit, he drew upon studies of mammalian remains (by E. Lendell Cockrum, William J. Schaldach Jr., and Jim J. Hester), charcoal (by Terah L. Smiley), and the nonmarine mollusks (Drake 1958) that were collected. Cooley (1958) made a study of the Recent alluvial geology. Identification of biological remains in archaeology is usually thought of for the purpose of supplying information on foodstuffs, building materials, and sources for material for some types of artifacts. Sometimes non-artifacts discovered in excavation and geological stratigraphic situations in connection with survey activities, as were carried out in the Matty Canyon-Cienega Creek region, can supply information on past ecologies and even in somewhat of a continuum.

Table III has been assembled from the information in the Eddy (1958: Table 9) and Cooley (1958: Table 10) reports. My study on the nonmarine mollusks originally was made with-

TABLE III
CORRELATION OF ENVIRONMENTAL AND
CULTURAL INFORMATION

| TIME | GEOLOGIC SEQUENCE | CULTURAL SEQUENCE | MAMMAL HABITAT | AQUATIC MOLLUSK HABITAT | LOCAL "CLIMATIC" INDICATION |
|-----------|---|-------------------|--------------------|-------------------------|-----------------------------|
| 1958 | Arroyo cutting | | | | dry |
| 1900 | Unit 1-Flood plain, quiet to torrential drainage, wind action | Ranching-mining | | ponds | wet, turning dry |
| 1870 | Stabilized conditions | | | | |
| 1851 | Ponds, surface drainage | | grass-shrub | | wet |
| (Gap) | | | | | |
| ? | Unit 2-soil formation | | | ponds | wet |
| ? | Channel deposits, ponding to torrential drainage | | | | |
| ? | Arroyo cutting | | | | dry |
| | | Tanque Verde | | | |
| 1200 | Unit 3-Flood plain, quiet to wet torrential drainage | Rincon | | ponds | wet |
| 500 | | Canada del Oro | | | |
| 1 A.D. | | Vahki-Estrella | grass-shrub | | |
| | "M" zone-Swamp and soil formation | | | ponds | wet |
| | Unit 4-Flood plain containing lakes and swamps | San Pedro Stage | grass, grass-shrub | ponds | wet |
| 500 | | | | | |
| 600 | Unit 5-Quiet drainage | | grass, grass-shrub | ponds | wet |
| 1300 B.C. | | San Pedro Stage | | | |

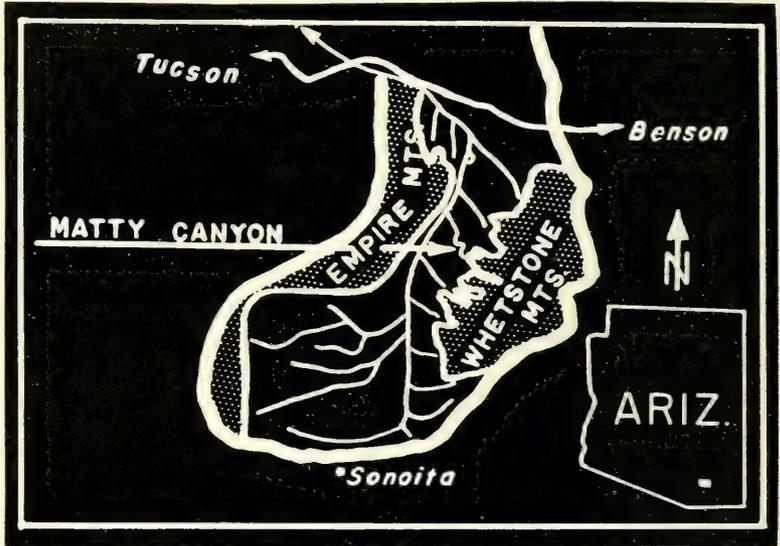


PLATE 43

Matty Canyon and environs: 60 miles southeast of Tucson; modern flood plain at mouth of Matty Wash is 4200 feet elevation; arroyo channel is to 25 feet deep and about 2 miles long; the narrow tongue of the Matty drainage off Cienega Creek is rimmed by 4200 and 4300 foot contours; vegetation is of mesquite-grasslands type in the Lower Sonoran life zone. *Cienega Creek*: waters of a permanent stream flowing northerly to join Fantano Creek, Rillito Creek, and the Santa Cruz River; drainage perimeter shown by wide band. *Surrounding mountain ranges*: Empires to ca. 5000 feet, Whetstones to ca. 7000 feet elevations; belt of oak at about 5000 feet. *Climate*: dry subtropical, all months with average temperatures above freezing; mean maximum ca. 90 F. in June, in low 70's for summer; mean minimum ca. 23 F. in December, low 40's for winter; occasional light snowfalls melting rapidly; annual precipitation about 18 inches with summer and winter rainy seasons; rain in July and August about 9 inches, from December to February about 4 inches; summer rains intense with rapid runoff; more general rain in winter, much moisture held by soil. *Archaeology*: material culture records of Indians of Cochise Culture (San Pedro Stage) and Hohokam Culture (to Tanque Verde Phase); man lived in Matty Canyon on a rising surface due to continuing alluviation. *Reference*: F. W. Eddy (1958).

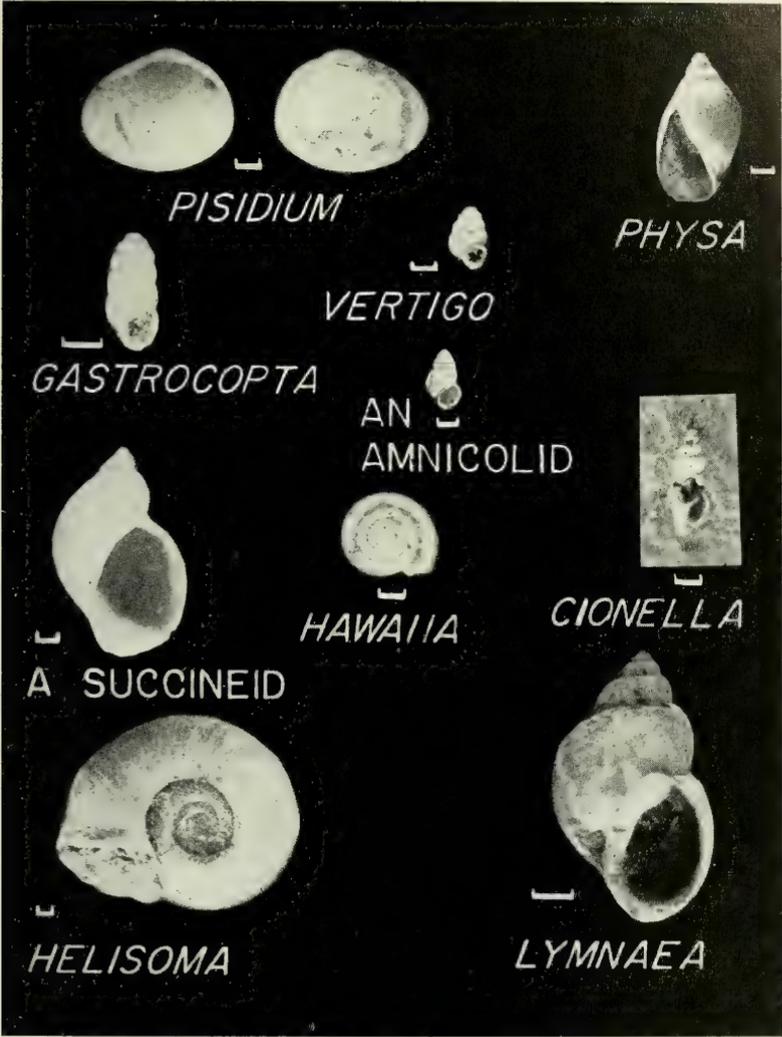


PLATE 44

Frequently occurring nonmarine molluscan shells from Recent deposits in Matty Canyon, Arizona. *Pisidium*, *Physa*, *Helisoma*, *Lymnaea*, and the amnicolid are aquatic. *Vertigo*, *Gastrocopta*, *Hawaiiia*, *Cionella*, and the succineid are terrestrial. Shells from collections of the University of Arizona Invertebrate Museum; provinces are given in Table II.

SCALE LINES - 1 mm.

out recourse to the reports on collected mammalian remains and the archaeologic-geologic study of the region. The post-June 1958 availability of Eddy's thesis has made more clear the value of this type of interdisciplinary study and for this reason the molluscan report is now presented. I did have some doubt that 350 small and minute shells would be reasonable samples and representative of the shells entombed in the sedimentary deposits supplying them. During the period of the last 3250+ years, millions of small terrestrial and aquatic mollusks could conceivably have lived and died in the changing drainage net of the small area now known as Matty Canyon. But, each study bears out the others if we keep in mind what is meteorologically meant by both "climate" and "weather" and that the terms are not interchangeable. In addition, the lack of even fragments of large landsnails present in large numbers now in forested and thus humid areas in upper altitudes of the mountain ranges of southeastern Arizona, is a strong negative indication that the Matty area has been essentially semiarid since ca. 1300 B.C.

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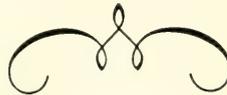
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RARE OR COMMON!

With Notes on the Life Histories of Two
Southwestern Moths.

By JOHN ADAMS COMSTOCK

Many entomologists have had the occasional experience of collecting a species of butterfly, moth or beetle, in great abundance at a given time and place, which, under ordinary circumstances was considered a great rarity. This applies particularly to the far southwest, where alternating periods of long drought, interspersed with occasional abundant rains are the rule. In order to survive, many insects have adapted to these drastic diversities of seasons, and can remain viable in aestivation for long periods of time, awaiting the particular combination of temperature and humidity that insures emergence.

"Rarity", therefore, is largely a question of time and place.

A good example is that of the large rain beetles of the genus *Pleocomma*. These scarabs are restricted to certain mountainous districts of the west coast, each species probably being limited in its range by its particular food plant. The males emerge only during the first two or three rains of the season, and fly for only a few minutes before settling on the ground in search of the flightless females. If no rain falls there will be no flight. If the rainfall occurs at night, the flight corresponds with it.

Since the range of each species usually covers uninhabited territory, it is impossible to schedule the time and place of flight for any given species. Hence these beetles are "rare" in collections, though each must be common at a particular time and place.

Another example of this occasional abundance of a "rare" species was recorded in the case of *Speyeria atossa* Edwards, which I found in quantity near the Sandberg resort on the old Ridge Route, June 10 to 13, 1922. (See "Butterflies of California", page 89, 1927).

My field notes contain records of two cases of "rare" moths being taken in abundance at the right time and place, which led to fragmentary notes concerning their life histories, and which are therefore worthy of publication.

The first of these is:

Cargida pyrrha (Druce)

The types of this distinctively marked moth were taken in the State of Jalisco, Mexico. It is illustrated in color on Plate XI, figure 15 of Holland's "Moth Book".

Examples have been taken sparingly in southern Arizona for many years, but it has usually been considered a rarity.

During July of 1947, while collecting with a group of associates in Madera Canyon, Santa Rita Mountains, Arizona, this moth came to our lights on July 16, to 18 in such numbers that we were unable to make a selection of other moths on our sheets. They were particularly abundant on the night of July 18, when they became a veritable nuisance. The collecting sheet was solidly covered and they were spread over the ground below it. Many of the females were laying masses of eggs on the sheet. At that time the sexes seemed to be about evenly represented. We confined several females and obtained quantities of eggs, all of which were laid in bunches or masses. Later on I found similar bunches of eggs laid in a single layer around the thorny twigs of a species of *Lycium* (probably *Lycium torreyi* Gray). This made possible the following life history notes.

EGG: Spherical; .75 mm. wide by .72 mm. tall. The surface is smooth. The base is flattened at its center, and the top is less rounded than the sides. There is a minute micropylar spot in the center of the top, which is slightly darker than the surrounding surface.

When first laid, the egg is a delicate light yellow, but it soon changes to ivory, and the top portion becomes tinged with a light mauve. Before hatching, the color darkens, particularly on the mauve cap, which becomes gray.

Eggs laid July 21, hatched July 28, which makes seven days in the ovum. The egg is pictured on Plate 45, figure 1.

FIRST INSTAR LARVA: Length, 3 mm. Width of head, .6 mm. Body cylindrical, tapering slightly towards cauda.

Head; jet black, and much wider than adjacent segments.

The first thoracic segment bears a large jet-black scutellum, and the cauda is topped by a heart-shaped jet-black plate.

The body ground color is yellow. There are several longitudinal rows of raised black papillae; each papillus topped by a relatively long black hair. These papillae are uniform in size except for those on the last three caudal segments, most of which are larger.

The legs are black. The four pairs of prolegs and anal pair are yellow, with prominent black plates placed laterally. There are also two minute black points placed distally on each proleg.

SECOND INSTAR LARVA: We neglected to note measurements.

The head was still jet black, and the body ground color yellow. There was a narrow middorsal longitudinal red-brown stripe, bordered with yellow, and next to this a wider longitudinal brown Band. Lateral thereto a wide yellow area is interrupted by two narrow, more or less discontinuous longitudinal stripes, the lowermost placed in line with the spiracles.

On the tenth or eleventh segment there was the beginning of a dorsally placed nodular black hump.



1



2

PLATE 45

Cargida pyrtha

Fig. 1. Egg, enlarged approximately X 45

Fig. 2. Larva, intermediate instar, lateral aspect, enlarged approximately X 5.

Reproduced from painting by the author.

The legs were black, and the prolegs mottled black and dull yellow. The setae were black, arising from black papillae.

Some difficulty was experienced at this time in obtaining fresh food plant for the larvae, and considerable disparity in the rate of growth, with high mortality resulted.

A larva measuring 13 mm. in length, and in its third or fourth instar was noted as follows:

The ground color is now predominantly black; the head, and all appendages, black. The first segment bears a large triangular scutellum.

Middorsally there is a narrow longitudinal black stripe, bordered with yellow. Lateral thereto is a wide black band, edged with a narrow white stripe. Below this is a narrow yellow stripe, edged inferiorly by a still narrower black stripe. Below this is a narrow stigmatal yellow stripe, interrupted at each black spiracle by a cirlet of white.

The suranal area is enlarged into a dorsal black hump with paired white spots in the center, and a pair of lunate white dashes near the crest.

Legs, black; prolegs, black on proximal and distal segments, and red-brown on middle segments. The anal prolegs are black proximally and red-brown distally. The venter is predominantly dull yellow.

The head and body are sparingly covered with short black setae, each arising from a black papillus.

The illustration of the larva (Plate 45, figure 2) was made from the example described above. In the next larval instar it was noted that no appreciable change in pattern or color had occurred.

Shortly thereafter the larvae had to be abandoned. Further study in the field will be required before the pupa can be described and illustrated.

With respect to the larval habits, it was noted that, in the earlier instars, they were gregarious, but in the later phases they were solitary. When resting, the larva tends to assume a posture with head and cauda raised, somewhat suggestive of the larval attitude of *Datana perspicua*, but lacking the extreme dorsal arching of the latter.

The second example of this "rare" versus "common" complex was recounted by Lloyd Martin and a group of his associates who were collecting at Sunnyside, on the west slope of the Huachuca Mountains, Cochise County, Arizona, in July of 1958.

During the evenings of July 6 to 17, while working with both Coleman and black lights, they experienced a flight of *Bertholdia trigona*, an arctiid moth that has always been considered a rarity. On this occasion, it came to light "by the thousands".

Not only were the entomologists thrilled, but the plethora of moths and beetles attracted skunks, to the extent of eight at one time. These Arizona Striped Skunks, *Mephitis mephitis estor* Merr., continued active competition with the entomologists throughout the evening. Long experience with skunks in camp has resulted in an unwritten pact of peaceful coexistence, based on mutual respect and admiration as between fellow insect collectors. In this instance the maxim, "watch your step", was applied with satisfactory results, and no explosive incidents or accidents occurred.

Two gravid females of *B. trigona* were confined, and produced over 100 eggs. These were laid in single layered groups, there being some tendency toward arrangement in parallel lines.

The eggs were turned over to me for possible rearing and life history notes, with the following somewhat incomplete results:

***Bertholdia trigona* (Grote)**

EGG: Hemispherical; width, .7 mm., height, .5 mm.

The surface texture appears smooth and glistening, but under high magnification a faint reticulation of hexagonal cell walls, irregularly arranged, is apparent.

The color, when first laid, is green, later changing to a dull olive, with a black spot in the region of the micropyle, and a few small black dots irregularly scattered over the surface.

Shortly before hatching the color becomes much darker.

Eggs which were laid July 16 and 17 gave forth larvae July 23 and 24. The greater part of each egg shell was consumed.

LARVA, FIRST INSTAR: Two days after hatching it measured 2 mm. Head; width, .3 mm. Color, bright yellow. The ocelli are black and the mouth parts tipped with black.

Body; ground color, light greenish-yellow. There are several longitudinal rows of black papillae, topped with single dark hairs. One row occurs on each side of the middorsal line, and is more conspicuous than the other two rows that parallel it laterally. The papillae composing the latero-inferiorly placed third row are very small.

The legs and prolegs are concolorous with the body. The crochets of the latter are black. The anal prolegs are black.

The food plant of *B. trigona* was unknown. Martin suggested *plantago*, but this was unavailable in good condition at the time.

The following plants were tried: Dandelion, clover, honey-suckle, wild buckwheat, oak, hackberry, acacia, grass, garden lettuce and flowers of evening primrose. All were passed up by the larvae except for a little nibbling on lettuce and the pollen of *Oenothera hookeri* T. & G.

It was obvious that pollen was not the natural food plant, even though it was accepted. The rate of larval growth and the period of time in each instar had no significance. When a precocious example reached the second instar it was recorded even though its fellows showed no signs of impending ecdysis.

SECOND INSTAR: Length, 3.5 mm. Head width .5 mm.

The head shows no change except for the increase in size and lighter shade of yellow.

The body color is rich yellow. There is a faint longitudinal middorsal stripe.

The black papillae are conspicuous, and each bears a centrally placed long black hair and several subsidiary short black hairs. Those on the 1st and 2nd thoracic segments are longest, and arch forward over the head.

There is a suggestion of a dark area on the 10th and 11th segments.

The legs are concolorous with the body, and the prolegs and anal prolegs are of a slightly richer yellow. The crochets are black.

At the end of this instar more than half of the larvae had died, and the survivors were feeding intermittently only on the pollen of *Oenothera*.

THIRD INSTAR: Length, 6 mm. Head width, .9 mm.

The color of the head is ivory, with a dark area high on the face. The adfrontal sutures are heavily margined with black. The ocelli and mouth parts are also black.

The body is a rich yellow-orange, and the middorsal stripe is well defined. The black papillae are prominent, particularly those on the thoracic and caudal areas, and the curving hairs arising therefrom are proportionally longer.

On each side of the middorsal orange stripe there is a bright yellow area, widest in the center of each segment. Lateral thereto is a very narrow longitudinal brown line. Latero-inferior to this is a wide dark band margined inferiorly with a narrow red-brown stripe. Below this is another narrow yellow stripe, margined inferiorly with still another red-brown stripe.

On the 3rd and 11th segments there are raised transverse bright yellow saddles arching over the dorsum.

The hairs arising below the spiracular line are white; those on the dorsum are black.

The rate of development continued to be irregular through this instar. On August 13 only 15 larvae were living, some of which were still in their first instar.

When the larvae were disturbed or touched they wiggled virogressively.



PLATE 46

Larva of *Bertholdia trigona*, fourth instar, lateral aspect, enlarged $\times 5$.
Reproduced from drawing by the author.

FOURTH INSTAR: Length, 13 mm. Head width, 1.5 mm.

The head is jet black except for a diagonal white dash running lateral to and paralleling the adfrontal suture on each side of the face. There is also a narrow marginal white band on the upper edge of the labrum.

The body is colored much as in the third instar, except as follows:

Lateral to the wide middorsal bright yellow band the narrow brown band has changed to black, and a series of longitudinal white dashes margins it inferiorly. The wide dark area below this has become still darker.

The yellow stigmatal stripe has become very conspicuous.

The tufts of long black hairs are more prominent, and an occasional long white hair occurs with them. The shorter hairs are white.

The legs are black, and the prolegs translucent light yellow, with some dark shading on the lateral surfaces. The anal prolegs are noticeably darker. The crochets are black.

The ventral surface is translucent light yellow, with a tinge of green.

The illustration of the larva, Plate 46, was made at this time, as we were uncertain as to the survival of any larvae from this point on.

A fifth instar was observed, with no apparent change noticeable in the color and markings.

Finally, on September 28, a single surviving larva changed to the sixth instar. The only noticeable change from the previous phase was in the size and color of the head. This was jet black throughout, except for the white labrum. It measured 2.8 mm. in width.

The length of the larva was not taken, as it obviously was not in a healthy state, and on October 4, 1958 it died.

CONCERNING NORTH AMERICAN NECROBIA.

By CHARLES S. PAPP*

(NOTES ON NORTH AMERICAN COLEOPTERA, NO. 10)

The genus *Necrobia*, from the family *Cleridae*, is represented by three economically more or less important species in North America. Recently I visited a few beetle collections, owned by private persons and by a scientific institution. I noticed that some of the species were incorrectly identified. Confusion usually occurred between *N. violacea* and *rufipes*. After some hesitation over writing a note about such a well known genus I decided to do so, in order to aid collectors who perhaps do not have the proper literature on hand, which is usually the case with those in the exterminating industry. I also include simple india-ink drawings prepared to aid in quicker understanding and proper identification.

NECROBIA VIOLACEA L.—Originally described by Linne in 1758 as a *Dermestes* species, and known as such until 1795, when Olivier established his new genus, *Necrobia*, with *Dermestes violaceus* Linne as generic type. After Olivier some of the authors, beginning with Paykull (1798) mention this species as a member of the genus *Corynetes*, but since Cockerell (1893) it has been known as *Necrobia*. It is a cosmopolitan species, 4.5 mm long, and 2 mm wide; oval; metallic dark blue or dark green, with very dark brown or entirely black antennae and legs (illustrated Plate 47, Fig. A). It is common on skin and bones of dead animals, also on dead fish. Quite commonly observed feeding on *Dermestes* larvae. Its ecology was handled by LeConte (1848: *Ann. Lyc. Nat. Hist. N.Y.*, 4:162). The second ecological account is given by Smith (1900: *Annual Rep. N.J. State Mus.* 2nd ed. p. 266), and also in the 1910 edition of the same (p. 304), and by Chapin (1917: *Bull. Brooklyn Ent. Soc.* 12:31). Later Sacharov mentioned it as predaceous on *Dermestes* larvae (1921: *Work Volga Biol. Sta.* 6:3); also Bedwell observed it as predaceous on *Dermestids* (1931: *Ent. Mo. Mag.* p. 93). The first good description of the larva was given by Weidner (1937: *Bestimmungstabelle Vorratschadl.*, p. 66, fig. B) and also by Larsson (1938: *Danmarks Fauna* 44:255, fig. 51). Lepesme definitely mentions this species as more beneficial than harmful (1939: *Rev. franc. d'Ent.* 6:18). Its taxonomy and biology were also discussed by Papp (1943: *Beetles of Hungary*, p. 171).

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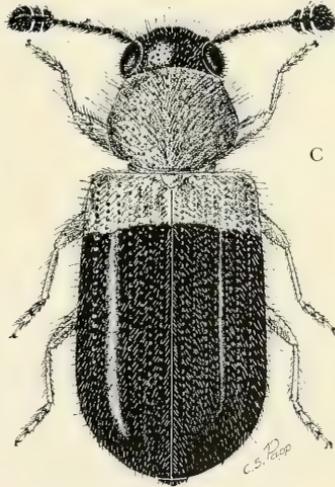
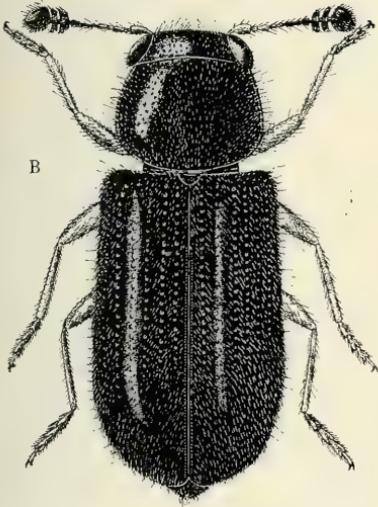
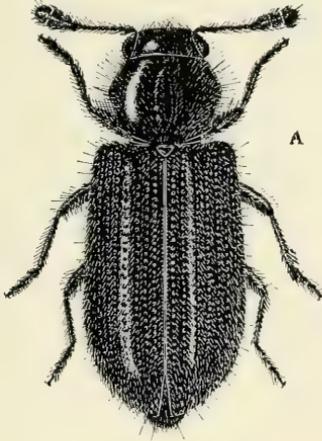


PLATE 47

The three North American species of the Cleid genus *Necrobia*. A: *Necrobia violacea* Linné; B: *N. rufipes* DeGeer; and C: *N. ruficollis* Fabricius.

NECROBIA RUFIPES DEG.—Described by DeGeer in 1775 as *Clerus rufipes*. Herbst (1792) first changed the generic name of this species to *Korynetes*, then LeConte (1849) used in America the name *Corynetes* after Spinola (1844) changed the spelling. It was known also as *Agonolia* by Mulsant and Rey (1863) and Baudi (1873). Since Wolcott (1910) the species has been listed in the genus *Necrobia*. It is a 5.4 mm long and 2.4 mm wide species, with metallic blue or green dorsal surface and with red legs, and red basal joints of the antennae (Plate 47, fig. B). It is a cosmopolitan species, saprophagus and predaceous, and known as a predator of Cheese Skipper and Dermestid larvae, but listed as a pest of grain, silk and food. Its biology was discussed first by Rosenhauer (1856: *Thiere Andalusiens*, p. 71); later Riley (1874: *Sixth Ann. Rep. Ins. Missouri*, p. 96, fig. 26) mentioned its noxiousness, observed the number of generations; and described the stages. Escher-Kundig (1907: *Mitteilungen Schweiz. Entom. Ges.*, 11:242) mentioned that the species was collected in a skull of a mummy in Egypt. Corporaal (1922: *Entom. Ber.* VI-126:93) gives a passably complete account of our knowledge of this species, including its mass occurrence and feeding habits. Loir and Legagneux (1922: *Bull. Acad. Medec., Paris*, 83:68) noted the species attacking man. De Ong and Roadhouse (1922: *Calif. Agric. Exper. Sta., Bull.* 343:401 and 418) mentions its occurrence in cheese, and gives an account of control measures. Simmons and Ellington (1925: *Journ. Agric. Res., Washington*, 30:845, figs.) described its behavior, eggs, hatching larvae, larval behavior, prepupa, pupa, cocoon, distribution, injury, incubation period, etc. There are approximately 1200 papers written about this species, especially about its life history and economic importance.

NECROBIA RUFICOLLIS F.—Described by Fabricius in 1775, as *Dermestes ruficollis*. Sturm (1837) first changed the generic name to *Corynetes*; later, from Girarg's paper (1873) it became known as a member of the genus *Necrobia*. It is a comparatively large species, 6.2 mm in length and 2.5 mm in width; front of the head, and the apical three-fourths of the elytra metallic blue; the ventral surface of head, also the prothorax and the base of elytra, the meso- and metasternum and legs, brownish red; the antennae and abdomen dark brown in color (Plate 47, fig. C). It is a cosmopolitan species, and is commonly found on bones and in skins of dead animals. Similar in habits to *N. rufipes*. The first written record of its "story" is given by Latreille (1804: *Hist. Nat. Crust.*, 9:157) as he reports its existence in an old anecdote. Ghiliani (1847: *Ann. Soc. Ent. France*, 5:92) mentions it as a species noxious to silkworms. Gallois (1875: *Bull. Soc. Etudes sci. d'Angers*, 4-5:74) described it as a member of the genus *Corynetes*, being predaceous on some dipterous larvae in carrion.

Later Tempel (1928: Die kranke Pflanze 5:186) recorded its occurrence in wood, and discussed its resistance to hydrocyanic gas. Balduf (1935: Bionomics Entomoph. Col. p. 107 and 108) discussed the food habits of the larvae and adults. Lapesme (1939: Rev. franc. Entom. 6:18) mentions it as a pest in dry fish, otherwise as beneficial.

The three species of *Necrobia* may be easily separated by the following short key:

1. Unicolorous. Metallic blue or metallic green.
4.5 mm in length. (Plate 47, fig. A) *violacea* L.
2. Not unicolorous:
 - a. The legs and the basal joints of antennae reddish brown. Otherwise metallic blue or metallic green. 5.4 mm (Plate 47, fig. B) *rufipes* DeG.
 - b. The legs, prothorax and the humeral fourth of elytra brownish red. 6.2 mm (Plate 47, fig. C) *ruficollis* F.

There are six other known species of this genus; *aenescens* Pic, *atra* Kl., and *tibialis* Spin. all from South Africa; *fusca* Steinh. from Argentina; *kelecsenyi* Gebien and *konowi* Hoffm. from Europe.



STUART LUTHER PECK

(1893-1959)

With the passing of Stuart Peck in January of this year, the Academy lost one of its most active archaeologists. His continued support of and participation in archeological projects in the southern California area will be missed by those whom he assisted and those whom he guided.

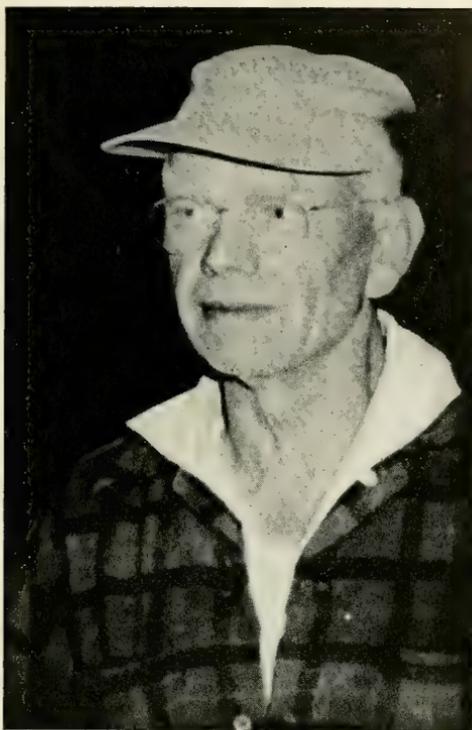
Born January 25th, 1893 in Rochester, New York, Stuart came to Pomona, California with his parents early in the 1900's. He entered Pomona College in 1910 and graduated with a B.S. in chemistry in 1914. He then attended Harvard University on a fellowship. An M.S. in chemistry was awarded Stuart by the University of California at Berkeley in 1917, the year he married Ethel Geier, and joined the United States Navy. He served in the Navy until 1919, attending the Naval Academy in 1918 and earning the rank of Lieutenant Junior Grade.

After leaving the Navy, Stuart worked in the cabinet-making trade until becoming a draftsman at Hughes Aircraft Company in Los Angeles, where he remained until 1947.

The desire to understand Nature became Stuart's major hobby even while a student at Pomona. Trips with Frank Coffey, well-known Mojave desert prospector, awakened his interest in rocks and minerals. Gradually archeology became the prime focal point of his study, and he developed an outstanding system of labeling and classifying his specimens. Soon the maintenance of meticulous records, logs and diaries were the hall-mark of his work. In 1939, Stuart joined the Southwest Museum and offered his services as a survey archeologist. His collections and reports are important elements in the archeological resources of that institution.

Travel restrictions during World War II did not stop his work, merely altered its locale, for during this period he made a thorough study and report of a site on the Hughes Aircraft property.

Interest in archeology grew until Stuart Peck decided to pursue this science professionally. In 1947, he enrolled at U.C.L.A., and earned a Masters Degree in Anthropology in 1949. Although continuing to work as an electronics draftsman, he managed also to work as a museum technician at U.C.L.A. until 1951, to take part in the archeological survey of Hells Canyon Reservoir on the Snake River, Washington, for the Smithsonian Institution,



to work for the Southwest Museum on its most recent expeditions and, finally, to serve as the first curator of the San Bernardino County Museum, a position he held from 1957 until his death.

Stuart was generous to his profession, giving time, knowledge, skill and equipment. He made substantial financial contributions to the Southwest Museum from his modest income. He and Ethel served the Archeological Survey Association faithfully. He was field chairman, technical advisor, trip leader, director of the dry-lakes survey. For more than a year, he and Ethel spent every weekend at the Zuma Creek Site A at Point Dume. The monograph resulting from this project is his most important publication although he had articles in *American Antiquity* and other scientific journals.

Stuart Peck spent many hours training young scientists, not only in the fundamentals of their professions, but training them to observe, to understand, to think, to conserve the out-of-doors. His dedication to learning will be missed by all who knew and worked with him.

R.D.S.

PROCEEDINGS OF THE ACADEMY

Meeting of September 18, 1959

"SEARCH FOR THE SOURCE OF MEXICAN JADE"

By

Thomas Clements

Head, Department of Geology, University
of Southern California, andCurator, Mineralogy and Petrology,
Los Angeles County Museum

The speaker and his wife spent part of the winter of 1956-57 and the summers of 1957, 58 and 59, following in the footsteps of the late Raymond Barber, former Curator of Mineralogy at the Los Angeles County Museum, seeking the source of the jade used by the ancient inhabitants of Mexico.

Travel was by jeep, and in 1959 by Volkswagen Kombi-wagon. Localities in which the search was centered were the areas of metamorphic rocks in the states of Guerrero and Oaxaca, headquarters being maintained in the cities of Taxco and Oaxaca respectively. From the former exploratory trips were made to Teloloapan, Ixcateopan, Rio Balsas, and Acapulco. From Oaxaca exploration was carried out as far south as Tehuantepec and Puerto Angel, as far east as San Cristobal de las Casas in Chiapas, and north to Ixtlan de Juarez, Nochixtlan and Uanhuitlan.

Very considerable help has been afforded by local people in the various areas, both Mexican and foreign. Hundreds of pieces of jade, or supposed jade, both carved and rough, have been tested by rapid field methods.

Samples that showed favorable field tests have been brought back to the museum where they are now awaiting optical and chemical tests.

October 16, 1959

TOUR OF THE LOS ANGELES HYPERION TREATING PLANT
AT PLAYA DEL REY — Section of special events.

About 42 members and guests attended the conducted tour of the 92 million dollar plant situated in a 78 acre area at Play del Rey. Mr. Harold Bock, U. C. L. A. graduate student of Industrial Design talked to the group and supervised the tour. The plant provides an excellent example of applied chemistry, hydraulics and engineering science. The group was particularly impressed by the use of automation in the operation of the plant. Methane gas from the sewage is used to generate the power to run the plant. Due to the efficient methods of purification, 100% of the water is made pure before it is diverted into the ocean, five to seven miles out from the shore. Important byproducts include hi-grade fertilizer, and use of the water for irrigation purposes is considered to be a practical venture in the future.

SCIENTIFIC NOTES

THE HOLOTYPES OF *ZAUSCHNERIA ORBICULATA*
AND *ZAUSCHNERIA VISCOSA*

During 1957 while I was a member of the faculty of Occidental College in Los Angeles, I found a number of specimens in the Occidental College Herbarium of *Zauschneria* which had originally formed a part of the private herbarium of George L. Moxley. Among the specimens were two holotypes, two sheets containing fragments of the holotypes of *Z. glandulosa* Moxley and *Z. pulchella* Moxley, and a number of specimens which had been cited by Moxley in his major paper on *Zauschneria* (Moxley, 1920). Information relative to the holotypes is presented below.

Zauschneria orbiculata Moxley, Bull. S. Calif. Acad. Sci. 19: 30. 1920. Saw Mill Canyon, eastern slope of the Sierra Nevada, in loose lava at 7500 feet altitude. Collected by Frank W. Peirson, Aug. 28, 1919. no. 759. The original description stated clearly that the holotype of *Z. orbiculata* was in the author's herbarium. This specimen is now no. 397702 in the Dudley Herbarium of Stanford University. Isotypes are at DS, CAS, US, GH (abbreviations of names of herbaria according to Lanjouw and Stafleu, 1959) according to the original description.

Zauschneria viscosa Moxley, Bull. S. Calif. Acad. Sci. 15: 22. 1916. Ridge near Barley Flats, San Gabriel Mts., Los Angeles Co., Cal. July 21, 1915. Type sheet - Elevation about 5000 ft. No. 412. Coll. G. L. M. It was stated in the original description that the type sheet was in the author's herbarium. Plate two (Moxley, 1920) is a photograph of the holotype, now DS no. 397704. Isotypes of this species are at UC and LAM (Moxley, 1916).

All of the specimens mentioned above are now in the Dudley Herbarium. They were removed from Occidental College with the consent of Dr. John McMenamin, acting chairman of the Department of Biology. An explanation of how a portion of Moxley's herbarium came to be deposited at Occidental College will be found in a biographical sketch of Mr. Moxley which Miss Bonnie C. Templeton, Curator of Botany, Los Angeles County Museum, is currently preparing. Both *Z. orbiculata* and *Z. viscosa* are referable to *Z. californica* Presl sp. *latifolia* (Hook.) Keck.

References

- Lanjouw, J. and F. A. Stafleu. 1959. The Herbaria of the World. Regnum Vegetabile 15: 1-249.
 Moxley, G. L. 1916. Notes on *Zauschneria*. Bull. S. Calif. Acad. Sci. 15: 47-49, 51-54.
 ————. 1920. A study of *Zauschneria*. S. W. Sci. Bull. 1: 13-18, 20-29.
 JOHN H. THOMAS
 Dudley Herbarium, Stanford University
 July 31, 1959

ENTOMOLOGICAL BRIEFS

In the process of carrying on life history studies of the Lepidoptera during the past two score years, a number of fragmentary items have accumulated which are worthy of recording since they represent unpublished information.

Anthanassa frisia Poey

Two pupae of this butterfly were sent to us on February 23, 1933 from Mrs. C. M. Grimshawe, then of Miami, Florida. The food plant of the larva could not be determined, but appeared to be a species of "*Ruellia*".

The pupa was 10.5 mm. long, and its greatest width was 3.7 mm. In color, it was light grayish brown, speckled and streaked with brownish black.

The form was very similar to that of several *Phyciodes* pupae, which is not surprising, as Röber, in Seitz, places it in this genus. The warty tubercles on the dorsal and subdorsal areas (characteristic of most *Phyciodes* pupae) are tipped with yellow-straw, and have dark brown areas in front of their bases. The segmental junctures are slightly olivaceous.

The notes by W. H. Edwards on the chrysalis of *Anthanassa texana*, published in Volume XI of the Canadian Entomologist, pp. 127-129, 1879, could, in most particulars, refer equally well to *Anthanassa frisia*. Edwards reared his *A. texana* on *Actinomeris*.

Itame extemporata B. & McD.

Mature larvae of this species were collected in the upper Bouquet Canyon, Los Angeles County, California, on June 7, 1939, feeding on *Cercocarpus*. They were reared to maturity, and the following brief notes were made:

LARVA: Length, 24 mm.

Head, ivory, heavily spotted with yellow-brown.

Body, ground color ivory, heavily spotted and streaked with brown and black in indefinite pattern. Legs, yellow-brown. Prolegs concolorous with body.

The spiracles have yellow-brown centers and black rims, and are placed near the tops of low warty tubercles. Aside from these, there are no marked processes on the body.

The setae are small and black.

PUPA: Length, approximately 13 mm. Color, wood brown, and shape, subfusiform.

The thorax is finely rugose, and the abdominal segments are heavily pitted. The caudal end is rounded, and terminates in two stout cremasteric spines, the ends of which are not recurved.

Dasyfidonia avuncularia macdunnoughi

E. Guedet

This handsome geometrid subspecies was described by Father Edward Guedet in the Pan Pacific Entomologist, Vol. XI, pp. 39-40, 1935, the holotype and allotype being taken in the Cajon Pass, San Bernardino County, California.

On April 24, 1935 Chris Henne secured eggs from a female captured at the type locality. These hatched May 1, 1935, and were reared as far as the second instar, but unfortunately no notes were made of the egg or young larva. However, Mr. Henne recorded the food plant as being *Coleogyne ramosissima* Torr.

Lita variabilis Busck

Several larvae of this species were found on *Stenopsis linearifolius* (DC.) Rydb., in the Antelope Valley, west of Palmdale, April 3, 1939. The larvae weave a loosely woven white webbing along the stem of the plant, incorporating several leaves. In the center of this is a silken tube in which the larva is concealed.

A larva of 7.5 mm. length was characterized by a jet black head, and scutellum. The body ground color was ivory, on which numerous wavy light chocolate lines ran longitudinally. Light colored setae were sparingly scattered over the body, each one arising from a black papilliform nodule.

Mature larva: Length, 14 mm.

The head was soiled yellow, mottled with black. The body ground color was yellow, and the same fine chocolate colored lines were present as in the earlier instar. The scutellum was concolorous with the body, and the first segment crowded forward over the head.

The ventral surface was concolorous with the remainder of the body.

The setae were much less conspicuous, and the nodules giving rise to them were colorless.

The larva pupates under ground, making a compact oval cocoon, covered with granules of sand.

NEW FOOD PLANT AND COLLECTING RECORDS

A number of years ago Chris Henne submitted a list of food plant and locality records for larvae that he had reared.

This list contains certain details that have not heretofore been recorded in the literature. A brief summary follows:

Hemileuca neumoegeni Hy. Edw.

Henne reports collecting 5 larvae in the New York Mountains, San Bernardino County, California, May 9, 1937. These were taken on *Rhus trilobata* Nutt., (Squaw Bush), which was growing in sandy soil.

Pygarctia elegans Stretch.

In the life history of this species published by the author in association with Commander Dammers (Bull. So. Calif. Acad. Sci., 35 (2): pp. 99-101, 1936) we gave the food plant as *Asclepias*. Henne's record is more specific. Based on 50 larvae taken at Mexican Well, Ibanpah Mountains, San Bernardino County, he lists the food plant as *Asclepias nyctaginifolia* Gray, "growing in gravelly soil in moisture-retaining hollows."

Kodiosoma fulva Stretch.

The previously published life history of this species, in Bull. So. Calif. Acad. Sci. (34 (2): pp. 131-132, 1935) was based on material collected in the Gavilan Hills near Riverside, California. The food plants there recorded were *Uropappus linearifolius* Nutt., and *Lactuca*. Henne's report lists only *Lactuca*, "growing in sandy river-wash soil", but gives two additional localities where he collected the larvae, namely, Chino Canyon "(Bajada)", Riverside County, April 1, 1936, and Fenner, San Bernardino County, March 17 to 24, 1934.

Diacrisia vagans Boisid.

This moth, known as the "Wandering Diacrisia", has apparently escaped the attention of the present generation of students interested in life histories. Aside from the account published in 1874 by Henry Edwards (Proc. Cal. Acad. Sci. Feb. 1874) and that of Stretch in 1873 (Zygaen. Bombyc. N. Am. p. 194) there are, to our knowledge, no adequate contemporary records in print. The food plants earlier recorded are *Pteris*, *Lupinus* and thistle.

Henne obtained eggs from a confined female collected at McCloud, Siskiyou County, California, June 24, 1938, which he carried through on *Plantago*. Unfortunately he made no notes of egg, larva or pupa.

Judging from the above, the larva probably feeds on a wide variety of herbaceous plants.

Alypia ridingsi Grote.

The life history of this species was recorded by the author in association with C. M. Dammers in 1942 (Bull. So. Calif. Acad. Sci. 41 (2): pp. 92-96). The larva is dealt with by Crumb in the U. S. Dept of Agric. Tech. Bull. #1135, p. 13, 1956. Food plants previously recorded were *Clarkia rhomboidea* Dougl., *Eulobus californicus* Nutt., and *Oenothera bistorta* Nutt. Henne's record, from Little Rock, Los Angeles County, California, April 9, 1939 adds *Oenothera dentata* Cav. to the list. (Bull. So. Calif. Acad. Sci. 38 (2): 107, 1939) John A. Comstock

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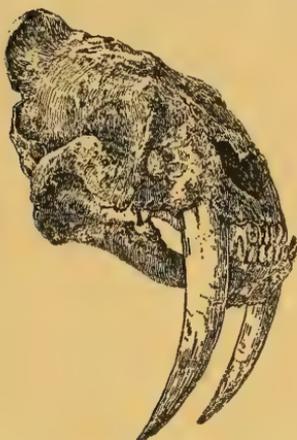
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LIFE CYCLE STUDIES OF THE BRACHYURA OF
WESTERN NORTH AMERICA, IV.
THE LIFE CYCLE OF *CYCLOXANTHOPS*
NOVEMDENTATUS (STIMPSON)

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INTRODUCTION

This paper is the fourth in a series of larval studies of Western North American Brachyura, and extends our knowledge to still another xanthid crab, *Cycloxanthops novemdentatus* (Lockington). With the completion of this paper the larval forms of all the common species of the family Xanthidae found from California to Alaska will be known. Members of this family were relatively simple to rear due to their large larvae and the ease in locating ovigerous species. The Xanthidae comprises only a small part of the brachyuran fauna of our coast, however, and thus there is a great deal of work to be done before keys to the brachyuran larvae can be worked out on a large scale. The importance of such studies is already evident in plankton and fish-feeding surveys, but will prove to be of ever increasing value as other phases of marine biology become known.

The work involved in this paper was completed at the Allan Hancock Foundation, University of Southern California, Los Angeles, California. I wish to express thanks to Dr. John S. Garth and the late Dr. Norman T. Mattox for their guidance in this project.

CYCLOXANTHOPS NOVEMDENTATUS (LOCKINGTON)

One female became ovigerous in the laboratory on June 10, 1955. The eggs of this brood hatched and were reared through the second zoeal stage only. Two additional ovigerous females were obtained at about the minus three-foot tide mark at Resort Point, Palos Verdes, California, on July 17, 1955, and the larvae reared through the third zoeal stage. Eight ovigerous females were collected for this study at the LaJolla Caves, La Jolla, California, on September 12, 1955, and the larvae reared through the megalops stage. Large mature males and females of this species are common

in the middle ranges of the intertidal zone early in the spring when molting most frequently occurs (Knudsen, 1957). However, at the time of reproduction mature individuals, especially the larger ones, descend to the lowest reaches of the intertidal zone, or, even more commonly, to the sub-intertidal zone. Thus, ovigerous females are more difficult to collect. The breeding season of this genus is the shortest of all known California genera of Xanthidae, extending from June through September. The average female becomes mature at 33 mm. carapace width. Probably only one set of eggs is produced each year at this latitude, with about 45,000 eggs per set as an average for all size classes. Newly deposited eggs are a dark purple, changing to an orange-brown before hatching. Larvae are hyaline and orange-brown. Larval development requires about seven weeks in the laboratory but it is probably somewhat shorter in the field.

PREZOEAE (Plate 1, Figure 1). Measurements: Carapace 0.57 mm. long by 0.38 mm. high.

DESCRIPTION. Dorsal, rostral, and lateral spines rudimentary, flattened against carapace.

Antennule and antenna rudimentary, compacted into short, fingerlike processes of unequal length. Mouthparts evident but lacking in development. First and second maxillipeds with natatory "hairs" within the exopodites.

Abdomen five-segmented. Telson forked, with seven spines per fork. Each spine with plumose flaps of cuticle (fourth pair not plumose).

FIRST ZOEAE (Plate 1, Figure 2 and Plate 2, Figure 1). Body 1.62 mm. measured from front of head to tip of telson. Dorsal spine 0.65 mm.; rostral spine 0.60 mm.; and distance from tip of dorsal spine to end of rostral spine 1.55 mm. Antenna equal in length to rostral spine.

DESCRIPTION. Carapace with all spines present. Dorsal spine smooth; lateral spines (Plate 2, Figure 5) with four prominent, dorsal spinelets; rostral spine (Plate 2, Figure 4) with four to five conspicuous spinelets projecting anteriorly.

Antennule (Plate 2, Figure 6) short, smooth, and conical, with two long aesthetes and two short "hairs" at the tip. Antenna (Plate 2, Figure 3) long, with short exopodite, three large spinelets, and five or six smaller spinelets on the anterior surface of the distal portion. Mandibles and maxillae not dissected or diagnosed.

First maxilliped with "hairs" on median surface of basis, four natatory "hairs" at tip of exopodite, and four "hairs" on tips of endopodite. Second maxilliped as first.

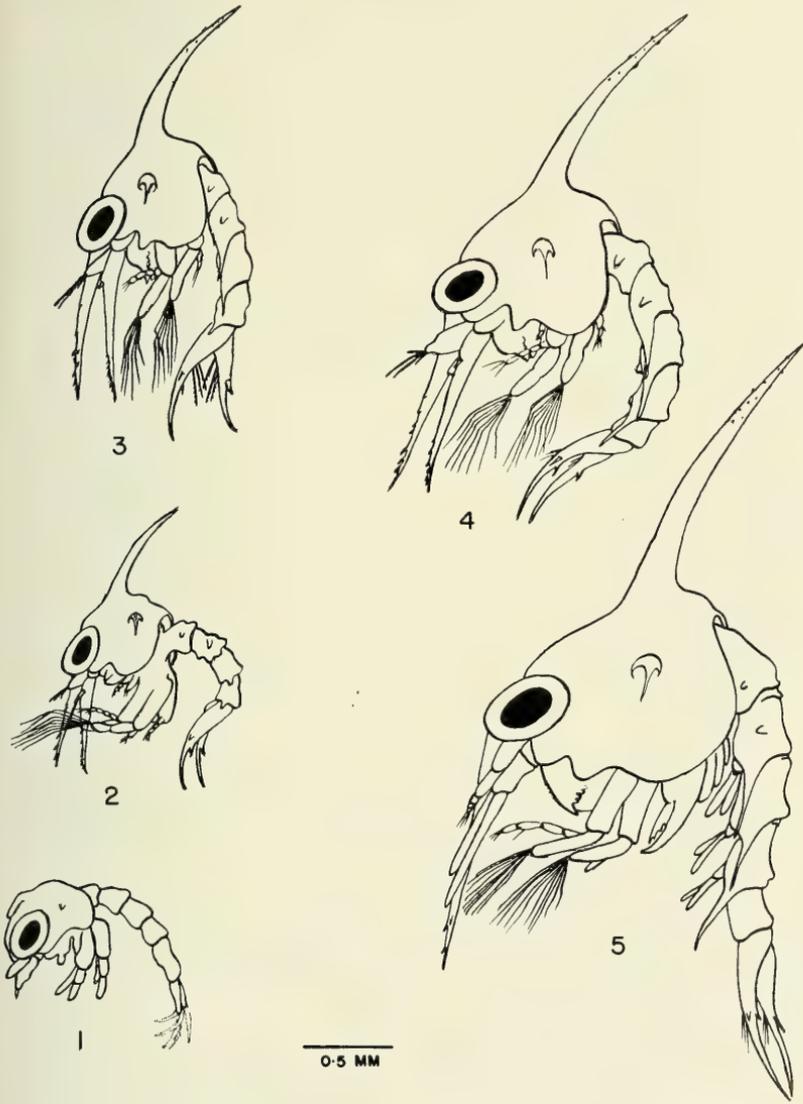


PLATE 1

Cycloxanthops novemdentatus (Stimpson): fig. 1, prezoa; fig. 2, first zoea; fig. 3, second zoea; fig. 4, third zoea; fig. 5, fourth zoea.

Abdomen composed of five segments and a telson, with spine-like projections on midlateral surface of second and third segments, and with sharp points on posterolateral margins of third, fourth, and fifth segments.

Telson (Plate 2, Figure 2) forked, with one major and one minor lateral spine, one dorsal spine and three median, barbed spines per fork. Third median spine smooth except for distal third where the barbs flare broadly.

The basic color in life is reddish brown. Yellow-orange pigment tints the mandible region. Distal portions of the carapace spines and maxillipeds clear.

SECOND ZOEA (Plate 1, Figure 3). Measurements: Body 1.83 mm. from front of head to tip of telson. Dorsal spine 0.83 mm.; rostral spine 0.83 mm.; and distance from tip of dorsal spine to end of rostral spine 1.82 mm. Antenna equal in length to, or slightly longer than the rostral spine.

DESCRIPTION. Carapace smooth, with all spines present. Dorsal spine recurved, with very fine spinelets on distal half. Lateral spines with four dorsal spinelets, however, less prominent than in first zoea and fourth spinelet almost wanting. Rostral spine with conspicuous spinelets on distal half.

Antennule conical and smooth, with two long aesthetes and "hairs" as first zoea. Antennal protopodite swollen proximally and tapering into a long process, without an endopodite, with a short (0.03 mm.) exopodite, and with several conspicuous spinelets on the distal fourth. Mandibles bilobed, with two posterior dentate projections.

First maxilliped with median "hairs" on protopodite, exopodite with six natatory "hairs," endopodite with one, one, one, three, and five "hairs" on the five segments. Second maxilliped with median "hairs" with seven natatory "hairs" on exopodite. Other thoracic appendages rudimentary.

Abdomen of five segments and a telson, with spinelike projections on the midlateral surface of segments two and three, with elongated, pointed projections on the posterolateral margins of segments three, four, and five. Telson armed at first zoea.

THIRD ZOEA (Plate 1, Figure 4). Measurements: Body 2.28 mm. measured from front of head to tip of telson. Dorsal spine 1.22 mm.; rostral spine 1.10 mm.; and distance from dorsal spine to end of rostral spine 2.33 mm. Antenna slightly shorter than rostral spine.

DESCRIPTION: Carapace with all spines present. Dorsal spine recurved, with short spinelets. Lateral spines smooth, without spinelets. Rostral spine with conspicuous anterolateral spinelets.



PLATE 2

Cycloxanthops novemdentatus (Stimpson) first zoea: fig. 1, first zoea; fig. 2, telson; fig. 3, antenna; fig. 4, rostral spine; fig. 5, lateral spine; fig. 6, antennule.

Antennule conical, with two aesthetes at tip. Antennal protopodite long and tapering, with a short exopodite, an endopodite (0.12 mm.) now present. Mandibles more elongate than last zoea, with four or five teeth posteriorly. Maxillae well developed but not dissected.

First maxilliped normal; endopodite five segmented with three "hairs" on the last segment; exopodite with eight natatory "hairs." The second maxilliped: endopodite three segmented with three "hairs" at the tip, exopodite with nine natatory "hairs."

Abdomen of six segments and a telson; with spinelike projections on the midlateral surface of segments two and three; with long (0.26 mm.) spines on the posterolateral margin of segments three, four, and five; segment six unarmed. Rudimentary pleopods visible. Telson armed as first zoea.

FOURTH ZOEA (Plate 1, Figure 5). Measurements: Body 3.60 mm. from front of head to tip of telson. Dorsal spine 1.76 mm.; rostral spine 1.60 mm.; distance from tip of dorsal spine to end of rostral spine 3.23 mm.

DESCRIPTION: All spines present on carapace; dorsal spine with slight lumps; rostral spine with small spinelet on distal half.

Antennule conical and segmented. Antenna with endopodite two-thirds length of protopodite. Maxillae not diagnosed. Exopodite of first maxilliped with nine natatory "hairs." Second maxilliped with ten natatory "hairs." Cheliped well developed, non-functional. Pereiopods extended.

Abdomen six-segmented, with armature as in third zoeal stage. Telson unchanged.

MEGALOPS (Plate 3). Only one *Cycloxanthops megalops* was obtained in the laboratory. This was drawn and preserved without dissection. Thus the mouth parts have not been drawn and cannot be described in full. However, sufficient difference can be seen superficially to diagnose and distinguish this form.

MEASUREMENTS: Body 3.00 mm. from rostrum to tip of telson. Carapace 1.78 mm. long and 1.34 mm. wide.

DESCRIPTION: Surface of carapace smooth, with stout bristles. Front broad, turned down medially, with double anterolateral projections.

Antenna eleven-segmented, with plumose setae on segments three and four.

Chelipeds and ambulatory legs densely bristled.

Abdominal segments bristled, with a prominent row of posterolateral spines per segment.

REMARKS. First zoeae of *Cycloxanthops novementatus* are distinguished from those of the genus *Lophopanopeus* by the presence of spinelets on the lateral and rostral spines, and from those of *Paraxanthias taylori* by the presence of four rather large spinelets located dorsally on the lateral carapace spine.

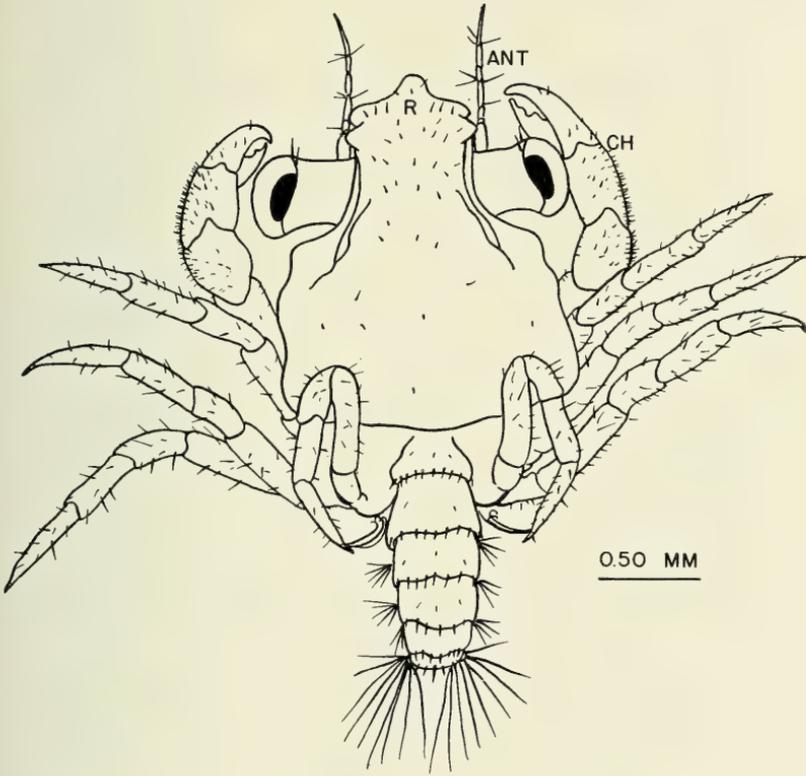


PLATE 3

Cycloxanthops novementatus (Stimpson) megalops: ANT, antenna; CH, chela; R, rostrum.

KEY TO THE KNOWN FIRST ZOEAE OF
CALIFORNIA XANTHIDAE

The xanthid first zoeae have the following distinguishing family characteristics: all carapace spines present; antennae equal in length to the rostral spine; two spinelike projections on the mid-lateral surfaces of the second and third abdominal segments; and posterolateral points on the third to fifth abdominal segments.

- 1a. Rostral and lateral carapace spines armed with spinelets... 2
 1b. All carapace spines smooth, unarmed..... 3
 2a. Lateral spine with four dorsal spinelets; third medial telson spine broadened with barbs on distal third.....
 *Cycloxanthops novemdentatus*.
 2b. Lateral spine with only three dorsal spinelets; all telson spines tapering distally*Paraxanthias taylora*.
 3a. Antennal protopodite smooth, unarmed except for exopodite.. 4

 3b. Antennal protopodite armed distally with stout spinelets...
 *Lophopanopeus l. leucomanus*.
 4a. Telson with two minute lateral spines.....
 *Lophopanopeus bellus diegensis*.
 4b. Telson without lateral spines (Hart, 1935).....
 *Lophopanopeus b. bellus*.

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MORPHOLOGY OF THE COMMON MUDFLAT SNAIL, *CERITHIDEA CALIFORNICA*, - II

By DONALD BOLTON BRIGHT*

The general morphological features of *Cerithidea californica* have previously been described (Bright, 1958). Herein the gross morphology and histological structure of the vascular and nervous systems, sense organs, kidney, gill, and reproductive system will be considered.

The histological technique and procedures are as previously indicated (Bright, 1958).

VASCULAR SYSTEM

The vascular system of *Cerithidea* is lacunar with two divisions, the heart and pericardial cavity, and the arterial vessels (Plate 4-A). The pericardial chamber lies medially in the second visceral spiral. The transparent pericardial membrane lining the cavity is composed of a thin layer of connective tissue with numerous irregularly shaped connective tissue cells similar to those found in the hepatic stroma. The relaxed heart, composed of an anterior sulphur yellow auricle, and a posterior maize yellow ventricle, occupies about half of the pericardial cavity. The ventricle has four layers: 1) a thin endothelium; 2) a layer of longitudinal smooth muscle; 3) a middle layer of circular and longitudinal smooth muscle fibers; and 4) an outer layer of loose connective tissue. The auricle has two layers in addition to the lining endothelium: 1) an inner layer of circular and longitudinal muscle, about one third the size of the two ventricular muscle layers; and 2) an outer layer of connective tissue. The auricle has two ostial openings, each with circular muscle.

Two vessels run posteriad from the ventricle: 1) the anterior aorta, and 2) the posterior aorta. The anterior aorta gives off major branches to the anterior portion of the digestive tract (crop, preoesophagus, and postoesophagus), the terminal portions of the intestine, and the head region. The posterior aorta sends major branches to the stomach, digestive gland, and the gonads. Numerous branches extend from these major arteries within the various organs.

The blood passes anteriorly and posteriorly toward the heart where, after passing through the kidney or gill, it enters the pericardial cavity. The basal stem of the gill is continuous with a small vessel of mesothelium, an epithelial sinus or branchial vein, which leads to the anterior end of the pericardial cavity. The

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cavity of the kidney is also similarly connected to the pericardial cavity by a mesothelial vessel or renal vein which opens at a point parallel with the vessel from the gill.

NERVOUS SYSTEM

The central nervous system is composed of three principal pairs of ganglia, the cerebral, the pedal, and the pleural ganglia and their associated connectives. These three pairs of ganglia lie dorsal to the preoesophagus. In a live specimen, these ganglia are warm buff with zinc orange spots. The cerebral ganglia are the most anterior, with the pleural ganglia immediately posterior (Plate 4-B).

The two cerebral ganglia are fused medially with a clearly indicated interganglionic depression. Extending anteriorly from each cerebral ganglion is the cerebro-buccal connective. This connective extends forward to the posterior limit of the buccal mass, and passes into the buccal ganglion, from which nerves lead into the buccal mass. The cephalic nerve proceeds anteriorly from the cerebral ganglia laterally to the cerebro-buccal connective. Two small nerves emerge from the lateral edge of each cerebral ganglion; they are the tentacular nerve and the optic nerve. The tentacular nerve is more anterior and slightly larger than the optic nerve.

Immediately ventral to the cerebral ganglia, below the preoesophagus, are two large pedal ganglia. These ganglia are larger than the cerebral. A large cerebro-pedal connective leads from the ventral surface of the cerebral ganglia to the dorsal surface of the pedal ganglia. A similar connective, the pleuropedal, leads from the ventral surface of the pleural ganglia to the pedal ganglia. Many branches lead downward from the pedal ganglia, ramifying in the pedal muscles.

The right pleural ganglion gives off two main branches, a median pleuro-parietal connective, and a lateral visceral connective. A small nerve also proceeds laterally from the pleural ganglia to the right side of the mantle. The pleuro-parietal connective extends posteriad from the pleural ganglion over the dorsal surface of the crop to the left side. It continues posteriorly along the left edge of the intestine to a point slightly anterior and ventral to the heart, where it expands to form the supra-intestinal parietal ganglion. The branchial nerve leads anteriorly from this ganglion, dividing into several branches. These branches go to both the ctenidium and the osphradium. A smaller medial branch from the intestinal ganglia goes to the heart. The lateral visceral connective extends backward and laterally to the digestive tract and dorsal to the columella muscle, runs parallel with portions of the preoesophagus, and ends in a visceral ganglion at the anterior

limit of the stomach. A similar visceral connective extends posteriorly from the supra-intestinal parietal ganglion. These two visceral nerves are given off from both visceral ganglia. They proceed to the posterior portion of the visceral spiral (Plate 4-C).

The left pleural ganglion is elongated antero-posteriorly, with a marked dorsal, transverse depression. This ganglion gives off three nerves, a lateral left mantle nerve, and two medial columella muscle nerves. The left mantle nerve passes to the left side, and branches in the mantle. The two columella nerves divide after leaving the ganglion, one going to the forward portion of the muscle, and the other going to the posterior portion.

All of the ganglia have the same histological appearance (Plate 4-D), differing only in their respective number of ganglion cells and fibers. These ganglia consist of a stroma of connective tissue, the perineurium, the ganglion cells, and a small amount of neuroglial tissue. A ganglion in cross-section shows all the cell bodies to be located in the upper dorsal area of the ganglion, arranged in the shape of a tilted "L," with the remainder of the ganglion ventral to the cells filled by nerve fibers.

SENSE ORGANS

The sense organs are the tentacles, eyes, and the osphradium. The eyes lie lateral on the base of the tentacles. They are cup-shaped structures, 0.25 mm. long, and 0.15 mm. wide. They have four anatomical components, the retina, lens, optic capsule, and optic nerve. A cross section of the retina shows two types of cells: 1) the sensory cells, with oval nuclei and prominent nucleoli, and 2) the pigment cells which separate the photoreceptor cells from one another and give the eye a black color. This arrangement of pigment cells between each photoreceptor cell is thought to be of value in the perception of small images by dividing the object into smaller units, with one receptor cell per unit (Scheer, 1948).

The internal cavity of the eye is almost completely filled by the lens. The lens has a translucent appearance. The retinal layer is continuous on the external surface with the cornea. The cornea is a simple layer of cuboidal cells, with little specialization. The entire eye is covered, with the exception of the corneal area, by a layer of connective tissue cells which form the optic capsule. The optic nerve arises from the base of the eye as a fan-shaped structure, with the individual fibers from their respective receptor cells regrouping posteriorly into the optic nerve.

The osphradium, typically martius yellow, is located on the left ventral surface of the mantle collar, just ventral to the ctenidium. It develops from the anterior margin of the gill, and projects

posteriad parallel with the gill for 1.91 mm. It is an oblong structure, composed of a continuous circle of tissue, with a central cavity. All surfaces of the osphradium exposed to the mantle cavity are composed of a single layer of pseudostratified ciliated epithelium. The small space between these cells is filled by a loose fibrous connective tissue network which is well supplied with minute nerve branches. The base of the osphradium is continuous with the epithelium of the mantle collar. Several functions have been ascribed to this structure, but it is generally accepted that it functions as a chemical testing device for water entering the mantle cavity.

KIDNEY

The kidney of *Cerithidea* is a pale gull gray oblong glandular organ. It is located on the left surface of the body, beginning on the posterior portion of the first visceral spiral, and ending on the midpoint of the second visceral spiral. It is somewhat reniform, with the greater curvature dorsal. The dorsal border of the gland is connected by a thin membrane to that portion of the intestine just posterior to the pellet compressor area. The anterior surface is adjacent to the pallial cavity, separated only by the mantle tissue.

The kidney is composed of a series of leaf-like lamellae encased in a thin connective tissue capsule. Each leaf is composed of a series of loosely organized glandular cells. These cells are irregular in shape, with oval nuclei, prominent nucleoli, and heavy cytoplasmic granulation. These cells normally have a large central vacuolated area (Plate 5-B). A single leaf has an unevenly arranged layer of cells peripherally, with a small central sinus channel. At irregular intervals throughout the entire gland small blood sinuses act as focal points for these sinus channels.

Two openings extend from the kidney, one going to the pericardial cavity, the other to the pallial cavity. The renopericardial opening lies at the anterior end of the kidney, and opens into the renal vein on the medial dorsal surface of the kidney. This sinus leads directly through the renal capsule and adjacent mantle tissue to the anterior end of the pericardial cavity. The external renal aperture on the anterior end of the kidney, lateral to the renopericardial aperture, leads through a short ureter to the pallial cavity. The ureter passes forward between the pellet compressor area on the right side and the anterior terminal portions of the style sac on the left side. The ureter is lined with pseudostratified ciliated columnar epithelium. The entrance between the kidney proper and the ureter is reduced to a small lumen, 0.07 mm.

wide, surrounded by a lip-like aggregation of glandular epithelial cells, the renal lip. The renal lip is continuous medially with the epithelium of the kidney and laterally with the epithelium of the ureter.

GILL OR CTENIDIUM

The gill, a cartridge buff structure, is located on the left ventral surface of the mantle collar. It is monopectinate, consisting of a main stem, and a series of laminae set at right angles to the main stem (Plate 5-A). The main stem is a simple tube composed of a layer of pseudostratified columnar epithelium encapsulated by connective tissue. It extends antero-posteriorly for 4.29 mm. The laminae are graduated, with those of the greatest length located centrally. Anterior and posterior laminae are 1.69 mm. long, central laminae 2.32 mm. long. They vary in width from 0.58 to 0.64 mm., and the number varies from forty-three to forty-nine. Typically there are forty-six. Each lamina consists of an external layer of pseudostratified ciliated columnar epithelium, and a central laminar cavity lined by mesenchyme-like cells. The outer epithelial layer is highly convoluted, presenting a scalloped appearance in cross-section and effectively increasing the respiratory surface. The cilia of these cells beat constantly, guiding either air or water toward the surface. The natural muscular action of the head mass and mantle collar also aids in keeping a fresh supply of oxygen near the ctenidial external surface.

REPRODUCTIVE SYSTEM

The sexes are separate. There is a single gonad, located peripherally on the last three whorls of the visceral mass. This gland lies beneath the thin mantle layer, and superior to the digestive gland, and extends over the spirals from the left-ventral surface to the right-ventral surface. In both sexes they are cobalt green. There is no external sexual dimorphism. There is a difference in the appearance of the gonads, the ovary being less compact than the testis. In either sex, a duct leads from the gonad, passing on the ventral surface of the visceral mass toward the anterior ventral margin of the mantle collar. This duct is cream-buff in both sexes.

1. *Female system:* The female reproductive system consists of the ovary, oviduct, and the terminal glandular portion of the oviduct (Plate 6-A). The ovary is follicular, each follicle consisting of a single layer of germinal epithelium. This germinal layer is thrown into numerous folds, producing small lobules which project into the lumen. The internal follicular surface is covered with many small groups of developing cells or germinal centers. After partial maturation these cells break from the germinal layer and continue to develop into mature ova in the lumen. A study of

several specimens indicates that only a small portion (about five percent) of the original cells in a germinal center reach maturity. The space between the mantle proper and the digestive gland, not occupied by the ovary, is filled with areolar connective tissue.

The oviduct is an elongated tube, ellipsoidal in cross-section, which passes anteriorly along the ventral surface of the visceral mass to a point just posterior to and median from the kidney and lateral to the heart. It then passes forward and dorsally parallel to the posterior portions of the intestinal tract and opens on the ventral surface of the mantle collar just to the right of the anus. At a point approximately even with the beginning of the pellet-molding area, the oviduct enlarges, and this bulbous condition continues to the genital aperture. This enlarged section is secretory in nature.

The oviduct is composed of an inner layer of pseudostratified ciliated columnar epithelium (Plate 6-C) with a marked basement membrane. The epithelial cells are arranged in three distinguishable areas: two dorso-lateral areas, one on each upper lateral surface, which projects two-thirds of the way down the lateral wall; and a third area which covers the ventral portion of the duct and the lateral surface to a point almost touching the dorso-lateral areas. The spaces between these ciliated areas are filled with non-ciliated pseudostratified epithelium. The posterior limits of the oviduct show a gradual transition from a ciliated to a non-ciliated epithelium. At the posterior limits of the glandular portion of the oviduct the cells become columnar. These columnar cells vary in appearance, some with supranuclear granules and others filled with mucoid secretions. These cells produce the gelatinous matrix which encases each individual fertilized egg in an egg mass. The aperture of the oviduct is slit-like, with the left lateral edge attached to the mantle collar.

2. *Male system:* The male reproductive system is composed of a testis, sperm duct, sperm trough, and a penis enclosed in a penis sac (Plate 6-B). The testis has the same appearance as the ovary macroscopically. It is composed of a highly folded and convoluted germinal epithelium. This convoluted epithelium affords an increased surface area on which the sex cells can mature. The germinal layer is thicker than that of the ovary. The primordial germ cells are arranged around this germinal lumen. Those cells which have erupted from this layer attach to large cells, nurse cells, remaining attached even after the tail has formed. Several sperm are attached to a single nurse cell.

The sperm duct passes forward on the ventral visceral surface as far as the kidney. The duct then joins with the tissue of the sperm trough, opening at a point on the left side midway up the trough. The sperm duct is composed of a thick ciliated epithelial layer, and an outer connective tissue capsule.

The anterior portion of the male system, following the sperm duct, is composed of an oval tube divided longitudinally into two sections (Plate 6-D). The larger of these sections, on the left side, is the sperm trough into which the sperm duct opens. The smaller section, on the right side, is the penis sac. The sperm trough is of an even depth throughout, while the penis sac is deepest at its anterior end, and gradually decreases in depth toward the posterior end so that it becomes continuous with the sperm trough. The copulatory organ is housed in this sac, and can, by muscular contraction, be extruded through the genital orifice which is directly in line with the sperm trough. The sperm trough and penis sac are lined with pseudostratified ciliated epithelium on their anterior portions, and the mid portions are lined by columnar cells. There is a middle layer of loose connective tissue of varying thickness. The entire structure is encased in a thin capsule.

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LIST OF ABBREVIATIONS USED IN FOLLOWING THREE PLATES

| | |
|-------------------------------|---|
| AA—anterior aorta | OV—ovary |
| AN—anus | OVD—glandular portion of oviduct |
| BM—basement membrane | P—pericardium |
| BG—buccal ganglion | PA—posterior aorta |
| BN—buccal nerve | PAC—pallial cavity |
| BRN—branchial nerve | PC—pericardial cavity |
| BV—branchial vein | PCT—pleuro-parietal connective |
| CBC—cerebra-buccal connective | PDN—pedal nerve |
| CG—cerebral ganglion | PE—pseudostratified ciliated columnar epithelium |
| CLN—columellar nerve | PG—pedal ganglion |
| CN—cephalic nerve | PLG—pleural ganglion |
| CNE—cardiac nerve | PN—perineurium |
| CPC—cerebro-pedal connective | POES—preoesophagus |
| CR—crop | PPC—pleuro-pedal connective |
| CRM—circular muscle | PS—penis sac |
| CT—connective tissue capsule | R—rectum |
| GC—ganglion cell | RV—renal vein |
| GO—genital opening | SD—sperm duct |
| IBC—interbuccal connective | SDA—sperm duct aperture |
| INT—intestine | SG—supra-intestinal parietal ganglion |
| K—kidney | SPT—sperm trough |
| KL—kidney leaf | ST—supportive tissue |
| LA—lamina | T—testis |
| LM—longitudinal muscle | TN—tentacle nerve |
| LMN—left mantle nerve | VAC—vacuolated cells |
| MC—mantle collar | VC—visceral connective |
| MT—mantle | VG—visceral ganglion |
| NF—nerve fiber | VN—visceral nerve |
| ON—optic nerve | |
| OS—ostia | |

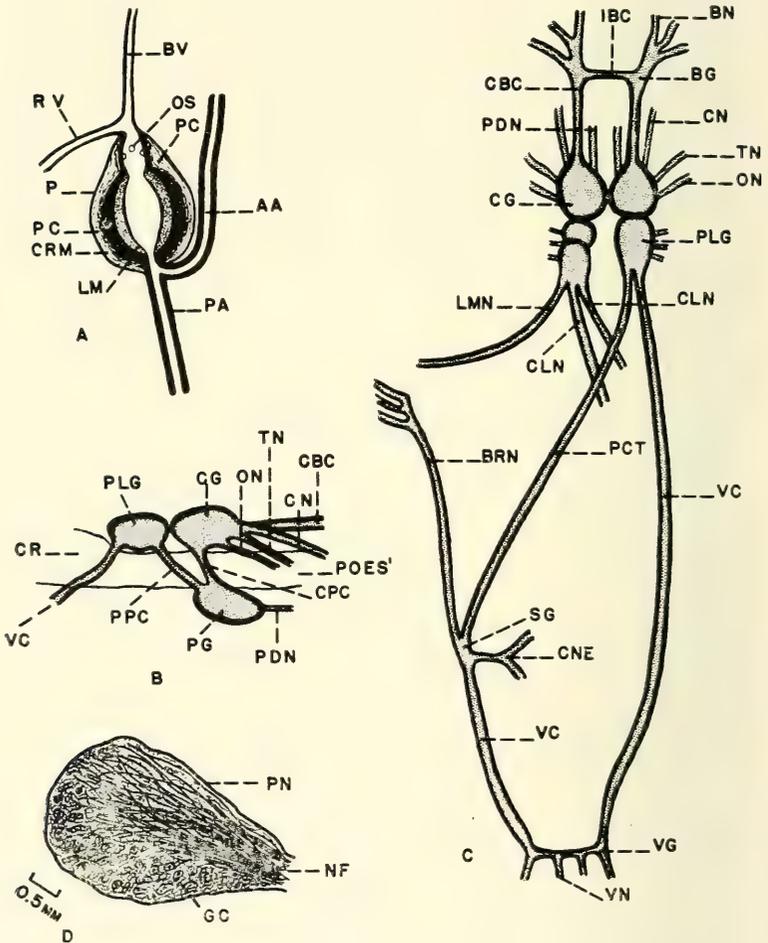


PLATE 4

- a. Ventral view of the heart and aortae.
- b. Lateral view of the three principle ganglia and their associated nerves.
- c. Diagrammatic sketch of the nervous system.
- d. Sketch of the histological components of the cerebral ganglion.

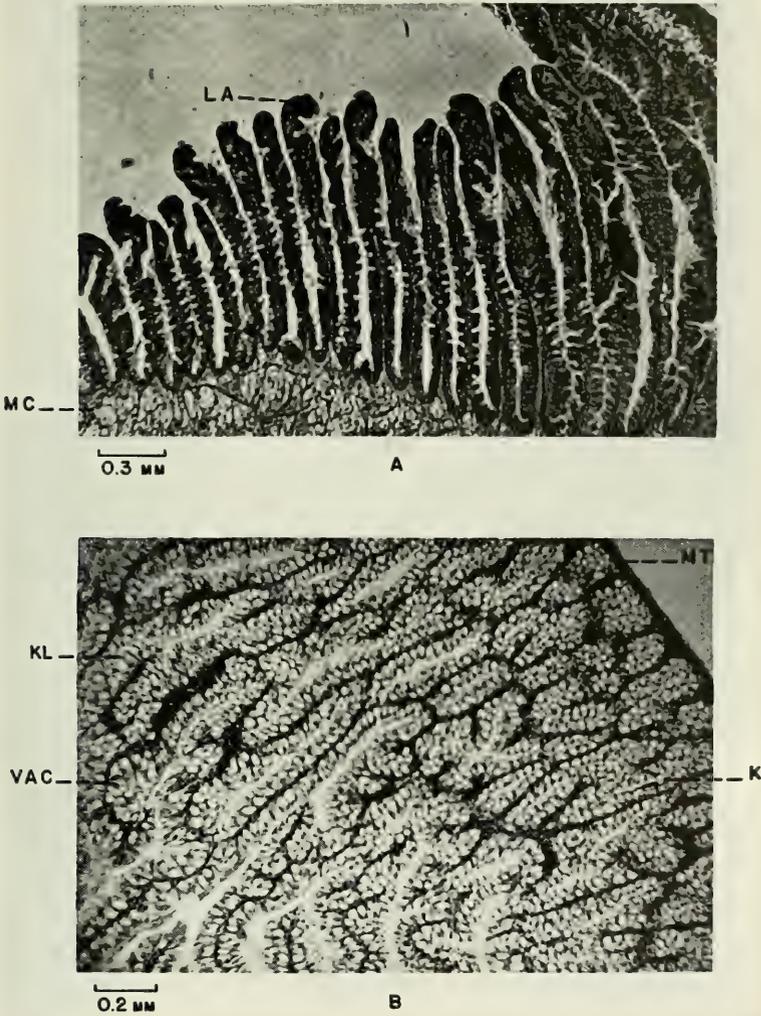


PLATE 5

- a. Photomicrograph of the gill laminae, longitudinal section.
- b. Cross-section through the "leaves" of the kidney showing the vacuolated cells (photomicrograph).

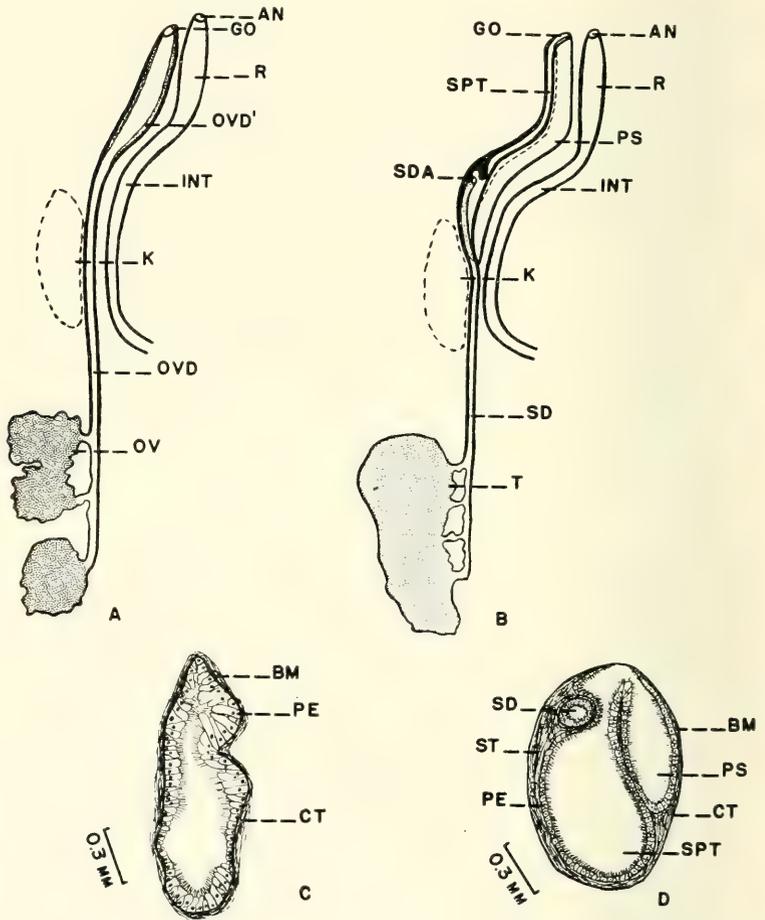


PLATE 6

- a. Diagram of the female reproductive system.
- b. Diagram of the male reproductive system.
- c. Cross-section of the oviduct at the level of the kidney.
- d. Cross-section through the sperm trough and penis sac at the posterior limit of the sperm duct.

DESCRIPTION OF A NEW SPECIES OF
GASTROPOD FROM EASTER ISLAND

By LEO G. HERTLEIN

Easter Island (Isla de Pascua or Rapa Nui), well known for the gigantic statuary found there, lies in the south Pacific ocean in latitude 27°05' South, longitude 109°20' West, about 2,350 miles west of Chile to which country, politically, it belongs. Marine mollusks from this island have been recorded by several authors. The number of species is not large; the recent list by Steele⁽¹⁾ contains 68 species and eight genera of which the species are unknown. To this list can be added *Dolabella agassizi* MacFarland⁽²⁾ also described from Easter Island. Further collecting on the island undoubtedly will reveal the presence of additional species.

In August, 1958, Mr. Ray Summers presented to the California Academy of Sciences 14 small gastropods which were collected at Easter Island by Fray Sebastian Englert⁽³⁾, a resident on the island. Study of the specimens failed to reveal their identity with any described form, therefore the species represented is here described as new.

The author wishes to express his appreciation to Mr. Summers for making the specimens available. Acknowledgment also is due the following who advised concerning the relationship of the species: Dr. G. Dallas Hanna and Allyn G. Smith, California Academy of Sciences, Dr. A. Myra Keen, Stanford University, and Dr. Edwin H. Bryan, Jr., and Dr. Dorothy Getz, Bernice P. Bishop Museum, Honolulu, Hawaii.

Genus *Pisania* Bivona***Pisania englerti* Hertlein, new species.**

(Plate 7, figures 1 and 2)

Shell small, one and one-half nuclear whorls followed by five and one-half slightly convex whorls; the first whorl with 12 rows of radial elongated nodes separated by shallow interspaces,

(1) Steele, P.H., "Easter Island Shells", *Nautilus*, Vol. 70, No. 4, pp. 111-113, April, 1957 (issued April 29, 1957).

(2) *Dolabella agassizi* MacFarland, *Mem. Mus. Comp. Zool.*, Harvard Coll., Vol. 35, No. 5, p. 306, pls. 1-2, 3 (figs. 2-4), 4-7,8 (figs. 1-3, 5-7), 9-10, September, 1918. "Habitat:—Easter Island, South Pacific Ocean."

(3) See P. Sebastian Englert, "La Tierra de Hotu Matu'a: Historia, Etnologia y Lengua de la Isla de Pascua." *Imprenta v edit.* "San Francisco" (Padre Las Casas, Chile), pp. 1-533, illustr., and map, 1948.

crossed by concentric threads irregular in size; the radial rows increase to 14 on the second whorl and the radial sculpture develops into flattened ridge-like nodes which on the fourth whorl develop into a series of fine ribs with intervening shallow interspaces, the whole crossed by numerous concentric threads; the last whorl broadly rounded and crossed by numerous fine low concentric threads, about 12 on the base; columella gently curved, near the base a faint oblique groove is present; interior of the outer lip smooth; color yellowish-white, most of the nodes on the early whorls are brown, and on the last two whorls there are rows of oblong or nearly square brown patches. Length, 9.9 mm., maximum diameter of body whorl, 3.7 mm.

Holotype and two paratypes in the California Academy of Sciences, Department of Geology Type Collection; paratypes also in Stanford University, in the San Diego Society of Natural History and in the Bernice P. Bishop Museum.

The generic assignment of this new species is provisional. A comparison with specimens in the collections of the California Academy of Sciences failed to reveal any very similar species. Dr. A. M. Keen, Stanford University, and Drs. E. H. Bryan, Jr., and D. Getz, Bernice P. Bishop Museum, likewise failed to find any similar shell in the collections in those institutions. All agreed that the species appears to be a buccinoid with a general resemblance to species of *Pisania* such as *P. ignea* Gmelin.⁽⁴⁾

This new species differs from *Pisania ignea* in that the shell is much smaller, the concentric sculpture on the later whorls is more closely spaced and the color is arranged in brown squares rather than in flammules. The smaller, more slender shell with coloration of brown squares rather than in flammules, are features which serve to separate the new species from *Pisania tritonoides* Reeve.⁽⁵⁾

The author is pleased to follow the suggestion of Mr. Ray Summers that the new species be named for Fray Sebastian Englert who collected the type specimen.

(4) *Buccinum igneum* Gmelin, Linn. Syst. Nat., ed. 13, Tome 1, Pars 6, p. 3494, 1791. "Habitat . . . an muricis potius species?" Ref. to Martini, Conchyl.—Cab., Bd., 4, pl. 127, fig. 1217. See also Tryon, Man. Conch., Vol. 3, p. 145, pl. 71, figs. 190-192 (only), 1881 (as *Pisania ignea*). "Red Sea; Singapore; Philippines; Viti Islands."

(5) *Buccinum tritonoides* Reeve, Conch. Icon., Vol. 3, *Buccinum*, sp. 77, December, 1846. "Hab. Island of Ticao, Philippines; Cuming." See also Tinker, S.W., "Pacific Sea Shells" (revised edit.) (Charles E. Tuttle Co.: Rutland, Vermont and Tokyo, Japan), 1958, p. 130, upper and middle rows of figures on plate (p. 131) (as *Pisania tritonoides*).

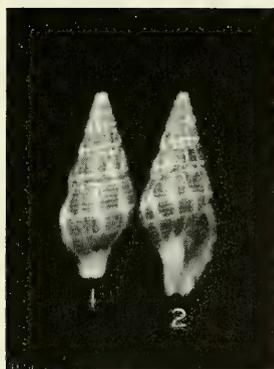


PLATE 7

Figures 1 and 2. *Pisania engleri* Hertlein, new species. Fig. 1. Paratype. Height, 9.0 mm. Fig. 2. Holotype. Height, 9.9 mm. (Photograph by G. Dallas Hanna).

NOTES ON THE LIFE HISTORIES OF THREE
WESTERN PHALAENID MOTHS

By JOHN ADAMS COMSTOCK

Acronicta othello Smith

There are two species of the Genus *Acronicta* occurring in California the superficial appearance of which is so close that it is difficult to separate them.

The first of these is *Acronicta perditata* Grote, which ranges from Canada on the west coast, southward to approximately Los Angeles County, California.

The second is *Acronicta othello* Smith, which is taken sparingly in San Diego County, and may range southward into Baja California. In the original description of the species (Ann. N. Y. Acad. Sci. 18; 94. 1908) the author says "The species is allied to *perditata* but is obviously distinct by the absence of basal streaks and by the soft gray and black shadings." By comparison of series of both species, in the collection of the Los Angeles County Museum, this differentiation is clearly evident.

In Volume 58, part 2 of the Bulletin, Southern California Academy of Sciences, pages 97 to 99, 1959, we published a partial life history study of *Acronicta perditata*. Shortly thereafter we were fortunate enough to obtain fertile eggs of *A. othello* from a female taken at black light in Del Mar, California. This made possible the more comprehensive life history record which follows.

Acronicta othello Smith

EGG: Diameter, 1 mm. Height, .3 mm. In form it is a markedly flattened hemisphere.

The ground color is ivory-white, which is heavily overlaid by wavy lines, dashes and dots of chocolate-brown in irregular pattern.

Beginning at the circumference of the egg there are approximately 80 ridges, which converge on the centrally placed micropyle, becoming progressively obsolescent to the extent that barely a dozen reach the margin of the micropylar pit.

The ridges are hyaline, and are topped by minute spicules, all of which point toward the micropyle.

The eggs were laid August 16, 1959, and hatched August 24, 1959. The shells were, for the most part, completely consumed by the young larvae. The food plant is Toyon,—*Photinia arbutifolia* Lindl. The egg is illustrated on Plate 9, fig. A.



PLATE 8

Mature larva of *Acronicta othello*, on spray of *Photinia arbutifolia*, enlarged $\times 2$. Drawing by the author.

FIRST INSTAR LARVA: Length, 2.5 mm. Head width, approximately .3 mm. When first hatched the head is considerably wider than the first cervical segment. In color it is translucent straw.

The body is predominantly translucent gray, and is covered with numerous nodules, each bearing a long black seta.

When disturbed, the larvae drop on a long silken strand.

On September 3, 1959 the larvae measured 8 mm. with head width of approximately 1 mm. They were presumably in their third instar.

The head was a glistening brownish-black, with lighter mouth parts. It was considerably obscured by the long black arching hairs of the cervical segments.

The dorsal surface of the body was predominantly black, but was interrupted by a transverse bar of dull yellow across the 5th segment, and some yellow mottling on the 9th and 10th segments.

The body surface was heavily obscured by tufts of black hair, arising from numerous black papillae.

Subspiracularly a longitudinal wavy band of yellow was present, on which, in the center of each segment there was a round black papillus, crowned with short white hairs.

The legs were black, and the prolegs soiled yellow, with black lateral plates.

September 9, 1959. Most of the larvae have just completed a moult, and are presumably in their fourth instar. Their length is 13 mm. and head width, 1.5 mm.

The head is mainly black, but has a large dull yellow spot on each side of the crown. The adfrontal margins, mouth parts and antennae are yellow.

The body is jet black above the stigmatal area except for pairs of yellow tubercles on the 5th, 9th and 10th segments. The sub-stigmatal band is more pronounced, and orange-yellow in color, and the small tubercles occurring along it, one on each segment, are now yellow, topped with white hairs.

Inferior to the sub-stigmatal band, the body is dark brownish-black.

Lines of prominent warty tubercles run transversely around each segment. Each of these is topped by tufts of hairs. The longest hairs are black, those of intermediate length are brown, and the shortest are white. The tubercles on the 4th and 11th segments are stoutest and produce the appearance of dorsal 'humps'.

The legs are black, and the prolegs gray-black. The spiracles are black centered, rimmed with dull yellow.

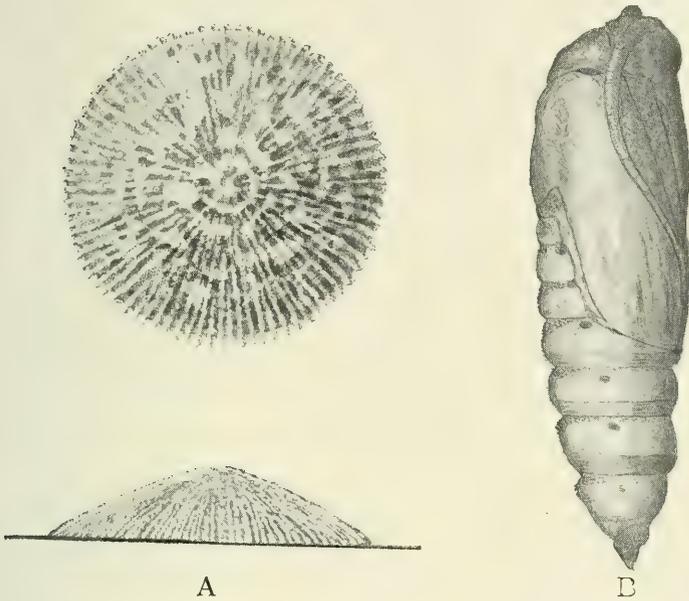


PLATE 9

Figure A. Egg of *Acronicta othello*, superior and lateral aspects, enlarged $\times 40$. Figure B. Pupa of *Acronicta othello*, lateral aspects, enlarged $\times 3/4$. Drawing by the author.

September 23, 1959. Penultimate instar.

Length of larva, 27 mm. Head width, 3.1 mm. The head is jet black except for two round spots of dark maroon on the crown, one on each side of the frontal suture. The adfrontals are gray-black, as are also the antennae, the labrum is a soiled yellow. The head is much obscured by a curtain of long arching white hairs which arise from the front of the first segment, and also by short setae arising on the face.

The body is predominantly a soft velvety black.

There are rows of spiculiferous nodules (verrucae) placed transversely around the middle of each segment. The most conspicuous are a pair placed on each side of the middorsal area. Those on the 5th to 10th segments have orange-yellow nodules. Lateral thereto are a pair of smaller dull maroon nodules, placed superior to the spiracles.

Subspiracularly the longitudinal white band is developed as a line of connected white crescents, each segmental crescent being concave superiorly. In the center of each segmental crescent is a bright yellow nodule bearing predominantly white setae. Inferior to each of these is a small black nodule topped by white setae.

On the 4th segment the two dorsal nodules are large and black, with black setae. The verrucae anterior to these are also black, but smaller. The verrucae on the 11th segment are larger, and all are black. This produces the appearance of a dorsal 'hump', anterior to the cauda. The smaller verrucae caudal to this 'hump' are black.

The venter is gray-black with a tinge of dull maroon.

The legs are black. The prolegs are concolorous with adjacent body surfaces, but the terminal pads are lighter in color. The crochets are developed in two groups on each foot, with a cleft between them. The spiracles are dull yellow centered, with black rims.

The drawing reproduced on Plate 8 represents this larval instar.

FINAL INSTAR: Length of larva, 39 to 40 mm. Head width, 4 mm. The head is entirely jet black except for a faint tinge of dull maroon on the points formerly occupied by the maroon spots. In the double row of dorsal verrucae, all of the nodules are bright yellow.

In all other respects there appears to be no variation from the larva of the penultimate instar.

There was considerable disparity in the rate of growth of the larvae. All the eggs hatched on the same day, and the brood was reared under non-varying conditions. The first larva started spinning on October 1, 1959, and the pupa was formed seven days later. On that date there were still a number of larvae of varying sizes feeding in the rearing cage.

The larva spins a tightly woven thin cocoon, into which is incorporated bits of leaves and small twigs of the food plant.

PUPA: Length, 22 mm. Greatest width through the area of the patagia, 5.75 mm.

In most particulars the pupa resembles that of *Acronicta perditata*, which we published and illustrated in the journal previously cited. In that paper, Plate 30 illustrated the ventral aspect of the pupa. Herein we include a drawing of the lateral aspect of the pupa of *A. othello*. (Plate 9 fig. B).

The only difference we are able to note between the pupae of the two species is as follows:

In *othello* the body is relatively somewhat narrower. The round nodule on the apex of the head is slightly smaller and more rounded. The tips of the metathoracic legs extend slightly beyond

the wing margins. (in the description of *A. perditia* we erroneously called them the mesothoracic legs).

The cremaster ends in a single brush of twelve or more minute spicules, the tips of which are not recurved.

Some of these differences may be the result of individual variation, as we did not have a series of pupae for comparison.

The Egg and First Two Larval Instars of *Cucullia aribac* Barnes.

Fertile eggs were obtained of the above species by Noel McFarland, while he was collecting at the 7C Bar Ranch, seven miles west of Williams, Coconino County, Arizona, between August 9 and 15, 1956.

Several of these were placed in my care on August 22, on which date all had hatched. The larvae were all vigorous, and apparently had not been long out of the egg.

As several members of this genus feed on the flowers of asters, we endeavored to find a native species for them, but without avail.

They accepted cultivated aster, and fed through the first instar, but all sickened and died before the second moult.

Since nothing is known of their life history, the publishing of this partial record is justifiable.

EGG: Hemispherical, the top rounded and the base flattened. The micropyle is very small, and not markedly depressed. Size, approximately .8 mm. wide; slightly less in height. The larva eats a large hole at the side of the egg, leaving the shell intact. The color could not be noted. See Plate 10.

There are about 20 nodule-studded ridges, running from base to top, several of which join with others or become obsolescent in the upper one-fourth of the egg. Minute inconspicuous ridges or striations run transversely between the ridges.

FIRST INSTAR LARVA; (Described shortly before ecdysis). Length, 4 mm. Cylindrical and elongate.

Head, width approximately .3 mm., narrower than first thoracic segment. Color, pale yellow, the mouth parts tinged with brown.

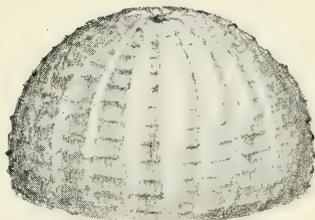


PLATE 10

Egg of *Cucullia aribac*, lateral aspect, enlarged approximately $\times 40$.
Drawing by the author.

Body, translucent light yellow, lighter in shade than the head.

There are several rows of minute raised black papillae bearing single short hairs. On the typical segments these are longitudinally placed in three rows, one dorso-lateral, one lateral and one substigmatal. In each row these papillae occur in pairs on each segment.

A roughened yellow scutellum occurs on the first segment, topped with eight minute papillae bearing short hairs.

Legs, concolorous with body, the joints edged with black.

Prolegs and anal prolegs black on the lateral surfaces of the proximal two segments and hyaline on the distal segments. The crochets are black.

The first two pairs of prolegs are short and non-functional. The second two pairs are well developed.

SECOND INSTAR: shortly after ecdysis, length 5 mm.

Head, width .5 mm. Color, light yellow, flecked with reddish brown spots. The mouth parts are tinged on their margins with light brown. The ocelli are black.

Body, evenly cylindrical. Ground color, light green, finely striped with longitudinal lines. A pair of these running middorsally, are brown. The next lateral stripe is gray-black, and a line of papillae is placed on it. The third latero-inferior line is less distinct, and those below it become progressively fainter until they fade out on the venter.

The legs and prolegs are much as in the first instar.

The Pupa of *Behrensia conchiformis* Grote

Four cocoons of the above phalaenid moth were sent me by Noel McFarland, early in May of 1957. These were collected by him as larvae, in the Santa Monica Mountains, four miles north of Beverly Hills, California, and were reared by him on *Lonicera*.

The cocoons were formed of tough white silk, of paper-thinness, and smooth texture.

PUPA: Fusiform; length, 14 mm; greatest width, through shoulders, 4.1 mm. The color is a blackish brown over the head, thorax, wing cases and cremaster, and shades to a slightly lighter brown or red-brown on the abdominal segments.

The cephalic end is unevenly rounded with a slightly protruding central portion. The eyes are far apart.

The maxillae terminate at a point slightly caudad to the sixth abdominal segment, and the tips of the antennae reach the wing margins. The spiracles are small and inconspicuous.

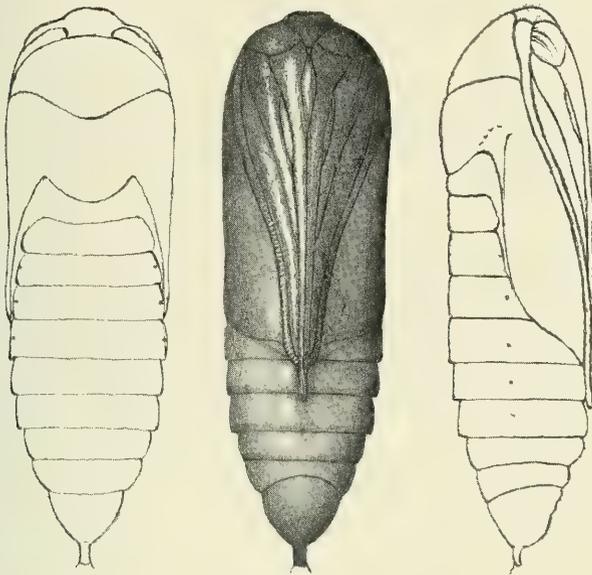


PLATE 11

Pupa of *Behrensia conchiformis*, dorsal, ventral and lateral aspects, enlarged $\times 5\frac{1}{2}$. Drawing by the author.

The cremaster is a quadrate plate which inclines slightly dorsad. At each lateral corner there arises a short straight spicule which inclines slightly laterally.

The pupa is illustrated in three aspects on Plate 11.

Two imagines emerged on May 9, 1957. The remaining two pupae were placed in preserving solution.



NOTES ON A SLEEPING AGGREGATION OF
SOLITARY BEES AND WASPSBy HOWARD E. EVANS and E. GORTON LINSLEY¹

Although the females of most species of solitary bees and many species of solitary wasps spend the night in their burrows or nest structures, males of a wide variety of species and both sexes of some tend to aggregate for "sleeping". Such aggregations may be dense and ball-like, or they may be loose, with the individuals sharing the same sleeping site but not maintaining physical contact. The denser aggregations usually consist of a single species, as with *Bembecinus godmani* (Cameron) [Evans (1955)] or bees of the genus *Nomia* [Rayment (1935); Lieftinck (1957); Linsley (1958)]. However, dense aggregations sometimes contain both host and parasitic bees, as *Anthophora* and *Melecta* [Linsley (1943)] or *Colletes* and *Epeolus* [Linsley and MacSwain (1958)]. By contrast, loose aggregations may be of diverse composition, involving bees and wasps of a number of different families.

Dense aggregations may form in temporary burrows excavated in the soil, in cracks and crevices, beneath overhanging rocks, on branches or twigs of trees or shrubs, on plant stems, in leaves or fronds, etc. Loose aggregations commonly occur in particular sites, to which individual bees and wasps may return, night after night. Thus Schwarz (1896), described "sleeping trees" in Texas which were utilized by *Exomalopsis pygmaea* (Cresson), *Coelioxys texanus* Cresson, and *Ammophila wrightii* (Cresson). The shrubs selected were dead specimens of the spiny, intricately branched *Celtis pallida* Torrey, which were scattered through chapparal. The sleeping Hymenoptera were found on the thinnest, outermost twigs, commonly attached to thorns. Schwarz observed that the plants selected for sleeping quarters were of small size (from 4 to 5 feet in height) and were surrounded by living shrubbery of larger size. He also noted that although a multitude of dead shrubs of the requisite size were available in well protected situations, only a few were utilized for sleeping purposes.

¹ Cornell University and the University of California, respectively. The authors are indebted to Dr. M. A. Cazier, Director, Southwestern Research Station, American Museum of Natural History, Portal, Arizona, for making the facilities of the Station available as a base for these and related studies. The authors are also indebted to R. M. Bohart for identifying the Vespidae, K. V. Krombein, the Scoliidae, and P. H. Timberlake the bees.

Sleeping bees and wasps usually grasp the substrate very tightly, and are difficult to disturb. Schwarz commented that it requires considerable force to dislodge bees which have grasped a twig with the mandibles. Rayment (1935) states that the jaws of some sleeping bees are clamped so tightly that large raindrops striking the body will decapitate them. Sleeping postures and orientation vary considerably from species to species and in some instances among individuals of the same species.

The observations reported here were mostly made during the summer of 1959 on the grounds of the Southwestern Research Station, in the Chiricahua Mountains, 5 miles west of Portal, Arizona. Opposite the main laboratory building and across an access road and parking area a meadow about 100 feet wide and 300 feet long, extending in a more or less East-West direction, is dominated in late July and August by dense stands of *Melilotus alba*. Toward the west end of the meadow the plants are scattered and during the latter part of August they were becoming densely crowded by rapidly growing *Heterotheca subaxillaris*, the dominant plant of the latter portion of the season. This area contained the major "sleeping" plant of the meadow. To the south, across the road, scattered clumps of *Melilotus* were growing under similar conditions. In this site a second major sleeping quarters was located; this was used for confirming observations made on the major sleeping plant, but all data in this paper pertain to the latter. Extensive areas of *Melilotus* occurred behind the Osborn Laboratory building and in an orchard behind nearby residential buildings, but no other major congregating areas were found.

Although our observations date from August 4, the plants involved had been in use by sleeping Aculeate Hymenoptera since at least the first week of July, when they were noted by M. A. Cazier and M. Statham. Our observations were made daily from August 4 to August 22; after that date they were made every fifth day up to September 11. Observations were made at dusk, when all Hymenoptera appeared to have settled for the night, and before it was too dark to see them well. Occasionally we made supplementary observations in the early morning or just before or after a heavy shower. From time to time we collected a specimen for identification, but we did this very sparingly; we believe that only a very small percentage of the decline in population noted between August 4 and September 11 can be attributed to our collecting.

In all, we found 21 species of wasps and 15 species of bees on this one clump of *Melilotus*. Three species of the genus *Ammophila* provided the major element in the sleeping aggregation; they

exceeded all the others in daily numbers and were present on all of the 23 days on which observations were made. Four other species appeared in moderate numbers and on more than half of the days. These seven species might be termed the "regulars". Six other species or groups of species appeared on at least 5 but not over 10 of the 23 days; these might be termed "irregulars". All the remaining species appeared on less than 5 days, often only once, and might be termed "casuals". A list of the species follows; except for casuals, after each species (or in some case group of species) is given the number of days (out of 23) on which each was found sleeping on the bush.

REGULARS: *Ammophila* spp. (*pruinosa* Cresson, *juncea* Cresson, *fernaldi* Murray) (23), *Bicyrtes capnoptera* (Handlirsch) (18), *Triepeolus* sp. near *timberlakei* Cockerell (17), *Priononyx pubidorsus* (Costa) (15), *Triepeolus* n. sp. (a large, robust species) (14).

IRREGULARS: *Scolia dubia haematodes* Burmeister (7), *Stenodynerus* spp. [*apache* Bohart, *papagorum* (Viereck), *bicornis cushmani* Bohart)] (7), *Rygius* spp. [*hidalgo* (Saussure), *guerrero* (Saussure)] (6), *Nomada crucis* Cockerell (6), *Melissodes* sp. near *confusa* Cresson (6), *Pterocheilus* spp. [*laticeps* Cresson, *arizonicus* Bohart] (5).

CASUALS: *Scolia otomita* Saussure, *Campsomeris completa* Rohwer, *Sphex lucae* Saussure, *Ammophila procera* Dahlbom, *Stictiella pictifrons* (Smith), *Steniolia elegans* Parker, *Eucerceris arizonensis* Scullen, *Philanthus gibbosus* (Fabricius), *Halictus tripartitus* Cockerell, *Nomia tetrazonata* Cockerell, *Melissodes* sp. near *confusa* Cresson, *Diadasia olivacea* (Cresson), *Anthophora montana* Cresson, *Anthophora californica texana* Cresson, *Coelioxys* sp., *Megachile texana* Cresson, *Megachile exilis* Cresson, *Megachile parallela* Smith, *Bombus morrisoni* Cresson.

The Scoliidae and Sphecidae were in most instances represented by both sexes, although in general males were more numerous than females. The Vespidae were represented almost entirely by males (one female *Pterocheilus laticeps* being the only exception). The female Sphecidae belonged mostly to species which typically do not spend the night in the nest; the Scoliidae, of course, do not have a nest as such. The nesting bees were represented primarily by males (a casual female of *Halictus tripartitus* provided an exception). The parasitic bees were represented by both sexes, although females of *Triepeolus* and *Nomada* were more numerous than males.

In his study of a sleeping aggregation of mixed wasps and bees on wild oats in California, Bradley (1908) noted that each species

tended to be grouped separately. This was in some measure true in the present case. The three species of *Ammophila* tended to arrange themselves (well mixed as to species) along several nearly vertical branches in the central part of the clump of *Melilotus*, from two to four feet high. The *Bicyrtes* occupied one or two horizontal branches at this same height but outside the main part of the *Ammophila* cluster. The top of the bush was the domain of *Priononyx* and the Scoliidae (4 to 5.5 feet high). The Vespidae occupied the ends of various branches from about 3 feet up. The bees tended to occur mostly below the main part of the *Ammophila* cluster. As the season progressed, there seemed to be less and less tendency for stratification and for separation by species. The *Ammophila* and the bees tended to move upward and to mingle with the few remaining scoliids and *Priononyx*. By this time the total population of bees and wasps had declined markedly, and the bush itself was becoming brown, desiccated, and overgrown by very tall *Heterotheca* plants.

Each genus of bees and wasps exhibited its own characteristic manner of grasping the plant (Plate 12). The four species of *Ammophila* all grasped the stem with the mandibles and all three pairs of legs, holding the body at a 50-70° angle with the stem. *Bicyrtes* oriented crosswise on horizontal stems in what appeared to us to be a precarious balance, held by the middle and hind legs (the front legs tucked in under the body). *Priononyx pubidorsus* held the body diagonal to the stem, head down, holding on with all three pairs of legs but not the mandibles. The species of *Pterocheilus* held their body parallel to the stem, holding on with all three pairs of legs, but sometimes with the mandibles also. The *Scolia* chose the flowers and curled the body about the racemes. Among the bees, *Melissodes* sp. near *confusa* curled about the stem, which it grasped with the mandibles. *M. paroselae* grasped the plant with the mandibles and hung with the legs free, as did both species of *Triepeolus*. *Nomada crucis* oriented head down, with the hind legs, or all legs free.

Discussion

The selective value of sleeping aggregations is not clear. Rayment (1935) states that the temperature is increased by clustering in dense aggregations. On the other hand, Grassé (1942) considers gregarious sleeping as a possible stage in the evolution of social habits. The most obvious explanation would appear to be that aggregations offer protection. However, since many aggregations are made up largely of males, they would appear to gain little in the way of re-inforced protection from predators. Most aggregations begin to form in the daylight hours while the diurnal

TABLE ONE—THE NUMBER OF BEES AND WASPS ON THE MAJOR SLEEPING PLANT ON SPECIFIC DATES

| Date | Regulars | | | | | | Casuals | Total Bees and Wasps |
|-------------|----------------------------|----------------------------|-----------------------------|------------------------------------|------------|---|---------|----------------------|
| | <i>Ammophila</i> (3 spp.)* | <i>Bicyrtes capnoptera</i> | <i>Priononyx pubidorsus</i> | <i>Triepolus</i> (2 spp.) | Irregulars | | | |
| August 4 | 15 | 2 | 2 | 1 | 7 | 7 | 34 | |
| 5 | 30 | 3 | 6 | 5 | 5 | 3 | 52 | |
| 6 | 27 | 4 | 0 | 2 | 18** | 2 | 53 | |
| 7 | 25 | 4 | 2 | 4 | 2 | 2 | 39 | |
| 8 | 14 | 5 | 10 | 5 | 2 | 1 | 37 | |
| 9 | 20 | 3 | 4 | 2 | 2 | 5 | 36 | |
| 10 | 15 | 3 | 1 | 3 | 3 | 0 | 25 | |
| 11 | 15 | 3 | 2 | 2 | 1 | 0 | 23 | |
| 12 | 19 | 3 | 1 | 6 | 5 | 0 | 34 | |
| 13 | 1 | 2 | 0 | 5 | 0 | 0 | 8 | |
| 14 | 10 | 1 | 0 | 3 | 2 | 0 | 16 | |
| 15 | 7 | 4 | 0 | 2 | 3 | 0 | 16 | |
| 16 | 15 | 3 | 1 | 3 | 5 | 0 | 27 | |
| 17 | 7 | 3 | 0 | 2 | 0 | 1 | 13 | |
| 18 | 10 | 3 | 1 | 4 | 1 | 2 | 21 | |
| 19 | 10 | 2 | 1 | 4 | 0 | 2 | 19 | |
| 20 | 7 | 1 | 1 | 1 | 0 | 1 | 11 | |
| 21 | 8 | 0 | 1 | 1 | 1 | 0 | 11 | |
| 22 | 8 | 1 | 2 | 3 | 0 | 0 | 14 | |
| 27 | 6 | 0 | 2 | 0 | 0 | 0 | 8 | |
| September 1 | 5 | 0 | 0 | 0 | 0 | 0 | 5 | |
| 6 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | |
| 11 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | |

*—The figures for *Ammophila* must be considered approximations, as it was difficult to make an exact count when the number was high.

**—Fourteen of these were *Scolia dubia haematodes*.

predators are still active. On July 24, 1959, in a patch of milkweed (*Asclepias subverticillata* Gray) near Rodeo, New Mexico, males of *Nomia tetrazonata* Cockerell were beginning to aggregate at 4:15 p.m. in dense groups estimated at from 10 or 12 to 35 or 40 individuals. The aggregations were noisy and were being preyed upon by a robber fly (*Mallophora bromleyi* Curran), three of which were found in the vicinity with male *Nomia* as prey. In the same area on August 3, 1959, some 25 to 30 males of *Protoxaea gloriosa* Fox were gathering noisily in a ball about half way up a 5 foot plant of *Heterotheca subaxillaris* (Lam.) at 3:50 p.m. The sky was clear, the sun bright and warm, and again asilids were active in the vicinity. An example of *Blepharepium secabilis* (Walker) was taken with *Protoxaea* as prey, another turned up in the net when an attempt was made to sweep up the aggregation for counting and identification. Although the bees in these instances were all males, it is a well established fact that many Asilidae prey upon bees and wasps of both sexes [Linsley (1960)].

The bees and wasps began to gather on the *Melilotus* at the Research Station an hour or two before sunset; as soon as the sun struck the bush in the morning, they began to show signs of movement, but a few were generally still in place for an hour or two after sunrise. Also, they tended to gather in much the same manner just before a storm. Although they were subjected to some very heavy rains and winds, there is no evidence that the storms had any serious effect on them. Although it is conceivable that bees and wasps in dense clusters obtain protection from physical factors in the environment, it is difficult to believe that the bees and wasps in this loose aggregation obtained any such protection merely by sleeping on the same plant.

The species of *Ammophila* are well known to form loose sleeping aggregations on vegetation. In the present instance the *Ammophila* may have "selected" this bush for certain properties not apparent to us. Returning to the same bush night after night, these wasps may have provided a stimulus of unknown nature for other wasps and bees to come to the same bush, until eventually a considerable array of them customarily slept together. Whatever the significance of this behavior, it was striking indeed to find so many species and individuals on a single clump of *Melilotus* while hundreds of similar plants all over the field were almost or completely uninhabited at night.



PLATE 12

Sleeping attitudes of some wasps and bees

Upper left: *Scolia otomita* Saussure; upper right: *Melissodes* sp.; middle left: *Ammophila procera* Dahlbom; middle right: *Priononyx pubidorsus* (Costa); lower left: *Triepeolus* sp.; lower right: *Bicyrtes capnoptera* (Handlirsch).

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A NEW SPIDER MITE FROM INDIA

(Acarina: Tetranychidae)

By E. A. MCGREGOR

Some years ago the writer received a sample of phytophagous mites from Dr. E. Browning of the British Imperial Institute of Entomology. The specimens were collected from jute, at Dacca, Bengal Province, India.

An inquiry, directed to the British Museum of Natural History, in an effort to obtain additional data as to the collector, date of collecting, biological features, etc., was unsuccessful due to personnel changes at Dacca. The writer therefore is proceeding to describe the mite, as follows:

***Tetranychus bengali*, new species**

Female.—Palp-tarsus slightly thicker than long; its terminal sensillum dome-shaped, distinctly thicker than long. Tarsus I typically with no setae distinctly proximal of proximal pair of duplex setae; this segment bears (in addition to the duplex setae) 10 tactile and 2 sensory setae. Mediodorsal spur of empodial claw conspicuous. The proximal duplex setae arise about one-fourth the length of tarsus from its proximal end. Tibia I with 8 tactile and one sensory setae. Collar peritreme consisting of a medium-length, narrow arm and a shorter, reflexed, swollen arm terminally.

Male.—Terminal sensillum of palptarsus one-third longer than thick. Aedeagus with dorsal outline of shaft continuing straight to base of knob, thus appearing to lack the hook element; the distal half of ventral outline of shaft sloping upward 45° from main axis of shaft. The knob is inconspicuous, its axial length being about one-sixth that of shaft; its acute anterior tip prominent, its weak posterior angulation inconspicuous.

Holotype.—One male and one female, Dacca, Bengal Province, India, on jute; Imperial Institute of Entomology No. 10548; U. S. National Museum No. 2602. (Collector's name and date of collecting not known.)

The present species is perhaps closest to *T. ludeni* Zacher (= *Septanychus deviatarsus* McGregor), from which it may be distinguished as follows:

T. ludeni

Male.—Posterioventral outline of shaft of aedeagus, in profile, becoming vertical near the terminal knob; posterior margin of knob rounded.

Female.—Mediodorsal spur of empodial claw I less than one-third as long as main claw divisions. Terminal sensillum of palptarsus nearly twice as long as thick. Tibia I with 9 tactile and one sensory setae.

T. bengali

Male.—Posterioventral outline of shaft of aedeagus, in profile, not vertical near terminal knob; posterior tip of knob noticeably angular.

Female.—Mediodorsal spur of empodial claw I fully one-half as long as main claw divisions. Terminal sensillum of palptarsus distinctly thicker than long. Tibia I with 8 tactile and one sensory setae.

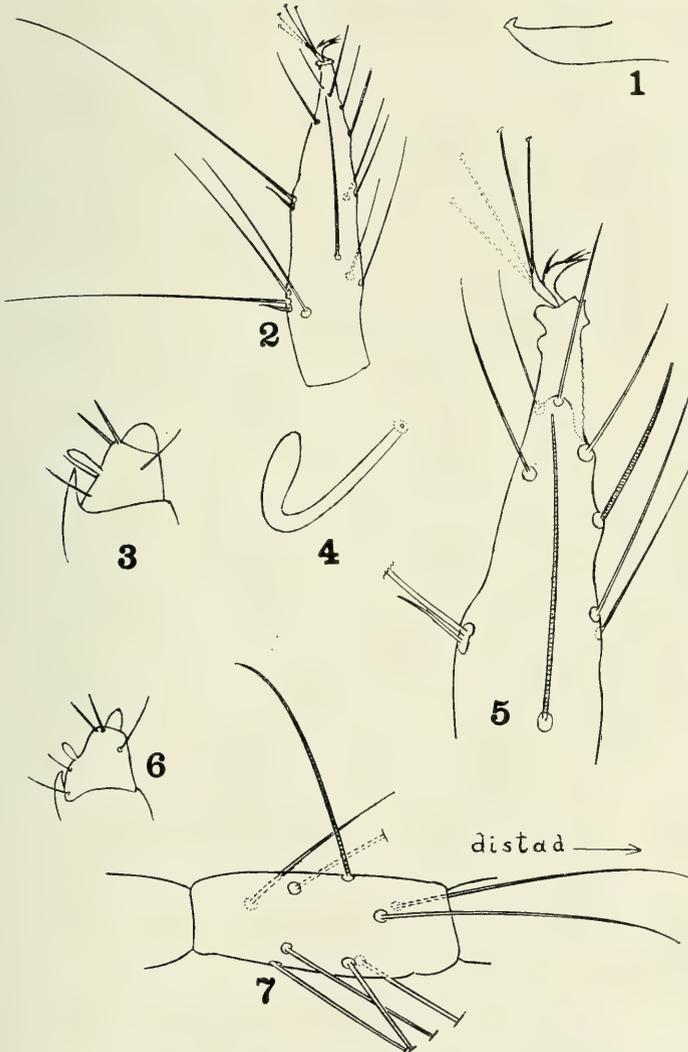


PLATE 13

Tetranychus bengali

Fig 1. Aedeagus, lateral view. Fig. 2. Tarsus I of female. Fig. 3. Palptarsus of female. Fig. 4. Peritreme, lateral view. Fig. 5. Apical half of tarsus I of female. Fig. 6. Palptarsus of male. Fig. 7. Tibia I of female.

FOSSIL ARTHROPODS OF CALIFORNIA
NO 23. SILICIFIED INSECTS IN MIOCENE NODULES
FROM THE CALICO MOUNTAINS.

By W. DWIGHT PIERCE

In No. 22 of this series (Bull. So. Calif. Acad. Sci. 58:72-78, 1959), the writer presented a general report on studies of fossils found in calcareous petroliferous nodules of Miocene age in Southern California. Recovery of the fossils has continued, with particular concentration on the nodules from the Calico Mountains. The vast amount of material accumulating, both in the Los Angeles County Museum laboratory, and in that of Mrs. Ruth Kirkby, at her home in Riverside, California, necessitates breaking down the results in short papers as rapidly as accurate reports can be prepared. The present paper includes some of the rarer finds in several orders: Collembola, Ephemera, Plecoptera, Corrodentia, and Coleoptera.

Order COLLEMBOLA Lubbock 1873.

Although the oldest known fossil insect remains recorded are Collembola from the Devonian of England, fossils in this order are very rare. Handlirsch (1906. Die Fossilien Insekten. V Lief.: 678, 679) lists seven of the Suborder Arthropleona, and three of the Suborder Symphyleona from the Lower Oligocene Baltic amber. It is with pleasure that a three-dimensional crystalline springtail from the Miocene is added to the Arthropleona.

Suborder ARTHROPLEONA Börner 1901.

Superfamily ENTOMOBRYOIDEA Womersley 1933.

Family ENTOMOBRYIDAE (Tömösvary 1883) Gisin 1944.

Tribe ENTOMOBRYINI Börner 1906.

Genus ENTOMOBRYA Rondani 1861.

Entomobrya (Entomobrya) Kirkbyae

New Species

(Figures 1, 2)

HOLOTYPE. No. 5-303. Ruth Kirkby collection, Kirkby private Museum, Riverside, California. From Kirkby site 2 (float), in Upper Switchback Cañon, NW $\frac{1}{4}$ Section 19, R.2.E., T.10.N., Calico Mts., Yermo Quadrangle, San Bernardino County, California. The photograph (Figure 1) slightly retouched by the author, while studying the specimen under the microscope, gives a good representation of the specimen, which is complete except for parts of the legs and antennae.

DESCRIPTION. Length of body 1.00 mm; length of body with extended manubrium 1.50 mm.

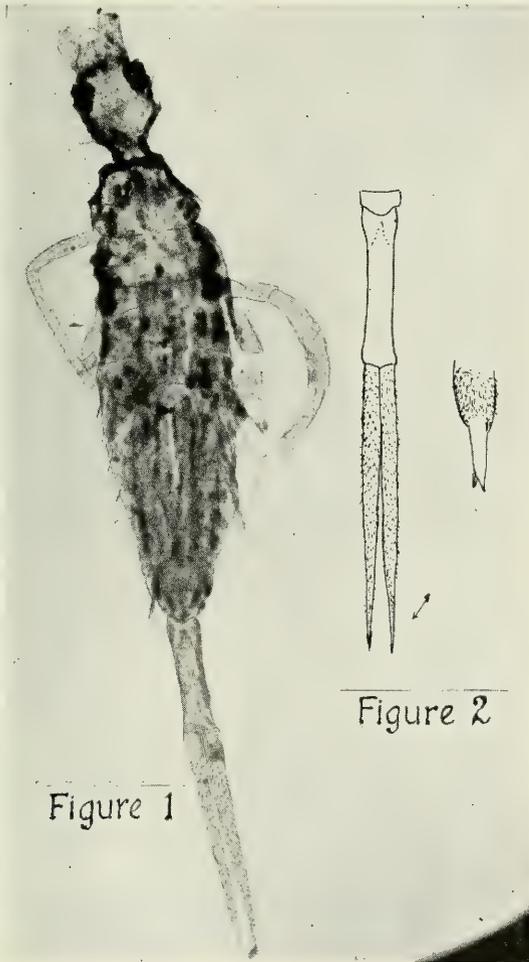


PLATE 14

Figure 1. *Entomobrya kirkbyae*, new species, type, actual length 1.5 mm. Photomicrograph by Edwin Horne.

Figure 2. *Entomobrya kirkbyae*, drawing by author of manubrium and dentes, with enlargement of mucro at tip of dentes. Size 0.5 mm.

Head elongate, in the proportions of: total length 28, frons and clypeus 8.5, eyes 7.5, behind eyes 9.5; width: clypeus 4, frons at base 10.5, head at eyes 17.5, vertex between eyes 7, occiput before narrowing 16, at apex 8.2. Prothorax length 4; width 8.5. Mesothorax length 17; width anterior portion 15, posterior portion 24. Metathorax length 11.5; width 28.5. First abdominal length 5.2; width 29. Second abdominal length 10; width 30. Third abdominal, length on median line 8.5; width 30. Fourth abdominal, length 39.5; width diminishing from 30 to 16.5. Fifth abdominal, length 7.5; width 14.5. Sixth abdominal length 7; width 10. Manubrium, length 25; width at base 7, narrowing at middle to 6. Dentes with mucro, length 52; width of single dens at base 3.5. All of these measurements are proportionate and obtained from photograph by centimeter calipers.

The head and body are sparsely clothed with long hairs. A great cluster of strong bristles on prothorax reaches forward over back of head. The dentes are minutely clothed with a short, fine pubescence. Frons and labrum show indistinctly between the bases of the antennae. Only basal joints of antennae are present. The eye patches are large and black, but the separate ocelli are not decipherable. The occipital area behind the eyes is longer than the eyes, and is abruptly angulately narrowed to the necklike prothorax.

Side margins of prothorax, also anterior margin and side margins of anterior half of mesothorax (scutum) sharply impregnated with black pigment. The scutal or anterior portion is almost twice as wide as prothorax at base, then curving abruptly widens to the wider posterior or scutellar portion. There is indication that the metathorax is evenly divided into scutum and scutellum.

Abdominal segments I, II, and III are short; while segment IV is much longer dorsally than the three combined, and four times as long as III. (From this we derive that the antennae are 4-segmented.)

The manubrium and dentes are together very long and slender, in the proportion to the rest of the body, as 4:7. The dentes are about twice as long as the manubrium, and taper to the tip. With difficulty, due to the transparency of the specimen, the mucro was seen at tip, and it seems to have a tooth as shown in sketch (Fig. 2).

The ventral lobe is short; the hamulus is indistinct.

This fossil species belongs to the group of cosmopolitan species of springtails, including *E. (E.) marginata* Tullberg (1871), and *E. (E.) atrocincta* Schött 1897. The latter is recorded as a present-day inhabitant of stagnant water pools in California.

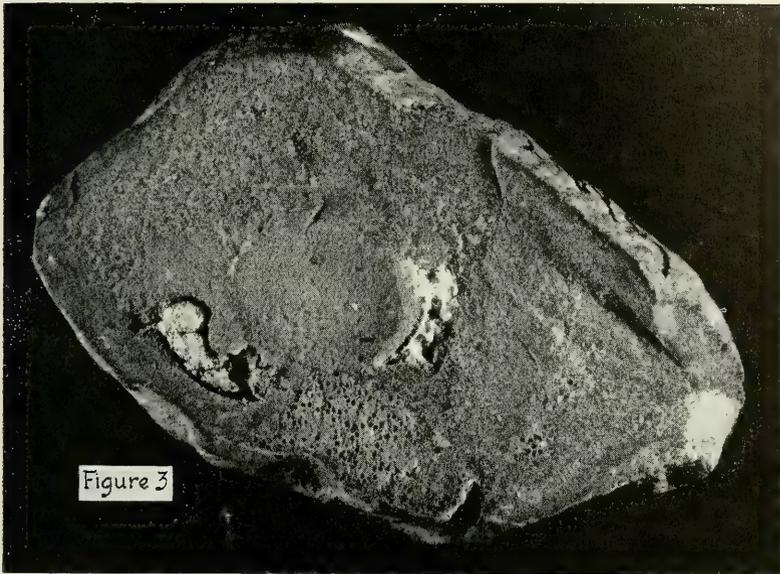


PLATE 15

Figure 3. Nodule 3686 containing mayfly and eggs. Size of nodule, $44 \times 34 \times 22$ mm. Photograph by George Brauer.

Order EPHEMERIDA Leach 1817.

Superfamily BAETIDOIDEA n.nom.
(BAETOIDEA Ulmer 1920)

Family BAETIDIDAE n.nom.
(BAETIDAE Ulmer 1920)

Subfamily BAETIDINAE Handlirsch 1929, or
BAETISCINAE Handlirsch 1929.

(Figures 3, 4, 5)

An interesting find, specimen 3686, was made in a very irregular, unpromising brown and gray-colored nodule, No. 28957, collected by Mrs. Laura Rouse, in Section 19, R.2.E., T.10.N., Yermo Quadrangle, when she broke the nodule in two. Here were disclosed in the two pieces, a female mayfly and her cluster of eggs, loosely placed in a mass which probably was originally foamy or gelatinous. The nodule weighs 34.7 gram, and measures $44 \times 34 \times 22$ mm.

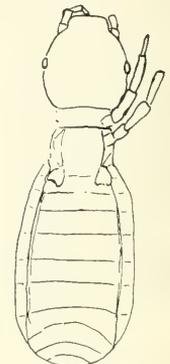
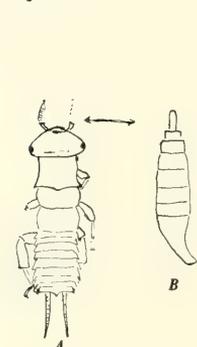
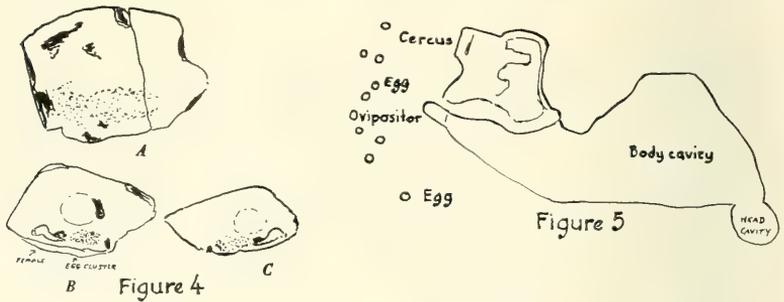


Figure 6

Figure 7

PLATE 16

Figure 4. Drawings of nodule 3686. a. Outside of nodule. b. Face of larger piece showing female mayfly and cluster of eggs. c. Face of smaller piece showing eggs and cavity occupied by female.

Figure 5. Mayfly from nodule 3686: sketch of female cavity, and proximity of eggs.

Figure 6. Stone fly, specimen 2597: a. First larva, length 1.8 mm.; b. Enlargement of antenna.

Figure 7. *Miotroctes rousei*, new species, type. Size 0.9 mm.

Robert W. Pennak (1953, Fresh Water Invertebrates of the United States. Ephemeroptera (Mayflies). pp. 509-521) states:

"In some species the female actually crawls below the surface and deposits on submerged objects. . . . The eggs are produced in great numbers . . . exceedingly small . . . sometimes imbedded in a gelatinous material." He further says that mayfly nymphs browse in the substrate, feeding with a grinding action of the mandibles, on algae, or the tissues of higher aquatic plants.

Mayflies, after emergence as adults, seldom live over a day (in which they mate and oviposit). The finding of the female and her egg cluster presents the event of one day perpetuated by the catastrophe that involved the lake.

The female is chalky, cream color, not crystallized, and contains many orange brown spherical bodies, but her cavity proves her identity as mayfly. The body measures 7.44 mm., height 2.80 mm. Her egg cluster is 14 x 6 mm. in cross section. The individual eggs measure 0.19 to 0.23 mm. in diameter. They are spherical, unornamented, without filaments. James G. Needham, Jay R. Traver, and Yin-Chi-Hsu (1935, *The Biology of Mayflies*) limit the known spherical eggs with smooth chorion to the genera *Baetisca* and *Callibaetis*.

The *Callibaetis* species are pond dwellers, and the eggs measure about 0.12 mm. in diameter. The *Baetisca* species are stream dwellers and the eggs measure about 0.18 mm. in diameter. The fossil eggs measure 0.19 to 0.23 mm. in diameter.

The size of the adult fossil (7.44 mm.) ranks her with the smallest of *Baetisca* and *Callibaetis*. The sketch of the cavity (Figure 5) shows the lowered head, the high thorax, the ovipositor tube extending to a point opposite the base of the cerci. The eggs lie just beyond the ovipositor. But their distribution in the nodule shows that she moved quite a distance during the oviposition.

Order PLECOPTERA Burmeister 1839.
(Figure 6).

While stone flies can be expected in the lake fauna, the only specimen so far found is a crystallized first larva, extracted by formic acid from Nodule 17212, and numbered specimen 2597; found by Ruth Kirkby at her site 10, which is not far from our site 10, the Rouse anticline, at the switchback in NE $\frac{1}{4}$ Section 19, R.2.E., T.10.N., Yermo Quadrangle.

This tiny larva is crystal clear, measuring 1.8 mm. in length; antennae 0.4 mm., cerci 0.5 mm. Figure 6a shows the general form, and Figure 6b an enlargement of the left antenna. The antenna has a large curved basal segment; segments 2 to 7 transverse, segment 8 elongate, slender.

So little is known of the early stages of this order that further placement is not yet possible.

Superorder CORRODENTIA Burmeister 1839.
Order COPEOGNATHA Enderlein 1903.

It is with great pleasure that a fossil bark louse is now added to the nodule series of fossils.

A total of 18 species in 10 genera of Copeognatha are known from amber (Handlirsch, 1906. *Die Fossilen Insekten* Lief. 5:702-704). One fossil of this order is known from North America,—*Parapsocus disjunctus* Scudder, from the Oligocene of Fossil Cañon, White River, Utah (Scudder, 1890. *Tertiary Insects of North America*. p. 119; pl. 5, fig. 51).

Suborder TROCTOMORPHA Borror and Delong 1954.
Family LIPOSCELIDAE (Troctidae)

Until 1907 only one species of fossil Liposcelidae (Troctidae) had been recorded. The specimen here described resembles our common household pest *Liposcelis divinatorius* (Müller 1776) (*Troctes*).

Genus MIOTROCTES, new genus.

The genus is separated from *Liposcelis* by the fact that the anterior and middle femora are not enlarged. The posterior femora are missing in the specimen.

Miotroctes rousei, new species.
(Figure 7).

Named in honor of the late John H. Rouse, who with Mrs. Rouse independently discovered this interesting field of fossil insects.

HOLOTYPE. A beautiful, clear crystalline specimen, No. 3633 (L.A.Co.Mus.Invert.Paleontology No.S 9103), separated by the author by use of formic acid from Nodule 26624, collected at Site 10 (Rouse anticline) (LACMIP 357), in Lot 313, from NE $\frac{1}{4}$ Section 19, R.2.E., T.10.N., Yermo Quadrangle, by Mrs. Laura Rouse.

DESCRIPTION. Length 0.903 mm. Head broadly rounded, with single eyes slightly in front of the middle of the head. Clypeus quadrate, one-half as wide as head, and about one-seventh as long as head. (In this it differs strongly from the common *Liposcelis divinatorius*.) Maxillary palpi 4-jointed.

Prothorax short, transverse; mesothorax and metathorax with common sternal plate. Anterior and middle legs with femur and tibia of equal length, not swollen. Posterior legs missing in specimen.

Abdomen 10-segmented, with pleural folds ventral.

Order COLEOPTERA Linnaeus 1758.
Family DERMESTIDAE Leach 1817.
Subfamily ANTHRENINAE.
Tribe MEGATOMINI.
Subtribe CRYPTORHOPALINA.
Genus MIOCRYPTORHOPALUM, new genus.

Characters based on larva only; ocelli probably 6; antennae short and stout; mandibles toothed, but without retinaculum; hastisetal hairs on meso- and methathorax, and seventh abdominal segment. The following table shows the position of this genus with respect to others in the family.

TABLE OF CHARACTERS OF DERMESTID LARVAE

| DERMESTIDAE | Ocelli on each side | Hastisetal hairs on segments | Antennae | MANDIBLES | | Caudal brush | Distribution |
|--|---------------------------|------------------------------------|----------|---------------|---------------------|-------------------------|-------------------|
| | | | | with tooth | with retinaculum | | |
| Thylodriinae Thylodrius | 3 | none | short | absent | absent | absent | Europe America |
| Attageninae Novelsis | 4 | none | long | absent | present | present | America |
| Attagenus | 5 | none | long | absent | present | present | America |
| Dermestinae Dermestes | 6 | none | long | tridentate | present | absent | America |
| Trinodinae Aspectus | 6 | none | short | present | absent | sparse long hairs | America |
| Anthreninae Anthrenini Anthrenus | 6 | 5-7 | long | absent | with or without | dense brushes | America |
| Megatomini Megatomina Perimegatoma | 6 | 5-8 | long | absent | present | | America |
| Thaumaglossa | 6 | 5-8 | short | absent | absent | | America |
| Trogoderma | 6 | 5-8 | short | absent | present | present | cosmopolitan |
| Cryptorhopalina Labrocerus | 6 | 7, 8 | short | present | present | hastisetal | |
| Globicornis | 6 | 7, 8 | short | present | present | hastisetal | |
| Miocryptorhopalum | prob. 6 | mesothorax metathorax 7 | short | present | absent | absent | fossil |
| Cryptorhopalum | 6 | 7 only | short | present | present | hastisetal | arid America |
| Ctesiini Ctesias | 6 | 4-7 | long | present | absent | present | Europe |

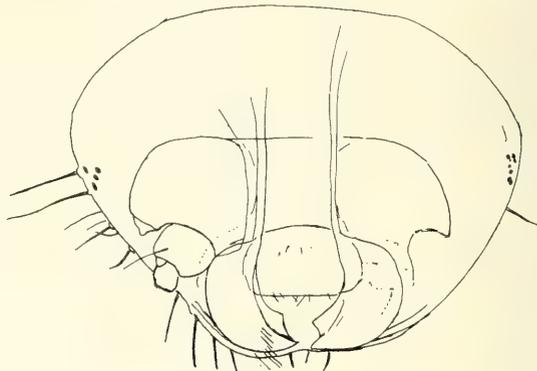


Figure 8

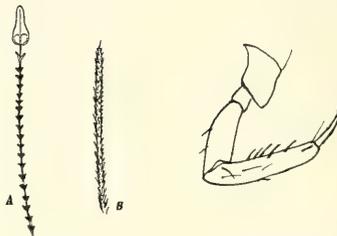


Figure 9

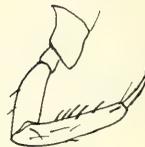


Figure 10

PLATE 17

Figure 8. *Miocryptorhopalum kirkbyae*, new species, type, larval head, Instar I.

Figure 9. *Miocryptorhopalum kirkbyae*, a. Hastiseta; b. Barbed seta.

Figure 10. *Miocryptorhopalum kirkbyae*. Hind leg of larva I.

There is a desert species *Cryptorhopalum aridum* Casey, from the Inyo Mts., of which the larva is undescribed. All of the species of *Cryptorhopalum* in the United States are from arid regions.

***Miocryptorhopalum kirkbyae*, new species.**

(Figures 8, 9, 10).

Named in honor of my friend and co-worker, Mrs. Ruth Kirkby.

HOLOTYPE No. S-776, in Kirkby Private Museum, Riverside, Calif. Crystallized larva extracted by formic acid from a Calico Mountain nodule, collected by Ruth Kirkby at her site 10, NE $\frac{1}{4}$ Section 19, Upper Switchback Cañon, R.2.E., T.10.N., Yermo Quadrangle.

DESCRIPTION. Instar I larva: length 1.44 mm.; width of head 0.203 mm.

Head (Figure 8) transverse, ovoid, with mandibles ventral. The mandibles are outwardly rounded, medianly about in contact, with abductor muscles just within the margin of the head; and the adductor muscles parallel, directed posteriorly. The armature of the mandibles consists only of the incisor and a molar tooth. The three-jointed robust antennae are postero-lateral to the mandibles, and the third segment barely surpasses the anterior margin of the head. A tiny lobe on second segment beside the third segment is characteristic of Dermestid larvae. The specimen is so clear that the maxillae and epipharynx are barely discernible. There are probably 6 pigmented ocelli in clumps at each side of head.

Body simply segmented, with 8 abdominal segments. The surface is armed with many barbed setae (Figure 9b), and a few hastisetae (Figure 9a) on mesothorax, metathorax, and seventh segment. The hastisetae are close in form to those of *Trogoderma ornatum* Say. There is no terminal brush.

Legs alike, four-jointed, with broad coxa, short trochanter, more robust femur, longer tibia, and a long acute tarsungulus (Figure 10).

The finding of this larva, usually associated with dry, dead material is unexpected. It was probably blown into the water with the dry material in which it was feeding.

This species has been studied by checking the following publications:

BÖVING, Adam G., and F. L. CRAIGHEAD.

1931. An illustrated synopsis of the principal larval forms of the Order Coleoptera. Brooklyn Ent. Soc. p. 55, plates 89, 90.

PETERSON, Alvah

1951. Larvae of Insects. An Introduction to nearctic species. Part II. pp. 42, 80, 174, plates 89, 90.

REES, Bryant E.

1943. Classification of the Dermestidae (larder, hide, and carpet beetles) based on larval characters, with a key to the North American genera. U.S. Dept. Agr., Misc. Publ. 511, pp. 1-18, 5 figs.



CONENOSE BUG ANNOYANCE IN GRIFFITH PARK IN 1958

By Sherwin F. Wood

Life Sciences Department, Los Angeles City College,
Los Angeles 29, California.

The following data on occurrence of *Triatoma protracta protracta* and infection with *Trypanosoma cruzi* in Griffith Park, Los Angeles, is presented as the result of field work by Peter J. Mehlinger, Jr. His efficient field assistance is hereby acknowledged. Table 1 summarizes the general occurrence of western conenose bugs at Griffith Park Boys' and Girls' Camps for the summer of 1958 through the cooperation of park and camp personnel.

These insects were collected in the usual sites as specified in the 1957 study (Mehlinger, Jr., and Wood, 1958, Bull. So. Calif. Acad. Sci. 57:39-46). Conenose bugs were found from June 24th through September 13th at the Boys' Camp. Two were collected in June, 22 in July, 22 in August and 7 in September. Bugs were found from July 2nd through September 18th at the Girls' Camp. Eleven were taken in July, 25 in August, and 12 in September.

Additional interesting locations of live bug captures were inside a shoe, a suitcase, a washing machine, and between cardboard strips in the craft room. As noted in Table 1, most bugs were captured inside the buildings. However, 3 male and 2 female *Triatoma* from the main lodge porch and 1 female from the crafts area were taken in the Boys' Camp. One male from the step and 1 female (negative for trypanosomes) from the outside wall of cabin No. 8 and 1 male from the Pioneer Area wash sink were found at the Girls' Camp. Some evidence of response to moisture by *Triatoma* is indicated by finding bugs in the dish-washing machine (dining hall), shower and rest room from the Boys' Camp. Additional bugs were taken from the kitchen sink, rest room sink, shower and wash sink in the Girls' Camp.

The 1957 Table 1 reveals a sex ratio of 49 ♂ to 113 ♀ as compared with 14 ♂ to 39 ♀ reported here for the Boys' Camp. The ratio of male to female bugs for 1957 at the Girls' Camp was 35 to 43 as compared with 14 to 34 for 1958. The ratio of male to female bugs infected with trypanosomes at the Boys' Camp for 1957 was 21 to 42 in contrast to 3 to 17 in 1958 and 3 to 2 for the Girls' Camp area.

Only 101 bugs were captured in 1958 as compared with 240 for 1957 but this may reflect variation in sustained interest by camp personnel in a general cooperative venture of this type.

TABLE 1
1958 Summer Collection of *Triatoma p. protracta*
from Griffith Park Youth Camps

| SOURCES | Boys' Camp | | | Girls' Camp | | |
|------------------------|------------|-------|---------|-------------|-------|--------|
| | Coll. | Exam. | Inf. | Coll. | Exam. | Inf. |
| Director's Home | 2♂, 4♀ | 6 | 2♀ | 7♂, 9♀ | 7 | 1♂ |
| Caretaker's Home | 1♀ | 1 | 1♀ | | | |
| Lodge Building | | | | | | |
| Office | 1♂, 4♀ | 5 | 2♀ | 1♂, 3♀ | 2 | |
| Kitchen | | | | 1♂, 2♀ | 3 | 1♂ |
| Pantry | 1♂, 1♀ | 2 | | 1♀ | 1 | |
| Cook's Quarters | 1♂, 1♀ | 2 | 1♂, 1♀ | | | |
| Dining Hall | 2♂, 5♀ | 7 | 1♀ | 1♀ | | |
| First Aid Room | | | | 2♂, 5♀ | 7 | 1♂ |
| Women's Rest Room | 1♀ | 1 | | | | |
| Porch | 3♂, 2♀ | 3 | 1♂, 1♀ | | | |
| Entry Hall | 2♀ | 2 | 1♀ | | | |
| Lost & Found | | | | | | |
| Closet | 1♂, 1♀ | 2 | 1♂ | | | |
| Cabin #2 | 1♂, 5♀ | 6 | 2♀ | | | |
| Cabin #3 | 1♂, 2♀ | 1 | 1♀ | | | |
| Cabin #4 | | | | 1♀ | 1 | 1♀ |
| Cabin #5 | 1♂, 5♀ | 6 | 2♀ | | | |
| Cabin #6 Rest Room | | | | 1♀ | 1 | |
| Cabin #7 | 1♀ | 1 | 1♀ | 1♀ | 1 | |
| Cabin #8 | 2♀ | 2 | 2♀ | 1♂, 2♀ | 3 | 1♀ |
| Cabin #9 | | | | 2♀ | 2 | |
| Cabin #10 | | | | 3♀ | 3 | |
| Cabin #11 | | | | 1♂ | 1 | |
| Cabin #11 Rest Room | | | | 2♀ | 1 | |
| Pioneer Wash Sink | | | | 1♂ | 1 | |
| Crafts Area & Building | 1♀ | 1 | | 1♀ | 1 | |
| Cabin #12 Shower | 1♀ | 1 | | | | |
| TOTALS: | 14♂, 39♀ | 49 | 3♂, 17♀ | 14♂, 34♀ | 35 | 3♂, 2♀ |

The 1957 infection rate of bugs from the Boys' Camp area was 38.8% as compared with 40.8% for 1958 and a 14.2% rate for the Girls' Camp area. The 1958 infection rate for male bugs was 25% and for female bugs 45.9% at the Boys' Camp and 30% and 8% respectively at the Girls' Camp. This is especially significant from a Public Health viewpoint since it reveals the existence of continued human contacts with bugs having a high enough natural infection rate with *Trypanosoma cruzi* to be significant in contaminative transmission of Chagas' disease.

One male dusky footed wood rat, *Neotoma fuscipes macrotis*, was caught from under the Director's House at the Boys' Camp July 25th. Examination of tail blood once each week for 7 weeks was negative for trypanosomes. On July 26th, 6 first instar *Triatoma p. protracta* were fed to capacity on the rat. The hind gut contents of all bugs dissected out on October 2nd were negative for trypanosomes.

The author thanks the Los Angeles City Department of Recreation and Parks and City Health Department for permits and the Camp Directors, Ann C. Woolf and Melvin C. Carlson, for their continued cooperation.

CONENOSE BUGS *Trypanosoma cruzi* FROM AREA 13
OF GRIFFITH PARK, LOS ANGELES, CALIFORNIA

By Sherwin F. Wood, Edward D. Mitchell, Jr., and Marsha J. Brenton, Life Sciences Department, Los Angeles City College, Los Angeles 29, California.

Twenty-six *Triatoma protracta protracta* were collected between March 13 and May 14, 1959 from 18 wood rat dens in Area 13, Griffith Park, Los Angeles. The Area reference designation is from the September 1955 revised Fire Map of the Department of Recreation and Parks. Two third and one fifth instar nymphs from two wood rat dens revealed living *Trypanosoma cruzi*. The average of 1.4 bugs per den compares with a California average of 2.6 previously reported by Wood (1950, Bull. So. Calif. Acad. Sci. 49:98-100).

One large (230 x 90 x 80 mm.) and 1 small (170 x 65 x 55 mm.) Sherman live traps were used at each setting to obtain mammals suspected of harboring trypanosomes. Ninety-two sets were made at 22 wood rat dens with 12 resets on 5 different days in Area 13, including the 2 dens where infected bugs were found. Seven female *Neotoma fuscipes macrotis* were captured in the large traps. The trap exposure time for mammal captures was less than 60 hours since the time the 7 captives were in the traps in the field was not checked and many traps were sprung without capturing the rodent. The mammals trapped per hour of exposure was 0.11 and the number captured per live set was 0.07. Possible explanations of the low rate of capture are human interference with the traps, rodent control activities, and poor bait acceptance due to high natural food supply.

Xenodiagnosis of the 7 dusky footed wood rats was carried out by allowing 27 laboratory raised 3rd and 4th instar nymphs of *Triatoma p. protracta* to feed upon their blood. All bug feces were negative for trypanosomes when examined 21 to 24 days after feeding on the wood rats showing that these rats did not harbor *Trypanosoma cruzi* in their peripheral blood at the time sampled.

The authors thank the Los Angeles City Department of Recreation and Parks and City Health Department for collecting permits.

Norman T. Mattox, Ph.D.

1910-1960

On February 1, 1960, death claimed Dr. Norman T. Mattox, 49, professor of biology at the University of Southern California, and member of the Southern California Academy of Sciences since 1957, as the result of pneumonia complicating a chronic lung ailment. Born in Cincinnati, Ohio, on October 22, 1910, Dr. Mattox in 1937 married Frances Southworth, who, with two children, Jo Ellen, 18, and Thomas Jay, 15, survives him. He graduated from Miami University, Oxford, Ohio, in 1933, and received his M.Sc. and Ph.D. degrees from the University of Illinois, Urbana, in 1934 and 1937, respectively, studying under such noted zoologists as Drs. Harley J. Van Cleave, Victor E. Shelford, and Waldo Shumway. His teaching appointments included those of instructor at Purdue University, 1937-38, instructor, assistant professor, and associate professor at Miami University, 1938-49, and visiting professor and professor at the University of Puerto Rico, 1946-52. Coming to the University of Southern California in the fall of 1952, he served as associate professor and professor in the department of biology, and prior to 1955 as research associate in the Allan Hancock Foundation. While on sabbatical leave during the 1959-60 fall semester, Dr. Mattox completed research on the biological productivity of the sea, started in Puerto Rico in the summer of 1957.

Dr. Mattox was a member of numerous professional societies: the American Association for the Advancement of Science; the American Society of Zoologists; the American Institute of Biological Sciences; the American Microscopical Society; the Society of Systematic Zoology; the American Society of Limnology and Oceanography; the American Malacological Union; the Western Society of Naturalists; and the Southern California Academy of Sciences. His honorary societies were Phi Beta Kappa, Phi Sigma, and Sigma Xi. On the local scene, he served as vice-president and president (1956) of the Conchology Club of Southern California, president (1955) and member of the board of the Miami University Alumni Club of Southern California, member of the board of elders of Wilshire Presbyterian and Angeles Mesa Presbyterian churches, and as cub master and Boy Scout troop committeeman.

Dr. Mattox's publications, 45 in number if two to be published posthumously be included, are concerned with the morphology, reproduction, and taxonomy of the gastropod Mollusca, the taxonomy and life history of the phyllopod Crustacea, and marine ecology in general. While at the Allan Hancock Foundation he took an active interest in the work of the *Velero IV* in exploring

the benthic communities of the San Pedro Basin and contributed to studies on the molluscan and branchiopod communities between the mainland and Santa Catalina Island. He was author of the chapter on the Conchostraca in Ward and Whipple's classic, "Fresh Water Biology," as revised by W. T. Edmondson in 1959. His concern for greater stability in the taxonomy of this group and of the tectibranch mollusks led to two overtures to the International Commission on Zoological Nomenclature, the first successful, the second pending.

Although Dr. Mattox's excellence as a classroom teacher should not be minimized, he was by common agreement at his best when individually counselling his graduate students, whom he was able to inculcate with his own enthusiasm for scientific research. Of this no better evidence could be given than that provided by the Bulletin of the Southern California Academy of Sciences, which since 1954 has included no less than twelve papers from the Mattox "school" of invertebrate zoology: five by Jens W. Knudsen, three by Lindsay R. Winkler, one by Donald B. Bright, and three by the "master" himself. As one of his students wrote on hearing of his passing: "Dr. Mattox has set an example that will be hard for us to live up to. Our work will not be good enough, nor will it have enough warmth and friendliness." His colleagues will remember his sterling character and the unflinching courage with which he met the challenge of his progressive disability, continuing to visit his beloved laboratory and to confer with his co-laborers in research until the very last. In summing Dr. Norman T. Mattox, death has claimed a great man.

John S. Garth





Norman T. Mattox, Ph.D.
1910-1960

SCIENTIFIC NOTES

During the summer of 1959, while engaged in rearing larvae of *Acronicta othello* Smith, which were fed on Toyon (*Photinia arbutifolia* Lindl.) I found a pair of larvae in the blossom of this plant, which were new to me. They subsequently proved to be *Nasusina vaporata* (Pears.) a small geometrid moth, the type locality of which is San Diego, California, and the life history of which is unknown.

The species is dealt with in some length in McDunnough's Revision of Eupithecia, pp. 689-690, 1949, and is illustrated in his plate No. 32, figure 13.

Brief notes of the larva and pupa were made, as follows:

Nasusina vaporata (Pears.)

MATURE LARVA, collected September 3, 1959, at Del Mar, California. Length 8. mm. Head width, 1. mm.

In color, the head is creamy-white. It is sparingly covered with short setae.

The body ground color is white. The first segment has a raised transverse brown collar and a sprinkling of brown dots.

Middorsally there is a longitudinal row of brown dashes, one to a segment, each of which is shaped like a tear-drop, the round end pointing caudally. A line of similar brown dashes parallels the first dorso-laterally, but this series is smaller, and fades out towards the cauda.

Each body segment is thrown into numerous transverse folds or ridges. Legs and prolegs concolorous with the body.

The setae are scant, short and colorless.

PUPA. The first pupa was formed September 9, 1959.

Length of pupa 7. mm. Shape, cylindrical.

The color was a light straw, with a brown cremaster. The wing cases were translucent. The antennae and maxillae extended to the wing margins.

The terminal portion of the cremaster was pyramidal. It was topped by eight or more yellow spines, each recurved at the tip. The two in the center were longest, and three or more on each side were progressively shorter.

The first pupa hatched September 20, 1959.

JOHN A. COMSTOCK
Del Mar, Calif.

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BULLETIN OF THE Southern California Academy of Sciences

LOS ANGELES, CALIFORNIA

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VOL. 59

MAY-AUGUST, 1960

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NOTES ON THE PLEISTOCENE
FLIGHTLESS GOOSE, CHENDYTES

By LOYE MILLER

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Loss of the power of flight by birds that once possessed it to a high degree is commonly associated in our minds with the idea of an insular habitat that was free of mammalian predators. Instances of such loss by living or by recently extinct species have received a great deal of attention by writers during the past one hundred years with much emphasis on the principle of survival through release of predatory pressure. Furthermore, this loss of flight may arise by either of two evolutionary trends. The wing may degenerate to a point where it becomes non-functional or on the other hand it may become modified for underwater locomotion and this change may progress to such a degree as to make aerial flight no longer possible.

Variou degrees of progress in both these trends are represented in living birds of today but the fossil avifauna of the southern California coast furnishes us with examples where both trends have been carried to the extreme and have resulted in completely flightless birds that have paid the penalty and have passed into extinction.

Geology tells us beyond challenge, that the Los Angeles basin and parts of the San Diego area were shallow seas dotted with islands during parts of Pliocene and Pleistocene time. These islands afforded breeding sites, we assume, where maritime birds were safe from mammalian predators. *Mancalla* is a Pliocene genus related to the auks and puffins, that had developed a wing structure very much like that of the penguins (Miller, '46; Miller and Howard, '49), a powerful limb, but useful only in the denser medium, water. *Chendytes*, on the other hand, is a lower and upper Pleistocene genus related to the geese and ducks, that had taken the other pathway and had suffered the wing to degenerate into complete uselessness (Miller, '25; Howard, '55). Like *Mancalla*, it was abundant and widely distributed in southern California. Each genus, also, developed at least two species. In the neighborhood of 200 bones represent *Mancalla* and an almost equal number of *Chendytes* parts have been retrieved.

However, sacrifice of motive power and a dependence upon an insular sanctuary involve great danger. The earth's crust in

this area is, and has been, notoriously unstable. Some of our hills were, geologically speaking, but lately islands. Some of our islands are the peaks of lately drowned mountain chains. The Los Angeles archipelago was a lovely land under the sanded feet of the Mission Padres. The sea had vanished. Elephants, foxes, mice and night lizards once passed dry footed to what are now islands in shallow coastal waters. The end of that earth restlessness is not yet—but the end of two genera of flightless birds that depended on the earth's stability is recorded in the marine deposits that give evidence of that rise and fall and rise again of an uneasy land.

The most comprehensive study of the genus *Chendytes* was made by Dr. Hildegard Howard (1947) who established the flightless character of these birds and pointed out the progressive degeneracy of the wing from lower Pleistocene on San Nicolás Island, *Chendytes milleri*, to upper Pleistocene, *Chendytes lawi*, at San Pedro, Newport Bay and Playa del Rey.

Along with the declining wing power there was an increase in the pelvic girdle, stronger attachment of the illia to the synsacrum and increased size of the leg bones.

In none of the previous recoveries of *Chendytes* material was there found any anatomical association of the various elements in the matrix. It was with interest therefore, that I examined a block of the coquina deposit from San Nicolás Island, that gave promise of associated parts. This block, along with a number of separate wing and leg elements, was brought in by Edward Mitchell and Jere Lipps, two enthusiastic students well trained in field work, who recognized the importance of the find. Lacking experience in avian anatomy, they turned over the material to me for preparation and study.

Some painstaking work on the block exposed a right tarso-metatarsus broken off at the level of the proximal foramina. The hind toe seems to have disappeared before entombment but the first phalanges of toes 2, 3, and 4 and the second phalangeal of the inner and middle toes are in place though strongly flexed. Just such flexure is shown in the carcass of a White-winged Scoter (*Melanitta perspicillata*) picked up on Hyperion Beach at the high tide mark. The drying foot-web had drawn the toes

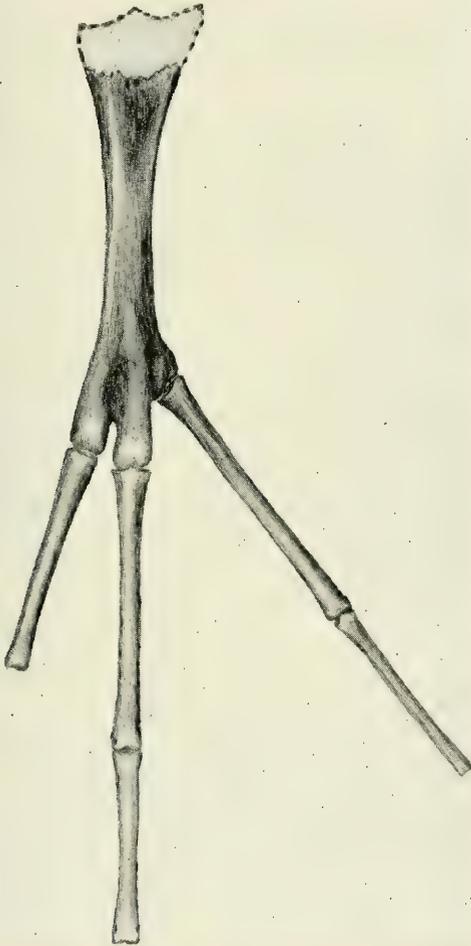


PLATE 19

Chendytes milleri $\times 1/1$
Semi-diagrammatic. L. Miller, 1960.

into exactly the same flexed position although the hind toe had been sloughed off before stranding. In all probability a carcass of *Chendytes* had been likewise stranded on the lower Pleistocene beach of San Nicolás Island and entombed before dis-articulation of its major parts. The loss of other parts of the body seems to have taken place subsequently. Our disappointment over this loss is only slightly mitigated by the evidence afforded that the poorly preserved condition of the various bones in this deposit is due to corrosion in situ and not to the mechanical abrasion of "beach wear." Furthermore, it keeps alive the spark of hope that some day we may find other associated parts in this deposit.

All studies of the various skeletal elements of *Chendytes* have indicated the relationship of the bird to the diving ducks. It was a goose only in its gigantic size. Table I shows a comparison of the retrieved foot elements with those of the White-winged Scoter (*Melanitta perspicillata*). The inner toe is relatively short but the middle and the outer toes are longer insofar as the preserved parts can tell us. The differences, however, are not great and they suggest no adaptation to the flightless condition unless it be possibly a stronger ambulatory power when on a firm substrate. The bird was obliged to walk from the sea shore to its nest site, we know not how far inland. A strong foot would have been to its advantage.

The relative straightness of the tibiotarsus was commented on in the original description of the genus (Miller, '25, p. 145). While on land, the bird probably held the body more erect than did the true geese and the tibial condyles being less displaced toward the median axis of the body than in even the surf ducks, *Chendytes* must have stepped forward in a more rectilinear fashion. Along with the reduction of weight in the pectoral region the balance of the body could have been maintained with less of the awkward gait characteristic of ducks in general. May not *Chendytes* have even walked with a degree of dignity? Furthermore he appears to have been a diving duck that, like the Dodo, the Galapagos Cormorant, the Great Auk and some other insular vertebrates, took advantage of released predatory pressure and developed a measure of gigantism that would otherwise have proved dangerous.

| | Chendytes | | Melanitta | |
|---------------------------------|-----------|-----------------|-----------|-----------------|
| | Length | Ratio to Tarsus | Length | Ratio to Tarsus |
| Lgth. Tarsus - to prox. foramen | 52.2 mm. | 1.00 | 36.3 | 1.00 |
| Digit II, phalanx - 1 | 37.5 | .718 | 27.2 | .749 |
| Digit II, phalanx - 2 | 25.4 | .487 | 19.2 | .529 |
| Digit II, phalanx - 3 | ..... | ..... | 6. | ..... |
| Digit II, phalanx - 1 | 39.0 | .747 | 26.8 | .738 |
| Digit III, phalanx - 2 | 25.4 | .487 | 18.5 | .509 |
| Digit III, phalanx - 3 | ..... | ..... | 13.5 | ..... |
| Digit III, phalanx - 4 | ..... | ..... | 6.0 | ..... |
| Digit IV, phalanx - 1 | 30.7 | .588 | 20.8 | .573 |
| Digit IV, phalanx - 2 | ..... | ..... | 15.2 | ..... |
| Digit IV, phalanx - 3 | ..... | ..... | 15.4 | ..... |
| Digit IV, phalanx - 4 | ..... | ..... | 14. | ..... |
| Digit IV, phalanx - 5 | ..... | ..... | 5. | ..... |

TABLE 1. Measurements of tarsi and phalanges of *Chendytes milleri* and *Melanitta perspicillata*.

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THE PLIOCENE LIZARD GENUS *EUMECOIDES* TAYLOR

By RICHARD ETHERIDGE

Department of Biology, University of Southern California

Introduction

In recent years a great many genera and species of lizards have been reported as fossil components of vertebrate faunas from the late Cenozoic of Florida, the southern Great Plains and southwestern United States. Nearly all fossil lizards recovered from Pleistocene deposits, and many recovered from the Pliocene are of species which are living today. Only one extinct Pliocene genus has been proposed, and all extinct Pliocene species which belong to modern lizard genera appear to be closely related to species which are living today. These facts are of considerable importance to studies of evolutionary rates and of Pliocene and Pleistocene paleoecology. Modern species, when found as fossils, are important paleoecological indicators.

The knowledge of life histories, ecological requirements, limiting factors in distribution and the present-day ranges of modern species found as fossils afford valuable information for paleoecological conjectures. With somewhat less confidence extinct forms may also be used for paleoecological interpretations *via* generalizations based on a knowledge of their close living relatives. Lacking fossil records for their particular groups, some herpetologists have suggested that the advance and retreat of glaciers, the rise and fall of sea-level, and the fluctuating climatic conditions of the Pleistocene were responsible for the isolation of segments of some "primitive stock", leading to the differentiation of modern species. The climatic changes of the Pleistocene were clearly important in the determination of present-day distribution of lizards, but the fossil evidence to date indicates that many, and possibly most, modern lizards were already present in earliest Pleistocene.

The genus *Eumecoides* was proposed by Taylor (1941) for two fossil lizard dentaries from the Upper Pliocene of Kansas. It is the only exception to my general contention that the late Pliocene and Pleistocene of North America held only modern lizard species or their close, congeneric relatives. Additional fossils from the Kansas Pliocene clearly demonstrate that the fossils described as *Eumecoides* by Taylor are not the remains of

an extinct genus, but are referable to the modern iguanid genus *Phrynosoma*, the horned lizards of western United States and Mexico. Furthermore, *Eumecoides hibbardi* and *Eumecoides mylocoelus* are both conspecific with, though slightly different from, the modern species *Phrynosoma cornutum*, a common species of horned lizard in the southern Great Plains.

HISTORICAL REVIEW AND LOCALITIES

In order to avoid the possibility of confusion of localities and ages I shall first present a brief history of the publications concerning this genus and a list of the localities referred to.

The first account of lizards from the Kansas Pliocene is that of Taylor (1941). From a small collection of reptilian fossils from the Upper Pliocene (upper part of the Rexroad formation) of Meade County, Kansas, Taylor described one new genus and four new species of lizards. These were *Cnemidophorus bilobatus* (a racerunner), *Eumeces striatulus* (a scink), and the new genus *Eumecoides*, with two species, *hibbardi* (the genotype) and *mylocoelus*. From the same horizon but from a different locality (Fox Canyon) in Meade County Twente (1952) described *Sceloporus robustus* (a swift) and reported one dentary each of *Eumecoides hibbardi* and *mylocoelus*. In addition Twente reported *Eumeces mylocoelus* from the Saw Rock Canyon fauna, then assigned to the upper Middle Pliocene. Oelrich (1954) added the first contemporary species to the Rexroad local fauna, *Phrynosoma cornutum*, based on a single parietal. A second modern species, *Cnemidophorus sexlineatus* was reported from the Rexroad local fauna by Etheridge (1958).

The Saw Rock local fauna is from the XI member of the basal part of the Rexroad formation and is now referred to the lower Upper Pliocene (Hibbard, 1953). It is known from a single locality near the west line of section 36, T.34 S., R. 31 W., Seward County, Kansas. The Rexroad local fauna is from the upper part of the Rexroad formation and is referred to the late Upper Pliocene (Hibbard, 1950; Taylor, 1960). The fauna is known from several localities, all of which are in Meade County, Kansas. These are: University of Kansas Meade County Locality No. 2, SE $\frac{1}{4}$ NE $\frac{1}{4}$ NW $\frac{1}{4}$ section 22, T. 33 S., R. 29 W.; University of Kansas Meade County Locality No. 3, Rexroad Ranch, W $\frac{1}{2}$ SW $\frac{1}{4}$ section 22, T. 33 S., R. 29 W.; University of Michigan Locality UM-K3-53, Wendell Fox Pasture, south side of Shorts Creek, SW $\frac{1}{4}$ SW $\frac{1}{4}$ section 33, T. 33 S., R. 29 W.; and University of Michigan Locality UM-K1-47, Fox Canyon, section 35, T. 34 S., R. 30 W.

REFERRED MATERIAL

With the exceptions of the type specimens of *Eumecoides mylocoelus* and *Eumecoides hibbardi*, which are in the Kansas University Museum of Vertebrate Paleontology (KUMVP), all specimens on which this study was based are in the vertebrate collections of the University of Michigan Museum of Paleontology (UMMP).

Saw Rock Canyon local fauna (lower Upper Pliocene) squamosal UMMP 35968.

Rexroad local fauna (late Upper Pliocene). Rexroad Locality No. 2: dentaries KUMVP 5115 (type, *Eumecoides mylocoelus*), KUMVP 5099 (type, *Eumecoides hibbardi*). Rexroad Locality No. 3: maxillaries UMMP 42177 (11), 41163 (25); frontals UMMP 42171 (11), 41157 (8); parietals UMMP 30191, 42172 (6), 41162 (14); squamosals UMMP 42176 (4), 42336 (4); premaxillary UMMP 42337; dentaries UMMP 35761 (16), 42338 (41); humeri UMMP 42175 (2), 41161 (5); brain case 42174; pelvis UMMP 42173 (2), 41167 (2); scapulocoracoid UMMP 42339; sacra UMMP 42346; vertebrae UMMP 41158 (8). Wendell Fox Locality: squamosals UMMP 42133 (7); humeri UMMP 41330 (2); femora UMMP 42341 (2); frontals UMMP 42135 (5); parietals UMMP 41323, 41326, 41324, 41325 (5); maxillaries UMMP 42139 (2); dentaries UMMP 42136 (6).

DISCUSSION AND COMPARISONS

The genus *Eumecoides* was established on the basis of two dentaries, each serving as the type of a different species. *Eumecoides* is characterized as follows: the medial ventral edge of the dentary is turned up, causing the Meckelian groove to be medial rather than ventral. The anterior end of the dentary is narrowed. There are 19 to 22 closely set pleurodont teeth that are strongly anchored to the outer wall. The teeth are hollow, having blunt, chisel-like tips. They are compressed laterally, widening more or less toward the base. Striations are lacking on the medial face of the tips (Taylor, 1941). Taylor referred the genus with some doubt to the family Scincidae, presumably on the basis of the blunt, chisel-shaped teeth and the position of the Meckelian groove. The two species were differentiated as follows: the outer face of the dentary concave in *hibbardi*, convex in *mylocoelus*; the terminal part of the Meckelian groove shallow in *hibbardi*, deeper in *mylocoelus*; about 18 moderately compressed teeth in *hibbardi*, 21 to 23 strongly compressed in *mylocoelus*.

Claude W. Hibbard and his summer field parties from the University of Michigan Museum of Paleontology have recovered many additional fossil bones of lizards from the Kansas Pliocene. Among these are about 200 elements which are clearly referable to the modern iguanid genus *Phrynosoma*. These include dentaries, parietals, frontals, squamosals, a brain case, a scapulocoracoid, pelvis, limb bones and vertebrae. The 63 dentaries in this series exhibit all of the defining characters of the genus *Eumecoides*; thus *Eumecoides* must be considered a synonym of *Phrynosoma*. Furthermore, this series of dentaries cannot be sorted into two types, but shows a continuous range of variation which includes the characteristics of both *Eumecoides hibbardi* and *Eumecoides mylocoelus*.

The specific identification of the Rexroad fossil *Phrynosoma* poses an important problem, for they are separated in time from contemporary populations by a gap of over one million years. The fossil dentaries have been compared with dentaries from the following modern species of *Phrynosoma*: *modestum*, *coronatum blainvillei*, *coronatum frontale*, *cornutum*, *douglassi brevirostre*, *douglassi hernandesi*, *orbiculare durangoensis*, *m'calli*, *platyrhinos platyrhinos*, *solare* and *asio*. No comparisons have been made with *branconnieri*, *cerroense*, *taurus*, *ditmarsii* or *boucardi*. The dentaries of *coronatum*, *orbiculare*, *douglassi* and *asio* are the least specialized; that is, most similar in structure to the dentaries of other iguanid lizards. The lateral face of the element is without ornamentation, dropping in a smooth convex curve from the lateral alveolar margin. The teeth are relatively large, with a trace of the typical iguanid triconodont condition. The most specialized dentaries are found in *modestum*, *solare* and *m'calli* in which the lateral face of the element forms a broad projecting shelf, ornamented along its ventrolateral margin by a series of scallops in *modestum* and *solare*, and by a series of sharp spines in *m'calli*. The teeth in these three species are small blunt cones, rising only slightly above the lateral alveolar border. A similar but less well developed shelf is present in *platyrhinos*. In this species the shelf is ornamented by several shallow scallops and a large posterior knob. The teeth of *platyrhinos* are small, blunt and conical. In *cornutum* the lateral face of the dentary drops steeply from the lateral alveolar border to meet the flat ventral face of the element in an acute angle. The lateral face is slightly concave, or flat, or slightly convex. In large individuals the posterior part of the ventrolateral margin of the element is ornamented with several small, irregular rugosities. The teeth are moderate in size and form simple chisel-like cones.

In all major features the fossil dentaries of the Rexroad local fauna referred to the genus *Phrynosoma* are identical with those

of modern *Phrynosoma cornutum*. Variation in details, however, is slightly greater in fossil elements. The upper and lower borders of Meckel's groove are separated in all of the recent elements but are in contact for a short distance anterior to the position of the distal extremity of the splenial in some of the fossils. The rugosities and curvature of the lateral face of the dentary appear to be correlated with size in both fossil and recent elements; i.e. smooth and flat or slightly concave in small individuals, rugose and slightly convex in adults. Tooth counts in fossil dentaries range from 15 to 23 with an average of 18.5 per dentary. Tooth counts in recent individuals range from 16 to 23, with an average of 18.2 per dentary. In recent individuals there may be as many as five more teeth in the dentary of one side of the jaw than in the other. There seems to be a general correlation between the number of teeth and individual size; i.e. there are more teeth in large individuals.

The fossil dentaries of *Eumecoides hibbardi* and *Eumecoides mylocoelus* reported from the Fox Canyon locality by Twente (*op. cit.*) were mistakenly identified. Both elements are referable to *Eumeces striatulus*. As yet, no fossil *Phrynosoma* have been recovered from this locality.

Additional elements of the skeleton support the conclusion, based on dentaries, that there was but one species of *Phrynosoma* in the Rexroad local fauna, and that this is very similar to modern *Phrynosoma cornutum*. All of the major features of the additional elements are in close agreement with those of modern *Phrynosoma cornutum*; however, as with the dentaries, there are some slight differences between fossil and recent elements.

In 33 fossil maxillaries there is a range of 14 to 20 teeth, with an average of 15.8 per maxillary. In recent maxillaries there are from 13 to 18 teeth with an average of 14.5. In recent individuals the maxillary of one side may contain as many as four more teeth than the maxillary of the other side. As in the dentaries there appears to be an increase in the number of teeth with increasing size. A single fossil premaxillary contains five teeth; from four to six teeth are present in recent premaxillaries.

Variation in the ornamentation of 20 fossil parietals is somewhat less than in modern elements. The upper surface of the parietal is covered with numerous low but sharp spines. They are irregularly arranged except for three somewhat larger ones: a median spine and one each between the median spine and the parietal horns. These three somewhat larger spines are present in all fossil parietals but are occasionally absent in recent elements. The parietal horns themselves are variable in size and orientation, more so in modern elements than in fossils. Oelrich (*op. cit.*) re-

ported the occurrence of two well developed recesses (for the insertion of the spinalis dorsi muscle) along the posterior border of a fossil parietal. These recesses are present in all of the fossil parietals now available, but they are occasionally absent or poorly developed in recent elements.

The frontal of *Phrynosoma cornutum* is very distinctive. Its upper surface is extremely rugose, with four or five enlarged tubercles in an arc along the orbital border. There is little variation in 24 fossil frontals, which are nearly identical with those of recent elements.

The squamosals of fossil *Phrynosoma* show the greatest deviation from the configuration of this element in modern individuals of *Phrynosoma cornutum*. In both modern and fossil elements there are three major horns. The central and posterior horns are about equal in length and width at their bases in all modern elements. In fossil squamosals, of which there are 11, the central horn is wider at its base than is the posterior horn. The anterior horn is somewhat shorter and narrower at its base than are the central and posterior horns in recent elements. This is also true for the fossils but the difference is more pronounced. In the majority of recent squamosals there are two additional prominences: a tiny spine between the bases of the central and posterior horns, slightly above their point of contact, and a low, rounded knob just above the posterior part of the base of the posterior horn. Neither of these additional ornaments is present in any of the fossil squamosals.

A single squamosal from the older beds of the Saw Rock Canyon local fauna (lower Upper Pliocene) is structurally identical to the fossil squamosals of the Rexroad local fauna, but is about one half as large as the smallest Rexroad element. This fossil may have come from a subadult individual or may indicate that the adult size of *Phrynosoma* in the Saw Rock Canyon fauna was actually much smaller than that of Rexroad or modern *Phrynosoma*. Indirect evidence for the latter interpretation is provided by a comparison of fossil *Eumeces striatulus* from the Rexroad and Saw Rock Canyon faunas. About 70 elements of this species are known from the Saw Rock Canyon fauna; over 100 elements from the Rexroad fauna. The maximum size of Saw Rock Canyon *Eumeces striatulus* is also about one half as large as that of their Rexroad counterparts. That this size difference was actual, rather than the result of selective sorting, is demonstrated by the comparative sizes of pelves and scapulocoracoids. The component parts of these elements do not become fused until adult size is reached. They become dissociated with maceration in all but adult individuals. Thus, all pelves and scapulocoracoids

recovered as fossils must be considered the remains of adult individuals. The decision as to the actual size difference between Rexroad and Saw Rock Canyon *Phrynosoma* must await the recovery of either pelves or scapulocoracoids from the latter fauna.

CONCLUSIONS

It is apparent that the structural differences between fossil *Phrynosoma* of the Rexroad fauna and modern *Phrynosoma cornutum* are very slight. Meckel's groove is sometimes closed in fossil dentaries, always open in modern elements. Three slightly enlarged spines near the posterior border of the parietal are present in all fossils but are occasionally absent in recent elements. Paired recesses in the posterior border of the parietal are present in all fossils but are usually absent in modern elements. The anterior horn of the squamosal is somewhat smaller in fossils than in recent elements. The central spine of the squamosal is wider at its base than is the posterior horn in fossils but the two are equal in width in modern elements. Two small additional prominences on the squamosal are present in most recent elements but absent in all fossils. These differences are not nearly as great as those which distinguish the skeletons of modern species of *Phrynosoma* from one another. They are more on the order of magnitude and of the same type as those differences which are ordinarily used to distinguish between modern geographic races, i.e. subspecies. The category of subspecies was originated and has had wide usage as a means for the recognition of horizontally distinctive populations of species. Its use to distinguish between vertically distinctive populations requires a totally different subspecies concept. I am strongly opposed to this usage, since it requires two mutually exclusive definitions for the same taxonomic category. It is of considerable interest that the fossil *Phrynosoma* of the Rexroad fauna is so similar to the modern species *Phrynosoma cornutum*, differing from it only slightly in structural details and variability. I believe that it is more important for the taxonomic placement of the Rexroad fossils to reflect their close resemblance to modern *Phrynosoma cornutum* than to indicate their slight differences from this species, and so here consider the two as conspecific.

The Rexroad fauna is separated from the modern fauna of Meade County, Kansas by a period of about one million years. It is very doubtful that *Phrynosoma cornutum* occupied this area continuously during the Pleistocene. The remains of lizards from glacial deposits in the area are very scarce. As yet only *Eumeces* (Cudahy fauna, Kansan Glacial) and *Ophisaurus* (Doby Springs fauna, Illinoian Glacial) have been recovered from them (Etheridge, 1960). *Phrynosoma cornutum* is an abundant fossil

in the Sangamon Interglacial deposits of the Cragin Quarry at Locality UM-K3-59. The lizard fossils from other interglacial deposits from the southern Great Plains have not been studied; however, their mammalian and molluscan faunas indicate climatological conditions which would have been suitable for *Phrynosoma cornutum*. The Saw Rock Canyon local fauna is separated from the Rexroad local fauna by a greater span of time than the Rexroad fauna is separated from modern times (Hibbard, 1953; Taylor, 1960). The acquisition of additional fossil material from the Saw Rock Canyon fauna will permit the study of still another, even older stage in the evolution of *Phrynosoma cornutum*.

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THE IDENTIFICATION OF *ACANTHIA HUMULI* FABRICIUS AND RELATED SPECIES (HEMIPTERA: TINGIDAE)¹

By CARL J. DRAKE² and FLORENCE A. RUHOFF²

Through the cooperation of Dr. P. L. Tuxen, Universitetets Zoologiske Museum, Copenhagen, Denmark, the authors have had the privilege of studying the type of the tingid characterized by Fabricius (1794) as *Acanthia Humuli* of Europe. Nine years later, Fabricius (1803) erected the Genus *Tingis* to hold a new form and 10 other species, which he transferred thereto from the Genus *Acanthia* Linnaeus, including *Humuli*. Of these 11 species, only *T. cardui* (Linnaeus) remains in the Genus *Tingis* at the present time.

Since the Fabrician Collection contains only a single specimen of *humuli*, this is naturally the holotype. This holotype, brachypterous female, is in almost perfect state of preservation, only the last two segments of both antennae being missing. In addition to the type specimen, the pin also bears the trivial name "*Humuli*" written in the handwriting of Fabricius. The holotype fits the original description, and there is no doubt or question relative to the identity of the species nor the authenticity of the species label.

Humuli of Fabricius has almost always been wrongly named in collections and in technical publications since it was originally described and later transferred to *Tingis*. As *humuli* is a very distinct and not easily confused with its congeners, it is plainly evident that hemipterists have not studied the tingid types of the species described by Fabricius.

Fieber (1844) transferred *T. humuli* (not Fabricius, wrongly named) to his new subgenus *Physatocheila* of the Genus *Monanthia* Le Peletier and Serville (1825). In the same paper, this author described *M.(P.) vesiculifera*, n. sp. from Europe. The latter is the same species that Fabricius (1794) had characterized as *Acanthia humuli*. *Monanthia symphyti* (Vallot) (1828-29) is also a synonym of *humuli* Fabricius (*New Synonymy*). This correction in identification and new synonymy makes it necessary to resurrect *T. convergens* Herrich-Schaeffer (1835) from synonymy as the valid trivial name for the species that Fieber (1844)

¹ Illustrations were made by Patricia J. Hogue, Alexandria, Va.

² Smithsonian Institution, supported in part by grant-in-aid, National Science Foundation (G4095).

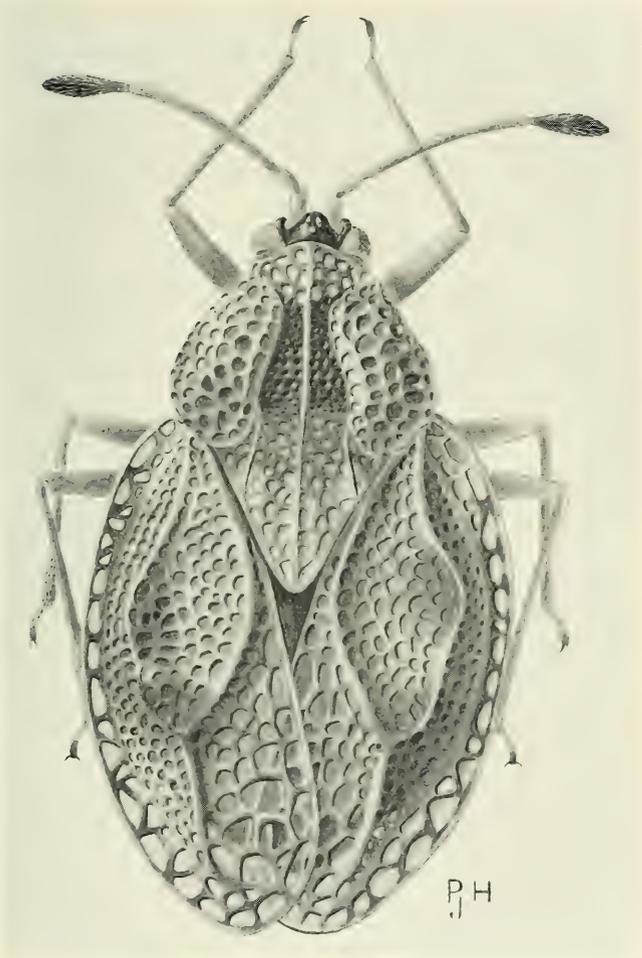


PLATE 20

Dictyla humuli (Fabricius)

and Horváth (1906) and other authors wrongly called *humuli* (not Fabricius) for more than a century. We are publishing illustrations of both *humuli* (Fabricius) (Plate 20) and *convergens* (Herrich-Schaeffer) (Plate 21).

In a recent paper, Drake and Ruhoff (1960) suppressed the Genus *Monanthia* Le Peletier and Serville (1825) (based on a study of *C. clavicornis* Linnaeus) as a synonym of the Genus *Copium* Thunberg (1822), and then restored the Genus *Dictyla* Stål (1874) as the valid generic name for most of the species theretofore included in *Monanthia*. To avoid further confusion in the literature, we have prepared the selected bibliography that follows:

Dictyla humuli (Fabricius)

- Acanthia humuli*: Fabricius, 1794, Systema Entomologiae, p. 77.
Tingis humuli: Fabricius, 1803, Systema Rhynctorum, p. 126.
Tingis symphyti: Vallot, 1829, Acad. Aci. de Dijon, p. 99.
Tingis humuli: Herrich-Schaeffer, 1835, Nomenclator entomologicus, vol. 1, p. 58.
Monanthia costata: Burmeister, 1835, Handbuch Entom., vol. 2, p. 261. —Herrich-Schaeffer, 1839, Die Wanzenartigen Insecten, p. 15, pl. 114, fig. 362.
Monanthia vesiculifera: Fieber, 1844, Entom. Monographien, p. 87, pl. 7, figs. 25-26. —Vollenhoven, 1878, Hem. Het. Neerlandica, p. 276, pl. 22, fig. 9.
Monanthia symphyti: Horváth, 1889, Revue Entom., vol. 8, p. 326; 1906, Ann. Mus. Nat. Hungarici, vol. 4, pp. 99, 101. —Cobben, 1958, Tijdschrift voor Entomologie, d. 101, p. 14, fig. 16. —Stusak and Stys, 1959, Acta Univ. Carolinae-Biologica, no. 3, pp. 178-187, 191, figs. 1, 2, 7, 8, 13-18, 25-28, 30, 32-35, 37-39.

Almost all of the references in the literature to *Monanthia symphyti* (Vallot) should be referred to *Dictyla humuli* (Fabricius) for the reasons stated here in previous pages. The illustration (Plate 20) agrees very closely with the brachypterous female holotype in the Fabrician Collection. According to Horváth (1906) and other authors, *Symphytum officinale* is the host-plant of this insect in Europe.

D. humuli (Fabricius) (Plate 20) can be separated from *D. convergens* (Herrich Schaeffer) (Plate 21) by having the pronotal disc deep black and slightly shiny, lateral carinae more divergent on the apical part of the posterior process of the pronotum, and the larger discoidal area with the apical third concavely widened outwardly and so as to extend deeply into the subcostal area. In *convergens*, the pronotum is stramineous-brown, lateral carinae feebly divergent posteriorly, and the discoidal area smaller with the outer boundary vein uniformly concave within and not



PLATE 21

Dictyla convergens (Herrich-Schaeffer)

projecting deeply into the discoidal area. Both species are represented by macropterous and brachypterous forms in our collection.

Dictyla convergens (Herrich-Schaeffer)

Tingis convergens: Herrich-Schaeffer, 1835, Nomenclator entomologicus, vol. 1, p. 59.

Monanthia convergens: Burmeister, 1835, Handbuch Entom., vol. 2, p. 261. —Herrich-Schaeffer, 1839, Die Wanzenartigen Insecten, pp. 15, 58, pl. 114, fig. 361.

Monanthia (Physatocheila) humuli: Fieber, 1844, Entom. Monographien, p. 84, pl. 7, figs. 17-18.

Monanthia humuli: Saunders, 1892, Hem. Het. of British Isles, p. 136, pl. 13, fig. 1. —Horváth, 1906 (in part), Ann. Mus. Nat. Hungarici, vol. 4, pp. 99, 102. —Stichel, 1926, Illustrierte bestimmungstabellen der Deutschen Wazen, Lief 4, p. 115, fig. 306. —Cobben, 1958, Tijdschrift voor Entom., d. 101, pl. 14, fig. 17. —Southwood and Leston, 1959, Land and water bugs of the British Isles, p. 151, pl. 21, fig. 12; pl. 25, fig. 2.

As stated in previous pages, this species has been wrongly identified in the literature as *humuli* (many authors). A macropterous female is illustrated (Plate 21). According to Horváth (1906) and other authors, *Myosotis palustris* and *M. lingulata* are host-plants.

Octacysta echii (Fabricius) (Fig. 3)

Tingis echii: Fabricius, 1803, System Rhyngotorum, p. 126.

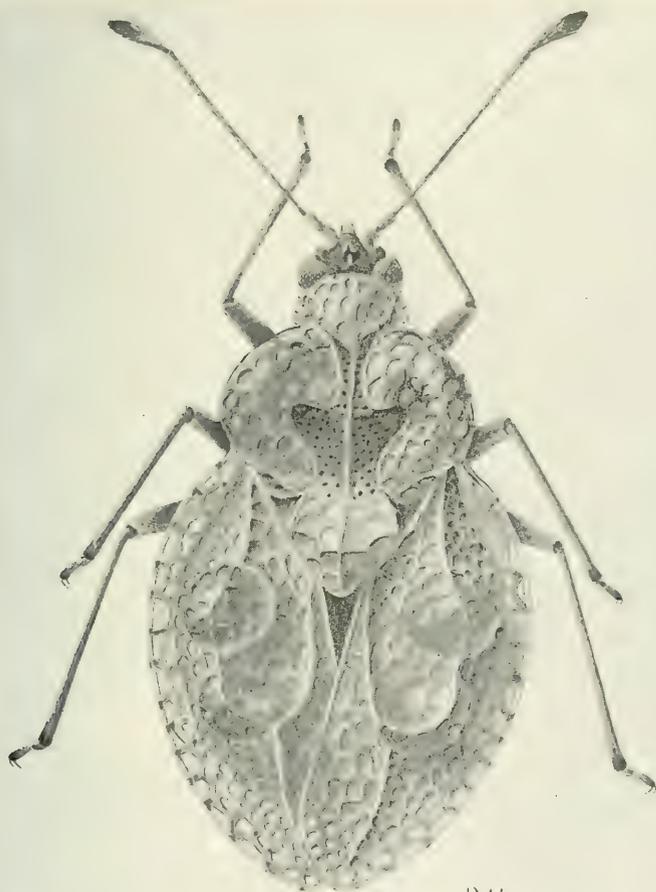
Tingis rotundata: Herrich-Schaeffer, 1835, Nomenclator entomologicus, vol. 1, p. 59; 1839, Die Wanzenartigen Insecten, pp. 52, 59, pl. 124, figs. F-G, pl. 125, fig. E.

Monanthia echii: Fieber, 1844, Ent. Monographien, p. 88, pl. 7, figs. 27-32.

Monanthia rotundata: Horváth, 1906, Ann. Mus. Nat. Hungarici, vol. 4, p. 108.

Octacysta rotundata: Drake and Ruhoff, 1960, Proc. U.S. National Museum, vol. 112, p. 71, figs.

The Fabrician Collection contains two specimens of *Tingis echii*. We are designating the brachypterous female (elytra and last two segments of both antennae missing), labeled *Echii* in the handwriting of Fabricius as the lectotype. The other brachypterous specimen (abdomen and both antennae missing; both elytra present) is a paratype. We have figured a brachypterous female that agrees closely with the lectotype (Plate 22). This is the same species as that described by Herrich-Schaeffer (1835) as *rotundata*, and thus the two names apply to the same species. The resurrection of this name is in accordance with the provision adopted at the Zoological Congress on Nomenclature (London, 1958).



P. H.

PLATE 22

Octacysta echii (Fabricius)

THE CLERIDAE OF NORTH AMERICA

PART I: *The geographical distribution of Cleridae of North America, North of the Panama Canal.*

(Notes on North American Coleoptera, No. 12)

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The entomophagous family Cleridae, of the order of Coleoptera, is represented in North America, North of the Panama Canal with 517 species and 88 subspecies. There are 212 forms known North of Mexico, including Alaska and Canada. Distributed South from the United States and North from the Panama Canal are 267 forms; 24 forms are known from South America with distribution North of the Canal. Seven of the 605 known forms are cosmopolitan and also occur in the Old World. There are approximately 3300 species known for this family, from which approximately 22% are distributed in the New World, North from the Canal Zone.

Preparation of this paper, collecting dates and material, began in 1949 with the inspiration of my friend and colleague, the late Dr. J. B. Corporaal (Netherlands), the best student of our time of this important family. This paper is sincerely dedicated to his memory.

Subfamily TILLINAE

- | | |
|---|---|
| 1. <i>Monophylla</i> Spin. 1841:75 | 3. <i>Tillus</i> Oliv. 1790:22 |
| <i>californica</i> Fall 1901:251.....Ariz. Calif., Oregon, Utah; L. Calif. | <i>collaris</i> Spin. 1844:98....Ala., Ga., Louisiana, Texas, North to Ohio; S. to Guatemala |
| <i>pallipes</i> Schaeff. 1908:128....Texas | <i>patagoniae</i> Knoll 1946:72.....Ariz. |
| <i>ruficollis</i> Schaeff. 1911:121....Ariz. | 4. <i>Perilypus</i> Spin. 1841:72 |
| <i>terminata</i> Say 1835:160....Eastern N. Amer., south to Texas and Arizona | <i>carbonarius</i> Spin. 1844:105....Nev., N. Mexico, Calif., South to Mexico |
| 2. <i>Callotillus</i> Wolc. 1911:115 | 5. <i>Lecontella</i> Wolc. & Chapin 1918:107 |
| <i>eburneocinctus</i> Wolc. 1911:115..S. Florida | <i>cancellata</i> LeC. 1854:81 (<i>brunnea</i> Melsh.).....Maine to N. Carolina, west to Arizona |
| <i>elegans</i> Er. 1847:85...(occidentalis Gorh.) N. Mexico, Arizona; Mexico, South to Peru and Brazil | <i>gnara</i> Wolc. 1927:105.....Okla., Ariz., L. California |
| ssp. <i>váfer</i> Wolc. 1921:270....Ariz., Calif., L. Calif. | |
| <i>intricatus</i> Wolc. 1947:146....Costa Rica | |

6. *Cymatodera* Gray 1832:375
aegra Wolc. 1921:271.....Ariz.
aemula Wolc. 1910:348.....Ariz.
aethiops Wolc. 1910:350.....Texas
to Arizona
angulifera Gorh. 1882:113..Mexico
to Costa Rica
antennata Schaeff. 1908:128..Ariz.
balteata LeC. 1854:81 (fallax
Horn)Texas
belfragei Horn 1876:221.....Texas
bicolor Say 1825:174.....Canada
to Ga., Illinois, Kansas,
West to Arizona
bipunctata Gorh. 1882:135..Mexico
to Costa Rica
brevicollis Schaeff. 1917:130..Ariz.
californica Horn 1868:134..Calif.;
L. Calif.
cephalica Schaeff. 1908:310.....L.
Calif.
championi Gorh. 1882:131..Panama
cognata Wolc. 1910:320.....Utah,
Nevada
corporaali Barr 1948:111.....Ariz.
cylindricollis Chev. 1833:no.11
(brunnea Dej.)Arizona
to Guatemala
decipiens Fall 1906:114.....Calif.
delicatula Fall 1906:113.....Ariz.,
Calif.; L. Calif.
depauperata Gorh. 1882:138..Gua-
temala
dietrichi Barr 1952:5.....Texas,
Ariz., NW Mexico
discoidalis Chev. 1843:10..Mexico
duplicata Wolc. 1910:353.....Mexico
fascifera LeC. 1866:95.....L. Calif.
flavosignata Schaeff. 1908:129,
Arizona
flexuosa Gorh. 1882:136.....Mexico
fuchsi Schaeff. 1904:216 (comans
Wolc.).....Utah to Texas,
West to Calif.
fuscula LeC. 1851:212.....Ariz.,
Mexico
ssp. *texana* Gorh. 1882:134..Tex.,
Mexico
geniculata Chev. 1874:282.....Gua-
temala to Panama
grandis Gorh. 1882:130.....Mexico
grossa Gorh. 1882:138.....Mexico
guatemalensis Schnkgl. 1900:325,
Guatemala
högei Gorh. 1882:135.....Mexico
hopei Gray 1832:375 (gigantea
Horn).....Mexico, probably
also California and Texas
horni Wolc. 1900:349 (californica
(tenera LeC.)
Horn).....Ariz., Calif.
inornata Say 1835:161 (tenera
LeC.)Canada,
E. USA to Utah, Ariz.,
South into Mexico
insignis Schnkgl. 1915:110.....Costa
Rica
intermedia Barr 1950:491.....Lower
Calif.
knausi Wolc. 1921:278.....Utah,
Ariz.
kolbei Schnkgl. 1907:303.....Mexico
laevicollis Schaeff. 1908:130..Ariz.
latefasciata Schaeff. 1904:216..Ari-
zona, L. Calif.
liturata Gorh. 1882:134..Guatem.
longicornis LeC. 1846:16.....Utah,
Ariz., New Mexico
longula Wolc. 1921:280 (rudis
Wolc.).....Ariz., L. Calif.
lunulata Gorh. 1882:133..Guatem.
maculifera Barr 1948:113..Ariz.,
Mexico
marmorata Kl. 1842:271.....Mexico
minacis Barr 1950:491.....Lower
Calif.
mitchelli Chapin 1927:144..Texas,
Arizona
mitis Wolc. 1921:273.....Ariz.
morosa LeC. 1858:71.....Colorado,
Ariz., New Mexico,
Calif., Mexico
mystica Wolc. 1921:285.....Utah
neomexicana Knull 1934:9.....New
Mexico
nitida Gorh. 1882:134.....Mexico,
Guatemala
obliquefasciata Schaeff. 1904:225,
New Mexico, Texas
oblita Horn 1876:221.....Nevada,
Ariz., L. Calif.
ovipennis LeC. 1859:76 (pilosella
LeC.)Ariz., New Mexico
Calif.
pallida Schaeff 1908:128.....Texas
pallidipennis Chev. 1943:8..Mexi-
co, Br. Honduras
parallela Gorh. 1882:32..Guatem.,
Panama

- prolixa* Kl. 1842:272 (modesta Spin.) Costa Rica
pseudotsugae Barr 1947:17.....N. Calif., Oregon
pubescens Wolc. 1909:94.....Texas
punctata LeC. 1852:212.....Calif., L. Calif.
puncticollis Bland. 1863:356. Texas, New Mexico, Ariz., Lower Calif.
purpuricollis Horn 1894:381. Ariz., L. Calif.
rufiventris Wolc. 1927:105.....Calif.
sallei Thoms. 1860:49 (emarginata Chevr., sallaei Gorb.) Mexico, Costa Rica
santarosae Schaeff. 1905:152.....L. Calif.
suturata Gorb. 1886:334 (suturata Lohde) Panama
schwarzi Wolc. 1921:274.....Ariz.
sericans Gorb. 1886:333.....Panama
sirpata Horn 1885:152.....Texas
 ssp. *spatiosa* Wolc. 1921:277 Texas
snowi Wolc. 1910:349.....Ariz.
soror Wolc. 1910:342.....Ariz.
spinolae Barr 1950:61 (angustata Spin., angustata LeC.).....Ariz., Calif., Mexico
striatopunctata Chevr. 1876:8, Mexico
subsimilis Wolc. 1910:343.....Ariz.
torosa Wolc. 1910:347.....Ariz., New Mexico
tricolor Skinner 1905:292. Canada, Arizona
turbata Horn 1885:151.....Texas, Arizona
tuta Wolc. 1910:344.....Ariz., New Mexico
umbrina Fall 1906:114.....New Mexico, Ariz., Colo., Calif.
undata Spin. 1844:142 (marmorata Spin., miletus Spin.).....Mexico
undulata Say 1825:174.....Canada, Maryland, Ky., Arkansas, Texas, Ariz.
 ssp. *arizonica* Schaeff. 1908:130 Ariz.
 ssp. *brunnea* (Dej.) Spin. 1844:147 Ariz.
 ssp. *vauthieri* (Dej.) Spin. 1844:147 (N. America).
uniformis Schaeff. 1905:151. Ariz.
usta LeC. 1858:71.....Texas, Ariz., New Mexico
- vagemaculata* Thoms. 1860:50, Mexico
valida Gorb. 1882:137.....Guatem.
vandykei Schaeff. 1904:217. Calif.
venusta Wolc. 1927:19. Costa Rica
wernerii Barr 1952:1.....Texas, New Mexico, Ariz., Mexico
wickhami Wolc. 1910:354. Mexico
wolcottii Barr 1950:61 (confusa Wolc.).....N. Carolina, Missouri, Texas
xanti Horn 1876:221.....L. Calif., Mexico
xavierae Knull 1940:555.....Ariz.
7. *Araeodontia* Barr 1952:3
isabellae Wolc. 1910:345.....Utah, Ariz., L. Calif.
marginalis Barr 1952:11.....New Mexico
peninsularis Schaeff. 1904:214, Ariz., L. Calif.
picipennis Barr 1952:11. L. Calif.
picta Barr 1952:5.....New Mexico
8. *Notocymatodera* Schnklg. 1907:310
modesta (Dej.) Spin. 1844:144 (prolixa Spin., terebrans Dej.) Mexico
 ssp. *confusa* Spin. 1844:145 Mexico
9. *Bostrichoclerus* Van Dyke 1938:189
bicornis VanD. 1938:190.....Islands of L. Calif.
- Subfamily PHYLLOBAENINAE
 10. *Phyllobaenus* Dej. 1837:127
aeneicollis Schnklg. 1907:306, Mexico
affiliatus Fall 1906:117.....Calif.
antillae Wolc. 1927:81. Costa Rica
apricus Wolc. 1927:83. Costa Rica
arizonicus Schaeff. 1908:132. Ariz.
asper Wolc. 1910:379.....Mexico
bicolor LeC. 1851:213.....Calif.
bimaculatus Wolc. 1908:232. Calif.
binotatus Chapin 1918:107.....Calif.
bituberculatus Chevr. 1874:322, Mexico, Guatem.
blanchardi Wolc. 1928:210.....New Mexico
chalybeatus Gorb. 1883:170. Mexico, Guatem.
chapini Wolc. 1927:81 (lateralis Schaeff.) Texas
cinctus Spin. 1844:48.....Ariz., South to Amazonas
clavatus Gorb. 1883:172.....Mexico

- cobaltinus* Chapin 1922:55..Calif.
coeruleipennis Wolc. 1908:299,
 Ariz.
commictus Chapin 1922:58..Mass.,
 New York
corticinus Gorch. 1883:173..Mexico,
 Guatem.
cribripennis Fall 1906:116..Texas,
 Ariz., L. Calif.
cuneiformis Wolc. 1928:208..Ariz.
cyanipennis Gorch. 1883:175..Gua-
 temala
cyanicinctus Fall 1906:116....New
 Mexico
cylindricollis Gorch. 1886:343 (bi-
 tuberculatus Gorch.)....Nicara-
 gua, Costa Rica, Panama
discoideus LeC. 1851:213 (furcatus
 (Gorch.)....New Mexico, Ariz.,
 Texas, Utah, Calif.,
 L. Calif.
dubius Wolc. 1912:60....N. Dakota
fallax Wolc. 1908:230....Colorado
fraudulentus Wolc. 1927:79....Costa
 Rica
fuchsi Schaeff. 1908:132 (nunen-
 macheri Schaeff., nunen-
 macheri Schnklg.)....Ariz.,
 New Mexico
fucosus Wolc. 1927:77..Costa Rica
fulvipennis Schnklg. 1898:366,
 Guatem.
gahani Wolc. 1910:379.....Texas
gorhami Wolc. 1910:378....Mexico
grandjeani Pic 1945:15.....Mexico
guatemalae Gorch. 1877:261..Gua-
 temala
hamatus LeC. 1876:517.....New
 Mexico
humeralis Say 1823:192 (axillaris
 Dej.)....Canada, Maryland to
 Fla., Illinois, Kansas
 ssp. *cyaneus* (Dej.) Spin.
 1844:44. (cyanescens LeC.),
 Texas, Arizona
 ssp. *difficilis* LeC. 1849:
 28.....Canada, E. U.S.A.
impressus Gorch. 1883:176..Panama
intricatus Gorch. 1883:174..Guate-
 mala
iowensis Chapin 1922:57.....Iowa
knausi Wickh. 1905:168....Kansas,
 Texas
lateralis Gorch. 1883:169.....Costa
 Rica, Panama
lecontei Wolc. 1912:62 (steniform-
 is LeC., subaeneus LeC.)....
 Alaska, Canada, Maryland,
 Louisiana, Ariz.
- longus* LeC. 1884:22.....Ariz.
macilentus Wolc. 1927:78.....Costa
 Rica
marginatus Gorch. 1877:260..Gua-
 temala
 ssp. *atriceps* Pic 1933:20..Gua-
 temala
maritimus Wolc. 1910:321..Mass.
mexicanus Wolc. 1911:122..Mexico
mirificus Schnklg. 1907:307..Mex-
 ico
mirus Wolc. 1928:207....Nebraska
negrescens Schaeff. 1909:381....N.
 Carolina
nigroaeneus Gorch. 1883:174..Mex-
 ico
nigrocyanus Corp. 1950:93 (cya-
 neus Pic).....Mexico
niveifascia Schaeff. 1905:156
 (niveifasciatus Wolc.)....Ariz.,
 Mexico
obscurus Gorch. 1883:172....Gua-
 temala to Panama
occidentalis Chapin 1922:56..Calif.
omoger Horn 1894:383.....Ariz.,
 Calif., L. Calif.
omogeroideus Barr 1950:504....L.
 Calif.
pallipennis Say 1825:176 (quadri-
 maculatus Dej. serratus New-
 man)....Canada, NE U.S.A.,
 west to Colo., south to Texas
picipennis Chapin 1922:56..Texas
plagifer Fall 1906:115.....Calif.
postsuturalis Pic 1945:15..Mexico
pubescens LeC. 1849:28....Illinois
 south to Texas, west to Colo.
pulchellus Gorch. 1883:171..Pana-
 ma
pulcher Chapin 1922:57.....Calif.
puritanus Wolc. 1928:208....Mass.
pygmaeus Wolc. 1912:63.....Calif.
quadrilineatus Chevr. 1874:322,
 Yucatan, Guatemala
robustus Horn 1868:135.....Calif.
rudis Gorch. 1886:342....Mexico
rufipes Newm. 1840:363.....Fla.,
 Ala., Arkansas
scaber LeC. 1851:213 (funebris
 Chevr.).....Wash., Idaho,
 Wyoming, Kansas, Arizona,
 New Mexico
scapularis Gorch. 1883:170..Panama
schmidti Pic 1940:3.....Costa Rica
semimarginatus Pic 1933:20..Gua-
 temala
simulans Schaeff. 1908:133..Ariz.
singularis Wolc. 1912:62....North
 Carolina

- sordidus* Gorch. 1883:173...Mexico
 ssp. *prolongatus* Pic 1945:
 14Mexico
spinolai Wolc. 1910:380.....Mexico
stupkai Knull 1949:199.....Tenn.
subaeneus Spin 1844:51 (steni-
 formis Spin.)Mass.
subfasciatus LeC. 1866:97...Kan.,
 Nebraska, Utah, Texas, Calif.
 ssp. *fraternus* Wolc. 1912:
 61Mass.
subulatus Gorch. 1883:169..Guate-
 mala to Panama
subvittatus Gorch. 1883:170..Gua-
 temala
superbus Wolc. 1911:122..Mexico
suturalis Kl. 1842:313 (limbatus
 Spin, marginatus var., Gorch.,
 transversalis Dej.).....Fla.,
 Mexico
 ssp. *aequinoctiale* Dej. 1844:
 50Mexico
tenellus Kl. 1842:314.....Mexico
tenenbaumi Pic 1945:15...Mexico
testaceus Gorch. 1882:169..Central
 America
tibialis Wolc. 1910:322...Nebraska
trichrous Gorch. 1883:171..Guatem.
tricolor Schaeff. 1904:219..Texas
tristis Schaeff. 1909:381.....Ariz.,
 Mexico
unifasciatus Say 1825:176 (punc-
 tatus Spin.)...Eastern Canada,
 south to Ala., west to Colo.,
 and Ariz.
vandykei Corp. 1950:93 (quadri-
 maculatus VanD.).....Calif.
varipunctatus Knull 1949:199,
 Texas
verticalis Say 1835:164 (brachyp-
 terus Kl., lineatocollis Spin.
 tenellus Say)...Eastern Canada,
 south to Fla., west to the
 South Dakota-Texas line
vicinus Chapin 1922:58.....Texas
villosus Schنگلگ. 1908:702..Mexico
virinus Gorch. 1886:343...Mexico
 to Panama
wickhami Wolc. 1908:231...Ariz.
11. *Isohydnocera* Chapin
 1917:83
aegra Newm. 1840:364..Ga., Fla.
albobincta Horn 1871:342...Texas
brunnea Chapin 1917:84..Kansas,
 Texas
chiricahuae Knull 1949:200..Ariz.
cryptocerina Gorch. 1883:175..Gua-
 temala, Costa Rica
- curtipennis* Newm. 1840:264 (lon-
 gicollis Ziegl.).....Canada, Conn.,
 District of Columbia, Illinois,
 Indiana, Minn.
gerhardi Wolc. 1910:323.....Ariz.
liebecki Wolc. 1928:211.....New
 Jersey
mima Wolc. 1928:211..N. Mexico
nigrina Schaeff. 1908:134.....Ariz.
ornata Wolc. 1908:233.....Ariz.
pusilla Schaeff. 1909:381.....Ariz.
schusteri LeC. 1866:67.....Illinois
tabida LeC. 1849:29.....Ontario,
 Wisc., Illinois, Indiana,
 Ala., Kan.
tricondylae LeC. 1849:26..Illinois,
 Missouri, Nebraska, Colo., Ariz.
12. *Wolcottia* Chapin 1917:84
parviceps Schaeff. 1908:134..Ariz.
pedalis LeC. 1866:97.....New
 Jersey to Illinois, south to
 Nebraska and Ariz.
sobrina Fall 1906:117.....Ariz.
13. *Eurymetopum* Blanch
 1842-43:92
viridiaenum Gorch. 1882:165,
 Guatemala
14. *Isolemidia* Gorch. 1877:257
cariniceps Wolc. 1910:376..Nica-
 ragua
subviridis Gorch. 1883:177..Panama
 Subfamily THANEROCLERINAE
15. *Thaneroclerus* Lef. 1838:13
buquet Lef. 1835:577 (buqueti
 Westw., girodi Chev., san-
 guinolentus Dej., tabacci
 Mats.)Cosmopolitan
16. *Zenodosus* Wolc. 1910:321
sanguineus Say 1835:162..Eastern
 U.S.A., south to Carolina, west
 to Colorado; also in Ontario,
 Canada
17. *Ababa* Casey 1897:653
tantilla LeC. 1865:96 (carinata
 Csy).....Eastern and southeastern
 U.S.A., west to Texas, south
 through Mexico to Brazil
 Subfamily CLERINAE
18. *Priocera* Kirby 1818:389
castanea Newm. 1838:380 (lepri-
 eurü Buq., maculata Ziegl.,
 rufescens Spin.).....Conn.,
 south to Fla., west to Indiana,
 Kan.

- catalinae* Cazier 1939:162....Ariz.
chiricahuae Knull 1939:27....Ariz.
clavipes Gorh. 1882:140....Guatem.,
to Panama
femoralis Kirsch 1865:93....Costa
Rica, south to Peru
gracilis Schnkgl. 1906:257....Costa
Rica
lecontei Wolc. 1910:356....Calif.
miersiana White 1849:49....Costa
Rica to South America
pusilla Kirby 1826:518....North
America?
pustulata Spin. 1844:118 (flavogut-
tata Chevr., trinotata var.
Spin.)Yucatan,
Guatemala, Nicaragua
salamandra Schnkgl. 1906:255,
Mexico, Costa Rica
spinosa F. 1801:280 (decorata
Spin., sexpunctata Cast.).....
Mexico to Brazil, also Peru
strictica Gorh. 1882:140....Central
America
ssp. *costaricana* Wolc. 1927:
26Costa Rica
ssp. *remota* Wolc. 1927:
26Costa Rica
trinotata Kl. 1842:283....Mexico,
south to northwestern South
America
19. *Opilo* Latr. 1802:111
domesticus Sturm. 1837:16..Can-
ada, Penn., Mexico; also the
Old World
20. *Colyphus* Spin. 1841:72
apicalis Pic 1941:10....Guatemala
bicolor Chevr. 1874:287....Mexico
bilineatus Gorh. 1886:335..Guate-
mala to Panama
biplagiatus Kl. 1842:379 (bima-
culatus Kl., not Donov.).....
Mexico
claudus Wolc. 1927:32..Costa Rica
criocerides Gorh. 1882:144..Mex-
ico
distinctus Chevr. 1874:289..Central
America
floralis Gorh. 1882:142....Panama
furcatus Schaeff. 1904:218..Texas
interceptus Spin. 1844:137..Mexico
lateralis Chevr. 1874:289 (margin-
alis Gorh.).....Mexico
limbatus Gorh. 1878:161..Mexico,
south to Venezuela
mutabilis Chevr. 1874:289..Mexico
- nigrifrons* Chevr. 1874:289 (ortho-
pleuridus Gorh.).....Mexico,
Costa Rica
ssp. *flavicornis* Wolc. 1927:
36.....Costa Rica
nigriventris Gorh. 1886:336..Gua-
temala to Panama
ornaticollis LeC. 1880:194 (melan-
opterus Dury).....Ohio
orthopleuridus Thoms. 1860:57
(collaris Chevr.).....Mexico
quadrilineatus Chevr. 1843:14
(orthopleurides Gorh.i.p.,
similis Thoms.).....Mexico,
Guatem.
relucens Gorh. 1886:336..Panama
rufipennis Spin. 1844:136..Mexico
signaticollis Spin. 1844:135 (cinc-
tipennis Spin.).....Mexico to
Panama
telephorides Gorh. 1882:142..Mex-
ico, Guatemala
testaceicornis Pic 1941:11..Panama
ventralis Gorh. 1882:141..Mexico,
Guatemala
vittipennis Chevr. 1874:290..Mex-
ico
21. *Systemoderes* Spin. 1841:72
amoenus Spin. 1844:131..Mexico,
Guatemala
22. *Phonius* Chevr. 1843:11
sanguinipennis Chevr. 1843:12,
Mexico
23. *Placopterus* Wolcott
1910:363
cyanipennis Kl. 1842:307..Mexico
ssp. *dasytoides* Westw. 1849:
50Texas, Mexico
frontalis Gorh. 1886:338.....
Guatemala
haagi Chevr. 1876:12.....Texas,
Mexico
obscuripes Pic. 1941:10....Mexico
plumbeus Gorh. 1886:337..Mexico
rufipes Schnkgl. 1898:364..Mexico
thoracicus Oliv. 1795:76..Canada
to Mexico
ssp. *pallipes* Wolc. 1912:
55.....Nebraska, Iowa,
Ohio, Kansas
varius Gorh. 1886:337.....Mexico
24. *Clerosoma* Wolcott 1910:363
gracile Gorh. 1886:337....Panama
hintoni Wolc. 1933:1.....Mexico

25. *Sallea* Chevr. 1874:286
coffini White 1849:53.....Mexico
necrobioides Chevr. 1874:287,
Mexico, Guatemala
26. *Blaxima* Gorb. 1882:165
rubripennis Chevr. 1874:287,
Central America
27. *Xenoclerus* Schnklg.
1902:327
edwardsii Horn 1880:149....Ariz.,
California, L. California
28. *Serriger* Spin. 1841:73
reichei Spin. 1844:171 (*antennatus*
Schaeff.).....Idaho,
Calif., Mexico
29. *Thanasimus* Latr. 1806:270
dubius F. 1776:229 (*erythrocephalus*
Spin., *nigrifrons* Spin., *rufipes*
Spin.).....Alaska to Mexico
formicarius L. 1758:387 (*brevicolis*
Spin., ?*fasciatus* Geoffr.)..(W.
Virginia); Europe
repandus Horn 1871:342....Calif.
? *subviolaceus* Gorb. 1882:148,
Costa Rica
trifasciatus Say 1825:175..Canada,
NE. U.S.A.
undulatus Say 1835:163 (*undulatus*
Wolc.).....Alaska to
New Mexico, mostly
eastern in the U.S.
ssp. *melanocephalus* Chevr.
1874:290.....Nova Scotia,
New Hampshire
ssp. *monticola* Wolc. 1910:
135.....Pacific States
ssp. *nubilus* Kl. 1842:386
(*abdominalis* Kby.)....Alaska
to Ontario, also Michigan,
Tenn., Colorado, and
New Mexico
ssp. *rubriventris* LeC. 1861:
351.....Canada,
Illinois, Indiana, Fla., Calif.,
L. Calif.
30. *Adelphoclerus* Wolcott
1910:356
fulgidus Wolc. 1927:73 (*nitidus*
Wolc.).....Mexico
inconstans Gorb. 1882:163 (*nitidus*
Gorb.).....Guatemala to
Venezuela
leucomelas Chevr. 1874:28,
Mexico
- mollifascia* Chevr. 1874:297 (*mol-*
lifasciatus Gorb., *nebulosus* Spin.),
Mexico to Colombia
nitidus Chevr. 1843:25....Mexico
to Bolivia
ssp. *brunneipes* Spin. 1844:
239.....Mexico
scutellaris Chevr. 1874:296,
Mexico
31. *Enoclerus* Gahan 1910:62
abdominalis Chevr. 1835:52 (*zon-*
atus Kl.).....Mexico
ssp. *spinolai* LeC. 1853:
320.....SW. U.S.A., from
Kansas to Mexico
acerbus Wolc. 1911:119 (*trullionis*
Barr).....Idaho, Utah,
Nevada, Oregon
aesopius Gorb. 1882:160..Nicar-
agua
albofasciatus Chevr. 1843:24,
Mexico
analisis LeC. 1849:20.....Central
states, west to Calif.,
south to Mexico
anceps Gorb. 1882:157..Guatemala
atriceps Gorb. 1876:82..Guatemala
to Panama
badeni Gorb. 1876:80.....Texas,
California, Mexico
beatus Gorb. 1882:154.....Mexico,
Guatemala
bicarinatus Gorb. 1882:152..Nica-
ragua to Panama
bimaculatus Skinner 1905:291 (*bi-*
oculatus Schaeff.).....Arizona
binodulus Gorb. 1876:77..(?Centr.
Amer.)
bispinis Wolc. 1927:47..Costa Rica
bombycinus Chevr. 1883:12 (*aene-*
icollis Spin., *purpureus* Spin.),
California to Nicaragua
ssp. *sericans* Westw. 1849:
58.....Mexico
boucardi Chevr. 1873:13 (*vulpinus*
Gorb.).....Mexico, Guatemala
cautus Gorb. 1882:152.....Mexico,
Guatemala
chapini Wolc. 1922:72.....Arizona
cinereus Gorb. 1882:152..Guate-
mala, Panama
coccineus Schnklg. 1906:272 (*car-*
ollinus Fall.....Minnesota to
Texas, New Mexico to Mexico
colligatus Vaurie 1952:26....Mexico
cordifer LeC. 1849:21....Montana,
Nebraska, Colorado, Ariz.,
New Mexico, Texas,
Kansas and Missouri

- crabronarius* Spin. 1844:247..?Tex.
ssp. deletus Wolc. 1927:62,
Costa Rica
- cuneatus* Gorh. 1882:160.....Mexico
- cupressi* VanDyke 1915:29..Calif.
- cylindricus* Gorh. 1878:164..Mexi-
co, Guatemala
- decussatus* Kl. 184:296 (hopfneri
Spin.).....Arizona, Mexico
ssp. ornatus Spin. 1844:257,
Mexico
- dilambda* Wolc. 1927:59.....Costa
Rica south to Ecuador
- dimidiatus* Schnklg. 1907:304,
Mexico
- erro* Wolc. 1922:68.....Ariz.
- eximius* Mannh. 1843:248 (holos-
ericus White).....Calif.
north to British Columbia,
Utah, Nevada, Wyoming,
Idaho
- ssp. trulionis Barr 1947:21,
Nevada, Idaho, Utah
- fugitivus* Wolc. 1927:57.....Costa
Rica
- ssp. cupidus Wolc. 1927:59,
Costa Rica
- gerhardi* Wolc. 1922:70.....Indiana
- griseopubens* Pic. 1932:32..Mexico
- guatemalensis* Gorh. 1882:157,
Guatemala
- högei* Gorh. 1882:159.....Mexico
- ichneumonius* F. 1776:230 (rufus
Oliv.)Canada to Florida,
westward in Texas, Ariz.,
California
- insidiosus* Gorh. 1882:160 (ar-
aneipes Corp.).....Costa Rica,
Panama
- ssp. costaricensis Wolc. 1927:
41.....Costa Rica
- inoensis* VanDyke 1938:191,
California
- knabi* Wolc. 1910:321.....Florida
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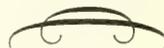
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LIFE-HISTORY OF THE SILVER-STRIPED
SCARABAEID, *PLUSIOTIS GLORIOSA*
LE CONTE

E. GRAYWOOD SMYTH, Santa Barbara, Calif.

This remarkable scarabaeid, known to most entomologists as one of the most outstandingly beautiful beetles of the entire world, is a native of the high mountain ranges of southern Arizona and New Mexico, and northern Mexico. With its broad metallic silver-gold stripes on a vivid emerald green background, it reminds one greatly of a piece of jewelry, and is in fact utilized in the making of very choice jewelry pieces by my friend Dr. John A. Comstock, the noted lepidopterist of Del Mar, California, who presented us with an elegant pair of earrings and a brooch made with specimens that we reared from eggs.

It was proposed to me by Dr. Mont A. Cazier, Director of the Southwestern Research Station of the American Museum of Natural History, founded and financed by Dr. David Rockefeller and located in the very scenic Chiricahua Mountains of south-east Arizona, that I come to his Station for a visit to work out the life history of this handsome beetle. This I did in the summer of 1957, accompanied by my wife, and it would be impossible to speak too highly of the excellent treatment and the high class laboratory facilities that were put at our disposal, to say nothing of the exceptional and exciting environment, surrounded by towering and very colorful canyon walls, and of the splendid personnel of the Station, that made the visit one to long remember.

We arrived at the Station the afternoon of July 5th, and left on July 21st, bringing back with us in cold storage, to be reared elsewhere, over 250 eggs of *Plusiotis* and some two score eggs of *Ancognatha* and *Ochrosidia*. The eggs made the trip by car across the hot country successfully and without casualties. It is by virtue of experience gained over twenty years ago, while working out the life histories of ten species of Puerto Rican white grubs, that I was able to breed out this beetle and bring to maturity, or near maturity, some sixty percent of the eggs. The *Ancognatha* and *Ochrosidia* eggs were also bred through to maturity; and it may be stated here briefly that both species proved to have a 1-year life-cycle. Specific data concerning them will be published later, as will also some details regarding the morphology of the early stages of *Plusiotis*.

The unexpected revelation that resulted from this work was the discovery that *Plusiotis gloriosa* has both a 1-year and 2-year life cycle; that both can, and practically always do, come from the same batch of eggs from the same female; that 1-year and 2-year generations are about equally divided in numbers; and that the determining factor as to whether a 1-year or 2-year grub will develop from an egg rests to all appearances entirely in the genes, and does not depend upon moisture, temperature, type or quantity of food, or other environmental factors. It is, there seems good reason to believe, a provision of Nature to protect an insect, very localized in its habitat, from extinction over wide areas as result of forest fires that occur so frequently in the mountains.

The *Plusiotis* adults used in the investigation were collected on the laboratory windows at night as they were attracted to light, and in securing them I was aided by the amiable personnel of the Station, and by other investigators—for these fine beetles are far from common, at the top of their season. Between July 9 and 19, fifteen *Plusiotis* females were confined in individual small cages with moist sifted earth, and with sweet clover foliage as food. To be sure that a female was fertile, a male was also put into each cage, though no doubt most of the females were already fertile. A total of 253 eggs were laid, between July 12 and 25, as follows: 7/13-14, 69; 7/15-16, 43; 7/17-18, 27; 7/19-20, 59; 7/21-23, 52; 7/24-25, 3; 7/26-30, 0. Between July 21 and 23 the adults were brought to the home laboratory along with the eggs in cold storage, and over 50 eggs were laid during and following the transfer. It may be fairly supposed that, had a longer time been spent at the Research Station, and had additional *Plusiotis* adults been confined in cages, eggs may still have been secured up to and including the early part of August. Of the 253 eggs secured, very few proved infertile, but a small number were preserved for study, and a few lost by accident. A total of over 220 young grubs were secured from the eggs.

For study, the female adults were numbered consecutively between 101 and 122, and the separate egg batches from each female were lettered consecutively, beginning with A. The largest single egg batch from one female (#101a) was 34, laid July 13-14. The largest number of egg batches from one female, counted at 2-day intervals, was three: this occurred in three cases: #102a-c, 12, 13 and 5 eggs, laid 7/13-18; #105b-d, 5, 11 and 11 eggs, laid 7/17-23; #115a-c, 8, 16 and 3 eggs, laid 7/18-23. Of the 15 females confined, only three failed to lay any eggs, and two others laid only 3 eggs. Eggs laid by the remaining 10 females were as follows: #101, 34 eggs; #102,

30; #103, 33; #104, 29; #105, 27; #111, 25; #112, 14; #115, 27; #121, 28 eggs. Numbers above #111 were confined after July 18, so it seems possible that the declining number of eggs laid was due to the fact that females confined after that date were already partly "spent" in egg laying.

The technique employed in rearing the grubs was similar to that previously used in Puerto Rico to rear the grubs of *Phyllophaga*, *Dyscinetus* and *Ligyris*. Small tin "salve cans" were used for the smaller grubs; for the larger and more mature grubs, either pasteboard cartons such as those containing cottage cheese, or similar plastic cartons, were used. The pasteboard cartons required no perforations to admit air, but in a few cages the grubs ate holes in the carton and escaped. The plastic cartons always required that the tops be perforated to admit air, to prevent grubs from smothering. It was found (as previous experience has also shown) that grubs do not require roots to feed on, but do very nicely on ground corn (chicken feed) with a small percentage of grain or wild grass seed intermixed to provide vitamins. An excess of viable seed in the feed causes too heavy germination between examinations, and a crowding of the earth. It is very important, too, that a mellow quality of earth be used, and that a proper degree of moisture be maintained—rather a little too dry than too wet. When a grub has pupated, a cell of proper size must be made for it. This is done by making smooth with pressure the surface of moist, sifted soil, and indenting this $\frac{1}{2}$ inch or more with a smooth oval object like the end of a plastic tooth brush holder. The cell must be smooth on the inside, and the top covered with blotting paper to maintain uniform moisture and exclude light. The notes are best kept on a gummed label on the cover of the carton, and permanent ink should be used as moisture may otherwise partly obliterate the notes.

In summing up the work in calculating, in days, the duration of the instars—egg, larva (or grub) and pupa—there were utilized only those figures derived from grubs that lived to, and into, the third and last instar of the grub. Of such, there were a total of 133. Of this number, only those that reached the pupal stage by, or before, the middle of June, 1958, were considered to be of the 1-year generation. Of these there were 51, and of that number, 32 successfully reached the adult stage. From them the length of pupal stage of 1-year generation grubs was calculated. All grubs still living, in the 3rd instar, after June 15, 1958, were recognized as belonging to the 2-year generation. Of these there were 44, six of which died before pupating, but the remaining 38 eventually pupated, and these furnished the data for the third instar of the 2-year generation

grub. It is plain that the extension of time spent underground by the 2-year generation grubs takes place mostly in this 3rd instar of the grub; to such extent, in fact, that the 3rd instar of the 2-year generation grub is over three times as long in duration as the same instar of the 1-year generation grub. This led us to suspect that the 1st and 2nd instars of the grub might also be longer in grubs of the 2-year generation than in those of the 1-year. And such was found to be the case. Also the pupal stage is considerably longer in the 2-year generation than in the 1-year; but no difference in the length of the egg stage was noted in the two generations.

The following table shows, very briefly, the average, minimum and maximum lengths of the various stages of this beetle, both for the species as a whole, and for the separate generations. The numbers in parentheses indicate the numbers of individuals averaged in each instance.

AVERAGE LENGTHS OF INSTARS
OF THE IMMATURE STAGES OF *PLUSIOTIS GLORIOSA*

| | Egg Stage | | 1st Instar | | 2nd Instar | | |
|----------|------------|------------|-------------|------------|--------------|------------|-----------|
| | (133) | All (133) | 1-yr.(51) | 2-yr.(44) | All(133) | 1-yr.(51) | 2-yr.(44) |
| Average. | 22.3 | 36.2 | 36.1 | 38.5 | 103 | 89.4 | 124.0 |
| Minimum. | 20.5 | 28.0 | | | 22 | | |
| Maximum. | 24.0 | 55.5 | | | 167 | | |
| | 3rd Instar | | Pupal Stage | | Egg-to-adult | | |
| | 1-yr. (51) | 2-yr. (38) | 1-yr. (35) | 2-yr. (15) | 1-yr. (35) | 2-yr. (15) | |
| Average. | 141.3 | 479.9 | 31.7 | 40.7 | 335.6 | 682.1 | |
| Minimum. | 63 | 415.5 | 26.0 | 37.5 | 297. | 676. | |
| Maximum. | 186 | 518.5 | 44.0 | 45.0 | 350 | 699 | |

It will be noted from the above table that the excess in duration of larval instars in the 2-year generation, over those of the 1-year generation, increased very considerably as the grubs advanced in maturity. The excess of duration of 1st instar of 2-year grubs over the 1-year was only 2.4 days, or an increase of about 6½%; in the 2nd instar the increase in average duration was 34½ days, or an increase of about 39%. In the 3rd instar

the increase was proportionately far greater, being 338.6 days (from 141.3 to 479.9), or an increase of 239½%. The average increase in the pupal stage (of the 2-year generation over the 1-year) was 9 days, or an increase of 28.4%.

The dates of pupation of the grubs did not vary greatly between the 1-year and 2-year generations, except that in the latter practically all pupation took place between middle April and middle May, whereas in the 1-year generation the pupation was well distributed between beginning of April and end of May. Out of 85 grubs that reached the pupal stage, only two pupated in latter March and two in early June. The following brief table shows the approximate dates of pupation.

DATES OF PUPATION OF 85 *PLUSIOTIS GLORIOSA* LARVAE

| | | | | | | | | | | |
|------------|---|---|---|---|----|----|----|---|---|---|
| 1-yr. gen. | 2 | 5 | 5 | 7 | 5 | 4 | 15 | 8 | 4 | 2 |
| 2-yr. gen. | 0 | 0 | 3 | 2 | 8 | 9 | 5 | 1 | 0 | 0 |
| Totals. | 2 | 5 | 8 | 9 | 13 | 13 | 20 | 9 | 4 | 2 |

The earliest pupation took place on March 25, the latest on June 9-10. The first adult issued, in 1958, on May 11; the last adult on July 7. In 1959, the first adult of the 2-year generation issued on May 21, the last adult on June 17.

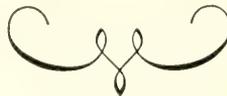
The total egg-to-adult period of the 1-year generation averaged 335.6 days (from 35 individuals); minimum, 297 days; maximum, 350 days. The egg-to-adult period of the 2-year generation (from 15 individuals) averaged 682.1 days; minimum, 676 days; maximum, 699 days. It thus appears that the average egg-to-adult period of this beetle requires, for the 1-year generation, about one month under a year, while that for the 2-year generation requires almost two months under two years. This would seem to indicate that 2-year generation adults may be expected to appear somewhat earlier in the field than 1-year generation adults. Whether this may have any significance or not, one may draw his own conclusions. All of the reared beetles were somewhat smaller than those collected in the field, due no doubt to the artificial conditions incident to their confinement. And fewer adults of the 2-year generation issued in perfect condition, this too as a result of their long confinement.

As to the proportions of 1-year and 2-year grubs that came from each female; the following brief table gives the figures. Those marked "undetermined" were grubs which either died, or were preserved for study, while in the 3rd instar prior to June of 1958, so it cannot be known whether they were 1-year or 2-year generation grubs.

PROPORTIONS OF 1-YEAR AND 2-YEAR
GENERATION GRUBS THAT CAME FROM EACH FEMALE

| | TEST NO. | | | | | | | | | | Total |
|---------------|----------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-------|
| | 101 | 102 | 103 | 104 | 105 | 111 | 112 | 115 | 121 | 122 | |
| 1-yr. gen. | 7 | 10 | 6 | 7 | 7 | 3 | 0 | 7 | 4 | 0 | 51 |
| 2-yr. gen. | 4 | 6 | 8 | 3 | 6 | 3 | 4 | 4 | 5 | 1 | 44 |
| Undetermined. | 7 | 4 | 5 | 5 | 5 | 6 | 1 | 3 | 1 | 1 | 38 |
| Totals. | 18 | 20 | 19 | 15 | 18 | 12 | 5 | 14 | 10 | 2 | 133 |

Attempts were made to secure eggs from adults of the 1-year generation, but without success. Two male and 10 female adults were released in a large screened cage with damp sifted soil, and with a variety of foliage as food, between June 23 and 30, 1958. These were removed as they died, and the soil examined at frequent intervals. On July 14 eight adults were alive; on the 22nd 5 females still active; on August 4th two were still alive. On August 10th the remaining female was observed feeding on pine foliage, but on the 12th it died. A final careful sifting of the soil revealed no eggs, although twice during July a pair had been observed copulating. Perhaps their failure to lay eggs was a reflection of their resentment of the long confinement they had undergone, or if the artificial food (grain instead of live roots) given the grubs.



NOTES ON THE EARLY STAGES OF TWO PHALAEINID MOTHS FROM SOUTHERN CALIFORNIA

By JOHN ADAMS COMSTOCK

Orthosia praeses (Grt.)

From our indefatigable correspondent, Noel McFarland, we received three clusters of eggs, numbering approximately 175 examples, of the above named moth. They were laid in single layers, each egg touching its neighbors, with no interspaces.

The date and time of laying was the night of January 13, 1957, by a gravid female collected at Beverly Hills, California.

McFarland reported that the larva fed well on *Sambucus* and that it might accept *Photinia arbutifolia*. Crumb (1956) lists *Spiraea douglasi* and *Holodiscus discolor*. He describes the mature larva in detail.

EGG: Width 0.75 mm. Height 0.5 mm. Color, light pea-green with minute brown dots in the micropylar area.

In form it is subcylindrical, the base flat, and top regularly rounded. There are approximately 40 raised vertical ridges running from the base toward the micropyle, with approximately half of these reaching the micropylar margin. These ridges are topped with round raised nodules. The grooves between the ridges are narrow, and apparently are not crossed by horizontal striae.

The micropyle is relatively small and shallow.

The egg is illustrated on Plate 23.

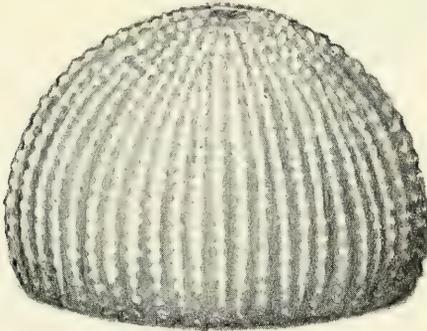


PLATE 23

Egg of *Orthosia praeses*, lateral aspect, enlarged $\times 42$.

Reproduced from drawing by the author.

The eggs hatched January 26 and 27, 1957. The larva exits from the side of the egg, the shell remaining largely intact.

The young larvae were given *Photinia arbutifolia* Lindl., which they immediately accepted, and on which they were reared to maturity.

LARVA, first instar: Length, 3. mm. Head width approximately 0.6 mm.

The head is wider than the first segment, bilobed, and glistening yellow with a slight tinge of orange. The mouth parts are tipped with orange-brown, the ocelli are black, and the antennae, hyaline. A number of black papillae occur over the face, each tipped by a short black seta.

The body is regularly cylindrical. The ground color is light translucent yellow. Rows of conspicuous black papillae occur transversely, one or more rows to a segment. Each papillus bears a short black seta.

The legs are translucent, with a number of small black dots on their surfaces. There are four pairs of prolegs excluding the anal pair. The first two pairs of anteriorly placed prolegs are nonfunctional. All prolegs including the anals are translucent and have small black dots scattered on them. There is no clearly defined scutellum. If present, it is concolorous with the body.

Second instar larva. Length, 6. to 8. mm. Head width 0.8 mm.

The head is marked and colored as in the first instar, except that the black dots are somewhat larger and more conspicuous.

The body ground color is light green. The dorsal and lateral surfaces have taken on a dull green color, with a light middorsal and dorso-lateral longitudinal line. Substigmatically the body is a light translucent yellow, slightly tinged with light green.

The black spots are present as in the first instar, but are larger and more conspicuous. Otherwise, in the early part of this instar, the color and other features are much the same as for the first instar.

Toward the end of the instar a prominent longitudinal stigmatal white band appears, and the two narrow longitudinal lines (one middorsal, the other dorso-lateral) become white. The face becomes yellow. The prolegs are now all functional.

On February 14, 1957 it was noted that heavy mortality had reduced the colony of larvae to 21 individuals, about half of which had changed to the third instar. With these it was evident that there was a wide variation in color, ranging from a form which was dull green on the upper half of the body, and a mottled light green on the venter, the two areas separated by a white stigmatal band, to a form in which the dorsal half was a mottled brownish-black, the stigmatal band was creamy white with a salmon band

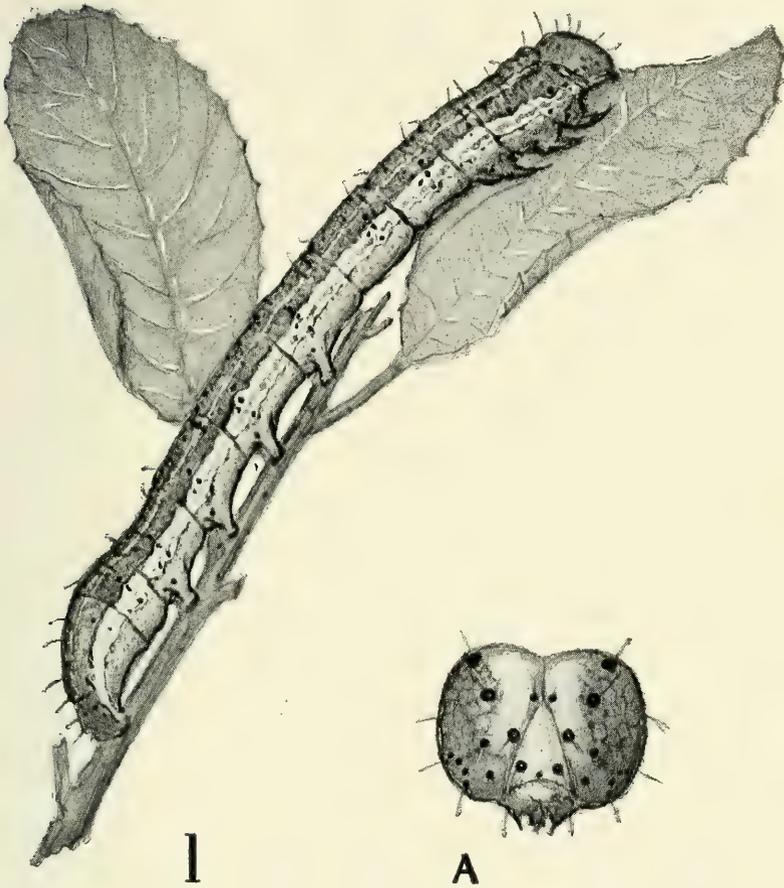


PLATE 24

Fig. 1. Larva of *Orthosia praeses*, third instar, lateral aspect, resting on a sprig of *Photinia arbutifolia*. Enlarged $\times 10$.

Fig. A. Head of larva enlarged $\times 25$.

Reproduced from painting by the author.

running through its center, and a mottled gray and white ventral surface. The following description applies to an intermediate color form.

Third instar: Length 11. mm. Head width 1.1 mm.

Head, straw color, glistening and semi-translucent. There are numerous round black dots disposed as shown in figure A of Plate 24. The ocelli are black, and the mouth parts are tipped with reddish-brown.

On the body, the narrow white middorsal stripe is margined with black. Lateral to this is a wide area, mottled in various shades of brown with a slight tinge of purple. Lateral to this area is another longitudinal narrow white stripe margined with black. Latero-inferior to this is still another wide mottled area similar to that above described except that it is slightly darker. Inferior to this is the wide stigmatal band, which is bisected for its entire length by a narrow crenulated salmon-colored stripe.

The ventral surface is mottled gray-green and white with a sparse sprinkling of mixed salmon and black dots.

The legs and prolegs are concolorous with the ventral surface. The prolegs are all functional, and of equal size in this instar.

The third instar larva is illustrated on Plate 24, figure 1.

On February 20 one of the larvae had moulted and was noted as follows:

Fourth instar: Length, 16. mm. Width of head 2. mm.

The markings and color of the head are much as in the last instar.

On the body the narrow middorsal stripe, and also the dorso-lateral one are less conspicuous than formerly. Each of the black papillae that give rise to the setae has a small white spot placed laterally at its base.

The wide mottled band on each side of the middorsal stripe is more of a reddish-brown, while the wide dorso-lateral band above the spiracles is more noticeably black. The narrow dorso-lateral white longitudinal stripe terminates on the eleventh segment as a triangulate black expansion.

The spiracles are clearly discernible at the upper edge of the whitish stigmatal band. Each has a cream-colored center and a cirlet of black.

Otherwise the larva is marked and colored as in the third instar.

S. E. Crumb, in "The Larvae of the Phalaenidae", Tech. Bull. No. 1135, U.S.D.A., p. 170, 1956, gives a full description of the mature larva, which obviates the necessity of its inclusion here.

Our larvae were nocturnal feeders in their later instars. They fed to maturity on *Photinia arbutifolia*.

Pupation occurs underground in a cocoon, the outer surface of which is covered with sand granules. Our examples went underground the last week in March, and pupae were formed the first week in April. The cocoon measured 21. mm. long by 9. mm. wide, and was regularly oval in shape.

PUPA: Length 14.5 mm. by 5.2 mm. wide through middle. Fusiform. The thoracic portion and wing cases are very dark brown, and the abdominal segments reddish-brown. The maxillae extend to the margin of the wing cases, and the antennae terminate about 0.2 mm. short of this. The spiracles are concolorous with the body, and relatively inconspicuous.

The cremaster is topped by two diverging black spurs 0.75 mm. long, having slightly recurved tips. Near their bases occur a pair of delicate spurs 0.35 mm. long, light brown in color, and with markedly recurved tips. Two or more still smaller hooklets are present at the base of the two largest spurs.

Apparently there are no setae on any portion of the pupa.

Oncocnemis ragani Barnes

This species was described by Dr. William Barnes in the *Pan Pacific Entomologist*, (5, 1; pp. 7-8, 1928), the type locality being Loma Linda, San Bernardino County, and paratypes recorded from San Diego County, California.

In August, 1956, Noel McFarland sent me a gravid female which he had taken in the Santa Monica Mountains, four miles north of Beverly Hills, at an elevation of 1100 feet. He reported the foodplant as wild honeysuckle (*Lonicera*).

From this female I obtained 18 eggs, which made possible the accompanying illustration and description.

The eggs hatched at a time when I was unable to give them attention, so the record of the first instar was lost.

Subsequently, both Noel McFarland and William A. Rees sent brief descriptions of the larva, and Noel furnished a pupa.

Their generosity made possible the record herein set forth.

EGG: Conoidal; 1 mm. wide by .8 mm. tall. Color, light cream.

There are 30 vertical ridges, starting at the base, and terminating at or near the micropyle. These are edged by minute pearl-shaped points. The troughs between these ridges are crossed horizontally by grill-like lines, of which there are about 20, counting from base to top. These lines correspond in position to the

pearl-like points. The micropyle is granular, and slightly depressed. See Plate 25.

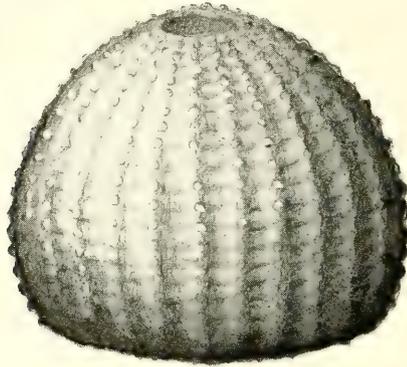


PLATE 25

Egg of *Onconemesis ragani* lateral aspect, enlarged $\times 25$.

Drawing by the author.

LARVA, second and third instars. (Quoting from William Rees' letter of September 28, 1956):

"Larva feeds on wild honeysuckle (*Lonicera*) found along the foothills in this area. General coloring of larva is a light grayish green with black lateral stripes, a rather broad grayish green stripe running down the back. The head is slightly lighter in color, with black spots. It has a few scattered hairs throughout.

It very closely resembles a geometrid larva at this stage. (2nd instar).

"In the third instar the general coloring is a light ochre, with fine light brown stripes running lengthwise. The black stripes remain on the sides. The cream-colored stripe is now only prominent at the anal hump, with two black spots at the apex of this hump.

"The black markings on the head remain, but are lighter.

"At this stage the larva died."

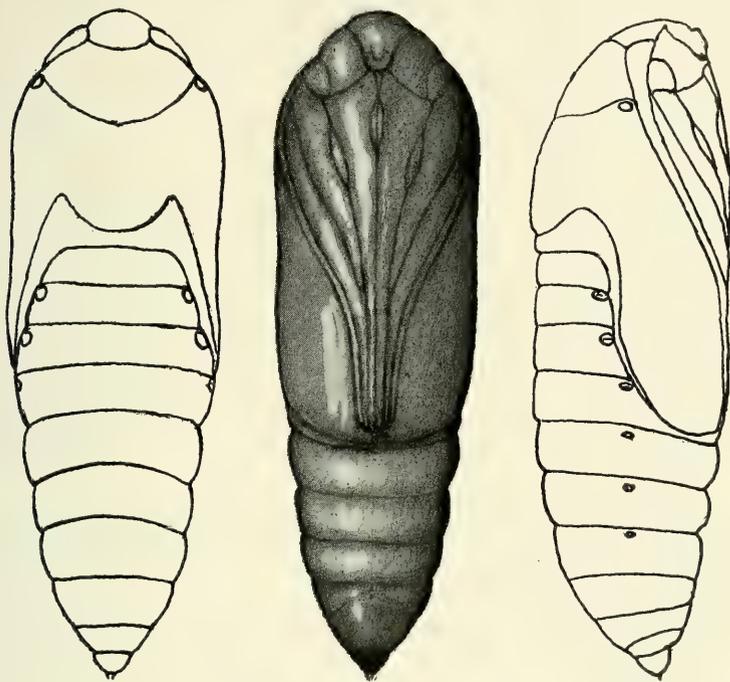


PLATE 26

Pupa of *Oncocnemis ragani*, dorsal, ventral and lateral aspects, enlarged $\times 5$.

Reproduced from painting by the author.

MATURE LARVA, (quoting from Noel McFarlane's letter of December 9, 1958).

"I have no notes on the *ragani* larva but I can tell you a few things about it from memory, not accurate in detail.

It was about one inch in length, and not plump when full grown.

The ground color is usually a pale tan, and sometimes dark gray-green. There were two little raised "spikes" at the rear end

as in some *Catocala* larvae. It crawled in the manner of a geometer larva, using only the last two pairs of prolegs. The third and fourth pair of prolegs were very small and useless. The fourth pair (in from tail) were extremely small.

The larva has a strange habit of vibrating its head and fore-body nervously with every step it takes, reaching in many directions before taking hold of anything.

There is a faint washed-out stripe pattern on the sides, and more definite markings near the raised "spikes" at the tail. There is a cream-colored area between the two "spikes", and darker stripes on the head."

PUPA. Length, 17 mm. Greatest width at shoulders, 5 mm. Fusiform. Color, uniform soft wood-brown, slightly darker over the dorsum, and with a faint greenish tinge on the wings. The segmental lines are narrow, deeper brown, and clearly defined.

Head, evenly rounded. Eyes, inconspicuous, and not noticeably elevated.

The maxillae and antennae extend almost to the edge of the wing margins. The spiracles are small, inconspicuous, and darker than the ground color. The first two are, however, much larger, and rest on raised circular nodules.

The cremaster is very dark, and terminates in two minute stubby spicules.

The surface of the chrysalis is smooth throughout, and no hairs are present.

Our example formed a pupa in July, 1956, and hatched July 2, 1957. See Plate 26.

Oncocnemis ragani is triple brooded in southern California.



WINDS OVER COASTAL SOUTHERN CALIFORNIA¹

By ROBERT E. STEVENSON

Allan Hancock Foundation University of Southern California

Introduction

Several years ago it was necessary that I collect some data on the wind system along coastal southern California. I was studying nearshore currents and needed to explain a diurnal shift in the direction of the flow that was not related to the tide.

The resulting information was of considerable value in this respect, and has since been used by several investigators in other problems. It is by no means a complete evaluation of the winds of this area, but is certainly more detailed than any other analysis available.

General Statement

The basic air flow along the southern California coast is from the northwest, the result of a semi-permanent East Pacific high pressure area. This anti-cyclone is most dominant in the warmer months of the year, May through September; and north-west winds are strongest and more constant during this time. Periodic and non-periodic variations in the intensity and position of the high occur, but usually only to the extent that slight changes in velocity and direction result. From October through April the high pressures diminish and the center of the area moves from about 35°N to near 30°N (Plate 27). Accompanying this change is an increase in the pressures in the permanent low pressure area over the southwestern United States, and a development of a high pressure area over the northwestern United States. The flow of air around the East Pacific high is thus much reduced, and during the cooler months an air movement from the land is common. Even so, the dominance is still from the sea, and a slight change in the continental pressure systems allows a return of a north-westerly flow.

Land and Sea Breeze Regime

Within the Channel Islands of southern California throughout the entire year the diurnal thermal differences between the ocean and the continent are instrumental in establishing land and sea breezes. The theory of these diurnal winds has been summarized

¹ Allan Hancock Foundation Contribution No. 240.

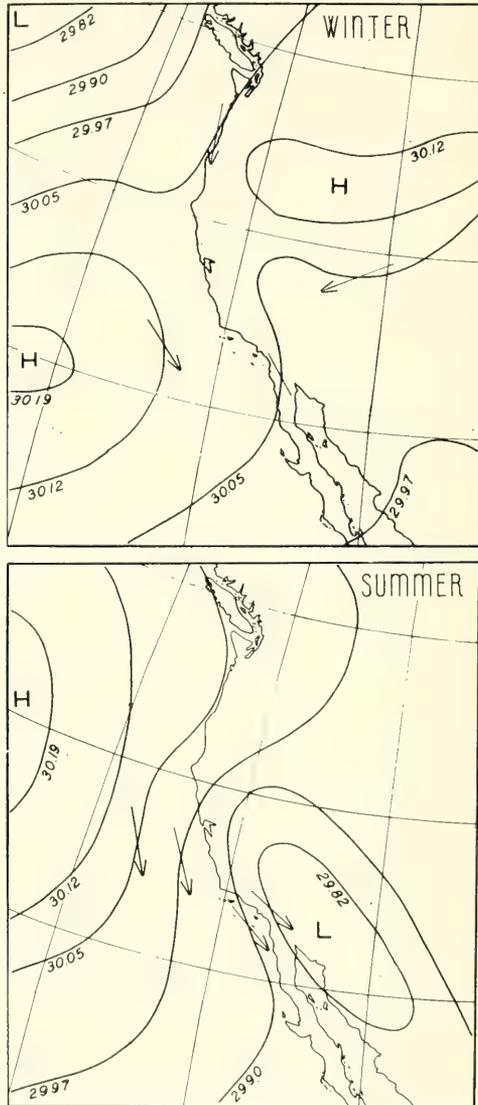


PLATE 27

The normal positions of the permanent East Pacific High Pressure Area, summer and winter.

well by Balkema (1950) and Defant (1951), but a few comments here are apropos. Temperature differences between the air over the land and that over the sea are instrumental in causing the diurnal local winds. These temperature anomalies are due to the differing response of ground and water to solar heating. It is obvious that the mobility of the water is responsible for the small temperature ranges over the sea. Mixing by wind and waves effecting a continuous downward transport of surface heat through large masses of water distributes the heat to an extent not possible in the rocks of the land. Where the temperature conditions of the ground are determined almost exclusively by its physical properties, those of water are governed also by turbulent mixing.

Most mixing of the surface water layers over the shelf is due to wind and wave action and is effective to a depth of about 45 feet. Under all conditions other than upwelling the lowest surface temperatures are controlled by the lowest temperature at this depth. Temperatures to 200 feet in Santa Monica Bay during 1955 to 1956 indicate the lowest recorded temperature at 45 feet was 53°F, and the lowest at the surface was 54°F (Plate 28). These were winter temperatures when insolation was minimum. The influence of solar radiation is seen from the maximum temperatures recorded at the depths. (Although it is apparent that mixing to some degree extends well below 45 feet, it is much less than near the surface. At about 300 feet over the shelf fairly constant temperatures continue throughout the year with a range of from 48° to 50°F.)

Thus, in contrast with the great capability of heating the air over the coastal region, the air over the adjacent water can be only mildly warmed resulting in a distinct air temperature difference.

The difference in monthly average air temperatures over the mainland and the sea is noted in Plate 29. Here the average surface water temperature over the shelf near Los Angeles is plotted along with the average air temperature at sea between Oceanside and Ventura, and the average temperatures at Riverside. The city of Riverside is about 40 miles inland behind the coastal mountains and is less affected by the cooling sea breezes than Los Angeles. During five months of the year the average temperature over the land is lower than over the sea; a condition that obviously modifies the directional flow of air.

Average daytime temperatures show a lesser land/sea difference, for even though insolation is low in the winter, the land still heats more than the water. In Plate 30, the air temperature at Los Angeles Airport and the water temperature one mile seaward from Newport Beach, taken between 1000 and 1100 hours

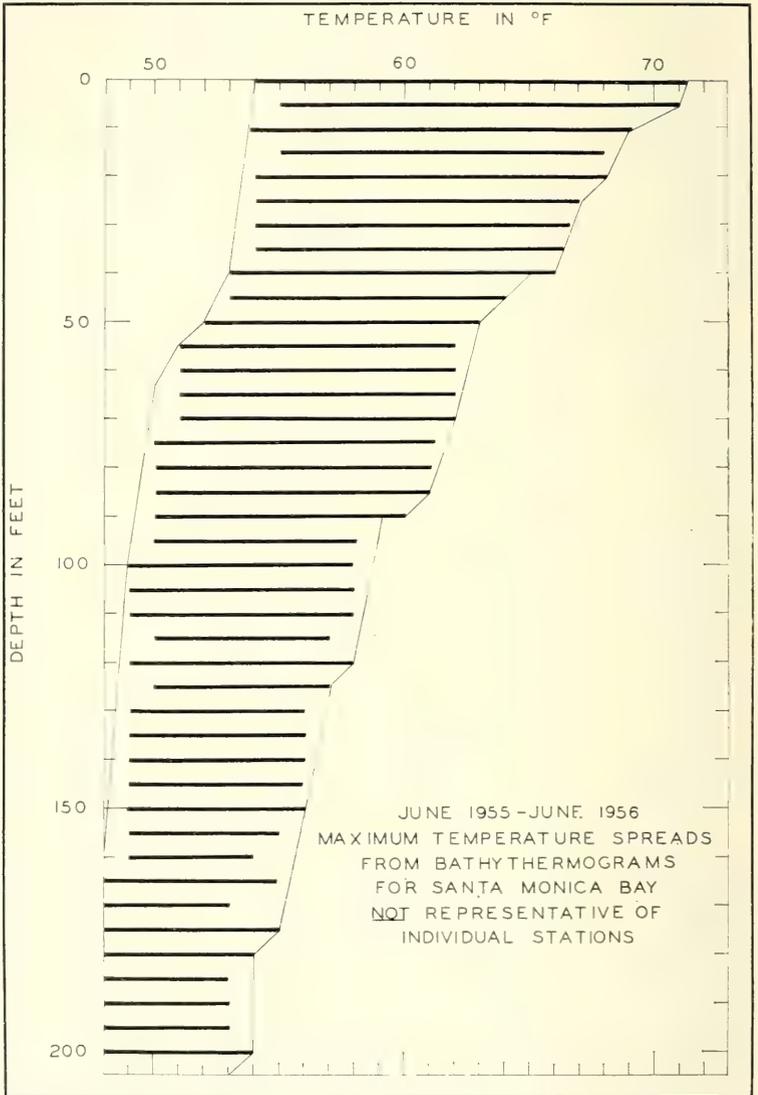


PLATE 28

Spreads of water temperature from the surface to a depth of 200 feet in Santa Monica Bay, 1955-1956.

each day, were averaged for the year 1956-57. The water temperature approximates the air temperature at this location, so the curves are comparable. At this time of the day only in January were temperatures lower over the land. Had temperatures taken at 1300 hours been available for comparison, it is likely that those over land would not be lower in any month than those at sea.

Owing to the persistence of the high pressure area offshore, the prevailing pressure gradient produces a slight onshore component which augments the sea breeze. These winds are therefore stronger and more persistent than those from land. The sea breeze, which starts some few miles at sea, reaches shore between 0700 and 1200 hours local time and obtains its maximum intrusion of about 70 miles inland between 1300 and 1400 hours.

The seaward extent of the land and sea breeze influence is not well-documented. Wind records from San Clemente Island indicate a diurnal wind shift that can be correlated with the wind regime on the mainland. Such a change was not recorded at San Nicholas Island. The former is about 50 miles from the mainland and the latter 65 miles, indicating that a distance of slightly more than 50 miles is effected. This interpretation is correlative with data taken aboard the *VELERO IV*, research vessel of the University of Southern California, in September, October, and December 1956 (Plates 31 A and B, and 32). In September the ship was at Cortez Bank, more than 60 miles from shore, and the wind directions were almost constant from the west and northwest. Calms at night may indicate that the ship was at the outer boundary of the land and sea breeze area. In October the vessel was more than 100 miles from shore on the 20th and 21st, and the winds were constant from the north and northwest. At the same time a typical diurnal reversal in directions occurred at Los Angeles Airport. On the 22nd the ship sailed between San Nicolas and Santa Cruz Islands, and wind directions were more allied to a land and sea breeze system. In December the ship sailed within the Channel Islands and wind directions and velocities reflected a normal diurnal shift. It appears reasonable to assume from these data that the width of the land and sea breeze regime at sea is close to 60 nautical miles.

Annual Variations

Of more than casual interest is the variation in the sea breeze throughout the year. The differences in solar radiation and pressure system are the primary causes of the variations, which include not only changes in directions and velocities, but differences in the times of the onset of the breezes. Such are the result of seasonal shifts in pressure patterns, changes in solar insolation,

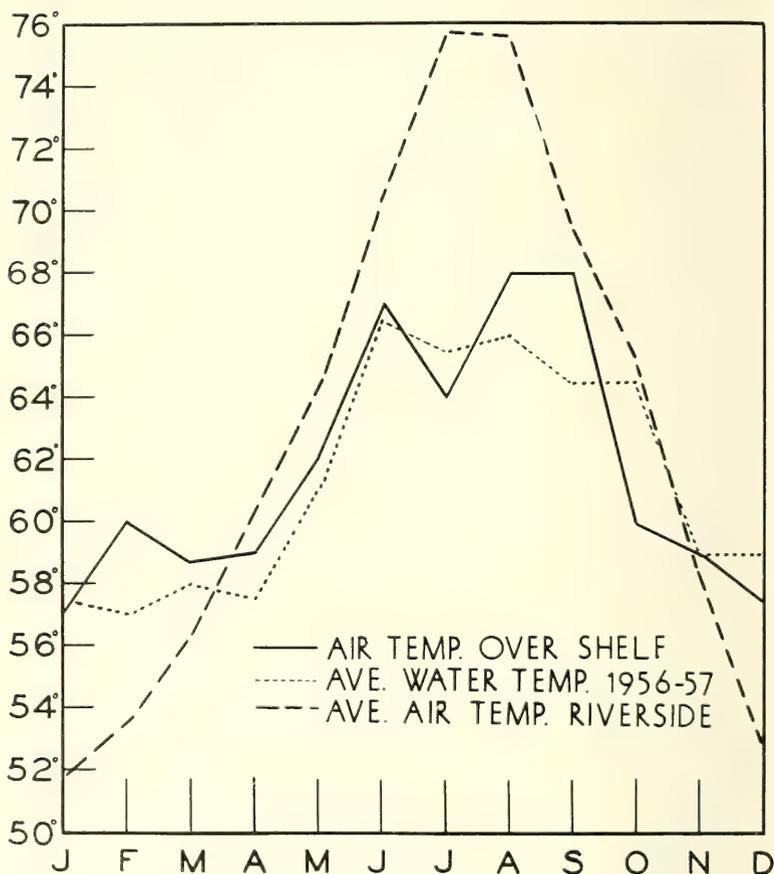


PLATE 29

Annual monthly air temperatures over the southern California shelf and at Riverside, California.

and the per cent of cloud cover. The latter is a condition where the cause and effect are difficult to assess, and even though the sea breezes are moderate at times of full cloud cover, the effect is usually local and probably not so significant when compared with seasonal heating.

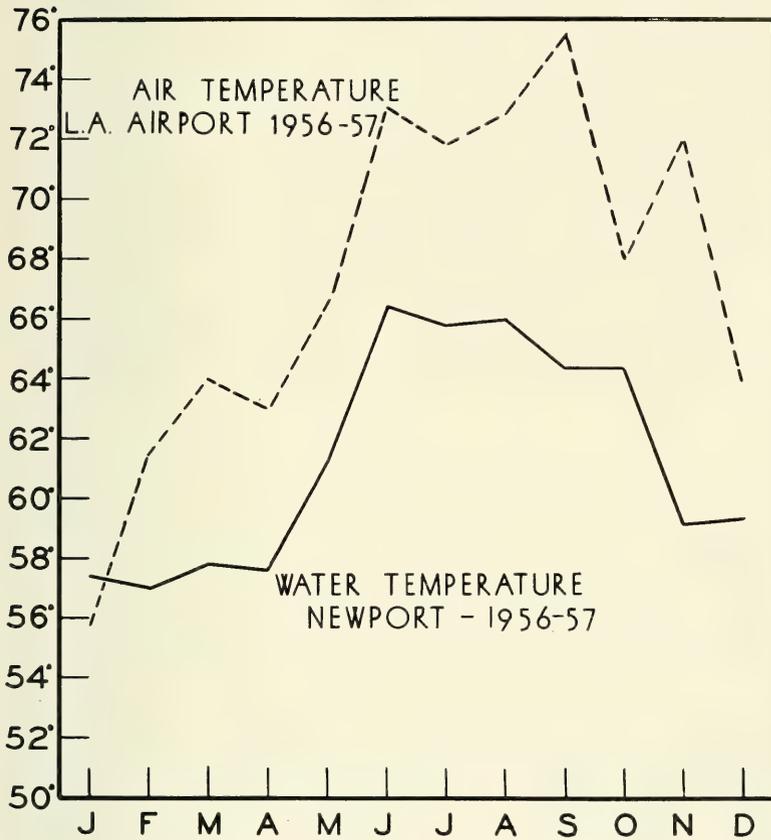
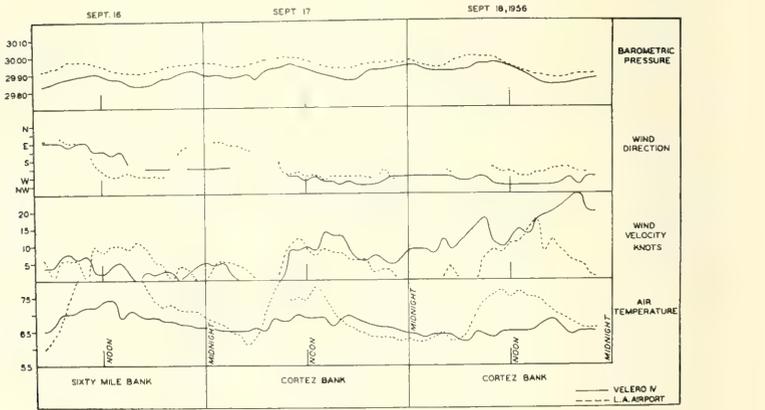


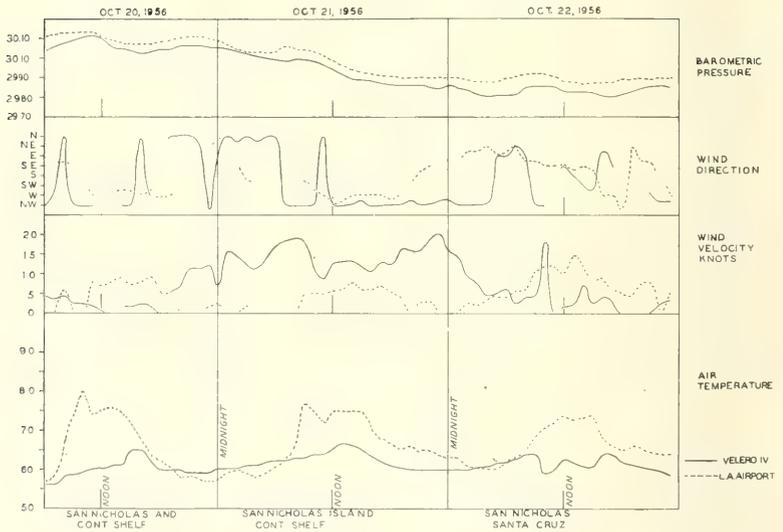
PLATE 30

Monthly water temperatures at Newport and air temperatures at Los Angeles Airport, 1955-1956.

The orientation of isobars and the position and strength of high and low pressure areas obviously affect both the velocity and direction of sea breezes. On occasion, especially in the fall months, air pressure rises in the interior of southern California to the degree that easterly winds with high velocities may blow several



A



B

PLATE 31

A. Meteorologic data collected aboard the R/V VELERO IV and at the Los Angeles International Airport, September 1956.
 B. Meteorologic data collected aboard the R/V VELERO IV and at the Los Angeles International Airport, October 1956.

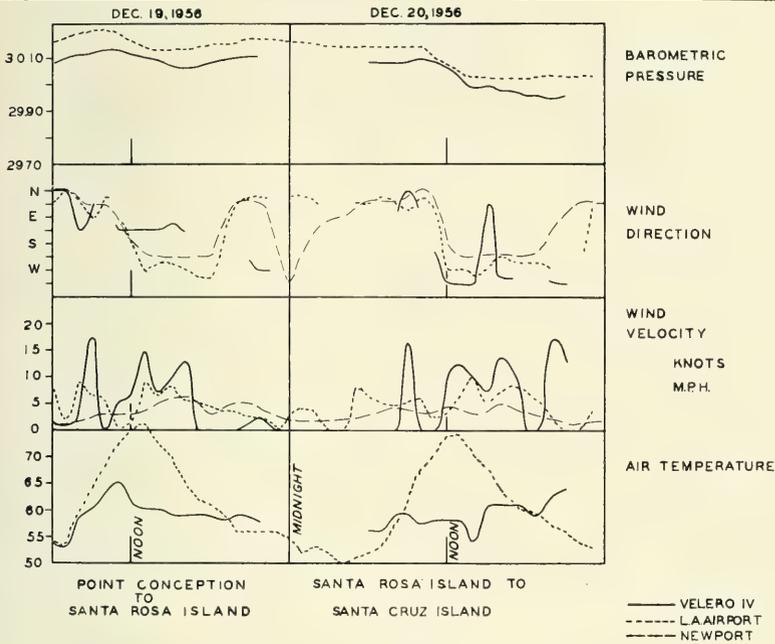


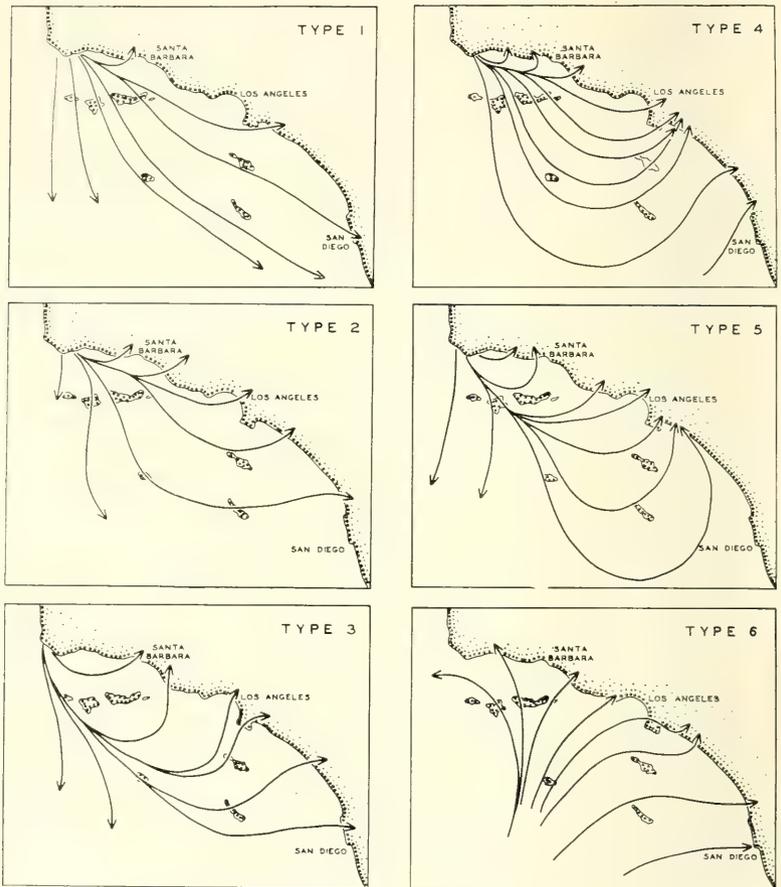
PLATE 32

Meteorologic data collected aboard the R/V VELERO IV and at the Los Angeles International Airport, December 1956.

days at a time. No sea breeze exists during such a condition, and the warm dry air often projects more than 100 miles seaward. The highest air temperatures at sea occur during these periods of so-called Santanna winds. Except for frontal systems, no other situation eliminates the sea breeze. The usual condition is one of modification, either in direction or velocity. When a gradient wind is parallel to the coast, the pressure gradient acts normal to the coast, as does that of the sea breeze, so that the only influence is a strengthening or weakening of the land and sea breeze gradient.

A 90° change in orientation of the isobars will, however, establish a pressure gradient parallel to the coast and either a landward or seaward transport of air. The breezes then become geostrophic in effect and no longer blow strictly down the pressure gradient. Obviously any number of variations between these extremes can and do occur (Plate 33).

The variation in the direction of the winds throughout the year is due both to the movement and intensity of the East



SEA BREEZE PATTERNS SOUTHERN CALIFORNIA

PLATE 33

Six sea breeze streamline patterns that occur frequently over the offshore area of southern California. Developed from analyses made by Mr. Rod Graham, U.S. Weather Bureau.

Pacific high pressure area and the strength of the land/sea breeze. In Plate 34 wind roses are shown for each month from July 1955 through June 1956 for the Newport Beach area. Here the sea breeze blows most frequently from the southwest-west octant, and the land breeze from the northeast to southeast quadrant. The significant seasonal change in the regime occurs in October, when

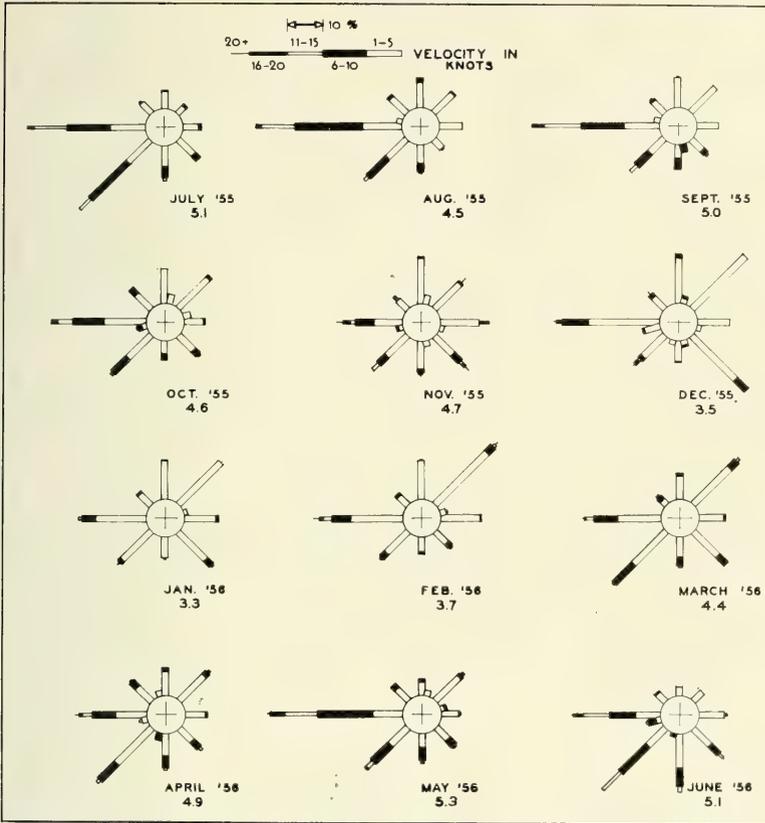


PLATE 34

Annual monthly wind roses at Newport Beach, California, from data gathered at Plant #2, County Sanitation Districts of Orange County.

the percentage of winds with easterly components increases markedly. This trend continues through March, but the greatest percentage of land breezes is in December. The shift to greater percentages of sea breezes is in April, with the highest number occurring in July.

The effect of the East Pacific high is more apparent in the winds at sea. The wind roses presented in Plate 35 were developed from data recorded in the log books of the S. S. *Catalina* and the S. S. *Avalon*, steamers of the Catalina Island Steamship Lines, and represent an observation period of ten years. At the

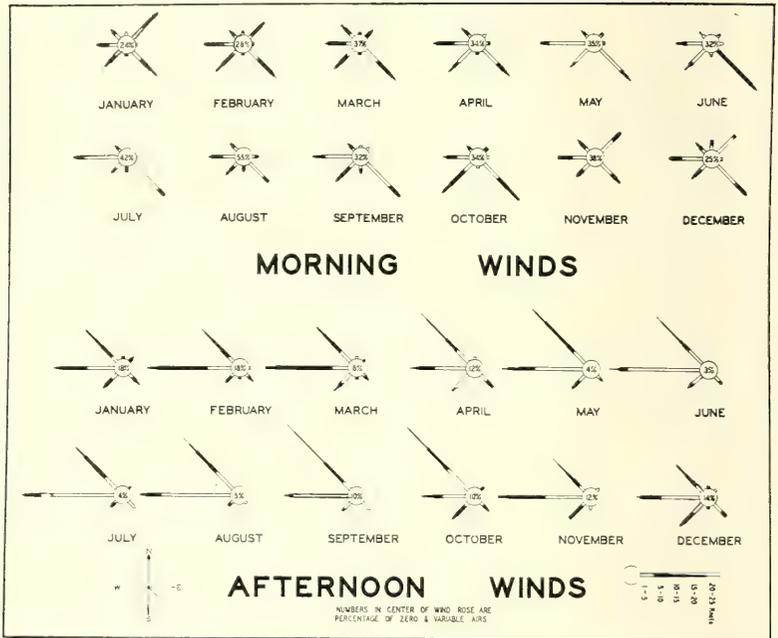
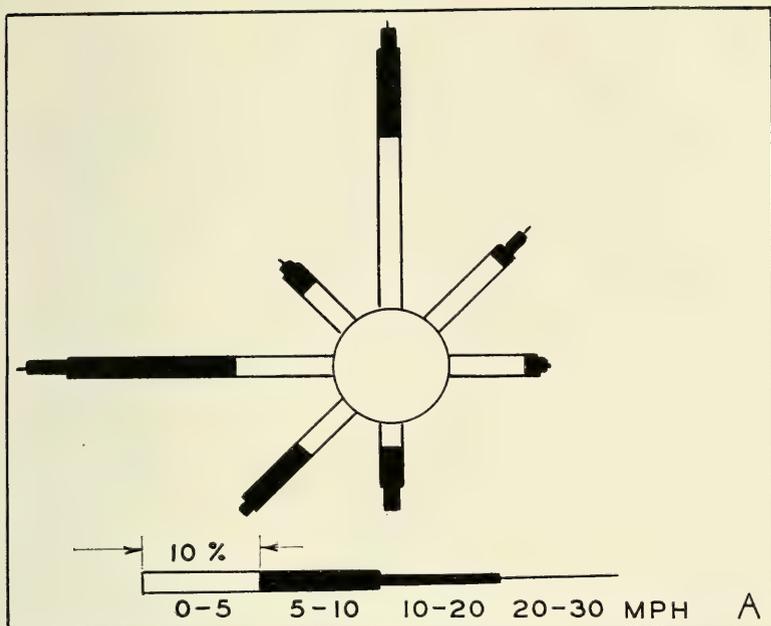


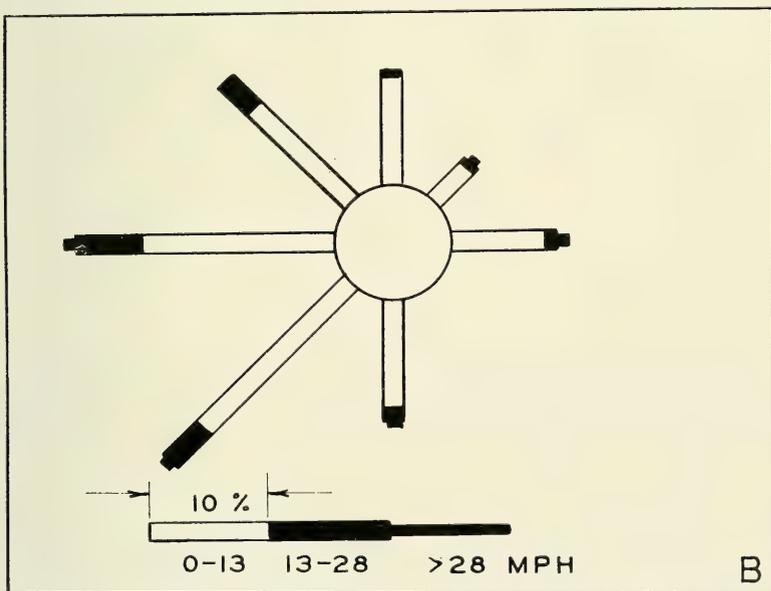
PLATE 35

Annual monthly winds over the San Pedro Shelf; morning and afternoon. From data collected by steamers of the Catalina Island Steamship Lines.

time of day when observations are made aboard the steamers, the ships are about 8 miles south of Los Angeles Harbor. The effect of the land and sea breeze is readily apparent by the differences between the morning and afternoon winds. Impressive is the great per cent of calm or variable airs in the morning; a condition that is maximum in July and August. Most significant, however, is the obvious influence of the East Pacific high on the intensity and direction of the afternoon sea breeze. Beginning in April and continuing through October, the northwest winds dominate in either direction or velocity, and in four of these months they are dominant in both factors. The shift from a northwesterly to a westerly dominance is not only marked but continuous through the winter months.



ANNUAL WIND - PT. MUGU



ANNUAL WIND - SAN PEDRO

PLATE 36

Annual wind roses from Point Mugu Naval Air Base and San Pedro, California.

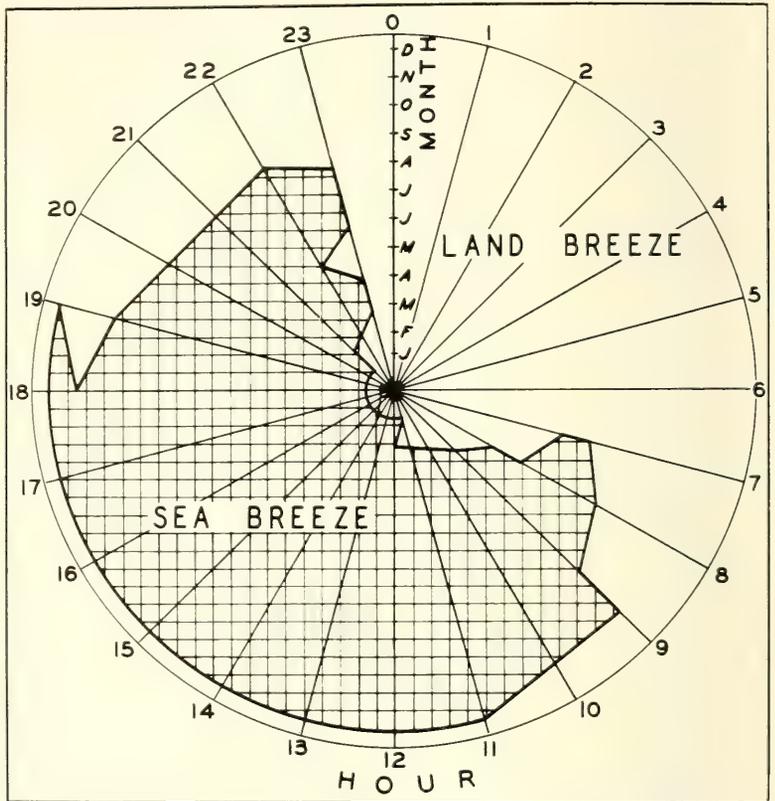


PLATE 37

A diagram showing the time of onset of land and sea breezes for each month of the year; analyzed from data gathered at Plant #2, County Sanitation Districts of Orange County.

Wind roses from coastal stations other than Newport Beach show again quite conclusively the influence of the East Pacific high. All stations have winds dominantly from the west, but with components ranging from south to north, depending on the geographic and topographic location of the station.

The winds near Point Conception have a more northerly component than those to the south, as a result of the greater control by the isobars of the high pressure area. This is shown by comparison of the annual winds at Point Mugu and San Pedro (Plate 36). At Point Mugu 56% of the winds are from the west, northwest, or north; 25% from the west, 8% from the northwest, and 23% from the north. All other winds are accounted for by the remaining percentage. At San Pedro the winds blow the greatest number of days from the southwest, with the next most common direction being west.

Wind velocities are rarely greater than 20 knots, and the most frequent velocity is 1 to 6 knots. At Point Conception, where the isobars are at times closely spaced, sea breeze velocities of 35 knots are not uncommon in summer; but for the rest of the year high velocity winds in any part of the area occur only with frontal passages.

The time of onset of both land and sea breezes at Newport Beach have been determined from wind records at Plant #2 of the County Sanitation Districts of Orange County (Plate 37). The direction and velocity of winds from June 1955 to June 1957 were analyzed, and all winds of a frontal storm origin were omitted in the tabulation. Plant #2 is approximately 400 yards inland from the shore and the winds are as representative of those over the shelf as can be obtained without having a permanent station at sea.

From October through December the land breeze begins in the early evening, a condition which does not exist in either January or February. This is believed to be caused by the lack of cloud cover in the last three months of the calendar year, followed by a dramatic increase in fog and low overcasts in January. The lack of clouds allows rapid cooling at night, so that pressure gradients are changed quickly. Conversely, a cloud cover delays cooling, until a later hour.

The sea breeze has its shortest duration in December, when it blows for an average of 8 hours. In June and July the average duration is 16 hours. There is no regular change in the wind velocity at this station accompanying the changes in duration. Average monthly velocities range from 3.8 knots to 5.3 knots,

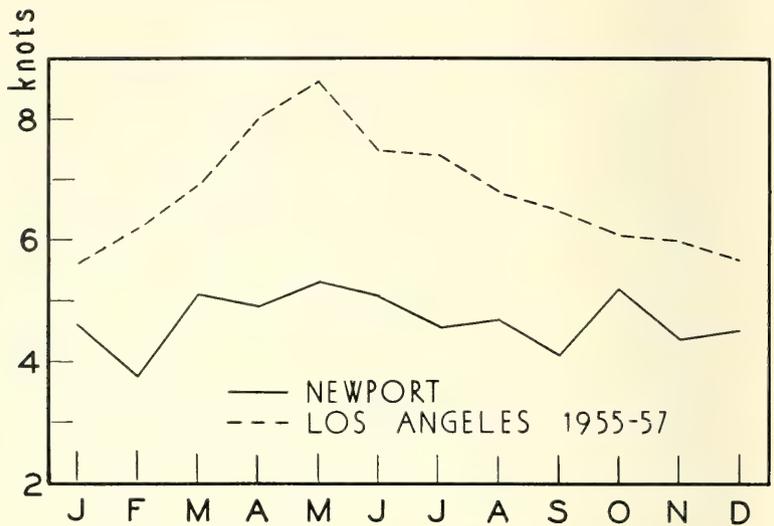


PLATE 38

A graph showing the average monthly wind velocity at Plant #2, County Sanitation Districts of Orange County and the Los Angeles International Airport.

and although velocities generally are higher from March through June, the increase of 0.5 knot in this period cannot be considered significant (Plate 38). Of greater importance is the constant low average velocities. Even though winds of 35 to 40 knots occur at times during the winter months, they are not frequent enough to raise the average. Thus, at this station the sea breeze is the dominant wind, and blows at a fairly constant but low velocity.

Other stations show a greater change in velocity with the different seasons. In Plate 38 the average monthly velocities from June 1955 to June 1957 at Los Angeles Airport have been plotted. Those in March, April, and May likely reflect frontal winds, so that the sea breeze average velocities probably reach a peak of 7.5 knots in June. The more pronounced effect of frontal winds at this station is due to its location some 35 miles west of Newport Beach along a westerly facing coast. Approaching fronts are much less effected by terrain as they reach the airport than they are on the eastern side of the Los Angeles Plain.

Resumé

The winds over the mainland shelf of southern California are primarily of the land and sea breeze regime. The diurnal air movements are augmented during the warmer months by a northwesterly geostrophic flow along the east side of the East Pacific high pressure area. The northwesterly flow becomes less dominant in the winter months, and during this period the winds have a more westerly component.

Wind velocities over the water are generally low. The most common velocity being between 1 to 6 knots. Farther seaward where isobars of the high pressure area are compacted, velocities of 30 knots or greater are not uncommon. On occasion the high may approach the coast, and high velocity winds result, particularly near Point Conception.

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PROCEEDINGS OF THE ACADEMY

November 20, 1959

The November meeting of the Academy, sponsored by the Section on Botany, was held in the Education Lecture Hall of the Los Angeles County Museum, with forty-five members and guests present. The program consisted of a symposium whose participants, Dr. Charles Burch (Chairman), Dr. Mildred Mathias, Dr. Louis C. Wheeler, Miss Bonnie Templeton, and Miss Bess Peacock, presented a report on the International Botanical Congress in Montreal, Canada.

Summary of Symposium's Presentation

As the Botanical Congress was the most significant botanical event of the year the participants attempted to bring the outstanding aspects of the meetings to the Academy.

Dr. Mildred Mathias reported on the sequential and organizational aspects of Botanical Congresses. It was shown that the security requirements of the United States makes such meetings unlikely in this country. The citizens and the officials of Montreal were remarkably cordial and efficient hosts.

Miss Bonnie C. Templeton reported on the Pre-congress sessions of the Bureau of Nomenclature and the Post-congress Field Trip on Forest Botany in Quebec.

Miss Bess Reed Peacock reported on the Pre-congress Grasslands Field Trip. She showed color slides on the ecology of the prairies and rangelands of southern Alberta and Saskatchewan.

Dr. Louis C. Wheeler reported on the General Colloquium on The Evolution of the Flower-insect relationship held in celebration of the Darwin Centennial.

The participants expressed general satisfaction with the Congress. It tended to widen the perspective of American botanists to international developments. It was impossible for any one individual to attend all of the significant papers. There was much mutual gain from the informal conversations with botanists from the entire world.

The following business was transacted at a meeting of the Board of Directors after the program on November 20, 1959. Mrs. Gretchen Sibley, secretary, presented the problems involved in the present scheduling of the committees and membership drive. It was decided to appoint committees for the coming fiscal year in January, if possible. It was also decided to send dues notices immediately after the beginning of the fiscal year.

Dr. Fred Truxal presented Dr. John Comstock's report that the Commonwealth Press and the press at Solvang would charge virtually the same prices for publishing the Bulletin and it was decided to remain with the Commonwealth Press.

Dr. Richard Loomis reported on the subsidizing of the publication of the Bulletin by National Science Foundation funds.

The following committee was appointed by the president to recommend action on a proposal by Mr. Theodore Payne that the Academy be given the opportunity to secure the Berlew collection of wild flower photos: Dr. Louis Wheeler, Chairman, Dr. Charles Burch, Dr. W. Dwight Pierce.

The following new members were elected: Ensign, Ina M. (Mineralogy), Ethridge, Richard (Herpetology), Heineman, Donald (Parasitology), Knox, Marlys Y. (Entomology), Stone, Alfred N. (Biology).

December 11, 1959

The Section on Invertebrate Zoology sponsored the regular December meeting of the Academy, which was held on the second Friday of the month in order to avoid conflict with the Christmas holidays.

Fifty members and guests were assembled to hear Dr. Richard Boolootian, Assistant Professor of Zoology, U.C.L.A., speak on "Reproductive Cycles in Marine Invertebrates".

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Mostra tuetur ipsi.



Vol. 59

SEPTEMBER-DECEMBER, 1960

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A NEW RODENT GENUS (FAMILY
HETEROMYIDAE) FROM THE TICK CANYON
FORMATION OF CALIFORNIA

BY WILLIAM G. REEDER

In 1940, R. H. Jahns discussed the stratigraphy of the eastern Ventura Basin of southern California. In so doing, it was determined that the basal segment of the non-marine Mint Canyon section was distinct in fauna as well as lithology. The several lines of evidence which led to the segregation and description of the Tick Canyon formation were outlined in detail. In addition, as a result of faunal comparison, a late-early, or early-middle Miocene time of deposition was suggested for the Tick Canyon sediments.

This small fauna has been described as consisting of a single falconiform bird (*Miohierax stocki* Howard,) an oreodont (*Merychys calaminthus* Jahns,) a leporid (*Archaeolagus acari-colus* Dawson,) and a single rodent which was listed as "Heteromyid, prob. n. gen. and sp." (Jahns 1940, p. 175). The latter had been examined by R. W. Wilson, who also furnished a descriptive statement enumerating several of the distinctive features of the form (*op. cit.* pp. 178, 182); the specimens were not figured. Through the courtesy of Dr. Theodore Downs, Los Angeles County Museum, these heteromyids were reexamined in connection with a larger problem. Their evident peculiarity, as seen after examination of all structurally-related forms (Reeder, 1956), warrants systematic recognition.

I am grateful to Mr. Ross A. Norris, staff artist of the Department of Zoology, University of Wisconsin, for preparation of the figures and plates.

FAMILY HETEROMYIDAE

Trogomys new genus

Type species: *Trogomys rupinimenthae* (described below).

Distribution: Known only from the late Arikareean or early Hemingfordian Tick Canyon formation, Mint Canyon series of southern California.

Diagnosis: Molariform teeth brachyodont and strongly rooted, with low cusps, as in *Perognathus*; true molars sexticuspidate; highly bilophodont, the cusps being conjoined to their apices, but with each cusp relatively low, rounded, and distinct, especially with slight wear; anterior cingulum present between

protoconid and protostylid; cingulum continues in unworn teeth as a minute remnant ridge on the anterobuccal margin of the metaconid; posterior cingulum present briefly at eruption between hypoconid and entoconid, at least of M_1 ; P_4 well developed, quadrate, quadricuspidate, but strongly bilophodont, with metalophid and hypolophid conjoining centrally; lower incisor slightly curvate and relatively narrow as in *Perognathus*, with anterior enamel surface curvate as seen in section; diastema short and concave throughout its length; least width of ramus at diastema about seven-eighths occlusal width of M_1 ; masseteric crest terminates anteriorly behind, but slightly dorsal to mental foramen which arises on lateral surface of the diastema; I^1 is asulcate.

Etymology: Combined from *trox*, *trogos*, Gr., gnawer, and *mys* Gr., mouse.

Trogomys rupinimenthae, new species

Plate 39, fig. 1. Plates 40, 41.

Holotype: LACM (CIT) 5184, anterior fragment of cranium with full dental complement.

Hypodigm: (numbers are those of California Institute of Technology Collection, now at the Los Angeles County Museum.) The holotype: LACM (CIT) 5185, anteroventral fragment of cranium with right I^1 , M^2 - M^3 and left I^1 , P^1 - M^3 ; 5186, 5187, right partial rami with P_4 - M_3 ; 5188, right partial ramus with I_1 , P_4 , M_3 ; 5189, left partial ramus with P_4 - M_3 ; 5190, left ramus with I_1 , P_4 , M_2 - M_3 . All were collected from the Tick Canyon formation, Mint Canyon series, California Institute of Technology locality 201, "near the narrows of Vasquez Canyon, a tributary of Boquet Canyon, at a distance of approximately 10 miles by road . . . (NE of) Saugus," Los Angeles County, California (Jahns, *op. cit.* p. 151).

Diagnosis: As for genus.

Etymology: Combined from *rupina*, L., rocky canyon and *mentha*, L., mint; intended to designate the stratigraphic series from which the specimens derived.

Description: The ramus is quite similar in conformation to that element of *Heliscomys* Cope and also *Cupidinimus* Wood (Plate 41). The anterior end of the ramus is slightly inflected at the diastema. The diastema is short and curvate throughout its length. Resembling *Cupidinimus* but not *Heliscomys*, the mental foramen opens into a marked depression one-third to one-half the length of the diastema anterior to P_4 and well down on the lateral face of the ramus. The masseteric crest rises in a gentle curve from the base of the ramus near the anterior border of M_2 and terminates anteriorly just behind and slightly dorsal to the

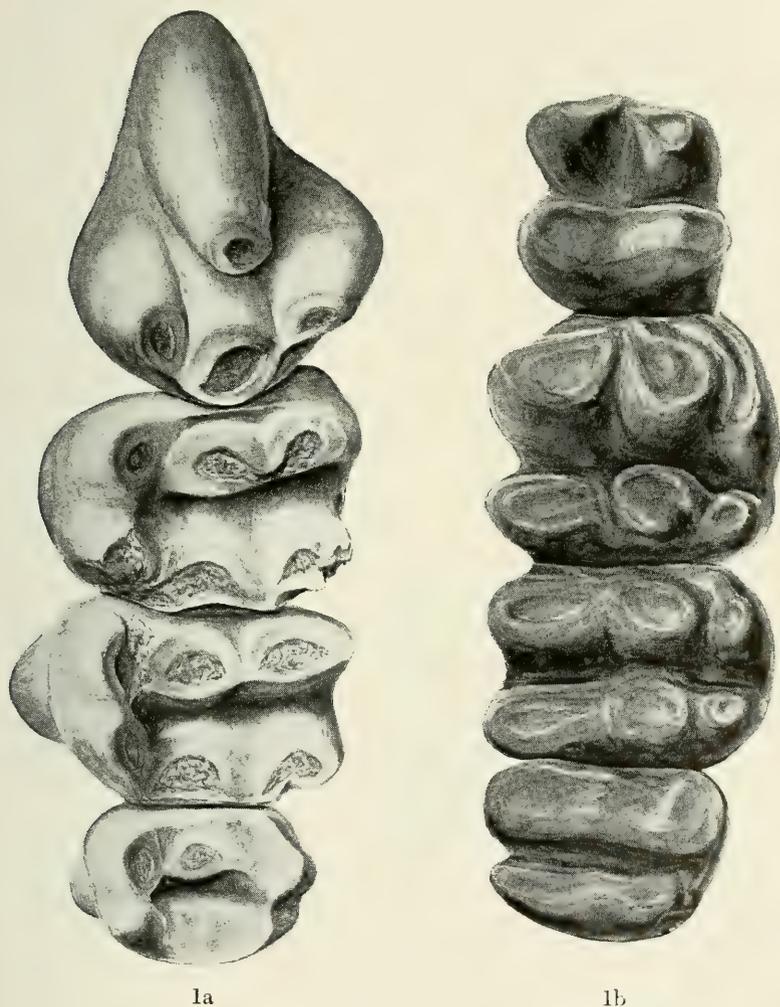


PLATE 39

Fig. 1a. *Trogomys rupinimenthae* new genus and species; holotype, LACM (CIT) 5184, left maxillary tooth row.

Fig. 1b. *Trogomys rupinimenthae* new genus and species; referred specimen LACM (CIT) 5186, right mandibular tooth row.

mental foramen. The lateral face of the ramus is plane, except as it flares laterad forming a prominent capsule of the incisor; the latter is strongly set off from the ascending ramus by a prominent groove. The ascending ramus lies in the same plane as the side of the jaw and originates at the level of the posterior margin of M_2 . Antero-posteriorly the basal margin of the jaw is shallowly convex; there is, however, a concave recurvature to the angular process at about the level of M_3 . The angle of the jaw appears to be slightly inflected. The remainder of the posterior portion of the ramus is lacking.

I_1 is somewhat more procumbent than in *Cupidinimus*, but less so than in *Mookomys* Wood. In cross section, the tooth is relatively broader than in the latter genus and is more nearly equivalent to the former or to *Perognathus* Wied-Nieuwied.

The structure of P_4 is quite variable. It is seen to consist of four transversely ovate cusps; the anterior pair is not quite parallel with the hypolophid, since the metaconid is placed well anterior to the protoconid. The anterior borders of the protoconid and metaconid are closely connected by buttress-like transverse extensions (Plate 1b). The molariform teeth are rather low-crowned (Figure 2) and become bilophodont very rapidly with wear. The hypolophid of P_4 loses its cusplarity much earlier than does the metalophid. The hypoconid bears an acuspluate shoulder-like lateral expansion. This structure is seen similarly in *Mookomys altifluminis* Wood. First union of lophs takes place between the protoconid and the hypoconid since the transverse valley rapidly deepens lingual to this point. Connection of the exposed dentine on the occlusal surface of the two lophs will thus, in all probability, first occur somewhat buccal to the center of the tooth.

M_1 and M_2 are nearly identical except for a lesser antero-posterior length of the latter (Table I). In both teeth the protoconid and metaconid are transversely ovate and are connected by extensions of their anterior borders. From this point a cingulum, as high as the apices of the cusps, curves laterad to the small, abliquely-elongate, protostylid. In M_1 the protostylid extends slightly into the transverse valley (Plate 1b,) while in M_2 the metalophid is nearly straight. In both teeth, when unworn, the cingulum extends briefly linguad from the junction of protoconid and metaconid.

The hypoconid is the longest and most prominent cusp of the posterior lophid; in M_1 it is set somewhat anterior to the other two cusps, thus displacing the transverse valley anteriad

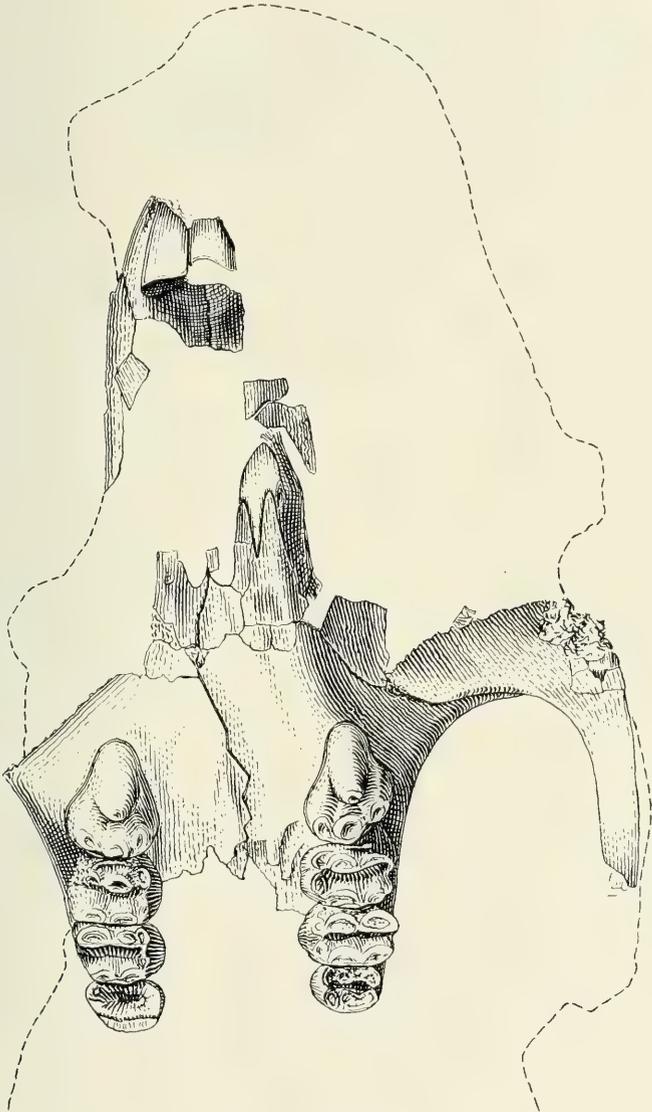


PLATE 40

Trogomys rupinimenthae new genus and species; holotype, LACM (CIT) 5184, palate and dentition.

near the center of the tooth. On M_1 , a rather distinct posterior cingulum connects the entoconid, the posterior surface of the hypoconid, and the hypostylid. First junction of lophids occurs between the protoconid and hypoconid with a second high point of the transverse valley between the stylids. An ephemeral stage may occur in which enamel of the transverse valley is completely surrounded by dentine, but is not evidenced in the little-worn specimens at hand. With moderate wear, cuspularity of the lophids is highly reduced.

M_3 is similar in pattern to the anterior molars and appears to be sextituberculate. The protostylid is of relatively reduced importance and tends to penetrate posteriad into the transverse valley. The hypostylid is very much reduced and is closely appressed to the hypoconid, as in the other molars.

The holotype consists of a fragmentary anterior portion of the cranium and a partial brain cast. The referred specimen LACM (CIT) 5185 does not add appreciably to our information since the same parts of the skull are present; the dorsal skull surface is, at present, unknown. The palate is nearly flat from the anterior border of M^1 forward at least to the incisive foramina. A faint median keel is present at least between P^4 and probably extends forward from this position. The incisive foramina, lying about 2.0 mm. anterior to P^4 , though not complete anteriorly, are seen to be rather wide, with nearly parallel lateral borders. The premaxillary-maxillary suture seems to cross the foramina at or near their posterior borders.

In this specimen the rostrum is distorted and the diastemal surface is almost completely absent. A marked concave curvature is evidenced, however, as the diastema decurves to the alveoli of the incisors. The entire rostrum appears to have been rather narrow, as in *Perognathus*; the planes of the lateral rostral surfaces are nearly parallel. The specimens are too badly eroded to give evidence as to the natural position of the infraorbital foramen. The entire curvature of the upper incisor is observable; the distance between the lateral surfaces of the incisors on the skull dorsum is about 2.2 mm. There is no evidence that the nasals had been tubular.

The zygomaseteric plate lies in a plane nearly perpendicular to the sagittal plane of the animal and rises sharply dorso-laterad from the palate, as in most species of recent *Perognathus* examined. Curving postero-ventrad, the zygomatic process is rapidly reduced in breadth. The ventral edge of the plate and

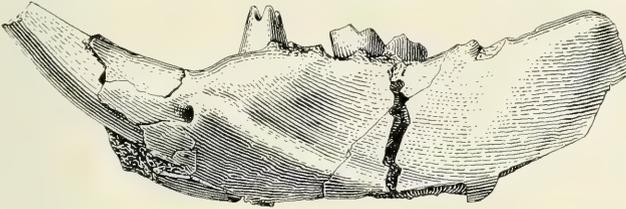


PLATE 41

Trogomys rupinimenthae new genus and species; referred specimen LACM (CIT) 5190, left ramus and dentition.

the zygomatic process describe a symmetrical concavity. It thus appears that the lateral borders of the zygomatic arches were not parallel, but rather were slightly flaring and laterally convex. The dorsal surface of the zygomatic process is not expanded in breadth to the extent seen in *Cupidinimus* but rather is again reminiscent of the structure of *Perognathus*.

The dorsal bones of the rostrum and cranial vault are largely lost in the available materials. The general shape of the right orbital region appears to approximate that of *Perognathus*. A supra-orbital ridge of the frontal is present at the least inter-orbital constriction. Including the breadth of this lateral overhang, the least interorbital distance seems to have been about 4.0 mm. Since there is some doubt as to the extent of development of this supraorbital ridge, the above measurement is likely to be an underestimate of the true value.

As is expected, the brain cast exhibits a central longitudinal sulcus; at the rear of the orbit, the brain flares laterad to the cerebral hemispheres. There is no definitely discernible posterior margin of the cerebrum or lines showing the presence of overlying sutures. A facet on the posterior third of the dorsolateral interorbital surface may be indicative of the extension of the squamosal onto the skull dorsum. There is no direct evidence as to the size of bullae, since it is impossible to say with certainty whether the rounded bulla-like bulge of matrix on the right ventral surface has been artificially formed and worn, or whether it is a true bullar cast.

I^1 is asulcate, no indication of a groove being seen. On the occlusal surface of the upper incisor, specimens consistently show a medial groove resulting from deep attrition of the narrow lower incisors. There was evidently little or no lateral movement in biting with the incisors since the grooves are exactly the width of the two appressed lower incisors.

The molariform teeth lie in parallel rows with an interalveolar distance of about 2.0 mm. The teeth do not exert perpendicular to the palatal plane, but rather diverge slightly latero-ventrad. The teeth are brachydont (Figure 1) though not to the extent observed in *Mookomys formicorum* Wood. There is no approach to the advancing hypsodonty of *Cupidinimus*. The molariform teeth are little reduced from front to rear (Table 1). P^1 and M^1 are about equal in width. M^2 is about 5 per cent narrower than M^1 , while M^3 is about 75% of width of M^1 . This reduction is less than that observed in most Recent *Perognathus* and is more nearly similar to that of *Cupidinimus*. P^1 (Plate 1a) is formed of a slender, elongate protocone which lies directly anterior and most closely connected to the transversely-ovate hypocone. The metaloph is crescentic with the ovate metacone lying anterior to the other cusps and joined fully with the hypocone. Medially the antero-posteriorly elliptical hypostyle is nearly connected by a cingulum to the hypocone, being separated therefrom only by a sulcus cutting rather deeply between them. The first junction of lophs with wear occurs between the protocone and the hypocone.

The molars are sextituberculate and vary but slightly in structure. Though lophodont, the cuspal patterns are clearly evident and are moderately persistent.

As is to be expected, the protocone is set between and behind the paracone and protostyle; these latter are connected anteriorly to the protocone by a prominent cingulum. The protostyle lies closer to the protocone than is the latter to the paracone. The metaloph consists of the metacone and hypocone, transversely oriented and closely connected, with the hypostyle placed slightly anterior to the line of the other two and closely joined to the hypocone. Medially, the protostyle and hypostyle are joined nearly to their apices, thus effecting a closure of the transverse valley.

M^2 varies from M^1 in its lesser antero-posterior dimension (Table 1). The protocone is less displaced posteriorly and the anterior cingulum is much less distant. M^3 is sexticuspluate; the styles are joined medially as in M^1 and M^2 . Wear has broadened the metaloph of M_3 to a wide surface. Connection of the paracone and metacone buccally thus completes the enamel ridge surrounding the deep pit-like transverse valley which persists as a central pit for nearly the life of the tooth.

Table 1

| | I1 | | | | P4 | | | | M1 | | | | M2 | | | | M3 | | | | |
|---------------------|------|------|------|------|-------|-------|-------|------|------|------|-------|-------|----|------|------|------|----|----|----|----|----|
| | GW | WP | WM | AP | WP | WM | AP | AP | WP | WM | AP | AP | WP | WM | AP | AP | WP | WM | AP | AP | |
| LACM (CIT) 5184-Rt. | 0.63 | 1.05 | -- | 1.27 | *1.30 | -- | 1.27 | 0.88 | 1.18 | 1.12 | 0.83 | *0.92 | -- | -- | 0.75 | | | | | | |
| LACM (CIT) 5184-Lt. | 0.60 | -- | -- | 1.27 | *1.40 | 1.27 | 0.95 | 1.18 | 1.13 | 0.82 | 0.95 | -- | -- | 0.78 | | | | | | | |
| LACM (CIT) 5185-Rt. | 0.50 | 1.02 | -- | -- | -- | -- | -- | 1.22 | 1.13 | 0.83 | 1.05 | -- | -- | 0.70 | | | | | | | |
| LACM (CIT) 5185-Lt. | -- | -- | -- | 1.37 | 1.30 | 0.90 | 1.23 | 1.13 | -- | -- | 1.03 | -- | -- | 0.72 | | | | | | | |
| ----- | | | | | | | | | | | | | | | | | | | | | |
| | I1 | | | | P4 | | | | M1 | | | | M2 | | | | M3 | | | | |
| | GW | AP | WM | WH | AP | WM | WH | AP | WM | WH | AP | AP | WP | WM | WH | AP | AP | WP | WM | WH | AP |
| LACM (CIT) 5188 | 0.47 | 1.05 | 0.77 | 0.90 | 1.18 | -- | -- | -- | -- | -- | -- | -- | -- | 0.88 | 0.72 | 0.77 | | | | | |
| LACM (CIT) 5190 | 0.47 | 1.07 | 0.87 | 0.93 | 1.00 | -- | -- | 1.12 | 1.00 | 0.93 | *0.80 | | | | | | | | | | |
| LACM (CIT) 5186 | -- | -- | 0.78 | 0.97 | 0.92 | *1.17 | *1.15 | 1.03 | 1.17 | 1.08 | 0.85 | *0.68 | | | | | | | | | |
| LACM (CIT) 5187 | -- | -- | -- | -- | 0.87 | *1.18 | *1.17 | 1.02 | 1.18 | 1.15 | 0.92 | *0.80 | | | | | | | | | |
| LACM (CIT) 5189 | -- | -- | -- | -- | *0.82 | *1.23 | *1.18 | 1.02 | 1.20 | 1.12 | 0.87 | 0.98 | -- | -- | 0.80 | | | | | | |

Trogomys rapinimenthae new genus and species; measurements of upper and lower teeth. Abbreviations used as follows: GW, greatest width; AP, antero-posterior length; WP, width protoloph; WM, width metaloph or metalophid; WH, width hypolophid. Starred measurements (*) are closely estimated values.

Relationships: It is suggested that the three genera *Perognathus*, *Mookomys*, and *Trogomys* are closely related and may be united as the subfamily Perognathinae. The three included genera are united by molar characteristics of moderate lophodonty with concomitant low crown. In characteristics of the ramus and cranium the genus *Trogomys* is quite similar to *Perognathus*. It differs, however, in lacking sulci on the upper incisors; this groove is present in *Perognathus* and apparently as well in *Mookomys*. Depending on one's preconceptions, since firm evidence is absent, the lack of incisoral groove could be primitive and retained through time as a separate line or it could have resulted from secondary loss of a previously present sulcus. In addition the molariform teeth of *Trogomys* possess strong cingula, which appears to be a primitive characteristic which has persisted. It is therefore the present contention that *Trogomys*, retaining these features of older heteromyid forms, represents a distinct line continuing into Tick Canyon time but which presumably had a rather long previous separate history.

Nothing is known as to the path by which the derivative perognathines descended from ancestral forms. Wood has supported *Heliscomys* as the ancestral genus. While agreeing that the latter genus is old, it is, nonetheless, specialized to an extent which suggests it to be removed, to some degree at least, from the stem of perognathine divergence. The other known Oligocene forms include the genus *Proheteromys* (*sensu latissimo*) of Wood and two new genera of heliscomyine structure (Reeder, 1960). Though no known specimen of the early *Proheteromys* group is as small as *Trogomys*, *Mookomys*, or most *Perognathus*, it appears that these specimens represent a more generalized structural stage which could have given rise to the perognathine dental type. Detailed discussion of Wood's genus *Proheteromys* will be found elsewhere (Reeder, 1956).

The presence of this new perognathine in the Tick Canyon formation at present can contribute little to the accurate dating of the formation. The obvious primitive nature of the remains, however, would suggest late early Miocene or early middle Miocene time of deposition to be reasonable and not out of line with the evidence presented by Jahns (*op. cit.* pp. 169-173) and Dawson 1958.

Environment: Two large fossil floras and several smaller ones have presented evidence which bears on the determination of physical and floristic conditions under which the Tick Canyon sediments were deposited. The Tehachapi flora, nearly contemporary with Tick Canyon, was deposited on the western margin

of Mohavia near the present town of Tehachapi (Axelrod, 1939). The Upper Miocene Mint Canyon flora (Axelrod, 1940) followed the Tick Canyon formation considerably in time, but occurs in the same stratigraphic sequence, documenting a more recent floral community, but of the area from which *Trogomys* derived. Axelrod (1950) has suggested that in the western region now desert, during Miocene time, the "Madro-Tertiary Flora, with its live oak woodland, chaparral, and arid subtropical scrub vegetation, characterized the regions of the present Mohave and Sonoran Deserts" (*op. cit.* p. 286). The climatic trend to increasing aridity, which continued into the Pliocene, shows continued restriction of lowland forest and woodland, with replacement by grass- and shrub-land. In a more recent summary, Axelrod states that "The Madro-Tertiary Geoflora was already the dominant vegetation in southeastern California by Early Miocene time . . . The absence of humid subtropical to warm temperate relicts in the Early Miocene of southeastern California suggests that the geoflora may have already been well established there by the Middle Oligocene, and possibly by Middle Eocene time" (Axelrod, 1958, p. 463).

Deposition of the Tick Canyon fauna occurred in deep lake waters surrounded largely by vegetation of arid or semi-arid facies. A riparian community, including hackberry, sycamore, and sabal palm, characterized the stream-border habitats and perhaps also the margins of the lakes. An arid subtropic scrub probably grew on lower slopes surrounding the lake basins; this "plant formation was common along the river valleys and drier plains of interior southern California from Early Miocene (or earlier) well into Middle Pliocene time" (*op. cit.* p. 502). Reasoning from the Tehachapi conditions, the higher dry slopes probably were characterized by live oak savanna and scattered chaparral. The Tick Canyon fauna thus probably lived under temperature conditions similar to those now prevalent in the region, with the exception that winter temperatures were somewhat higher than at the present time. Rainfall varied from 15 to 25 inches annually, with bi-seasonal distribution as summer showers and winter rains.

It may be postulated that the absence of *Trogomys* from previously-known fossil assemblages is due to 1) the semi-arid nature of its habitat and the concomitant improbability of its preservation, or 2) its recent migration, in company with elements of

the north Mexican flora, from areas to the southeast which are biotically very little known in the lower and middle Tertiary. It is suggested that the geographic region within which the Madro-Tertiary Geoflora probably evolved, (the border-tropics of northwestern Mexico and adjacent parts of southwestern United States) was simultaneously an area in which mammals also were changing, better to adapt to the developing arid conditions.

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NONMARINE MOLLUSCAN REMAINS FROM AN
ARCHAEOLOGICAL SITE AT LA PLAYA,
NORTHERN SONORA, MEXICO

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National Museum of Canada

ABSTRACT. Two hundred and sixteen molluscan shells, in four genera, from the upper cultural bearing zone of the La Playa site were studied as to environmental conditions under which they had lived. They showed cienega conditions (marsh, pond, or sluggish stream) had existed. Some shells may have been redeposited from considerably earlier times.

INTRODUCTION

The La Playa site has long attracted attention (see Plate for location); it was reported in the Sauer and Brand surveys of the late 1920's (Sauer and Brand, 1931: 93-94). During the last 15 years, it has been visited by numerous archaeologists of the United States and Mexico. Alfred E. Johnson, The University of Arizona Department of Anthropology, lately studied its stratigraphy and artifacts for report. In November of 1959 he supplied, for study, examples of land and freshwater molluscs from its upper cultural bearing zone. He had received a report from local Sonorenses that, prior to the arroyo cutting of the late 1800's, the area was once a cienega; he hoped study of the occurrence and deposition of the shells might verify this. Some of the interpretation of the archaeology of the site would depend upon whether or not this were so.

FAUNAL REMAINS

Four genera of nonmarine molluscs were represented: (land) *Succinea*; (freshwater) *Pisidium*, *Helisoma*, and *Lymnaea*. But for the gastropods *Physa* and amnicolids, this is the same general freshwater genera assemblage (*Pisidium*, *Helisoma*, and *Lymnaea*) that occurred in pond deposits in Matty Canyon, southeast Arizona (Drake, 1959: 149-151, Tab. II, Pl. 44). The *Succinea*, it can again be emphasized, is almost amphibious and commonly associated with moist conditions.

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PLATE 42

Location of La Playa archaeological site, Sonora, Mexico: 27 miles northwest of Santa Ana (which is 11 miles north of Magdalena as shown), 8 miles south of Ocuca, and 7 miles north of Las Trincheras: Arizona State Museum Site Number: Sonora: F:10:3. The site is located on the old road from Santa Ana to Altar; now, the Rio Boquillas cuts through it.

The specimens (collected in early November, 1959, by A. E. Johnson) have been deposited in the National Museum of Canada (NMC) at Ottawa, in The University of British Columbia Invertebrate Museum (UBCIM), at Vancouver, and The University of Arizona Invertebrate Museum (UAIM) at Tucson.

Succinea: 184 shells.

- NMC: 8627 (2 shells—drawings made);
 8619 (50 shells—Class I size);
 8618 (35 shells—Class II size);
 8620 (68 shells—Class III size);
 8621 (10 shells—Class IV size);
 8625 (hypotype): 1 shell—Pl. 43.
- UBCIM: 6551 (9 shells—Class III size);
 UAIM: 481 (9 shells—Class III size).

Discussion: 181 of the 184 shells were divided into four size classes according to height (length): I. 3-6 mm (50); II. 8-9 mm (35); III. 10-15 mm (86); IV. 15-17 mm (10). This arbitrary classification, probably not representing species or subspecies but perhaps size clines in a single population or series of genetically- and time-related populations, is presented here because similar gross groupings have long been noted for the succineids, lymnaeids, and physas in particular in assemblages in recent deposits in western North America and in modern aquatic situations. The larger classes, III and IV, are very heavy shelled and have an almost carinated sculpture, possibly denoting drought conditions (higher salts concentrations going into the shells). They closely resemble, in carination and shell thickness, succineas observed weathering out of lower parts of arroyo walls in early man sites in southern Sonora and southern Arizona, but not at places such as the arroyo in Chaco Canyon (New Mexico) or later deposits in Matty Canyon, Arizona. When received, some of the class III and IV La Playa succineas had air spaces behind dirt plugs in the apertures, and would float in water. Thus, the possibility may be suggested that some snail shells may have originally lived in pre-ceramic times and have been redeposited due to any of the four or five processes uncovering them as earlier fossils. Depositional features might offer further information of this nature when more archaeologists can make or get geological studies of their sites. If it could eventually be shown that some biological materials in sites had been redeposited this would offer much toward clearer interpretation of sites and for regional climatic changes. (For a premature review of the problems, see Drake, 1954).

Helisoma: 18 shells.

NMC: 8623 (14 shells);

8624 (hypotype): 1 shell—Pl. 43

UBCIM: 6550 (3 shells).

Discussion: These are all under 15 mm across and none of them look individually old as far as shell maturity is concerned—more as though they had grown quickly in temporary ponds; or, there was warmth and plant food for several months for rapid growth but the ponds dried out. And, they are certainly not heavy shelled. Perhaps not too many helisomas are readily recovered by arroyo bank collecting. These don't seem to have taken up extra deposits from ground water.

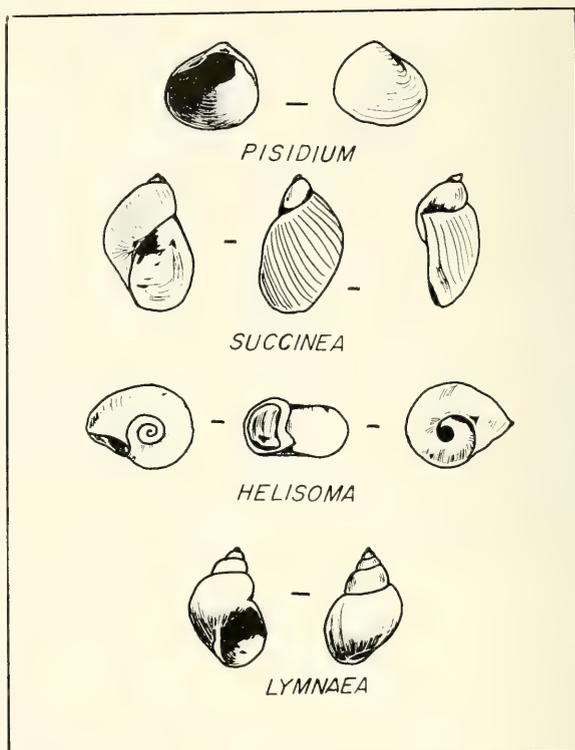


PLATE 43

Shells of nonmarine molluscs occurring in upper cultural levels of La Playa Site (Ariz. State Mus. No: Sonora: F:10:3.), Sonora, Mexico. Hypotypes: *Pisidium* (NMC 9458), *Succinea* (NMC 8625), *Helisoma* (NMC 8624), and *Lymnaea* (NMC 8626).

SCALE LINES — 1 mm.

Pisidium: 12 valves (none were articulated).

NMC: 8622 (8 valves);

9458 (hypotype): 1 valve—Pl. 43

UBCIM: 6522 (3 valves).

Discussion: Most of the valves are heavy shelled and appear to have grown in water which was silty part of the time, and as if they were built to withstand some abrasive action in shallow streams rough part of the year. Not enough living sphaeriids have been personally observed in Arid America to offer valid comparisons at this time. The long awaited monograph by Rev.

H. B. Herrington of the Anglo-America sphaeriids is currently (1960) in press at Ann Arbor.

Lymnaea: 2 shells.

NMC: 8629 (1 shell);

8626 (hypotype): 1 shell—Pl. 43

Discussion: Two specimens offer little for study. They are of the short, bulbous type found at Matty Canyon and found living in many parts of the arid regions of western North America.

CONCLUSIONS

The report which A. E. Johnson received from people living near the La Playa site regarding the former existence of a cienega there seems substantiated by study of small nonmarine snail and clam shells. When an archaeological report is available, a further assessment may be forthcoming; or, the La Playa sedimentary records will be so designated and described that they can be correlated with physiographic features associated with cultural horizons existing in the area. The commonness of *Pisidium*, *Succinea*, *Helisoma*, and *Lymnaea* will probably be more point to their use in archaeology as nonartifacts.

ACKNOWLEDGEMENTS

Mr. A. E. Johnson gave permission to study and report upon the specimens. This report is part of results of Northwest Mexico research supported by American Philosophical Society Grant 2696 (Penrose, 1959). Miss J. Lanko (drawing) and Mr. R. J. Hyslop (enlarging) assisted with illustrating.

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SILICIFIED TURBELLARIA FROM CALICO MOUNTAINS NODULES

W. DWIGHT PIERCE

Drawings by the author.

The following is the fifth report of the writer's investigation of fossils from calcareous petroliferous nodules formed in a Miocene lake in the area which is now the Calico Mountains, San Bernardino County, California (See Bull. So. Calif. Acad. Sci., 57:13-24; 58:72-78; 58:79-83; and 59:40-49).

The material herein discussed constitutes a first record of fossil preservation for the Class Turbellaria. Only by instantaneous death and preservation, and catalytic replacement of the tissues by colloidal silica can this material be explained.

Included are six specimens of flat worms representing three species, belonging to three families; also 360 eggs of one type, and 53 eggs of another type, believed also to be Turbellarian. The material was extracted by formic acid from nodules preserved in six quarter sections of the southeast mountain mass of the Calico Mountains, at altitudes 2500 to 2800 ft., and was collected at 10 sites, in 12 lots, by 8 persons. The extracted specimens are now mounted in balsam on fourteen microscope slides in the collections of the Los Angeles County Museum. See Table 1 for essential data.

CLASS TURBELLARIA

Free-living flat worms, with cellular or syncytial epidermis; body undivided; life cycle simple.

While common in fresh waters, these worms are so soft that none have ever been recorded in Paleontology. We now have three silicified types from the Miocene.

ORDER RHABDOCOELA

Small Turbellaria with complete digestive tract: intestine sac-like, without evident diverticula.

Specimen 4065 (Plate 44, Figure 1) is a very thin disc of pale yellowish color, slightly convex dorsally and concave ventrally. The eye spots are complex and near the anterior lateral margin. The mouth opening is ventral, close to the anterior third, and has two organs extending forward. The intestine is dimly outlined from mouth to penis bulb, which is elongate. The male gonopore is terminal with long canal to the antrum, into which three canals lead, the middle one probably connected to the penis bulb. There are a number of tactile hairs on the margin of the body.

TABLE 1. DATA ON TUBELLARIAN WORMS AND EGGS FROM NODULES

| Objects | No. | Measure mm. | Spec. No. | Nodule No. | ¼ Sect. R1E R2E | Site | Lot | Alti- tude | Collector | | |
|------------------------------|-----|----------------|--------------|---------------|--------------------|------|------|---------------|---------------|--------------|-----------------------|
| Worms | | | | | | | | | | | |
| Rhabdoceola | 1 | 0.809x0.42 | 4065 | 12825 | | SW18 | 84 | 171 | 2800 | D. Weissman | |
| Tricladida Rhynchodemidae | 1 | 3.57 x0.44 | 4359 | 2855 | | SW18 | 2D | 20 | 2700 | Dara Shilo | |
| Planariidae | 1 | 1.59 x0.307 | 2721 | 31 | | SW18 | 2 | 1 | 2650- 2800 | W. D. Pierce | |
| | 2 | 0.48 x0.0769 | 1179 | 6568 | | SW24 | | 15 | 84 | 2500 | Chas. Artman |
| | 1 | 1.00 x0.288 | 4316 | 12582 | | SW24 | 101B | 167 | | | John Carr |
| Eggs | | | | | | | | | | | |
| Type I | 345 | 0.19 diam. | 4235 | 3231 | | SW24 | | 15 | 25 | 2500 | G. Kanakoff |
| | 15 | 0.21 diam. | 4245 | 16054 | | NE24 | | 92 | 218 | | G. Kanakoff |
| Type II | 1 | 0.23 diam. | 4215 | 3231 | | SW24 | | 15 | 25 | 2500 | G. Kanakoff |
| | 1 | 0.21 diam. | 4197 | 10193 | | SW24 | | 15 | 104 | 2500 | G. Kanakoff |
| | 2 | 0.25-0.26 | 2299 | 21 | | SW18 | 2 | 1 | 2650- 2800 | | Jeanne Hotch- kiss |
| | 15 | 0.21-0.23 | 2966 | 12733 | | SE18 | 74 | 169 | | | John Carr |
| | 5 | 0.21-0.23 | 2715 | 13608 | | NE19 | 17F | 185 | 2700 | | G. Kanakoff |
| | 1 | 0.23 | 3813 | 4741 | | NE19 | 25 | 60 | 2725 | | John Carr |
| | 3 | 0.21 | 4222 | 27062 | | NE19 | ? | 319 | ? | | Laura Rouse |
| | 25 | 0.19-0.25 | 2962 | 17505 | | NW19 | ? | 258 | ? | | Laura Rouse |

It is excluded from Order Acoela, family Proporidae, in which the genus *Afronta* has a terminal genital opening, but no intestine.

According to Ludwig von Graff (1905. Monograph of Turbellaria II Rhabdoceola. in *Das Tierreich*, lief. 23) all of the families with terminal genital opening fall in the suborder Lecithophora.

SUBORDER LECITHOPHORA

Libbie Henrietta Hyman (1951. *The Invertebrates: Platyhelminthes and Rhynchocoela. The Acoelomate Bilateria*. vo. II, p. 59) defines this suborder as "Rhabdoceols with bulbous pharynx, paired protonephridia, ventral gonopores, germovitellaria, or separate ovaries and yolk glands; reproduction exclusively sexual; fresh water, marine, or terrestrial, mostly free-living, some commensal or parasitic.

In this suborder, the families Umagillidae (Anoplodiidae), Cylindrostomidae (Genostomatidae), Byrsophlebiae, and Gyraetricidae have the genital opening terminal. The first three families are parasitic, the last predaceous.

It is not the function of the writer in this article to name this fine specimen, as many of the characters used in the group are too obscure for delineation. However the characters delineated by Hyman and by von Graff seem to bring this specimen into the Section Typhloplanoida.

In Hyman's classification the section Typhloplanoida is composed of Lecithophora without a proboscis, pharynx usually of rosulate type, mouth ventral, back from tip; with one or two gonopores.

ORDER TRICLADIDA

SUBORDER TERRICOLA

FAMILY RHYNCHODEMIDAE

The largest Turbellarian so far found is Specimen 4359 (Plate 44, Figure 2). The intestinal canal lies diagonally, indicating a twisting of the body. The shape is elongate, stem-like. The eye spots are near the anterior lateral margin. The mouth opening is ventral at the anterior fifth of the body. A faint double line forward from the mouth indicates the division of the two forward portions of the intestines, while the posterior part lies in a diagonal position. The posterior half of the body is crystal clear. The body is constricted behind the middle. There are clusters of tactile hairs not far behind the mouth on each side, and a few other hairs behind. At posterior quarter on right side is a genital pore with a well defined covering flap; and nearer the apex on the left side is another pore with a smaller flap.

SUBORDER PALUDICOLA

FAMILY PLANARIIDAE

Four specimens of planarians (Plate 44, Figures 1-3) have been extracted by acid from the nodules as listed in the table. These tiny flat worms have typical eye spots, rounded head, pointed apex, and the side view of one shows the mouth opening. They are speckled, but show no describable details of the internal structure.

CLASS TURBELLARIA (?)

In the second paper of the nodule series (Bull. So. Calif. Acad. Sci. 58:72-78) the writer recorded for the first time the

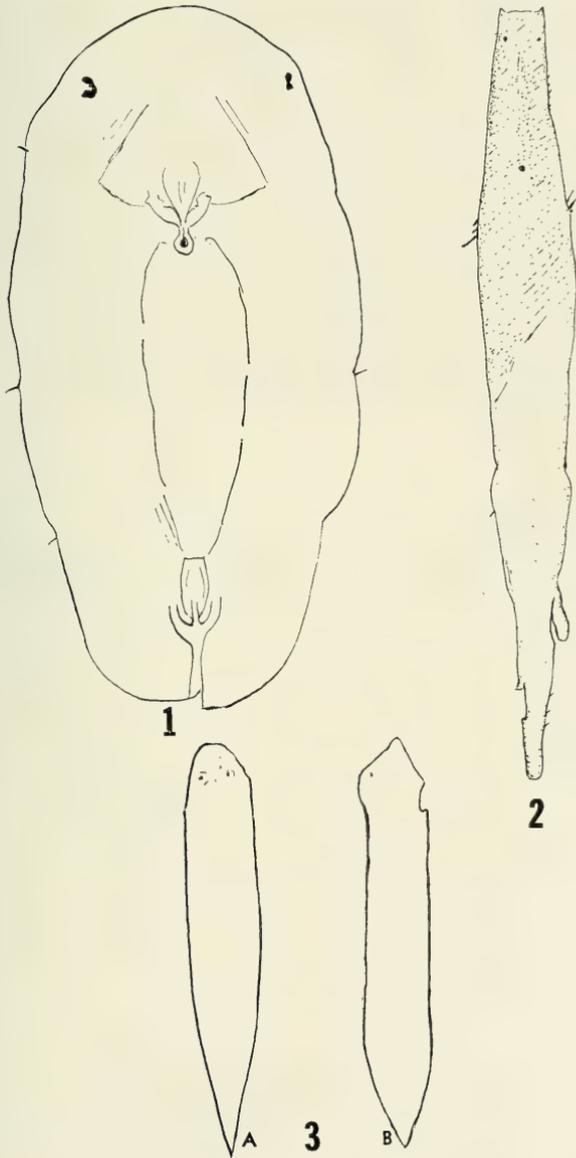


PLATE 44

Fig. 1. Fossil Rhabdocoel, Specimen 4065; length 0.809 mm.
Fig. 2. Fossil Rhynchodemid, Specimen 4359; length 3.57 mm.
Fig. 3. Two fossil Planarians, Specimen 1179; length 0.48 mm.

finding of fossil insect eggs. Some of these will be recorded in another paper; but in addition to insect, mite, and fairy shrimp eggs, there have appeared in the acid digestion of the nodules, two kinds of eggs which more closely resemble the Turbellarian type.

Turbellaria sometimes develop the eggs and offspring within the body; while others deposit eggs singly or in strips of gelatinous material. The yolkcells are usually not stored in the egg itself, but in special cells. Among the Tricladida the eggs are surrounded by yolk cells to form a capsule. Rhabdocoele eggs are generally laid singly, each enclosed in a rounded, oval, or hemispherical albuminoid shell or capsule. In Polycladida the worm ejects a continuous adhesive gelatinous thread containing a row of eggs. The eggs of Acoela are also enclosed in a delicate capsule embedded in gelatinous material.

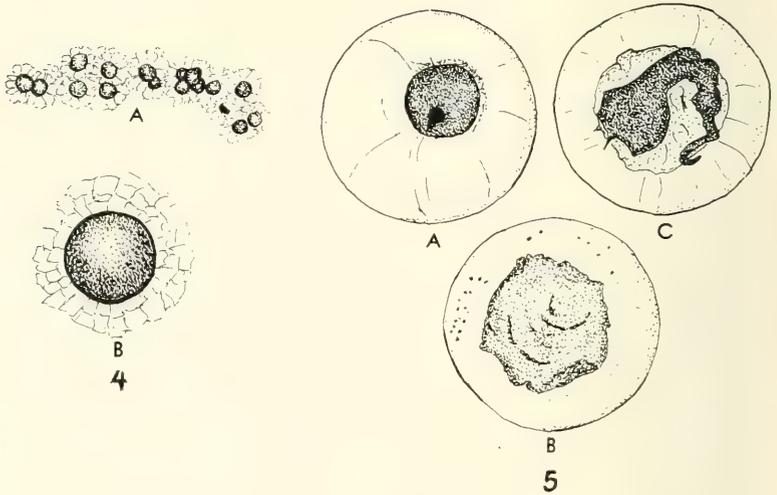


PLATE 45

Fig. 4. Fossil eggs, Type I, in ribbon, and enlarged single egg, thought to be Turbellarian, Specimen 4235; size of single egg 0.19 mm.

Fig. 5. Three fossil eggs, deposited singly, showing three phases of embryonic development, thought to be Turbellarian, Specimen 2962; size of eggs 0.19 to 0.25 mm.

Development is very rapid, so we may consider it very fortunate that the unusual conditions under which the Miocene nodule fossils were rapidly silicified, made possible the preservation of these delicate eggs.

We will make no attempt to assign these eggs to any family, but desire to record them now and alert the specialists to the fact that fossil eggs of the Miocene age, perfectly preserved three dimensionally, exist in the Calico Mountains nodules. As may be seen from the tabulation, these eggs are tiny.

The Type I eggs are spherical, black, surrounded by many gelatinous flakes and held together in long strips. The 345 contained in nodule 3231 were, for the most part in one mass of coiled strips. The actual egg proper measures 0.086 mm., but with the surrounding flakes the diameter averages 0.19 mm. These were found in two localities, two quarter sections. (Plate 45, Figure 4).

The Type II eggs are spherical consisting of a central egg enclosed in a clear convex capsule of smooth outer surface, each laid singly. In Nodule 17505 there were 25 eggs in different stages of development as shown in the illustration (Plate 45, Figure 5). The tiny egg proper may measure as little as 0.057 mm., within a clear mass measuring 0.23 mm. in diameter. These eggs have been found, as shown by the tabulation, in five quarter sections, in other words through the entire lake area.



A NEW TECTIBRANCH, *Aplysia reticulopoda*,
FROM THE SOUTHERN CALIFORNIA COAST

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Specimens of a distinctly new tectibranch of the genus *Aplysia* have been collected along the coast of southern California. The holotype was collected by Mrs. Vicky Whitford in Diver's Cove, Laguna, Orange County in mid-May 1957. The specimen was captured underwater during skindiving activities. It was crawling on a large loose kelp holdfast which was resting on the bottom about two fathoms below mean tide line. The surf was fairly strong; but there had been no recent storm activity.

The single paratype was collected by Mr. Jim Graves at Portuguese Bend, Los Angeles County on February 22, 1960. This specimen was found cast up, freshly dead, among red algae growing in the rocky intertidal zone. The surf was moderate and without recent storm activity.

Aplysia reticulopoda, new species

The following description of these two specimens stresses those features considered of specific value by Pilsbry (1896), Eales (1944), Marcus (1955), and Winkler (1959a). The main external measurements of the preserved specimens are listed below:

Contraction due to preservation was notably lacking. Measurements of the paratype when freshly dead and after four months of preservation varied less than one per cent. The collector of the holotype noted no contrast between that specimen when fresh and after three years in formalin.

TYPE LOCALITY: Subtidal zone, Laguna, Orange County, California. Also known by paratype from Portuguese Bend, Los Angeles County, California.

HOLOTYPE: Allan Hancock Foundation Mollusc Specimen No. 1032. The specimen is somewhat pyriform, firm, stout, and notably "streamlined". Width is about two-thirds of total length. Dorsal surfaces are smooth, free of wrinkles or papillose projections.

Pigmentation did not change noticeably during three years in formalin and exposure to light. The pigmentation of the preserved specimen consists only of a very light pale yellowish-white on all surfaces except the foot grooves. The foot ridges, similar in color to the dorsal surfaces, contrast sharply with the dark purplish-black of the grooves.

| | HOLOTYPE | PARATYPE |
|---|----------|----------|
| Total length. | 193 mm. | 136 |
| Length without cauda. | 179 | 121 |
| Width, widest point. | 122 | 74 |
| Height. | 82 | 42 |
| Foot width. | 116 | 68 |
| Foot length, curved surface. | 220 | 148 |
| Anterior end to origin of parapodia. | 64 | 47 |
| Width of parapodial lobes, foot to dorsal edge: | | |
| a. lateral | 85 | 54 |
| b. posterior | 54 | 30 |
| Gap between origins of parapodia. | 61 | 38 |
| Mean width of dorsal slit. | 31 | 8 |
| Length of oral lobes. | 10 | 8 |
| Length of rhinophores. | 10 | 9 |
| Basal width of rhinophores. | 9 | 7 |
| Anterior end to rhinophores. | 27 | 24 |
| Penis, length. | 114 | 63 |
| Penis, basal width. | 16 | 10 |
| Penis, basal thickness. | 7 | 5 |

TABLE I

The body narrows cephalad to a blunt, rounded head. The region between the anterior end and the rhinophores is distinctly convex in both transverse and sagittal planes. Cephalic, or oral, lobes are relatively short, unruffled, and not extended into distinct cephalic tentacles. Eyes present as minute black spots 4 mm. antero-lateral to rhinophores. Rhinophores are auriculate, unruffled, acute, curved convexly on lateral edges and concavely on medial edges, basal cross section forms a long oval. Mouth is a 12 mm. vertical slit.

The foot is about the same width and length as the body. Caudal extension is simple, obtuse, pigmented with transverse lines on its dorsal surface. Anterior section of foot is obtusely rounded, grooves longitudinal in anterior area but not forming an area well-defined from the posterior section. Entire foot surface is strongly grooved; a transverse to reticulate pattern changing to longitudinal at both ends. Parapodial lobes are simple, unfrilled, stout, and broadly joined immediately behind the ex-current siphon. The parapodia are too short and fleshy to allow their free edges to touch over the dorsal slit or to be used for swimming motions.

The mantle in the shell area seems to be extremely delicate. The mantle in both holotype and paratype had been torn; the vestigial shells were missing in both specimens when collected (see plate 48). Loss may have been partially due to a large mantle foramen. This might have been considered more serious before Winkler (1959b) reported that the shell in *Aplysia californica* Cooper (1863) changes shape as the animal grows; he concludes that the shape of this structure is of low value in systematic studies. Future specimens should be examined for the presence or absence of an accessory plate below the apical membrane of the shell and for the nature of the mantle foramen. The posterior margin of the mantle is twisted about the anus area to form a distinct, unprojecting excurrent siphon. A slight pseudosiphon is also present. The lateral mantle forms a flap to the right of the shell cavity that is similar in structure to the purple gland of *A. californica*. However, this flap did not contain purple spots and did not give off purple during preservation. The only color leached from any part of the specimen into the preservative was a faint yellow.

No opaline gland could be located. This gland is probably of the diffuse type, as found in the paratype, under atrophic conditions. Salivary glands are paired, conspicuous, and up to 13 mm. wide. The anterior gizzard is heavily muscular and bears 11 (10-12) rhomboid-shaped major attachment scars of the deciduous grinding teeth. The jaws are chitinous, dark brown plates with distinct transverse ridges; wear is evident on the anterior edges.

The lateral radular teeth show little variation. A typical mid-lateral tooth (plate 46) has a large central cusp with one or two moderately developed secondary spines on the side opposite the basal wing. The central cusp is bordered by one stout lateral cusp on the basal wing side. This lateral point is supplemented by tiny cusps; two or three below it, and often one above it. Radular formula is approximately 50-1-50.

The penis is a large, smooth, flattened, curved organ tapering equal to the foot width. A shallow groove extends medially along each flattened surface thus giving the appearance of a double shaft. The tip is bifid, each point acute, with the tip of the lesser curve of the penis slightly exceeding the other tip. This organ assumes about two-thirds of its relaxed length as it lies reflected across itself in the penial sheath. The seminal groove, up to 6 mm. deep, extends from the extreme tip, along the greater curve of the penis to the base of the penial sheath, along the sheath's infolded surface to its external aperture and then medio-caudad along the dorsal surface into the genital orifice located caudal to the origin of the right parapodium. This groove is formed by

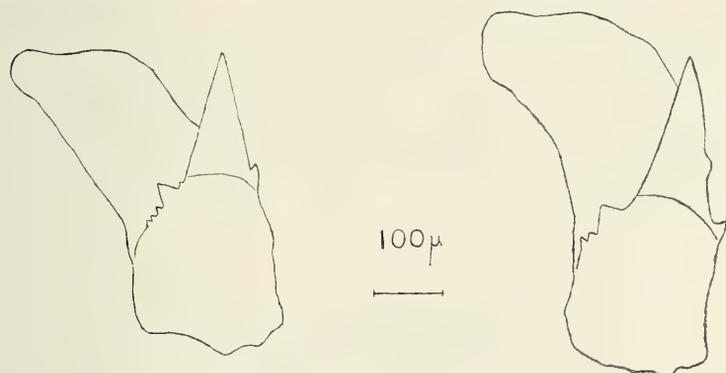


PLATE 46

Typical mid-lateral radula teeth of *Aplysia reticulopoda*. Left: paratype. Right: holotype.

two thin folded ridges which also form numerous blind grooves paralleling the main one. A large area of fungiform papillae is evident near the base of the penial sheath. The sheath is lined with a dark purplish pigment that rubs off easily. Base color of the penis is white; groove edges are black. The penis is unarmed; the only projections are two small rows of papillae extending distad from the base on the lesser curve.

Approximately ninety-five percent of the ingested contents of the crop consisted of tangled sections of *Phyllospadix torreyi* leaves. The remainder was mainly small fragments of algae. Several large angular and a few smaller acute corneal teeth, displaced from the grinding section of the anterior gizzard, were also present in the crop.

PARATYPE: Allan Hancock Foundation Mollusc Specimen No. 1033. Similar to holotype except as otherwise noted. Width is slightly over one-half of the total length. Weight of the fresh specimen was 270 grams.

Notes and color transparencies of the coloring of the paratype were made from the fresh specimen. Pigmentation of the foot is similar to the holotype except for fusion of the dark groove color into an almost black area posterior to the foot's midpoint. A dorsal and lateral lightness, similar to the holotype, is overlaid by an irregular, asymmetrical reticulation of a light maroon pig-

ment. This color is strongly reminiscent of the color given to algae such as *Plocamium pacificum* by phycoerythrin and associated pigments. Winkler (1958) has stated that such superficial color in *A. californica* is due to the pigments in the plants of the animals' diet. This led him to conclude that only the basal color remaining after preservation, and not such diet-dependent colors, should be used in classification. The paratype still retained its almost original color after four months in a special color preserving fluid, Östapp C3A3.

The digestive gland and most of the hemocoel is a deep steel-gray. The opaline gland consists of numerous opalescent grape-like units; the total mass measuring 45 by 20 mm. This gland is imbedded almost completely into the proximal surface of the right dorso-lateral body wall. It is tightly cross-bound by muscle and connective tissue strands except for an anterior section of about one square centimeter which is exposed to the hemocoel. The location of the gland is marked externally by a firmer oval area, 33 by 15 mm., to the right and caudal to the genital orifice within the gill cavity. The gland is of the diffuse type; in life it must discharge through numerous minute pores in its externally exposed surface.

The jaws are darker but not quite as heavily ridged as the holotype; they are only loosely attached to the inner walls of the mouth.

The crop and gizzards contained about 15 ml. of a light brown granular pulp. This pulp, now under further study, is apparently organic but its origin was not apparent under microscopic examination.

Remarks: The specific name refers to the net-like residual pigmentation pattern of the foot.

The distinctiveness of this species is apparent at once when examining the specimens. However, the necessary similarities within the written descriptions of others in the same genus or subgenus tend to obscure this contrast unless the following points are considered. These specimens do not have close affinities with *A. nettieae* Winkler (1959a) or the common *A. californica* of the subgenus *Neaplysia* Cooper (1863). The opaline gland in *Neaplysia* is uniporous, alveolar, and hangs free in the hemocoel. The presence of the diffuse opaline gland is among the major anatomical features excluding *A. reticulopoda* from this subgenus. The contrast between *A. californica* and *nettieae* and *A. reticulopoda* is extreme enough that other differences need not be considered in detail. Several contrasting features of *A. reticulopoda* worth just mentioning are the gross appearance, the reti-

culate pattern of the foot, the shape and brevity of all lobes, the nature of fusion and lack of overlap of the parapodia, the absence of darkness and spotting in the basal pattern, the lower width and height to length ratio, the nature of the penis, the lack of numerous lateral spines of the central cusp of radular teeth, and the more conspicuous salivary glands. The apparent lack of pigment from the "purple gland" of *reticulopoda* is a marked distinction from the purple glands of *californica* which quickly and thoroughly obscure their preserving fluids.



PLATE 47

Right lateral aspect of *Aplysia reticulopoda* holotype. Bar indicates 1 cm.

The simplicity of the lateral radular teeth would indicate affinities with the subgenus *Tullia* Pruvot-Fol (1933) but additional specimens in which the nature of the mantle foramen and the presence or absence of an accessory shell plate can be determined are needed to confirm this.

The only California sea hare which seems to be near to *A. reticulopoda* is *Aplysia* (*Tullia*) *vaccaria* Winkler (1955). The almost total lack of pigment and basal body pattern on the present specimens contrasts completely with the pattern and deep purplish black of *A. vaccaria* however. *A. reticulopoda* has a distinctive pattern of dark foot grooves compared to the patternless deep blue-black of the *vaccaria* foot. The nature of the lobes is significant. All specimens of *vaccaria* (and *californica*) that I have collected to date have parapodia which overlap dorsally even after preservation. This immediately separates them from *reticulopoda*. The parapodia and excurrent siphon of *reticulopoda* are without the characteristic frilling of *vaccaria*. The rhinophores and oral lobes of the *reticulopoda* specimens are also simpler than those of *vaccaria*. *Aplysia reticulopoda* appears more "streamlined". The strong contraction of my specimens of *vaccaria* during preservation suggests a tissue contrast with my much firmer *reticulopoda* specimens. The mid-lateral radular teeth of *reticulopoda* have tiny lateral cusps not evident in *vaccaria*. The radula formula of 50-1-50 for *reticulopoda* seems significantly lower than the 80-1-80 count for *vaccaria*. The penis is lacking the surface pits evident on the penis of present *vaccaria* specimens. Strong transverse ridges of the jaws are one of the few identical features of these two species; this further separates them both from the smooth-jawed *A. californica*. Quantitative significance of the above features and differences in the shell, mantle foramen, and purple gland will be considered in further study now in progress.

The collector of the *A. reticulopoda* holotype observed a similar animal near the south side of Bird Rock, Laguna in late July 1959. It was crawling among bottom-growing algae in one or two fathoms of water at a distance of about 75 meters from shore. This individual could not be captured, but it was observed carefully through a face plate. It was reported as identical with the holotype except for a reddish color and a 13 cm. size.

It seems most unusual that such a bulky and distinctive animal, attaining a length at least near 20 cm., should have been overlooked in the marine fauna of southern California. It is the author's hypothesis that these animals range in the relatively poorly explored upper subtidal areas and gain protective coloration and shelter from the algae and eelgrass which may be their diet and habitat. Attempts are now being made to collect more

specimens for additional study; specimen contributions would also be most appreciated.

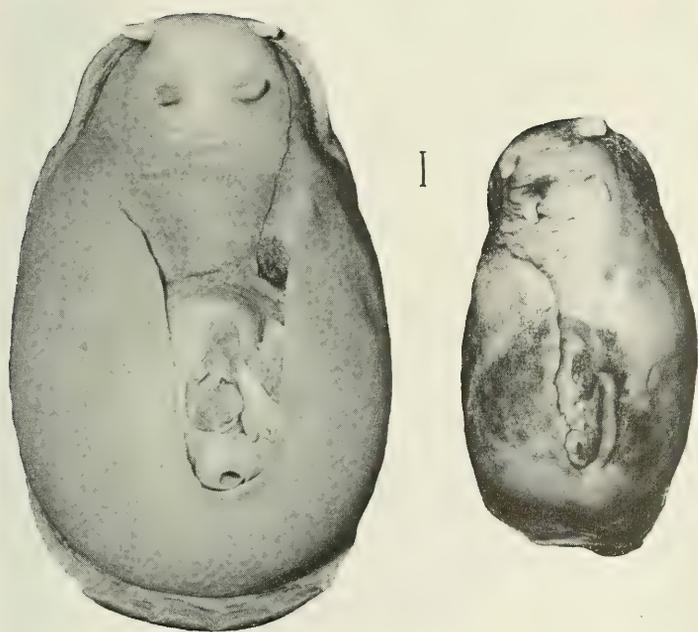


PLATE 48

Dorsal aspect of *Aplysia reticulopoda*. Larger specimen: holotype. Smaller specimen: paratype. Bar indicates 1 cm.

ACKNOWLEDGEMENTS: I would like to acknowledge my indebtedness to Mrs. Whitford and Mr. Graves for their donation of the specimens. I also wish to express thanks to Dr. R. Phillips Dales, Bedford College, University of London for helpful advice and to Mr. Arthur S. Lockley, Department of Zoology, Long Beach State College for much helpful advice and the critical reading of this paper. Any errors remaining are entirely those of the author. The Allan Hancock Foundation, University of Southern California, was very generous in allowing the use of their outstanding library.

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THE SALAMANDER GENUS, *Oedipina* IN NORTHERN CENTRAL AMERICA

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The attenuate bolitoglossine salamanders of the genus *Oedipina* are poorly known, with probably less than 600 specimens in museum collections. Twenty-two individuals have been recorded from northern Central America, (Brocchi, 1883; Rand, 1952; Stuart, 1943 & 1952; Schmidt, 1936 & 1941; and Mertens, 1952), seven from El Salvador, 10 from Guatemala, and five from British Honduras.

Brocchi (1883) was the first to obtain northern Central American representatives of these elongate urodeles. His material consisted of four specimens from Guatemala which he assigned to *Spelerpes vermicularis* (Gray, 1868), but they are not conspecific with this form which is known only from the Costa Rican type specimen. Schmidt (1936) described *Oedipus elongatus* from Escobas near Puerto Barrios, Izabel, Guatemala, based on one example. Important characters of this species were: seventeen costal grooves and toes fully webbed. These characters plus a proportionally broader head and longer hind limbs readily separate the robust *O. elongatus* from the more attenuate forms of northern Central America. In 1941, Schmidt reported on the collection of five more individuals from the Bokowina-Double Falls region of British Honduras by I. T. Sanderson and placed them in *O. elongatus*. Stuart (1943) referred a salamander from Finca Volcan, Departamento de Alta Verapaz, Guatemala to *Oedipina elongatus*. This species is known only from the above localities in British Honduras and Guatemala and will not concern us further in this paper (see plate 52). Stuart (1952) on January 29th described two new species of *Oedipina* based on the contrasting characters listed below (Table I). Each circled number represents a measured museum specimen, (see Table II for key).

The holotype of one species, *Oedipina ignea*, was taken just south of Yepocapa, Departamento de Chimaltenango, Guatemala and an additional headless individual was collected in the same area. Stuart tentatively assigned the four Brocchi (1883) specimens to this form on the basis of Jean Guibe's report that they have 18 costal grooves.

TABLE I
COMPARISON OF STUART'S TYPE DESCRIPTIONS OF TWO DIFFERENT SPECIES OF
OEDIPINA WITH THOSE MADE BY SUBSEQUENT WORKERS

| Agrees with <i>Oedipina ignea</i> | Type description of <i>Oedipina ignea</i> | Agrees with neither species | Type description of <i>Oedipina taylora</i> | Agrees with <i>Oedipina taylora</i> |
|--------------------------------------|---|---|---|--|
| 1 4 10 11 12 14 15 16 | Maxilla toothed | | Maxilla untoothed | 3 |
| 1 16 | Maximum of 10 vomerine teeth on right side | 12 14 | Maximum of 5 vomerine teeth on right side | 3 4 5 6 7 10 13 15 |
| 1 12 13 14 16 | Sublingual fold well developed | 11 15 | Sublingual fold barely evident | 3 4 10 |
| 1 4 10 11 13 14 | Paravomerine teeth not separated medially by narrow channel | | Paravomerine teeth separated medially by narrow channel | 3 15 16 |
| 1 | All digits connected by webs not extending to tips | 13 14 15 -- Digit IV is al- most fused to V | Absence of webs between the outer phalanges of all digits except number I on hands and feet both I fused to II; rest part webbed | 2 3 4 10 11 12 |
| 1 5 6 7 8 9 | 19 costal grooves | L R 2 = 19 - 20 4 = 21 - 21 | 20 costal grooves | 3 |
| 1 2 5 6 7 | 11.5 to 13 costal folds between appressed limbs | 4 = 14.5 8 = 16 | 15 costal folds between appressed limbs | 3 9 |

TABLE I—Comparison of measurements and data taken by this author with those of Stuart's type descriptions of 1952.

TABLE II
MEASUREMENTS OF ALL OEDIPINA FROM NORTHERN CENTRAL AMERICA
RECORDED BY STUART, RAND AND MERTENS, AND BY BRODIE

| Specimens Museum Number | Key # this paper | Costal grooves | Snout-vent length | Head width distance | Axilla-groin length | Hind limb length | Appressed limbs | Median channel in paraphrenoid teeth | Piercing tip of premaxillary teeth | Maxillary teeth | Vomerine teeth | Relative size of sublingual fold | Feet vs. webbed condition of coxae |
|--|------------------|----------------|-------------------|---------------------|---------------------|------------------|-----------------|---|---------------------------------------|-----------------|----------------|-------------------------------------|---------------------------------------|
| (Type- <i>O. ignea</i>) USNM 127359 | ① | 19-19 | 56.5 | 4.5 | | | 13 | no | 0 | I, R present | I, R 7-10 | large | I webbed to II IV & V webbed |
| UMMZ 107719 | ② | 19-20 | | | | 5.8 | 11½ | | | | | | I fused to II IV & V webbed |
| (Type- <i>O. taylori</i>) UMMZ 102281 | ③ | 20 | 55.0 | 4.3 | | | 15 | yes | 2 | | 7-5 | small | I fused to II IV & V webbed |
| UMMZ 98125 | ④ | 21-21 | 55.1 | 4.7 | 40.0 | 6.2 | 14½ | yes | 2 | 7-8 | 4-2 | small | I fused to II IV & V webbed |
| (Type- <i>O. salvadorensis</i>) CNHM 65030 | ⑤ | 19 | 33.0 | | | 5.0 | 13 | | 3 | present | 7-6 | | |
| CNHR 65028 | ⑥ | 19 | 34.0 | | | 5.0 | 13 | | 3 | present | 5-6 | | |
| CNHR 65029 | ⑦ | 19 | 32.0 | | | 5.0 | 13 | | 1 | present | 5-? | | |
| SM 44393 | ⑧ | 19 | 63.0 | | | | 16 | | | | | | |
| SM 44392 | ⑨ | 19 | 49.0 | | | | 14 | | | | | | |
| UMHR 46485 | ⑩ | 20-20 | 48.0 | 4.7 | 32.7 | 5.8 | 13½ | no | 1 | 12-9 | 5-4 | small | I fused to II IV & V webbed |
| UMHR 46486 | ⑪ | 20-20 | 41.1 | 4.1 | 27.7 | 5.3 | 11½ | no | 1 | 11-13 | 6-5 | medium | I fused to II IV & V webbed |
| UMHR 46487 | ⑫ | 20-20 | 40.3 | 4.0 | 28.6 | 5.0 | 12½ | | 2 | 14-14 | 6-7 | large | I very fused to II IV & V webbed |
| UMHR 46488 | ⑬ | 20-19 | 44.6 | 4.1 | 30.5 | 5.2 | 12½ | no | 4 | 16-15 | 6-5 | huge | I fused to II IV & V almost fused |
| UMHR 46489 | ⑭ | 19-19 | 41.1 | 4.3 | 27.7 | 5.4 | 13½ | no | 1 | 15-15 | 5-6 | large | I fused to II IV & V also fused |
| UMHR 46490 | ⑮ | 20-20 | 39.9 | 3.9 | 25.2 | 4.9 | 12½ | yes | 2 | 13-15 | 4-4 | medium | I fused to II IV & V almost fused |
| UMMZ 120229 | ⑯ | 19-19 | 43.2 | 4.3 | | 5.1 | | yes | 2 | 14-15 | 8-10 | large | I almost fused to II IV & V webbed |

TABLE II—A table of significant measurements and data of Stuart (1952), Rand (1952), Mertens (1952), plus the specimens recorded here for the first time by this author.

The holotype of *O. taylori* was obtained 4 kilometers East of Hacienda La Trinidad, 23 kms by air SE. of Chiquimulilla, Departamento de Jutiapa, Guatemala and another individual was found at the out-skirts of the city of Jutiapa in the same department. Both localities are near the El Salvador border.

Rand on February 9th, 1952 described *Oedipina salvadorensis* from the city of San Salvador, El Salvador, based on three specimens (CNHM 65028-30), the latter being the holotype. Except for one less costal groove and less costal folds covered by appressed limbs (characters of *O. ignea*), the new form agreed with *Oedipina taylori*. Mertens (1952) and Stuart (1954) both

regard *salvadorensis* as a synonym of *taylori*. Mertens obtained additional material from several localities just to the north of San Salvador, El Salvador.

Recently, through the courtesy of Dr. Hobart M. Smith of the University of Illinois, I examined six splendidly preserved specimens of *Oedipina* from Finca Naranjo, on the south slope of Volcan Santa Clara, between 1000 and 2000 meters altitude, Departamento de Suchitepequez, Guatemala, collected by Major Chapman Grant in December, 1958. Another individual of the genus from Finca La Paz, 1500 meters elevation, 18 kilometers (straight line) due north of Coatepeque, Departamento de San Marcos, Guatemala, collected by Lothar Menzel, December, 1956, together with Stuart's non-holotypic material of *ignea* and *taylori* were made available to me by Dr. Norman E. Hartweg and Dr. Charles F. Walker of the University of Michigan Museum of Zoology. This material sheds considerable light upon the *ignea-taylori-salvadorensis* problem. A re-examination of UMMZ 98125 — Stuart's *O. taylori* and UMMZ 107719 — Stuart's *O. ignea* together with analysis of the characters of UMMZ 120229 from Departamento de San Marcos, Guatemala, and UIMNH 46485-90 from Departamento de Suchitepequez, Guatemala, suggests that only one species is involved. Stuart (1952) himself expressed great hesitancy in recognizing two species from three intact specimens of *Oedipina*; "It is with some misgivings that they are herein assigned to two new species". The data and measurements from Stuart, Rand, Mertens and my specimens are presented on (Table II).

A number of characters which have been used formerly in describing salamanders and distinguishing between species have upon critical examination of large series, been found to be untrustworthy or even useless. Hilton (1945) and Stebbins (1951) after examining large numbers of *Batrachoseps*, concluded that vomerine tooth arrangement and numbers are so variable within each species that the character had to be discarded. Pope (1950) and Pope and Pope (1949 and 1951), reached a similar conclusion with respect to *Plethodon glutinosus*, *P. ouachitae*, and *P. yonahlossee*. They show that the number of vomerine teeth is closely correlated with the size of the animal and varies considerably within age groups. They also recommend that only large series of counts from adults or near adults should be used in taxonomic studies. The presence or absence of a median channel in the parasphenoid tooth patch is highly variable in many plethodontids, including *Oedipina*.

There has been a great disparity in costal groove counts due to different methods used by various workers. My counts for instance, are different from those of Dr. Stuart's for two speci-

TABLE III

DISPARITY IN COSTAL GROOVE COUNTS FOR THE SAME
SPECIMENS MEASURED BY STUART AND BY BRAME

| Specimen | Number of Costal Grooves | |
|---------------------------------|--------------------------|----------------|
| | Stuart | Brame |
| <u>O. taylori</u> UMMZ 98125 | 20 | L R 21 - 21 |
| <u>O. ignea</u> UMMZ 107719 | 18 | L R 19 - 20 |

mens of *Oedipina* (see table III). All costal grooves plus one each for the axilla and groin if a groove fails to touch them are counted in my method. Using this technique, I have found variation up to a difference of four costal grooves in large samples of *Batrachoseps attenuatus* and *B. pacificus* from any one locality. Even this method is subject to error and individual interpretation owing to the degree that a costal groove may come in contact with the axilla or groin. Neither Rand nor Mertens mention the techniques they used. There is variation in number of costal grooves (usually 20, occasionally 19) among the six specimens of *Oedipina* (UIMNH 46485-90), from the Finca Naranjo locality.

Size of sublingual fold too shows great variation. In these same six *Oedipina*. I found three with large folds, two with medium folds and one with a very small sublingual fold.

A graph (plate 49) of hind limb length by snout-vent length (posterior end of vent); (plate 51) number of costal folds not covered by adpressed limbs by snout-vent length; and (plate 50) head breadth by snout-vent length; shows that each of these characters when graphed against a standard measurement (snout-vent length) is largely a factor of differential growth. When one compares an individual of 56 mm. snout-vent length to one of 33 mm., there should be considerable differences in number of costal folds between adpressed limbs, limb length and head breadth, if the same careful techniques are used in all of the measurements and counts. I believe that the discrepancies seen on the graph are due to different styles of measurement em-

ployed by various workers. Some differences are of course attributable to individual variation within the population.

The type of *Oedipina taylora*, UMMZ 102281, had no teeth but another individual matching the description of the type for most other characters, had teeth present on the maxilla. The work of Taylor (1952) indicates that when large numbers of specimens are used the number of maxillary teeth may be significant. Rabb (1958) in discussing the use of dental characters in the genus *Chiropterotriton*, made the comment that "dental features be treated cautiously as taxonomic characters and that their relative weight may have to be adjusted or discounted in individual cases." As Stuart (1952) implied, the importance of maxillary teeth in *Oedipina* is not understood.

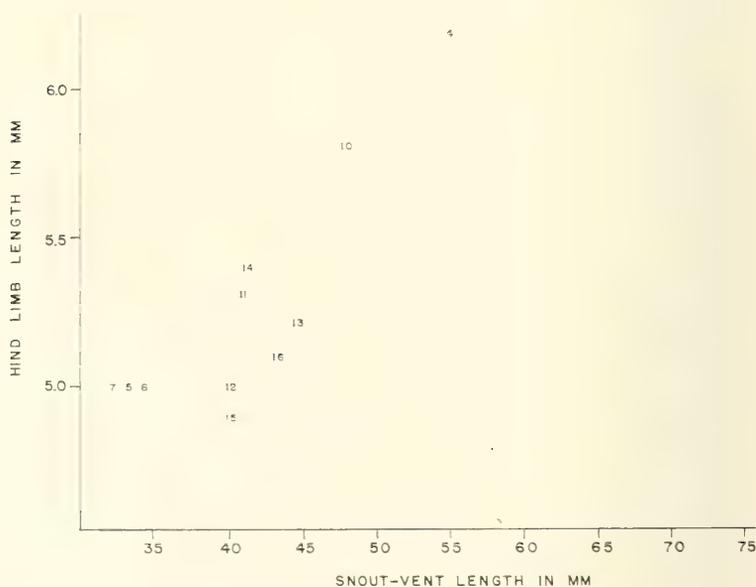


PLATE 49

A graph of hind limb length to snout-vent length measured in millimeters of the salamander, *Oedipina taylora*.

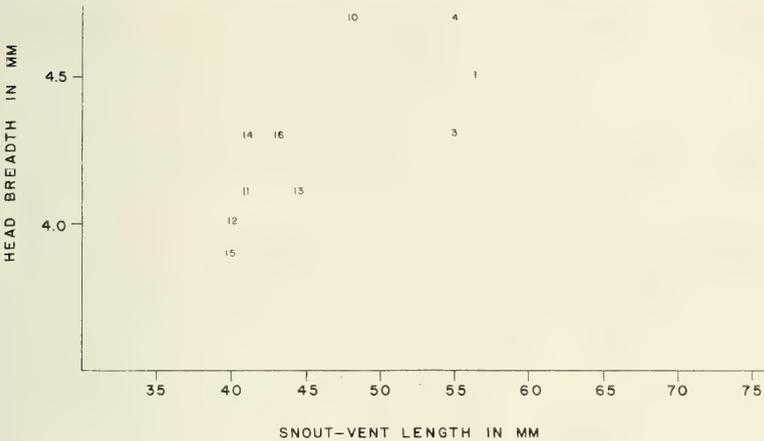


PLATE 50

A graph of head breadth to snout-vent length measured in millimeters of the salamander, *Oedipina taylori*.

The character of the digits in webbed versus fused digits I to II appears to me to be worthless. I examined the feet of the headless *Oedipina ignea*, UMMZ 107719, and digits I and II are definitely fused, a characteristic which does not agree with the type description. I have found variation of webbed versus fused in the six *Oedipina* from Finca Naranjo (see Table II).

An analysis of new material together with the data and examples of Stuart, Rand, and Mertens, shows that some of the characters of each specimen agree with *Oedipina ignea* and others with *Oedipina taylori* (see Table I). Specimens from the same locality display different combinations of *ignea* and *taylori* characters. The measurements and data from the recently acquired material suggest that the characters are either of a variable nature or are due to differential growth or a combination of both. It seems proper to recognize only one species of attenuate *Oedipina* from northern Central America. As pointed out earlier, *O. ignea* and *O. taylori* have eleven days priority over *O. salvadorensis*. I therefore propose that the name *Oedipina taylori*, because of its wider usage, be maintained for these urodeles. The known range of the species (plate 52) extends from San Salvador, El Salvador to Finca La Paz, 18 km. north of Coatepeque, Departamento de San Marcos, Guatemala. There is no doubt that *Oedipina* will eventually be taken in southern Mexico.

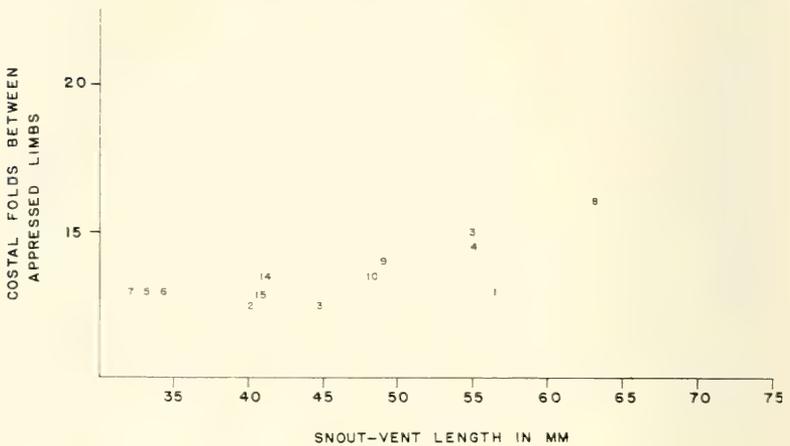


PLATE 51

A graph of the number of costal folds not covered by appressed limbs to snout-vent length in millimeters of the salamander, *Oedipina taylori*.

I wish to acknowledge and extend my gratitude to the following for their opinions on this problem: Dr. Hobart M. Smith, Thomas M. Uzzell, Jr., David B. Wake, and also thank Dr. Jay M. Savage for reading the manuscript and for offering advice.

This problem was aided in part by a grant from the National Science Foundation.

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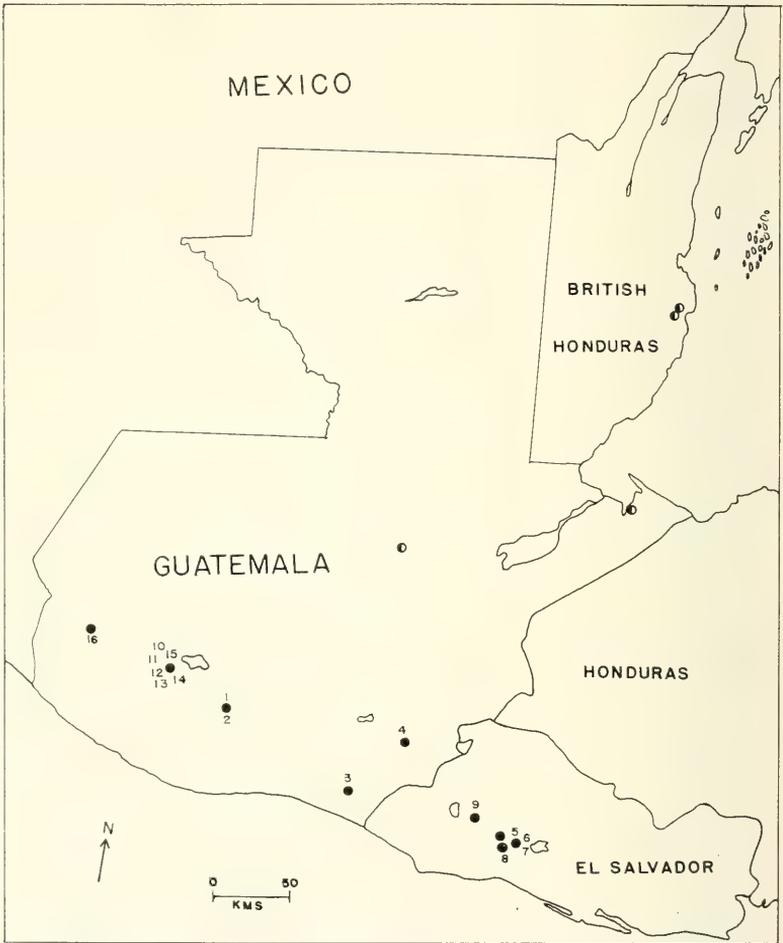


PLATE 52

Map of Northern Central America; British Honduras, Guatemala, Northern Honduras, and El Salvador, showing the known ranges of *Oedipina taylori* - black circle; and *Oedipina elongatus* - half circle.

A REVIEW OF THE HEAD MUSCLES OF SALAMANDERS

BY WILLIAM A. HILTON

Part II

HYNOBIIDAE

In *Salamandrella*, the intermandibularis posterior is well developed with the median aponeurosis rather broad in the cephalic region. No genio-glossus is evident near the surface although deep fibers may represent part of it. The interhyoides appears as one muscular system, although in some species of the family two divisions are recognized, the anterior called the sub-hyoides, the posterior the inter-os-quadratum. The genio-glossus is as usual, the term subhyoideus should be used for the muscle called either this or the genio-hyoideus lateralis found each side of the genio-hyoid. For all but Plethodontidae this might be considered the subhyoideus. In this species it is from the ceratohyl to the aponeurosis towards the middle line under the intermandibularis, only slightly connected with the lower jaw. *Hynobius*. It is said that the first two ceratobranchial cartilages are inclosed in the distal end of the subarcualis rectus I. The cranio-mandibular muscles above form a V or Y which is about 7.5 mm in length when the head and neck are 11 mm. The sternohyoid and abdomino-hyoid are usual with a slip from the later ending ventrally on the middle line of the copula.

AMBYSTOMIDAE

Several species of *Ambystoma* have the genio-glossus. In *Rhyacotriton* it is especially large; in *Dicamptodon* adult it seems to be lacking. The subhyoideus is well developed in some *Ambystoma*. in *Dicamptodon* it is small and short. In some *Ambystoma* a few fibers run to the lower jaw and this is true of the *Rhyacotriton* examined. In *Ambystoma* it is said that the cranio-mandibularis is represented by the sublimis and profundus, Lubisch '14, Eaton '36.

The cranio-mandibularis in all but the *Dicamptodon* has a Y-shaped arrangement above, but it has a convex outline in front.

An adaptation of the mandibularis externus to a special kind of action which does not involve great change of form has been reported by Easton '33 as follows:

"In Rhyacotriton, *A. gracile* and *A. macrodactylum*, especially the first, a group of three bones, the squamosal, quadrate and pterygoid, has become a movable as a unit, pivoting on the protic by means of the dorsal end of the squamosal. A long posterior horn of the latter is developed in Rhyacotriton. The mandibularis externus originates along the anterior-dorsal border of this horn. Since this origin is mostly beyond the pivoting point, and since the insertion is on the lower jaw, which in turn articulates with the quadrate, the effect of contraction of the mandibularis externus is to pull forward the horn of the squamosal, thus pushing the ventral end backwards, the latter carrying with it the lower jaw and hyoid apparatus. The whole movement is not more than 2 or 3 mm, perhaps less, but is no doubt of service in engulfing large prey—"

SALAMANDRIDAE

In *Salamandra* the genio-glossus is well shown, the interhyoideus one muscle with some of its fibers running above the interhyoid posterior or the quadrato-pectoralis. The subhyoideus is inserted into the aponeurosis of the intermandibularis and not as far as the lower jaw bones. The genio-glossus is not well developed if at all in *D. viridescens*, *T. torosus*, *Cynaps pyrogaster* or *Pleurodellides*. The subhyoideus is moderately developed in all, usually with some fibers connecting with the lower jaw. The cranio-mandibularis muscles form a Y above. In some, such as *C. pyrogaster*, fibers run from the lower jaw to the upper end of the ceratohyal. The cranio-mandibularis has a Y-shape in all forms examined.

PLETHODONTIDAE

Piatt '40, groups these into a number of divisions based on the hyobranchial region. In this review one of the groups will be extended.

1. The *Desmognathus* group, including this genus and *Leurognathus*.

In this division the quadrato-pectoralis is very large and the gularis small, especially in *Leurognathus* and some of the smaller species. The genio-glossus is well developed and also the genio-glossus lateralis. The cranio-mandibularis posterior is Y-shaped above, moderately large and very strong, ending in an unusually strong tendon, especially in *Desmognathus*.

INDEX TO FIGURES

In all the scale equals 1 mm.

CHE, Ceratohyoideus externus; CM, Ceratomandibularis; DM, Depressor Mandibulae; G, Gularis; GG, Genioglossus; GHL, Geniohyoideus lateralis; IA, Intermandibularis anterior or submentus; IH, Interhyoideus; IOQ, Inter-Ossaquadrata; IP, intermandibularis posterior; LAR Levatores arcuum branchiarum; LMP, Levator mandibulae posterior; SR, Subarcuales recti.

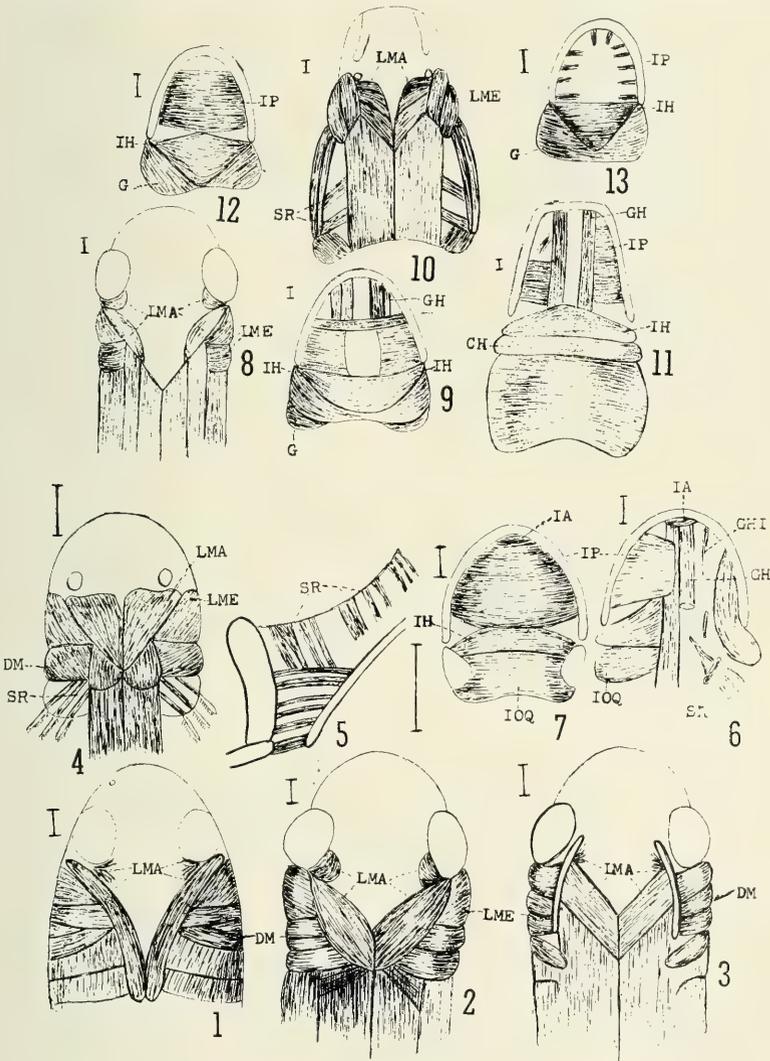


PLATE 53

Head muscles of Hynobiidae, Salamandridae and Ambystomidae.

- 1. *Ambystoma maculatum* from above. 2. *Salamandrella* from above.
- 3. *Taricha* from above. 5. Enlarged Subarcualis recti muscles from the last.
- 6. A *maculatum* larva of 22 mm, from below, showing some deep muscles. *Rhtocotriton* adult from below.

Head muscles of Plethodontidae.

- 8. *Hydromantes* adult, above. 9. Same below. 10. *Typhlomolge* adult above. 11. Same below, showing some superficial and some deep muscles.
- 12. *Manculus* adult, below. 13. Adult *Hemidactylum*, below.

2. The *Steriochilus* group.

Including this genus and *Typhlotriton*.

There is no genio-glossus although the tongue is attached. The gularis element is most marked; very little could be considered quadrato-pectoralis. In *Typhlotriton* examined there is a little forward extension of the interhyoideus. The cranio-mandibularis is Y-shaped above in old and younger specimens examined; each lateral half is separated from its fellow by a narrow space.

3. The *Gyrinophilus* group, which includes this genus and *Pseudotriton*, *Eurycea* and *Manculus*.

In these there is a small lingual cartilage in the front of the copula. These are free-tongued and there is no genio-glossal. In the *Eurecea* examined, the gular is especially well developed with very little indication of the quadrato-pectoralis. The lateral genio-hyal is well developed with fibers connecting with the lower jaw.

Manculus had very little indication of any but the gularis in this region. In *Gyrinophilus* and *Pseudotriton*, especially the former, the quadrato-pectoralis is broad; the gularis is also well marked. The cranio-mandibularis is Y-shaped in all and especially marked in *Gyrinophilus*. In one specimen at least of this genus the posterior intermandibularis has 8 or more lobes on each side.

4. The *Plethodon* group, including also *Hemidactylum* and *Ensatina*.

In all the genio-glossus is well developed and not clearly separate from the pecto-quadrato portion. The interhyoideus is not separated into two parts.

The genio-hyoideus lateralis present but not marked.

5. *Aneides*.

Piatt places this with the last group but there are many differences. The gularis is well developed but runs under a strong pecto-quadrato. There is a strong genio-glossus. The interhyoideus is especially extensive, its fibers extend under the intermandibularis almost up to the genio-glossus and are inserted in the aponeurosis near the middle line, but it seems not to be divided into more than one muscle. The genio-hyoideus lateralis is present.

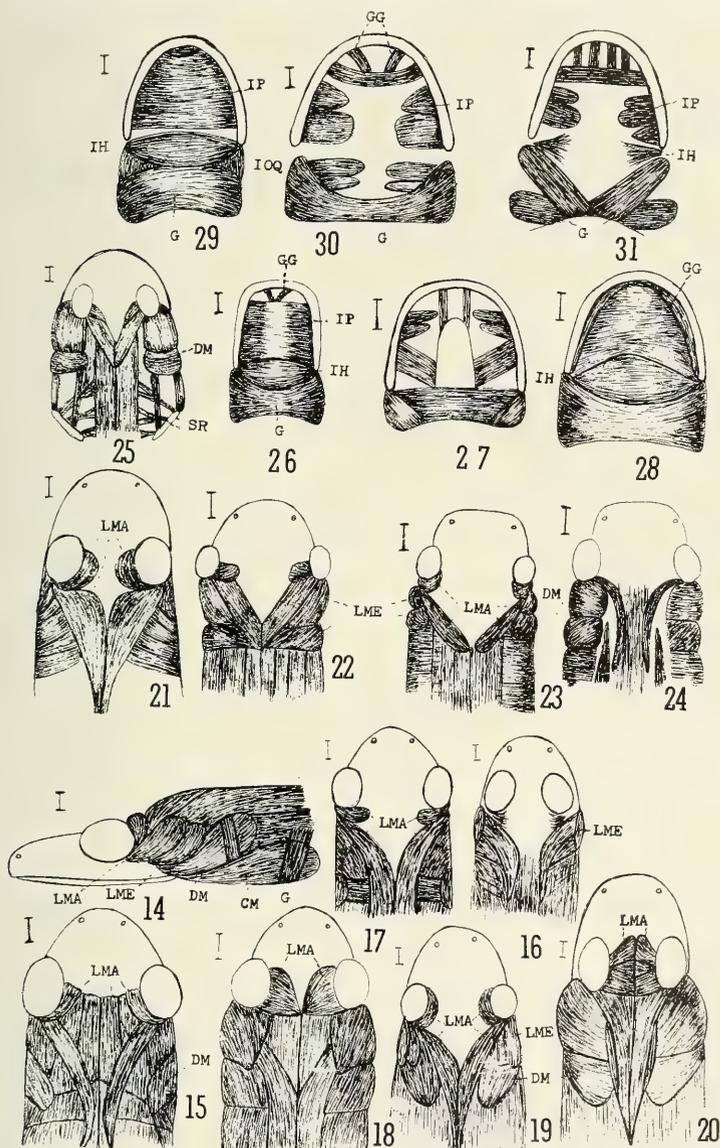


PLATE 54

Family Plethodontidae continued.

14. *Desmognathus fusca* adult, side of head. 15. The same, above. 16. *Batrachoseps* adult, above. 17. *Stereochilus* adult above. 20. *Aneides lugubris* adult, above. 21. *Gyrinophilus* adult, above. 22. *Eurecea bislineata* adult, above. 23. *Manculus* adult, above. 24. *Hemidactylum* adults, above. 25. *Leurognathus* larva, above. 26. Young *Hemidactylum* above. 27. *Oedo-*

pinola adult, below. 28. *Plethopsis* (*Batrachoseps*) from below, adult. 29. *Leurognathus* larva, below. 30. *Ensatina*, adult. 31. *Boletoglossa leprosa*, adult, below.

6. Mexican and Central American genera of *Plethodontidae* with *Hydromantes*.

In none of these is a *genio-glossus* found. In *Boletoglossa leprosa*, *Oedipus adspersa* and *Oedopinola*, there is little indication of any *quadrato-pectoralis*, not more than a few fibers. The *genio-hyoideus lateralis* is not marked.

In *Hydromantes*, there is quite a strong *pecto-quadrate* in addition to the *gularis*, a condition different from that described by Piatt '40, for the European species of the genus. The *genio-hyoideus* are thin and widely separated in the middle line in two parts, the first rather short ending in connective tissue, the second more ventral extension joins the other rather laterally to run caudally. The *genio-hyoideus lateralis* is thin and flat like the last muscle mentioned and is usual in other ways. The *cranio-mandibularis posterior* forms a wide V, the caudal ends separated by a space and ending in a slender tendon. The anterior ends on each side become tendinous as they pass over the skull, resembling *Desmognathus* in this last.

7. *Batrachoseps* and *Plethopsis*, if this is a separate genus.

They have the same muscular arrangement in the head region. A *genio-glossus* arises quite far back on the lower jaw and runs forward to pass into the floor of the mouth and tongue near the *symphysis*. The *gularis* has little indication of a *quadrato-pectoralis*. The *genio-glossus* was especially marked in the examples of *Plethopsis* examined.

SOME REMARKS ON THE HEAD MUSCLES OF THE LAST FOUR FAMILIES

In general the larvae of these are very much alike in their muscular arrangements, and with a few exceptions quite like those of *Necturus*.

In larvae and adults the external parts of the *M. Levator mandibulae* are alike, usually of two divisions; the one under the eye is exposed in varying degrees. The separation of the whole muscle down the middle line of the back is quite variable, sometimes in the form of a wide V, with the lateral parts in contact in a variable manner, being usually wider apart in larvae than in adults. In *Desmognathus* and *Leurognathus* as well as in less degrees in some others the lateral, more caudal muscle is furnished with a very strong tendon which runs forward back of the eye to its attachment to the lower jaw. *Profundus* fibers may usually be recognized, but seldom any that might go under the name of *pterygoid*.

The muscles related to the gill region are much the same, but most Plethodontidae have three gill arches, not four, and the attachments are a little different here. The oblique muscle, with some differences is more often associated with the second arch and one other. *Desmognathus* and *Leurognathus* have four gill arches each and their muscles in this region are like species of three other families, mentioned in this paper.

In *Desmognathus* the *M. Levator mandibulae* in the caudal region may be covered over by trunk muscles. In *Leurognathus* and *Rhyacotriton*, the first levator arcum is long and runs almost parallel with the long axis of the body.

The intermandibularis anterior and genio-glossus and lateral geneo-hyoideus are variable in distribution.

The laryngeal muscles where they occur are of the usual type; in the Plethodontidae they are lacking because this family does not have lungs.

The eye muscles are typical as to recti and oblique. The retractor bulbi is well developed and the levator bulbi although differing in detail is much the same in all with the exception of the blind *Typhlomolge* where the eye muscles are difficult to recognize and *Typhlotriton* in the blind condition where the bulbi muscles are not easily found.

(Bibliography is given in other articles of the series.)



LIFE HISTORY NOTES ON A SATURNIID AND
TWO LASIOCAMPID MOTHS
FROM CALIFORNIA

BY JOHN ADAMS COMSTOCK

SATURNIA MENDOCINO

The beautiful saturniid moth, *Saturnia mendocino*, was described by James Behrens in 1876¹ from a male taken in the redwood belt of Mendocino County. No holotype was designated and no exact type or locality given. It was originally thought to be limited in range to northern California, and non-variable in character.

Sixty-two years later (1938²) John Warren Johnson described *Saturnia (Calosaturnia) albofasciata* from two examples, the holotype taken at Clearlake Highlands, Lake County, and the allotype from the Sequoia National Forest, Tulare County, California. The figure shown in Johnson's plate strongly suggests aberrant examples of *mendocino* rather than a distinct species, but long series and rearing experiments will be needed to fix its exact status.

Shortly thereafter (1940³) the same author described *Calosaturnia meridionalis*, based on a single female taken in the Santa Ana Mountains, Orange County, California, by Erich Walter. This proved to be a distinct species. However, it was later established by Charles L. Hogue and John W. Johnson that the name was preempted in 1887⁴ by Calberla for a subspecies of *Saturnia pavonia*, and therefore is a homonym of *Saturnia walterorum* described by Frank P. Sala and Charles L. Hogue in 1958⁵. This species is the southern California entity of the complex, the plesiotype being reared from a female that was taken in the Arroyo Seco Canyon, San Gabriel Mountains, southern California. With their description of it the authors also published a record of the egg, larva, pupa and cocoon, with excellent illustrations.

Their notes on the life history of this southern species were not the first to appear in print. Robert Babson, in 1935⁶ published a brief note on what he called *Saturnia mendocino*, but in view of his material having been taken in "upper Evey Canyon, mountains near Claremont, Los Angeles County" was doubtless *S. walterorum*.

1. Can. Ent. 8 (8): p. 149. 1876.
2. Bull. Bklyn. Ent. Soc. 33 (3): pp. 128-130. 1938.
3. Bull. Bklyn. Ent. Soc. 35 (3): pp. 100-102. 1940.
4. Corres. blatt Ent. Vereins "Iris" 1: 157. 1887.
5. Lep. News, 12 (1-2): pp. 17-25. 1958.
6. Pomona College Jour. 27 (3): p. 49. 1935.

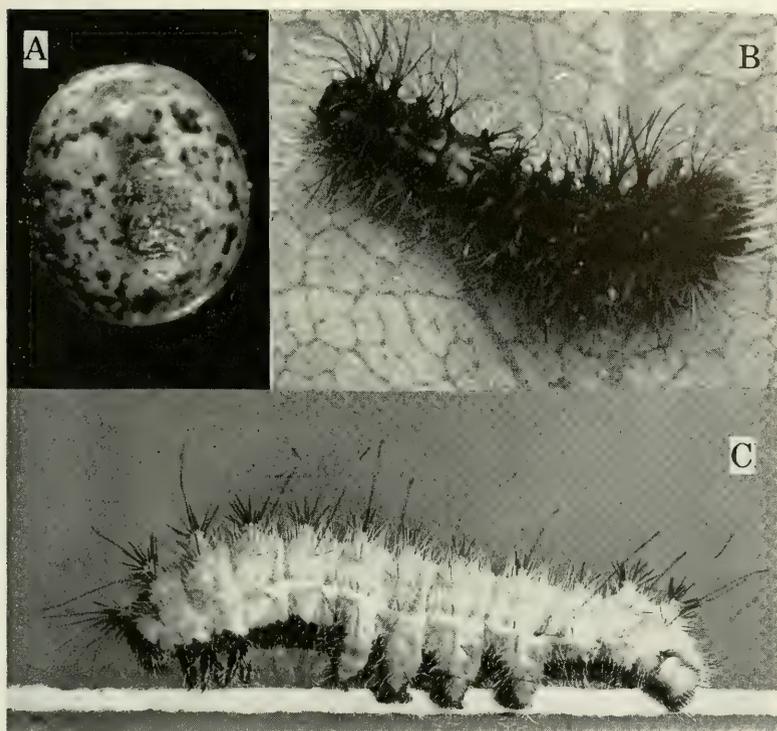


PLATE 55

Fig. A. Egg of *Saturnia mendocino* enlarged x 20.

Fig. B. First instar larva of *C. mendocino* enlarged x 14.

Fig. C. Fourth instar larva of *C. mendocino* enlarged x $2\frac{1}{2}$.

Photographs courtesy Los Angeles County Museum.

My interest in the early stages of *Saturnia mendocino* were first aroused in 1935 when Robert G. Wind, then of Berkeley, California sent me six eggs, secured April 16 at Kelseyville, California. A description of the first instar larva was drawn up at that time, and a photograph of the egg and larva made. Owing to lack of fresh Manzanita leaves these larvae did not survive beyond the first instar.

Subsequently, in 1939, Mr. W. M. Hooton of Clearlake Highlands, Lake County, California, sent me a batch of thirty eggs, which hatched on April 7 and 8, 1939, and were carried through to the end of the fourth instar, when they also perished from lack of fresh foodplant. Notes were made of these instars, and photographs taken.

Mr. Hooton also sent me a considerable amount of information concerning the habits of *S. mendocino* together with examples of the cocoon and pupa.

In Lake County the moth is on the wing from February to early May. The males are first to emerge, and females do not appear in significant percentages until the last of March. Males emerge about 8 a.m., and females about one hour later. The female does not fly until after mating. Her eggs are usually laid between noon and 4 p.m. of the same day in which mating took place. She deposits from 75 to 150 eggs, and thereafter does no further flying or laying. In the wild she will lay a few eggs on one bush, then fly to another, thus spreading the larval population.

If a virgin female can be secured, males can be lured in considerable numbers.

Care must be observed in handling the larvae as the spines can sting the hands as do those of *Pseudohazis* larvae.

When the mature larvae are ready to pupate they crawl down to the base of the bush and spin their cocoons on rocks or dead branches, where they are hidden from casual observation. Dr. Francis X. Williams (1905⁷) particularly mentions this in his brief note on the life history wherein he says "the cocoon is spun closely compressed to the trunk and covered with the curling bark in imitation of its surroundings."

METAMORPHOSIS OF *Saturnia mendocino*

The following notes were made from the rearing of the thirty eggs received from Mr. Hooton.

EGG: (Plate 55, fig. A) In form this is a flattened oval, averaging 1.80 mm. in length, 1.56 mm. wide, and 1.30 mm. high. The color is ivory, with a mottling of reddish-brown, and a few

small spots of black. The surface appears to be smooth, but on magnification is slightly granular. The young larva exits through one end, leaving most of the shell intact.

LARVA, FIRST INSTAR: (Plate 55, fig. B) Length 4.5 mm. Head width approximately 1 mm. The head and all appendages are black, except for a sparse covering of short white setae.

The body color is black throughout except for the following: In the 8th, 9th and 10th segments a soiled yellow quadrate spot occurs dorsally on each segment, bisected in the median line by a narrow black stripe. Two similar spots occur on corresponding areas of the 2nd and 3rd segments but these are not bisected by the black stripe.

There are three rows of tall stalked processes (scoli) each side of the median line (six stalks to each typical segment). Each one of these is topped by a cluster of spiculiferous hairs. The stalks are black. In the uppermost two rows the hairs are also black, but in the lower row they are predominantly white. A collar of long arching white hairs arises from the first segment. These hairs bend over the head, partly obscuring it from view. Ecdysis occurred April 20.

SECOND INSTAR: Head width approximately 1.48 mm. It was colored as in the first instar.

The body is predominantly velvety-black with numerous small white setae scattered among the large tubercles. In the median line on the thorax there is a kite-shaped spot reaching from the front of the 2nd to the middle of the 3rd segment. This is flesh-colored. A long quadrate spot of somewhat similar character extends from the front of the 7th to the back of the 10th segment. This is a mauve-flesh color on the 7th and 8th segments, and flesh-color from the 8th to 10th segments. It is bisected in the median line by a narrow brown stripe.

The row of tall tubercles each side of the middorsal area are black on the 1st to 7th segments, orange on the 8th to 10th, and black on the cauda. These are topped with a series of spiculiferous brownish-black hairs. In the center of each group of these hairs there is on the first two thoracic and last caudal segments a long fine hair, fully four times the length of the others, which is black on the shaft and white on the tip. A second longitudinal row of tall tubercles is entirely black and is topped by brownish-back spiculiferous hairs. In addition, all of these have the long central hair. A third substigmatal row of tubercles is not as tall or heavily developed as the others. The first two thoracic members of this row are black. The remainder have dull orange shafts and black tips, and the hairs arising from these are all white.

The legs, prolegs and anal prolegs are black. A number of white hairs arise on the prolegs. There is also a collar of white hairs on the first thoracic segment, arching over the head.

Toward the end of the instar there develops in the infrastigmatal area an indistinct longitudinal band of dull orange.

The length of the larva at the end of the instar is 12 mm. Ecdysis occurred May 13, 1939.

THIRD INSTAR: The head is still black, with a sparse covering of short white setae. The measurement of a cast head capsule was 2.20 mm.

The body ground color is lemon-yellow. The usual rows of tall processes with spiculiferous hairs arising from them are all present. The base of the shaft of each process is yellow, while the crown is deep reddish-orange. The crowning hairs are chocolate.

Transversely over the dorsum on the 4th segment is a saddle of deep chocolate. In the middorsal area there is on the 11th segment a small chocolate spot. Laterally above the spiracles there is a longitudinal bar of the same chocolate color extending from the 5th to the 10th segments.

The venter is chocolate, and the legs are a darker shade of the same color. The prolegs are light mauve. Ecdysis occurred May 22, 1939.

FOURTH INSTAR: (Plate 55, fig. C) Length of larva, 30 mm. The head is a deep chocolate with numerous white setae arising from it. The ocelli are black. The body color has changed to uniform mauve-yellow with a pinkish cast. The shafts of all processes are of the same color but the crowns are a bright salmon-red. The spicules arising from these crowns are brown except for the long black central hair.

In the dorsum of the first thoracic segment there is an apple-green scutellum. A patch of the same color occurs below the anal orifice and on the posterior surfaces of the anal prolegs.

Substigmatally, along the infrastigmatal fold, there is a light yellow line extending from the cauda to about the 3rd segment, where it fades out. The venter is a deep chocolate as are also the legs and the distal segments and crochets of all prolegs.

The spiracles are orange with red-brown margins. The body is covered with numerous small white setae.

At this point in the rearing of our series of larvae circumstances prevented our obtaining food plant, and all of the brood perished.

At a later date we obtained a few cocoons and pupae, which were photographed, but in the press of other business no notes were made. See Plate 56.

Very likely the descriptions and illustrations of the cocoon and pupa of *Saturnia walterorum* published by Sala and Hogue will apply equally well to *S. mendocino* except for the fact that they pictured a female pupa, and our plate shows a male.

The preferred food plant of all members of the *mendocino-walterorum* complex is Manzanita (*Arctostaphylos*) of several species. In captivity Laurel-sumac (*Rhus laurina* Nutt.) has been used successfully. Squaw bush (*Rhus trilobata* Nutt.), Lemonade-berry (*Rhus integrifolia* R. & W.) and Buck-brush (*Ceanothus cuneatus* [Hook] Nutt.) have been mentioned.

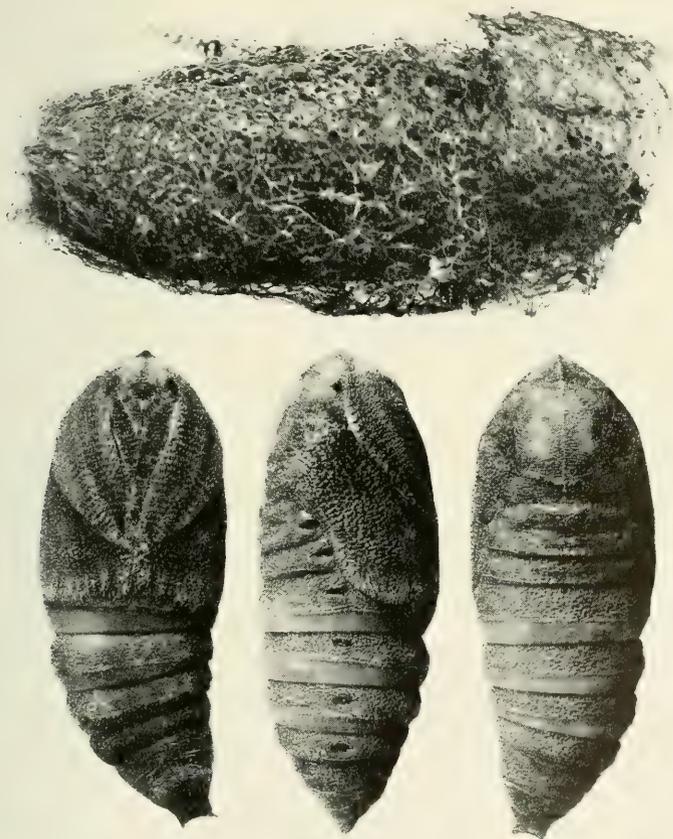


PLATE 56

Fig. A. Cocoon of *Saturnia mendocino*, enlarged approximately x 3.

Fig. B. Pupa, ventral, lateral and dorsal aspects, enlarged x 2½.

Photographs courtesy Los Angeles County Museum.

GLOVERIA ARIZONENSIS AND
GLOVERIA GARGAMELLE MEDUSA

Two species of the genus *Gloveria* are occasionally encountered in southern California. One of these, *Gloveria arizonensis*, is apparently confined to the juniper-piñon belt of the southern foothills, and ranges into Arizona from whence it was first described by Packard in 1872¹.

The other, *Gloveria gargamelle* subsp. *medusa*, was named in 1898² by Herman Strecker from a single example, reared from a larva that was picked up in Los Angeles County. This subspecies frequents the coastal lowlands of southern California.

Gloveria arizonensis Packard

My first acquaintance with *G. arizonensis* was in 1929 when the late Commander Charles M. Dammers brought in a number of larvae which he found in Whitewater Canyon, Coachella Valley. From these and subsequent finds I was able to describe the egg, first instar and mature larva and pupa which, with illustrations, was published in 1930³.

Since that time several colonies of larvae have been brought in and reared, which has furnished additional information as to the habits and metamorphosis of this interesting moth.

The males fly very rapidly in the bright sunlight of midday, in search of mates. The females probably fly nocturnally after mating. Eggs are deposited in bunches on the twigs of their food plant. I have reared them on species of juniper, cypress and, as substitutes in the laboratory, on Torrey Pine and Monterey Pine. They probably also feed on piñon and other conifers. I supplement the previously published record by the following:

The egg is oval, (Plate 57, Fig. A) and measures 1.75 mm. wide by 2.5 mm tall. The ground color is ivory-white, suffused over most of its surface with a light pinkish-brown. On the top there is a dark brownish-pink round spot, surrounded by a circle of white. An oval spot of similar character occurs on each side, as will be noted on Plate 57, Fig. A.

LARVA, FIRST INSTAR: Length, 7 mm. Head width, 1.35 mm.

The description and illustration published in 1930 is adequate. The last group of larvae under observation in 1959 moulted August 5-6.

1. Rep. Peabody Acad. IV, 90, 1872.
2. Ent. News, 9 (1): 13, 1898.
3. Bull. So. Calif. Acad. Sci. 29 (1): 26-29, Pls. 19-12, 1930.

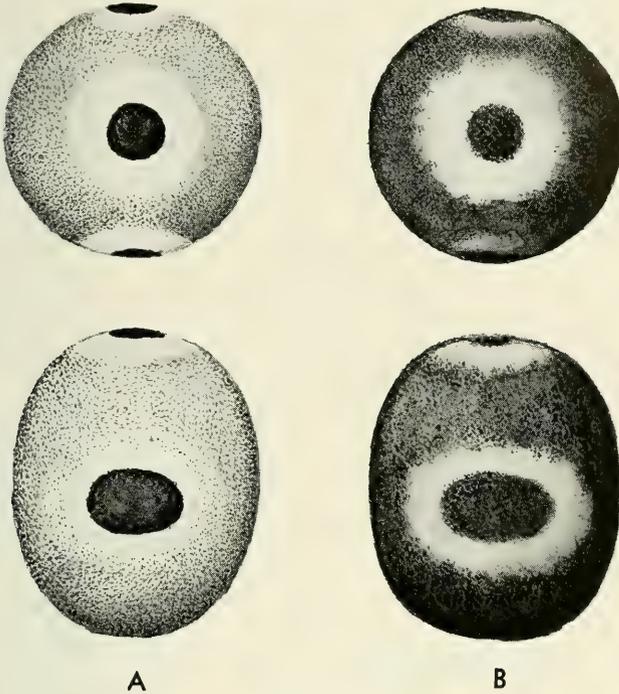


PLATE 57

Fig. A. Egg of *Gloveria arizonensis*, side view, enlarged approximately $\times 16$.

Fig. B. Egg of *Gloveria gargamelle medusa* side view, enlarged $\times 16$.
Upper figures are top views.

Reproduced from painting by J. A. Comstock.

SECOND INSTAR: Length, 11 mm. Head width, 1.75 mm.

The head is streaked with gray on a black background. The clypeus is light yellow.

On the body the middorsal white band is wider and the black margin practically eliminated except for the black nodules. The longitudinal line of crescents running dorso-laterally is now bright yellow. There is considerably more white on the subspiracular area.

Ecdysis occurred August 17-18.

THIRD INSTAR: Length, 13 mm. Head width, 2.25 mm.

The head is gray, with white margins on the sutures. It appears to be less heavily covered with short white setae than in the former instar. The clypeus and antennae are dull yellow, as are also the legs. The wide white middorsal band of the body

is not bisected by a black stripe. The first thoracic segment is black in the center, with wide white margins internal to the tufted tubercles. The dorsolateral stripe is nearly continuous. The lateral surface is more heavily sprinkled with white, and the tubercles are much whiter than in the previous instar. The setae are nearly all white.

The prolegs are banded gray-white and black.

The remaining instars from this point on were not recorded in detail as the lengthy periods between ecdysis made this difficult.

Mature larvae were noted on April 15, 1960. The earlier record of the last instar and the pupa, published in 1930 was sufficiently complete to obviate repetition.

Gloveria gargamelle medusa Strecker

Commander Dammers made brief notes of the egg, larva and pupa, accompanied with illustrations, in 1932. His painting is here reproduced on Plate 58.

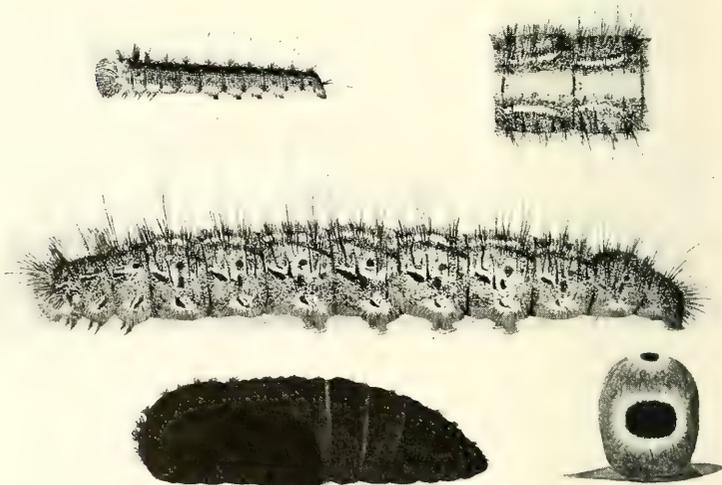


PLATE 58

Upper left figure, first instar larva, lateral view, enlarged $\times 2\frac{1}{2}$.

Upper right fig., two typical segments of mature larva, dorsal view, enlarged approximately $\times 1\frac{1}{4}$.

Center fig., mature larva, lateral view, enlarged $\times 1\frac{1}{4}$.

Lower left fig., Pupa, lateral view, enlarged $\times 1\frac{1}{4}$.

Lower right fig., egg, enlarged $\times 6\frac{1}{2}$.

I have reared *medusa* several times in Del Mar. The females were frequently taken at light, and larvae of various instars were recovered from *Eriogonum*. I have never observed the males in flight. The long period of larval growth and the disparity in the rate of development of individuals in a given brood makes it difficult to accurately note the dates of ecdysis. This accounts for the somewhat incomplete record that follows.

A female taken at light July 4, 1959 laid 41 eggs on July 5, 67 on July 6, and 108 July 7, a total of 216. In nature the eggs are deposited in single layered clusters, usually around stems, each egg in close contact with its neighbors.

EGG: (Plate 57) Width, 2 mm. Length, 2.6 mm.

The ground color is ivory, overlaid by a regular pattern of mottled brown, disposed in the following manner:

On the top, a round spot 0.4 mm. in diameter and reddish-brown in color. This is bordered by a circlet of ivory. On the side, a larger oval spot of the same color measuring approximately 0.5 mm. by 1 mm. This is surrounded by a circlet of ivory. On the opposite side occurs a similar spot and circlet. The remaining surface is covered with a lighter mottled brown. As this brown approaches the edges of the circlets it gradually and irregularly fades out.

Some of the eggs hatched July 24 and 25, the majority being infertile. Egress of the larva occurs through the top of the egg.

FIRST INSTAR LARVA: Length, 7 mm. Head width, 1.2 mm.

The head is black, sparsely covered with short white setae. The clypeus is red-brown, the basal segments of the antennae are soiled white, and the mandibles are black.

The body bears a middorsal longitudinal discontinuous white line, bordered with black. Lateral thereto is a parallel line of orange crescents. On the side of the first segment there is a large black tubercle bearing long curved black hairs.

There are a number of rows of smaller tubercles running longitudinally on the body, each bearing black hairs and shorter white hairs.

Spiracularly and subspiracularly the area is covered with white and black dashes. The legs are black, and the prolegs are black proximally and orange-brown distally. Ecdysis occurred August 4-5, 1959.

In the early stages the larvae are gregarious.

SECOND INSTAR: Length, 12.5 mm. Head width, 1.6 mm.

The ground color of the head is gray, with red-brown clypeus, mouth parts and antennae. The ocelli are black. The head is somewhat obscured by long curving white hairs arching forward from the first segment.

The body is distinguished by a conspicuous middorsal white band, bordered widely with a black band which bears black nodules that are topped with bundles of black hair. Lateral there-to the longitudinal line of crescents is present as in the prior instar. Inferior to these the mottled white, gray and black surfaces are much as in the first instar.

The legs and prolegs are dull orange-brown.

THIRD INSTAR: Length, 16 mm. Head width, 2 mm.

The description of this instar is made with a table showing the comparable characteristics of

G. garmelle medusa

Head gray, heavily obscured by a covering of gray hair. Front black. Clypeus and antennae orange-yellow.

White middorsal band divided by narrow black stripe.

Wide black band bordering it laterally.

First thoracic segment black.

Dorso-lateral stripe of orange broken into dashes and dots.

Lateral narrow alternating broken stripes of black and white.

Tubercles above legs and prolegs spotted yellow and black.

Legs reddish-brown.

Prolegs gray-black, the terminal segments tinged with yellow.

Hairs on dorsum black, in spiracular area, gray to white.

In late instars not gregarious.

and

G. arizonensis

Less tendency to gregariousness.

Head gray with white margins on sutures. Less heavily covered with hair. Clypeus and antennae soiled yellow.

White middorsal band not divided Black border similar.

First thoracic segment black only in center, with wide white edge medial to tufted tubercle.

Dorso-lateral stripe nearly continuous.

Similar, but more heavily sprinkled with white.

Tubercles much whiter.

Legs soiled yellow. Prolegs banded gray-white and black; terminal segments tinged with bright yellow.

Hairs on dorsum and all lateral surfaces nearly white.

Markedly gregarious.

FOURTH INSTAR: Length, 20 mm. Head width, 3 mm. Observed Sept. 10, 1959.

All features are substantially as in the last instar.

From this point on, and particularly through the winter, development was slow and feeding infrequent. I made no record of the instars until the final stage other than a brief table of differentiation on April 15, 1960.

MATURE LARVA:

G. g. medusa

Middorsal white band distinct, bisected by black stripe.

Head gray-brown, with lighter brown frontal and adfrontal sutures.

Spiracular area mottled dull white, brown and black.

G. arizonensis

Middorsal band indistinct, light gray; not bisected by black stripe.

Head black, with very narrow gray sutural margins.

Spiracular area predominantly gray.

Commander Dammers' notes on the mature larva go into greater detail. I quote their essential points, with slight alterations only in technical terminology.

"Body color gray, speckled with black, the speckling being absent on the broad middorsal band from the 2nd to the 11th segments, and similarly a narrow band on the 1st segment.

Subdorsally on the 4th to 10th segments, a narrow band of white feather-like hairs, the area around them being speckled brown.

In front of and above the spiracles a diagonal blotch of heavy black speckling, and superior to the spiracles of the 4th to 10th segments a round black blotch.

On the first three segments laterally, a short black horizontal bar. On the 2nd and 3rd segments below the line of the spiracles a diagonal black bar, with a soiled white bar directly above it.

On the 4th to 11th segments in line with the junction of the body and legs, a soiled white blotch, speckled black.

The upper half of the body is covered with long erect black and short erect brown hairs, arising from the brown specklings.

The lower half of the body is covered with tufts of drooping buff-gray hairs. A tuft of white hairs on the top of the 1st and 2nd segments extends out over the head.

Segmental joints show black. Spiracles, yellow with black rims.

Venter, dark gray. Legs, dark brown with chestnut points. Prolegs and anal prolegs dark gray. Crochets, colorless, with brown hairs."

PUPA: 30-40 mm. long by 11-14 mm. wide.

The color is black and the surfaces rugose. The entire body, except for the wing cases, antennae, thoracic appendages, and movable portions of the segmental junctures is thickly covered with short orange-brown hairs.

The cremaster is made up of a pad of numerous short recurved spicules, colored as are the hairs over the body.

A loose cocoon is spun around the chrysalis, through which the pupa can be dimly seen. Emergence of the imagines usually occurs in May or June.

The larval food plants thus far recorded are False buckwheat (*Eriogonum fasciculatum* Benth.) White wild lilac (*Ceanothus verrucosus* Nutt.) and probably other *Ceanothi*, Oak (*Quercus agrifolia* Neè) and *Pinus* sp. In Del Mar they seem to favor *Eriogonum*, and in the Santa Barbara region Bob Denno reports them favoring *Ceanothus*.

PROCEEDINGS OF THE ACADEMY

March 18, 1960

The March meeting of the Academy, sponsored by the Section on Vertebrate Zoology, was held in the Education Lecture Hall of the Los Angeles County Museum, with seventy members and guests present. The program consisted of an excellent, illustrated lecture by Dr. James R. Peters, Associate Professor of Zoology, San Fernando Valley State College, entitled "Studies on the Reptiles and Amphibians of Ecuador."

BOARD OF DIRECTORS

The following business was transacted at a meeting of the Board of Directors after the program on March 18, 1960:

Dr. W. Dwight Pierce, chairman of the Constitution and suggested that sented the latest proposed revisions of the Constitution and suggested that they be studied and then be acted upon at a later meeting.

Dr. Theodore Downs, a co-chairman of the Annual Dinner Committee reported that the Annual Dinner will be held in the African Hall, Los Angeles County Museum.

Dr. John White suggested that because of the rapidly developing field of Experimental Biology, the Academy Directors should study the feasibility of activating a section in this field. This recommendation will be acted upon after further study.

The following new member was elected: Wise, Mrs. Lorna L. (Mineralogy).

April 15, 1960

The April meeting of the Academy was sponsored by the Section on Anthropology and was held in the Jean Delacour Auditorium of the Los Angeles County Museum. This newly constructed facility enabled the thirty-five members and guests present to enjoy an enlightening talk by Mr. Robert Ariss, Curator of Anthropology, Los Angeles County Museum, entitled "The Interrelationship of Biological and Sociological Processes: The Role of Charles Darwin in Evolutionary Thought."

Dr. Fred Truxal, President, announced to the membership that a proposed amendment to the Constitution would be presented at the May meeting.

BOARD OF DIRECTORS

The Board of Directors met after the program on April 15, 1960, and transacted the following business:

Dr. Hildegarde Howard, member of the Fellows Committee, presented a report which was unanimously accepted: Those to be granted this honor will be announced at the Annual Meeting.

Dr. Fred Truxal reported on the results of the elections for the 1960-1961 Board of Directors and Advisory Board, in the absence of Dr. John White.

Dr. Theodore Downs, chairman of the Annual Dinner Committee announced that plans are almost completed for the Annual Dinner to be held in May.

Dr. Fred Truxal appointed the following three members to serve on the Committee on awarding the A.A.A.S. research grant: Gretchen Sibley, chairman, Thomas Clements and Charles Burch.

The following new member was elected: Stevenson, Dr. Robert E. (Oceanography).

May 20, 1960

The annual dinner meeting was sponsored by the Committee on Special Events with Henry Anson Wylde, chairman, in cooperation with the co-chairmen of the Hospitality Committee, Theodore Downs and Russell Belous. The meeting was held in the Los Angeles County Museum.

Annual reports were presented by the Secretary, the Treasurer (with Auditor's report by Mr. Allen Steuart), and the Editor (see below). A proposed Constitutional amendment was read to the membership with the announcement that ballots for voting on said amendment would be mailed to the membership in the near future. Members of the newly elected Board of Directors and Advisory Board were announced as follows:

Board of Directors: Thomas Clements, John A. Comstock, Theodore Downs, Hildegard Howard, Richard B. Loomis, Lloyd M. Martin, W. Dwight Pierce, Gretchen Sibley, Ruth D. Simpson, Fred S. Truxal and Sherwin F. Wood.

Advisory Board: A. Weir Bell, Russell E. Belous, J. Stanley Brode, Charles Burch, Howard Hill, Dorothy Martin, Charles A. McLaughlin, Theodore Payne, Kenneth Stager, Richard Swift, Louis C. Wheeler, and John A. White.

The following were awarded the degree of Fellow: Dr. John G. Franclemont, Dr. Leo G. Hertlein, and Dr. Walter E. Martin.

The address of the evening was an excellent presentation by Dr. W. F. Libby, Professor of Chemistry, U.C.L.A., entitled "Carbon-14 Dating." One hundred and fifteen members and guests were in attendance.

BOARD OF DIRECTORS

The newly elected Board of Directors and Advisory Board met on May 6, 1960 to hear reports and elect officers for 1959-1960. Condensed versions of the reports are given below. Officers are as follows: President, Fred S. Truxal; first Vice President, Theodore Downs; second Vice President, Richard Loomis; Secretary, Gretchen Sibley; Assistant to the Secretary, Lloyd M. Martin; Treasurer, W. Dwight Pierce; Editor, John A. Comstock.

The proposed amendment to the Constitution concerned with enlarging the membership of the Advisory Board was finalized as to content and approved.

Secretary's Report: The Southern California Academy of Sciences met nine times during the fiscal year, 1959-1960. The average attendance was approximately sixty. Eight meetings were held at the Los Angeles County Museum; one was held at the Hyperion Treating Plant, Los Angeles. Dinner meetings were discontinued after completion of a new meeting room in April, the Jean Delacour Auditorium. Membership for the year totaled 287. Deceased during the year were: Donald Drake, Clarence Shoemaker, E. O. Palmer, N. T. Mattox, and Arthur D. Howard.

The section on Earth Sciences also held regular meetings at various laboratories in nearby colleges and universities.

Editor's Report: In line with established policy, three issues of the Bulletin were edited and issued in 1959, and the first issue for 1960 was published. These issues contained a total of 28 papers exclusive of the section devoted to Scientific Notes and Transactions of the Academy.

Lack of space in this issue necessitates running the detailed report of the Treasurer for the fiscal year 1959-1960 in the ensuing issue of the Bulletin.

June 17, 1960

Approximately forty-five members and guests assembled in the Jean Delacour Auditorium of the Los Angeles County Museum for the last meeting of the 1959-1960 Academy year. Dr. Theodore Downs, first vice-president, presided. The names of the officers and committee and Section chairmen for 1960-1961 were read. The program consisted of the Presidential Address given by Fred S. Truxal, entitled, "Ecology and Zoogeography of Western Hemisphere Water Bugs."

BOARD OF DIRECTORS

Section Chairmen met with the 1960-1961 Board of Directors and Advisory Board on June 17 to organize the monthly programs for the coming fiscal year. In addition to the already established regular monthly meetings, it was decided to combine the May and June meetings and provide for a one day conference at Long Beach State College on May 19, 1961, at which time invitational and submitted papers will be presented.

The Board of Directors ratified the amendment to the Constitution concerned with enlarging the membership of the Advisory Board. This amendment had been sent earlier to the membership and the returned ballots indicated approval.

Dr. Hildegard Howard recommended that the Academy become an affiliate member of the Southern California Chapter of Nature Conservancy. A motion to this effect was passed.

The following new members were elected: Given, Robert R., (Zoology); DeYoung, Alvin H. (Entomology); Tiemann, Darwin L. (Entomology); Johnson, Kenneth L. (Physiology); Moss, John L. (Paleontology); Brush, Alan H. (Zoology).

EARTH SCIENCES SECTION MEETING

The Earth Sciences Section sponsored the regular September meeting of the Academy. Dr. Thomas Clements gave a stimulating, illustrated lecture on "The Search for Jade in Mexico."

Five other informal but highly technical meetings were held at the California Institute of Technology, U.C.L.A., Webb School, Long Beach State College, and the Los Angeles County Museum.



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BULLETIN OF THE Southern California Academy of Sciences

LOS ANGELES, CALIFORNIA

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VOL. 60

JANUARY-APRIL, 1961

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THE RELATIONSHIP OF TEMPERATURE AND
DISSOLVED OXYGEN TO THE SEASONAL
SETTLEMENT OF THE POLYCHAETOUS
ANNELID *HYDROIDES NORVEGICA*
(GUNNERUS)¹

By DONALD J. REISH
Department of Biological Sciences,
Long Beach State College

INTRODUCTION

Hydroides norvegica (Gunnerus) is a serpulid polychaete that is widely distributed in the warmer temperate seas of the world. It constructs white calcareous tubes (Plate 1, Fig. 2 and 4) which are found attached to pilings, docks, hulls of ships, as well as other sedentary organisms or solid substrates.

While pursuing other biological studies in Los Angeles — Long Beach Harbors in 1950-1955 the author observed that *H. norvegica* appeared to have a seasonal period of settlement. Furthermore, there seemed to be a greater amount of settling some years than in others. It was not possible until 1956 to establish a study to determine the validity of these previous observations. This paper constitutes the results of observations made from 1956 through 1958.

Seasonal settlement of fouling organisms in the Pacific Ocean have been studied at Friday Harbor, Washington (Johnson and Miller, 1935), in California at Oakland estuary (Graham and Gay, 1945), Los Angeles — Long Beach Harbors (Barnard, 1958), Newport Bay (Scheer, 1945), La Jolla (Coe and Allen, 1937), San Diego Bay (Wheldon, 1937, in Anon, 1952), and at Kaneoke Bay, Oahu, Hawaii (Edmondson and Ingram, 1939). *Hydroides norvegica* was reported only from Los Angeles — Long Beach Harbors and Kaneoke Bay. Additional seasonal studies have been made in Japan south to Australia (see Anon, 1952), but *H. norvegica* was not present. Settlement of *H. norvegica* occurred throughout the year at Kaneoke Bay where the water temperatures were never below 22°C. The relationship of water temperature to seasonal settlement of *H. norvegica* in Los Angeles — Long Beach Harbors was not discussed by Barnard (1958).

¹This study was supported in part by research grant number [E-556 (C3-C4)] from the National Institutes of Health, United States Public Health Service to the Department of Biology, University of Southern California.

Periodicity in settling has been studied in Sydney, Australia, by Dew and Wood (1955) and Wisely (1958). It was found that *H. norvegica* settled on test panels during each month of the year with peaks occurring in December and April (Wisely, 1958). Peaks of settling coincided with the spring tides from October to March (Dew and Wood, 1955).

MATERIALS AND METHODS

Douglas fir wood blocks, measuring 6 X 1.5 X 1.5 inches, were suspended for 28 day periods at the 15 foot water depth at eight stations in Los Angeles — Long Beach Harbors (Plate 1). The 28-day period was selected since it divided the year into 13 periods of equal time. The study commenced at some of the stations

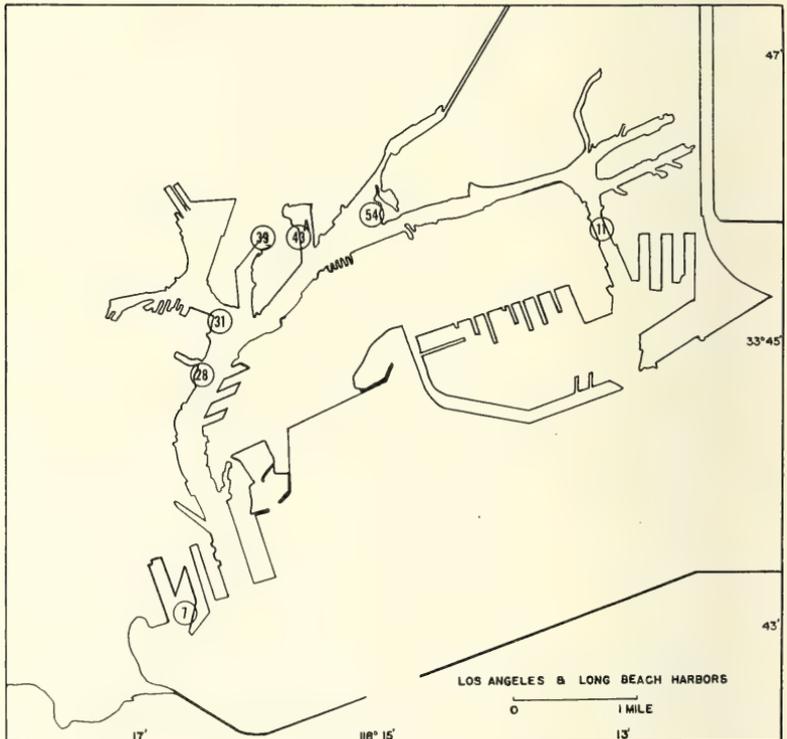


PLATE 1

Los Angeles-Long Beach Harbors, California, showing station locations where test blocks were suspended. Station 11 is in Long Beach Harbor; the remaining stations are in Los Angeles Harbor.



PLATE 2

Figure 1. Test block and gallon jar suspended at LA 31 for 28-day period ending May 7, 1958. Principle organisms are *Balanus* sp. and *Obelia* sp.

Figure 2. Same test block and bottle as in figure 1 exposed for 56-day interval ending June 4, 1958. *Hydroides norvegica* and *Tubularia* sp. are principle animals.

Figure 3. Same test block as in previous two figures exposed for 84 days ending July 3, 1958. *Ciona intestinalis* and dead *Balanus* sp. constitute the majority of the attached organisms.

Figure 4. Test block suspended at LA 28 for 28-day period ending July 30, 1959, during heavy settlement of *Hydroides norvegica*.

December 21, 1955 (with the first period extending until January 18, 1956, this constituting the first month in 1956). At some stations the study was terminated at the end of 1957, at others near the end of 1958.

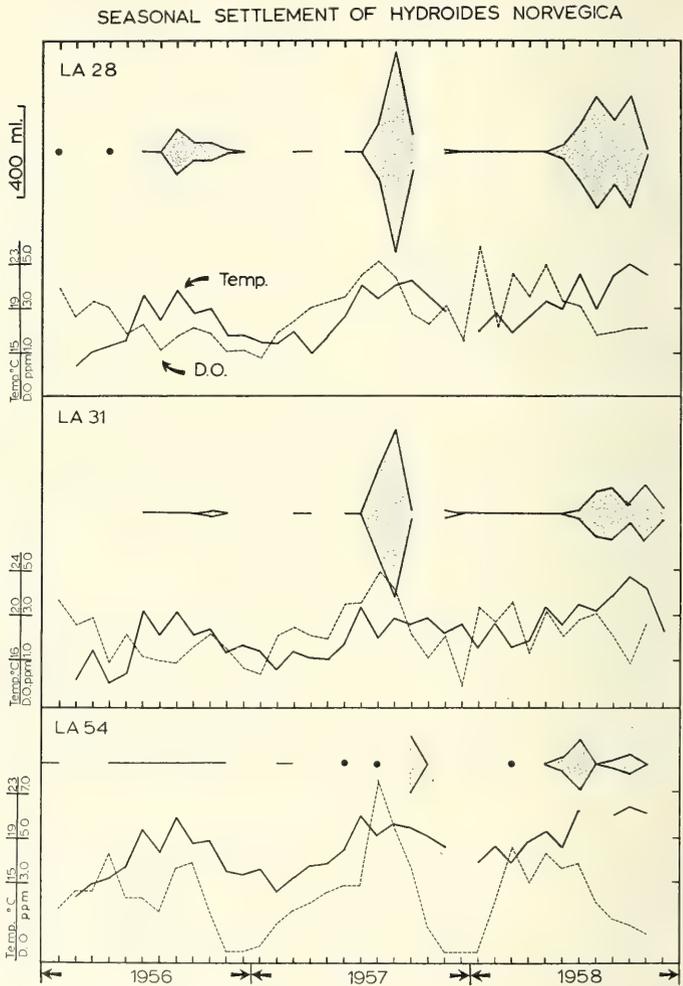


PLATE 3

Seasonal settlement of *H. norvegica* in relation to temperature and dissolved oxygen during 1956-1958 at stations LA 28, LA 31, and LA 54. The scale for the volume of *H. norvegica* is indicated in the upper left margin. Black dots indicate *H. norvegica* was present in a small amount

The wood blocks were picked up and replaced with a new one each 28-day period. Photographs were made of many of the blocks (Plate 2, Figs. 1-4). At the same time the temperature of the water at the 15 foot depth was determined. Dissolved oxygen was measured at the same depth utilizing the modified Winkler method. Chlorinity was not determined since it was known to be that of normal sea water and to vary little (Reish, 1959).

The wood blocks were brought to the laboratory; the specimens were scraped from the test blocks and preserved in formaldehyde. The samples were analyzed and the volume occupied by each dominant species determined. While there were many other species of animals observed on these blocks, only the seasonal settlement of *Hydroïdes norvegica* is discussed herein.

The seven stations (Plate 1) were selected from various ecological areas of Los Angeles—Long Beach Harbors. The station numbers employed are those used in previous studies in these harbors (Anon, 1952; Reish, 1955; 1959). The stations located in Los Angeles Harbor are indicated by "LA"; and the one station in Long Beach Harbor by "LB." These stations may be briefly located and characterized as follows. Since the amount of dissolved oxygen present in the water-mass in harbors is frequently dependent on the degree of pollution, these data are included.

- LA 7 Berth 42, Los Angeles outer harbor, Watchhorn Basin. Pollution was not serious in the vicinity of this station, wastes include small amounts of discharges from oil well operations, cooling waters, and domestic sewage.
- LA 28 Berth 92, Los Angeles Harbor main channel. The area was influenced by the large amounts of oil refinery wastes emptied into the West Basin.
- LA 31 Berth 99, at the entrance of West Basin, Los Angeles Harbor. Waste discharge as station LA 28.
- LA 39 Berth 162, at Los Angeles Harbor Department docks. No major contributors of waste discharges are in the vicinity; however, the station is located at the end of slip and water circulation is limited.

but was not the previous or following times. Horizontal lines indicate *H. norvegica* present at least for two successive collections but never abundantly. Blank spaces indicate that *H. norvegica* was either not present (usually the case) or the test panel was lost (rare).

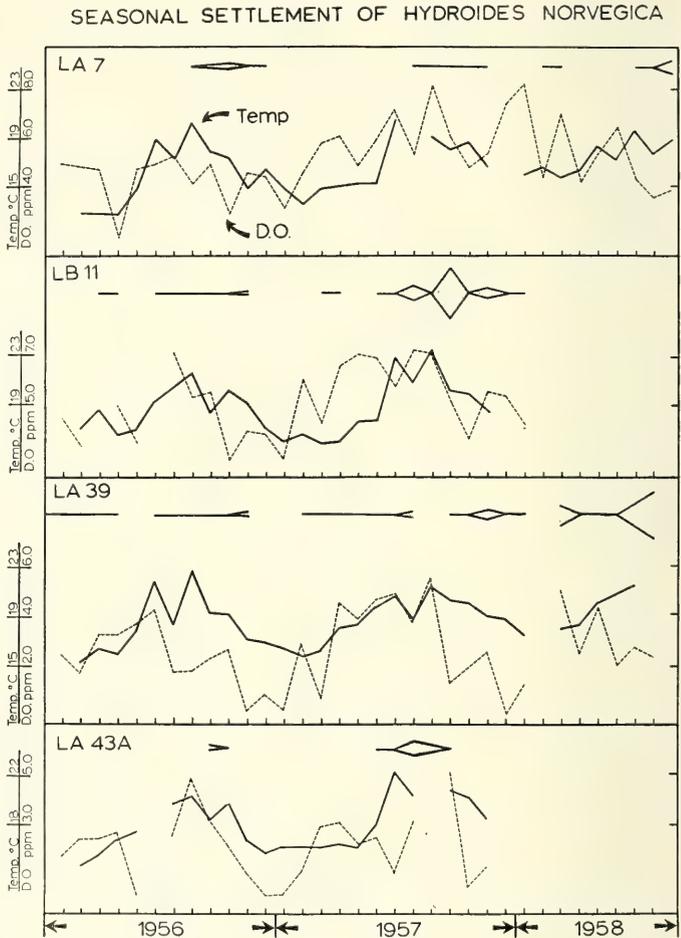


PLATE 4

Seasonal settlement of *H. norvegica* in relation to temperature and dissolved oxygen during 1956-1958 at stations LA 7, LB 11, LA 39, and LA 43 A. Scale for volume of *H. norvegica* and additional explanations as in Plate 3.

- LA 43A Berth 179 is Slip 5 region of Los Angeles Harbor. Fish cannery wastes and vegetable oil plant wastes are discharged in the vicinity.
- LA 54 East Basin, opposite Berth 203 in Los Angeles Harbor. Large quantities of oil refinery wastes emptied into the Consolidated Slip influenced this station (Reish, 1957).
- LB 11 Pontoon bridge in Long Beach Harbor. Pollution was not serious in this area.

RESULTS

The data are summarized in Plates 3 and 4. The seasonal settlement and volume of *H. norvegica* are indicated for each station along with the water temperature and amount of dissolved oxygen.

It can be seen from Plates 3 and 4 that there is a considerable amount of variation in the amount of settling, during a year, during different years, and from station to station. Settlement was greatest at all stations, except at LA 7, during 1957 and 1958. Only at station LA 28 did moderately heavy growths of *H. norvegica* occur in 1956. Water temperatures were high in 1957-8 and low in 1956. Peaks in settling coincided within the same seasonal period at all stations. The range of time within a year was more extensive at some stations than at other stations. The maximum settlement occurred during months 8 to 10, or from early July through late September, which corresponded to the times of the highest water temperatures. Little or no settlement occurred during the winter months.

Tables 1 and 2 summarize the water temperature and dissolved oxygen data for each station according to whether or not *H. norvegica* was collected and for those stations at which the volume exceeded 100 ml. The ranges and averages are included for each category for each station. While there were some overlaps in temperature, in general the data show that *H. norvegica* does not settle when the temperature is low. The warmer the water temperature the more likely that *H. norvegica* will be present, and if the water temperatures are high, the greater the possibility that a large quantity will settle.

The lowest temperature recorded at which *H. norvegica* was present was 15.0° C; the lowest temperature measured at which there was a large settlement of the serpulid was 18.4° C. *Hydroides norvegica* was present in all instances when the temperature was above 20.0° C. There were three instances in which the temperature was at 20.0° C but no *H. norvegica* was present on the test block. Two of these occurred on October 23, 1957, at LA 28 and LA 31 when the dissolved oxygen was low. The other was at LA 43A on

Table 1
Relationship between Settlement of *Hydroides norvegica*
and Water Temperature (°C)

| Station | <i>H. norvegica</i> absent | | <i>H. norvegica</i> present | | Volume of <i>H. norvegica</i> 100 ml. + | |
|---------|----------------------------|---------|-----------------------------|---------|--|---------|
| | Range | Average | Range | Average | Range | Average |
| LA 28 | 13.8-20.0 | 16.2 | 15.0-23.0 | 18.9 | 19.8-23.0 | 21.1 |
| LA 31 | 14.5-20.0 | 16.4 | 16.5-23.8 | 19.4 | 18.4-22.8 | 20.5 |
| LA 54 | 14.0-18.9 | 16.8 | 15.5-22.2 | 18.8 | 20.2-21.8 | 21.0 |
| LA 7 | 13.0-19.0 | 15.6 | 15.0-20.4 | 18.2 | | |
| LB 11 | 16.5-17.5 | 17.0 | 15.9-23.0 | 18.8 | | |
| LA 39 | 16.0-17.5 | 16.7 | 15.0-22.3 | 18.4 | | |
| LA 43A | 14.5-20.0 | 16.5 | 18.3-22.0 | 19.8 | | |
| Summary | 13.0-20.6 | 16.4 | 15.0-23.8 | 19.0 | 18.4-23.0 | 20.9 |

Table 2
Relationship between Settlement of *Hydroides norvegica*
and Dissolved Oxygen (ppm)

| Station | <i>H. norvegica</i> absent | | <i>H. norvegica</i> present | | Volume of <i>H. norvegica</i> 100 ml. + | |
|---------|----------------------------|---------|-----------------------------|---------|--|---------|
| | Range | Average | Range | Average | Range | Average |
| LA 28 | 0.7-3.3 | 2.0 | 1.1-5.7 | 3.2 | 1.8-5.1 | 2.9 |
| LA 31 | 0.5-3.8 | 2.1 | 0.0-5.0 | 2.4 | 2.3-5.0 | 3.7 |
| LA 54 | 0.0-3.1 | 1.5 | 0.0-4.5 | 2.4 | 3.8-4.0 | 3.9 |
| LA 7 | 2.0-8.2 | 5.4 | 3.0-8.2 | 4.9 | | |
| LB 11 | 3.2-7.0 | 4.6 | 2.7-7.3 | 5.1 | | |
| LA 39 | 0.0-3.5 | 1.4 | 0.0-5.4 | 2.7 | | |
| LA 43A | 0.0-4.7 | 1.6 | 0.9-5.0 | 2.7 | | |
| Summary | 0.0-8.2 | 2.9 | 0.0-8.2 | 3.2 | 1.8-5.1 | 3.3 |

August 22, 1956; there was adequate oxygen present in the water at this time.

The relationship between the amount of dissolved oxygen present and the settlement of *H. norvegica* is not as well defined as it was for water temperature (Table 2). Maximum readings may be encountered nearly any month of the year. Minimal amounts generally occurred during December and January (Plates 3 and 4). In most cases, the greater the concentration of dissolved oxygen at a station the more likely that *H. norvegica* will be collected, and at stations LA 28, 31, and 54, the more likelihood of larger volumes. High dissolved oxygen values were measured the majority of the time at LA 7 and LB 11 and because of this, this factor is probably of minor importance as a limiting factor at these stations.

In general, there are probably two factors that play a role in attaining heavy settlement of this serpulid polychaete. Warmer water temperatures and adequate oxygen supply over a long period

of time probably result in a faster rate of maturity and greater amount of spawning over a longer period of time. Lower amounts of dissolved oxygen and lower temperatures in the late months probably play a major role in the reduction in settling.

SUCCESSION

If growth of *H. norvegica* is rapid and the block is allowed to remain in the water for a period of time greater than one month, some indication of succession is noted. Plate 2, figures 1-3 represent such a change. In figure 1, the test block had been exposed for 28 days. Principle organisms include *Balanus* sp. and *Obelia* sp. Figure 2 shows the same block at 56 days. The block, line, and bottle are covered with an extensive growth of *H. norvegica*. A small quantity of the hydroid *Turbellaria* sp. is present on the lower surface of the block and on the bottle. By 84 days, no *H. norvegica* were present (Fig. 3). The weight of the tube mass had become too large and *H. norvegica* had fallen off. The majority of the animals on the block consisted of empty *Balanus* sp. shells, apparently these were killed by the growth of the polychaete. A few specimens of *Ciona intestinalis* were present at this time.

ASSOCIATED ORGANISMS

Generally there are about ten different animal species associated with the extensive growths of *H. norvegica* (Plate 2, fig. 2). Chief among these are the tube building amphipod *Corophium acherusicum* (Costa), the tube building polychaete *Polydora* (*C.*) *paucibranchiata* Okuda, the bryozoan *Bugula neritina*, Linnaeus), the solitary tunicate *Ciona intestinalis* (Linnaeus), and the barnacle *Balanus* sp. Free living species found among the tubes include the polychaetes *Capitella capitata* (Fabricius), *Platynereis bicanaliculata* (Baird), *Halosydna johnsoni* (Darboux), and *Podarke pugettensis* Johnson, and the crustacean *Epinebalia* sp.

The attached organisms, including *H. norvegica*, feed on particulate matter present in the water mass. The waters in the harbors are very turbid and can support a high population of suspension feeders (Barnard, 1958). The free-living organisms feed largely upon debris within the association; although *Halosydna johnsoni* and *Podarke pugettensis* are known to feed upon crustaceans and diatoms (Reish, 1954).

While it was stated that the other major sessile organisms attaching on the wood blocks is not the subject of this paper, a few remarks concerning these animals are worthy of mention. The tunicate *Ciona intestinalis* was particularly abundant in the late spring to early summer months at LA 5 and LA 28. An unidentified species of *Obelia* sp. was taken in the winter and spring months

at LA 31, in the spring at LA 28, and sporadically at LA 7 and LA 43A. *Bugula neritina* appeared at various times at LA 43A and LA 54. *Corophium archerusicum* built extensive mud tubes on the panels at LA 7 and LB 11, generally in spring. *Polydora paucibranchiata* was present sporadically at LA 39.

SUMMARY

1. The seasonal settlement of the calcareous tube-building polychaetous annelid *Hydroides norvegica* was studied from 1956 through 1958 at seven stations in Los Angeles-Long Beach Harbors.
2. Large populations of *H. norvegica* settled on wood test panels at some stations during 1957 and 1958. This was found to be related to warmer water temperatures.
3. Settlement occurred in all instances when the water temperature was above 20°C. Large growths of *H. norvegica* occurred at temperatures above 18.4°C. No animals attached to test panels at water temperatures below 15.0°C.
4. In most instances, heavier settlement of the polychaete occurred at stations having greater concentrations of dissolved oxygen.
5. The succession of the *H. norvegica* population, the associated organisms, and the other principle fouling organisms in Los Angeles-Long Beach Harbors are discussed.

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A NEW SPECIES OF SILIQUA (PELECYPODA) FROM WESTERN NORTH AMERICA

By LEO G. HERTLEIN

During the course of dredging off the coasts of California and Alaska, specimens of a *Siliqua* were obtained by Dr. G. Dallas Hanna which did not seem referable to either *S. lucida* or to the young of *S. patula*. The coloration of the shell, together with the fact that their habitat was in moderately deep water in comparison to the coast-inhabiting *Siliqua patula* and *S. lucida*, suggested that they represented a distinct form. Such proves to be the case and it is here described as a new species.

The genus *Siliqua* has been reported in California in strata of late Cretaceous¹ age, and from late Miocene to Recent. A synopsis of the Recent species of North America and the Antilles was published by Dall².

The writer wishes to acknowledge the assistance and advice given by Dr. G. Dallas Hanna, Curator of the Department of Geology, California Academy of Sciences, and Mr. A. G. Smith, Research Malacologist in the same institution. Dr. I. McT. Cowan, Department of Zoology, University of British Columbia, furnished specimens and information concerning their occurrence in British Columbia. Photographs used in the present paper were prepared by the late Frank L. Rogers.

Key to the Recent West American species of SILIQUA.

- A. Internal radial rib sloping anteriorly *patula*
- B. Internal radial rib sloping nearly vertically:
 - a. Adult shell large, high, thick, usually exceeding 40 mm. in length *alta*
 - aa. Adult shell, small, very elongate, thin, usually not exceeding 40 mm. in length
 - b. Posterior end squarish *lucida*
 - bb. Posterior end elliptical *sloati*

(1) *Siliqua alisoensis* Packard, Univ. Calif. Publ., Bull. Dept. Geol. Sci., Vol. 13, No. 10, p. 427, pl. 34, fig. 2, June 30, 1922. "Chico group, *Tellina ooides* zone," late Cretaceous, in Santa Ana Mountains, Southern California.

(2) See Dall, W. H., "Synopsis of the Solenidae of North America and the Antilles," Proc. U. S. Nat. Mus., Vol. 22, No. 1185, pp. 107-122, October 9, 1899 (*Siliqua*, p. 109.).

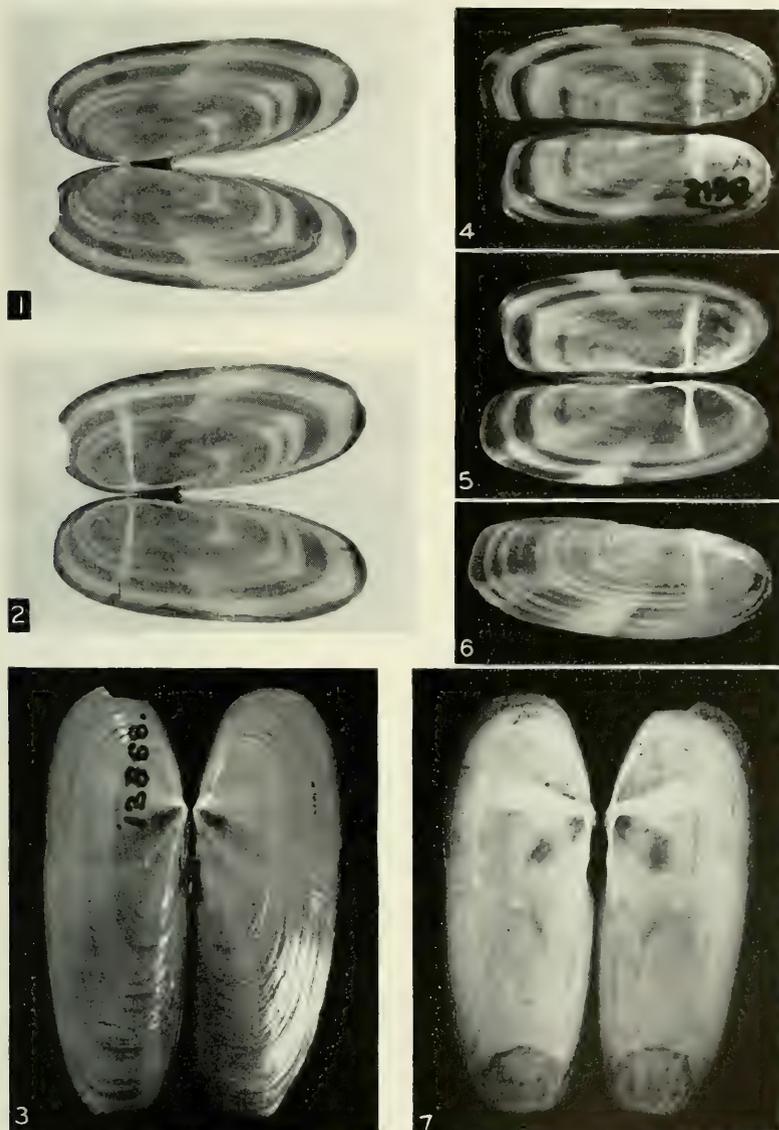


PLATE 5

Explanation of Figures

Figs. 1, 2. *Siliqua sloati* Hertlein, new species. Holotype, from off Laguna Point, Mendocino County, California; length, 35 mm. 1. View of exterior. 2. View of interior. Figs. 3, 7. *Siliqua patula* Dixon. From Morro Bay, San Luis Obispo County, California; length, 46 mm. 3. View of exterior. 7. View of interior. Figs. 4, 5, 6. *Siliqua lucida* Conrad. From breakwater at North Island, Los Angeles County, California. 4. View of exterior; length, 30.9 mm. 5. View of interior of same specimen. 6. View of exterior of a right valve; length, 32 mm.

***Siliqua sloati* Hertlein, new species**

Plate 5, Figs. 1, 2; Plate 6, Figs. 4-7

Shell elongately oval, thin; beaks situated at about one-fifth the length from the anterior end which is ovally rounded; posterior to the beaks the shell gradually curves toward the posterior end which is rather acutely rounded; exteriorly the shell is beautifully polished and ornamented by concentric oval brownish bands on a cream colored background; interior as in *Siliqua lucida* with the internal rib sloping nearly vertically to the ventral margin. Length, 35 mm., height, 12.2 mm., convexity (both valves together), approximately 5 mm.

Holotype (Calif. Acad. Sci. Paleo. Type Coll.), from Loc. 31156 (C.A.S.), 356° 2.8 miles off Laguna Point, Mendocino County, California, dredged in 46 to 49 meters (25½-27 fathoms); G. Dallas Hanna, collector, August 6, 1940. Paratypes (Calif. Acad. Sci. Paleo. Type Coll.), from Loc. 28545 (C.A.S.), at point where line W. ¾ S. from Pt. Bonita, California, crosses the 55 meter (30 fathom) line; G. H. Clark and G. D. Hanna, colls., April 29, 1936.

Additional specimens, the largest 40 mm. long, were dredged in northern California. Dr. I. McT. Cowan presented two specimens which were dredged in 18 meters (10 fathoms) in Plumper Sound, Saturna Island, British Columbia. He also mentioned (written communication) that this species was dredged in Georgia Strait, British Columbia, in 22-82 meters (12 to 45 fathoms) on a muddy bottom. One specimen was dredged by Dr. G. D. Hanna in Portage Bay, Alaska, in 31 meters (17 fathoms).

Range: Portage Bay, Alaska, to Point Bonita, Marin County, California, in 18 to 157 meters (10 to 86 fathoms).

This new species differs from *Siliqua lucida* Conrad³ in that the posterior end is more pointed, the posterior dorsal area is less expanded, more curved and not bordered by a distinct groove, and the exterior of the shell is highly polished and ornamented by bright colored bands of brown and cream in comparison to the subdued brownish and purplish color of *S. lucida*.

(3) *S[olecurtus]. lucidus* Conrad, Jour. Acad. Nat. Sci. Philadelphia, Vol. 7, p. 231, pl. 17, fig. 8, 1837. "Inhabits the sand beach, near Sta. Barbara, uncommon." Also illustrated by I. S. Oldroyd, Stanford Univ. Publ. Univ. Ser. Geol. Sci., Vol. 1, p. 189, pl. 52, fig. 2, 1924 (as *Siliqua lucida*). Monterey, California, to Todos Santos Bay, Lower California. Also in the Pleistocene at San Pedro and San Diego, California — Grant and Gale, Mem. San Diego Soc. Nat. Hist., Vol. 1, p. 389, pl. 21, fig. 6, 1931 (as *Siliqua lucida*). Earlier records cited. Pliocene to Recent.

Compared to the young of *Siliqua patula* Dixon⁴ the new species is less elongate, the beaks are more anteriorly situated. It also differs in the decided color banding exteriorly and in that the internal rib is smaller and usually extends to the ventral margin in nearly a vertical line rather than sloping anteriorly.

This new species differs from juvenile forms of *Siliqua alta* Broderip and Sowerby⁵ in the more elongated, thinner, more highly colored shell, thinner internal riblet and in that the pallial sinus is narrower and extends forward from the posterior adductor impression before descending.

This new species is named for Lewis Warrington Sloat⁶ one of the founders and first secretary of the California Academy of Natural Sciences.

The anatomy of three individuals of the new species was studied by the late Dr. Harold Heath. Two have a shell length of 34 mm. and the third specimen, of approximately the same size, had been removed from the shell. The first two were taken off Laguna Point, Mendocino County, California, in 46 to 49 meters (25.5-27 fathoms); the other came from a depth of 155 to 157 meters (85-86 fathoms), off Mad River, Humboldt County, California. Specimens of *Siliqua patula*, with whose anatomy that of *S. sloati* was compared, were collected at Pismo Beach, California, and range in length from 32 to 116 mm. Unfortunately no preserved specimens of the anatomy of *S. lucida* were readily available to enable Dr. Heath to make a comparison with that species.

Dr. Heath gave the following discussion of his study of the anatomy of the two species.

Externally *S. patula* and *S. sloati* resemble each other closely, but there are significant differences. One difference is the degree of pigmentation. In *S. patula* all traces of pigment are lacking or are confined to the bases of the few papillae surrounding the siphonal openings. In the new species, taken from a depth of ap-

(4) *Solen patulus* Dixon, Voyage Round the World, p. 355, fig. 2 [two figs.], 1789. "At the mouth of Cook's River," northwest coast of America [Alaska]. — I. S. Oldroyd, Stanford Univ. Publ. Univ. Ser. Geol. Sci. Vol. 1, p. 190, pl. 48, fig. 1; pl. 52, fig. 1, 1924 (as *Siliqua patula*).

(5) *Solen altus* Broderip and Sowerby, Zool. Jour., Vol. 4, No. 15, p. 362, 1829. "Hab. in Oceano Arctico." — I. S. Oldroyd, Stanford Univ. Publ. Univ. Ser. Geol. Sci., Vol. 1, p. 190, pl. 47, figs. 1, 2, 1924 (as *Siliqua patula alta*). "Swikshak Beach, Alaska."

(6) See Hertlein, L. G., "Lewis W. Sloat Pioneer Conchologist in California," Amer. Malacol. Union 25th Anniversary Issue. Ann. Repts. 1956 (Bull. No. 23), pp. 7-8, December 31, 1956.

proximately 155 meters (85 fathoms), pigment is lacking entirely. In the two from shallower water the siphons and sensory papillae fringing the mantle border are provided with a brownish pigment, and the foot also is blotched with the same material.

It is worthy of note that in the deeper water individual the mantle papillae, along the front margins of the shell, are greatly reduced, and the siphon surface is as smooth as in *S. patula*. In the other two specimens the papillae are as prominent as in *S. patula*, and the siphons are provided with what evidently are sensory out-growths (Pl. 6, Fig. 5). Obviously, the presence or absence of these structures is correlated with the amount of light, which conceivably may act as a developmental stimulus.

The musculature of these species is altogether too resistant to permit of a detailed dissection. However, it may be said that the pedal protractors originate as paired bundles in the neighborhood of the anterior shell adductor, and, although their component fibers appear to merge, they nevertheless are distinct throughout. Those of the group adjacent to the adductor form in part the lateral wall of the visceral cavity, while others radiate more ventrally and enter into the formation of the median and more posterior divisions of the foot. The other member of this pair extends into the more anterior portion of the foot, and in both species their radiating fibers evidently cooperate with intrinsic circular muscles in decreasing the caliber of the foot, thus causing its extension.

In this process of extending the foot the transverse muscle bundles bridging the visceral cavity also may play a part. Their contraction obviously must constrict the pedal sinuses, and if the

Explanation of Figures on Plate 6

Fig. 1. Lateral view of stomach and digestive gland of *Siliqua patula*. Shell length, 116 mm.

Fig. 2. Right half of body of *Siliqua patula*, showing internal features of stomach, arrangement of pedal protractors and of the muscles spanning the visceral cavity. Shell length, 32 mm.

Fig. 3. Lateral view of the digestive system of *Siliqua patula*. Shell length, 116 mm.

Fig. 4. Lateral view of the digestive system of *Siliqua sloati*.

Fig. 5. Siphon of *Siliqua sloati*, from 46 meters (25 fathoms).

Fig. 6. Right side of stomach of *Siliqua sloati*.

Fig. 7. Right half of body of *Siliqua sloati*.

Fig. 8. Right lateral view of stomach of *Siliqua patula*. Shell length, 32 mm.

Fig. 9. Dorsal view of main organs of *Siliqua patula*. Shell length 55 mm.

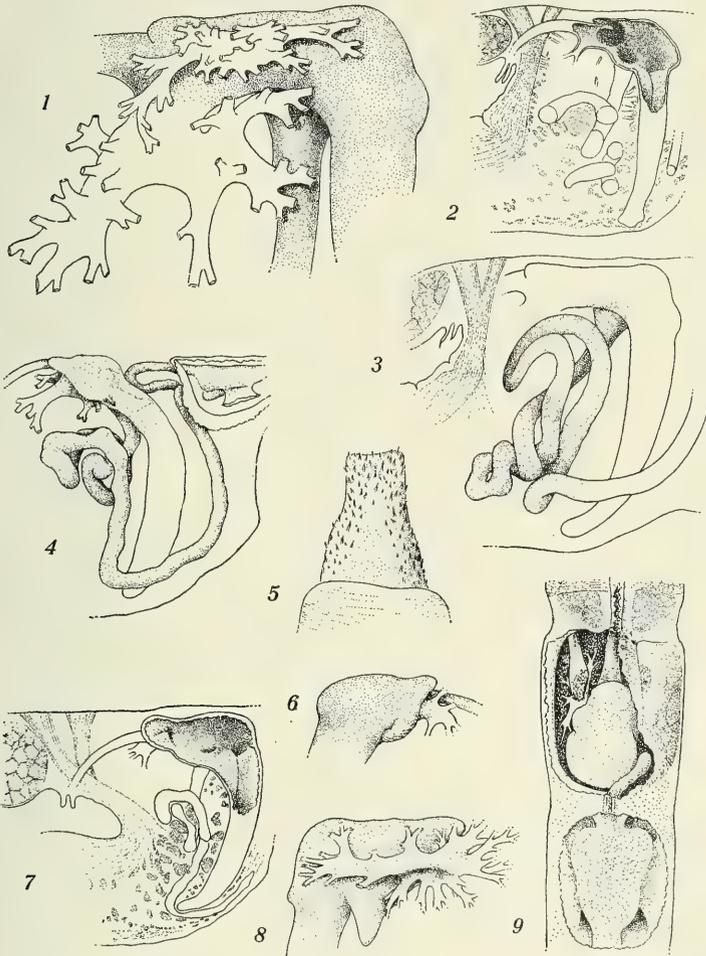


PLATE 6

The explanations of figures and the line drawings used for illustrations on this plate were prepared by the late Dr. Harold Heath.

contained blood is forced anteriorly it produces a forward extension of the foot. It is important to add that here, as in several other genera, the arrangement of these muscles constitutes an important item in the list of specific differences.

Fundamentally the digestive system in both species is constructed upon the same plan. There are, however, several obvious differences. The esophagus in each is dorso-ventrally compressed to some extent, is of essentially the same diameter throughout, and in most instances the inner epithelial lining is marked by delicate longitudinal grooves.

Among what appear to be the more primitive pelecypod families, the stomach comprises two divisions, a dorsal and ventral section. Ducts from the digestive gland open into the dorsal division, and the crystalline stile secretion is developed by the lining cells of the lower portion. In *S. patula* the upper region is typical, whereas the lower section no longer is continuous with the intestine, but has become fashioned into a capacious diverticulum. The intestine therefore directly unites with the upper division.

The configuration of the stomach proper is similar in both species. The chief differences being those of proportion. One striking variation appears in relation to an out-pouching from the right side of the gastric wall. In *S. patula* (Pl. 6, Fig. 8) it is a conspicuous plain-walled structure; in *S. sloati* it is situated more anteriorly, is relatively of small size and its lining is fashioned into several distinct folds. Developmentally the bile ducts originally were doubtless paired, and this condition persists in *S. sloati* (Pl. 6, Figs. 4, 6). In *S. patula* (Pl. 6, Figs. 1, 8) the main duct of the right hand gland is single; the left, on the other hand, has a single duct with ventral opening, and more dorsally there may be one or several connections.

The diverticulum responsible for the crystalline stile secretion is a plain-walled structure in both species. In primitive pelecypods, where the lower division of the stomach is attached directly to the intestine, a longitudinal groove is reported to be the channel whereby nutritive material is passed along to the intestine. In the genus *Siliqua* the same groove persists (Pl. 6, Figs. 2, 7), but obviously, if originally it constituted a transportation feature, it no longer carries on the same function.

The intestine in the two species differs with respect to relative length and in the arrangement and disposition of the coils. With the exception of slight variations the general plan in *S. sloati* is that represented by Plate 6, Fig. 4. In all specimens of *S. patula*, with a shell length ranging from 32 to 116 mm., the condition of affairs is shown on Plate 6, Fig. 3. Evidently, therefore, these differences are not due to size or age differences, and furthermore the position of several of the transverse muscle bands precludes the

shifting to any considerable degree of the intestinal tract. It may be added that the intestine penetrates the heart.

The gonads of specimens of *S. patula* taken in early June contain fully developed eggs; those collected in late summer evidently had passed the breeding season. In this last named collection the reproductive gland presents essentially the same appearance as in the case of individuals of *S. sloati* dredged in the month of August. It therefore is difficult to determine whether this last named species is represented by adult individuals. No sections were made of the gonad or kidney of either species, and their relations to each other are unknown.

The pericardial cavity is single, no dorsal or ventral septum being present. The general position of the organ is represented on Plate 6, Fig. 9.



POPULATIONS OF THE BUTTERFISH, *PORONOTUS TRIACANTHUS* (PECK), WITH SYSTEMATIC COMMENTS¹

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ABSTRACT

Examination of large series of butterfish from throughout their range revealed three major populations: a deep-bodied form in the Gulf of Mexico; an intermediate form in Western Atlantic waters of 12 fathoms or less south of Cape Hatteras; and a generally shallow-bodied form in Western Atlantic waters north of Hatteras and south of Hatteras beyond 13 fathoms. *Peprilus burti* Fowler is placed in the synonymy of *Poronotus triacanthus* (Peck).

INTRODUCTION

The butterfish, *Poronotus triacanthus* (Peck), a fish of the family Stromateidae, constitutes an important human food and sport resource in parts of its range, particularly in New England

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waters (Bigelow and Schroeder, 1953: 367) and the mid-Atlantic states (Hildebrand and Schroeder, 1928: 215). This species also finds many uses as a commercial scrap fish in various processed forms and as crab bait and fertilizer—in addition to being, through its large numbers, a valuable forage species.

During the course of routine identifications of fishes from the Western Atlantic and Gulf of Mexico at the University of Florida and at the U. S. Bureau of Commercial Fisheries Biological Laboratory at Brunswick, Georgia, it was thought that perhaps more than one species of *Poronotus* was being encountered. Preliminary investigations based on few specimens revealed the presence of a shallow-bodied Atlantic form and a deeper-bodied Gulf form. Fowler (1944:1) described the latter as a species of *Peprilus*, another stromateid genus, though it is clearly a form of *Poronotus* as determined by examination of the types which show a row of pores beneath the dorsal fin and much lower dorsal and anal fins. Fowler (p. 4) figured the pores and these fins properly and called (p. 2) particular attention to the pores. *Peprilus* lacks the pores and has high, falcate vertical fins. The two genera are easily distinguished. The types of *Peprilus burti* are especially deep-bodied, which may account for Fowler's generic placement. Specimens of *Peprilus* are usually deeper-bodied than most individuals of *Poronotus*. Fowler (1933: 61) had earlier identified these same specimens (as shown by labels in the jars with the types and by his own synonymy in describing *Peprilus burti*) as *Poronotus triacanthus*. *Peprilus burti* Fowler is therefore placed in the synonymy of *Poronotus triacanthus*, a wide-ranging species.

In view of the two seemingly geminate species or populations, large series of butterfish were assembled from throughout the range to analyze their variation. A number of meristic, proportional, and pigment characters were examined, but all except body depth were discarded because of extensive overlapping. Although quite variable and subject to overlap in local and regional stocks, body depth, on a mean basis using large numbers of specimens, does suggest the existence of three separate populations which may prove useful in future fishery studies on butterfish.

METHODS

Standard length (recorded to the nearest tenth mm.) was measured with dial calipers, placing one point of the jaws at the base of the mid-caudal rays (distal end of the hypural plate) and the other at the tip of the upper jaw with the specimen's mouth closed. Body depth was measured with one point of the dial calipers hooked over the exposed preanal pterygiophore and the other

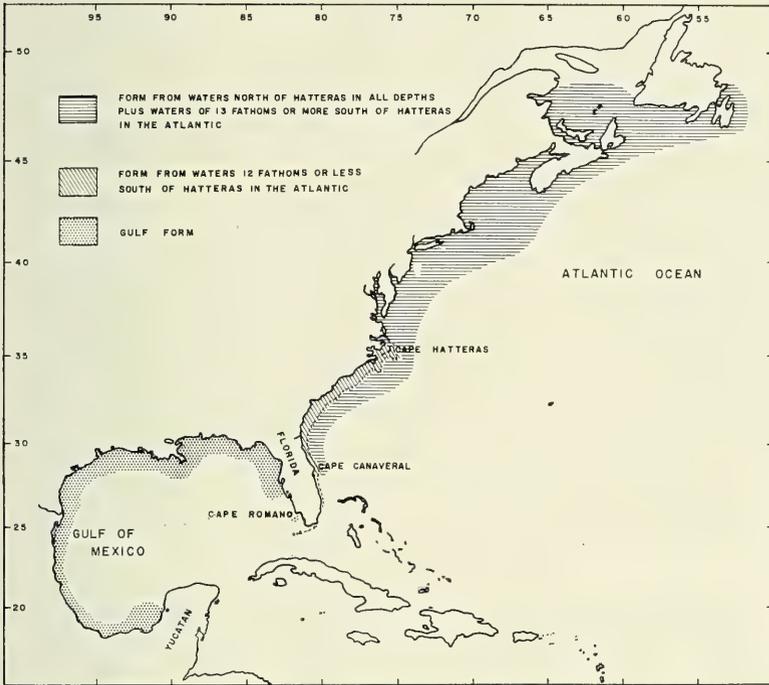


PLATE 7

Geographical distribution of *Poronotus triacanthus* (Peck). Three apparent populations, unnamed, are also shown. Dashed line off the south Atlantic coast denotes approximately the 10-fathom depth curve.

in a vertical from this point at the base of the dorsal fin. Standard length-body depth ratios were calculated to the nearest hundredth and rounded to the nearest tenth.

Water-depth data for a station often included a range through which the collecting gear (usually bottom trawls) was used (for example, "25 to 27 fathoms"). A mean depth value, rounded to the nearest fathom, was determined (in this example, 26 fathoms). Station localities are midpoints between the start and finish of trawling drags.

MATERIAL EXAMINED

Most of the specimens examined were obtained through the exploratory fishing operations in the Gulf of Mexico and in the Atlantic south of Cape Hatteras, North Carolina, by the U. S. Fish and Wildlife Service vessels OREGON, SILVER BAY, COMBAT, GEORGE M. BOWERS, and PELICAN. Additional material was obtained from shrimp trawlers in the Brunswick area and from crab bait brought from Portsmouth, Virginia, to the Lewis Crab Company at Brunswick. Gifts of material came from the University of Delaware through Dr. Donald P. deSilva and from the U. S. Bureau of Commercial Fisheries Biological Laboratory at Woods Hole, Massachusetts, through Robert L. Edwards. Specimens were borrowed from or examined at the following institutions: Academy of Natural Sciences of Philadelphia (types of *Peprilus burti*), through Dr. James E. Bohlke; University of Florida Collections, through Dr. John D. Kilby; Tulane University, through Dr. Royal D. Suttkus; University of Miami Marine Laboratory, through Dr. C. Richard Robins; U. S. National Museum, through Dr. Leonard P. Schultz; California Academy of Sciences, through Dr. W. I. Follett, and University of Georgia, through Dr. Donald C. Scott.

GEOGRAPHICAL RANGE

Based on literature, museum specimens, and station records from exploratory operations conducted by the U. S. Bureau of Commercial Fisheries, *Poronotus triacanthus* ranges (Plate 7) in the northwestern Atlantic from the outer coast of Nova Scotia and Cape Breton, and northward as a stray to the Gulf of St. Lawrence and to the south and east coasts of Newfoundland (Bigelow and Schroeder, 1953: 365), southward to 28°03' N., 79°52' W., in 150-175 fathoms (PELICAN station 25) and 28°03' N., 80°29' W., in 8 fathoms (SILVER BAY station 239) both in the vicinity (to the southward) of Cape Canaveral, Florida. There is an apparent discontinuity around the tip of the Florida peninsula to about Cape Romano (at 25°54' N., 81°45' W., SILVER BAY station 524) in the Gulf of Mexico. The species ranges widely around the perimeter of the Gulf to a recorded extreme of 21°45' N., 91°30' W., SILVER BAY station 341, off the western side of the Yucatan peninsula in Mexico.

Fishes ranging this far into Yucatan waters *may* also occur to the northeastern tip of the peninsula (Caldwell, 1955: 233). However, the butterfish may be somewhat restricted by bottom type. Bigelow and Schroeder (1953: 363) noted that in the northern part of its range the species shows an apparent preference for sandy bottoms, as opposed to rock or mud. A different situation

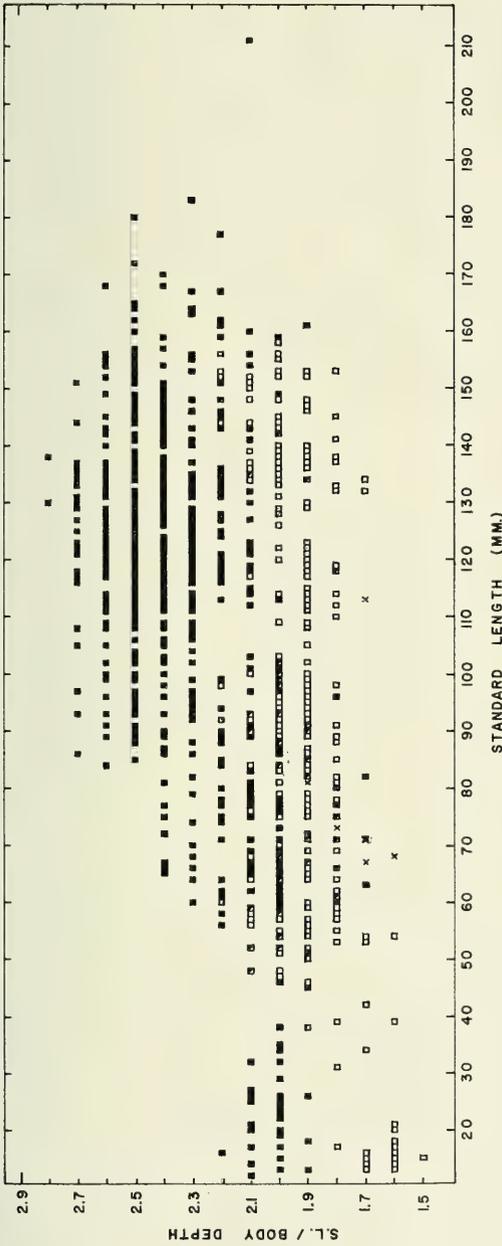


PLATE 8

Relationship between standard length and relative body depth for *Poronotus triacanthus* (Peck). Solid squares denote Atlantic specimens, open squares Gulf of Mexico specimens. Each symbol represents one or more individuals. Crosses denote types of *Peprilus burii* Fowler, a synonym.

seems to exist for the Gulf and for an inshore Atlantic form south of Hatteras. A soft bottom seems to be preferred, as determined from station data and hydrographic charts. This restriction may play a part in the distribution in the Gulf and on the Atlantic side of the lower part of the Florida peninsula. The bottom off the northern part of the Yucatan peninsula is generally hard (Lynch, 1954: 79).

Recent studies by Moore and Gorsline³ show a hard bottom off the Atlantic Florida coast from somewhat south of Cape Canaveral southward. The offshore bottom on the Continental Shelf along the entire South Atlantic coast also is hard, extending inshore to about 10 fathoms, thus associating ecologically the deeper population noted below with the northern stock.

The Cape Romano specimen may be a straggler, or a misidentification (the record is based on an unsupported field report). Despite considerable exploratory work by the Service in the intervening area, there are apparently no other Florida records south of Big Sarasota Bay, Florida (about 27°30' N.), California Academy of Sciences (CAS 17237). The nearest northerly record based on Service explorations (again, with much work in the intervening area) is at OREGON station 2158 (28°04' N., 83°42' W.) off Tarpon Springs, Florida. Thus, except for one possibly erroneous record, the waters of the entire southern half of the Florida peninsula are apparently devoid of butterfish. This break in range, possibly related to bottom type, may act as an effective barrier to gene flow between Gulf and Atlantic populations.

There are no records of *Poronotus* from the Caribbean, the Bahamas, or from Bermuda.

POPULATION ANALYSIS

The ratios of standard length to body depth for all specimens examined, regardless of size and depth of capture, were compared simply by plotting the ratios against standard length for the Gulf forms versus the Atlantic (Plate 8). Although many specimens from the two areas overlap, it is evident that many from the Atlantic are more slender than any of those from the Gulf. Examination of Plate 8 reveals that up to about 80 mm. standard length there is a tendency for relative body depth to decrease with increase in length. As this ontogenetic change tended to complicate the problem of geographic variation, only fish 80 mm. in standard

³Moore, Joseph E., and Donn S. Gorsline. *in press*. Physical and chemical data for bottom sediments South Atlantic coast of the United States M/V THEODORE N. GILL cruises 1-9. Spec. Sci. Report—Fish., U. S. Fish and Wildlife Service.

length or larger were considered further. The geographic relationship discussed for adults holds for smaller specimens, however. The early development of *P. triacanthus* has been summarized by Pearson (1950: 87).

There is also a slight tendency for specimens from deeper water to be shallower-bodied (Plate 9). However, since large series from both deep and shallow water produced individuals encompassing nearly the full range of relative body depths, as well as actual lengths, this factor was disregarded in considering populations.

Butterfish may occur in surface or midwater schools or at or near the bottom. Fathometer traces of butterfish schools were recently illustrated in a report of cruise number 65 of the OREGON. These indicate that a school (in March, at least) may extend through a considerable range of depth, from quite near the bottom up into midwater. Since it was not determined whether most specimens used in this study were taken on the bottom or by the trawl as it was going down or coming up (also noted by Bigelow and Schroeder, 1953: 364), water depths at the stations were used in making comparisons, although the fish themselves may have come from a somewhat shallower depth. There were so many catches in depths of 100 to 200 fathoms that the occurrence of the species at these depths is considered real.

Despite the above clouding phenomena, examination of series of adults provided evidence for the following populations when the factor of depth occurrence in the Atlantic specimens is also considered. (1) All of the Gulf forms. (2) The fish occurring south of Cape Hatteras to a depth of approximately 12 fathoms. (3) The fish south of Cape Hatteras occurring in depths of about 13 fathoms or more, plus those north of Cape Hatteras. These three populations are illustrated in Plate 7.

The exact depth division between the two populations occurring south of Cape Hatteras is difficult to determine because of inadequate samples in the 10- to 20-fathom range, but it apparently lies at about 12 fathoms, and there is undoubtedly some overlap between the two. Bottom type may, in fact, account for this distribution (see Geographical Range, above).

Bigelow and Schroeder (1953: 364 and 366) postulated a winter offshore movement in the north and at least south into Carolina waters. This is at variance with the results of this study, and except for the lack of records of specimens less than 45 mm. standard length from the deeper-water population south of Hatteras, possibly due to mechanical failures in collecting, two other factors seem to bear out the apparent validity of two groups in these more southerly waters: (1) ripe individuals have been taken

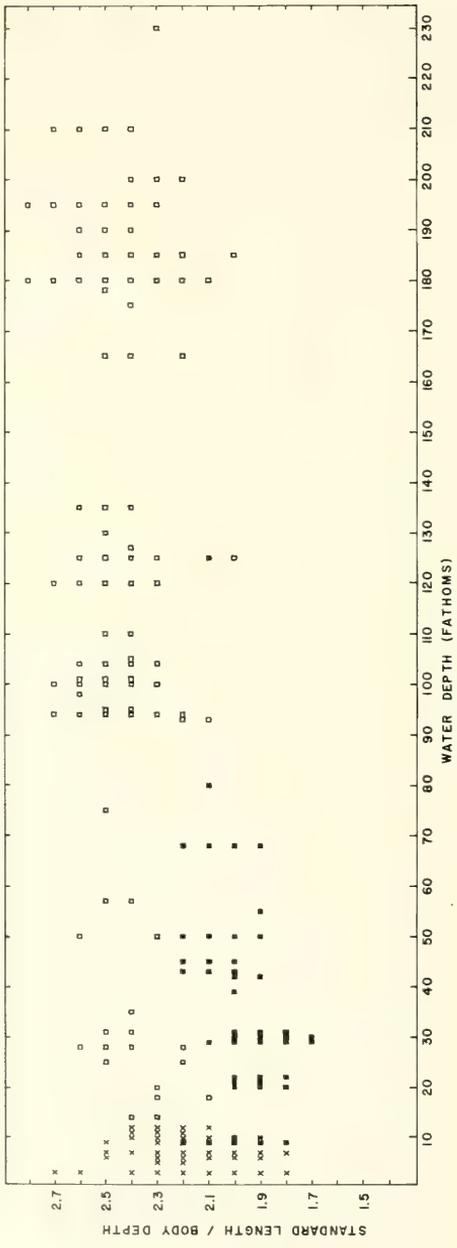


PLATE 9

Relationship between water depth and relative body depth of *Poronotus triacanthus* (Peck), greater than 80 mm. standard length, from the Gulf of Mexico (solid squares), waters 13 fathoms or greater south of Cape Hatteras, plus all depths from north of Hatteras (open squares), and Hatteras from waters 12 fathoms or less south of Hatteras (crosses). Each symbol represents one or more individuals. Note the specimens from the Gulf are not known out to as deep water as those of the Atlantic—despite extensive trawling in the Gulf to depths much greater than 125 fathoms.

from both populations, and there is thus apparently no significant spawning migration; (2) collections during each season of the year and in almost every month have produced specimens larger than 100 mm. standard length from most depths, including particularly the two populations.

The three populations were first visualized from preliminary studies on which Plate 8 is based, and proved clearer when the specimens from the Gulf and the Atlantic were compared in relation to water depth (Plate 9, considering the two Atlantic populations so depicted as one). They proved more valid when they were taken as groups and considered as such with reference to each other. The relationship between the populations of the Gulf and offshore south of Hatteras plus those north of Hatteras is graphically depicted in Plate 9. The actual numbers of specimens involved in each relationship are shown in Table 1. Based on Ginsburg's (1938: 261) arithmetical definition of the taxonomic concept, these two populations show a divergence of 70 percent and would therefore be considered subspecies. In such a case, the name *Poronotus triacanthus burti* (Fowler) would be available for the Gulf form (type locality, Breton Island, Louisiana) and *P. t. triacanthus* (Peck) for the Atlantic form, since Peck's type came from the Piscataqua river in New Hampshire (Peck, 1800: 48). A synonym of *P. triacanthus*, *Stromateus cryptosus* Mitchell (1815: 365), also came from northern waters — New York Bay.

However, when the Atlantic inshore population south of Hatteras is compared with the two above, Plate 9 and Table 1, it completely overlaps both, with the exception of two very slender individuals, and on a mean basis, relative body depth for this population also lies intermediate between those of the others. Series of specimens from about 3 fathoms in the Brunswick shrimp trawling area span this range, and the great variation is considered real rather than being an artifact showing the influence of ecological overlap in the 12-fathom range mentioned earlier in this paper. While on a mean basis this inshore Atlantic population can be distinguished from the other two, the overlap which thus links all three seems to make it useless to try to distinguish the three on a nomenclatorial basis.

Therefore, while the knowledge of the existence of three apparent major populations of butterfish should prove useful in management of the species, for the present it seems that no useful gain would be had in naming them. *Peprilus burti* Fowler, actually *Poronotus burti* (Fowler), is placed in the synonymy of *Poronotus triacanthus* (Peck) until such time that some future studies prove taxonomic distinction valuable. The three populations do seem to be in a process of divergence through geographical and ecological

isolation (in the Atlantic, especially bottom, depth, and/or possibly temperature related to geography and depth), but at present they seem merely to represent a cline, with the extremes arithmetically distinguishable on a mean basis as subspecies. The extreme variation in relative body depth within this species is illustrated in Plate 10.

ACKNOWLEDGMENTS

Aside from the persons noted above as having furnished material, I am especially indebted to Harvey R. Bullis of the U. S. Fish and Wildlife Service at Pascagoula, Mississippi, for specimens from the exploratory vessels under his charge and for the opportunity to examine the station records from those vessels. Frederick H. Berry, now of the Bureau of Commercial Fisheries Biological Laboratory at La Jolla, California, examined the holotype and two of the paratypes of *P. burti* and also made many useful suggestions at the onset of the study. Much assistance and many helpful comments came from members of the staff of the Brunswick Laboratory. Of these, I am particularly indebted to William W. Anderson, Jack W. Gehringer, and my wife Melba C. Caldwell for their critical examination of the manuscript.

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PLATE 10

Specimens of *Poronotus triacanthus* (Peck) showing variation in relative body depth (given below in parentheses). Top to bottom: 130.4 mm. S.L., (2.8), from SILVER BAY station 470, 29°48' N., 80°12' W., 195 fath. off St. Augustine, Florida; 129.7 mm. S.L., (2.4), from about four fathoms near Portsmouth, Virginia; 131.8 mm. S.L., (2.1), from about four fathoms near Portsmouth, Virginia; 131.9 mm. S.L., (1.7), from SILVER BAY station 844, 20°01' N., 91°47' W., 30 fathoms off Campeche, Yucatan. Disregard the differences in color and color patterns.

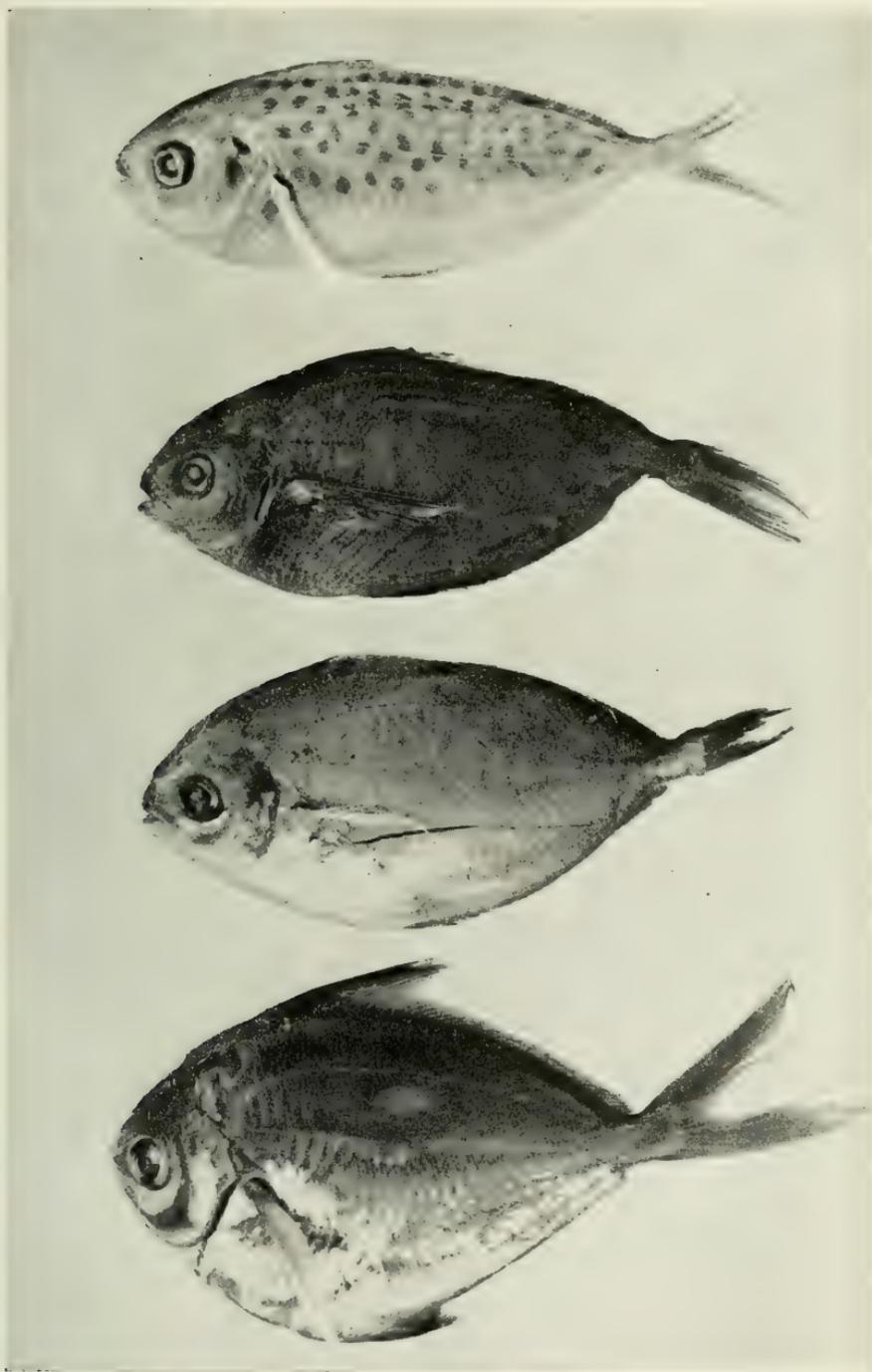


PLATE 10

Fowler, Henry W.

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Table 1. — Frequency distribution of relative body depths in *Poronotus triacanthus* (Peck) 80 mm. standard length or more.

| Population | Mean | 1.7 | 1.8 | 1.9 | 2.0 | 2.1 | 2.2 | 2.3 | 2.4 | 2.5 | 2.6 | 2.7 | 2.8 |
|--|------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 1. Gulf of Mexico in all depths. | 2.0 (1.95) | 3 | 25 | 75 | 78 | 19 | 7 | | | | | | |
| 2. Atlantic south of Cape Hatteras from depths of 12 fathoms or less. | 2.2 (2.19) | 1 | 2 | 9 | 17 | 28 | 28 | 38 | 12 | 3 | 2 | 1 | |
| 3. 3a and 3b combined. | 2.4 (2.44) | | | | 5 | 12 | 29 | 72 | 120 | 147 | 85 | 26 | 2 |
| 3a. Atlantic south of Cape Hatteras from depths of 13 fathoms or more. | 2.5 (2.46) | | | | 3 | 8 | 12 | 46 | 77 | 96 | 62 | 20 | 2 |
| 3b. North of Cape Hatteras in all depths. | 2.4 (2.42) | | | | 2 | 4 | 17 | 26 | 43 | 51 | 23 | 6 | |

A NEW TROGLODERUS FROM THE AEOLIAN
SALINE DUNES OF SOUTHERN CALIFORNIA

(Notes on North American Coleoptera, No. 15)

By CHARLES S. PAPP

The Tenebrionid genus *Trogloderus*, which is one of the most interesting paleo-entomological groups of rare beetles, has been treated by Ira La Rivers (1942). The generic relationship in comparison to some of the closely related genera also were discussed by him (1948). In another paper La Rivers (1946) modified the specific value of all species known at that time, and except for *costatus* LeC., he sank all into subspecific rank. His excellent discussion and evaluation of concrete facts and theoretical ideas concerning the evolution of this remarkable Tenebrionid is a must for those who are engaged in the study of our deserts. Here is an example of an insect, entirely bound to the ground, with some special and as yet unknown processes of complete adaptation to the great environmental changes that have occurred. This genus could be used as a stepping stone to a greater understanding of the evolutionary processes through the ages.

The geological past of this area often has been discussed by several authors (Van Dyke 1932, Spieth 1950, Jaeger 1955, 1957). The old fauna probably appeared during the Oligocene or Early Miocene, when possibly a broader connection between North and South America existed, as a route for the migration of species of the southern fauna. Then, when the climate became cooler and the once flat land began to rise, a great change took place in this territory. The species of warmer origin were exposed to great climatic stress. Those that survived began to change in habits and also in form. Many of them, however, such as the phytophagous forms, could not survive so well, and they gradually disappeared. These environmental changes have been frequently discussed, but first hand information, ("on the spot" observations) of this fascinating problem is needed to understand all those dramatic events which give our deserts their thousand faces. The writings of Jaeger (1957, etc.) and Spieth (1950) are highly recommended to those concerned with North American deserts.

Sporadically there are a few reports (other than those of La Rivers, cited earlier) on *Trogloderus* from the southwestern United States. Most recently Papp and Pierce (1960) reported the collection of fairly large numbers of this rare beetle in stored

chicken feed in the high desert area of Mojave. These were *T. costatus tuberculatus* Blaisd., collected in September 1958. I did not have the good fortune to observe other specimens before or since, until I received a large number of beetles (99% Tenebrionids) from Dr. W. W. Mayhew, Assistant Professor of Zoology, University of California, Riverside, Calif. These beetles had fallen into his traps that were set for desert reptiles in the aeolian saline sand dunes near Dale Dry Lake, San Bernardino County, in the Lower Mojave Desert. This interesting habitat is very seldom visited by collectors. It is a highly arid portion of the Mojave Desert approximately 22 miles east of the desert town of Twentynine Palms. In this material the writer found 6 specimens of *Trogloderus*, collected on October 16th, 1960. Another two specimens were picked up with other trapped Tenebrionids by Mayhew's coworkers (Walter Moberly and Betty Aaron) on December 23rd, 1960 at the same location. No *Trogloderus* were found in all the trapped material Dr. Mayhew obtained from other areas of the desert (Palm Springs and Algodones Dunes). After careful study of these specimens, I found this group to be new to science and will describe it below. There is now one species (*T. costatus* LeC.) and four subspecies (including this new one) known to science, and all are members of the fauna of North America (Papp, 1961-a).

Trogloderus costatus mayhewi Papp, new subspecies (Plate 11).—It is easily recognized by its black color, strongly developed longitudinal ridges on the elytra and by its broad pronotum.—The HEAD is slightly wider than long, very coarsely, irregularly granulate. The transverse impression of the vertex deep at base; on the deepest anterior edge very finely at the shallower posterior edge very coarsely granulate. The central elevation with rough granulation is slightly divided by an irregular short groove. The pre-ocellar edge widely rounded, labial margin slightly curved, heavily granulated. Eyes small, deeply set and partially covered by the end of the transverse groove of vertex.—PRONOTUM as wide (♀) or wider (♂) than the elytra on its widest point. Lateral margin evenly rounded, slightly wider behind middle, more or less evenly annulated; the annules somewhat sharp and each annule with a short but strong black seta (which can not be indicated on the enclosed illustration). Anterior angles sharp, pointed, with a deeply set anterior, and with a more or less even posterior margin, with a short but sharp posterior angles. Sides broad, almost flat, very coarsely granulated; just before the elevated center portion begins with large irregularly shaped impressions with sharp and shiny edges. The elevated portion similarly but somewhat finely granulated, with a shallow transverse impression, which occasionally in deeper in its posterior end.—ELYTRA as wide (♂) or slightly wider (♀) than the pronotum, with four prominent

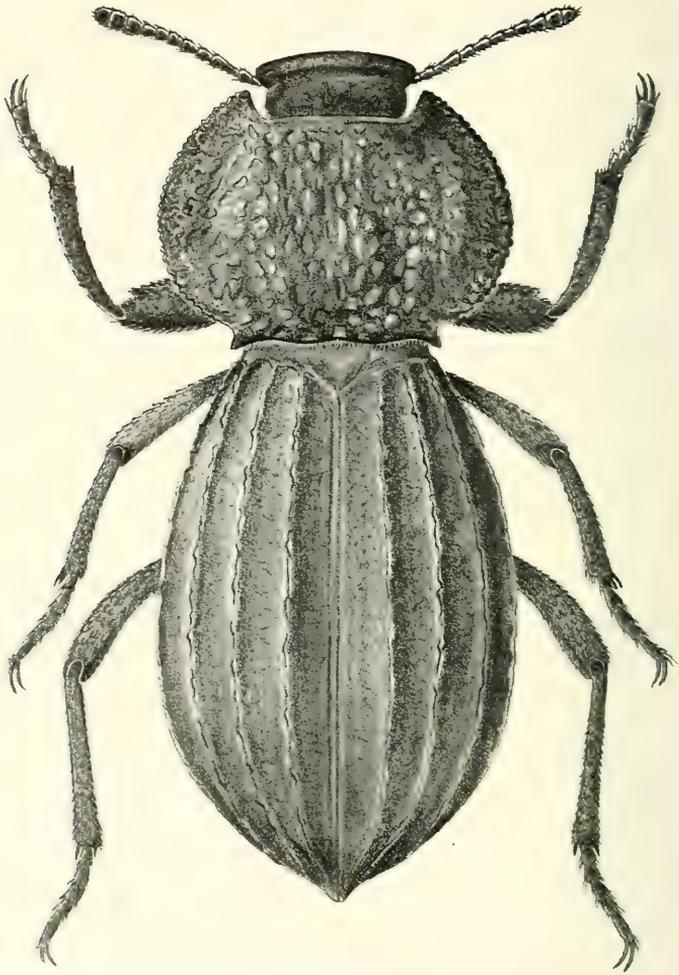


PLATE 11

Trogloderus costatus mayhewi Papp, new subspecies.
(Drawing by the author)

longitudinal ridges, from which the two external costa shallow, the others gradually higher toward the middle of the elytra, the fourth is the highest. All the ridges are continuous, shiny, slightly uneven in their longitudinal line. The caudal ends shallow and are individual endings. The intercostal spaces are sharply concave, more or less opaque, with a very slim remains of shallow punctures, which are hardly visible on some specimens. There are no setae present.—LEGS, especially the anterior pair, roughly granulate, the others smoothly punctulated, all on their ventral side with golden, sharp setae. The profemora with a blunt tooth, the protibiae with a broad tooth dorsally and with two narrower ones ventrally.—ABDOMEN flat, somewhat concave, sides smoother, other parts finely granulated and sporadically covered with short golden yellow setae.—Length: Males 8.0-11.7 mm., Females 9.5-13.5 mm.

LOCALITY: Dale Dry Lake, southern San Bernardino County (the lower Mojave Desert area), California. Six specimens were collected on October 16, 1960, two specimens on December 23, 1960. The area was generally discussed in another paper (Papp, 1961-b) in connection with the description of a new *Saprinus*.—Type (male) deposited in the type collection of the Department of Entomology, Los Angeles County Museum, Los Angeles, Calif.; female specimen deposited at the same place.—Paratypes: One specimen in the collection of the Division of Life Sciences, University of California, Riverside, Calif.; one specimen in the British Museum (Natural History), London, England; one specimen in the Rijksmuseum van Natuurlijke Historie, Leiden, Nederland; one specimen in the collection of the Swedish Academy of Sciences, Rijksmuseum, Stockholm, Sweden.

Specimens of *Trogloderus costatus tuberculatus* Blaisd. also have been sent to the above mentioned institutions, plus the Museum Georg Frey, Tutzing bei München, Germany.

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EXTENSIONS OF RANGE AND A NEW HOST
PLANT OF *PHILOTES SPECIOSA*

(Lepidoptera: Lycaenidae)

By FRED THORNE, El Cajon, Calif.

The capture of a specimen of *Philotes speciosa* (Hy. Edw.) by Mr. William Hedges of Spring Valley on March 8, 1959 at Sweeney Pass, fifteen miles north of Jacumba, San Diego County, is a noteworthy extension of range. This record came to my attention too late in 1959 to permit exploring the area for additional specimens.

On March 11, 1960 Mr. O. E. Sette of Los Altos, California, and the writer spent some time in scouting Sweeney Pass, but were unsuccessful in finding the insect despite ideal weather conditions. However, on March 15, 1960, on our return from a collecting trip to Arizona, we stopped at the bottom of In Ko Pah Gorge east of Jacumba, where Mr. Sette collected two freshly emerged specimens near the thousand foot elevation marker on U. S. Highway 80. This location is approximately thirty miles west of El Centro in western Imperial County. An intensive search of the canyon disclosed no additional specimens.

On March 16, a trip to this spot was made in company with Mr. Hedges, and in two hours, thirteen specimens including eight females were taken, leaving no doubt that this species is established well south of the recorded range in the Mojave Desert.

The larval foodplant in the Mojave Desert was found to be *Oxytheca perfoliata* T. and G. by Comstock and Dammers, but this plant is absent at Sweeney Pass and at In Ko Pah Gorge. The insect seemed to be associated with a small species of annual *Eriogonum* in the gorge and here on April 2, 1960 a female was observed ovipositing on the involucre of the flowers of this plant. Mr. Oscar F. Clark of Riverside, Calif. has kindly identified this plant as *Eriogonum reniforme* Torr. and Frem. A careful search disclosed several more eggs, and at Sweeney Pass ova were found abundantly on this same plant as well as at Mountain Palm Springs a few miles north of there where *speciosa* was flying in large numbers.

On April 9, 1960 the insect was found in abundance in the Kramer Hills near Boron in San Bernardino County where

females were observed ovipositing on the terminal involucre of *Oxytheca perfoliata*. However, two days later at a location south of Rabbit Dry Lake in Lucerne Valley, Mr. John Montgomery of Redwood City, Calif. and the author each took a single specimen of *P. speciosa* where no *Oxytheca* could be found. A search of *E. reniforme* plants in the area disclosed several eggs, hence this plant appears to be a suitable host in the Mojave desert area also.

Comstock and Dammers have recorded the curious larval habit of feeding only on the small fleshy points which arise from the stem around the leaf junctures on *O. perfoliata*. Since these points are lacking on *E. reniforme* the larvae probably feed on the floral parts but there was no opportunity to verify this.

This choice little blue was described by Henry Edwards in 1876 from a single specimen taken by R. H. Stretch at Havilah, Kern County, California. Comstock and Dammers have recorded captures in Upper Mint Canyon, Los Angeles County; from the lower Mojave Desert near Victorville; and the "Box S" Ranch in San Bernardino County, as well as the Randsburg area of eastern Kern County.

Dr. R. H. T. Mattoni of Los Angeles, an authority on the *Philotes*, has kindly verified identification of the specimens reported herein, and has also added a record of a single specimen from Maricopa, Kern County, and captures in the vicinity of Little Rock, Los Angeles County where *Oxytheca trilobata* Gray appears to serve as the foodplant. Mr. Robert Langston of Berkeley has shown me a fresh male specimen captured Apr. 9, 1960 west of Lone Pine in Inyo County on Tuttle Canyon Road in the Alabama Hills.

The discovery of this butterfly in the southwestern edges of the Colorado desert indicates that it should extend into adjacent northern Baja California which offers very similar habitats, and from whence *E. reniforme* has been recorded. It may extend onto the Colorado Desert and perhaps into western Arizona where *Oxytheca perfoliata* grows.

It has undoubtedly escaped the observation of experienced collectors, either because it is difficult to see, flying as it does close to the ground over highly reflective surfaces in the intense desert sunlight, or because it has been mistaken for the ubiquitous *Brephidium exilis* Bdv. Indications are that collectors might expect to discover colonies over a much broader range than is presently known, but that it may require special diligence to locate them.

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BRIEF NOTES ON THE LIFE HISTORIES
OF THREE SOUTHWESTERN MOTHS

By JOHN ADAMS COMSTOCK

GERRA SEVORSA (GROTE)

One of the colorful moths that were taken in quantity near Kohls Ranch, in the Tonto Creek area, Arizona, was *Gerra sevorsa* (Grote). On June 25, 1956 we found six pupae in a piece of dry, pithy wood, each in a separate sealed-in chamber. On the following day we obtained a number of infertile eggs from a female held in captivity. We were unable to find larvae, hence only the egg and pupa are here recorded.

The moth was first described by Grote in *Papilio*, II, p. 132, 1882, as *Fenaria sevorsa* from a single example taken in "Arizona" by Neumoegen. Druce redescribed it as *Diamuna aedessa*, in *Biol. Cent. Amer.* 1, Heterocera, p. 334, 1889, and figured it on Plate 30, figs. 21-22.

Notwithstanding the fact that the species is common throughout its range, from Arizona, through Mexico to Guatemala, nothing has apparently been published on its early stages.

EGG: Diameter 0.8 mm., less than half as tall. The color is bright green. Laid (in captivity) singly, or in small clusters.

The egg is a flattened disc, gently rounded toward the micropyle, but with a wide flattened base.

There are approximately 35 ridges, which start at the base and rise toward the micropyle. As this is approached, many of these ridges terminate, and only a dozen or so reach the micropylar margin.

Each ridge is studded with raised points or nodules.

The micropyle is composed of two rings, one within the other. The ridges terminate at the outer ring.

The surface within the rings is not markedly depressed. See Plate 12.

PUPA: Length 15-19. mm. Width 4.5 mm. Color of the wing-cases, thorax and head, blackish-brown; of the abdominal segments brown; the cremaster black.

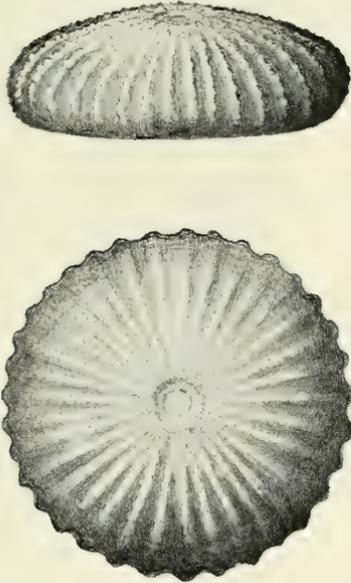


PLATE 12

Egg of *Gerra sevorsa*, lateral and superior surfaces, enlarged $\times 56$.

Reproduced from painting by the author.

The form is fusiform, with the head rounded and the cauda squared.

The entire surface is heavily papillated except for the movable joints of the abdomen. Some of the nodules along the dorsum are extended as short pointed papilliform spines, many of which are recurved.

The antennae extend to the edge of the wing cases, and the maxillae terminate at about three-fifths the distance toward the wing margins. The eyes are not prominent.

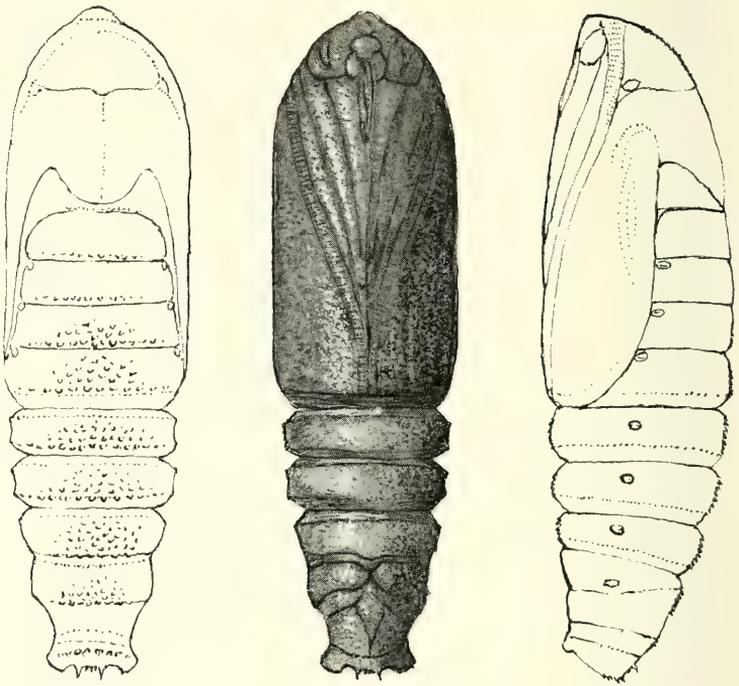


PLATE 13

Pupa of *Gerra sevorsa*, dorsal, ventral and lateral surfaces, enlarged $\times 6$.
Reproduced from painting by the author.

The cremaster, as viewed ventrally, has two blunt knobs, one on each side, pointing caudo-laterally. Between these are a few short sharp spines pointing caudally. There is considerable variation between individuals in the knobs and spines of the cremaster. The spiracles are concolorous with the body.

The pupa is illustrated on Plate 13.

In the Kohl's Ranch area where the specimens were collected, the associated vegetation was dominantly wild grape, Ponderosa pine, sycamore, and wild walnut. We suspect that wild grape is the food plant, but were not able to find larvae on it.

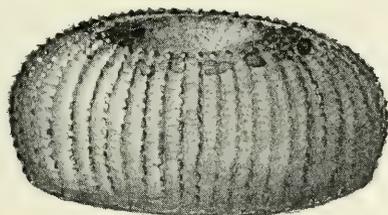


PLATE 14

Egg of *Sarbena extusata*, lateral aspect, enlarged $\times 84$.
Reproduced from painting by the author.

THE EGG AND FIRST LARVAL INSTAR OF *SARBENA EXTUSATA* DYAR

In August of 1956, I received from my valued correspondent, Noel McFarland, a number of eggs of *Sarbena extusata* Dyar. He had obtained these from a gravid female captured at the 7 C Bar Ranch, seven miles west of Williams, Coconino County, Arizona, sometime between August 9 and 15, 1956.

The eggs hatched August 25 and 26. Since the nearest relatives of *S. extusata* had been reported as feeding on oak and willow, an effort was made to obtain fresh young leaves. We were unable to find suitable willow. Oak was available, as was also *Ceanothus*, both of which were offered to the newly hatched larvae, without avail. Consequently, our notes cover only the egg and first larval instar.

EGG: Hemispherical, the base flattened and the micropylar pit large, deeply depressed and granular. Size, .6 mm. wide by .3 mm. tall. Color, light yellow, with a few red-brown flecks placed irregularly around the micropylar margin.

The surface is covered by about 40 clearly defined ridges, extending continuously from base to micropylar margin. Each ridge is studded along its crest with a line of minute nodules.

In the channels between the ridges there are minute lines or grills running horizontally, in line with the nodules.

The eggs hatched August 25 and 26, 1956. Egress of the larva is made through the large micropylar 'cup', the remainder of the shell being intact. Plate 14 illustrates the egg.

FIRST LARVAL INSTAR: Length, 1 mm.

The head and body are uniformly yellow, the tips of the mouth parts only being darker. The head is wider than the body segments.

There are several longitudinal rows of setae running the length of the body. Those on the dorsum are black, the remainder, translucent white.



PLATE 15

Egg of *Fernaldella fimetaria* enlarged \times approximately 50.
Reproduced from painting by the author.

THE EGG AND FIRST LARVAL INSTAR OF *FERNALDELLA FIMETARIA* (GROTE & ROBINSON)

On June 19, 1958 I received a group of eggs of the beautiful little moth, *Fernaldella fimetaria* from Noel McFarland. They were obtained by him two days earlier, from a gravid female collected at Apple Valley, Mojave Desert, California.

The EGG is regularly cylindrical, slightly flattened, with acutely rounded ends. Length, .75 mm, width, .3 mm. by .15 mm. Color, deep green. The surface has a finely granular appearance, due to a covering of minute hexagonal pits, more or less regularly arranged in rows.

The eggs are usually laid in rope-like rows, attached at their small ends, thus resembling soldered chains.

The eggs hatched June 27, 1958, which gives an incubation period of ten days.

FIRST INSTAR LARVA. Length, 1.8 mm. Head width, approximately .3 mm. which is wider than the first thoracic segment.

The head is a bright yellow, with a tinge of orange. Ocelli, black.

The body is cylindrical. The ground color is light yellow. There is a relatively wide middorsal band of bright yellow, bordered laterally by a wide black band. Latero-inferior thereto the body is a lighter yellow. The ventral surface is slaty-black. Numerous small black dots occur on the body, each topped by a single short colorless hair.

The legs, and two pairs of prolegs are yellow.

The food plant of *F. fimetaria* is unknown, and I was unable to find a plant that was acceptable to the young larvae.

The species is widely distributed, from the Rocky Mountains south to Texas, and west to Arizona, Nevada and California.

The moth is illustrated in Packard's Monograph of the Geometrid Moths, U. S. Geol. Survey (Hayden's), Plate 9, figure 45, 1876. On page 228 of that work, Packard says that the larva is unknown. It seems strange that eighty-three years have had to pass since that statement was published, before a single item appears in print concerning the life history of this colorful and relatively common moth.

A NEW EUPITHECIA FROM ARIZONA (LEPIDOPTERA, GEOMETRIDAE.)

CARL W. KIRKWOOD
Summerland, Calif.

EUPITHECIA CAZIERI n. sp.

Male: antennae finely ciliate; front dark brown, vertex gray; palpi smooth, upturned, extending beyond front, gray flecked with brown. Thorax covered with a mixture of brown and gray scales. Abdomen: first segment gray with an admixture of brown scales, segment II dark brown, balance of segments brown with gray scales intermixed.

Forewing: maculation obscure, ground color gray. Cross lines gray-brown, weakly indicated, strongest on costa. Discal streak black, and is the most prominent feature.

Secondaries: gray with brown scaling in the region of the inner margin. Black discal spot present.

Underside: gray-brown with greatest concentration of brown scales along costa. P.m. and s.t. lines faintly indicated on primaries, stronger on secondaries. Discal spots present on all wings.

Female: same as male, except that the front of head appears to be more gray, and palpi roughly scaled.

Expanse: 15-16 mm. Length of forewing 8-9 mm.

Male genitalia: hair pencils of segment IX well developed. Uncas hooded with two well developed spines. Clasper of moderate width, with broadly rounded apex. Aedeagus moderately broad, vesica armed with two long, pointed, chitinous rods, subparallel to the rods a row of fine spiculations, the usual end piece, and an obscure piece of twisted chitin. Ventral plate of segment VIII subtriangular, shortly bifid at apex with two projecting spines strongly chitinized.

Female genitalia: dorsal plate of segment VIII rectangular, caudal margin with a slight median excavation. Ostium membranous, collar lightly chitinized, ductus bursa starting as a ridge high on the left side of collar and forming a trough, directed downwards and toward the right, terminating in the ductus seminalis, the bursa well covered with long spines.

Holotype male: Southwestern Research Station, Chiricahua Mountains, Cochise Co., Arizona. September 3, 1959.

Allotype female: same data as the holotype.

Paratypes: two males, same locality with dates September 4,

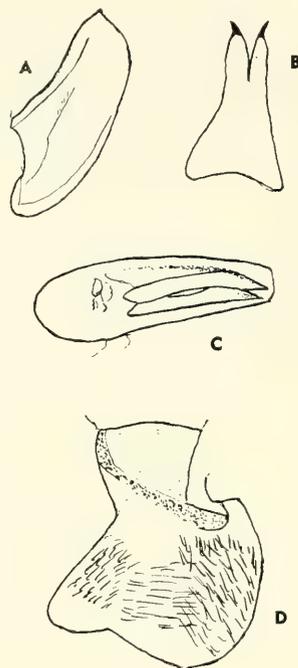


PLATE 16

Genitalia of *Eupithecia cazieri* n. sp.

- A. Right clasper, B. ventral plate, and C. aedeagus of male genitalia.
 D. Female genitalia; ventral view of bursa.

1959 and August 21, 1957. Eight females, same locality, dates from September 1-8, 1959.

Holotype and allotype to be deposited in the Los Angeles County Museum, paratypes in the American Museum of Natural History, and in the collection of the author.

Named for my good friend Dr. Mont A. Cazier, Director of the Southwestern Research Station.

This species can most easily be separated from *misturata*, to which it bears a most remarkable likeness (especially in old or lightly marked specimens) by the brown band of segment II. On fresh specimens the fringe on the inner margin of *cazieri* appears to be much finer, with fewer coarse scales intermixed.

There seems to be no actual relationship to other members of the genus and for the present I am placing it in the *neomexicana-herfordaria* group, because of the general resemblance of the female genitalia.

EARLY COTTON INSECTS OF THE
IMPERIAL VALLEY

E. A. MCGREGOR

U. S. Department of Agriculture, Agricultural Research Administration,
Bureau of Entomology and Plant Quarantine¹

In the early spring of 1916 the writer was assigned to the project of conducting a study of the cotton insects of the Imperial Valley. The observations covered a period of about three years. At the time of the studies this valley only recently had been reclaimed from a complete desert condition. Much interest attached to the problem of determining which insects had been able to invade cotton plantings during the brief period since 1909, when this crop was first planted commercially in this region.

An opportunity to record the insects occurring on a single commercial crop under such fascinating conditions is of rare occurrence, and the writer believes that the list of insects found on cotton in the Imperial Valley in that early period should be placed on record. The list is not presumed to be a complete inventory of all species present in cotton fields at the time, but it includes among many others, those insects that were of economic importance.

During a 2-day visit in the Imperial Valley (August 15-16, 1913), W. Dwight Pierce was able to recognize a total of 17 species of insects in cotton fields.

The taxonomic nomenclature followed herein is that in use at the time of the studies, or shortly thereafter. The identifications were made by taxonomists in the United States National Museum, and in the Bureau of Entomology. All material of interest was retained by the Museum. In instances where the term "not identified" is used, the specialists had placed the insect under the particular family, or the genus. In the case of certain species brief notations are included which bear on their economic importance, or their relative abundance. The list follows.

ARACHNIDA

Araneida

Numerous spiders, not identified.

ACARINA

Trombidiidae

Trombidium sp.*Euthrombidium* sp. (Probably the most important predator attacking the field cricket (*Gryllus assimilis* (Fabr.) in cotton fields.)¹Retired

Tetranychidae

Tetranychus bimaculatus Harv.*Tenuipalpus bioculatus* McG.

ORTHOPTERA

Locustidae

Conozoa behrensi Sauss.*Melanoplus atlantis* (Riley). Lesser migratory locust.*Orphulella compta* Scudd. Green desert grasshopper.*Trimerotropis vinculata* Scudd.

Other grasshoppers (not identified).

Gryllidae

Gryllus assimilis (Fabr.) Field cricket (McGregor, 1929). (A serious cotton pest.)*Miogryllus pictus* (Scud.). A true cricket.*Oecanthus quadripunctatus* Beut. (Both phytophagous and predatory.)*O. nigricornis* var. *argentinus* Sauss.*O. quadrinotatus* Bent.

Mantidae

A mantid (Not identified).

ODONATA

Zygoptera

A damselfly (Not identified).

Anisoptera

A dragonfly (Not identified).

NEUROPTERA

Hemerobiidae

Hemerobius sp. Brown lacewing.

Sympherobiidae

Sympherobius sp.

Chrysopidae

Chrysopa californica Coq. (Often quite instrumental in controlling aphids on cotton.)*C. rufilabris* Burm.

THYSANOPTERA

Thripidae

Microthrips piercei Morgan. (Very abundant, scarring the leaves of young cotton.)*Thrips tabaci* Lind. Onion thrips.*Heliothrips fasciatus* Perg. Bean thrips. (Occasionally destroying considerable portions of cotton plantings.)*Scirtothrips citri* (Moult.). The citrus thrips.*Frankliniella gossypii* (Morgan).*F. tritici* (Fitch).*Anaphothrips tricolor* Moult.

HOMOPTERA

Cicadidae

Cicada sp.

Membracidae

Ceresa occidentalis Funkh. Western treehopper. (Chiefly a pest of alfalfa, but common on cotton.)

C. uniformis Fair.

Stictocephala festina (Say). Three-cornered alfalfa hopper.

Campylenchia sp. Brown treehopper.

Other treehoppers, not identified.

Jassidae

Agallia uhleri Van D.

Helochara communis Fitch.

Draeculacephala mollipes Say. Sharp-headed leafhopper.

D. reticulata Sign. Yellow-headed leafhopper.

Gypona sp.

Empoasca sp.

Graphocephala versuta Say.

Chlorotettix sp.

Acinopterus acuminatus Van D.

Oecleus fulvidorsum Ball.

Oliarus sp.

Psyllidae

Aphalaria sp.

Aphididae

Aphis gossypii Glover. Cotton aphid. (One of ten worst cotton pests. In certain seasons, as in 1918, the infestation became very general and severe.)

Myzus persicae (Sulzer).

Coccidae

Pseudococcus sp. A mealy-bug.

Aleyrodidae

A whitefly, not identified.

HEMIPTERA

Pentatomidae

(Next to *Lygus elisus* Van D. (Miridae), the pentatomids, as a group, caused the greatest damage to cotton bolls. In 70 cotton fields the locks punctured by these bugs averaged 27.6 per cent.)

Brochymena tenebrosa Walker.

Chlorochroa sayi Stal. (Probably the most injurious of the pentatomids.)

Euschistus impictiventris Stal. Brown cotton bug. (One of the most serious pests of the cotton boll.)

Rhytidolomia uhleri Stal. (Punctures many bolls.)

Coreidae

Leptoglossus zonatus (Dallas). (This plant bug was shown by Fawcett (1929) to be a carrier of the disease-causing fungus, *Nematospora coryli* Peg., in the case of cotton bolls, citrus fruits, and pomegranates in the Imperial Valley.)

Corizidae

Corizus hyalinus (Fabr.)
C. lateralis (Say).

Lygaeidae

Geocoris punctipes Say. (An active predator of aphids and spider mites.)
Ischnocoris imperialis (Dist.).

Pyrrhocoridae

Dysdercus albidiventris Stal. A cotton stainer.
Euryopthalmus cinctus (H.-S.).

Tingidae

Corythucha sp.
Gargaphia iridescens Champ.

Phymatidae

Phymata erosa (Linn.). The jagged ambush bug. (Predaceous.)

Reduviidae

Atrachelus cinereus (Fabr.).
Sinea diadema Fabr. The spined soldier bug.
Zelus renardii Kolen.
Z. socius Uhler.

Nabidae

Nabis ferus (Linn.).

Anthocoridae

Triphleps tristicolor White. The dusky *Triphleps*. (Usually very numerous, attacking aphids, bean thrips, and spider mites.)
An anthocorid, not identified.

Miridae

Lygus elisus Van D. Western tarnished bug. (The writer (1927) appraised this to be the insect most injurious to cotton during the period of the investigations. Estimated damage to the 1918 crop was \$1,280,000.)
Lygus pratensis (Linn.). The tarnished plant bug.
Psallus seriatus Reut. Western cotton-flea.
Rhinocloa forticornis Reut. An active enemy of spider mites and aphids, capable of devouring 60 mites per day.)
Reuteroscopus sp. (In cotton blossoms.)
Trigonotylus pulcher Reut.
A small, dark-colored bug resembling *Lygus*, not identified.

COLEOPTERA

Cicindellidae

Tetracha carolina (Linn.).
A cicindellid, not identified.

Carabidae

Calosoma triste Lec. (Attacks various caterpillars.)

A carabid, not identified.

Silphidae

A silphid beetle, not identified.

Staphylinidae

A black and green staphylinid, not identified.

A rufous staphylinid, not identified.

Lampyridae

A lampyrid beetle, not identified.

Malachiidae

Collops marginellus Lec.

C. punctulatus Lec.

Meloidae

Epicauta puncticollis (Mann.).

A meloid beetle, not identified.

Anthicidae

Anthicus vividus Cay.

Notoxus alamedae Cay.

An ant-mimicing anthicid, not identified.

A brown anthicid beetle, not identified.

Elateridae

Drasterius livens Lec. (This wireworm occasionally was of serious economic importance to seedling cotton on new land.)

Stenopodius flavidus Horn. Malva miner.

Buprestidae

Acmaeodera sp.

Coccinellidae

Cycloneda munda (Say).

Hippodamia convergens Guer. Convergent ladybeetle. (This insect's importance in the control of aphids in the Imperial Valley was greatly exaggerated. Critical studies of grain fields in which millions of this ladybeetle were liberated, showed the average census of *H. convergens* to be two per acre, and of aphids, 25,370,000 per acre. Eight syrphids, six small coccinellids, *Triphleps*, *Geocoris*, *Chrysopa* spp., reduviids, and internal parasites were much more effective against aphids.)

Hyperaspis sp.

Megilla maculata De G.

Olla abdominalis (Say).

Paranemia maculata (Deg.)

Scymnus marginicollis Mann. (Tests revealed that 3rd instar larvae of this ladybeetle consumed an average of 23 cotton aphids per day.)

S. apacheanus Casey.

S. ardelio Horn.

S. nubes Casey.

Tenebrionidae

Blapstinus sp. Darkling ground beetle.*Cryptoglossa verrucosa* Lec.

Chrysomelidae

Chaetocnema ectypa Horn. Desert flea-beetle.*Deloyala clavata* Fabr.*Diabrotica duodecimpunctata* var. *tenella* Lec. 12-spotted cucumber beetle.*D. trivittata* (Mann). Western striped cucumber beetle.*Disonycha 5-vittata* (Say).*Epitrix parvula* Fabr. Tobacco flea-beetle.*Myochrous longulus* Lec. (The writer (1917) reported a severe outbreak of this beetle south of Yuma on seedling cotton.)*Systema taeniata* (Say). Pale banded flea-beetle.*S. taeniata* var. *blanda*. Melsh.*Trirhabda* sp.*Metachroma californicum* Cr.

A minute fuscous chrysomelid, not identified.

Bruchidae

Mylabris prosopis (?) Lec.

Curculionidae

Dinocleus molitor Lec.A weevil (near *Anthonomus*).

Anobiidae

Catorama vestitum Fall.

Lagriidae

Statira defecta Schffr.

Mordellidae

Anaspis pusio Lec.*Pentaria nubila* (Lec.).

DIPTERA

Syrphidae

Allograpta fracta O. S.*A. obliqua* (Say).*Catabomba pyrastris* Linn.*Eupeodes volucris* O. S.*Mesograpta geminata* (Say).*Paragus bicolor* (Fabr.).*Syrphus americanus* Wied.*S. nitens* (Zett.).

Culicidae

Species of mosquitoes, not identified.

Asilidae

An asilid, not identified. Robber fly.

Phoridae

Aphiochaeta sp. (Reared from cotton square-borer, *Uranotes melinus* (Hbn.).)

Tachinidae

Frontina frenchii Will. (Reared from salt marsh caterpillar,
Estigmene acraea (Drury)).
A tachinid, not identified.

Sarcophagidae

Sarcophaga opifera Coq. (A parasite of *Melanoplus atlanis* Riley.)
S. helcis Tns.

Oscinidae

Meromyza americana Fitch. (Captured by sweeping in cotton
fields.)
An oscinid, not identified.

Agromyzidae

Agromyza scutellata Fall. The serpentine leaf-miner.
A. sp., near *minima* Mall.
Desmometopa n. sp.
Menoneura vagans Fall.

Ochthiphilidae

Leucopis griseola Fallen. (Reared from syrphid puparium in col-
ony of *Aphis gossypii*.)

Trypetidae

Eutreta diana O. S.

Bombyliidae

Mythicomyia scutellata Coq.

LEPIDOPTERA

Eurymus eurytheme (Bdv.) Alfalfa caterpillar. (Extremely abun-
dant at times.)

Lycaenidae

Uranotes melinus Hbn. The cotton square-borer. (The phorid fly,
Frontina frenchii Will., was reared from this lycaenid.)

Noctuidae

Alabama argillacea ? (Hbn.). The cotton leaf worm. (Material
was not identified as this species, but the writer believes that
it was seen on a few occasions.)

Plusia sp. (This looper was occasionally seen boring into cotton
squares.)

Heliothis obsoleta (Fabr.). The cotton bollworm. (This insect
probably ranked as one of the six worst cotton pests during
the period of the studies.)

Laphygma exigua ? (Hbn.). The beet armyworm.

Prodenia ornithogalli Guen. The cotton cutworm. (Occasionally
destroyed many seedling cotton plants.)

Geometridae

A measuring worm, not identified.

Pyralidae

Loxostege sp. A webworm.

Gelechiidae ?

An inter-carpel miner. (A lepidopterous larva was seen occasionally tunneling along the inner walls of the carpels of cotton bolls. A similar larva was observed in Sonora, Mexico.)

Lyonetiidae

Bucculatrix thurberiella Busck. The cotton leaf-perforator (McGeor 1916). (During the period of the studies this insect ranked about tenth in importance as a cotton pest. Damage by it was limited mainly to plantings suffering from drouth or alkali. Two species of chalcidid flies, and one pteromalid fly were reared from pupae of *Bucculatrix*, the parasitism being at times as high as 80 percent. See below.)

HYMENOPTERA

Braconidae

Lysiphlebus testaceipes (Cress.). (Reared from *Aphis gossypii* Glov.)

Apanteles n. sp.

A braconid, not identified.

Ichneumonidae

An ichneumonid, not identified.

Pteromalidae

Arthrolytus aeneoviridis Gir. (Reared on numerous occasions from *Bucculatrix thurberiella* Busck.)

Trigonogastra aurata Ashm.

Chalcidae

Two chalcidids, not identified. (Reared from pupae of *Bucculatrix thurberiella* Busck.)

Scelionidae

Scelio ? sp. (Reared from eggs of the true cricket, *Gryllus assimilis* (Fabr.).)

Formicidae

Pogonomyrmex californicus (Buck.). The California harvester ant. (Frequently accused in the Imperial Valley of stinging to death new-born pigs.)

A small red ant, not identified.

Chrysididae

A cuckoo wasp, not identified.

Bethylidae

Epyris sp.

Mutillidae

A velvet ant, not identified.

Pompilidae

A spider wasp, not identified.

Vespidae

Polistes sp.

Vespa sp. Yellow-jacket ?

Polybia ? sp.

Apidae

Apis mellifica Linn. The honey bee.

An aphid-bee (Frequenting cotton leaves coated with honeydew of the cotton aphid.)

Halictidae

Halictus sp.

Entedontidae

Closterocerus utahensis Cwft.

Eulophidae

Paragaleopsomyia gallicola Gahan.

Eurytomidae

Eurytoma medicaginis Gahan.

Encyrtidae

Rileyia cecidomyiae Ashm.

Callimomidae

Callimome sp.

Summary: It is here shown that 191 species in 84 insect families were collected in cotton plantings in the Imperial Valley during the period 1916-1918. These fields had been in cotton only from 1 to 7 years, and the entire valley had been opened to agriculture for only a very brief period previously.

The vast majority of the insects reported herein had doubtless occurred originally in the general area on the native plants. The data reveals the remarkable ability of this great variety of insects to transfer, for one reason or another, to a single species of plant, foreign to their experience in the area.

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CORRIGENDUM: Vol. 59, page 180, 12th line from top, under *G. arizonensis*, strike out line reading "less tendency to gregariousness."

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BULLETIN OF THE Southern California Academy of Sciences

LOS ANGELES, CALIFORNIA

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VOL. 60

MAY-AUGUST, 1961

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CLARENDONIAN INSECTIVORA
FROM THE RICARDO FORMATION,
KERN COUNTY, CALIFORNIA

RICHARD H. TEDFORD
University of California at Riverside

ABSTRACT

Two new insectivores of middle Clarendonian age are described from the upper part of the Ricardo formation, Kern County, California. Both species seem closely related to living North American representatives of their respective subfamilies. A soricine shrew, *?Hesperosorex chasséae*, is represented by jaw fragments showing the complete lower dentition. These remains closely resemble the jaws and lower dentition of the living and fossil species of *Notiosorex* suggesting an ancestor-descendant relationship.

Also represented by lower jaw fragments is a scalopine mole, *Scapanus shultzi*, the earliest record of the genus. *Scapanus shultzi* seems most closely related to the hypsobrachyodont living species, *S. orarius* and *S. towsendii*, but could conceivably be ancestral to the hypsodont *S. latimanus* and even *Scalopus* (via the Blancan *Hesperoscalops*) as well.

Dominoides Green, 1956 is shown to be a talpid and not a soricid. It may be more closely allied to *Parascalops* than to the advanced scalopines such as *Scapanus*.

INTRODUCTION

Knowledge of the Clarendonian Insectivora of western North America has been very meager to date, essentially limited to a single locality, Fish Lake Valley, Nevada. The best known Fish Lake Valley insectivorans are two genera of erinaceids, *Metechinus* and *Meterix*. The Soricidae are represented solely by the genus *Mystipterus* known from a jaw fragment with the last lower molar.

Careful prospecting of the Ricardo formation in recent years has brought to light a variety of small mammal remains. All of these new discoveries come from the upper portion of the Ricardo formation associated with an assemblage of larger mammals of approximately mid-Clarendonian age.

Talpid remains have been collected from two localities near the top of member 6 of the Ricardo formation as defined by Dibblee (1952). Associated mammalian remains at this horizon include sciurid, geomyid, *Hypolagus* sp., *Tomarctus robustus* (holotype), *Vulpes* sp., felid, *Pliohippus* sp., *Hipparion* cf. *mohavense*, *Usta-tochoerus* cf. *californicus*, *Merycodus* sp., and *Sphenophalos* sp.

Soricine shrew mandibles representing two individuals were collected from a quarry (Chassé Quarry, L.A.C.M. locality 1553) at the base of member 7 of the Ricardo formation (Dibblee, 1952) at a stratigraphic position very nearly equivalent to the horizon producing the talpid remains. Members 6 and 7 are in part facies of one another hence the approximate equivalence in stratigraphic position. Associated mammals from Chassé Quarry include sciurid, *Perognathus* sp., *Peromyscus* sp., *Aelurodon aphobus*, *Osteoborus* cf. *diabloensis*, mustelid, *Pliohippus* cf. *tantalus*, *Ustatochoerus* cf. *californicus*, camelids, and *Merycodus* sp.

I am indebted to Drs. R. A. Stirton, T. Downs, M. C. McKenna and W. A. Clemens for their criticism of the manuscript in its preliminary form, and to Messrs. Owen J. Poe and Karoly Fogassy for their careful illustration of the material (their individual contributions are acknowledged in the figure legends). Drs. Seth B. Benson (Museum of Vertebrate Zoology, University of California, Berkeley), Charles A. McLaughlin (Los Angeles County Museum), and Rudolfo Ruibal (Division of Life Sciences, University of California at Riverside) loaned Recent insectivore material under their care.

A special debt of gratitude is owed to Mr. Robert L. Shultz, Jr., Miss Beth H. Chassé, and Mr. Sherwood D. Mayall for their enthusiastic assistance in the field. They are primarily responsible for the discovery of the insectivore material reported in this work.

This study was assisted by Intramural Grant 2085 from the University of California at Riverside.

The abbreviation "U.C.M.P." refers to material in the University of California Museum of Paleontology collections; "L.A. C.M." to collections of the Los Angeles County Museum. All measurements are in millimeters.

SYSTEMATIC DESCRIPTIONS

Class MAMMALIA

Order INSECTIVORA

Family Soricidae Gray, 1821

Subfamily Soricinae Murray, 1866

?*Hesperosorex chasséae*¹, n. sp.

HOLOTYPE.—L.A.C.M. 4264 right mandibular fragment with the complete dentition, but lacking the ascending ramus. Teeth in early wear. Plate 14.

1. For Miss Beth H. Chassé whose careful collecting in the Ricardo deposits yielded the type materials of this shrew and many other valuable fossil remains.

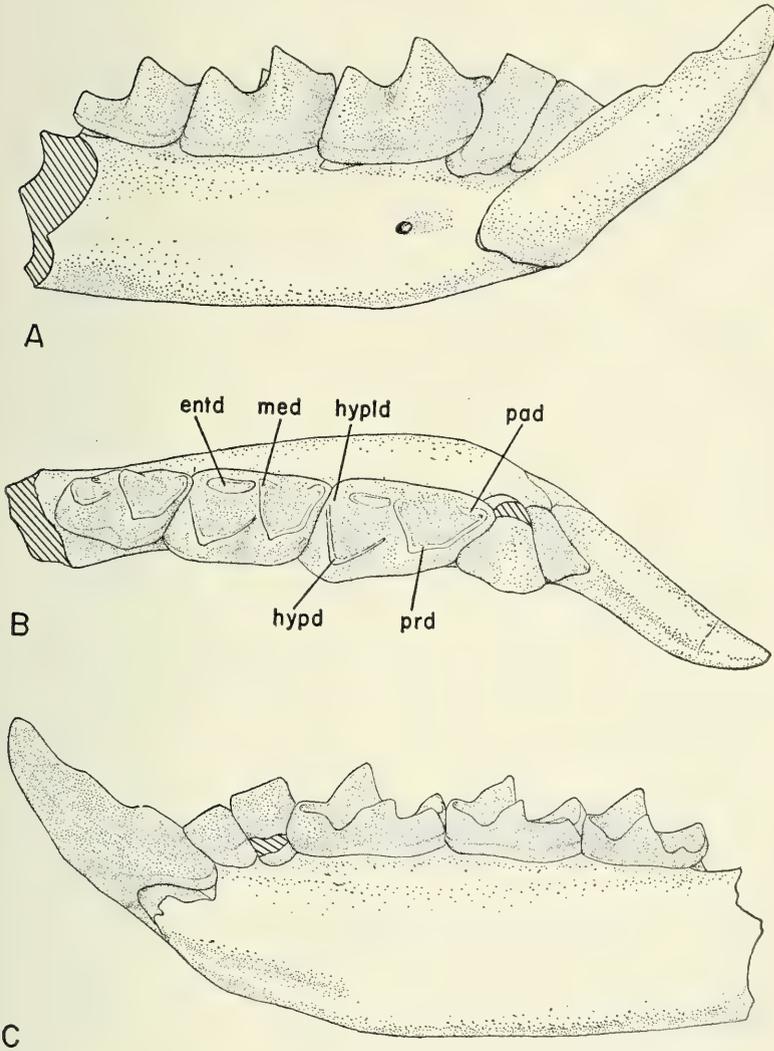
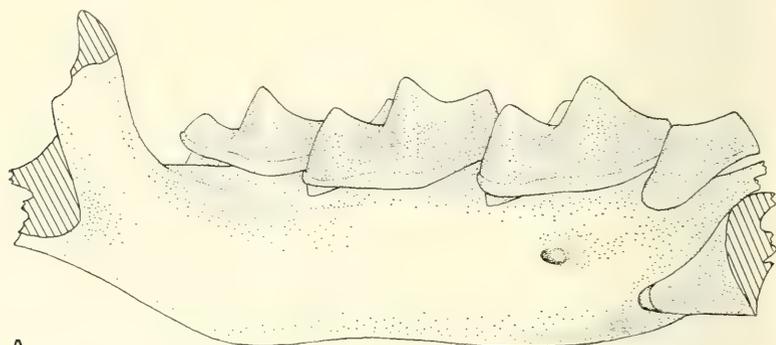
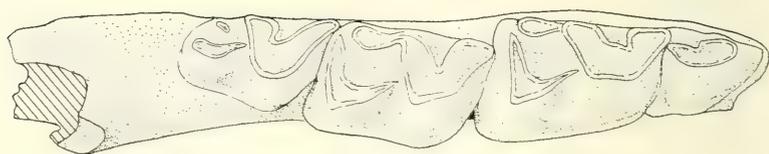


PLATE 14

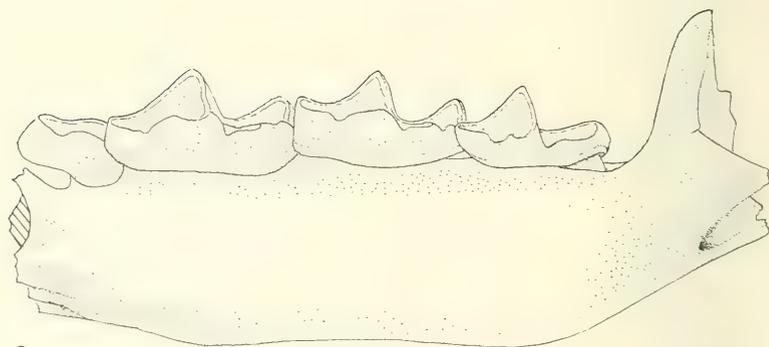
?*Hesperosorex chasséae*, holotype right mandible, L.A.C.M. 4264, approx. $\times 16$. A. labial, B. occlusal, C. lingual views. Abbreviations: entd, entoconid; hypd, hypoconid; hypld, hypoconulid; med, metaconid; pad, paraconid; prd, protoconid. Figure by Karoly Fogassy.



A



B



C

PLATE 15

?*Hesperosorex chasséae*, paratype right mandible, L.A.C.M. 4265, approx. $\times 18$. A Labial, B. occlusal, C. lingual views. Figure by Karoly Fogassy.

PARATYPE.—L.A.C.M. 4265 right mandibular fragment showing the base of the ascending ramus but lacking the P/1 and most of the incisor, P/4 M/1-3 complete showing moderate wear. Plate 15.

TYPE LOCALITY.—The holotype and paratype were collected at Chassé Quarry, L.A.C.M. locality 1553, in buff sandy siltstones with caliche lenses near the base of member 7 of the Ricardo formation (Dibblee, 1952), about 1.2 miles northwest of Ricardo, grid coord. 1,299,850-1,384,250 yds., Saltdale Quadrangle, 1:62,500, Corps Eng., U. S. Army, edition 1943.

AGE.—Middle Clarendonian.

DIAGNOSIS.—Smaller than *Hesperosorex lovei* about the size of *Notiosorex crawfordi*; lower molars with entoconids relatively stronger than in *H. lovei*, entoconid of M/2 as close to posterior base of metaconid as in M/1; lacks well developed anteriolabial cingula on M/1-2.

DESCRIPTION.—Size of jaw teeth about that of *Notiosorex crawfordi*. Traces of yellow pigment are retained on the tips of the incisor and protoconid of M/1. The presence of pigment on the tips of the premolars and protoconids of M/2-3 is suggested by their response when exposed to ultraviolet light.

The lower incisor is long, its unworn dorsal surface possesses two lobes, the posterior lobe relatively larger than the anterior. The angle made by the incisor relative to the axis of the lower jaw in the holotype is distorted due to crushing of the anterior part of the jaw in that specimen. The undistorted base of the incisor in the paratype indicates that the orientation of the long axis of this tooth was similar to that of *Notiosorex*.

The FIRST PREMOLAR¹ is present only in the holotype, somewhat crushed between the distorted incisor and fourth premolar. It overlaps the dorsal base of the incisor with a strong anterior projection of the crown. Its labial cingulum is very low.

The FOURTH PREMOLAR is somewhat distorted in the holotype, but is well preserved, although more heavily worn, in the paratype. It is larger than the P/1 with a strong anterior projection of the crown and a crest emanating from the major cusp and passing posteriorly to the posterolingual corner of the tooth. This crest is concave lingually forming a shallow basin in the posterolingual portion of the crown. This basin is quickly eliminated through wear, but at the state of wear of the paratype it is still visible as a reentrant in the posterolingual border of the crown. There is a low labial and lingual cingulum on P/4.

1. The dental formula follows that proposed by Arnbach-Christie-Linde (1912).

The FIRST MOLAR is the largest tooth in the molar series. It is lower crowned than in the Pleistocene or Recent species of *Notiosorex*. The trigonid is only slightly narrower than the talonid, its metaconid and paraconid are more widely separated than in the other molars giving the trigonid a more open appearance. The paraconid and metaconid both have ridges extending into the lingually open trigonid valley. The entoconid is well developed and strongly attached to the posterior base of the metaconid closing the talonid valley lingually. A notch separates the posterior end of the entoconid from the hypoconulid. The hypoconulid is located at the end of the lingually projecting crest from the hypoconid which makes up the posterior rim of the talonid. A crest from the hypoconid passes anteriolingually to the posterior base of the protoconid. The labial and lingual cingula are well differentiated but low. There is no prominent development of the anterolabial cingulum.

The SECOND MOLAR is much like the first in general morphology. It is somewhat smaller and its trigonid and talonid are of approximately equal width. The paraconid and metaconid are set closer together giving the trigonid a more compressed appearance. The configuration of the crown is otherwise much as in M/1. The labial cingulum is somewhat better developed, particularly anteriorly.

The THIRD MOLAR is the smallest molar. The configuration of its trigonid is like that in M/2. Its talonid is reduced, the hypoconid and a crest leading to the posterior base of the protoconid make up the bulk of the heel. A tiny entoconid is present close to the metaconid and just above the lingual cingulum. The labial cingulum is somewhat better developed than in M/2 although it is no more expanded anteriorly than in the latter tooth.

The jaw is fairly deep for the size of the tooth row, a single mental foramen occurs beneath the M/1. The anterior margin of the mental foramen is slightly depressed. Only a portion of the ascending ramus is preserved in the paratype. This specimen shows that the mandibular foramen lies in a groove at the base of the ascending ramus below the posterointernal ramal fossa.

COMPARISONS.—Of the described Tertiary genera of Soricinae only the Hemphillian *Hesperosorex* Hibbard, 1957, is close enough to the Ricardo fossil to warrant detailed comparison. Unfortunately, complete comparison between the genotype *H. lovei* and ?*H. chasséae* cannot be made due to the lack of the anterior dentition and M/3 in the former and the lack of much of the ascending ramus in the latter.

Hibbard defined the genus *Hesperosorex* on the large size of the entoconid and its relative proximity to the metaconid on M/1-2. These features are also characteristic of the presently described species. The Ricardo fossil is slightly smaller than *H. lovei* (see Table 1) and differs in lacking well developed anteriolabial cingula

TABLE I

Measurements of the Molar Dentition and Jaw of Hesperosorex

| | | <u>?Hesperosorex</u> | | |
|-----|--------------------------------|----------------------|-----------------|-----------------|
| | | <u>chasséae</u> | | <u>H. lovei</u> |
| | | <u>Holotype</u> | <u>Paratype</u> | |
| M/1 | Length | 1.47 | 1.40 | 1.58 |
| | Width trigonid | 0.75 | 0.82 | 0.95 |
| | Width talonid | 0.85 | 0.84 | 1.03 |
| M/2 | Length | 1.29 | 1.35 | 1.40 |
| | Width trigonid | 0.76 | 0.83 | 0.90 |
| | Width talonid | 0.78 | 0.82 | 0.93 |
| M/3 | Length | 1.05 | 1.11 | - |
| | Width trigonid | 0.67 | 0.72 | - |
| | Width talonid | 0.53 | 0.57 | - |
| | Depth jaw below M/1 externally | - | 1.31 | 1.50 |

1.) Measurements courtesy of D.W. Taylor, U.S. National Museum

on M/1-2. The entoconids appear stronger than in *H. lovei* and the entoconid on M/2 is as close to the base of the metaconid as its homologue on M/1. Hibbard did not describe the condition of the mandibular foramen in *H. lovei*. I am questionably referring the Ricardo jaws to *Hesperosorex* on the basis of their close correspondence with the genotype in such features as can be compared. Further discussion of the generic assignment of *?H. chasséae* is presented below.

?Hesperosorex chasséae was compared with the following living North American genera: *Blarina*, *Cryptotis*, *Microsorex*, *Notiosorex*, and *Sorex*.

Sorex and *Microsorex* are at once eliminated from further comparison by their more massive premolars, more open molar trigonids, and retention of a strongly bicuspidate talonid on M/3. What is known of the Clarendonian soricine *Mystipterus* allies it with shrews possessing little reduced M/3 talonids such as the foregoing living genera. It cannot be further compared with *?H. chasséae*.

Blarina brevicauda is larger than ?*H. chasséae*, but about the same size as *H. lovei*. The tip of its lower incisor is more strongly procumbent than in ?*H. chasséae*. Its lower molars make a more strongly graduated series with the M/1 much larger relative to M/3 than in ?*H. chasséae*. In the lower molars of *Blarina* the trigonids are more open lingually, the entoconid is separated by a deep groove from the metaconid in M/1-2. The talonid of M/3 is crescentic and lacks the entoconid.

Cryptotis parvus is smaller than ?*Hesperosorex chasséae* and differs from the Ricardo shrew in the same way as does *Blarina*. The M/3 is more reduced relative to M/1 than in ?*H. chasséae*, its talonid is reduced to a single cusp (the hypoconid). The trigonids of M/1-2 are more open lingually than in ?*H. chasséae*, and the talonids of these molars open lingually through a deep notch between the metaconid and entoconid.

The Ricardo shrew makes a closer approach to species of the genus *Notiosorex* than to any other living genus of Soricinae. The three specimens of *N. crawfordi* available to me for comparison come from widely separated localities (L.A.C.M. 5051, ♀, from Ventura County, California, L.A.C.M. 6065, ♀, from Hidalgo County, Texas, and L.A.C.M. 8429, ♂, from Cabo San Lucas, Baja, California). These specimens show considerable intraspecific variation in dental characters with some individuals making a remarkably close approach to the conditions in ?*Hesperosorex chasséae*. The specimen from Texas is noteworthy in this regard.

The unworn incisor is more massive, particularly at the tip in *Notiosorex* and does not bear the conspicuous two lobed dorsal surface as in ?*H. chasséae*. The premolars are larger relative to the molars in *Notiosorex*. The molars of ?*H. chasséae* are definitely lower crowned than in any of the specimens of *N. crawfordi*, and their anteriolabial cingula less well developed. The M/3 is not as reduced relative to the anterior molars in ?*H. chasséae*, its trenchant talonid still retains a tiny entoconid. The latter cusp was not observed in the M/3 of *Notiosorex*, but a lingual shelf is present where the entoconid should be. The Texas representative of *N. crawfordi* shows the greatest development of this shelf and also the least reduction of the M/3 relative to the anterior molars. In morphology of the molar trigonids the two genera are closely similar. The talonids of M/1-2 differ only in the strength of the entoconid. In the California and Baja California representatives of *N. crawfordi* the entoconid on M/1-2 is small and distinctly separated by a deep notch from the metaconid. In these specimens a somewhat shallower notch may (California) or may not (Baja California) separate the entoconid from the hypoconulid. The entoconid is a much larger cusp in the individual from Texas closely approaching the condition held typical of *Hesperosorex*. In the

Texas example the entoconid is separated from the hypoconulid by a shallow notch and is connected to the metaconid by a strong ridge thus closing the talonid valley.

Hibbard (1950, 1953) does not discuss the morphology of the entoconid in the M/1-2 of *N. jacksoni*, but from his figures (especially 1953, fig. 5A) that cusp appears to be well developed and connected to the metaconid much as in the Texas specimen of *N. crawfordi* described above.

?*Hesperosorex chasséae* lacks the postalveolar process of *Notiosorex*, and has a prominent groove leading anteriorly into the mandibular foramen which is lacking in *Notiosorex*.

A comparison of ?*H. chasséae* with the Oligocene soricine *Domnina gradata* as described and illustrated by Patterson and McGrew (1937) is instructive. The two forms differ greatly in the number of premolar teeth. *D. gradata* has the full eutherian premolar formula whereas in ?*H. chasséae* this is reduced to two premolars as in living soricines. The lower incisor of ?*H. chasséae* is much enlarged over the condition in *D. gradata*.

In the lower molars, however, we see a closer resemblance between the two species. Although *D. gradata* is larger there is little difference in relative crown height of the molars. The lower molars of *Domnina gradata* have decidedly better developed labial cingula than in ?*H. chasséae*. The molar trigonids are rather similar except that the protoconid is sharply angulate labially in *D. gradata*. The hypoconids of M/1-2 are also more sharply angulate labially in *D. gradata*, but otherwise the talonids of these teeth closely resemble those of ?*H. chasséae*, including the presence of a large entoconid strongly connected to the metaconid and enclosing the talonid basin lingually. The entoconid on M/3 in *D. gradata* is either absent or reduced to a low ridge. It is present as a tiny, but distinct, cusp in ?*H. chasséae*.

Domnina is a primitive soricine and some of its species may be structurally ancestral to such later Tertiary genera as *Hesperosorex*. Whether they are in fact ancestral depends on much more evidence than presently available. The above comparison serves to demonstrate the possibility of such a phylogeny and shows that the morphological plan of the molars of *Hesperosorex* is present in the Oligocene.

DISCUSSION.—From the foregoing comparisons it seems clear that ?*Hesperosorex chasséae* is closely related if not actually ancestral to *Notiosorex*. Some of the morphological changes in the lower jaw and dentition leading from ?*H. chasséae* to *Notiosorex* would involve an increase in height of crown of the post-incisor teeth, development of more massive lower incisors, reduction of

the size of M/3 relative to M/1, loss of the entoconid on M/3 and reduction in the size of this cusp in M/1-2, enlargement of the anterior cingula on the molars, enlargement of the post-alveolar process and probable change in the ascending ramus.

A mandibular condyle like that in *Hesperosorex lovei* could easily be transformed into that characteristic of *Notiosorex* by enlargement of the superior articulation. The other described and figured features of the ascending ramus in the Hemphillian species do not differ radically from *Notiosorex*.

The validity of the genus *Hesperosorex* cannot rest exclusively on the large size of the entoconids and their proximity to the metaconids on M/1 and M/2 as originally diagnosed. The characters are definitely possessed by some individuals of *Notiosorex crawfordi*. They appear to be primitive characters in the Soricinae as evidenced by the development of these cusps in *Domnina*. The diagnosis of *Hesperosorex* should also include the condylar characters of *H. lovei*.

It could be argued that ?*H. chasséae* might be better referred to *Notiosorex* itself. However, the above comparisons of ?*H. chasséae* with *Notiosorex* demonstrates greater morphological separation than exists among the presently recognized species of *Notiosorex* (*N. crawfordi* and *N. jacksoni* excluding *N. gigas* made the type of a new genus, *Megasorex* Hibbard, 1950). For this reason the Ricardo shrew has been referred to its nearest Tertiary ally, *Hesperosorex*, despite the fact that satisfactory comparison of ?*H. chasséae* and *H. lovei* is not possible at the present time. The questionable generic assignment serves to emphasize the uncertainties involved.

Family Talpidae Gray, 1825
Subfamily Scalopininae Thomas, 1912
Scapanus shultzi¹, n.sp.

HOLOTYPE. — U.C.M.P. No. 46646; right mandibular fragment with P/4 and M/1-3 complete, root of P/2, and alveoli for C, P/1 and P/3. Ascending ramus broken away behind anterior edge of the masseteric fossa. Teeth present show moderate wear. Plate 16.

TYPE LOCALITY. — U.C.M.P. locality V5376, fine grained gray sandstones and sandy siltstones, uppermost part of member 6 of the Ricardo formation (Dibblee, 1952), north end of the badland cliffs about 1/3 mile west of Ricardo, Kern County, California,

¹For Mr. Robert L. Shultz, Jr., in appreciation of his comradeship and invaluable assistance in the field over the course of several years.

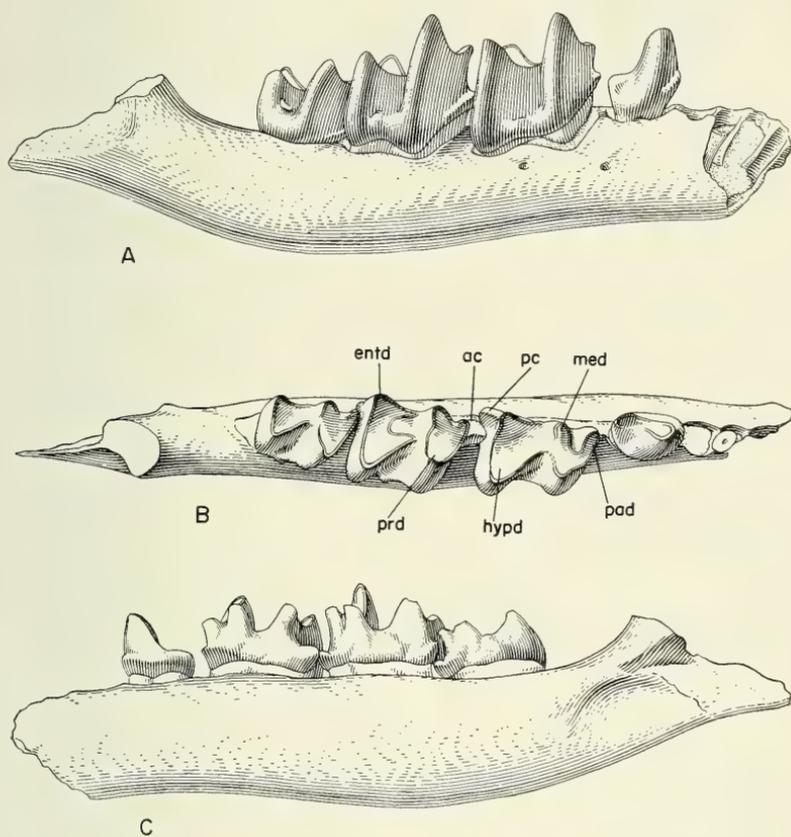
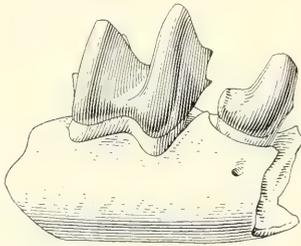


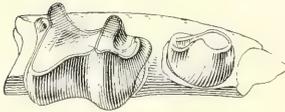
PLATE 16

Scapanus shultzi, holotype right mandible, U.C.M.P. 46646, approx. $\times 7.5$. A. labial, B. occlusal, C. lingual views. Abbreviations: ac, antero-lingual cingular cusp; entd, entoconid; hypd, hypoconid; med, metaconid; pad, paraconid; pc, posterolingual cingular cusp; prd, protoconid. Figure by Owen J. Poe.

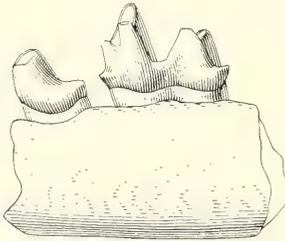
at approximately grid coordinates 1,298,500-1,382,300 yds., Salt-
dale Quadrangle, 1:62,500, Corps Eng., U. S. Army, edition 1943.



A



B



C

A fragment of a right humerus, U.C.M.P. 35320, broken proximally above the teres tubercle and distally lacking the wings of the lateral epicondyle and medial epicondyle, was collected in 1937 by a University of California party from buff tuffaceous sandstones in the uppermost part of member 6 of the Ricardo formation (Dibblee, 1952), at approximately the same stratigraphic position as the holotype of *Scapanus shultzi*. The locality, U.C.M.P. V3732, site 2, is approximately 500 yards east of the old segment of Highway 6, opposite the junction with the Dove Springs road, grid cord. 1,296,000-1,393,900 yds., Salt-dale Quadrangle, 1:62,500, Corps Eng. U. S. Army, edition 1943.

PLATE 17

Scapanus shultzi, referred right mandibular fragment, U.C.M.P. 29281, approx. $\times 7.5$. A. labial, B. occlusal, C. lingual views. Figure by Owen J. Poe.

AGE. — middle Clarendonian.

REFERRED SPECIMENS. — A fragment of a right ramus containing P/4 and M/1, U.C.M.P. 29281 (Plate 17), was obtained from the Ricardo formation by a University of California party in 1913. This specimen comes from an unknown horizon apparently within the upper part of the Ricardo formation. The state of wear of the dentition approximates that of the holotype.

DIAGNOSIS. — Fourth premolar double-rooted with well developed posterior cingular shelf. Molars with cuspidate labial cingula between protoconid and hypoconid, antero- and posterolingual cingular cusps better developed than in other species of the genus.

DESCRIPTION. — Size of the holotype mandible and dentition about that of *Scapanus orarius*. Four alveoli or parts of alveoli lie anterior to the last premolar. The symphyseal articulation lies opposite the anteriormost alveolus and identifies this alveolus as

that of the canine by analogy with living talpids. Post-canine dental formula: P/1.2.3.4., M/1.2.3. The canine and anterior premolar alveoli are slanted anteriorly, the premolar alveoli gradually becoming vertical posteriorly. Alveoli indicate that the canine and P/1 to P/3 are single-rooted, and have the following size relationship: $P/4 > P/3 \geq P/1 > P/2 > C$. *P/4*: Double-rooted (confirmed by X-ray examination) with a high conical crown, its principal cusp slightly lower than the protoconid of M/1 at this state of wear. It bears a small anterolingual cingular cusp and a well developed posterolingual cingular cusp. *M/1*: This tooth is only slightly smaller than M/2. The anterolingual cingular cusp is present, but it is smaller than its homologue on M/2. The posterolingual cingular cusp is well developed and larger than on M/2. The trigonid is more open than on the succeeding molars and of relatively lesser width. Ridges from the entoconid and hypoconid to the metaconid have coalesced to form a broad union with the posterior base of the metaconid at this state of wear. The labial cingulum between the protoconid and the hypoconid lacks the median cuspule present on M/2 or M/3. *M/2*: The largest molar; its anterolingual cingular cusp is shelf-like, and approximately twice the size as the same cusp on M/1. This cusp is overlapped anteriorly by the posterolingual cingular cusp of M/1. The posterolingual cingular cusp is approximately half the size of, and narrower than, its counterpart on M/1. The trigonid is approximately as wide transversely as the talonid, but is more strongly compressed antero-posteriorly than in M/1. Ridges from the entoconid and hypoconid extend to the base of the metaconid as in the M/1, and at this state of wear these ridges enclose the talonid basin. The labial cingulum possesses a well developed cuspule situated somewhat nearer the hypoconid than the protoconid. *M/3*: Approximately three-quarters the size of M/2. The anterolingual cingular cusp is larger than same cusp on M/1, but smaller than that on M/2, it is overlapped anteriorly by posterolingual cingular cusp of M/2. No posterolingual cingular cusp is present. The trigonid is wider transversely than the talonid, and not so compressed antero-posteriorly as in M/2. The labial cingulum has a well developed cuspule attached to anterolabial base of the hypoconid. Two mental foramina are present in the holotype. The anterior foramen is the largest, situated between P/4 and M/1, and the posterior foramen the smaller, situated near the alveolar border below the middle of M/1. The mandible is shallow with a pronounced convexity of the inferior border below M/3. For measurements see Table II.

The referred jaw fragment represents an individual having a slightly larger horizontal ramus than the holotype. *P/4*: X-ray examination shows that the roots of this tooth are fused for 2/3

of their total length below the base of the crown. The crown is high and conical, its main cusp slightly lower than the protoconid of M/1 at this state of wear. The anterolingual cingular cusp is relatively smaller than in the holotype, but its posterolingual cingular cusp is as well developed as in the holotype. M/1: Slightly larger than the same tooth in the holotype with the anterolingual cingular cusp as well developed as in the latter. Its paraconid is relatively smaller than in the holotype, giving the trigonid a more compressed appearance. Ridges from the entoconid and hypoconid to the posterior base of the metaconid have nearly coalesced to form a broad union with metaconid in this state of wear. The labial cingulum is represented by only two tiny cusps on the bases of the protoconid and hypoconid. The mental foramen lies below P/4; there is no foramen below M/1.

It is impossible to determine the stratigraphic position of the referred jaw fragment relative to that of the holotype. Larger size, partial fusion of the roots of the P/4, and the reduced antero- and posterolingual cingular cusps on the M/1 suggest closer approach to the living species of *Scapanus*.

TABLE II

Measurements of the Dentition and Jaw of *Scapanus shultzi*

| | | Holotype | Referred Specimen |
|-------|--------------------------|----------------|-------------------|
| | | U.C.M.P. 46646 | U.C.M.P. 29281 |
| P/4 | Length | 1.24 | 1.31 |
| | Width | 0.82 | 0.90 |
| M/1 | Length | 2.08 | 2.36 |
| | Width trigonid | 1.20 | 1.55 |
| | Width talonid | 1.47 | 1.83 |
| M/2 | Length | 2.25 | - |
| | Width trigonid | 1.54 | - |
| | Width talonid | 1.58 | - |
| M/3 | Length | 1.69 | - |
| | Width trigonid | 1.13 | - |
| | Width talonid | 0.92 | - |
| Depth | jaw below M/1 externally | 1.6 | 2.0 |

The humerus fragment is smaller than specimens of *Scapanus latimanus* available for comparison, although it displays a marked similarity in the parts preserved. It differs chiefly in being relatively narrower across the shaft; in having a broader notch between the medial epicondyle and the teres tubercle, a feature correlated with a less expanded teres tubercle; and in possessing a relatively larger and more ventral opening of the entepicondylar foramen.

The Ricardo fossil greatly resembles the slightly larger humerus described by Gregory (1942) from the Big Spring Canyon local fauna. *?Talpa platybrachys* Douglass from the Barstovian Flint Creek local fauna represents a larger animal whose humerus possesses a relatively longer and narrower shaft. *?Scapanus* sp. described by Merriam (1911) from the Hemphillian Thousand Creek local fauna makes a much closer approach in size and morphology to the humerus of living species of *Scapanus* than does the humerus referred to *S. shultzi*. The only difference is that the teres tubercle is somewhat smaller in the Hemphillian form.

COMPARISONS. — The following materials were available for comparison in the University of California Museum of Vertebrate Zoology: *Scapanus latimanus* (Bachman), *S. orarius* (True), and *S. townsendii* (Bachman).

The living species of the genus *Scapanus* may conveniently be separated into two groups based on the height of crown of their molar teeth. The molars in the genotype, *S. townsendii*, and *S. orarius*, are hypsobrachyodont whereas *S. latimanus* possesses hypsodont teeth (high crowned teeth whose crown bases lies below the alveolar border in early wear, essentially the "cusp hypsodonty" of White (1959)). *Scapanus shultzi* is hypsobrachyodont and shares many characters with the species of that group, yet it also shows definite affinity with the hypsodont *S. latimanus*.

The P/4 of *S. shultzi* is distinguished from all the species of *Scapanus* by its double-rooted condition and large posterior cingular shelf.

Scapanus shultzi is smaller than *S. townsendii*. The lingual and labial cingular cusps on the molars are better developed in the fossil species. The molars are relatively longer for their width in *S. townsendii* due to the greater separation of trigonid and talonid cusps, yet the trigonid cusps are compressed, making a closely knit triangle as in *S. shultzi*. The M/1 has a low anterolingual cingular cusp in *S. townsendii*.

Scapanus orarius is similar in size to *S. shultzi*. The labial and lingual cingular cusps are somewhat better developed in *S. shultzi*, but *S. orarius* presents a closer approach to the condition of the fossil than any other living species. The possible range of variation

in the development of these cusps in *S. shultzi* may overlap the condition in *S. orarius*. The molar trigonids in *S. orarius* are not as compressed as in *S. shultzi* or the other species. The M/1 has a low anterolingual cingular cusp in *S. orarius*.

Scapanus latimanus is only slightly larger than *S. shultzi*. The labial cingula on the molars are much reduced in *S. latimanus* approaching the condition in *Scalopus* and the anterolingual cingular cusp on M/1 is lacking. The lingual cingular cusps approach the degree of development seen in *S. shultzi*. The paraconid on M/1 in *S. latimanus* is reduced over the condition seen in *S. shultzi* and the trigonid is more open lingually. The trigonids of M/2-3 are compressed as in the fossil species. In early wear, a small cuspule (metastylid) between the entoconid and metaconid blocks the lingual opening of the talonid valleys in all the molars of *S. latimanus*. It is possible that the talonids of *S. shultzi* also possess a tiny metastylid in early wear, but at the state of wear of the available specimens this cannot be definitely determined. A suggestion of a metastylid is present in the M/3 of the holotype of *S. shultzi*.

DISCUSSION.—The Clarendonian *Scapanus shultzi* constitutes a reasonable common ancestor for the hypsobrachyodont living species as far as its lower jaw and teeth are concerned. The lower jaw of *Scapanus townsendii* can be derived from it by overall size increase, accompanied by lengthening of the molars, complete fusion of P/4 roots, and slight suppression of the lingual and labial cingular cusps.

Scapanus orarius can be derived from *S. shultzi* with even fewer modifications. Complete fusion of the roots of P/4, and a slight opening of the trigonids would be the morphological changes involved.

The lower jaw of the hypsodont *Scapanus latimanus* requires more modifications in its hypothetical derivation from *S. shultzi*. These changes involve reduction in size of P/4 and complete fusion of its roots, increase in height of crown and suppression of the labial cingula on the molars, and elimination of the anterolingual cingular cusps and reduction of the paraconid on M/1. Perhaps differentiation of the line leading to *S. latimanus* had taken place prior to Clarendonian time. In any case *S. shultzi* may not be far from a common ancestry with *S. latimanus*.

Continuation of the same trends leading to *S. latimanus* could also yield *Scalopus* through an intermediate form such as *Hesperoscalops* Hibbard, 1941. Some additional modifications would be necessary such as an increase in size and hypsodonty and the loss of premolars and possibly incisors. Considering the variability in numbers of antemolar teeth in some scalopines, loss of the

anterior dentition may not be too drastic a modification to have taken place during the span of Pliocene and Pleistocene time. Loss of premolars is a common feature of variation within populations of *Scapanus latimanus* in Southern California and Baja California (Palmer, 1937). Loss of a premolar above or below occurs in *S. l. occultus* from Los Angeles County, California, whereas reduction to three premolars above and below seems to be complete in *S. l. anthonyi* from Northern Baja California. Further reduction to two premolars above and three below is occasionally found in *S. l. anthonyi*.

In 1956 Green described a lower jaw of an insectivore, *Domninooides riparensis*, from the late Clarendonian Wolf Creek local fauna of South Dakota. Green placed this form in the Soricidae pointing out its similarity to *Domnina*, an Oligocene soricine. On the basis of Green's description and figure, and closely allied material from the late Barstovian Niobrara River local fauna in the U.C.M.P. collection, I believe *Domninooides* is clearly a talpid. The reasons for this reassignment are outlined in the following comparison:

1. Dental formula. — Said to be I/1, C/0, P/1-4, M/1-3 in *Domninooides* by Green, which would agree with *Domnina* and not with the Talpidae. Green's figures, however, suggest additional alveoli at the front of the jaw. For the present I feel that the evidence for the ante-premolar dental formula is open to question and should not be relied on in assessing the affinities of this form.

2. The nature of "I/1", Green's figure shows an alveolus, apparently identified as "I/1", which indicates a tooth whose root is distinctly smaller relative to jaw size than in the enlarged incisor of *Domnina*. To link the two genera would involve reduction in size of "I/1".¹

3. PREMOLARS. — *Domninooides* agrees with *Domnina* and *Scapanus* in the possession of four premolars. It differs from *Domnina* in that the lower premolars make a relatively graded series, and the P/2-4 are double-rooted. The second and third lower premolars are not reduced relative to P/1 and P/4 as in *Domnina*. *Scapanus* has a relatively well graded series from P/1 to P/4, the premolars are not double-rooted, although P/4 is double-rooted in *Scapanus shultzi*. The P/4 in *Domninooides* does not extend forward over the alveolus of P/3 as in *Domnina*, but is upright as in the moles; its form closely approached by *Scapanus shultzi*.

¹The single enlarged lower incisor in all known soricids, except the problematical Eocene genus *Saturninia* (three incisors, the middle one enlarged), is usually identified as the I/3 or I/4 following Arnbach-Christie-Linde (1912).

4. MOLARS. — Like the moles, the molars of *Domninooides* do not decrease in size posteriorly in a regular fashion as in the shrews; M/2, not M/1, is the largest tooth. The talonids and trigonids of the lower molars are compressed anteroposteriorly as in the moles, and not open as in the shrews. The manner of connection of the ridge from hypoconid to metaconid is similar to that of *Scapanus* except that in the latter the low ridge noted between the entoconid and metaconid in *Domninooides* is enlarged so that the talonid basin is encircled. In most shrews the talonid valleys are widely open lingually, the hypoconid connecting the posterolingual base of the protoconid.

Domninooides agrees that *Scapanus* in the characters listed above as common to the Talpidae. It differs from *Scapanus* in larger size; presence of birooted P/1-3; molars with well developed anterior (except on M/1) and labial cingula; M/1-2 with small metastylid with ridge from hypocone connecting this stylid; talonid valleys of M/2-3 open lingually, closed on M/1; anterior mental foramen beneath P/3; and relatively deeper jaw, without marked upward flexure of the ascending portion of the ramus. The presence of a fairly well developed metastylid and the morphology of the talonid recalls *Parascalops* and *Scapanulus*.

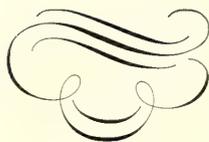
The presence of a form generically identical to *Domninooides* in the Niobrara River local fauna is indicated by several lower jaws and isolated teeth associated in the same quarry (Fort Niobrara, U.C.M.P. locality V3218) with a number of limb elements, including humeri, of unmistakable talpid morphology. Evidence of direct association in individual specimens is lacking, but the expected frequency of jaw fragments matches closely that of skeletal elements. No other talpids have been identified among the dental materials from the Fort Niobrara quarry, thus indicating the association of dental and limb material on circumstantial grounds. The description of this material has been undertaken by another worker, but for the time being it suffices to indicate that *Domninooides* seems to represent a distinct line of talpids which can be traced at least from Barstovian to the late Clarendonian time (Green, 1956, p. 153, mentions a possible Arikareean member of this group with reduced anterior cingula on the lower molars). The relationship of *Scapanus* to this group is not clear at present. *Domninooides* seems more closely related to *Parascalops*, in which lingually opening talonid valleys, metastylids and anterior cingula are present on M/2-3.

At present it is impossible with the evidence available to determine the relationships of *Scapanus shultzi* with *Proscalops* Matthew, 1901, *Talpa incerta* Matthew, 1924, or the talpid tooth mentioned by Galbreath from the Martin Canyon local fauna (1953), as none of these forms has been figured or described adequately enough to allow comparison.

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WATER TRANSPARENCY OF THE SOUTHERN CALIFORNIA SHELF¹

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INTRODUCTION

For nearly a century the Secchi disc has been used by limnologists and marine scientists to obtain a rough estimate of transparency. Since the time this simple instrument was described by Ciladi and Secchi (1865), attempts have been made to relate extinction coefficients of visible light, the amount of detrital debris, organism content, and other parameters to Secchi disc measurements. Most of the investigations in recent years have demonstrated that deviations of various magnitudes exist between calculations resulting from disc measurements and other methods of transparency determination (Le Grand 1939, Clark 1941, and Gall 1949). To eliminate the deviations, equipment using light-sensitive selenium cells have been devised, with and without light sources, for both qualitative and quantitative evaluations (Holmes 1957). These advances in instrumentation have lead some to believe that no measurement is valid unless made with a complex device of some kind, even though the electronic characteristics of the photometer or transparency meter may compel one to use it more experimentally than as a matter of routine in oceanographic surveys.

A compilation of several hundred measurements taken over the southern California shelf has pointedly shown the value of the Secchi disc in delineating seasonal and annual variations in transparency and in determining causative agents in relation to other parameters of the water. The significance of such compilations has been shown by Emery (1954) from data obtained over the continental borderland of southern California, and by Stevenson, Tibby, and Gorsline (1956) from information gathered in Santa Monica Bay, California.

More than 800 measurements of water transparency using the Secchi disc have been made in the southern California shelf area since 1953. These were taken by many different individuals, representing a wide range of acquaintanceship with the disc and during as great a variation of light and sea conditions as can be imagined. All measurements were made as a matter of routine with no forethought of future correlation. Considering these factors and the

¹Allan Hancock Foundation Contribution 242.

²Now at Shell Oil Co., Sacramento, California.

fully recognized inaccuracies involved in utilizing Secchi disc depths, the results that have been obtained are considered truly remarkable.

ACKNOWLEDGMENTS

The writers wish to express their appreciation to the Hyperion Engineers, Inc., Los Angeles, to the California State Water Pollution Control Board for the support of oceanographic surveys from which many of the data were obtained, to Dr. Donn S. Gorsline, FSU, for critically reading the manuscript, and to Captain Allan Hancock and the crew of the R/V VELERO IV for their aid while at sea.

FACTORS EFFECTING TRANSPARENCY

NATURAL EFFECTS

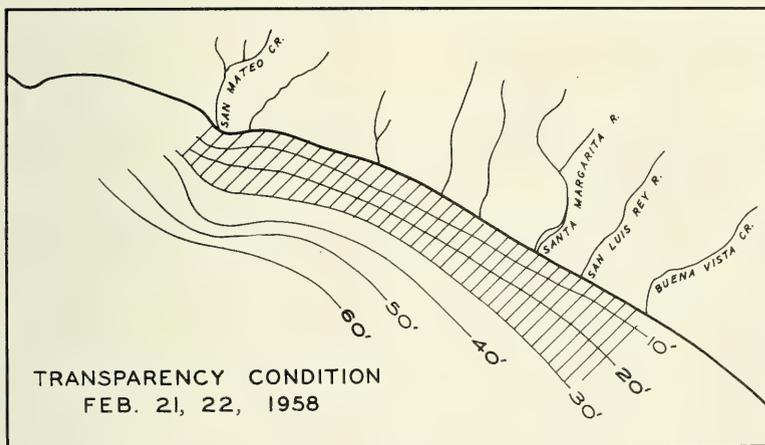
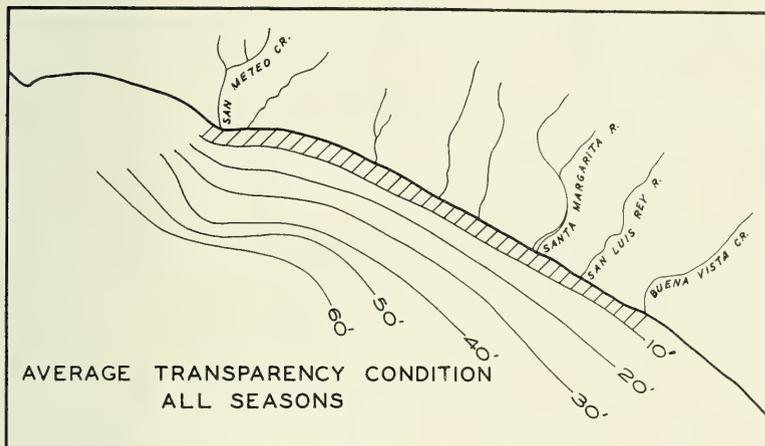
The coast of southern California is in an active stage of erosion and deposition so that detrital material is continually in suspension in the nearshore waters. Approximately 170 miles of the 250 mile coast from Mexico to Point Conception are cliffed. The exposed rocks are mainly poorly indurated shales, silt-stones, and sandstones of Tertiary age, and unconsolidated sands and gravels formed during the Pleistocene Epoch. Isolated headlands and short distances of cliffed shores are composed of various kinds of volcanic and metamorphic rocks. Approximately half of the cliffed coast undergoes erosion from the sea during storms. The remainder is exposed to erosion only during winter and spring rains.

The remaining 80 miles of coastline are bordered by coastal plains, the widest being in the Los Angeles area extending about 25 miles inland, and small triangular deposits at the narrow mouths of intermittent streams that cut through the terraced cliffs adjacent to the shore. The coastal plains are constructional surfaces of alluvial debris deposited by streams. Normally the rivers flow only after rains, but in the past, before man's intervention, some undoubtedly flowed to some extent all year. Wide sand beaches, large and small sandspits, and coastal dunes make up the shores of the plains. The mainland shelf is widest in these areas, eight to fifteen miles in comparison to the one to three miles along the cliffed coast.

The turbidity of the water is greater (transparency less) in waters offshore from the coastal plains than along the cliffed shores. This is a normal condition arising from the more abundant detritus contributed by the rivers, tidal flows from lagoons and estuaries, and by the action of the waves over the shelf in keeping material in suspension for longer periods of time.

Transparencies measured in centimeters rather than in feet, common along the northwest coast of Florida (D. S. Gorsline, and

A



B

PLATE 18

Fig. A. The average transparency of the water over a portion of the southern California mainland shelf near the city of Oceanside, which lies between the Santa Margarita and San Luis Rey rivers.

Fig. B. Transparency of the water over a portion of the southern California mainland shelf near Oceanside on February 21 and 22, 1958 two days following an intense storm in southern California.

P. Hoagland personal communication), are experienced rarely and then under only the most unusual of conditions in a confined area.

The relative effect of river-borne detritus on nearshore transparency can be shown from measurements made near Oceanside, California, on February 21 and 22, 1958, two days following a major storm. There are 12 hydrographic stations in this area, each of which had been occupied 3 or 4 times prior to the February period. The average transparency in all seasons under no-storm conditions is shown in Plate 18, fig. A. The area of readings less than 30 feet has been cross-hatched and indicates a normal condition of a band about one mile wide adjacent to the shore. As the streams flow intermittently there is no detectable effect of their flow on the transparency. Also, from 1956 through 1957 when these measurements were taken, rainfall was so minor that little debris reached the sea from the streams.

In Plate 18, fig. B, the transparency pattern for February 21 and 22 is shown, and again the area where the disc readings of less

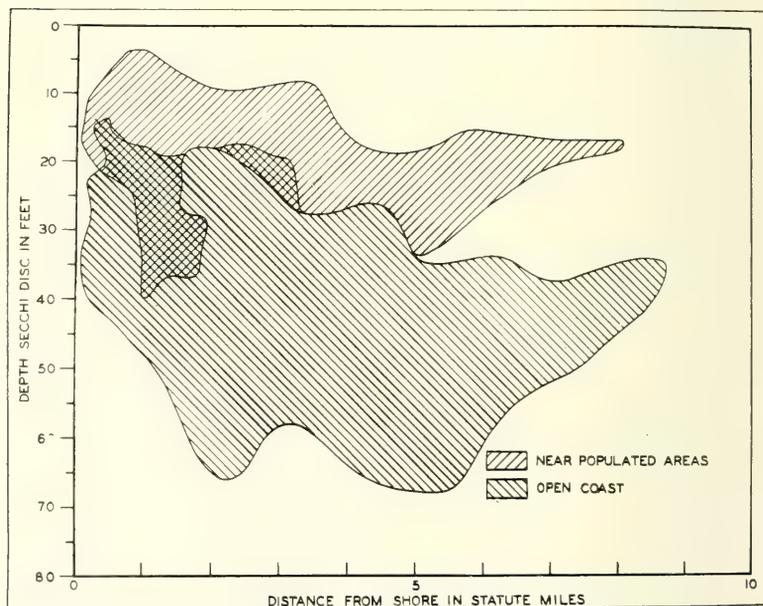


PLATE 19

Depth of Secchi disc readings near populated coasts and along open coasts versus distance from shore. The two distinct areas on the graph show the range of disc readings encountered under all conditions. The upper area shows that transparency near populated shores is normally less than along open coasts regardless of distance from shore.

than 30 feet were obtained is cross-hatched. The band of low transparency has widened to 3 or 4 times its normal width with bulges opposite the major streams San Mateo Creek, Santa Margarita River, and San Luis Rey River. The 50, 60 and 70 foot transparency contours are shifted seaward opposite San Mateo Creek, but are about the same distance from shore along the rest of the coast. The 80 foot depth contour is nearly the same in each instance. Thus, it can be seen that the increased turbidity is impinged upon the normal water with a sharp front bounding the two waters of differing transparency. Likely the edge of the low transparency water became diffused in later days, but it is probable that before much of the detritus spread through more of the shelf water, it settled to the bottom as in the smaller scale phenomenon around sewage outfalls (Stevenson, Tibby and Gorsline, 1956). Dispersal, diffusion and settling obviously depend to a considerable extent upon wind, sea, and swell conditions during the post-storm period.

ARTIFICIAL EFFECTS

The urbanization of man has had an effect on the transparency of coastal waters that is naturally more obvious where the population is greatest (Plate 19). The decrease in transparency is most conspicuous in the Los Angeles region where nearly four million inhabitants are crowded onto the coastal plain.

There are several contributing factors from man's constructive activities, but in only one is the magnitude of the effect known. This is the turbidity resulting from the discharge of sewage effluent into the ocean at Playa del Rey, Whites Point and Newport Beach. During 1955-56 the University of Southern California conducted an intensive oceanographic survey in Santa Monica Bay to determine the desirability of lengthening the submarine outfall pipe and increasing the volume of sewage flow. In the course of the survey many hydrographic stations were occupied in the vicinity of the three outfalls. One of the parameters measured at these stations was water transparency. Measurements were made with both Secchi disc and a transparency meter. From these data it was determined that, except under unusual oceanographic conditions, the effect of sewage discharge on transparency was not measurable beyond a distance of two nautical miles at the City of Los Angeles' Hyperion outfall (Stevenson, Tibby, and Gorsline 1956). Here more than 250 million gallons of effluent are discharged each day. Lower volumes have a decreasing effect, and at the Newport Beach outfall of the County of Orange (25 MGD) the contributed turbidity was not measurable more than a few hundred feet from the discharge site.

The effect of other man-made factors is difficult to evaluate, mainly due to the lack of data. The main artificial contributors to

nearshore turbidity are, however, drainage from flood control channels and storm drains, erosion of beaches around groins, jetties, and breakwaters, and the tidal flow of turbid water from harbors. Each is of varying local importance, but all three contribute significantly in the waters off the Los Angeles area.

HYDROPHOTOMETER AND SECCHI DISC MEASUREMENTS

In the winter of 1957-58 at 54 hydrographic stations in various localities on the southern California shelf, Secchi disc readings and light measurements from a hydrophotometer were taken simultaneously. The hydrophotometer used was similar to that described by Holmes (1957) with a deck cell, a submerged cell, and an indicating unit reading in micro-amperes. Others have made similar measurements (Le Grand 1839 and Clarke 1941, for example), but in southern California the stations were in coastal waters and represented a greater variety of water conditions than those encountered in the previous investigations. The percentage of light at the surface remaining at the Secchi disc depth was computed without assuming a 15% light loss at the surface as did Poole and Atkins (1929). Thus, the values are lower than they reported but are valid for the purpose of comparison.

As noted in Plate 20, the percentage of light at the compared depths varied from 3.2% to 22%, but most of the values are so grouped that a best-fit line can be drawn. The interesting feature of the results is that at the shallower depths at which the disc disappeared from sight there was two times or more the percentage of light remaining than at the greater depths. Were this variation irregular in nature one might suspect the readings of either or both instruments, but even though both are prone to some inaccuracies the plot is too regular to dismiss for this reason. The data presented by Poole and Atkins (1929) and Clarke (1941) indicate similar conditions at their stations. Of particular interest is Clarke's station #542 taken off Trinidad where a series of readings gave results reasonably similar to those reported here.

This condition appears to be due to the effect of scattering by particles, with the more turbid the water the greater this effect. As noted by Clarke (1941) and Sauberer (1939) where scattering is greater the light from a Secchi disc would be more diffuse and therefore less easily seen from the surface. Since scattering by particles is relatively high whereas absorption is low in the ocean, and scattering does not greatly effect vertical extinction, the conditions as noted in Plate 20 appear reasonable. From this it is perfectly obvious that the Secchi disc is far from a reliable

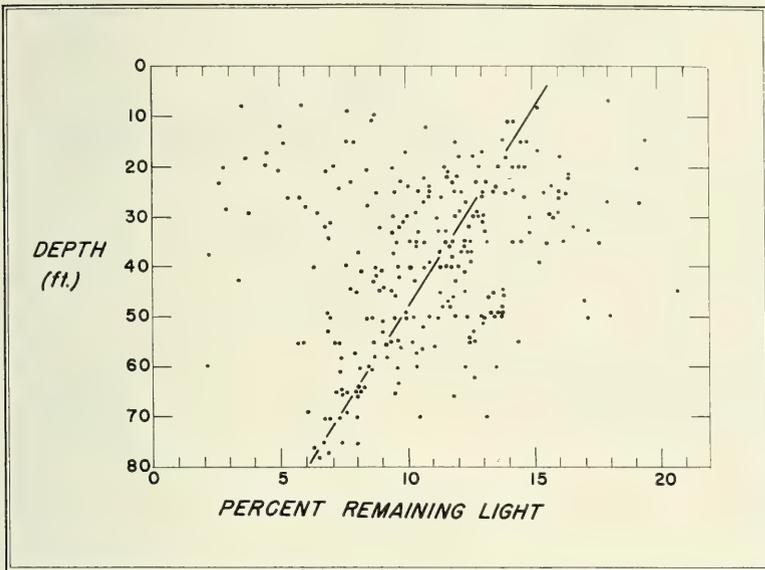


PLATE 20

The per cent of light remaining as determined from a hydrophotometer at the disappearance depth of the Secchi disc.

instrument to determine the amount of light present at a given depth. On the other hand it is equally obvious that the photometer used at these stations is not a reliable means of determining the depth to which a person can see into the water. To the engineer, fisherman, and beach visitor the depth at which an object can be seen is more important than extinction coefficients and the like. Conversely, the amount of light present at a given depth is of importance to biologists, ecologists, and others. Thus, one must judge the value of the instrument by the characteristic of the water that is desired rather than by the relative complexity or accuracy.

THE WATER TRANSPARENCY AVERAGE CONDITIONS

Upon a natural background of turbidity from wave erosion and river drainage has been constructed a series of communities with growth rates unparalleled in the United States. These cities and towns extend more or less continuously from Santa Barbara to San Diego, a distance of more than 200 miles. The effects of this tre-

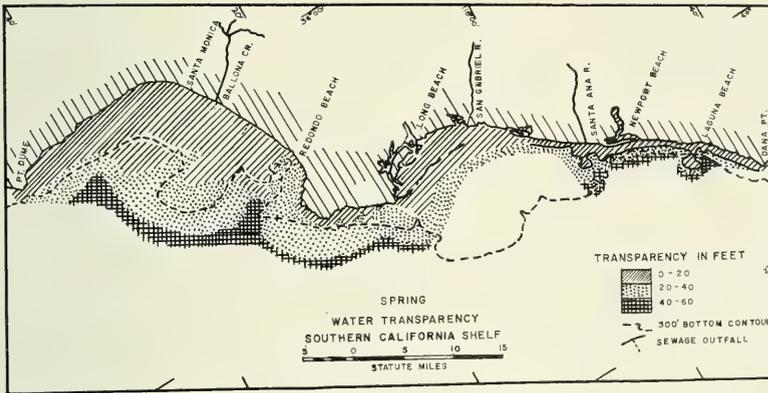
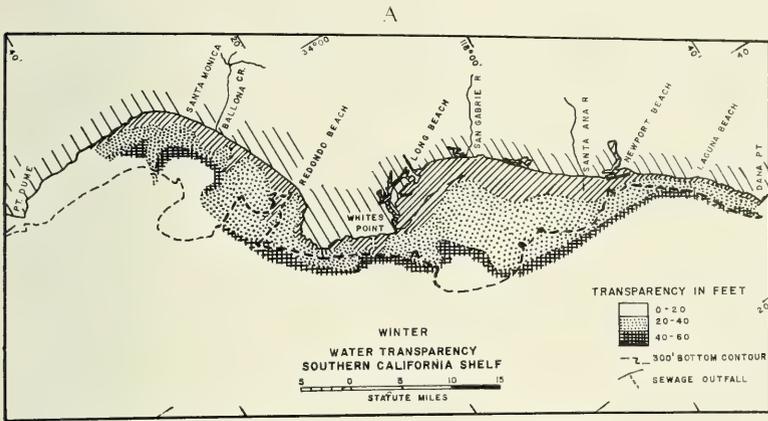


PLATE 22

Fig. A. Average water transparency during the winter of the shelf waters between Point Dume and Dana Point.

Fig. B. Average water transparency during the spring of the shelf waters between Point Dume and Dana Point.

occur over the Santa Monica Shelf, and probably this clearer water is absent at San Pedro.

Man's activities are noticeable, therefore, but have not produced exceptional areas of abnormally low transparencies when average conditions are considered.

SEASONAL VARIATIONS

The winter and spring transparency measurements show most dramatically the effects produced by land drainage and man's construction. During the winters of 1953 to 1956, rain was not plentiful in southern California. When it did fall, the parched soils and the short periods of precipitation reduced the runoff into the ocean. Plankton populations were not great so that in these winters the water was clearer than during years of greater rainfall. The low transparency water occurred in a rather narrow band close to shore (Plate 22, fig. A). Extruding from this band, resulting in seaward projections of turbid water, were the discharges from sewer outfalls and harbors, and detrital material from beach erosion. The large Hyperion outfall produced the turbid projection south of Ballona Creek. The Los Angeles County outfall (150 MGD) formed the low transparency bulge at Whites Point. The area south of Long Beach was turbid due to the flow of tidal waters from the Los Angeles-Long Beach Harbor, and the Orange County outfall at the Santa Ana River mouth probably added a minor amount of detritus in that area.

Beach erosion along the shore of the Los Angeles Basin is most pronounced at Redondo Beach and at the San Gabriel River mouth. The seaward projections in these two areas may be attributed to this erosive activity, although a southerly inshore current in Santa Monica Bay probably brings sewage debris to the Redondo area to increase turbidity there.

The spring seasons of the above noted years had rains and plankton growths that were impressive in contributing lowered transparencies (Plate 22, fig. B). Runoff was most noticeable at the Santa Ana River mouth and Laguna Beach. However, the tremendous area of transparency less than 20 feet in Santa Monica Bay was also due to runoff, in this case from Ballona Creek and a number of streams from the Santa Monica Mountains on the north side of the bay. This detritus, plus blooms of blue-green algae and phytoplankton, resulted in the low transparencies in this area in the spring.

Little detritus is contributed to the water off Whites Point during rains, so that even during the spring, the effect of the outfall is considerable. In Santa Monica Bay, however, the turbid effluent is lost in the much greater contribution from other sources.

RESUME

The average transparency of the water over the mainland shelf of southern California is influenced by oceanographic, geographic, climatologic and geologic factors that differ in most respects from those of other coastal areas in the United States. The transparency is much greater than along the Gulf Coast and less than along the New England coast.

The most important factors are the physiographic and geologic nature of the coast and shelf. Great quantities of fine-grained detrital material are available to be transported to the sea from a coast with a rather high relief. When the rivers and streams flow, the effect is obvious. With a narrow shelf, deep water close to shore, and consequently minor wave action over a large area, a more or less quiescent sea exists so that the detritus settles quickly. Low transparencies are thus generally close to shore and the clear oceanic water is not far distant.

Seasonal differences due to variations in rainfall, algal blooms and wave activity are present and result in marked changes in transparency patterns. Winter is the usual season when transparencies are greatest; spring when they are the least.

The effects caused by population growth and the accompanying constructive activities of man are apparent, but only by degree rather than magnitude. Their impressions on the average condition are negligible and are best noted in restricted areas.

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THE DISTRIBUTION OF THE SINALOA
NARROW-MOUTHED TOAD,
Gastrophryne mazatlanensis (Taylor)

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As a result of recent collections of the Sinaloa narrow-mouthed toad, *Gastrophryne mazatlanensis* (Taylor), outside its supposed range, it seems advisable to briefly review the distribution of this poorly known amphibian. Charles F. Walker of the University of Michigan Museum of Zoology and Richard G. Zweifel of the American Museum of Natural History have assisted me in locating museum specimens. William H. Woodin, III of the Arizona-Sonora Desert Museum has kindly allowed me to report on important specimens collected by him.

On August 2, 1959, collections of amphibians were made by Roy W. McDiarmid, Jr., and me along state highways 85 and 86 between Ajo, Lukeville, and Tucson, Pima County, Arizona. In the late afternoon a heavy downpour of rain occurred causing numerous flash floods. The ditches as well as the floor of the desert were covered with water that flowed across the road in almost every dip, often forcing traffic to halt temporarily. Anurans were present in large breeding choruses. At about 9:00 p.m., six adult *Gastrophryne mazatlanensis* were collected on highway 86 near a drainage in the San Simon Valley at a point approximately 28 miles east-southeast of Ajo. The specimens range from 25 to 33.2 mm. in snout-vent length and agree in coloration with the type of *G. mazatlanensis* as described by Taylor (1943). The venter is cream colored with a slight peppering of pigment on the chin and somewhat more pigment along the sides. A distinct black bar extends across the tibia and femur of the folded limb in five specimens and is faintly indicated in the sixth. Other amphibians in the area included *Bufo cognatus*, *Bufo alvarius*, *Bufo retiformis*, *Scaphiopus hammondi*, and *Scaphiopus couchi*. In the late afternoon of August 2, individuals of *Gastrophryne* were heard calling about three miles southeast of Ajo in a large chorus of *Scaphiopus couchi* immediately following a heavy downpour of rain. Search for these individuals was fruitless.

William H. Woodin, III has recently informed me of specimens of *Gastrophryne* collected by him and Mervin W. Larson in the middle of the San Simon Valley at a point approximately

37 miles east-southeast of Ajo on July 29, 1958. *Pternohyla* was collected at the same locality.

Both of the above localities represent northwestern extensions of the known range of *Gastrophryne mazatlanensis*. The first reported locality is about 85 miles northwest of the previous northwestern record (1.3 miles northwest of Ruby, Santa Cruz County, Arizona; Williams and Chrapliwy, 1959), and represents the northern and western records for the species. The species doubtless occurs to the north and west of the new localities, as is evidenced by the call record reported above. The localities reported upon in this paper are located on the floor of the San Simon Valley in areas of typical Sonoran Desert floral associations. San Simon Valley is separated from the other localities at which *Gastrophryne* has been collected in Arizona by the Baboquivari and Quijotoa Mountain ranges and by the broad Altar Valley.

The Sinaloa narrow-mouthed toad was described by Taylor (1943) as *Microhyla mazatlanensis*. A single specimen of *mazatlanensis* (UMMZ 78333) from ten miles north of Pilares in northeastern Sonora was considered to be somewhat intermediate between *mazatlanensis* and *olivacea* by Hecht and Matalas (1946), but this specimen is not said to be a member of an intergrading population and is not indicated as an intergrade on the accompanying map. However, Hecht and Matalas regarded both *olivacea* and *mazatlanensis* as subspecies of the polytypic *Microhyla carolinensis*. Recently, Blair (1955 a, 1955 b) has presented evidence to show that *carolinensis* and *olivacea* are separate species, and *mazatlanensis* has been assigned by him as a subspecies of *olivacea*. Hybridization, not intergradation, apparently occurs in regions where the ranges of *olivacea* and *carolinensis* overlap. Blair (1955b) has shown that the call of *mazatlanensis* is more similar to that of *carolinensis* than to that of *olivacea*. The arguments presented by Hecht and Matalas (1946) concerning the taxonomic position of *mazatlanensis* remain unconvincing, and, in view of the recent discoveries concerning *carolinensis-olivacea* relationships, as well as the fact that *olivacea* and *mazatlanensis* are allopatric and distinct with little or no evidence of intergradation, it seems advisable to consider *mazatlanensis* a separate species. Search should be made in western Chihuahua and western Durago for sympatric populations or evidence of intergradation.

Carvahlo (1954) has demonstrated that the narrow-mouth toads of the *carolinensis-olivacea-mazatlanensis* complex are not congeneric with Old World *Microhyla* and referred them to the genus *Gastrophryne*.

The accompanying map illustrates the distribution of *G. mazatlanensis* as indicated by museum specimens or literature reports. A list of localities at which *G. mazatlanensis* has been collected is presented below. Abbreviations are as follows: AMNH, American Museum of Natural History, UMMZ, University of Michigan Museum of Zoology.

MEXICO

Sinaloa:

- 2 miles E Mazatlan, (Taylor, 1943), TYPE
- 18.6 miles NNW Mazatlan, UMMZ 115461

Sonora:

- Guirocoba, (Bogert and Oliver, 1945)
- Alamos, (Bogert, 1958)
- 3 miles NW Navajoa, UMMZ 117354
- Hermosillo, AMNH 63736
- 22.5 miles W Hermosillo, (Zweifel, in litt.)
- 5 miles N Noria, (Allen, 1933)
- Trincheras, AMNH 53029-32
- 10 miles N Pilares (Hecht and Matalas, 1946)
- 35.5 miles S. Nogales, (Langebartel and Smith, 1954)

UNITED STATES

Arizona:

Santa Cruz County:

- Peña Blanca Springs, (Campbell, 1934; Stebbins, 1951; Blair, 1955 b)
- Near Yank's Spring, Sycamore Canyon, (Stebbins, 1951)
- Vicinity of Patagonia, (Stebbins, 1954)
- 1.3 miles NW Ruby, (Williams and Chrapliwy, 1959)

Pima County:

- 37 miles ESE Ajo, (Woodin, in litt.)
- 28 miles ESE Ajo

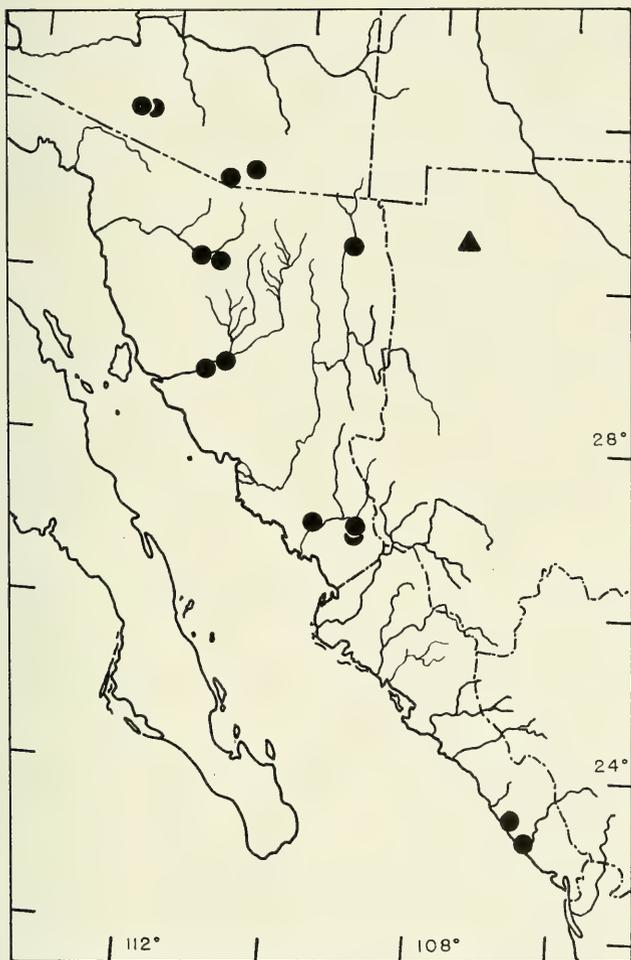


PLATE 23

MAP LEGEND

Distribution of *Gastrophryne mazatlanensis* in Northwestern Mexico and Southwestern United States. Collection localities indicated by circles. Nearest record of *Gastrophryne olivacea* indicated by triangle.

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THE EGGS OF TOADS OF THE *BUFO BOREAS* GROUP, WITH DESCRIPTIONS OF THE EGGS OF *BUFO EXSUL* AND *BUFO NELSONI*

By JAY M. SAVAGE AND FREDERICK W. SCHUIERER

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and Department of Biology, Cabrillo College, Watsonville, California

As part of a program of biosystematic analysis of variation and evolution in North American toads of the *Bufo boreas* Group we have assembled materials for comparative life history studies. Among the collections are samples of the eggs of the isolated dwarf desert forms *Bufo exsul* Myers, from Deep Springs Valley, Inyo County, California and *Bufo nelsoni* Stejneger, from the Amargosa River, Nye County, Nevada. Since no detailed account of the eggs of *B. nelsoni* has been published previously, a description and figure (Plate 24) are presented, together with comparative notes on the eggs of the related forms *Bufo boreas* Baird and Girard and *Bufo canorus* camp. In addition we find that the recent description of the eggs of *B. exsul* (Livezey, 1960) is incomplete or erroneous and the eggs of this form are redescribed on the basis of more adequate material. *Bufo alvarius* Girard has also been placed in the *B. boreas* Group by some authors (Blair, 1959) and eggs of this species are included in the comparisons (Plate 24).

Bufo nelsoni have been taken during the breeding season on only one occasion. Several hundred examples were observed in amplexus on March 19, 1960, by A. J. Gaudin and J. M. Savage. All breeding pairs were in shallow waters along the edge of the Amargosa River, two miles south of Springdale, Nye County, Nevada. A number of egg masses were collected from shallow water among submerged sedges and many additional strings were counted. All eggs were apparently in masses deposited within the previous 48 hours. Although several hundred mated pairs were noted only a single non-amplexed individual was seen. No toads were found after sunset and it seems likely that *B. nelsoni* is a diurnal breeder. F. W. Schuierer visited the same area on April 1 and 2, 1960, but no breeding pairs were seen. About 50 specimens were collected after sunset and a number of tadpoles and a single egg mass were found. Air temperature at 7:30 P.M. on the first of April was 15° C. Air temperature on the second of April at 11:30 A.M. was 20° C. The water temperature on the first was 15° and on the second 19° C. Eggs produced by artificially stimulated laboratory females of *B. nelsoni* agree in all important details with those collected in the field.

In addition to the toads discussed above we have collected adult *nelsoni* along the Amargosa River between Springdale and Beatty, Nye County, Nevada, on the following dates: March 30, May 17, June 20 and November 9, 1958 and June 13, 1959. Linsdale (1940) mentions larvae seen on May 4, 1932 and Wright and Wright (1949) record larvae taken on May 13, 1942. Mature larvae were collected by F. W. Schuierer as part of the present study on May 17, 1958. These data indicate that breeding probably begins in mid-March and continues over a two week period into early April. We have taken recently metamorphosed toadlets in June of 1958 and 1959. Apparently *B. nelsoni* first emerges from hibernation in March and is active during the day. After the breeding season the toads become increasingly nocturnal as diurnal temperatures rise. By mid-April little or no activity is observed in the daytime but the toads are numerous and found feeding at night.

The eggs of *Bufo exsul* have been collected by us on three occasions from amplexed females taken in the slough area at the base of Buckhorn Springs, six miles southwest of Deep Springs Post Office, Inyo County, California. In the first instance eggs were obtained by Richard Clark and F. W. Schuierer on March 30, 1958. The eggs were deposited in long strings and were loosely attached to sedge plants in a water depth of 16-20 cm. The source of the water is an underground stream system and water temperatures remain relatively constant at 20-21° C. during the entire year. Air temperature at noon on the day of collection was 10° C. A considerable number of amplexing pairs of *B. exsul* were taken at the same time and many pairs were seen engaged in breeding activity. Two undispersed clusters of free larvae were also noted and seem to indicate that breeding commenced some few days earlier. Breeding pairs and eggs were again obtained on March 19, 1960, by Anthony J. Gaudin and J. M. Savage, under conditions similar to those noted in 1958. The eggs were in shallow water, 16-25 cm. in depth, and had all been laid in the previous 48 hours. Air temperature at noon on the day of collection was 21° C. The water temperature in moving streamlets was 21° C. Air temperatures were slightly below 0° C. the previous night. A third collection was made on April 1, 1960 by F. W. Schuierer and party. Only one amplexing pair was observed although over sixty individuals were seen. The number is in marked contrast to conditions on March 19 when over 100 mated pairs were counted. The air temperature was 19.5° C at noon; water temperature 20.5° C. Livezey (1960) reported eggs taken on March 22, 1959, under conditions similar to those described above. He includes no data on breeding activity.

Breeding apparently occurs in this species in late March and early April under the influence of local annual weather differences. Our 1960 collections suggest a short breeding season of two to three weeks. All breeding activity observed by us took place during the day. *Bufo exsul* is essentially diurnal at all seasons and breeds at a time of year when nocturnal activity may be lethal. The diurnal breeding habits are in contrast to those of the nocturnal breeding *Bufo boreas*. Larvae of *B. exsul* are numerous in the slough areas below Buckhorn Springs by mid-April and recently transformed individuals are most common in June. Comparison of 10 samples of eggs taken at Deep Springs with eggs produced by laboratory females induced to ovulate by pituitary implants, reveals no marked differences.

The eggs of both *Bufo exsul* and *Bufo nelsoni* share the following features with *Bufo alvarius*, *Bufo boreas* and *Bufo canorus* (all terms follow the system recommended by Karlstrom and Livezey, 1955): aquatic deposition in long submerged strings encased in a continuous gelatinous envelope and eggs pigmented. *B. exsul* and *B. nelsoni* further agree with *B. boreas* and *B. canorus* in having two gelatinous envelopes with each egg separated from adjacent eggs by partitions formed from the inner envelope. *B. alvarius* lacks a second gelatinous envelope and has no partitions separating the individual eggs.

DESCRIPTIONS: *Bufo exsul*—eggs laid in single or usually double strings; usually a single row of eggs in string but sometimes two rows; two jelly envelopes, outer envelope large, 4.0-6.9 mm. in diameter, with even margins and no evidence of scalloping; inner envelope surrounds each ovum and usually in contact with inner envelopes of next adjacent eggs so as to form a series of partitions, greatest diameter 2.4-3.3 mm., least diameter 2.0-2.8 mm.; ova dark in color, brownish black to jet black, vegetal pole lighter, diameter 1.2-1.4 mm., approximately 60 ova in a single file 10 cm. in length.

Bufo nelsoni—eggs laid in single or usually double strings; only a single row of eggs in string; two jelly envelopes, outer envelope large, 4.3-5.0 mm. in diameter, with even margins and no evidence of scalloping; inner envelope encasing each ovum and usually in contact with inner envelopes around next adjacent eggs to form partitions, greatest diameter 2.1-2.7 mm., least diameter 1.4-2.2 mm.; ova dark, blackish above, somewhat lighter at vegetal pole, diameter 1.3-1.8 mm., approximately 60 ova in a single file 10 cm. in length.

COMPARISONS: A summary of salient characteristics for the five species, *alvarius*, *boreas*, *canorus*, *exsul* and *nelsoni*, is presented below (Table 1) and illustrated (Plate 24). Eggs may be in

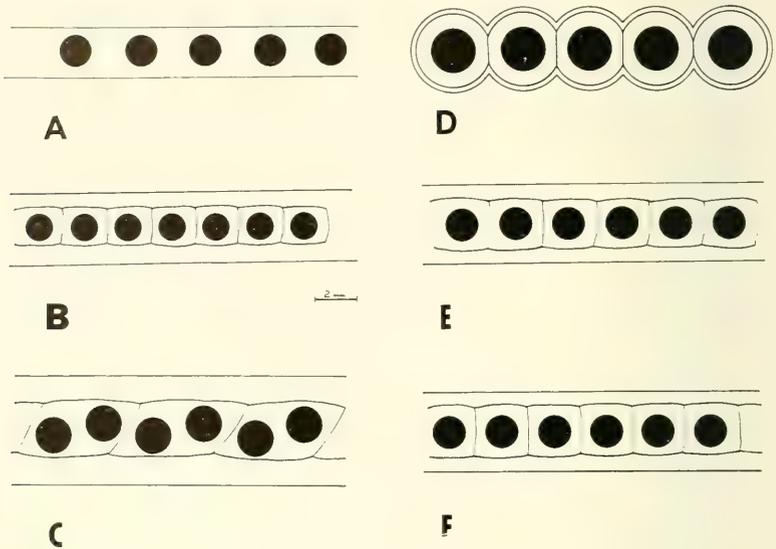


PLATE 24

Diagrammatic Representations of Eggs of Members of *Bufo boreas* Group. A. *Bufo alvarius*; B., C. *Bufo boreas*; D. *Bufo canorus*; E. *Bufo exsul*; F. *Bufo nelsoni*. All eggs drawn to same scale.

single or double rows in *B. boreas*, *B. canorus* and *B. exsul* but are usually single in the latter two species and always single as far as known in *B. alvarius* and *B. canorus*. Double rows are typical of *B. boreas*. *B. canorus* is unique in the group in frequently having the eggs deposited to form a radiating network or clusters of four to five eggs in depth and in the scalloped outline of the outer gelatinous envelope. *B. alvarius* differs from the other species and figures of *Bufo canorus* eggs are based on the

The data and figures of *Bufo canorus* eggs are based on the account by Karlstrom and Livezey (1955) and eggs deposited by laboratory females stimulated to ovulate with pituitary implants. Eggs deposited in the laboratory agree in all essentials with the description by Karlstrom and Livezey. The data and figure of the eggs of *B. alvarius* are taken from the synopsis by Livezey and Wright (1947).

In previous descriptions of the eggs of *Bufo boreas* no mention has been made of the partitions formed by the inner gelatinous membrane between individual eggs (Storer, 1925: 178; Livezey and Wright, 1947: 195; Stebbins, 1951: 241; Karlstrom and

Table 1
EGGS OF TOADS OF *BUFO BOREAS* GROUP

| | Outer Envelope | Diameter of Outer Envelope | | Diameter of Inner Envelope | | Diameter of Ovum | Eggs per 10 cm. |
|--------------------|----------------|----------------------------|----------------|----------------------------|----------------|------------------|-------------------|
| | | Maximum | Minimum | Maximum | Minimum | | |
| <i>B. alvarius</i> | even | 2.1-2.3 2.2 | same | none | none | 1.1-1.7 1.4 | 48-112 |
| <i>B. boreas</i> | even | 3.1-4.0 3.6 | same | 2.2-3.1 2.7 | 1.9-2.5 2.2 | 1.2-1.5 1.3 | 120 (two rows) |
| <i>B. exsul</i> | even | 4.0-6.9 5.8 | same | 2.4-3.3 3.0 | 2.0-2.8 2.4 | 1.2-1.4 1.3 | 60 |
| <i>B. nelsoni</i> | even | 4.3-5.0 4.7 | same | 2.1-2.7 2.4 | 1.4-2.2 1.8 | 1.3-1.8 1.5 | 60 |
| <i>B. canorus</i> | scalloped | 3.7-4.6 4.1 | 0.5-3.9 2.6 | | 3.4-4.1 3.8 | 1.7-2.7 2.1 | 28 |

Livezey, 1955: 222). Our material from several southern California localities all exhibits the partitions as indicated (Plate 24). The inner membranes have the same segmental relations in all *boreas* eggs examined although there is some variation in the number of eggs, one or two, inclosed in each partitioned segment. The inner membranes and partitions are clearly evident only if sub-stage lighting is used in examining the eggs. The partitions are especially difficult to locate even with proper lighting when the outer gelatinous envelope is dirty. Very likely the inter-egg partitions have been overlooked by previous workers although it is possible that the partitions are variable in *Bufo boreas*. Very few *B. boreas* egg masses have been described in the literature and it seems that all of the references to egg size and structure in this species are based upon repetition of the data provided by Storer (1925) and Livezey and Wright (1947).

In basic characteristics the eggs of *B. boreas*, *B. exsul* and *B. nelsoni* are similar. The principal point of difference is in the tendency for *boreas* to deposit eggs in a dual series within each string, while the other species usually have a single row. Although there appears to be some slight difference among the species in the diameter of the outer jelly membrane, the variation is probably more apparent than real. The jelly coats usually imbibe water when the eggs are laid and considerable differences may be produced by local conditions, time of preservation and strength of preservative. Storer (1925: 178) gives outer envelope diameters for *boreas* as 4.9-5.3 mm. and maximum inner envelope diameters

as 3.5-3.8 mm. His values are somewhat higher than those recorded in the present study (Table 1). The size of the ovum appears to be greater in *B. nelsoni* than in either *boreas* or *exsul*. Storer's (1925) values and those of Livezey and Wright (1947) for *B. boreas* are again greater than those recorded in this study, 1.6-1.7 mm. and 1.5-1.8 mm., respectively. The sizes recorded by these authors include the limits of variation noted for *B. nelsoni* eggs (Table 1).

Livezey (1960) in his description of the eggs of *Bufo exsul* presents measurements for a single egg mass as follows: diameter of outer envelope 4.5-6.6 mm.; diameter of inner envelope (maximum) 2.7-3.8 mm.; diameter of vitellus (late blastula) 1.5-1.8 mm. The last two values are much higher than ours (Table 1) but the differences are probably due to the age of the eggs. Our measurements are based on recently deposited eggs, either unfertilized or at early cleavage. The eggs were preserved after soaking in water for two to five hours after deposition. The description given by Livezey differs from that given above in one additional significant point. He mentions and figures the eggs of the Deep Springs toad as either in a continuous string or with partial partitions between them. Although partitions occur between the eggs in all of our *exsul* strings, a few short segments in most strands lack visible divisions. Reduction in the partitions begins to occur as the vitellus grows and develops. We suggest that Livezey's material is not typical of freshly laid eggs but represents a condition resulting from the relatively advanced stage of development in his embryos.

The eggs of *Bufo canorus* differ strikingly from those of the three species discussed above in the scalloped outer envelope, size of the ovum and diameter of the inner envelope. The number of eggs per 10 cm. of string length (28) reflects the latter two characteristics. Very little is known concerning the ecologic significance of the features which differentiate amphibian eggs but it appears likely that the high altitude habitat (above 9,500 feet in the Sierra Nevada of California) of *B. canorus* is related to its peculiar eggs. The period of development in this species is abbreviated and the daily temperature fluctuations in the shallow breeding ponds are extreme. Larger eggs and jelly envelopes as well as the tendency for clustering of the eggs may be related to temperature adaptations in the development of *Bufo canorus*.

The eggs of *Bufo alvarius* differ strikingly from other members of this group in completely lacking an inner gelatinous membrane and partitions between individual eggs. The eggs and single gelatinous envelope are much smaller than in the other toads discussed in this report. If *B. alvarius* is actually a member of the *Bufo boreas* Group as proposed by Blair (1960) it is as

different from other members of the stock in egg characteristics as in morphological features (Plate 24).

Materials used in the present report was obtained with the financial support of grants from the Penrose Fund of the American Philosophical Society and the National Science Foundation. Illustrations were prepared by Priscilla H. Starrett of the University of Southern California.

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RECORDS OF FLEAS (SIPHONAPTERA)
FROM NORTHWESTERN ARIZONA

BY G. F. AUGUSTSON AND FLOYD E. DURHAM

The "Strip Area" of northwestern Arizona has been visited many times since 1956 by the junior author. Besides a wealth of native mammals, and many notes on their ecology, a large collection of ectoparasites were obtained. Among the latter are many specimens of fleas which are considered worthy of recording and placing in the collections of the Hancock Foundation. There follows a phylogenetic list of these with the number and sex of each.

A list of the collecting stations has been compiled. It is accompanied by a map (Plate 25) of the area, all in Mohave County. Numbers in parentheses in the text refer to these stations.

Host animals were identified by the junior author and Dr. Donald F. Hoffmeister, Museum of Natural History, University of Illinois, Urbana, where the study skins have been retained. Flea identifications are those of the senior author, who is grateful for the opportunity of studying such an interesting and large series.

COLLECTING STATIONS

1. Beaver Dam, 1900 feet.
2. 12 mi. S., 1 mi. W. Littlefield, 5000 ft.
1. Manager-Entomologist, Madera County Mosquito Abatement District, Madera, California.
2. Allan Hancock Foundation, University of Southern California, Los Angeles, California.
3. 13 mi. S., 4 mi. W. Littlefield, 3200 ft.
4. 17 mi. N., 3 mi. E. Pakoon Springs, 4250 ft.
5. 13 mi. N., 1 mi. E. Pakoon Springs, 4000 ft.
6. 9 mi. N., 5 mi. W. Pakoon Springs, 4500 ft.
7. 7 mi. N., 5 mi. W. Pakoon Springs, 4500 ft.
8. 3 mi. N., 1 mi. W. Pakoon Springs, 2800 ft.
9. Pakoon Springs, 2300 ft.
10. 2 mi. S., 3 mi. E. Pakoon Springs, 2100 ft.
11. 3 mi. S., 3 mi. W. Pakoon Springs, 2200 ft.
12. 4 mi. S. Pakoon Springs, 1900 ft.
13. 6 mi. S., 1 mi. W. Pakoon Springs, 2000 ft.
14. 8 mi. S., 1 mi. W. Pakoon Springs, 1600 ft.
15. Grand Wash, 1200 ft.
16. Tasi Springs, 1840 ft.
17. 3 mi. S., 8 mi. E. Pakoon Springs, 2900 ft.
18. 4 mi. S., 10 mi. E. Pakoon Springs, 4200 ft.
19. 8 mi. S., 9 mi. S. Pakoon Springs, 4500 ft.
20. 8 mi. S., 12 mi. E. Pakoon Springs, 4400 ft.
21. 8 mi. S., 15 mi. E. Pakoon Springs, 6000 ft.

22. 10 mi. S. St. George (Utah).
23. 12 mi. N., 3 mi. W. Wolf Hole, 3500 ft.
24. Seegmiller Mt., 4500 ft.
25. 14 mi. N., 4 mi. W. Mt. Dellenbaugh, 5100 ft.
26. 9 mi. N., 1 mi. W., Mt. Dellenbaugh, 5300 ft.
27. 3 mi. N., 2 mi. W. Mt. Dellenbaugh, 5900 ft.
28. 4 mi. E., 1 mi. S. Mt. Dellenbaugh, 6000 ft.
29. 1½ mi. N.E. Diamond Butte, 4500 ft.
30. 2 mi. S.W. Diamond Butte, 4700 ft.
31. 1 mi. E. of Mt. Trumbull, 5000 ft.
32. 3 mi. N.E. Trumbull Mtn., 6000 ft.
33. Short Creek, 5040 ft.
34. Cutler Pockets, 5500 ft.

FAMILY HYSTRICHOPSYLLIDAE

Atyphloceras echis (Jordan and Rothschild)

- 1 ♀, 1 ♂ (4) ex *Peromyscus eremicus eremicus* (Baird)
 1 ♀ (22) ex *Peromyscus boylii utahensis* Durrant
 1 ♀ (7) ex *Neotoma lepida monstrabilis* Goldman

Catallagia chambrelini Hubbard

- 1 ♀ (7), 1 ♂ (36) ex *Reithrodontomys megalotis megalotis* (Baird)
 2 ♀ ♀ (6), 1 ♂ (3) ex *Peromyscus maniculatus sonoriensis* (LeConte)
 1 ♀ (25) ex *Peromyscus truei truei* (Shufeldt)

Epitedia stanfordi Traub

- 4 ♀ ♀ (22) ex *Peromyscus boylii utahensis* Durrant
 1 ♀ (3) ex *Peromyscus truei truei* (Shufeldt)

Rhadinopsylla multidenticulatus Morlan and Prince

- 5 ♀ ♀, 1 ♂ (3) ex *Citellus leucurus leucurus* (Merriam)
 5 ♀ ♀, 3 ♂ ♂ (9) ex *Thomomys bottae nicholi* Goldman
 1 ♀ (9) ex *Onychomys leucogaster melanophrys* Merriam

Carteretta carteri clavata Good

- 2 ♀ ♀ (10) ex *Perognathus formosus mohavansis* Huey
 1 ♀ (13) ex *Perognathus pencillatus sobrinus* (Goldman)

Meringes dipodomys Kohls

- 3 ♀ ♀ (11), 1 ♀, 1 ♂ (10), 1 ♀ (12), 9 ♀ ♀ 4 ♂ ♂ (13) ex *Dipodomys deserti*
 Stephens

- 1 ♀ (13), 2 ♀ ♀ 1 ♂ (14), 6 ♀ ♀ 12 ♂ ♂ (1), 7 ♀ ♀ 3 ♂ ♂ (15), 5 ♀ ♀ 1 ♂ (16),
 5 ♀ ♀ 1 ♂ (11), 8 ♀ ♀ 6 ♂ ♂ (10), 3 ♀ ♀ (17), 2 ♀ ♀ (27) ex *Dipodomys merriami merriami* Mearns

- 4 ♀ ♀ 2 ♂ ♂ (16), 1 ♀ (14) ex *Onychomys torridus longicaudus* Merriam
 2 ♀ ♀ 2 ♂ ♂ (14), 2 ♀ ♀, 1 ♂ (16) ex *Peromyscus crinitus stephensi* Mearns
 3 ♀ ♀ (15), 1 ♂ (11) ex *Peromyscus eremicus eremicus* (Baird)
 2 ♀ ♀ 1 ♂ (15), 1 ♀, 1 ♂ (11) ex *Neotoma lepida monstrabilis* Goldman

Meringes parkeri (Jordan)

- 1 ♂ (22) ex *Peromyscus boylii utahensis* Durrant

Anomiopsylla amphibolus Wagner

- 1 ♀, 2 ♂ ♂ (5), 1 ♀ (28), 1 ♀ (18) ex *Neotoma lepida monstrabilis* Goldman

Jordanopsylla allredi Traub and Tipton

- 1 ♀ (23) ex *Peromyscus eremicus eremicus* (Baird)

Megarhroglossus becki Tipton and Allred

- 1 ♂ (6), 1 ♂ (5) ex *Peromyscus maniculatus sonoriensis* (LeConte)
 2 ♀ ♀ (22) ex *Peromyscus boylii utahensis* Durrant
 1 ♀ (5), 5 ♀ ♀ (7) ex *Neotoma lepida monstrabilis* Goldman

FAMILY CERATOPHYLLIDAE

Amphipsylla neotomae Fox

- 1 ♀ (1) ex *Peromyscus crinitus stephensi* Mearns
 1 ♂ (15) ex *Neotoma lepida monstrabilis* Goldman

Malaraeus eremicus (Baker)

- 4 ♀ ♀ 2 ♂ ♂ (23), 1 ♀ (2), 12 ♀ ♀ 11 ♂ ♂ (15) ex *Peromyscus eremicus eremicus* (Baird)
 1 ♀ (5) ex *Peromyscus truei truei* (Shufeldt)

Malaraeus sinomus (Jordan)

- 1 ♂ (11), 1 ♂ (19) ex *Dipodomys merriami merriami* Mearns
 4 ♀ ♀ 4 ♂ ♂ (11), 4 ♀ ♀ 3 ♂ ♂ (12), 11 ♀ ♀ 7 ♂ ♂ (17), 5 ♀ ♀ 5 ♂ ♂ -
 (26), 1 ♂ (31), 1 ♀ (24), 1 ♀ (1) ex *Peromyscus crinitus stephensi*
 Mearns
 9 ♀ ♀ 3 ♂ ♂ (2), 10 ♀ ♀ 5 ♂ ♂ (4), 1 ♀ (13), 1 ♀ 1 ♂ (1), 2 ♀ ♀ 1 ♂ (16),
 32 ♀ ♀ 17 ♂ ♂ (11), 20 ♀ ♀ (12), 3 ♀ ♀ (17), 2 ♀ ♀ 1 ♂ (24), 6 ♀ ♀ 4 ♂ ♂ -
 (26) ex *Peromyscus eremicus eremicus* (Baird)
 1 ♀ 4 ♂ ♂ (22), 2 ♀ ♀ (1), 4 ♀ ♀ 4 ♂ ♂ (26), 7 ♀ ♀ 1 ♂ (31), 1 ♂ (24) 2 ♀ ♀ -
 2 ♂ ♂ ex *Peromyscus boylii utahensis* Durrant
 3 ♀ ♀ (26), 1 ♂ (33) ex *Peromyscus maniculatus sonoriensis* (LeConte)
 3 ♀ ♀ (20), 2 ♀ ♀ 1 ♂ (22), 5 ♀ ♀ (8), 1 ♀ (18), 11 ♀ ♀ 2 ♂ ♂ (3), 1 ♀ (26),
 1 ♀ 2 ♂ ♂ (28) ex *Peromyscus truei truei* (Shufeldt)
 1 ♀ 1 ♂ (11), 1 ♂ (26), 1 ♂ (28), 1 ♀ (3), 1 ♂ (24) ex *Neotoma lepida monstrabilis* Goldman

Malaraeus euphorbi (Rothschild)

- 1 ♀ (13) ex *Dipodomys merriami merriami* Mearns
 3 ♀ ♀ (2) ex *Peromyscus eremicus eremicus* (Baird)
 1 ♂ (7) ex *Peromyscus maniculatus sonoriensis* (LeConte)
 2 ♀ ♀ (2), 2 ♀ ♀ (7) ex *Neotoma lepida monstrabilis* Goldman

Malaraeus n. sp.

- 1 ♀ 1 ♂ (1), 1 ♂ (12), 5 ♀ ♀ 3 ♂ ♂ (17) ex *Peromyscus crinitus stephensi*
 Mearns
 1 ♂ (11), 1 ♀ 1 ♂ (16), 4 ♀ ♀ 1 ♂ (17), 1 ♂, 2 ♀ ♀ (12) ex *Peromyscus eremicus eremicus* (Baird)
 (Note: in manuscript by Frank M. Prince).

Malaraeus vonfintalis Prince

- 1 ♀ (7) ex *Peromyscus maniculatus sonoriensis* (LeConte)
 1 ♂ (3) ex *Peromyscus truei truei* (Shufeldt)

Monopsyllus eumolpi (Rothschild)

- 2 ♀ ♀ 2 ♂ ♂ (8), 3 ♀ ♀ (25), 1 ♀ (26) ex *Eutamias dorsalis utahensis*
 Merriam

Monopsyllus exilis (Jordan)

- 4 ♀ ♀ 2 ♂ ♂ (9), 3 ♀ ♀ 5 ♂ ♂ (6) ex *Onychomys leucogaster melanophrys*
 Merriam

Monopsyllus wagneri wagneri (Baker)

- 2 ♀ ♀ (5), 6 ♀ ♀ 3 ♂ ♂ (25), 2 ♀ ♀ (5) ex *Peromyscus maniculatus sonoriensis* (LeConte)
 2 ♀ ♀ (25) ex *Reithrodontomys megalotis megalotis* (Baird)
 1 ♂ (18), 1 ♀ (5), 3 ♀ ♀ (25), 1 ♀ (6), 1 ♂ (5) ex *Peromyscus truei truei*
 (Shufeldt)
 1 ♀ (25) ex *Neotoma lepida monstrabilis* Goldman

Orchopeas leucopus (Baker)

- 1 ♀ (5) ex *Reithrodontomys megalotis megalotis* (Baird)
 1 ♂ (3) ex *Peromyscus crinitus stephensi* Mearns
 4 ♀ ♀ (13), 3 ♀ ♀ (24), 2 ♀ ♀ (28), 22 ♀ ♀ 18 ♂ ♂ (23), 3 ♀ ♀ 3 ♂ ♂ (31),
 2 ♀ ♀ (1) ex *Peromyscus eremicus eremicus* (Baird)
 2 ♀ ♀ 2 ♂ ♂ (6), 1 ♀ (6) ex *Peromyscus maniculatus sonoriensis* (LeConte)
 1 ♀ 2 ♂ ♂ (22), 2 ♂ ♂ (26) ex *Peromyscus boylii utahensis* Durrant
 1 ♀ (20), 1 ♀ 1 ♂ (22), 3 ♀ ♀ 1 ♂ (8), 1 ♂ (18), 3 ♀ ♀ (21), 5 ♀ ♀ 2 ♂ ♂ (25),
 9 ♀ ♀ 1 ♂ (6), 2 ♂ ♂ (28), 9 ♀ ♀ 6 ♂ ♂ (5), 1 ♀ (6) ex *Peromyscus truei truei* (Shufeldt)
 1 ♀ 1 ♂ (23) ex *Neotoma lepida monstrabilis* Goldman

Orchopeas sexdentatus agilis (Rothschild)

- 1 ♀ (16), 1 ♀ (28) ex *Peromyscus crinitus stephensi* Mearns
 1 ♀ (2), 1 ♀ (4), 2 ♀ ♀ 2 ♂ ♂ (11), 4 ♂ ♂ (12), 1 ♀ (16), 1 ♀ (24) ex
Peromyscus eremicus eremicus (Baird)
 4 ♀ ♀ 2 ♂ ♂ (25) ex *Peromyscus maniculatus sonoriensis* (LeConte)
 1 ♀ (4), 1 ♂ (2), 1 ♀ (5), 1 ♀ (14), 2 ♀ ♀ 3 ♂ ♂ (15), 13 ♀ ♀ 5 ♂ ♂ (11),
 4 ♀ ♀ 6 ♂ ♂ (12), 2 ♀ ♀ (26), 16 ♀ ♀ 20 ♂ ♂ (27), 21 ♀ ♀ 11 ♂ ♂ (1), 27-
 2 ♀ ♀ 22 ♂ ♂ (23), 1 ♀ 3 ♂ ♂ (5), 15 ♀ ♀ 8 ♂ ♂ (28), 3 ♂ ♂ (31), 1 ♂ (34),
 2 ♀ ♀ 2 ♂ ♂ (13), 2 ♀ ♀ 3 ♂ ♂ (15), 1 ♂ (3), 10 ♀ ♀ 11 ♂ ♂ (11), 4 ♀ ♀ -
 4 ♂ ♂ (15), 2 ♀ ♀ 2 ♂ ♂ (20), 1 ♀ (7), 1 ♀ (25), 6 ♀ ♀ 3 ♂ ♂ (24) ex
Neotoma lepida monstrabilis Goldman

Diamanus montanus (Baker)

- 2 ♀ ♀ 1 ♂ (6) ex *Citellus variegatus grammurus* (Say)

Thrassis bacchi consimilis Stark

- 11 ♀ ♀ 4 ♂ ♂ (27), 21 ♀ ♀ 15 ♂ ♂ (24) ex *Citellus leucurus leucurus* (Merriam)

Thrassis arizonensis littoris (Jordan)

- 1 ♀ 2 ♂ ♂ (1), 8 ♀ ♀ 9 ♂ ♂ (11), 5 ♀ ♀ 4 ♂ ♂ (15), 1 ♀ 2 ♂ ♂ (23) ex *Citellus leucurus leucurus* (Merriam)
 1 ♂ (15) ex *Peromyscus eremicus eremicus* (Baird)

Thrassis aridis hoffmani (Hubbard)

- 1 ♀ (13), 6 ♀ ♀ 1 ♂ (1), 1 ♂ (15), 10 ♀ ♀ 4 ♂ ♂ (16), 2 ♀ ♀ 1 ♂ (11), 2 ♀ ♀ -
 2 ♂ ♂ (10), 1 ♀ (11) ex *Dipodomys merriami merriami* Mearns
 1 ♀ (11), 2 ♀ ♀ 1 ♂ (10) ex *Dipodomys deserti deserti* Stephens
 4 ♀ ♀ 3 ♂ ♂ (16) ex *Onychomys torridus longicaudus* Merriam

Thrassis setosis Prince

- 20 ♀ ♀ 11 ♂ ♂ (20), 7 ♀ ♀ 21 ♂ ♂ (4), 2 ♀ ♀ (13), 18 ♀ ♀ 6 ♂ ♂ (18), 15 ♀ ♀ -
 5 ♂ ♂ (11), 7 ♀ ♀ 5 ♂ ♂ (15), 12 ♀ ♀ 4 ♂ ♂ (3), 1 ♀ (24), 1 ♀ (32)
 ex *Citellus leucurus leucurus* (Merriam)
 1 ♀ (2) ex *Thomomys bottae nicholi* Goldman
 1 ♂ (19) 1 ♂ (23) ex *Dipodomys merriami merriami* Mearns
 1 ♀ (6), 2 ♂ ♂ (24) ex *Onychomys leucogaster melanophrys* Merriam
 1 ♀ (23) ex *Onychomys torridus longicaudus* Merriam
 1 ♀ (5) ex *Reithrodontomys megalotis megalotis* (Baird)
 1 ♀ (28) ex *Peromyscus eremicus eremicus* (Baird)
 1 ♀ (28), 1 ♀ (3) ex *Neotoma lepida monstrabilis* Goldman

Dactylopsylla bluei psilos Prince and Stark

- 1 ♀ (24) ex *Thomomys bottae nicholi* Goldman

Dactylopsylla ignota utahensis (Wagner)

- 1 ♀ 3 ♂ ♂ (9), 2 ♂ ♂ (6) ex *Thomomys bottae nicholi* Goldman
 12 ♀ ♀ 18 ♂ ♂ (8) ex *Thomomys bottae planirostris* Burt
 1 ♀ (25) ex *Thomomys bottae trumbullensis* Hall and Davis
 1 ♀ (5) ex *Peromyscus boylii utahensis* Durant

Peromyscopsylla ebrighti (C. Fox)

- 1 ♂ (7) ex *Reithrodontomys megalotis megalotis* (Baird)
 4 ♀ ♀ 3 ♂ ♂ (16), 1 ♀ (3), 1 ♀ 3 ♂ ♂ (11), 3 ♀ ♀ (10) ex *Peromyscus crinitus stephensi* Mearns
 2 ♀ ♀ 1 ♂ (3), 8 ♀ ♀ 4 ♂ ♂ (11) ex *Peromyscus eremicus eremicus* (Baird)
 1 ♂ (6) ex *Peromyscus maniculatus sonoriensis* (LeConte)
 1 ♀ (3), 2 ♂ ♂ 1 ♀ (6) ex *Peromyscus truei utahensis* Durrant
 1 ♂ (11) ex *Neotoma lepida monstrabilis* Goldman
 (Note: verified by Dr. Phyllis T. Johnson. The senior author has also taken this species from Madera County, California.)

Peromyscopsylla hesperomys adelpha (Rothschild)

- 1 ♂ (9), 1 ♀ (6) ex *Onychomys leucogaster rudosae* Stone and Rohn
 1 ♂ (7) ex *Reithrodontomys megalotis megalotis* (Baird)
 2 ♀ ♀ (21), 2 ♂ ♂ (1) ex *Peromyscus crinitus stephensi* Mearns
 2 ♀ ♀ 1 ♂ (4), 1 ♂ (1) ex *Peromyscus eremicus eremicus* (Baird)
 2 ♀ ♀ (5), 1 ♂ (7), 2 ♀ ♀ (3) ex *Peromyscus maniculatus sonoriensis* (LeConte)
 1 ♀ (20), 4 ♀ ♀ (18), 1 ♂ (21) ex *Peromyscus truei truei* (Shufeldt)

Sternistomera alpina (Baker)

- 9 ♀ ♀ 6 ♂ ♂ (5) ex *Neotoma lepida monstrabilis* Goldman

Miochaeta macrodactyla (Good)

- 2 ♀ ♀ (21) ex *Peromyscus crinitus stephensi* Mearns

FAMILY PULICIDAE

Cediopsylla inqualis interrupta Jordan

- 1 ♀ 3 ♂ ♂ (1) ex *Urocyon cinereoargenteus scottii* Mearns
 1 ♀ (30) ex *Citellus leucurus leucurus* (Merriam)
 1 ♀ (32) ex *Peromyscus crinitus stephensi* Mearns
 65 ♀ ♀ 65 ♂ ♂ (24) ex *Sylvilagus auduboni arizonae* (Allen)

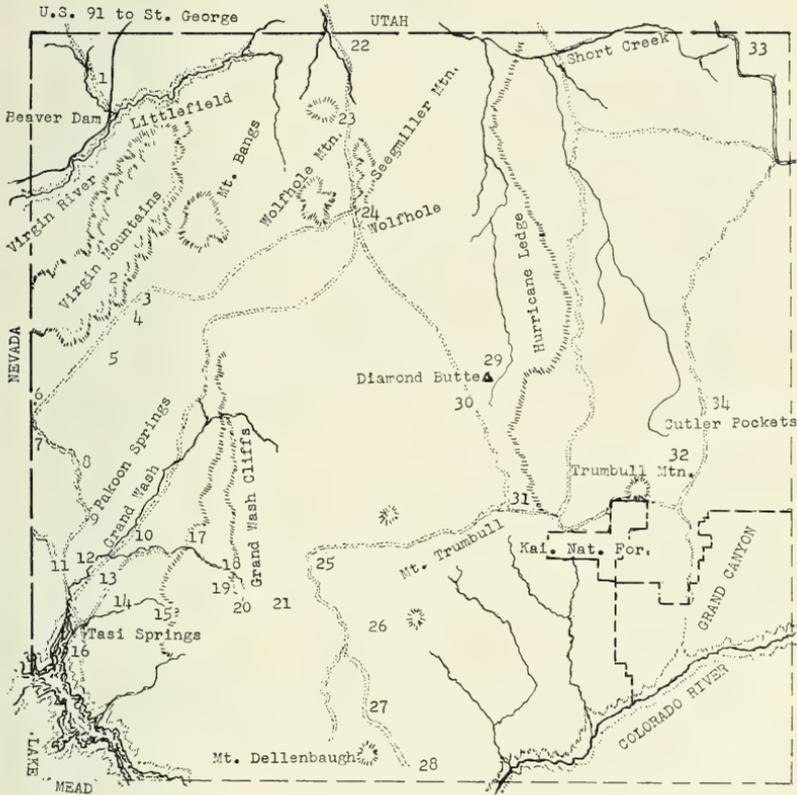
Hoplopsyllus anomalus (Baker)

- 1 ♀ (2), 18 ♀ ♀ 6 ♂ ♂ (30) ex *Citellus leucurus leucurus* (Merriam)
 1 ♀ (24) ex *Onychomys leucogaster melanophrys* (Merriam)

Hoplopsyllus glacialis affinis (Baker)

- 4 ♀ ♀ 1 ♂ (30) ex *Sylvilagus auduboni arizonae* (Allen)

Thirty-five (35) species of fleas are reported. These representing twenty-one (21) genera and three (3) families. The known distributional range of many species have been extended.



6 mi.

After U.S. Dept. of Interior

PLATE 25

PELECYPHORUS RECORDS FROM
SOUTHWESTERN UNITED STATES
WITH DESCRIPTION OF TWO NEW SPECIES

(Notes on North American Coleoptera, No. 16)

By CHARLES S. PAPP

The Tenebrionid genus *Pelecyphorus* was erected by Solier (1836). Specimens with the same taxonomic characters were later named by Lacordaire (1859) as *Philolithus*. Horn (1870) included Solier's generic name as synonym to *Asida* Latreille (1804) with another genus *Euschides* LeConte (1858, not 1851). Only *Philolithus* is a synonym of *Pelecyphorus*, all the others represent species with excellent generic characters and as such they are accepted as valid names (Papp 1961).

There are several old species of this genus discussed with descriptions of several new ones in Horn's paper (1870). The discovery of *Pelecyphorus actuosus* Horn in stored chicken feed from the Mojave Desert (Quartz Hill area) was reported by Papp and Pierce (1960). These specimens have recently been compared with specimens obtained from the type locality of *P. actuosus* and are now considered as a new species. Another new species from the lower portion of the Mojave Desert will also be described.

Pelecyphorus actuosus Horn 1870 (Trans. Amer. Philos. Soc. 14:284). Type locality Owen's Valley, California, collected by Horn and by Cronkhite. See Plate 26, fig. A-C.—Specimens from the Bishop area, collected by the late George P. Mackenzie, August 29th, 1946, average 19.0-22.0 mm in length. There are little differences between male and female; however females usually are broader. I have seen smaller females and larger males from the same locality. *Pelecyphorus actuosus* Horn, is one of the early Californian species. In the original description Horn observed an obsolete costa, which I could not observe on any specimens seen from this area. The costae are moderately prominent and reaching to the end of the elytra where they appear to be nearly united from the dorsal view, but clearly separated if seen from the anal view. The third costa between the sutura and the second costa is broken but still visible and slightly shorter than costa one and two (Fig. B, C). The costae are all shiny, smoothly curved longitudinally. The surface of elytra is opaque. The fine granules are sharply elevated and appear to be smooth.

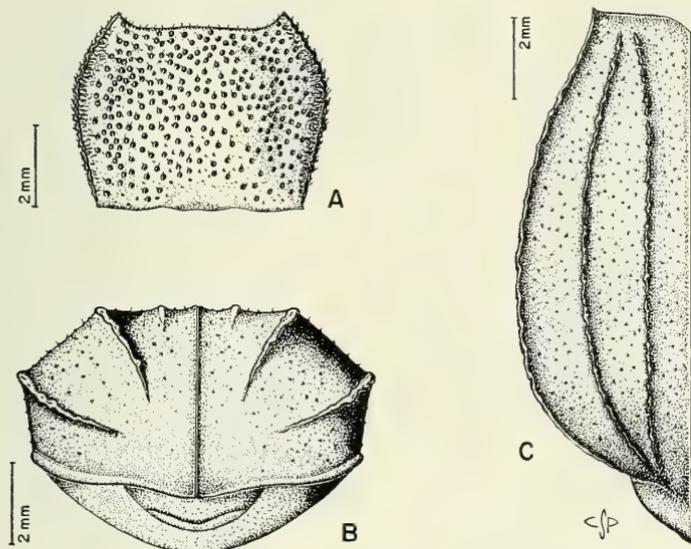


PLATE 26

Pelecyphorus actuosus Horn

Pelecyphorus jaegeri Papp, new species (Plate 27, A-C).—
 Locality: Quartz Hills, eight miles north of Palmdale, in the Upper Mojave Desert, Los Angeles County, southern California.—
 Black. Large, males 19.0-21.0 mm., females 20.0-23.0 mm. Head, pronotum, anterior legs opaque, the rest of the body, especially the strongly elevated elytra are smooth and shiny.—HEAD finely granulated, each granule with very short setae. Vertex flat, squarely impressed; labium widely rounded, anterior margin with dense, blackish-brown short setae. Labial palpi strong, last joint about twice as long as the second, triangularly shaped, smooth, on the exterior margin with short semi-erect setae. Antennae black.—
 PRONOTUM (A) slightly wider than the length, anterior margin longer than the posterior, sides more or less sharply rounded, margin heavily crenulated; edges sharp, pointed, in the anterior cornel with one more or less well visible rounded depression. Surface in the middle roundly elevated, near posterior end, occasionally also along the middle, with a smoother line; this surface very finely punctulate, occasionally with few heavier punctures. The anterior margin always with short, brownish-golden hairs.—
 ELYTRA (B, C) smooth, shiny. Margin rounded and less elevated than any of the longitudinal costae. The surface between the elytral margin

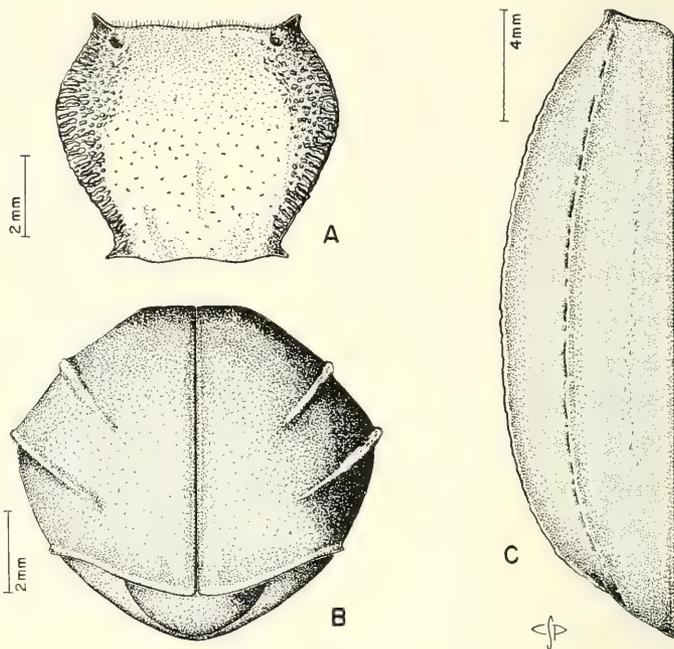


PLATE 27

Pelecyphorus jaegeri n. sp.

and the outer costa slightly concave, that between the outer and second costae flat; the surface between the latter and the sutura somewhat broken (B), well visible posteriorly. Humerus sharp, slightly pointed (C); a third costa near the sutura, as a shallow ridge sometime visible. — LEGS heavily crosswise granulated, claws dark brown, otherwise black; anterior pair opaque, others slightly shining; all with very short, dense setae. — ABDOMEN shiny, smooth, much finer punctured than the middle of the pronotum. — There are externally, except in sizes, no morphological differences in structure between sexes.

This species was previously reported by Papp and Pierce (1960) as *P. actuosus* Horn. It was first found by H. D. Pierce in October 1958, who is now conducting his study on the life history of this species. All ecological notes mentioned on page 156 under *actuosus* are to be added to observations with *P. jaegeri*.

The new species is sincerely dedicated to Dr. Edmund C. Jaeger, distinguished student of the North American deserts.

Pelecyporus porcatus Papp, new species (Plate 28, A-C). — A single female specimen from Whitewater, Southern California, from the aleolian sand dunes, west of the Joshua Tree National Monument. Length 22.0 mm. This extremely large, black species can easily be recognized by the sharp second costa, the deeply set middle portion of the elytra, and the comparatively small pronotum (A). — HEAD slightly wider than long; the surface with sharp, deep punctures; vertex flat and not separated; labium slightly annulated in the middle; the margin above and beneath the eyes with well developed and somewhat pointed sharp cornels. Antennae deep dark brown, nearly as long as the head. — PRONOTUM small (A), wider than long, anterior margin slightly

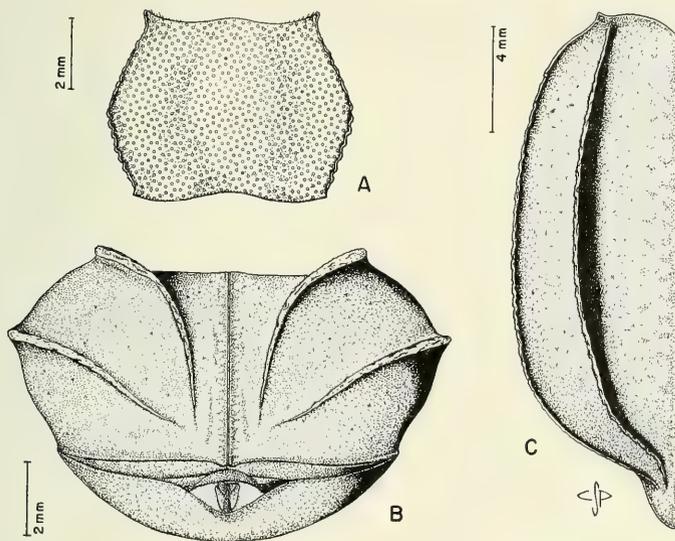


PLATE 28

Pelecyporus porcatus n. sp.

shorter than the posterior, anterior tip sharply pronounced, sides behind middle wider and more roughly edged as nearing the middle, posterior tips less pronounced, weakly pointed. Surface with fairly large rounded punctures evenly punctuated, middle sharply concave, edges almost flat, the latter with more dense granulation. The edges of the anterior of posterior portions of the pronotum are roughly parallel. — ELYTRA (B, C) in size very large compared with the pronotum, its margin shallow and smooth (B), the first

costa gradually elevated, the surface between the edge and the first costa, and between the first and the second costae similarly convex; that between the second costa and the sutura deeply set and flat (B); the second costa in its inner side sharply, in its outer side gradually elevated (B, C). The surface very finely and densely punctured with small and occasionally larger punctures; the middle slightly impressed, and smoothly wrinkled near the suture (C). The shoulders sharply pointed; the anal end narrow and more pointed compared with the previous species.—LEGS, only one right middle and hind left legs are present; they are roughly granulated, the spaces between granules smooth, almost shining.—ABDOMEN evenly and sparsely punctured, these punctures slightly finer than those of the pronotum.

The specimen was collected by Dr. A. L. Melander, on October 27th, 1934, and as type specimen it is now in the collection of the Department of Biological Control, Citrus Experiment Station, Riverside, California. Thanks are given to Prof. P. H. Timberlake for loaning *Pelecyporus* material for examination.

Pelecyporus carinatus LeConte (1851) briefly mentioned by Horn (1870:285) and referred to the illustrations of Lacordaire (1859) and quote only the type locality San Felipe, California. The Department of Entomology, Citrus Experiment Station, Riverside, Calif. has three specimens in the late George P. Mackenzie collection, collected by Mackenzie in Borrego, southern California, on October 7th, 1939. An additional specimen from the same location is in the author's collection.—This species is easily distinguished by its opaque but smooth general appearance, the short distance between the two costae, and the sharply, triangularly elevated middle portion of the pronotum. This interesting species will be discussed in detail in another paper with a group having similarly composed form of the pronotum.

Pelecyporus adversus Casey (1912), a roughly built species with two very prominent costae. There are two specimens in the Mackenzie Collection from Phoenix, Arizona, collected by G. P. Mackenzie on October 7th, 1939. The author also has one specimen from Phoenix, Arizona, and one from Wickenburg, Arizona.

Pelecyporus opinus Casey (1912). Two specimens from Muroc, California, collected by G. P. Mackenzie, on September 15th, 1944, are in the collection of the Department of Entomology, Riverside.

Pelecyporus morbillosus LeConte (1858) represented by two specimens from Gila Bend, Arizona, collected by F. H. Parker, on September 13th, 1935. Also known from Sonora and Lower California. Pallister (1954) has previously discussed the restricted distribution of this remarkable species.

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NOTES ON THE LIFE HISTORY OF
PALTHIS ANGULALIS HUBNER
(LEPIDOPTERA; HERMINIINAE)

By JOHN ADAMS COMSTOCK and NOEL MCFARLAND

In October of 1958 the junior author of this paper obtained larvae of *Palthis angulalis* in the Natural History Reserve of the University of Kansas, six miles northeast of Lawrence, Kansas. They were feeding on and in the dried seed pods of *Lobelia siphilitica* L.

Rearing of these in cooperation with the senior author made possible the data here presented, which is supplemental to the previously published notes of earlier writers.

In rearing the larvae attempts were made to substitute other plants, both green and dried, but without avail. Preference was always shown for the dried *Lobelia*. However, the literature revealed that a wide variety of host plants had been listed for *P. angulalis*. In 1904 Dyar¹ mentioned the food plant of a closely related species as "dead dry leaves." R. D. Bird, in 1927² listed the host plant as *Prunus virginiana* L. Brown and McGuffin, in 1942³ reported it feeding on Balsam fir, white, black and Engelmann spruce, gray birch, sugar maple and chokecherry. Putman, in 1942⁴ recorded it on "*Spiraea van houttei*." Forbes, 1954⁵ listed *Cornus stolonifera* and "honeysuckle," and also "reared from the frass-mass formed by *Tetralopha robustella*." Crumb, in 1956⁶ listed serviceberry (*Amelanchier*), blackberry and alder. Obviously the species is an indiscriminate feeder, but its habit of feeding on frass and dead leaves places it with a large group of potentially beneficial insects which convert waste organic matter into fertilizer.

It is not out of place to record a few other lepidoptera that serve a like purpose, even though the list is far from complete.

Laciniipolia cuneata (Grt.), *L. quadrilineata* (Grt.), *L. perbrunnea* (Grt.), *Homorthodes furfurata* (Grt.), *H. lindsei* (Benj.), *H. communis* (Dyar), *Elaphria grata* Hbn., *Anorthodes tarda* (Gn.), *Epizeuxis* of various species, including *jacchusalis* Wlk., *Philometra metonalis* (Wlk.), *Phalaenostola larentioides* Grt., *Horisma litophora* (Grt.), *Chytolita morbidalis* (Gn.), all species of *Renia*, three species of *Bleptina*, and *Herculia phoezal* Dyar.

The egg of *Palthis angulalis* was described in some detail by Dyar in 1904¹. He reported the color as "translucent whitish, with some irregular red spottings." Our single example had hatched

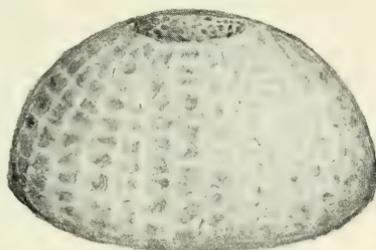


PLATE 29

Egg of *Palthis angulalis*, enlarged \times approximately 75.
Reproduced from painting by John A. Comstock

and the accompanying drawing (Plate 29) was based on the form only as shown by the empty shell.

Size: 0.65 mm. wide by 0.45 mm. tall. Hemispherical, with a flattened base. Vertical ridges run from the base to the micropylar area, but many of these in the upper area converge with their next parallel members. There are numerous horizontal grills running between the vertical ridges.

Dyar states that the vertical ridges were "about 40" in number. We could not distinguish that many.

The micropyle is relatively large and deep. Its floor is composed of irregular hexagonal pits.

Young larva. Dyar's notes, published in 1904¹ give the only known record of the young larva. Due to the fact that our examples were a composite lot and were feeding chiefly within the seed pods, it was difficult to determine the particular instar of any given individual. From head measurements we judge that our descriptions cover the last three instars.

LARVA OF THIRD INSTAR: Length, 5 mm. Head width, 0.9 mm. Head, deep black, covered with raised nodules. Mouth parts, black. Antennae, brown on basal segment, black distally. The face is covered sparingly with short translucent setae.

The body ground color is black, with occasional indefinite brownish-black lines. The entire surface is covered with raised black nodules. The segments are raised (rounded) transversely.

There is a raised "hump" on the 11th segment (8th abdominal segment). The remainder of the body is cylindrical, with a slight tapering of the caudal and thoracic segments.

A prominent brownish-black stripe extends from the side of the "hump," diagonally downward and forward to the base of the

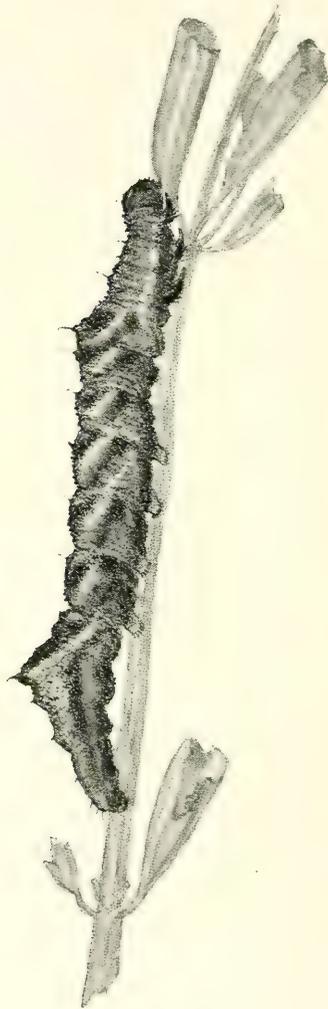


PLATE 30

Mature larva of *Palthis angularis* enlarged $\times 4$.
Reproduced from painting by John A. Comstock

proleg on the 9th segment. Five short diagonal lines of similar character occur dorso-laterally on each side.

The legs are black, and the prolegs, including the anal, brownish-black. The crochets are black.

There is a very sparse covering of short colorless setae scattered over the body, those of the caudal segments being longer.

The body has a frosted or encrusted appearance, due to the vestiture of raised nodules.

The larva is sluggish, and deliberate in its movements throughout all instars. Its color and texture in all instars is an excellent camouflage.

PENULTIMATE INSTAR. Length of larva, 7 mm. Head width, 1.2 mm. In color and shape the larva is as in the prior instar except for the following particulars: The diagonal light bar extending from the hump to the last proleg is larger and wider, and the small bars on the dorso-lateral surface now form a continuous longitudinal series of crescents extending from the 1st to the 9th segments. In addition, the prolegs are black.

FINAL INSTAR. This is treated in considerable detail by Brown and McGuffin³ and also by Crumb⁵. The length of the larva at the beginning of the instar is 11 mm.; when full grown, 20 mm. Head width, 1.5 mm.

The body ground color is a mottled light and dark brown, on which is superimposed a heavy sprinkling of black nodules. There is a narrow black middorsal longitudinal stripe.

From the 3rd to 9th segments the black nodules are concentrated middorsally to form a series of triangulate spots, one to a segment, the apices of the triangles pointing caudally. The dorso-lateral line of crescents is almost obsolete. The bar extending downward and forward from the hump has developed a bright yellow spot at its anterior end. The hump has become more prominent.

Toward the end of this instar the 4th segment expands laterally and superiorly into a transverse ridge with a pair of papilliform nodules on top, and one dorso-laterally on each side. The middorsal series of black triangles becomes more conspicuous, and a grayish-white powdering edges them laterally. The area latero-inferior to the hump also has developed into a whitish triangle, and the tip of the hump is surmounted by a pair of papillae. The spiracles are black, with black centers.

Other characteristic features not specifically mentioned are brought out in our illustration, Plate 30.

PUPA. Date of pupation, April 5, 1959. Length, 9.5 mm. Greatest width through patagia, 2.5 mm. Fusiform. Brownish-black on thorax and wing cases. Rich brown on abdominal segments.

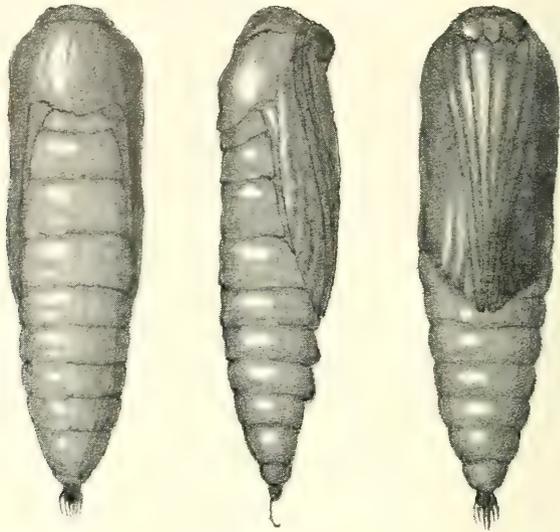


PLATE 31

Pupa of *Palthis angularis* in three aspects, enlarged $\times 7$.
Reproduced from painting by John A. Comstock

The eyes are not prominent. The antennae and maxillae extend to the margin of the wings. The spiracles are inconspicuous, and concolorous with the body. The cremaster is a pyramidal button, from which extends six slightly curved spicules. These terminate in minute recurved tips. The outer pair arise near the base of the papilliform cremaster, the inner two pairs near or on the tip.

The body surface is smooth and glistening. No setae are apparent. See Plate 31.

The cocoon is loosely woven and fragile.

The larvae of the fall brood overwinter, and change to pupae in the early spring. The imago is figured in Holland's "Moth Book," Plate XXXVII, fig. 25. He states (p. 285) that the insect is very common everywhere from Canada to the Gulf of Mexico east of the Great Plains. We have records from Texas and Arizona.

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SCIENTIFIC NOTES

A DESERT OBSERVATION OF
NECROBIA RUFIPES

In Vol. 58, part 3, pp. 162-165 of your "Bulletin" an interesting paper caught my attention, "Concerning North American *Necrobia*", by C. S. Papp (3 figs). After reading this paper it brought to mind specimens of *Necrobia rufipes* DeG. in my collection, which I gathered during late December of 1958 in the Palo Verde Valley, near Blythe, Calif. These specimens were taken from the decaying remains of two sheep quite infested with Dipterous larvae.

On close observation, I found the *N. rufipes* to be extremely numerous, (the largest population I have ever witnessed), and actively engaged in preying on the fly larvae. Adults and larvae of *Dermestes marmoratus* Say were also present, but they apparently were of little interest to the *Necrobia* at that time. Some of these beautifully colored beetles would attack one fly larvae, only to immediately leave it and pounce on another as though they had never eaten. This group may have been new emergents, as larvae were present and active copulation was taking place. The rapid activity of these beetles was quite amazing, for the nights were near freezing with day temperatures in the mid-seventies.

Other desert area *N. rufipes* in my collection include specimens from Lancaster, Calif., one group collected from fly larvae, the other from rancid peanuts. The further investigation of the life habits of *Necrobia* could contribute to our knowledge of the desert fauna of Southern California.

Harold D. Pierce
U.S.D.A. Plant Pest Control
Riverside, Calif.

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VOL. 60

SEPTEMBER-DECEMBER, 1961

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SUPPOSED MIOCENE FISH EGGS AND
EMBRYO FROM CALICO MOUNTAINS
NODULES, CALIFORNIA,
IDENTIFIED AS OSTRACODES¹

CARL L. HUBBS AND ROBERT RUSH MILLER

In two papers recently published in this journal, Pierce (1959a-b) reported as fish eggs a number of small fossils extracted from nodules collected in the Calico Mountains, in San Bernardino County, California. These nodules, which are interpreted as of middle or late Miocene age (Palmer, 1957), have yielded an amazing array of superlatively well-preserved arthropods, chiefly insects, many of which are silicified. Ostracoda were included in a list of arthropods from the nodules (Pierce, 1959a: 75).

Dr. Pierce (1959b: 79) stated that "the eggs were in different stages of development, some being solid, undifferentiated; others had 2 cells, 4 cells, up to complete embryo showing the typical forms of vertebrate embryos . . . In view of the absence of amnion, I consider these eggs and the separated embryo to be fish."

This report naturally caught the eye of the senior author, who brought the problem to the attention of his colleague, the junior author, who is expanding his researches on the fossil fishes of western North America. Dr. Pierce very kindly made available all the specimens he had listed (1959b: 82), with the exception of No. 8 ("bruised") and No. 9 ("broken"), but with the addition of 6 other specimen lots, comprising 9 "eggs."

Failing to note characteristics of fish eggs in these specimens the junior author referred them to his research associate, Dr. R. Jack Schultz, who has been studying the early development of the Cyprinodontes, the group of fishes represented by two fossils in other nodules from the same area (Pierce, 1959b: 79-83, pls. 25-26). Dr. Schultz was unable to find any indication that the fossil "eggs" are identifiable as of fish origin.

When, later, the specimens were jointly examined by the authors, the senior author interpreted the specimens as ostracodes rather than as fish eggs. This rough identification was confirmed by Dr. Claude W. Hibbard, of the Museum of Paleontology of the University of Michigan. The specimens were then referred to Dr. Robert V. Kesling of the same museum, a specialist on Paleozoic ostracodes, who further confirmed their pertinence to the Ostracoda, and noted their resemblance to the genus *Candona*.

At Dr. Kesling's suggestion the specimens were submitted to Dr. Erhard M. Winkler, of the Department of Geology, University of Notre Dame, a specialist on Cenozoic ostracodes.

¹Contribution from Scripps Institution of Oceanography, New Series, and from the University of Michigan Museum of Zoology.

Under date of February 16, 1961, Dr. Winkler reported on his findings. Except for a few specimens in much damaged condition, he identified all of the material as ostracodes. He stated that the generic identification was especially difficult since the original shell, carrying the diagnostic features of the muscle scars and details of the hinge line, had apparently been dissolved in the treatment of the nodules with acid.

Dr. Winkler's necessarily approximate diagnosis of the specimens that were figured by Dr. Pierce (1959b: pl. 24) follows:

Specimen 193 ("3 eggs"): "*Eucypris* or *Cyprinotus* [ostracode genera]; the specimen (193c) with the dorsal view clearly shows bivalval characteristics." Dr. Pierce listed each of these specimens as in good condition and as having a developing embryo, and figured, from drawings, A and C, both in lateral view, one of which (193c) is now mounted in dorsal view. This specimen and No. 193a (upper left) are herein refigured in more detail, from photomicrographs (Plate 33).

Specimen 114 ("3 eggs"): "Outline of *Cyprinotus* or *Candona*?; hinge line clearly visible." Dr. Pierce listed these specimens as "good" and as "solid" or "developing."

Specimen 274 ("10 eggs"): "*Cyprinotus* or *Cytheridea*; bivalval character clearly visible." Dr. Pierce listed these as in good condition and as containing, with one exception (not figured), a developing embryo.

Specimen 225 ("egg"): "Outline of *Cyprinotus*, possibly of *Candona*?" Dr. Pierce entered only the measurements of this specimen.

Specimen 113 ("embryo"): "Part of posterior shell margin of *Eucypris* (?)." This is the specimen that Dr. Pierce listed as "embryo alone," as "separate," and as "complete." The parts of the shell that remain attached to the intact posterior margin do bear a striking resemblance to a vertebrate embryo, but very clearly are part of the shell of an ostracode. The specimen was figured by Pierce, from a drawing.

Of the other specimens that Dr. Pierce listed (1959b: 82) Dr. Winkler noted:

Specimen 10 ("egg?"): "Broken up residue of *Eucypris*?"

Specimen 34 ("2 eggs"): "Dorsal hinge of *Eucypris*, other 'egg' mutilated."

Specimen 197 ("egg"): "Outline of *Cyprinotus* or *Candona*?"

Specimen 1772 ("broken egg"): "No clear outline visible."

Specimen 2298 ("fish egg"): "Irregular potato-shaped mass of plasma."

The 6 other specimen lots, not previously listed, added nothing.

Although the condition of these specimens did not yield certain generic identifications, it is clear that, so far as at all recognizable, they represent ostracode crustaceans and not fish eggs. No structures interpretable or countable as blastomeres were seen by us.

The two fish fossils, from nodules taken in the same area, that Pierce (1959b: pls. 25-26) figured and interpreted as "possibly Cyprinodont," are obviously referable to the Cyprinodontidae. An effort will be made to identify these fossils, though they now appear to have no bearing on the interpretation of the supposed fossil fish eggs. The junior author (Miller, 1945) described 4 fossil cyprinodontids from eastern California, including *Fundulus davidae* from the Mohave Desert near Black Mountain.

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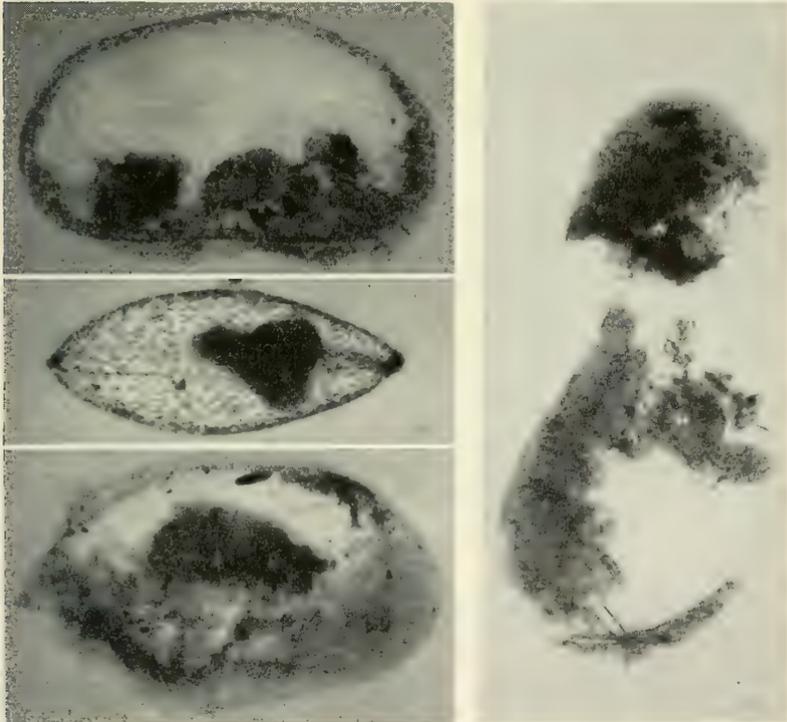


PLATE 33

Ostracode remains from Calico Mountains nodules: left figures, specimens 193a-c; right figure, specimen 113f. Photomicrographs by Carol J. Bumgardner.

BIRD REMAINS FROM INDIAN MIDDENS
IN THE DAKOTA AREA

By LOYE MILLER

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On several occasions in recent years I have undertaken with some reluctance, the study of bird remains from various Indian Middens in several western states. It was encouraging therefore to receive a personal letter from Dr. Wm. H. Burt of the Univ. of Michigan regarding his own attitude and efforts in such matters. The following is quoted from his letter: "It was my hope to shake the lethargy from some who are qualified to identify this kind of material, but who refuse to do it because they see no immediate personal gain. If those of us who can do this service won't do it, then it must be undone or performed by those who are not qualified — and too much of that has happened in the past." He is quite right. Some of us older students can only hope that we *are* qualified, because a blunder once spread upon the printed page can never be erased.

The subject of this discussion is a collection of bird remains from three sites along the Missouri River in North Dakota representing culture stages of the Mandan and the Arikara Indians and ranging in age from 1250 A.D. to 1650 A.D. (approximate dates). The Thomas Riggs Focus, the Huff Focus of the Mandans and the Chouteau Aspect of the Arikara are the culture stages recognized by Anthropologist W. Raymond Wood to whom I am indebted for loan of the material. I am deeply in debt also to the director, Dr. Alden H. Miller, of the Museum of Vertebrate Zoology at the University of California, Berkeley, for providing every facility of the museum while the study was carried on.

THE MATERIALS. Most of the bones are in an excellent state of preservation, very little fractured and none of them showing evidence of fire. All midden material that has come to me heretofore has puzzled me by the high degree of breakage (Miller 1957, 1960A, B).

Ten bones representing four species had been worked into awls for sewing animal skins. The very dense and hard bird bone would serve this purpose well in the sewing of lighter skins for clothing or ornament. I am inclined to ascribe the majority of the remaining bones to such functions as ornamentation, to totemic, ceremonial or religious function (not that these uses are entirely separable).

REMARKS ON CERTAIN SPECIES. In the fauna of the Dalles Midden of Oregon, the Bald Eagle ranked next to the highest in

abundance of all species. It was the only eagle present. Here only the Golden Eagle (*Aquila chrysaetos*) is present and only in very small numbers. One claw, fragments of the radius, the ulna and parts of the very strong tibia, which had been worked into awls, are present. The eagle feather became of great significance in the culture of the plains Indians. If we can credit some non-scientific authors we are given to understand that the Golden Eagle was captured alive and robbed of its prized feathers, then liberated much as the pre-contact Hawaiians practiced "Game conservation" in obtaining feathers for their remarkable feather cloaks and capes. The Indians of Southern California and Arizona sacrificed the large vultures and eagles in certain of their rituals (Miller '57).

If, as seems questionable, the Dakota Indians practiced such ceremonial sacrifices, the eagle remains were perhaps removed to certain sacred spots apart from the camp sites that provided the midden material. An alternate suggestion is that, in the main, other species, for example the corvids, were the subject of sacrifice.

The Raven and the Crow (*Corvus corax* and *C. brachyrhynchos*) occur in every midden and their numbers are relatively great. It is difficult to visualize them as favorite food species when so many others were doubtless available. Along with *Corvus* there is one bone of the Magpie (*Pica pica*), a bird with striking plumage. Various parts of the trunk and limbs of *Corvus* are represented. My surmise is that at least certain clans or brotherhoods of the tribe used the corvids in sacrifice or captured them for their plumage without the conservation practice suggested above for the eagle. I saw in 1919, a temporary camp of "Digger" Indians in Death Valley, Calif., who had a captive magpie in a cage.

Marsh Hawk (*Circus cyanea*). Howard (1929, Univ. of Calif. Publ. Zool., vol. 32, p. 350) records a single bone (femur) of this species among the more than 4,000 bones from the Emeryville Midden in central California. Otherwise it is not known to me from any of the western middens. It was a great surprise therefore to find it in all three Dakota middens and ranking high in the scale of abundance. Much the same may be said of the buteonid hawks (*Buteo* spp.).

Buteo regalis must be present. It is the only living *Buteo* of sufficient size. *Buteo lagopus*, *B. jamaicensis*, *B. swainsoni*, *B. platypterus* might be equally appropriate names to apply to the series of hawk bones that range greatly in size. Eight tarsi of *Circus* occur, as against only one tarsus of *Buteo*. Wing bones, especially the metacarpus, of both genera are abundant. Possibly the wings of both genera were desirable in ornament or as symbols of rank. The feet of *Circus* might have been important to the medicine man or in the rites of certain clans within the tribe.

Pipe stems or "flutes" are made from long bones of large birds by some primitive peoples (not to mention deep water sailors) but no such artifact has come into my hands. The distal end of the humerus of a White Pelican (*Pelecanus erythrorhynchos*) is the only bone that suggests such an interest on the part of the Indians.

FOOD SPECIES. The Caucasian palate, modified by familial generations (and the individual's years) of artificial living, should perhaps be used only as a minor and a hypothetical factor in determining this category of our artificial classification. The American Bison was probably the Indian's main source of sustenance, even before the introduced horse became his great assistant in its pursuit.

The Canada Goose and the Prairie Chicken would probably appeal as a variant in the diet of buffalo meat and venison. Both birds are fairly well represented. The category of "Food species" need not, however, be considered as exclusive. Goose quills may have feathered the best arrows, the rich tones of certain grouse feathers have decorative value while the stout, thick walled long bones qualify them well for the making of awls and beads. No bone shows evidence of fire and only one is from an immature bird.

A striking feature of this precontact avifauna is its brevity. The Indians seem to have had little interest in acquiring birds. Many striking species must have been fairly common in their environment but they fail to appear in the refuse heaps. Had they developed the nomadic habit of following the buffalo to such extent as to modify the midden picture in comparison with the less migratory peoples heretofore studied? There is no bone of the Trumpeter Swan and but one of the Whooping Crane both of which species must have been conspicuous in the ecologic setting of the pre-columbian Indian. The Passenger Pigeon, that "darkened the skies" with its migrating millions a century or two ago, does not appear in the collection. Why was this ready source of food neglected? Squaws and children could have done all the food gathering here. Other birds of the area, such as gulls, cormorants and loons, abundant in western middens, do not occur. Owls, represented by a single fragment, may have been protected by superstition or by tabu. The Carolina Parakeet formerly ranged through this area. Its striking plumage should have attracted the Indian here as the various parrots and macaws did those of Peru and Chile.

Much of this paper is confessedly speculation but we can't ask the Indians. The picture can be built up only in such fashion.

LIST OF SPECIES

| | Age Culture Site | A.D. 1250-1300 Thomas Riggs 32 SI - 4 | A.D. 1450-1500 Huff Focus 32 MO - 11 | A.D. 1500-1650 Chouteau 39 CO - 1 |
|----------------------------------|------------------------|---|--|---|
| <i>Pelecanus erythrorhynchos</i> | | | | |
| Humerus | | | | 1 |
| <i>Botaurus lentiginosus</i> | | | | |
| Carpus | | | 1 | |
| <i>Cygnus columbianus</i> | | | | |
| L. mandible | | 1 | | |
| <i>Branta canadensis</i> | | | | |
| Tarsus | | 1 | 1 | |
| Coracoid | | 3 | | |
| Ulna | | 1 | | |
| Furcula | | 1 | | |
| Humerus | | 4 | | |
| Carpus | | 3 | | |
| Femur | | 3 | | |
| Duck (gen. sp?) | | | | |
| Tarsus | | 1 | | |
| Humerus | | 1 | | |
| Furcula | | 1 | | |
| Ulna | | 1 | 1 | |
| <i>Aquila chrysaetos</i> | | | | |
| Radius | | 6 | | |
| Claw | | 1 | | |
| Ulna | | 2 | | |
| <i>Buteo</i> sps. | | | | |
| Tarsus | | 1 | | |
| Femur | | 1 | | |
| Humerus | | 1 | | |
| Ulna | | 10 | | |
| Carpus | | 10 | 4 | 2 |
| Pelvis | | | 1 | |
| <i>Circus cyanea</i> | | | | |
| Tarsus | | 6 | 1 | 1 |
| Humerus | | 2 | | |
| Tibia | | 2 | 1 | |
| Pelvis | | 1 (?) | | |
| Femur | | 3 | | |
| Ulna | | 5 | | |
| Carpus | | 4 | | |
| Sternum (?) | | 1 | | |
| <i>Tympanuchus cupido</i> | | | | |
| Sternum | | 4 | | |
| Humerus | | 3 | 1 | |

| | Age Culture Site | A.D. 1250-1300 Thomas Riggs 32 SI - 4 | A.D. 1450-1500 Huff Focus 32 MO - 11 | A.D. 1590-1650 Chouteau 39 CO - 1 |
|------------------------------|------------------------|---|--|---|
| Ulna | | 3 | 5 | |
| Carpus | | 2 | | |
| Radius | | 1 | | |
| Furcula | | 2 | | |
| Femur | | 3 | 2 | |
| Tarsus | | 5 | | |
| <i>Grus americana</i> | | | | |
| Radius | | 1 | | |
| <i>Grus canadensis</i> | | | | |
| Ulna | | 3 | | |
| Radius | | 1 | | |
| Tibia | | 1 | | |
| Tarsus | | | | 1 |
| <i>Bubo virginianus</i> | | | | |
| Ulna | | 1 | | |
| <i>Corvus corax</i> | | | | |
| Humerus | | 2 | | |
| Femur | | 1 | | |
| Coracoid | | 4 | | |
| Tarsus | | | 1 | |
| Ulna | | | 2 | |
| Carpus | | | | 1 |
| <i>Corvus brachyrhynchos</i> | | | | |
| Humerus | | 2 | | |
| Tibia | | 3 | 2 | |
| Ulna | | 1 | | 1 |
| Femur | | 1 | | |
| Sternum | | 1 | | |
| Tarsus | | 1 | | |
| Carpus | | | | 1 |
| <i>Pica pica</i> | | | | |
| Tarsus | | | 1 | |

SPECIMENS WORKED INTO AWLS

| | | | | |
|---------------------------|--|---|--|--|
| <i>Cygnus columbianus</i> | | | | |
| Distal end of ulna | | 1 | | |
| <i>Aquila chrysaetos</i> | | | | |
| Distal end of ulna | | 2 | | |
| Distal end of radius | | 3 | | |
| Proximal end of radius | | 1 | | |
| Proximal end of tibia | | 1 | | |
| <i>Grus americana</i> | | | | |
| Proximal end of radius | | 1 | | |
| <i>Bubo virginianus</i> | | | | |
| Proximal end of ulna | | 1 | | |

NONMARINE MOLLUSCS FROM THE
LA PLAYA SITE, SONORA, MEXICO: 2*.

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ABSTRACT. Ceramic cross-dating indicates the La Playa site was occupied by people of the Trincheras Culture ca. A.D. 800-1100. *Pisidium*, *Helisoma*, and lymnaeids discussed in a previous report are believed to be of this time. Other molluscs, succineid snails, may represent both earlier Cochise and later Trincheras times. Molluscs of common genera occurring in Southwestern sites are discussed.

INTRODUCTION

In November of 1959, Alfred E. Johnson of The University of Arizona, submitted nonmarine shells from the upper cultural bearing zone of the La Playa site in Sonora for evaluation of their environmental implications. A report was made to him that the succineids (called *Succinea* for want of a better genus-term) were terrestrial (almost amphibious) and that the *Helisoma* was a pond form. A second sample from him contained in addition a small lymnaeid called *Lymnaea*—also a pond type and small freshwater bivalves (*Pisidium*). A report (illustrating the 4 genera) on the 216 shells from the La Playa site was published (Drake 1960). Mr. Johnson's thesis has now been submitted and was obtained by interlibrary loan in August 1960. A further discussion upon some implications of nonmarine shells in the site is now presented.

DATING OF THE SHELLS

The predominant painted pottery in and at the La Playa site was Trincheras Purple-on-Red (Johnson 1960: 220). This is found in dated southern Arizona sites of ca. A.D. 800-1100. Intrusives at La Playa were: Santa Cruz Polychrome and Rillito or Rincon Red-on-Black (Johnson 1960: 222), also of the same time span.

With cross-dating from ceramics, a start can now be made in dating members of the older populations of pond snails and bivalves from the drainage of the Rio Boquillas, Sonora; the succineids, however, present more problems (Drake 1960: 134). It is

*In part the result of archaeo-malacological investigation supported by American Philosophical Society grant 2696 (Penrose Fund).

possible that future controlled collecting may turn up the 4 forms reported from the La Playa site in other sites and/or still living in the area.

The La Playa site was badly eroded and little stratigraphy could be studied and reported for later correlation in the area.

COMMON GENERA IN SOUTHWESTERN SITES

Many, if not most, sites in the arid and semi-arid portions of Western North America contain snail shells of prominent genera of the families Planorbidae, Lymnaeidae, Physidae, and Succineidae; valves of small bivalves of the family Sphaeriidae are also common. At the present time and for most geographical areas, taxonomic concepts of many species of these 5 families are not generally understood; the average student of molluscs usually cannot make "correct" species determinations to pass along to the archaeologists.

With rare exceptions, archaeologists don't have time to be interested in the taxonomic and distributional problems of mollusc shells found in sites they dig. They are, for the most part, and naturally, more interested in what the shells can show as to the history of events during periods in which sites were occupied or *not* occupied. Study of some shells from some sites has (*along with other factors*) shown reversed or disturbed stratigraphy, broad environmental pictures, and climatic changes.

Molluscs found in sites and referred to here are small pond forms and minute terrestrial snails which lived uphill in regions of sites and which were deposited in living areas maintained by Indians or other (later) peoples. They are not the large and sometimes edible snails and bivalves found in the more southern and tropic regions; such, especially the larger landsnails, can sometimes provide information of value to the archaeologist (MacNeish 1958: 144-152).

During the 1960's and on, there should certainly be more regional nonmarine molluscan literature available to archaeologists so they may check determinations if need be; in time, manuals on mollusc-identification prepared expressly for archaeologists may be available. For advances in recent literature, the monographs by D. W. Taylor (1960; Hibbard and Taylor 1960) are constructive models.

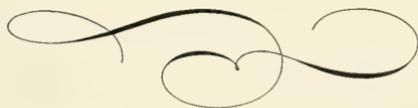
SUMMARY

Perusal of the archaeological report on site Sonora: F:10:3 written by A. E. Johnson suggests a possibility of more than one occupation. Typology of stone artifacts pointed to two cultural

pictures although his report on La Playa was also of the Trincheras Culture. In the first paper on nonmarine molluscan remains from La Playa, redeposition of some pre-ceramic time succineid snail shells was intimated. Similar molluscs from future excavations in northern Sonora (and Cochise and Trincheras sites) might provide additional ecological or climatic information.

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THE CUMACEAN FAUNA OF THE
SOUTHERN CALIFORNIA
CONTINENTAL SHELF

No. 1, Family LEUCONIDAE

By ROBERT R. GIVEN¹

INTRODUCTION

An extensive survey of the soft-bottom areas of the southern California coast has recently been completed by the Allan Hancock Foundation of the University of Southern California, under the direction of the State of California Water Pollution Control Board. The continental shelf, from Point Conception on the north to the Mexican border on the south, was systematically sampled, in depths ranging from twelve to six hundred feet. The R/V VELERO IV, marine laboratory of the University of Southern California, was used to obtain the samples, which were then processed according to the methods described by Barnard and Ziesenhenné (1960).

Members of the arthropod class Crustacea comprise about one-third of the total number of invertebrate specimens recovered. The Ostracoda are most abundant, although it is thought that most of these are lost due to screening methods. Second in abundance are the gammaridean amphipods, with the cumaceans ranking third.

The order Cumacea is represented on the southern California coast by at least eleven of the twenty-six accepted families. The last major work on the cumaceans from this area was done by Zimmer in 1936, in which he described several new species. These were found again in the study just completed, and, in addition, many undescribed forms were noted.

Due to the large number of samples taken in this survey, most of the species are represented by many specimens, making taxonomic and developmental studies and comparisons relatively simple and yet statistically significant. Especially important is the opportunity to follow the development of the juvenile male into the adult form. Because of the abundance of undescribed species in this collection, it was deemed essential by this writer to have these described and available in the systematic literature before attempting a compilation of the distribution and ecology of the cumacean fauna of this coast. It is anticipated, however, that such a study will be completed in the near future, making use of the physical and chemical data from the aforementioned survey report.

¹Allan Hancock Foundation, Univ. of So. Calif.

The new forms will be presented systematically, family by family, similar to the method used by Hale in his work on the Cumacea of Australia. The family Leuconidae will be treated first, chosen because one of its members, *Eudorella pacifica* Hart (1930), is one of the two most abundant cumaceans on this coast. Descriptions and illustrations will be made, but the ecological information will be cursory at this time, consisting mostly of depth ranges within the boundaries of the southern California continental shelf.

FAMILY — LEUCONIDAE

DIAGNOSIS — body usually slender, carapace small and laterally compressed. All pedigerous segments distinct. Pseudorostral projection either distinctly prominent or obsolete. Eye wanting. First antenna either variously geniculate or straight; outer flagellum in female very small, in adult male well developed, often reaching or exceeding body length. Mandibles broad at base, comparatively short, with two small setae behind the cutting edge, spines few. First maxilla with palp having only one seta; second maxilla small. Exopods on first four legs in male, first three legs in female. Two pair of pleopods in male. Telson lacking; last abdominal segment slightly produced behind. Uropods with endopod two jointed, spinulose; exopods setiferous.

DISCUSSION

The four genera presently accepted as belonging to this family are at times widely separated by striking external differences, but agree rather closely in many of their anatomical details. This is especially noticeable in the comparative morphology of the mouth parts of all the genera. The total absence of the telson separates the family from the Vaunthompsoniidae and Diastylidae; it resembles the former in having three pair of exopods on the female pereopods, and the latter by having only two pair of pleopods present in the male.

Calman (1907) placed three new genera in this family (*Paraleucon*, *Hemileucon*, and *Heteroleucon*). Stebbing in 1912 removed these from the Leuconidae and made each the type genus of a family, using the contrasting number of male pleopods to separate them. He also considered the fact that *Heteroleucon* has only two pair of exopods on the pereopods of *either* sex. This writer holds with the families which Stebbing has erected, and therefore considers only four genera in the family Leuconidae — *Leucon*, *Eudorella*, *Eudorellopsis* and *Pseudoleucon*. Three of these four genera are represented on the southern California coast, *Pseudoleucon* being absent as far as is known.

Key to the genera of the family Leuconidae after Stebbing

- | | | | |
|---|---|--|----------------------|
| 1 | } | First antenna not geniculate..... | <i>Leucon</i> |
| | } | First antenna geniculate..... | 2 |
| 2 | { | First antenna geniculate between second and third joints..... | <i>Eudorella</i> |
| | { | First antenna geniculate between first and second joints..... | 3 |
| 3 | { | Pseudorostrum obsolete; or short, vertical, truncate..... | <i>Eudorellopsis</i> |
| | { | Pseudorostrum obliquely upturned above the carapace..... | <i>Pseudoleucon</i> |

GENUS — LEUCON

DIAGNOSIS — general body shape slender; carapace small and laterally compressed. A serrated dorsal crest is present on the carapace of the female, the serrations varying in number and appearance among the species; the male may or may not have this crest. Pseudorostral projection always present, may vary in size, shape, and angle among the species, between sexes, and to some extent, among individuals of the same sex and species. First antenna not geniculate, inner flagellum rudimentary. Second antenna in male typically long, sometimes exceeding body length; in female very small with distal joint well defined. First pereopods long and slender, last joint usually provided with long heavy bristles. Second pair of pereopods stout, last joint bristled. Third pair of pereopods also stout, may have peculiar appendages appearing on the inside of the ischial joint in the male (several species lack this, however). Uropods with rami tending to be nearly equal in length, the inner ramus usually the shorter. In some species the inner ramus of the female is considerably shorter than the outer ramus, in contrast to the male of the same species where the rami are nearly equal in length. Both rami are generally well armed with spines and ciliated bristles, with the inner ramus tending to be most heavily armed with stout spines; this armament often varying between sexes of the same species.

DISCUSSION

This being the type genus, it adheres closely to the diagnosis of the family. Some species show marked sexual dimorphism. The main taxonomic characters are the differences in the dorsal crest and the size and armament of the uropodal rami.

***Leucon subnasica* new species**

DIAGNOSIS—this species closely resembles *Leucon nasica* (Kroyer) and the description can best be made by citing differences and similarities between the two. Sars (1900: 30, pl. XXI, XXII) redescription of *L. nasica* will be used for comparison.

Carapace— as in *L. nasica*, with adult male having a shorter, more truncate and more horizontal pseudorostrum than the female, and lacking any trace of a subrostral sinus. Differs from *L. nasica* in that both male and female specimens possess the dorsal crest, extending *to but not beyond* the middle of the carapace; and *not* continued again on the posterior portion. The serrations vary in number from six to fourteen, with the most frequent being from nine to eleven. In the adult female the angle which the pseudorostrum makes with the horizontal may vary slightly between specimens, as may the relative depth of the subrostral sinus.

Antennae and mouth parts—very similar to *L. nasica*, with some minor differences in numbers of setae.

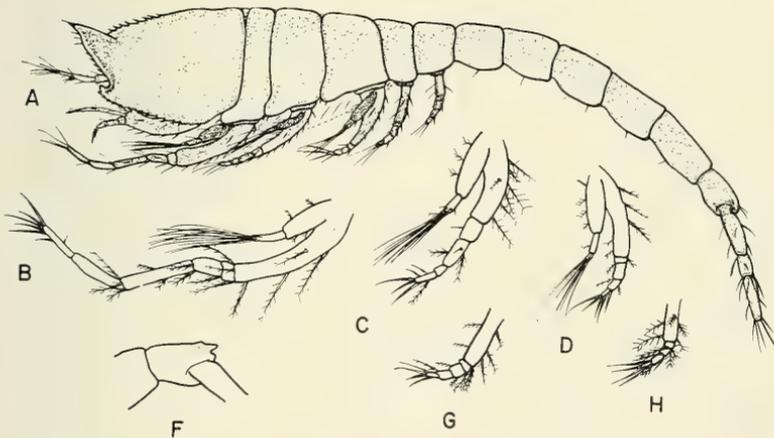


PLATE 34

Leucon subnasica n. sp.

- A—adult female, sta. 5874, 3.5 mm.
 B—pereopod 1
 C—pereopod 2
 D—pereopod 3
 F—last pleon segment, adult male
 G—pereopod 4
 H—pereopod 5

Pereopods and pleopods — as in *L. nasica*, noting the following differences:

Pereopod 1 — lacking the stout spines on the first and second joints, as Sars depicts in *L. nasica*. The male, and sometimes the female, of *L. subnasica* have a small, slightly curved tooth on the second joint.

Pereopod 2 — lacking the “nine diverging ciliated spines on the last joint,” as described by Sars for *L. nasica*. The new species may have three or four large bristles or “spines,” finely ciliated at the tip.

Pereopod 3 — in the adult male, lacking the “two very conspicuous, ensiform appendages — originating from inside the ischial joint” which Sars has shown to be most prominent in *L. nasica*. *L. subnasica* has two long, finely ciliated bristles at this place, but they are not peculiar or outstanding enough to make them diagnostically important.

Pereopods 4, 5 and peopods 1 and 2 — as in *L. nasica*.

Uropods — similar to *L. nasica*, being robust, with the rami in both sexes being subequal in length, but varying somewhat in their armament. The inner ramus in both sexes has a heavily spined inner edge; and a long spine with one long bristle associated with it, located at the tip of the distal joint. The outer ramus of both sexes is armed with long setae, but while Sars depicts the female *L. nasica* as having the same setation as the male, in the new species setae on the outer ramus in the male are considerably more numerous, longer and more plumose than those of the female. Many of the bristles on the inner ramus of the female uropod lack any ciliation whatever, a distinct difference from the situation in *L. nasica*. The adult male of this species possesses a modification of the last, or sixth abdominal segment, which is not characteristic of this genus. It is a character of the family that, while lacking a telson, the last segment is slightly produced behind. As seen in a side view, this “slight production” of the segment is exaggerated to form a definite knob-like protuberance, preceded on the same segment by a small hump, both of which are covered with tiny denticles. This is in marked contrast to the female of the species, whose last segment is more rounded and is provided with short bristles. In all the other species of this genus there appears to be no marked difference in this segment between male and female.

Observations on general development of juvenile males

As is characteristic for this family, and probably for the order as a whole, the juvenile males look very much like the females in the early stages of development. The same is true in this

species, with the juvenile males being distinguished only by a slight tendency of the pseudorostrum to become more horizontally aligned; and by the presence of the developing exopods on the fourth pereopod, the rudiments of the pleopods, and the elongation of the second antenna. As the males grow older, evidenced by the increase in size of the exopods and pleopods, the angle of the pseudorostrum becomes more horizontal; the small teeth present on the anterior edge of the carapace, as seen in the female and the juvenile male, disappear; the subrostral sinus begins to straighten out and eventually disappears; and an increase is seen in the length of the second antenna. It is not until the very latest stages of development that the peculiar knob-like protrusion of the last abdominal segment appears. Up until that time the segment looks like that of the female, except that it may lack the small bristles.

DISCUSSION

The appendages not specifically mentioned in this description, especially the mouth parts, correspond so closely to Sars' redescription of *L. nasica* (Kroyer) that it was not deemed necessary to redraw them. The differences between the two species have been pointed out, the major ones being the lack of the pronounced ensiform appendages on the third male pereopod; the lack of the continuation of the carapace crest past the mid-point; and the presence of the peculiar extension of the sixth abdominal segment in the adult male.

The presence of the dorsal carapace crest in both sexes in this species is also a most important taxonomic character, and merits some further discussion. In diagnosing the genus *Leucon*, Sars (1900:29) stated, "Carapace of male generally without any dorsal crest—." Under "Remarks," on p. 31 of the same work, in describing *L. nasica*, he discussed the transformation of the juvenile male to the adult male: "In the young, not sexually mature state, the male does not exhibit any pronounced difference in its general appearance from the female, the form and armature of the carapace being the very same in both. It is quite otherwise when the male has reached full sexual maturity. In this state, on account of the peculiar transformation of the carapace, it looks so very different from the female that even in quite recent times, its true relation has been wholly misapprehended." "As will be shown further on, an altogether analogous transformation of the male is proven to take place in all our other species of the genus."

The last statement, which seems to encompass *all* species of the genus, may be misleading if interpreted in this way, since Sars has stated previously, in the same manuscript, that the male may or may not have the dorsal crest. If Sars' statement is interpreted

literally, that this juvenile-to-adult transformation has taken place "in all *our* other species —," (meaning the group he described from Norway), the statement is valid. It is important to clarify this point concerning the dorsal crest in the male *Leucon*, especially in connection with the species just described (*L. subnasica*). The adult male definitely has a fully developed dorsal crest, and shows no signs of any transformation from the juvenile in this respect. Certainly Sars' statement concerning this must not be interpreted to mean that the loss of the dorsal carapace crest is a diagnostic character for the whole genus.

DISTRIBUTION — generally distributed along the coastal shelf of southern California, in depths of 20 to 540 feet, most abundant from 90 to 270 feet.

HOLOTYPE — AHF 5618, adult female, 4 mm.

COTYPE — adult male, 4 mm.

TYPE LOCALITY — VELERO IV station 4722-56, near Newport Beach outfall, Orange County, bearings 33-34-52 N, 117-58-16 W, in 181 feet of water. Fine sand, taken with Hayward grab, November 21, 1956.

Leucon armatus new species

DIAGNOSIS — While strongly resembling *Leucon nasica* (Kroyer) in most of the appendages, this species shows a marked

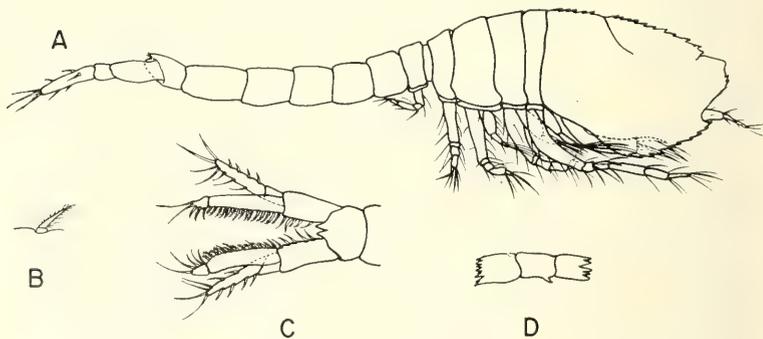


PLATE 35

Leucon armatus n. sp.

A—adult female, sta. 4851, 5.5 mm.

B—uropodal endopod spine, showing setation

C—female uropod

D—pereopod 1, third joint, female

superficial similarity to *Leucon nasicoides* Lilljeborg (see Sars 1900, pl. XXIII). This is especially noticeable in the truncate pseudorostrum and the lack of uropodal setation. This species lacks the three denticles on the anterior portion of the carapace, which typify *L. nasicoides*.

There were no adult males found among the nineteen specimens available for study, so the description of this species will be confined to that of the adult female, with comments on some of the juvenile males. *Leucon armatus* shows many similarities to *L. nasica*, particularly when comparing the appendages. In view of this, and since *L. nasica* is the type species of the genus, this writer feels that a comparative description will be most valuable. Sars (1900: 30) redescribed and illustrated *L. nasica* most completely, and this description will be used as the basis for comparison. Only the parts that differ from *L. nasica* will be described in detail.

Carapace — the appearance of this animal tends to be deeper, more robust and slightly larger than *L. nasica*. The carapace strongly resembles *L. nasicoides*, being slightly inflated, and possessing an extremely short, truncate pseudorostrum with two or three small teeth on its anterior edge. It lacks the three denticles seen on the carapace of *L. nasicoides*. A dorsal crest of large teeth extends to the posterior carapace margin, interrupted only by a peculiar break in the symmetry of the dorsal part of the carapace. This break is caused by a shallow depression beginning dorsally about two-thirds of the distance posteriorly from the pseudorostrum, and descending in a slightly anterolateral direction for a short way, then smoothing out and blending into the general contour of the carapace. This depression, although not a true break in the carapace, or even a groove, is enough to provide a small hump in the dorsal line of the carapace and interrupt the dentition of the dorsal crest. This situation is similar to that seen in *L. nasica*, except that no antero-lateral depression is indicated for that species.

Antennae and mouth parts — as in *L. nasica*, with some minor differences in setation.

Pereopods — as in *L. nasica*, with the following exceptions:

Pereopod 1 — bearing only *one* large tooth, situated on the lower margin of the third joint, whereas in *L. nasica* there is an additional tooth on the lower margin of the second joint.

Pereopod 2 — possessing nine long, stout bristles on the last joint, finely ciliated, but different from the "nine diverging ciliated spines" described by Sars for *L. nasica* in their length and in the lack of heavy ciliation.

Uropods — the differences between *L. nasica* and *L. armatus* n.s. are most strongly noted in a comparison of the uropodal region. *L. armatus* has extremely stout, slightly curved, broad uropodal rami, heavily armed with spines and noticeably lacking in bristles or setae. The peduncle is armed with four or five large spines on the inner margin. The exopods are slightly shorter than the endopods, and very sparsely armed with stout, naked bristles. The endopods are broad, slightly curving outward, with the second joint less than one-third as long as the first, while in *L. nasica* it is about one-half as long. There are about 15 large, stout spines on the inner margin of the first joint, resulting in an extremely heavily armed appearance. These spines also appear to be barbed, but close microscopic examination shows rows of short pinnations on each side of the spine. The second joint of the endopod possesses three small pinnate spines on the inner margin and two longer spines on the end.

NOTES ON JUVENILE MALES —

No adult males were at hand. The most fully developed juvenile male had moderately well developed exopods on pereopods 3 and 4, and the pleopods were distinctly more than embryonic buds, although the second antenna was still folded under the carapace. Otherwise, this specimen resembled the female, but showed a tendency to the loss of its dorsal crest dentition, which is common, but not characteristic, of the genus. These teeth were absent from about the midpoint of the carapace back to the posterior edge, on this particular animal. A less fully developed juvenile male (smaller pereopods, less development of the pereopodal exopods and of the second antennae) still showed the full dorsal crest which is characteristic of the female.

In the absence of the adult male, no comparison could be made between this species and *L. nasica* concerning the ensiform appendages on the third pereopod. The most fully developed juvenile male, however, gave no indication of possessing these structures.

DISCUSSION — The characteristic morphological features for this species are:

1. peculiar interruption of the carapace dentition, apparently caused by the shallow antero-lateral depression;
2. presence of only a single tooth on the third joint of the first pereopod;
3. broad, stout, curving uropodal endopods, with their armament of large pinnate spines and lack of accessory bristles or setation. The extreme paucity of the typical small body bristles and setae is most noticeable, especially when compared with other members of the genus, or other families of the order.

HOLOTYPE — AHF 5726, adult female, 5.5 mm.

TYPE LOCALITY — VELERO IV station 4851-57, Mugu Canyon, 7.75 miles 134°T from Port Hueneme light, California, bearing 34-03-30 N, 119-05-55 W; in 560 feet of water, found at this station only. Total of 19 specimens, females and juvenile males. Hayward grab, olive green sandy silt.

***Leucon magnadentata* new species**

DIAGNOSIS — Adult female. Carapace compressed, slender, not robust. Pseudorostrum large, triangular, slightly upturned; anterior margin equipped with two or three small, curved, blunt teeth and a few setose bristles. Subrostral notch not extremely deep; ventrolateral margin of carapace strongly toothed anteriorly for about one-third its length. The dorsal crest of this species is extremely diagnostic, consisting of a few large, curving denticles instead of many small serrations, as is seen in many species of this genus.

Of the four specimens examined, three were adult females, showing slight variations in carapace character, as seen below :

Female No. 1 — pseudorostrum slightly upturned, with two or possibly three small blunt teeth; immediately behind the pseudorostrum are five large teeth followed by two smaller ones, carrying the dentition of the dorsal crest to about the halfway mark on

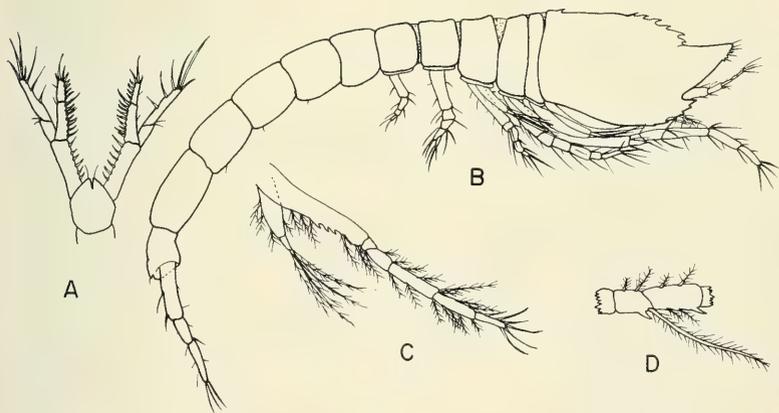


PLATE 36

Leucon magnadentata n. sp.

A—uropods

B—Adult female, sta. 5762, 5.5 mm.

C—Pereopod 1

D—section of maxilliped 3, fourth and fifth joints, showing teeth

the carapace. Following these teeth is a long, smooth space, terminating in a slight depression leading to an elevation supporting a single medium sized denticle.

Female No. 2 — has two, or possibly three, small blunt teeth on the anterior edge of the slightly upturned pseudorostrum. The dorsal crest consists of three small teeth followed by four larger ones, followed by the long smooth space with the depression, elevation and single tooth.

Female No. 3 — pseudorostrum slightly upturned, three blunt teeth on the anterior edge. Dorsal crest starts with two small teeth, followed by four very large and three smaller denticles, with a very small tooth on the posterior elevation.

The fourth specimen examined was a juvenile male, which will be described later.

The abdominal segments of this species are thick, robust, and sparsely setose.

Appendages — as is characteristic of this genus, many of the appendages of the different species are nearly identical in morphology, except for minor differences in bristles and setation. *Leucon nasica* (Kroyer), being the type species of the genus, has been used previously in this report for comparison of appendages, and Sars' (1900) description and illustrations of this species will be used again here for this purpose.

Antennae — as in *L. nasica*, with the accessory flagellum of antenna 1 very small, last joint of primary flagellum as long as the second.

Mouth parts — similar to *L. nasica*, with the following exception: maxilliped 3 has a large tooth on the fourth joint, and another on the fifth joint, not seen in *L. nasica*.

Pereopods — pereopod 1 differs noticeably from *L. nasica*. Last joint almost as long as the sixth, second joint somewhat slender, and exhibiting three large, strong teeth on the lower margin. The small tooth on the margin of the third joint is also present, as in *L. nasica*. There is no evidence of setation on the lower margin of the large second joint. Pereopods 2-5 essentially as in *L. nasica*, but pereopod 2 lacks the "nine strongly diverging ciliated spines" shown for *L. nasica*.

Uropods — six stout spines on the inner margin of the peduncle. Endopod noticeably shorter than exopod, first joint about half again as long as the second and possessing a long spine on its distal margin. There are nine large spines on the inner edge of the first endopodal joint, and four on the inner edge of the second joint, terminating in a single large spine. Exopods long, slender, sparsely bristled. All spines slightly pinnate, but the entire uropodal

assembly shows very few bristles, and no heavy setation as seen in *L. nasica*.

JUVENILE MALE—There were only four specimens of this species found, three of which were adult females (already described), and the fourth an extremely juvenile male. The pereopodal exopods were moderately well developed, but the pleopods were merely buds and the second antenna was barely discernible. The carapace strongly resembled the female, having two teeth on the pseudorostrum and eight large denticles on the dorsal crest, but with only a trace of a small tooth on the posterior elevation. In other characters it resembled the female, having the three strong teeth on the first pereopod. The uropod was missing on this specimen, making any comparative study impossible.

DISCUSSION —

A preliminary investigation of this form, following the key set up by Stebbing for the genus *Leucon* (1913:70), indicates a similarity to *L. heterostylis* Calman (1907). ("Median line of carapace coarsely and irregularly dentate in the anterior half, with one little tooth near the hind margin following a depression.") Further examination of the original description of *L. heterostylis* by Calman (1907:32), immediately indicates distinct differences in the dorsal crest dentition between the two species. As the name *Leucon magnadentata* infers, this new species is separated from the other species of the genus by the possession of large, recurved teeth, appearing on the dorsal crest, the first pereopod, and the third maxilliped. Other secondary diagnostic characters may be the long, triangular, dentate pseudorostrum; the size ratio of uropodal endopod to exopod; and the robust abdominal segments.

This writer was hesitant to describe a new species from only four specimens, but the character of the dorsal dentition and the teeth on the appendages is so distinctive that it seems unlikely to be an aberrant form of another more common species. *L. magnadentata* is represented by these four specimens, found only in one bottom sample in relatively deep water, as is seen in the description of the type locality. No adult males were found.

HOLOTYPE—AHF 585, adult female, 5.5 mm.

TYPE LOCALITY—VELERO IV station 5762-58, 8.6 miles 310.5°T from Point Loma light (near San Diego), bearings 32-45-28 N, 117-22-20 W, in 575 feet of water. Hayward grab, olive-green sand and mixed shells.

GENUS — EUDORELLOPSIS

DIAGNOSIS—Body short, club-shaped; similar to *Eudorella* in many ways, except for the prominent pseudorostral projection in five of the six known species of this genus, and the geniculation of the first antenna. Carapace usually deeper than long; first an-

tenna strong in both sexes, conspicuously geniculate between the first and second joints: second antenna of female very small, unarticulate, with two strong hirsute setae; mouth parts characteristic of the family, with minor variations. Legs strong, usually densely setiferous, spinulose in some species; uropod short, strong, exopods longer than endopods, tending to be broadly curved outward. Endopods characteristically spinulose on the inner margin. End of last segment either truncate or broadly rounded.

DISCUSSION — Of the six known species of this genus, only one resembles *Eudorella* to any extent upon gross examination, this being *Eudorellopsis deformis*, the type species of the genus. This genus was erected by Sars in 1882, and before that *E. deformis* was known as *Leucon deformis* Kroyer 1846; *Eudora deformis* Sars 1865, and *Eudorella deformis* Sars 1882. The carapace of *E. deformis* lacks the prominent pseudorostrum and thus superficially resembles members of the genus *Eudorella*. The other five species of the genus have a prominent, acute pseudorostrum erected close behind the frontal margin. Aside from this carapace difference, the rest of the body resembles the general *Eudorella* body form.

The diagnostic characters used to separate the two genera are very distinct:

1. *Eudorellopsis* — first antenna geniculate between first and second joints.
Eudorella — first antenna geniculate between second and third joints.
2. *Eudorellopsis* — second antenna of female with only two strong setae.
Eudorella — second antenna of female has three strong and two smaller setae.
3. *Eudorellopsis* — uropods with exopod longer than endopod.
Eudorella — uropods with endopod longer than exopod.

***Eudorellopsis longirostris* new species**

DIAGNOSIS — Closely resembles *Eudorellopsis biplicata* Calman (1912: 625), internally as well as externally. The appendages and mouth parts are essentially the same, with the main differences lying in certain carapace characters and some minor uropodal features. Carapace similar to *E. biplicata* but less laterally compressed and more robust. The anterior margin is sinuous but not so strongly convex as in *E. biplicata*. Pseudorostrum long, pointed, and not truly vertical. On the sides of the carapace are two strong, deep, obliquely curved ridges, the more anterior one being produced into a lateral, "horn-like" projection on each side. The carapace is finely pitted.

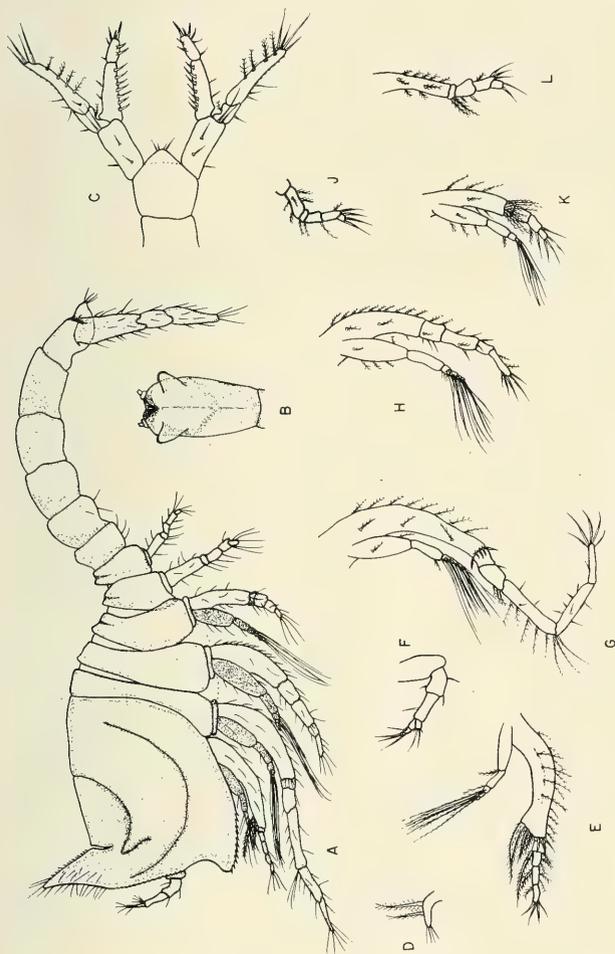


PLATE 37

Eudorellopsis longirostris n. sp.

- A—adult female, sta. 4820, 5 mm.
- B—dorsal view of carapace, showing processes
- C—uropod
- D—antenna 2, female
- E—maxilliped 3
- F—antenna 1, female
- G—pereopod 1
- H—pereopod 2
- J—pereopod 5
- K—pereopod 3
- L—pereopod 4

Leg-bearing somites have shallow to deep transverse ridges. Abdominal segments may or may not be sparsely setose. The last abdominal segment has a deep transverse groove, and is not as broadly rounded as in *E. biplicata*. There are always four centrally located setae on the trailing edge of this segment, not two on each side as seen in *E. biplicata*. Uropodal peduncle and rami similar to *E. biplicata*.

DISCUSSION — The similarity of this species to *E. biplicata* (as described by Calman in 1912) is so marked that only after examining some of the original specimens of *E. biplicata* was this writer able to ascertain the differentiating characters. The pseudorostrum is much more elongate and angular than the short, truncate, vertical pseudorostrum of *E. biplicata*. Another character separating these two species is the extension of the anterior carapace groove into the prominent, laterally projecting "horn-like" extensions. These are most evident from the dorsal view of *E. longirostris*, yet could not be seen in *E. biplicata*. Calman does not mention any enlargement of these grooves in his description of *E. biplicata*, even though he uses the grooves themselves as strong characters. Hart (1932) described *E. biplicata* from the Vancouver, British Columbia area, but on examination of these specimens this writer found that they too possessed these lateral projections of the carapace and were evidently not *E. biplicata*. The projections may vary slightly in size and sharpness among the animals, but they are always prominent. Over 200 specimens were microscopically examined, and the size and shape of these projections has no correlation with size, age or sex of the animal.

JUVENILE CHARACTERS — In the specimens examined no adult males were found, but several juvenile males in various stages of development were studied. As is characteristic of the group, the juvenile male closely resembles the female. In this species the development is marked by growth of the long second antenna and of the pleopods. The anterior edge of the carapace becomes shallow and generally more strongly toothed than the female.

DISTRIBUTION — Most common in the Point Conception and San Diego areas, found in scattered locations in between. Absent in 30-120 feet of water, rare in 130-180 feet, most common from 240-550 feet.

HOLOTYPE — AHF 584, adult female, 4.0 mm.

TYPE LOCALITY — VELERO IV station 5828-58, 10 miles 231.5° T from Ventura Pier light, bearings 34-10-00 N, 118-26-27 W, in 515 feet of water. Hayward grab, olive green silty sand, shell rubble.

GENUS — EUDORELLA

This genus is represented by only one species on this coast, *Eudorella pacifica* Hart. It is one of the two most abundant species recovered in the survey, comprising, with *Diastylopsis tenuis* Zimmer, about one-half of the total number of cumaceans. Due to the large number of specimens available for study, some discoveries were made regarding the primary taxonomic character for separating the species of the genus, the dentition of the anterior carapace margin. As a result of this, the species was completely re-described (see Barnard & Given, 1961), and placed in a new synonymy.

SUMMARY

This is the first section of a systematic study of the cumacean fauna of the southern California coast. Four new species are described: *Eudorellopsis longirostris*, *Leucon subnasica*, *Leucon armatus* and *Leucon magnadentata*. The family Leuconidae is prominently represented on this coast, with *Eudorella pacifica* Hart and *Leucon subnasica* being extremely common and well distributed. Little ecologic or distributional data is given at this time, the main purpose of this study being to describe new and poorly known species collected in the recent survey of the continental shelf of southern California. With this accomplished, it will be possible to interpret the relationships of the various species of cumaceans with the environmental factors such as depth, sediment type, and geographical location.

ACKNOWLEDGEMENTS

The author wishes to acknowledge the assistance received from the staff of the Allan Hancock Foundation, University of Southern California, the State of California Water Pollution Control Board, and the facilities of the R/V VELERO IV, without whose cooperation it would have been impossible to obtain and study these specimens. Special thanks go to Dr. J. L. Barnard of the Beaudette Foundation, Dr. Olga Hartman of the Allan Hancock Foundation, and J. F. L. Hart, for their assistance and advice in preparing this manuscript, and to the U. S. National Museum for loan of specimens.

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NOTES ON THE EARLY STAGES OF
TWO TEXAS BUTTERFLIES

By JOHN A. COMSTOCK

1. LIFE HISTORY OF *Asterocampa texana* SKINNER

The several species of butterflies which feed as larvae on Hackberry (*Celtis*) have long been of interest to collectors. These include a number of species and subspecies of the Genus *Asterocampa*, and one species of the Genus *Libytheana* with three subspecies or forms.

In 1911¹, Henry Skinner named *Chlorippe texana*, listing it as a variety of *Chlorippe clyton* Boisduval & LeConte. McDunnough places it in his Check list of 1938² as a subspecies of *Asterocampa clyton*, along with *A. flora* Edwards and *A. subpallida* B. & McD.

I recently had the good fortune to record and illustrate the life history of *Asterocampa texana*, thanks to the valued cooperation of Roy O. Kendall of San Antonio, Texas.

The eggs are laid in a cluster, two or three layers deep, the eggs of each layer being closely and evenly adherent—their micropylar areas pointing outward. An observed cluster contained 52 eggs.

EGG. Oval nearly spherical, 0.85 mm. wide by 1. mm. tall.

The color is light cream-yellow, with a slight tinge of green.

There are 20 vertical ribs, each arising near the base, and extending to the micropylar margin. These ribs are white, and pearl-studded along their crests. Between each rib the surface is crossed by fine horizontal lines. The micropyle is relatively large, slightly concave, and the surface is covered with numerous small pits, somewhat hexagonal in shape.

The base is deeply concave, and around its circumference there appears to be a broken hyaline membrane. The eggs are strongly adherent to the surface on which they are laid. Forcing them loose from their attachment probably tears the membranous connection.

Prior to hatching, the upper portion of the egg takes on a tinge of chocolate.

Eggs which were laid October 18, 1960, hatched October 28, resulting in 52 healthy first instar larvae. The egg is illustrated on Plate 38, figures B and C.

Exit was made through the upper end of the egg, the remainder of the shell being left intact. The newly emerged larvae immediately started feeding colonially on the upper surface of the *Celtis* leaf. On the second day they were feeding on the entire leaf.

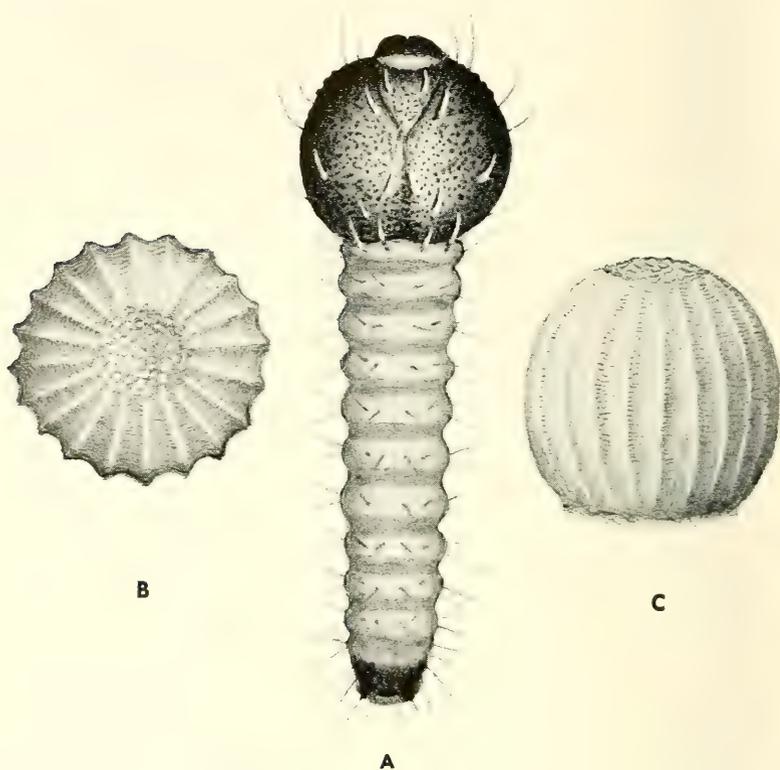


PLATE 38

Egg and first instar larva of *Asterocampa texana* Skinner. All figures greatly enlarged. Drawing by the author.

LARVA, FIRST INSTAR. Length, 0.45 mm. Head width, 0.14 mm.

The head is globular, and twice as wide as the first thoracic segment. Its color is translucent black, with a tinge of yellow in the center. The surface is covered with minute black punctae, and bears a few white setae, disposed as shown on Plate 38, fig. A.

The body tapers gradually from the first segment to the narrow cauda. The color is light lemon-yellow. The terminal segment is tinged with gray-black and bears two jet-black papillae, each topped with a short white seta. The body is sparingly covered with relatively short white setae.

Toward the end of the instar the body takes on a greenish shade. Well defined longitudinal middorsal and dorso-lateral green stripes are then present, and the width of the larva has increased to 0.18 mm. with slight tapering of the caudal portion. At this time the length of the larva is 4. to 6. mm.

Ecdysis occurred November 7, 1960 for a majority of the specimens.

SECOND INSTAR. Measurement taken November 8; length of larva, 6. mm. Width, 1.4 mm. through center, tapering gradually toward the cauda. Head width from edge to edge of the spiculiferous horns or processes, 1.6 mm. These 'horns' arise from the outer and upper corners of the crown. They are predominantly white, but bear a black spot at the tip.

The face is margined with white spicules, arising from a black ground. The front is solid black. There is a spot of black on the upper part of the central suture. The ocelli are black. The labrum is edged with white above and black below, merging with the black mouth parts. The remainder of the head is white.

The body is cylindrical, and is longitudinally striped green and white. There is a middorsal longitudinal dark green stripe, margined laterally with white. Parallel to this laterally is a narrow discontinuous stripe, margined white laterally. Latero-inferior to this is a wider green longitudinal stripe which shades to greenish-yellow as it approaches the cauda. This is margined inferiorly with a narrow white stripe.

Inferior to this, and on the ventral surface, the color is yellow with a tinge of green.

The cauda terminates in a pair of yellow papillae, each bearing small nodules, topped with short white setae.

The body is thickly covered with minute white nodules, each topped with a short white seta. The legs and prolegs are concolorous with the venter. Each segment of the body is thrown into a number of transverse ridges. The colonial habit of feeding was still evident at the end of this instar.

THIRD INSTAR. Ecdysis observed from November 16th on. Length of larva, two days after moulting, 7.5 mm. Head width, 1.75 mm. from tip to tip of the horns.

These spiculiferous horns are white, with a yellow-green tinge on top, each spicule ending in a minute white hair. The anterior surface of the horn has a black triangulate spot, which is continued downward and inclines medially on the face as a speckled black band. Between these horns is a spotted black area. The re-

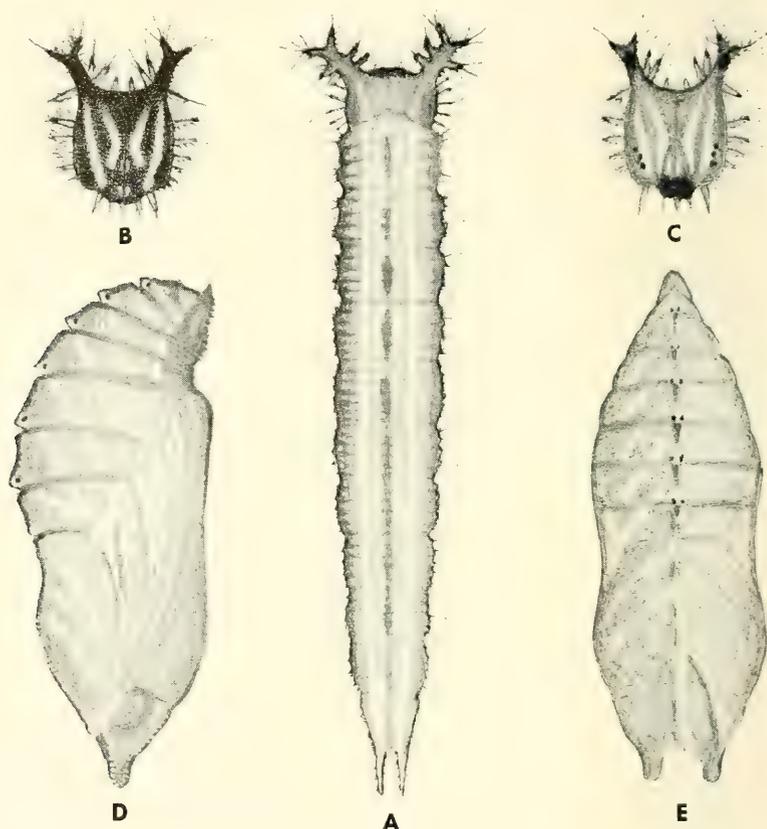


PLATE 39

Mature larva and pupa of *Asterocampa texana* Skinner. A. Larva, dorsal aspect. B. C. Two color phases of larval head. D. Pupa, lateral aspect. E. Pupa, dorsal aspect. All figures enlarged. Drawing by the author.

mainder of the face is light yellow, from which white papillae arise. These are particularly conspicuous around the circumference of the head. The ocelli and mouth parts are black.

On the body, the green longitudinal middorsal stripe persists. The stripes and bands of the preceding instar are somewhat less conspicuous, being obscured by longitudinal lines of white papillae. Otherwise the body is colored as in the second instar. The pair of

caudal processes are longer, more conspicuous and contrastingly yellow.

From this point on the larvae began going into hibernation. This occurred in small groups, within the curved surfaces of dried *Celtis* leaves.

Activity was not resumed until late in February, 1961. On March 3, 1961 larvae of the third, fourth and fifth instars were present.

FOURTH INSTAR. Observations made March 3, 1961. Length of larva, 13 mm. Head width at tips of spiculiferous horns, 2.4 mm.

The ground color of the head is light green, with a suggestion of yellow on the horns. The black markings on the face and horns are much as in the prior instar. A few examples show a predominance of green, and reduction of the black markings.

Two white bars run diagonally across each cheek. One arises from the ocellar area, the other from the edge of the adfrontal suture.

The body ground color is light green. In the middorsal area there is a longitudinal line of lanceolate green spots, with their points meeting on the segmental junctures. The green on these spots is slightly darker than the remainder of the body, and each is bordered by a row of raised white dots. Two white bands run the length of the larva, each beginning on the base of the spiculiferous horns of the head, and terminating on the caudal horns. A pair of narrow white lines run longitudinally in the spiracular area.

The legs and prolegs are concolorous with the body. As in previous instars, the entire surface of the body, exclusive of the venter, is thickly studded with raised white nodules bearing colorless or white hairs.

FIFTH INSTAR. Length at the beginning of the instar, 19 mm., and at the termination, 36 mm. Head width, 3.5 mm. between outer edges of the horns; width of head proper, 3. mm.

The head is colored and marked as in the prior instar, except that there are two extreme types, with intergrades between them.

The first type is predominantly brownish-black, including the front surface of the horns and the surface of the entire face except for the white bars.

The second type is yellow-green, except for the white bars on the face and a black triangular spot near the tip of the horns. This color phase predominates. The two extremes are illustrated on Plate 39, figs. B. and C.

The body of the larva is colored and marked essentially as in the prior instar. See Plate 39, fig. A.

Toward the termination of the instar the white lines and dots become fainter and less contrasty.

The first pupa was formed March 13, 1961, and the last on April 4, 1961.

PUPA. Length, 17 to 22 mm. Width of an average example through widest part, 8 mm. The ground color is a light yellow-green.

The ventral surface is relatively flat, and the dorsum rises to a narrow keel-like ridge. The caudal tip bears a pair of stout tubercles, rounded at their tips. The cauda ends in a boat-shaped process.

Middorsally there is a longitudinal stripe which is white anteriorly, gradually changing to yellow from about the 5th segment to the cauda. From the 5th segment on, each segmental juncture bears a pair of black dots with a raised white nodule between them. These raised nodules and the segmental depressions in front of them give a serrated appearance to the median dorsal ridge when viewed from the side.

The junctures of the abdominal segments are smooth. The remainder of the surface is speckled green, interspersed with minute whitish dots. The antennae are raised in a line of white dots, and extend to the wing margins. The venules show prominently on the wings as slightly elevated white lines formed of raised nodules.

On the lateral surfaces there are diagonal white bars, beginning at the dorsal ridge and extending downward and forward. Their exact placement and number are shown on Plate 39, figs. D. and E.

The eyes are inconspicuous and flat. The spiracles are concolorous with the body, and difficult to distinguish. The cremaster is an ovate plate on which a raised V-shaped ridge is covered with minute hooklets. The apex of the V points caudally. This arrangement allows the chrysalis to maintain a horizontal position on a horizontal surface without a supporting girdle.

The first pupa gave forth an imago on March 30, 1961, and the last on April 20, 1961.

Twenty-four perfect specimens resulted from this rearing, in addition to which several pupae and numerous larvae in various instars were put up in preserving fluid, for use by the Department of Entomology of the Canadian Science Service.

Careful comparison of descriptions and drawings of other supposedly closely related species convinces me that *Asterocampa texana* is a valid species. This opinion is shared by Dr. Wilfried J. Reinthal (in litt. 4/22/61) to whom I sent a reared pair for comparison. Dr. Reinthal has made a thorough study of this genus, and "has raised and described almost all of known *Asterocampa* in all immature stages."

Aside from this particular study, my own rearing experience has been limited to *Asterocampa leila* Edw., and *A. subpallida* B. & McD., which I illustrated and published in 1953³.

Our series of *texana* were reared on *Celtis laevigata* K. Koch. Doubtless all species of *Celtis* are acceptable to *A. texana* and all other *Asterocampa*.

Scudder⁴ reports feeding one example of *A. clyton* "in its third stage" on *Aristolochia*. He states that Boisduval and LeConte's record of "Prunus and . . . other trees of the same family (Rosaceae) . . . is probably a complete error." However, in more tropical lands there may be other host plants. William P. Comstock, in 1944⁵ cites Gundlach's record of *Ardisia cubana* as a host plant for *Asterocampa argus idyja*.

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2. THE EGG AND FIRST LARVAL INSTAR OF

Satyrus pegala texana

The handsome satyrid butterfly occurring in Texas, and placed in the McDunnough Check List of 1938¹ as a subspecies of *Minois alope*, has been shunted about in classification by various authors. Dr. Holland, in his revised edition of the "Butterfly Book." 1931² calls it a variety of *Cercyonis alope*, but in his earlier editions placed it in the Genus *Satyrus*.

The latest generic reassignment is that of Prof. William T. M. Forbes, 1960³, who lists it as *Satyrus pegala texana* Edw.

The life history of *texana* has not been published, but it presumably is similar to that of *alope*. W. H. Edwards' classic paper of 1880⁴ (in which he briefly described *texana*) goes into revealing detail on the early stages of *S. alope* and *S. nephele*.

Scudder, 1888⁵, shows an excellent line drawing of the first instar larva of *alope* on his Plate 70, figure 6.

We recently were fortunate in obtaining first-hand information on the egg and first larval instar of *Satyrus pegala texana* through the courtesy of Roy O. Kendall of San Antonio, Texas.

Two lots of eggs were observed. The first of these was laid September 25, and hatched September 30, 1960. The female was

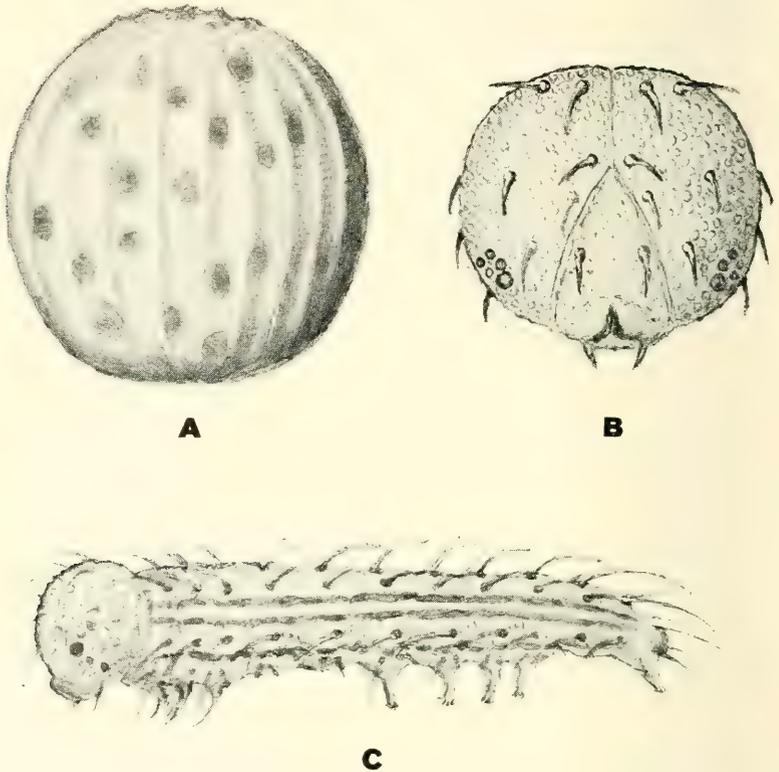


PLATE 40

Satyryus pegala texana

A. Egg. B. Front view of head. C. Lateral view of first instar larva.
All figures enlarged drawings by the author.

taken in Gillespie County Texas. Later an additional number were secured, which hatched October 26, 1960.

EGG. Nearly spherical, the base slightly flattened, and the micropylar area pitted. Size, 0.90 mm. wide by 1. mm. tall. The color is lemon-yellow with several pinkish spots of varying sizes scattered irregularly over the surface.

There are from 18 to 20 vertical ribs, running from the base nearly to the micropyle. These are white, and are studded with barely discernible pearly nodules. The troughs between these

ridges are crossed by fine vertical lines that are only visible with the application of strong side-lighting. The egg is shown on Plate 40, figure A. The figure was drawn from an egg that was midway between the time of laying and hatching. It may have lacked the pink spots when first laid, as is the case with the egg of *S. alope*, described by Scudder on page 166, of Volume 1 of his monumental work.

FIRST INSTAR LARVA. Length, 2.5 to 2.7 mm. Head width, .6 mm. Color of head, light yellow. The surface is covered with minute hyaline nodules. The conspicuous setae arise from dark brown papillae, and are brownish-black in color. The ocelli are unusual in that the anterior one of the cirlet is large, protruding, and bright green. The others are small and light brown to hyaline. The mandibles are edged with black. See Plate 39, fig. B.

The body ground color is light yellow. There is a narrow longitudinal middorsal stripe of reddish-brown. Paralleling this dorso-laterally there are two stripes of the same character. Between the middorsal and paired lateral stripes there is a longitudinal row of hyaline setae. These setae arch forward on the three thoracic segments, and caudally on the others. A similar row of setae runs below the paired stripes. These all arch anteriorly. This row is paralleled by still another row of arched setae running sub-stigmatically, all of which incline caudally.

The legs and prolegs are concolorous with the body.

Scudder's description suggests a different body color of the young larva of *alope*. His excellent line drawing on Plate 70, figure 6, shows features closely matching those of the first instar *texana* larva, as illustrated on our Plate 40, Figure C.

All of our larvae went into hibernation in early December and did not survive the winter.

It is hoped that some one of our Texas confreres will carry through the remaining chapters of the life history of *Satyris pegala texana*.

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SYNONYMIC CHANGES AND FOUR NEW SPECIES OF TINGIDAE (HEMIPTERA)

BY CARL J. DRAKE and FLORENCE A. RUHOFF*

In assembling the catalog of the Tingidae of the World, the authors have uncovered several new synonyms and homonyms in the literature. This paper corrects these errors, describes four new species from the Eastern Hemisphere, and two North American tingids are treated as synonyms of European species.

The illustrations were made by the artists Robert E. and Patricia J. Hogue, Alexandria, Virginia. This paper is a by-product of a study supported in part by grant 4095 National Science Foundation.

NEW STATUS

The following forms described as varieties or subspecies are here raised to the rank of full species: *Corythauma ayyari varia* Drake and Maa (1953) to species *C. varia* Drake and Maa; *Amnianus burgeoni depicta* Schouteden (1923) to species *A. depictus* Schouteden; and *Haedus bellus pallens* Schouteden (1953) to species *H. pallens* Schouteden.

NEW SYNONYMY

Based largely upon a study of the types (mostly holotypes), the following new synonyms are here proposed: *Bako usumburana* (Drake) (1947) is synonymized with *B. lebruni* Schouteden (1923); *Leptoypa nubilis* Drake (1941) with *L. minor* McAtee (1917); *Compseuta tropica* Hacker (1928) and *C. tessellata* Drake and Poor (1936) with *C. lefroyi* Distant (1909); *Corythucha bullata* Van Duzee (1917) and *C. heteromelecola* Drake (1920) with *C. incurvata* Uhler (1894); *Phymacysta malpighiae* (Drake) (1922), *P. walcott* (Drake) (1928) with *P. tumida* (Champion) (1897); *Ischnotingis yanchevana* Drake (1953) with *I. proluxa* Horváth (1925); *Nethersia pugna* Drake (1944) with *N. maculosa* Horváth (1925); *Urentius echinus* Distant (1903), *U. olivaceus* Distant (1909) and *U. aegyptiacus* Bergevin (1930) with *U. hystricellus* (Richter); *Urentius nanus* (Schumacher) (1913), *U. maculatus* Drake (1933) and *U. hoggari* Bergevin (1928) with *U. euonymus* Distant (1909); *Tingis necopina* (Drake) (1919) with *T. auriculata* (Costa) (1843); *Tingis aegyptiaca* Priesner (1951) with *T. elongata* (Fieber) (1861).

Dictyla novaki, nam. nov.

Monanthia flexuosa Novak, 1877, Sitzungsberichte der Kaiserlichen Akad. der Wissenschaften, vol. 76, p. 79, pl. 2, figs. 8-11: 1877, reprint as pamphlet, p. 9, pl. 2, figs. 8-11. —Scudder 1890,

*Smithsonian Institution, Washington, D.C.

U.S. Geol. Surv. Territories, vol. 13, p. 357; 1891, U.S. Geol. Surv. Bull. 71, p. 421.

Dictyla flexuosa: Drake and Ruhoff 1960, Proc. U.S. Nat. Mus. vol. 112, pp. 11, 51.

In 1858, Stål (Ofv. Kong. Svenska Vet.-Akad., vol. 2, No. 7, p. 61) described a new tingid as *Monanthia (Phyllontocheila) flexuosa* (now *Gargaphia flexuosa* (Stål) from Brazil. Seventeen years later, Novak (1877, p. 79) described a fossil tingid as *Monanthia flexuosa*, from the Tertiary of Krottensee, Bohemia. Since the two trivial names are primary homonyms, we are here proposing *nozaki* as a replacement for the fossil tingid described by Dr. Novak. Recently, the authors suppressed *Monanthia* as a synonym of *Copium*, and resurrected the genus *Dictyla* to hold most of the species formerly included in *Monanthia*.

***Cysteochila euphues*, sp. nov.**

Small, elyptical, grayish testaceous, prominently marked with large, dark fuscous areas; head dark brown, cephalic spines testaceous or brown; body beneath brown, buccal and sternal laminae of rostral sulcus pale testaceous, the rostrum brownish testaceous, with apex dark. Antennae testaceous, fourth segment brown. Legs testaceous, tarsi brownish. Hind pair of wings slightly infusate. Length 2.54 mm., width (elytra) 1.12 mm.

Head very short, slightly produced in front of eyes, armed with five, moderately long spines, the frontal pair porrect, median erect, and hind pair appressed; bucculae wide, areolate, with ends meeting anteriorly; rostrum extending slightly beyond mesosternum. Antennae slender, moderately long, inconspicuously pubescent, measurements: segment I, 0.09 mm.; II, 0.08 mm.; III, 0.56 mm.; IV, 0.30 mm.

Pronotum moderately convex, tricarinate, punctate, with pronotal disc on each side up to and including lateral carina concealed by the reflexed paranotum; hood small, quadrate in outline, feebly extended anteriorly, extending backwards between calli, with a raised, transverse vein on crest; median carina plainly visible, uniseriate, slightly more elevated than lateral pair, the lateral carinae slightly less elevated than median, uniseriate, strongly convergent anteriorly on triangular process, thence anteriorly slowly convergent, concealed by reflexed paranota on pronotal disc; paranota large, slightly elevated, each longitudinally impressed between humeral angle and its outer margin. Hypocostal laminae uniseriate. Ostiole and ostiolar sulcus present on each metapleuron.

Elytra widest near middle, outer margins uniformly convex, sutural areas overlapping so that their apices are jointly rounded at rest; costal area moderately wide, biseriate; subcostal area slightly narrower than costal area, also biseriate; sloping sharply downward; discoidal area large, extending beyond middle of ely-

tron, acutely angulate at base of apex, five or six areolae deep in widest part; sutural areas on same level and with areolae of same size as in discoidal area.

HOLOTYPE (macropterous female) Larat Island, Tanimbar Islands, E. Malay Archipelago, California Academy of Sciences. PARATYPE (female) same data as type, Drake Collection (USNM).

***Cysteochila malaisei*, sp. nov.**

Large, oblong, fuscous-brown with slight grayish tinge; elytra with all veinlets and areolae of subcostal, discoidal, sutural, and cross-band of costal areas fuscous brown, the areolae not in cross-bands of costal areas hyaline; body beneath fuscous brown. Antennae brown, with fourth segment black, the pubescence short, decumbent and pale. Legs brown, with apical two-thirds of tibiae and tarsi testaceous. Entire dorsal surface clothed with very small, flakelike, golden pubescence. Length 4.20 mm., width (across elytral bands) 1.62 mm.

Head very short, armed with five, moderately long, stout spines; bucculae areolate, closed in front. Antennae long, segmental measurements: I, 0.10 mm.; II, 0.08 mm.; III, 1.50 mm.; IV, 0.40 mm. Beak extending slightly beyond middle of mesosternum; laminae of rostral sulcus uniseriate, open behind. Legs long, slender, sparsely clothed with short, inconspicuous pubescence. Orifice and sulcus of metathoracic scent glands not visible. Hypocostal lamina narrow, uniseriate.

Pronotum moderately convex, with disc mostly covered by reflexed paranota, tricarinate; medium carina long, slightly more raised than lateral pair, uniseriate; lateral distinctly convergent anteriorly, uniseriate, completely covered on disc by paranota; hood small, tectiform; paranota very large, reflexed, with outer margins not quite reaching to median carina. Elytra wider than pronotum, with sutural areas overlapping so that their apices lie jointly rounded in repose; costal area wide, composed largely of two rows of large, clear areolae except in cross-band, there with areolae smaller, three deep, and clouded with fuscous; subcostal area nearly vertical, narrower than costal area, biseriate, areolae small; discoidal area large, extending beyond middle of elytron, six areolae deep in widest part, acutely angulate at each end; subcostal area on same level as discoidal area, areolae densely clouded with fuscous.

HOLOTYPE (macropterous male) Kambaiti, NE Burma, 7-9, vi. 1934, René Malaise, Stockholm Mus. Nat. Hist. ALLOTYPE (female) same data as type, Drake Collection (USNM).

About the same size as *C. undosa* Drake, but differs in the more elevated pronotal carinae and form of the elytra. In *undosa* the carinae are non-areolate and each elytron is widely obtusely expanded at the cross-band of costal area.

Eteoneus homelys, sp. nov.

Plate 41

Moderately large, oblong, brownish fuscous with costal areas tending to be brownish; body beneath with abdomen reddish fuscous and sternum blackish. Entire dorsal surface moderately

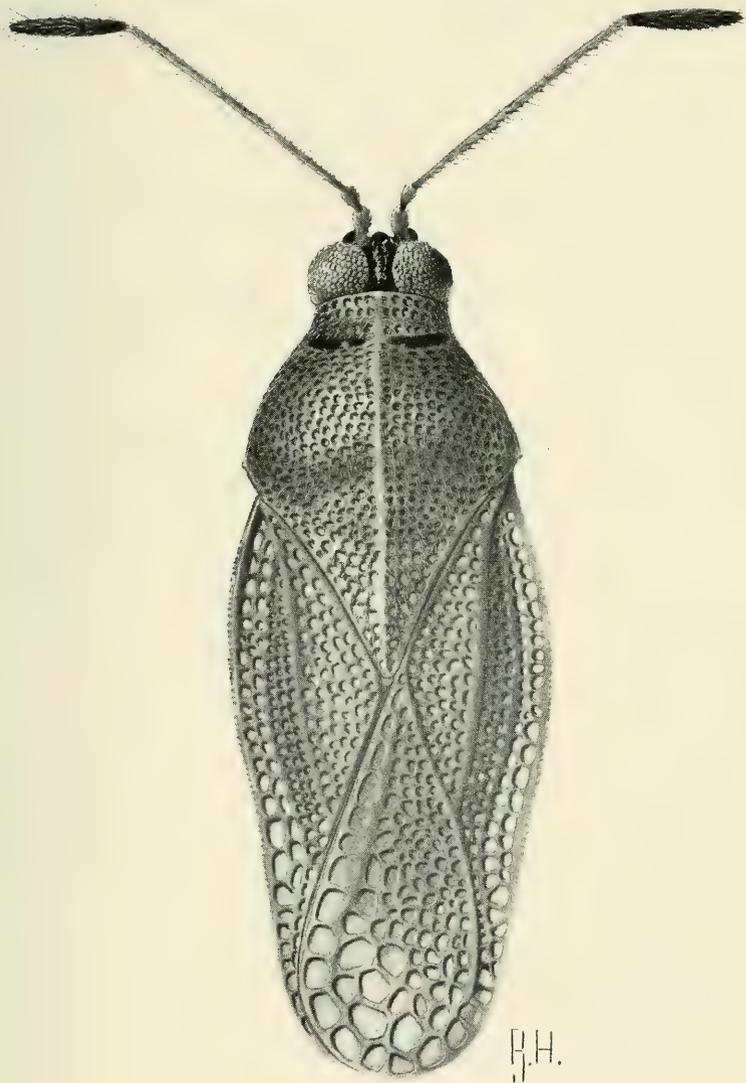


PLATE 41

Eteoneus homelys, n. sp.

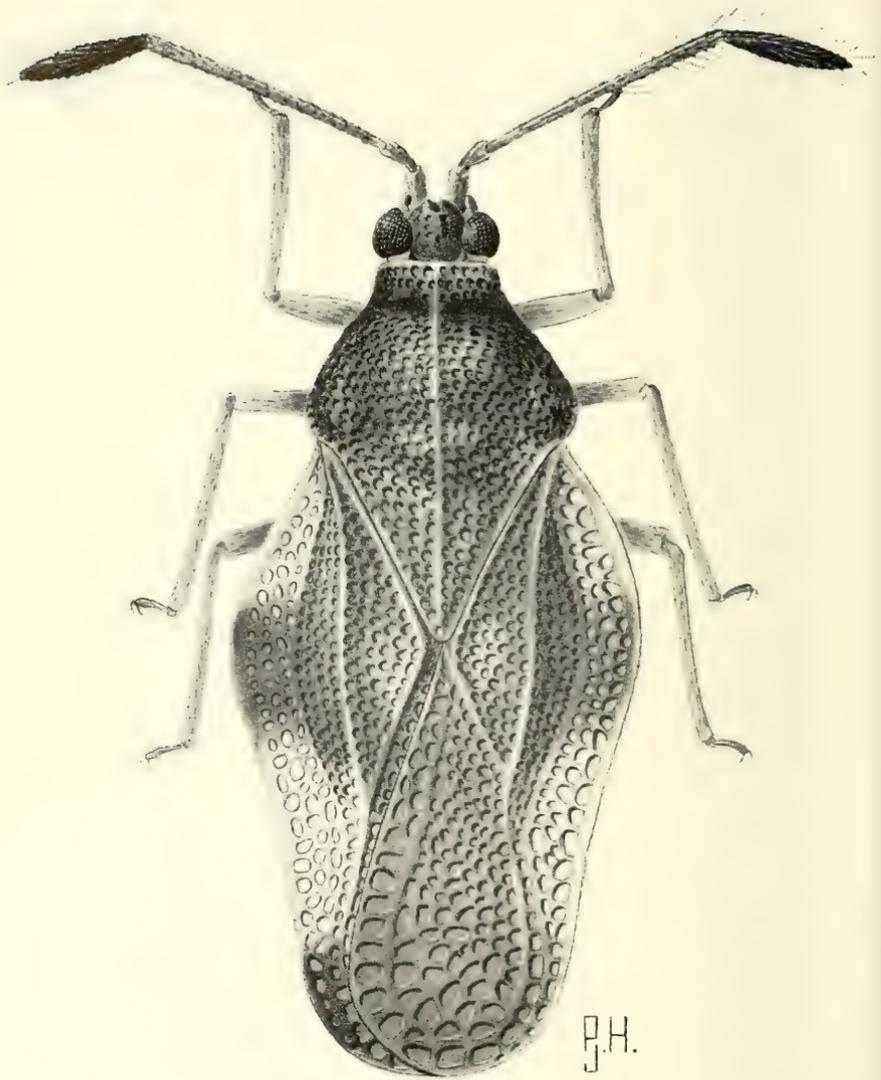


PLATE 42
Etoneus peroronus Drake

clothed with fine, short, hardly discernible, yellowish, flakelike pubescence. Antennae brownish testaceous with fourth segment mostly black. Legs brownish testaceous, tips of tarsi dark. Length 3.10 mm., width 1.10 mm.

Head very short, smooth, dark ferrugineous, armed with frontal pair of tiny tubercles; bucculae areolate, ends meeting in front; eyes extremely large, each as wide as vertex. Labium testaceous with apex black, reaching to base of mesosternum; laminae of rostral sulcus narrow, uniseriate. Metathoracic scent gland with ostiole and channel on each metapleuron, the channel nearly upright, its side raised. Hypocostal lamina uniseriate. Antennae sparsely clothed with yellowish, setalike pubescence; segmental measurements: I, 0.10 mm.; II, 0.10 mm.; III, 1.00 mm.; IV, 0.45 mm. Legs sparsely clothed with yellowish pubescence.

Pronotum moderately convex, closely punctate, unicarinate, the carina distinct, without areolae; humeral angles each with a tiny projecting plate. Elytra longer than abdomen, with sutural areas overlapping each other so that their apices lie jointly rounded at rest; costal area moderately wide, biseriate, areolae arranged in regular rows, outer marginal vein thick and not clearly serrated on basal half; subcostal area wider than costal, triseriate, sloping gently downward; discoidal area large, extending beyond middle of elytron, acutely angulate at each end; sutural area on same horizontal level as discoidal area, with areolae becoming larger in distal third.

HOLOTYPE (macropterous male), Amboina, Malay Archipelago, East Indies, figured, California Academy of Sciences.

Separated from *E. peroronus* Drake (Plate 42) by its hairy dorsal surface, biseriate costal area, and lack of elytral fasciae.

***Ammianus mayri septuosus*, nam. nov.**

Phyllontocheila mayri var. *obscura* Schouteden, 1919, Rev. Zool. Afr., vol. 4, p. 276.

As the subspecific names of *Ammianus mayri obscurus* (Schouteden) (1916) and *Ammianus dilatatus obscurus* (Schumacher) (1912) are homonyms, we are here proposing the subspecific name of *septuosus* for the form *obscurus* described by Schouteden.

***Gargaphia angulata* Heidemann**

Gargaphia angulata Heidemann, 1899, Canadian Entom., vol. 31, p. 301.

Gargaphia undulata Heidemann, 1900, Proc. Ent. Soc. Washington, vol. 4, p. 493. (nom. nud.).—Van Duzee, 1917, Catalogue of Hemiptera, p. 218.

Specimens of *G. undulata* Heidemann (MS) show that it is the same species that he described as *angulata* in 1899. Type specimens of *angulata* and *undulata* are in USNM.

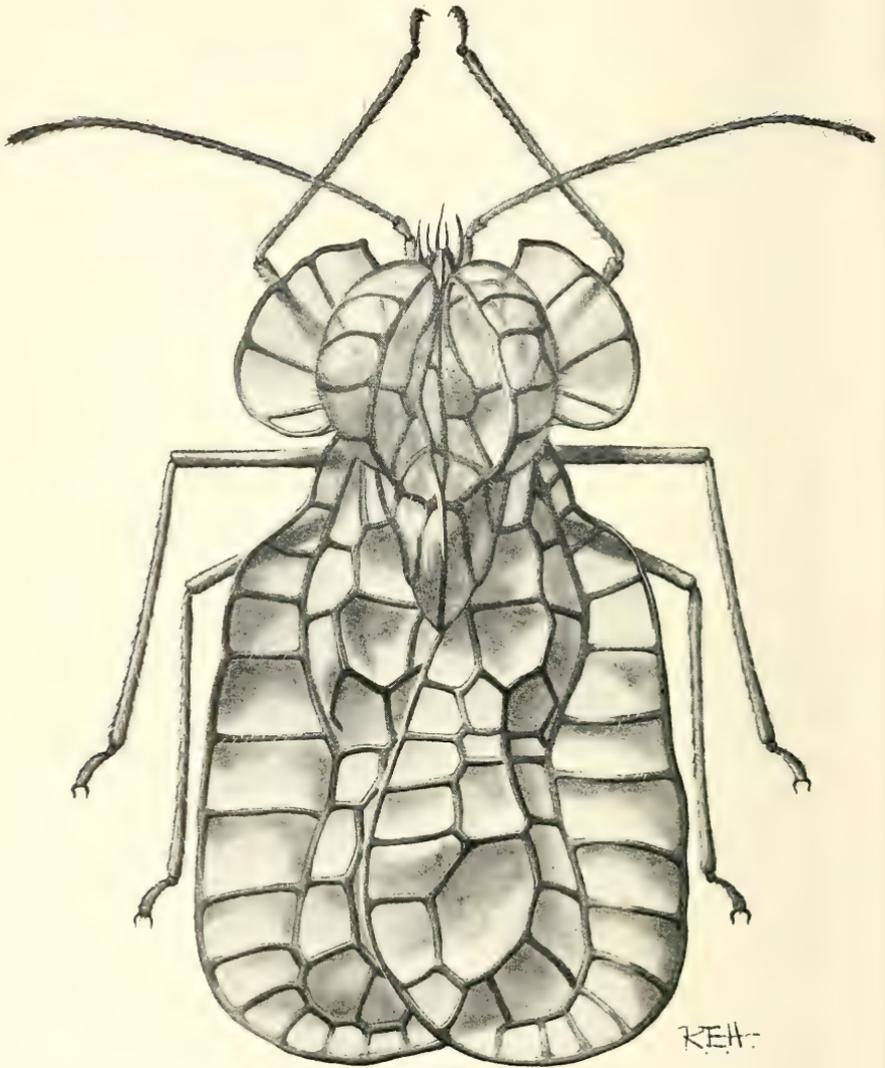


PLATE 43
Galeatus angusticollis Reuter

Galeatus angusticollis Reuter

Plate 43

Tingis spinifrons (not Fallén): Herrich-Schaeffer, 1835, Nomen. Etnom., vol. 1, p. 58; 1838, Wanzenartigen Insekten, vol. 4, p. 67, pl. 130, figs. a-c, g-h. —Fieber, 1844, Ent. Mono., p. 105, pl. 9, figs. 6-12.

Galeathus (sic) angusticollis Reuter 1874, Ann. Soc. Ent. France, vol. 4, p. 563.

Sphaerocysta peckhami Ashmead, 1887, Entom. Americana, vol. 3, p. 156. (New synonymy).

Galeatus angusticollis: Horváth, 1906, Ann. Mus. Nat. Hungarici, vol. 4, p. 52.

Galeatus peckhami: Drake, 1922, N. Y. State Coll. Forestry, Bull. 16, pp. 105-110, pl. 5.

A careful study of many specimens of European *Galeatus angusticollis* Reuter and of *G. peckhami* (Ashmead) of the United States and Canada shows that these two trivial names apply to the same species, the former having priority by 15 years. (new synonymy).

According to Fieber (1844) and Horváth (1906) *angusticollis* feeds on the composite *Artemisia campestris* in Europe. Drake collected nymphs and adults of *peckhami* in large numbers on *Aster macrophyllus* and a species of *Eupatorium* (boneset) at Cranberry Lake, New York. According to our records *G. angusticollis* has been netted in the United States (N. Y.; Wisc.; Mich.; Mass.; N. H.; Mo.; Minn.; Colo.; Utah) and Canada (Ontario; Alberta; Manitoba). Based on the records listed by Horváth (1906) and others, *angusticollis* is also very widely distributed in northern Europe.

Galeatus Curtis is an Old World genus. Distribution records seem to indicate that *angusticollis* was probably accidentally introduced into the New England states (or eastern Canada) many years before it was collected and described from Milwaukee, Wisconsin.

Galeatus angusticollis uhleri Horváth

Galeatus uhleri Horváth, 1923, Ann. Carnegie Mus., vol. 15, p. 108.

The validity of *Galeatus uhleri*, described by Horváth (1923) from New Mexico, is open to question. It is probably not more than a subspecific form or color variation of *angusticollis*. We are here treating it as a subspecies.

***Agramma ecmeles*, sp. nov.**

Small, slender, grayish testaceous with pronotum brown (collar, paranota, and hind process pale testaceous), head black, body beneath with abdomen reddish brown and sternum blackish. Antennae brown, two basal segments dark fuscous, fourth segment blackish. Legs dark fuscous, the tibiae and tarsi brownish. Length 2.25 mm., width (elytra) 0.80 mm.

Head short, subdepressed, rugose, armed with frontal pair of short pale tubercles, other spines wanting. Antennae moderately long, clearly granulate, segmental measurements: I, 0.18 mm.; II, 0.12 mm.; III, 0.52 mm.; IV, 0.20 mm. Bucculae wide, areolate, closed in front. Rostrum extending slightly beyond middle of mesosternum; sternal laminae of rostral sulcus narrow, open behind. Hypocostal ridge uniseriate.

Pronotum depressed, coarsely punctate; median carina fairly distinct, becoming obsolete on hind process; paranotum narrow, pale, composed of one complete row of small, round cells, slightly wider and then biseriate opposite calli, the backward projection areolate. Legs short, femora slightly swollen.

Elytra slightly wider and a little longer than abdomen, moderately convex; costal area narrow, composed of one complete row and a partial second row of small rounded cells beyond the middle; subcostal area wide, sloping gently downwards, with four rows of rounded cells; discoidal area extremely long, wide, wider than subcostal area, six cells deep, about nine-tenths as long as elytron, nearly uniform in width, the areolae of both costal and discoidal areas arranged in fairly regular rows. Brachypterous form unknown.

HOLOTYPE (macropterous male), Kimberly District, N. W. Australia, E. Mjöberg, in Natural History Museum, Stockholm.

This is the third species of the genus *Agramma* Stephens to be described from Australia. It can be separated at once from *A. pictipenne* (Horváth) and *A. vulturum* (Kirkaldy) by the aeration of paranotal and costal areas, each of which is partly biseriate.

THREE NEW TIGER BEETLES of the
GENUS *CICINDELA* from
SOUTHWESTERN UNITED STATES
(CICINDELIDAE-COLEOPTERA)

By

NORMAN L. RUMPP
China Lake, California

Although most of the Southwest has been explored for tiger beetles, there is still an abundance of material that has remained either undiscovered or undescribed. The three tiger beetle subspecies described and discussed in this article are part of this material. They will be used to illustrate some of the interesting interdisciplinary correlations that can be achieved between entomology and geology, provided it is assumed that:

1. The rate of evolutionary change is very slow in tiger beetles, in some more so than in others. The resulting morphological changes have been minor, even in the more derived forms, so that these insects have remained relatively unspecialized for a very long time.

2. Environmental pressures forced many tiger beetle migrations along the ever changing hydrographic channels of various geological epochs of the Cenozoic era. This is the more evident in the arid Southwest.

The first assumption is based on comparison with *Carabid* fossils of Cenozoic age. Since no tiger beetle fossils have been recorded to date, it is assumed that their evolution paralleled that of closely related families, at least through this era. As for the second assumption, it is necessary for many species of these beetles to live close to water for ecological reasons; for example, the moisture content of the ground must remain between predictable limits for proper larval and pupal development. With the ecologies of many western species balanced on the proximity to permanent moisture, they must remain with watered places, or with moist areas with permanent subsurface water. The species that frequent lake shores and stream banks remain with their environment, even when the environment is moved, segmented, or re-formed for geological reasons. The Basin and Range Province which makes up much of the Southwest, contains many closed basins with disrupted, and often indistinct, hydrographic connections. These disconnected regions have served to isolate populations for extended lengths of time. Fortuitous dispersal of most of the riparian and littoral species of *Cicindela*, from one disrupted area to the next, does not take place easily, and from many observations, does not occur in fact.

Systematic studies of the regional physiography, grossly and in detail, indicate that some of the geological changes have had significant effects on tiger beetle evolution. Conversely, where tiger beetle change is observed, it is often possible to postulate the probable correlation between this change and the geological events. Hence, one can sometimes predict the occurrence of specific populations from the physiography, both past and present, and also, one can often reconstruct some of the geological changes from the random discovery of variant tiger beetle populations.

The sand dune tiger beetles are less predictable, maybe only because they require more study with regard to ecology, geological relationships, and overall distribution. Although the subspecies of *C. limbata* described herein is a sand dune dweller, an attempt will be made to correlate its derivation.

ACKNOWLEDGMENTS

Sincere appreciation is expressed to all those who helped the author by supplying data and insects which, to a great degree, make this paper possible. Mr. Hugh B. Leech of the California Academy of Sciences, San Francisco, California, loaned a series of *C. hirticollis* from the lower Colorado River and its main tributaries. Mr. Merle C. Slagle of Ft. Lauderdale, Florida, loaned a series of *C. hirticollis* from Moab, Utah, which he captured on the banks of the Colorado River. Dr. Ernest R. Tinkham of Indio, California, discovered the *C. limbata* population at the Coral Pink Sand Dunes in southern Utah, and sent his entire series for review.

Cicindela willistoni estancia, new subspecies

Medium in size, narrow and convex, head and thorax bronze, elytra duller bronze basally, otherwise the white maculation is so confluent as to nearly cover the entire surface. Head and thorax as in ssp. *willistoni*, except that the proportions are narrower, and the sides of the pronotum are slightly more parallel. Elytra of male are narrower than in ssp. *willistoni*; the central basal area is pigmented only in the region below the scutellum, the maculation then converges abruptly toward the suture; the sutural ridge is pigmented throughout its length; a few minute bronze foveae form a line near the suture, diverging outward in the apical region. Underside bright blue, clothed with white decumbent hairs. Male—Length 11.7 mm, width 4.7 mm. Female similar to male but broader—Length 11.8 mm, width 5.1 mm.

Holotype male, allotype female, and 5 topotypical paratypes in the author's collection. Collected at the type location, 7.0 miles east of Willard, Torrance County, New Mexico, on 13 June 1959 (4 males including the type) and 28 September 1961 (1 male and 2 females).

Named for Pleistocene Lake Estancia.



PLATE 44

Dorsal views. 1. *Cicindela willistoni estancia*, 2. *C. hirticollis corpuscula*, 3. *C. limbata albissima*.

THE TYPE SERIES

The four male specimens that make up the June 1959 series are remarkably alike in form, size, and extent of maculation. One paratype is more dull and more green in color, while in two paratypes the sutural maculation is broader near the base, reaching barely to the row of minute foveae. All were caught in a draw leading to the open flats of a salt sink. This sink is one of many located east of Laguna del Perro and south of Laguna Salina, in the complex of basins that now forms the remnants of Pleistocene Lake Estancia. The area was covered by a layer of white alkali, and nurtured a sparse growth of short salt grasses. The ground was damp just below the leached out alkali cover. All specimens of the series were captured between the hours of eleven A.M. and noon. The weather was clear, with the temperature at 94°F.

The single male and two females captured in September 1961 are similar in maculation to the earlier specimens. The male is an old specimen, dull in color, with eroded pilosity particularly lacking on the frons. The females were teneral specimens, brightly colored, with full pile, but with elytral maculation still slightly greasy. The females, normally, would have hibernated, while the male died after a few days in captivity. They were caught between 10:30 A.M. and 1:00 P.M. at the edge of a playa that still contained water from Summer rains. The weather was clear but with a strong wind blowing from the southwest, while the temperature was at 70°F.

OTHER *CICINDELAE* WITH SSP. *ESTANCIA*

Three species of *Cicindela* were in evidence in June 1959. The *C. willistoni estancia* were flushed from the grasses of one small strip of ground, approximately 30 feet long by 8 feet wide. *C. fulgida* specimens were also flushed from grasses and clumps of grass, but over a much more extensive area. Individuals of *C. circumpecta johnsoni* were on the open flats, where the ground was smooth and damp. All specimens seen were captured so that the ratio of occurrence was, therefore, proportional to the number caught. The number caught is as follows: 4 *C. willistoni*, 14 *C. fulgida*, and 22 *C. circumpecta*.

In September 1961 there were five species of *Cicindela* at the edge of the playa. The number caught was as follows: 3 *C. willistoni*, 2 *C. fulgida*, 1 *C. punctulata*, 5 *C. togata*, and 1 *C. nigrococculca*.

RELATIONSHIP OF SSP. *ESTANCIA* WITH OTHER
SUBSPECIES OF *C. WILLISTONI*

Subspecies *estancia* is differentiated from all other subspecies of *C. willistoni* by an extreme amount of elytral maculation. This maculation covers about 74% of the total area of the elytra, whereas in ssp. *willistoni*, which is nearest to it in maculation coverage, this only amounts to between 40% and 50% of the total area. The maculation is reduced considerably in the more western subspecies, until it completely disappears in many specimens of ssp. *praedicta*. The color differences between subspecies also show much variation; in ssp. *estancia*, as in ssp. *willistoni*, it is generally bright reddish or greenish bronze, in ssp. *echo* it is usually brown, while in ssp. *pseudosenilis* and ssp. *praedicta* it is dark blue green.

The discovery of a subspecies of *C. willistoni* in central New Mexico is significant by its isolation. The nearest populations are those of ssp. *willistoni* from the Laramie Plain of Wyoming, and ssp. *echo* from Little Salt Lake in southwestern Utah; both areas are 400 to 450 miles away. The Great Salt Lake populations of ssp. *echo* are about 500 miles distant, while the ssp. *praedicta* population at Lake Tecopa (dry) along the Amargosa River in Inyo County, California, is about 550 miles from Willard. There are no known intervening populations of this species. Significantly, *C. willistoni* has never been reported in any part of the Colorado River drainage system, hence none are found in Arizona, nor east of the Wasatch Mountains, from Utah through western Colorado.

The male genitalia of *C. willistoni* are distinct from all other tiger beetles by the unique design of the internal structures within the sac of the aedeagus. Representative internal sacs from all the subspecies were examined, both at rest and everted; in all cases the degree of variation is negligible. Small anomalies are due to

individual freedom of form within very narrow limits, while the main structural design pattern never varies. The form of the internal sac places this species in an intermediate position in the evolution of the more primitive nearctic *Cicindela*. The phylogenetic position lies between the *C. tranquebarica* complex (*C. tenuicincta*, *C. tranquebarica*, and *C. latesignata*) and *C. senilis*, the latter being the more derived.

C. willistoni inhabits damp salt flats in areas of open drainage. It is very common in the Great Basin where it is always found on wet playas, i.e. playas with ground water at, or within a few inches of, the surface. It emerges late in the year, hibernates, then reappears very early in the following year, with elevation and latitude causing some readjustments in time.

PHYSIOGRAPHY OF THE ESTANCIA VALLEY

The Estancia Valley lies near the geographic center of New Mexico, most of it south of the 35th parallel, and nearly bisected by the 106th meridian. It is east of Albuquerque, and south of Santa Fe. The valley lies to the east of the Manzano Mountains, which separate it from the valley of the Rio Grande River. The east of the valley is made up of hills that separate it from the uplands that extend to the Pecos River. To the north, the valley rises to a number of hills and mountains, while in the south the very distinct Mesa Jumanes encloses the region. The basin is one of internal drainage, consequently the central portion contains evidence of a pluvial lake known as Lake Estancia, described by Meinzer (1911), and Antevs (1935:308). According to both authors the lake covered, at its maximum, about 450 square miles; its surface was then at an elevation of 6,200 feet, and its maximum depth did not exceed 150 feet. The total drainage basin covers 2,000 square miles. Today, the lake bed is usually dry, except during the rainy season, or following heavy storms. The lowest parts are broken up into many sink-like depressions, except for the extensive north-south one called Laguna del Perro. These depressions are at ground water level, hence are classed as wet playas. They are sunken as a result of deflation caused by a prevailing southwesterly wind that has deposited the lake bed sands into low dunes on the east side of the valley. Wet playas, in the Southwest, always support some *Cicindela* life, and these, in particular, are remarkable for the large number of species supported.

SPECIES OF *CICINDELA* IN ESTANCIA VALLEY

There are twelve species of *Cicindela* known to the author from Estancia Valley. Most of these were sampled east and southeast of Willard, a town on the southwestern side of the valley. They were found on the shores of sinks, in grasses near these sinks, or in grassland a great distance from the sinks. The best time for

collecting most of the tiger beetle species in the Southwest is after the rainy season starts. This season begins after July 1, and continues through September.

The littoral species:

1. *C. togata fascians* Casey, found on wet sands at the edge of water. July 1958.

2. *C. marutha* Dow, also near the water's edge, but not mixed with the above. These were scarce in July 1958.

The damp flat species:

3. *C. circumpecta johnsoni* Fitch, which were fairly numerous in July 1958, and June 1959. Of 37 specimens at hand, 24 are bronze, 11 are green, and 2 are blue. These are normal proportions for this subspecies according to Vaurie (1951:4).

4. *C. nevadica olmosa* Vaurie, found on the darker parts of the flats, but in relatively small numbers in July 1958. In these, the maculation is broad, as in typical ssp. *olmosa*, but the color is slightly more ruddy. This may be the upper limit of the range of this subspecies.

Species in grasses at the edge of playas:

5. *C. willistoni estancia* n. ssp., which by habit do not usually frequent these areas, but are usually seen in open spots, either near water, or far out on an alkali flat. It is probable that those specimens found here were young, had only recently emerged, and were about to descend to the open flats. This seems to be borne out by the fact that the four specimens of the type series are brightly colored, have all their setae intact, and show a lack of tarsal erosion.

6. *C. nigrocoerulea nigrocoerulea* × *bowditchi*, these were all found at a mud hole on very wet ground at the edge of the grasses bordering the playa. This hybrid population contains admixtures of both parent populations.

7. *C. fulgida* Say, which were flushed from grasses, but alighted again among this sparse growth, not far from the edge of the playas.

Species on open roads or in sparse vegetation
not over ¼ mile from sinks:

8. *C. lemniscata rebaptisata* Vaurie, which is the subspecies with highly pigmented legs. The Estancia Valley is at the edge of the zone of hybridization between this subspecies and ssp. *lemniscata*. No hybridization can occur, however, because of natural mountain barriers to the west and south of the valley.

9. *C. punctulata chihuahuac* Bates. Of seven specimens captured, all were bright green to deep blue, except for one that had dark brown elytra with green foveae, as in typical ssp. *punctulata*.

10. *C. pusilla cinctipennis* LeConte. Only one broadly maculated specimen of this subspecies is available. It closely resembles Colorado members of the subspecies, although more samples are required to determine the true affinities of this population.

Species from open plains, found in grasslands far from water:

11. *C. flavopunctata rectilatera* Chaudoir, often found near water in the Southwest, hence this species must have a broad ecological tolerance. Specimens of *C. punctulata chihuahuae* were also found with these.

12. *C. obsoleta anita* Dow, the melanic form close to ssp. *santaclarae* is one of the largest nearctic tiger beetles, measuring about 20 mm in length. The sample from a few miles southeast of Willard was captured on 18 July 1958, at noon, when the temperature was 80° F., and the sky partly cloudy. The elevation above sea level was about 6,000 feet. Individuals were solitary, most of them hiding among the grasses, but when flushed, flew away slowly, but for a long distance. A few were mating. The sample specimens vary greatly in maculation, from totally immaculate, to those with full sets of dots as in typical ssp. *santaclarae*, or even with a complete marginal connection. This black form is found westward into Arizona, somewhat north of the locations where ssp. *santaclarae* is usually found.

CONCLUSIONS DRAWN FROM THE ESTANCIA VALLEY *CICINDELA* FAUNA

The Estancia Valley has been excluded hydrographically from other basins, at least during the pluvial periods of the Pleistocene; from this it may be concluded that migrations of *Cicindela* species, either in or out of the valley, have not occurred for at least the latter part of the Pleistocene, or roughly the past 100,000 years. Hydrographically, it is considered by Hubbs and Miller (1948: 117) to be a disrupted part of the Rio Grande System. The tiger beetle fauna indicates the following detailed hydrography:

1. The Estancia Valley was connected hydrographically to the Pecos River drainage system during the late Pleistocene. Half of the tiger beetle species of the valley belong, faunistically, to those of the Pecos region. These are *C. circumpecta johnsoni*, *C. nevadica olmosa*, *C. punctulata chihuahuae*, *C. flavopunctata rectilatera*, *C. lemniscata rebaptisata*, and *C. togata fascinans*, all of which show no variation from those of the Pecos Valley, hence recent intrusion. The whole region, including Lake Encino, and several adjacent small areas of internal drainage, appears to be an embayment of the Pecos fauna, of recent origin. The Hills of Pederal, which separate the Estancia Valley from the eastern uplands, were formed by an uplift, according to Meinzer (1911: 11), which probably happened in pre-pluvial times, but still during the late Pleistocene.

2. A connection between the Estancia Valley and the Tularosa Basin (Otero Drainage System) to the south is not evident. The only tiger beetles common to both basins are *C. nevadica olmosa* and *C. punctulata*, but these are also common to the Pecos fauna. *C. circumpecta johnsoni* has been replaced in the Tularosa Basin by its near relative *C. praetextata fulgoris* which appears to have a similar ecology, so that overlap is improbable between these two species. The Tularosa Basin specimens of *C. lemniscata* are hybrids, as this is the zone where ssp. *lemniscata* and ssp. *rebapicata* come in contact.

3. A connection between the Estancia Valley and a northern drainage system at some remote time is clearly evident. Several connections may have occurred to allow migrations of *C. fulgida*, *C. willistoni*, *C. nigrocoerulea*, and *C. obsoleta*. The peculiarities of the populations of these species, as they are found in Estancia Valley, point to a remote time.

C. fulgida is superficially different from northern New Mexico and midwestern populations by the broadening of the maculation, so that the lunules and bands are as confluent as in *C. parowana platti* of the Death Valley System of California. When more specimens of this population are examined, it may be discovered that this is a distinct subspecies.

C. nigrocoerulea is a hybrid between the southern populations of ssp. *nigrocoerulea* found from southwestern Texas to southern Arizona, and the southern Colorado populations of ssp. *bowditchi*. Of 24 specimens from Estancia Valley, only 7 are dark blue-black, while the majority are green; furthermore, they vary from immaculate to white-bordered as in typical ssp. *bowditchi*. It is postulated that ssp. *bowditchi* occupied the Estancia Valley region after mid-Cenozoic, and that its original range covered extensive areas to the east, and northward into Colorado. Long isolation during the Pleistocene produced the strong superficial difference between this subspecies and the nearly always immaculate ssp. *nigrocoerulea*. There was ample time for subspeciation, and later there was time also for isolation of a population in the area. The eventual intrusion of ssp. *nigrocoerulea* upon this isolated population of ssp. *bowditchi*, during the Pecos stage, caused the hybridization that is the mark of today's population.

C. obsoleta is very closely related morphologically to *C. nigrocoerulea*, but unlike the latter, it lives on dry, grass covered, uplands. Near Showlow, Arizona, there are similar melanic specimens at the same latitude, whereas at Springerville, Arizona, also at nearly the same latitude, typical ssp. *santaclarae* are found. Until more populations are discovered and examined, it will remain difficult to understand the derivations of this form.

ORIGIN AND MIGRATION OF
C. WILLISTONI ESTANCIA

C. willistoni estancia is most closely related to ssp. *willistoni* of the Laramie Plain of Wyoming. The chronological tracing of its ancestry can be hypothesized in a general way.

It was pointed out by Blackwelder (1909: 430) that the Laramie Plain was a lowland at the close of the Cretaceous, and that through much of that epoch, the region was beneath the sea. At that time, the initial Rocky Mountain disturbance had not yet begun, so that the lowlands extended all the way to, and considerably beyond, the present site of Lake Estancia. It is probable that *C. willistoni* had not yet evolved into a species, but precursor species existed which were equipped with very rudimentary genitalic internal structures.

The orogenic Laramide Revolution, that marked the beginning of the Cenozoic era, caused important climatic changes affecting the ecologies of these early species, within the region of influence. The ancestral species began to take form in a region far to the north, so that the warmer, wetter, and subtropical Oligocene epoch had only partial effect on its development. Farther south, a whole host of new forms were evolved during this epoch; these were disseminated throughout the region, later migrated southward, and today form the bulk of the Mexican species.

Since *C. willistoni* was a more northern form, less affected by the period of greatest evolutionary pressure, it displays relatively lesser change. Following the warmer period, it spread across the whole mid-Cordilleran region to the Pacific Coast. In its eastern range it moved southward across the slowly rising, and drier lowlands, of Colorado and New Mexico, along intermittent saline flats characteristic of the drier Miocene. Renewed Rocky Mountain uplift, during this epoch, was not sufficient to interfere much with this species, except to create intermittent isolation around the extensive shallow lake system of that time. The great Pleistocene upthrust, however, completely isolated the population groups of Wyoming, New Mexico, and the Great Basin.

Only slight evolutionary change took place in *C. willistoni* after the period of formation. It is believed that this species came through the Miocene in its present form because from this epoch on, the general landscape was not severely altered, and the overall climate was relatively unchanged (it slowly continued to get drier), hence ecological pressure remained constant. It is the specific saline ecology of *C. willistoni*, coupled with fairly constant conditions that supported intermittent saline lakes in interconnected areas of internal drainage, that retained this species in its relatively unmodified state.

Subspeciation is a phenomenon generally associated with the Pleistocene, though in some species it may have begun during the Pliocene or earlier. Because of the recency of these epochs, widely separated subspecific populations are found which always retain their morphological identities with the phenotype, especially in the structures of the genitalia. To further uphold this condition, widely separated favorable habitats are still available, so that populations that have been separated for several hundreds of thousands of years are still extant. *C. willistoni estancia*, preserved by the favorable conditions in Estancia valley, is such a population.

Cicindela hirticollis corpuscula, new subspecies

Medium to small in size, slender, dull bronze with broad complete maculation connected at margin. HEAD: Eyes prominent, interocular striae very shallow. Frons dimpled with many scattered pits from which arise white setae, these also extending to the sub-orbital region. Antennae bronze through the first four segments; scape with two setigerous punctures near the tip and forward of the junction with the second segment. Labrum white, the middle third extending forward into a flat protrusion, from the center of which arises a single, very small, sharp tooth. Mandibles white at base, with a bronze central band, and long acute black tips. Both sets of palpi pale in color, except for the last segment of each which is pigmented metallic green with a bronze cast; tips very slightly securiform. THORAX: Barely narrower than the eyes at its widest forward section, thence tapering so slightly toward the base as to appear nearly parallel. Disc bronze, median longitudinal impression shallow, while the anterior and posterior transverse impressions are deep. All impressions green at their deepest points. Posterior angles rounded, with a bulbous region between the posterior impression and the bottom edge. Sides of disc with long white hairs along the whole margin; a few recumbent hairs forward of the anterior transverse impression, with a bare spot at the center, also a very few hairs scattered over the lower half of the disc, blending into the side hairs. ELYTRA: Widest just forward of halfway, from there slightly narrowing to the apical third, where they curve inward evenly toward the suture. In the female the outer shape of the elytra differs from the male here described, in that the sides extend outward abruptly above the basal third, giving the female a broader appearance; the tip of the elytra is slightly recurved before reaching the basal spine. The ratio of length to width, in the type specimens, reflects this dimorphism, where the L/W ratio in the male is 2.43, while in the

female it is 2.29, indicating that the male is, indeed, relatively more narrow. Color bronze, pitted throughout the pigmented area, except for the sutural ridges which are unpitted and reddish bronze; pits green, numerous, and shallow, each with a slightly raised portion forward. Maculation white and relatively broad; humeral lunule with tip recurved inward and forward into a straight line ending in a small bulb. Apical lunule with a slightly recurved tip. Middle band entering from the side in a forward line nearly parallel to the extension of the humeral lunule, thence descending into a deep, longitudinal apical extension, with sinuous contour on the sutural side; it terminates with an inwardly directed bulb that nearly reaches the sutural ridge. The side margin is complete, broad above the middle band, then tapering narrowly, but very slightly, to the humeral lunule; broadens steadily to more than halfway to the apical lunule where it smoothly narrows nearly to the vanishing point before connecting to the latter, this narrow section is slightly more extensive than the width of the inner extension of the apical lunule. UNDERSIDE: Color metallic blue-green in the middle, bronze at the head and thoracic sides. Head: Genae bright bronze with fine deep striae, color becomes greenish near the eyes. Gula dull bronze and glabrous. THORAX: Episterna coppery, and bearing long white recumbent hairs. Sterna shining green and glabrous, except for the metasterna which have bronze areas, with long white hairs, covering nearly half the region adjacent to the metaepisterna. Anterior and median coxae green and glabrous, but for the region adjacent to the metaepimera, which are covered with hairs. Abdomen: Bright green with blue reflections. Outer half of sternites moderately covered with short recumbent hairs. Penultimate sternite of the male has a shallow penial notch, lying to the left of the body centerline, to accommodate the asymmetrical penis. Legs: Trochanters dark, with green reflections, glabrous. Legs covered with the usual hairs and bristles; bright reddish bronze, femora tinged with green near the connection with the tibia; tarsal joints long, the combined tarsal joints of the male longer than the anterior tibia; tarsal claws moderately long, rear ones nearly $\frac{2}{3}$ the length of the fifth tarsal segment. DIMENSIONS: Male—Length 11.3 mm, width 4.7 mm. Female—Length 11.7 mm, width 5.1 mm.

Holotype male, allotype female, and 20 topotypical paratypes from Potholes, Imperial County, California, collected 12 May 1946. 35 paratypes collected on the banks of the Colorado River as follows: 3 from 14 miles south of Needles, San Bernardino County, California, 10 May 1952; 2 from Imperial Dam, Yuma

County, Arizona, 16 April 1954; 8 from Yuma, Arizona, (2 by F. H. Shoemaker, 1904; 2 from the Blaisdell collection, 1922; and 4 by E. P. Van Duzee, April 1923), and 22 from Moab, Grand County, Utah, 23 July 1959 (M. C. Slagle), 2 paratypes from Gila Valley, Graham County, Arizona, 14 September 1924 (D. K. Duncan), 2 paratypes from Phoenix, Arizona, no dates, and 1 paratype from St. George, Washington County, Utah, no date, (V. M. Tanner).

The name is from the latin *corpuscula* meaning small body.

DISTRIBUTION OF TYPICAL SPECIMENS

Holotype, allotype, 25 paratopotypes and 7 paratypes in the author's collection. 2 paratopotypes in the U. S. National Museum, Washington, D.C., in the care of Dr. O. A. Cartwright. 12 paratypes in the collection of the California Academy of Sciences, San Francisco, California, in the care of Mr. Hugh B. Leech. 16 paratypes from Moab, Utah, in the collection of Mr. M. C. Slagle of Ft. Lauderdale, Florida.

THE TYPE SERIES

The type series of *C. hirticollis corpuscula* consists of 64 specimens. The main characteristics of the series are the smallness of size, and the relatively wide maculation, especially in those from the lower Colorado River Basin. The series may be divided into two distinct population groups: 1. The lower populations, found along the Colorado River below Grand Canyon, especially from below Needles, to the Gulf of California, and also along the main tributaries, i.e. the Virgin, and the Gila — Salt Rivers. 2. the upper population, recorded from Moab, Utah, well above the Grand Canyon.

Measurements substantiate this smallness in size, as shown in Table A. The two population groups of ssp. *corpuscula* were compared to each other, as well as to a Pacific Coast sample of *C. hirticollis gravida*.

Table A
 Comparison of Length in Various Populations
 of *C. hirticollis corpuscula*, and *gravida*

| subspecies | population | sample size | | longest | shortest | average length | | | standard deviation s | |
|------------|----------------|-------------|----|---------|----------|----------------|------|------|-------------------------|-----|
| | | n | ♂ | | | ♀ | × | × ♂ | | × ♀ |
| corpuscula | Lower Colorado | 27 | 12 | 15 | 12.4 ♀ | 10.0 ♂ ♀ | 11.3 | 11.0 | 11.5 | .50 |
| | Upper Colorado | 22 | 8 | 14 | 13.0 ♀ | 11.2 ♂ | 12.1 | 11.7 | 12.5 | .58 |
| gravida | Pacific Coast | 30 | 15 | 15 | 14.5 ♀ | 12.0 ♂ | 13.3 | 12.8 | 13.7 | .57 |

COMPARISON OF SSP. *CORPUSCULA* WITH
OTHER SUBSPECIES OF *C. HIRTICOLLIS*

Subspecies *corpuscula* may be differentiated from all other subspecies of *C. hirticollis* principally by the small size, and wide maculation. *C. hirticollis ponderosa* is also broadly maculated, but is much larger in size — in his original description, Thomson (1859:23) lists it between 13 and 15 mm — and its range is the southern Midwest, and along the Gulf of Mexico from Texas to Vera Cruz, Mexico, although Harris (1911:15, in footnote), questioned the propriety of all but the Mexican population from near Vera Cruz, and possibly the Arizonian specimens. Cazier (1954:241) reported ssp. *ponderosa* from Algodones, Baja California, Mexico (near Yuma, Arizona); these cannot be in consonance with the larger size of ssp. *ponderosa*, and therefore are referred to ssp. *corpuscula*. *C. hirticollis gravida* of the Pacific Coast is also larger, but with narrow maculation and a greenish color. *C. hirticollis abrupta* is also larger, darker, and with very distinctly and abruptly narrowed elytra at the apical third, especially in the female. *C. hirticollis shermani* is a doubtful race that is blackish bronze in color, with sharp elytral apices, and though relatively small, according to Casey (1916:30) it is still larger in size (12.5 mm), but narrower (4.6 mm).

The lower Colorado River population of ssp. *corpuscula* is reddish bronze in March and April, the color turning to a darker dull bronze by June and July. This population is of the more typical form, and is well developed throughout most of the lower Colorado River Basin. Some small specimens, very similar to this subspecies, have been noted from Texas.

The upper Colorado River population from Moab is intermediate in size, with a maculation that is more in keeping with, but less variable than typical ssp. *hirticollis*. It is more closely related to the lower Colorado River populations of ssp. *corpuscula* than to other subspecies, primarily because of the smaller size, and the geographical location along the Colorado River. This population has been known for some time, having been reported by Tanner (1929:80). The population along the lower Colorado River has been known for still longer, the first report coming from Wickham (1899:220) who stated that H. C. Fall took it along the river during July; later, Tanner (1929:80) recorded it from St. George, Utah, along the banks of the Virgin River.

C. hirticollis corpuscula is a gregarious riparian subspecies throughout its range.

RELATIONSHIP OF SSP. *CORPUSCULA* WITH
ITS GEOGRAPHICAL LOCATION

The theory originally advanced by Blackwelder (1934:560) on the origin of the Colorado River states, in brief, that during the late Pliocene, the Rocky Mountains of Colorado were lower, maybe as low as 5,000 feet, so as to allow the westerly winds to carry their moisture beyond the range, thereby causing the formation of a semi-arid region westward. Since the Colorado uplift had not yet begun, he further states that in that time there existed a region lower in altitude, and distinctly more arid than now, and that this landscape extended from Wyoming, Utah, and Colorado, south into Mexico. Consequently the Colorado River was small, had reached grade or nearly so, and entered the Gulf of California on the eastern side since the latter extended considerably into the region now occupied by the Mojave and Colorado deserts. With the Pleistocene uplift, the mountains of Colorado provoked more rain and the river grew, enabling it, by volume, to maintain itself at the same general grade. This is the uplift theory that explains meanders in deeply encised gorges, such as the Goosenecks of the tributary San Juan River, near Mexican Hat, Utah.

One of the first effects of uplift was the formation of a series of lakes along the path of the river. This was the beginning of isolation for the tiger beetle populations. Later, by adjusting itself to a more direct path, the river filled and overflowed these lakes, then created deep gorges. By then, populations were not only isolated, but the chance of intermingling from time to time became less and less possible, until deepening gorges, such as the Grand Canyon, became such imposing barriers as to cause complete isolation of the populations from up and down the river. It has been advanced that the Colorado River has been cutting its way through a gradual uplift for nearly a million years. It may be assumed that the riparian tiger beetle populations were isolated for some lesser part of that time, so that something in the order of 300,000 years will be the best guess for complete isolation of the upper and lower population of *C. hirticollis corpuscula*.

In the nearly 300,000 years of total isolation there were no evolutionary pressures of any consequence on these two populations. Under the conditions, any evolutionary change brought on by isolation would be restricted to size, color, or maculation coverage. Any change in morphology would not be noticeable because *C. hirticollis* belongs to one of the most primitive groups of the nearctic *Cicindelae*; this is indicated by most rudimentary structures in the internal sac of the male armature.

While the upper Colorado River population somewhat recalls small ssp. *hirticollis*, the lower Colorado River and tributary populations are still smaller, more distinctly marked, and possibly more reddish bronze in color. These modifications indicate an origin based on several widespread migrations of the ancestral species. There was a possible migration into the Colorado Basin from the north after mid-Cenozoic. Another migration, of a more widely maculated relative to ssp. *ponderosa*, may have entered the basin from the east or southeast during the same period. Migrations were stopped from reaching the Pacific Coast by the extension of the Gulf of California. Migration, in and out of the basin, may have continued until late Pliocene.

It is believed that the mixing of these ancient stocks created the basic pattern for ssp. *corpuscula* which then evolved during the long isolation that followed. It is this very genetic derivation that brought about variations between the upper and lower Colorado River groups following this isolation during the latter half of the Pleistocene. A basic plasticity was retained that caused the one population to partially converge to the appearance of the northern migrants, while the other converged in appearance to the eastern migrants; each reverting to the preponderant genetic force of its region, albeit both are still small in size, but unequally so.

The Little Colorado River enters the Colorado River at the eastern end of Grand Canyon, below Marble Canyon, in a region isolated from both the upper and lower populations of ssp. *corpuscula*. In the upper reaches of this tributary, at Holbrook, Arizona, there is a very distinctive, large, red, and broadly maculated *C. hirticollis* of considerably different origin. It is foreign to the Colorado River populations.

GEOLOGICAL AND FAUNAL CONCLUSIONS DRAWN FROM SSP. *CORPUSCULA*

1. *C. hirticollis* entered the Colorado River Basin by two routes, one from the north, the other from the east. It developed characteristics of subspecific nature during late Pliocene or early Pleistocene.

2. Isolation of populations by the great canyons at midriver created an upper river population at Moab, Utah, slightly distinct from the lower river population. The Virgin and Gila river drainage systems have been connected to the lower Colorado River system, at least since early uplift time.

3. The Little Colorado River was created during, and as a result of uplift. Prior to this, its upper basin was part of an eastern hydrographic system.

Cicindela limbata albissima, new subspecies

Medium to small in size, narrow, convex; head and thorax green, elytra almost completely covered with white maculation. HEAD: Bright green with a bronze central tinge between the eyes, extending from the vertex to the occiput, in an area that is granulately wrinkled; interocular striae fine and tinged with blue, especially behind the eyes; clypeus bright green with a bright blue suture; frons punctate, from each puncture arises an erect white hair; hairs on head numerous and erect, covering the frons, vertex, and the entire area between the eyes; the eyes are not excessively prominent; first four joints of the antennae are bronze, the third and fourth joints with a more metallic red tint, scape with 3 or 4 hairs forward of, and above the junction with the second joint; labrum white and truncate, feebly curved anteriorly, and with a very small central tooth, submarginal hairs 8 to 10 in number; mandibles long, white at their basal $2/3$, terminating in sharp black tips; joints of palpi pale testaceous, but not the last ones which are pigmented and with tips slightly securiform. THORAX: Pronotum narrower than the eyes, subquadrate, widest forward, thence tapering very slightly to the base; surface granulately wrinkled; long hairs covering the sides, and halfway to the longitudinal impression; this impression is very shallow, while the transverse impressions are deep: ELYTRA: Wider at the shoulder than the head, then tapering outward slightly for nearly $2/3$ their length, at which point the body reaches maximum width; from there the elytra are smoothly rounded to the apex; in the latter half of this curve, the edge is micro-serrulate; the apical tooth is barely indicated. The pigmentation of the elytra is dull bronze, consisting of a small area at the humeral disc nearly parallel to the suture; this area begins at the green scutellum, it is about $1/3$ the width of the elytra, broadens slightly for a distance equal to its width, then tapers toward the suture for nearly $2/3$ the length of the elytra; the sutural ridge is brightly pigmented throughout its length; the sutural bronze foveae nearly parallel the suture, then extend outward $3/4$ of the way to the apex; the rest of the elytra is dull white but for two short rows of black foveae near the outer edge of the humeral disc; the entire white surface is covered with widely separated micro punctures, these punctures are raised forward in the central apical region in an indistinct band. UNDERSIDE: Bright green with bluish tinge centrally, also blue where there are impressions; covered nearly throughout with long white decumbent hairs; genae wrinkled and hairy; sides of thorax hairy laterally; front and median coxae hairy, back ones bare on top but not so laterally; center of abdomen nearly bare except for a few hairs at the edge of the segments; penial notch of moderate depth but off-center with respect to the centerline of the body, bearing to the left side to accommodate the

asymmetrical penis; legs are a bright green, bearing a medium amount of white hairs and bristles; the tarsal joints are of medium length, and bear a number of white recumbent hairs; the tarsal claws are very long, the rear ones are fully as long as the last tarsal joint.

The female is similar to the male except for being a little broader in the elytra, and being slightly larger in size. DIMENSIONS: Male—Length 10.8 mm, width 4.4 mm. Female—Length 11.7 mm, width 4.7 mm.

Holotype male, allotype female, and 115 topotypical paratypes from Coral Pink Sand Dunes, located 14 miles south of Mt. Carmel Junction, Kane County, Utah. Elevation 6,300 feet. Collected at the following dates: 9 on 5-6 August 1958 (E. R. Tinkham), 40 on 17 September 1960, and 68 on 29 September 1960, this last date includes the type specimens.

Name from the latin *alba* (white) and the superlative *issima*, hence, very white.

DISTRIBUTION OF TYPICAL SPECIMENS

Holotype and allotype in the author's collection. Paratopotypes as follows: 5 to Dr. E. R. Tinkham of Indio, California; 5 to Dr. M. A. Cazier, Director, Southwestern Research Station of the American Museum of Natural History, Portal, Arizona; 5 to the California Academy of Sciences in the care of Mr. Hugh B. Leech; 4 to Dr. O. A. Cartwright of the United States National Museum, Washington, D.C., 2 to Dr. H. Howden of the Canadian Department of Agriculture, Ottawa, Ontario; 2 to Dr. F. Truxal of the Los Angeles County Museum, Los Angeles, California; 2 to the Reverend B. Rotger C. R. of Pagosa Springs, Colorado; 2 to Dr. J. A. Knudsen of Pacific Lutheran University, Tacoma, Washington; 2 to Dr. F. M. Beer of Oregon State College, Corvallis, Oregon; 2 to Dr. W. A. Drew of Oklahoma State University, Stillwater, Oklahoma, and the balance of 84 in the author's collection.

THE TYPE SERIES

This whole series is homogeneous with few exceptions. In some specimens the color is closer to blue, while the pigmentation is nearly all green and the legs are a greenish blue. In others, the central apical irregular areas of the elytra have a few faintly pigmented dots in close juxtaposition, in the region that is normally pigmented in other subspecies. *C. limbata albissima* is the only member of its species found west of the Continental Divide, considerably to the west of the Rocky Mountains. It may be readily distinguished from ssp. *limbata* and ssp. *nympha*, of the midwestern United States and Canada, by its lack of discal pigmentation

in the apical region of the elytra, and from ssp. *hyperborea* of Canada's Northwest Territories and northern Alberta which is darkly pigmented, and maculated in the more conventional *Cicindela* fashion.

BIOLOGY AND ALLIED SPECIES

C. limbata albissima is a sand dune tiger beetle. On the Coral Pink Sand Dunes, individuals of this subspecies emerge suddenly on the northern side of dunes, between the hours of 9:30 and 10:00 A.M., first by the few, then increasing in numbers, but always remaining solitary. Those collected in September were teneral specimens, only recently emerged, as borne out by their softness of body, especially in the earlier sample, also the bright pigment, the full pilosity, and the fact that the sexes were about evenly divided. Of the 40 collected on 17 September 1960, there were 19 males and 21 females. Two weeks later, 66 were captured, of which 32 were males and 34 females. The 9 specimens collected in August of 1958, by Dr. Tinkham, were old specimens with well worn claws from long exposure to the motion of the sand, also with a darker, mat pigmentation, which is also an indication of advancing age. It is evident that this population emerges in September and October, then hibernates until Spring; the last specimens disappear in August, or just prior to the emergence of the new generation.

Since none were mating, it was of interest to find out if this was by choice or necessity. From an inspection of several male armatures, it was discovered that this organ had not yet hardened, and at the time, was unsuited for mating. Mating probably begins after Spring emergence, and it is unlikely that any overlap of the generations results in intermating.

On the early September visit, there was evidence that it had rained heavily the day before from the large rain spots on the sand. When the upper layer of the sand had dried in the 80°F. temperature, the insects began to appear. On the 29th of September there was an increasing southwesterly wind that rippled the sand surface, until it reached 15 knots at noon; so much sand was stirred up by that time, that the few tiger beetles remaining out sought shelter on the lee side of the slightest rise, finally, even these few insects failed to appear. The early morning coolness of the sand may have something to do with the late appearance of these insects. As the temperature increased they became wary, until it was extremely difficult to approach them on the open sand without their taking flight. Their burrows were somewhere on the lee side of very large dunes, in sandy areas covered by scattered brush, as the beetles flew that way when disturbed. Those not disturbed were seen alighting on the steep sides of dunes, then fly-

ing up and over the top, to sun themselves on the more exposed sand.

The sand of the Coral Pink Sand Dunes is very fine in texture, and will saltate in the slightest breeze at the level of the tiger beetles. It is this fine blown sand that causes erosion of their hairs and tarsal claws. Because of the wind conditions associated with sand dunes, these active insects will seek shelter when the velocity is too high for controlled flight; this may be a reason for finding them more numerous at the edge of the dune area, especially on the downwind side. The Coral Pink Sand Dunes cover several square miles, and are situated on the windward side of a range of hills called the Vermilion Cliffs. Their direction is southwest to northeast, along the line of prevailing winds. The composition of the sand is finely ground sandstone, of Chinle formation. These were the only species of *Cicindelids* found in the dunes.

The subspecies of *C. limbata* inhabit sandy areas, and preferably sand dunes. This is the strongest ecological characteristic of the species. Species allied to it morphologically have similar ecologies; these include *C. theatina* Rotger of the Great Sand Dunes in the San Luis Valley of south central Colorado, and *C. bellissima* Fall of the sand dunes found along the Oregon-Washington coast, and the Columbia River Valley. The subspecies of *C. limbata* live at intermediate elevations, up to 6,300 feet, *C. theatina* at 7,500 to 8,000 feet, while *C. bellissima* is found at, or near, sea level. It is not the elevation, nor the proximity or isolation from water, that is the characteristic of their combined ecologies, but rather their affinity for sandy habitats. Because of this they exhibit a wide tolerance of latitude and faunal zones.

C. limbata, the easternmost species of this complex except for ssp. *albissima*, displays variations in maculation with latitude; this is equivalent to change in elevation at the same latitude, so let us examine it from this standpoint. The more extensive pigmentation prevails, on this basis, at the higher elevations (equivalent to more northern latitude); this is exemplified by ssp. *hyperborea* of northern Canada. The lack of pigmentation shows up at lowest elevation (lower latitude equivalence), as represented, in the extreme, by ssp. *albissima*. This may have something to do with the amount of reflection or absorption of light that they will tolerate, then again it may only be a coincidence resulting from other factors. To be considered is the probability that during the glacial periods of the Pleistocene, ssp. *hyperborea* migrated northward ahead of the Keewatin Advance, while the more northern Canadian populations of ssp. *nympha* and ssp. *limbata* were forced to lower latitudes. Following glaciation, ssp. *hyperborea* returned southward, while during the latter part of the Pleistocene ssp. *albissima* gained altitude

(northern latitude equivalence). This may explain the greater pigmentation of ssp. *hyperborea* on the basis of longer isolation from the main population groups, at a very northern latitude. Conversely, the lack of elytral pigmentation in ssp. *albissima* may be due to longer isolation also, but at more southern latitudes. If latitude actually does control the amount of elytral maculation in this species, then it might be expected that in the future ssp. *hyperborea* will lose some pigment, while ssp. *albissima* will gain pigment.

ORIGIN AND MIGRATION OF

C. LIMBATA ALBISSIMA

A branch of *C. limbata* moved freely in and out of the Colorado River Basin during the mid-Cenozoic (Miocene) by a migration route across Wyoming, Montana, and Alberta via the Green River Basin and other basins farther north. This route was available until early Pleistocene. If this hypothesis is correct, then ssp. *albissima* is more closely related to the Canadian ssp. *nympha* than to ssp. *limbata*. To further support this view, it is noted that *C. formosa* and *C. scutellaris*, both closely related to each other, both near related to *C. limbata*, and both ecologically tolerant of sandy locations, are found together in sand blowouts near the Yampa River, a short distance from Maybell, Colorado. This *C. formosa* is ssp. *gibsoni*, identical to the typical form of Saskatchewan, while the *C. scutellaris* is an endemic form, closely related to ssp. *criddlei* of Manitoba.

Since *C. limbata* and *C. hirticollis* have a similar type of genitalia, and therefore belong to the same phylogenetic group, it is postulated that, although the two species are distinct ecologically, they were derived somewhat on the same time scale. This strengthens the earlier conclusion that there was a migration route for *C. hirticollis* into the Colorado River Basin from the north. The method of migration chosen by *C. limbata* was of necessity quite different from that chosen by *C. hirticollis*.

It is concluded that *C. limbata* was a relatively northern rudimentary nearctic species at the beginning of the Cenozoic. It remained in the north, and it developed without influence from the Rocky Mountain uplift. Because of this, it was not under pressure to alter its basic habits, thus enabling it to remain unspecialized to this day. The intrusion into the Cordilleran region was along a natural migratory route, at a time when climatic conditions were favorable. These favorable conditions have not totally changed, hence ssp. *albissima* is able to survive in the Colorado River Basin, although very restricted in its distribution.

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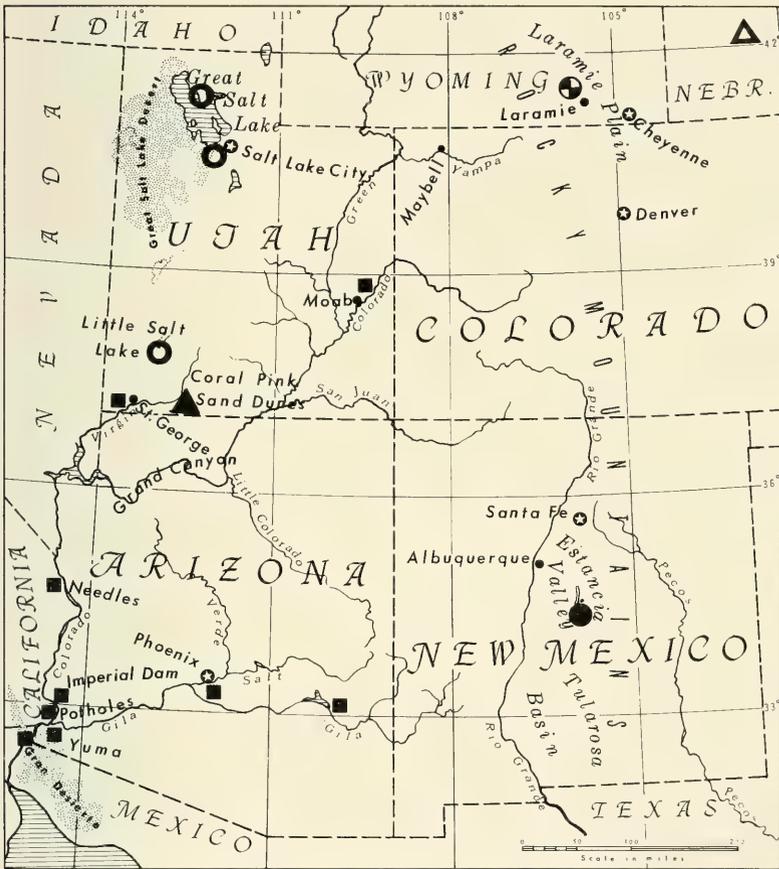
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- ▲ *C. limbata limbata* ● (with dot) *C. willistoni willistoni*
- ▲ (with horizontal line) *C. limbata albissima* ○ (with horizontal line) *C. willistoni echo*
- *C. hirticollis corpuscula* ● (with vertical line) *C. willistoni estancia*

PLATE 45

Map of a portion of southwestern United States showing location of some tiger beetle populations of the genus *Cicindela*.

OBSERVATION OF
PELECYPHORUS JAEGERI PAPP (1961)
AND OTHER TENEBRIONIDS FROM
THE MOJAVE DESERT, CALIFORNIA
(Notes on California Coleoptera No. 2)

By
HAROLD D. PIERCE¹

While working a Khapra beetle survey, *Trogoderma granarium* Everts, during the summer of 1958, I noticed a very interesting dead *Pelecyphorus* specimen under a feed tank on a poultry ranch. After showing the specimen to the rancher, I was told that on occasion he had seen what he thought to be this beetle in his poultry house at night. Sometime later, a group of the same species appeared again under the false flooring of a poultry feed room, in the Quartz Hill area.

The very black, shiny surface of this beetle, together with its larger size, makes it quite noticeable after looking at smaller grain storage pests. Having become quite accustomed to seeing the more common Tenebrionids, associated with stored grain and poultry feed, (Papp and Pierce 1960), this particular species appeared to be quite different. After showing these specimens to C. S. Papp, it was determined by him to be not only an interesting beetle, but a new species, as *P. jaegeri*.

Not having seen this beetle moving during the day, I took night trips into the desert area approximately one and one-half miles East of Quartz Hill. This area was found to be very active with the *Pelecyphorus* sp. Many were traveling from place to place with no set goal in mind other than feeding. Their natural feed is apparently the same as other Tenebrionids. At no time was this beetle seen in noticeable numbers during the day.

On the night trips, it was quite evident that an erratic variation in male and female sizes of *P. jaegeri* was common. At times, larger males than females were noticed in the copulation act. At other times their size would be the same. One female was seen ovipositing her eggs in a soft, open, sandy area. Not having a screen at the time, I was unable to collect eggs. A dissection showed she had completed her laying. While observing her, she seemed to deposit in many different spots, using a rather long ovipositor.

It will be of great interest to find the biological habits of this amazing creature. Further study of this desert species will un-

¹U.S.D.A., Plant Pest Control, Riverside, Calif.

doubtedly add to the many wonderful findings of the man for whom this species is named, Dr. Edmund C. Jaeger.

On cold, cloudy, and rainy days, other Tenebrionids seem to be very active, especially in the late fall, when a type of migration appears on the desert. It has always puzzled me as to where they think they are going. They seem to travel in different directions, with many going into the same area from which many just came. The same is true of Tarantulas in the Victorville, Lancaster, Barstow, and Red Mountain districts. The Tenebrionids do not seem to congregate in any special place, other than deep burrows, such as squirrel dens. I might mention that at times I have found many Tenebrionid species in the warehouses of squirrel dens.

One of the more interesting Tenebrionids in the Mojave Desert is *Eleodes gigantea* Mann. This beetle can be found in all parts of the desert with little trouble. One area with significant numbers of this species is approximately ten miles northwest of Lancaster. This small area is still unclaimed for agricultural purposes, leaving the native flora intact. It is exceedingly interesting to see this large, elongated beetle going about its "duty" of searching for food. Another area in which *E. gigantea* has been found abundantly, is in the Palmdale district. On one occasion, on a poultry farm, the mass congregation of 100 or more beetles was found under a pile of old sacks, by the feed bin.

At one time, while inspecting a poultry feed bin, I noticed two *Trogloclerus costatus tuberculatus* Blaisdell specimens busily feeding on spilled mash feed. Further investigation failed to show any mass population in the area until one showed himself around the opening of a mouse digging under the bin. It was then found that every digging in deep burrows were quite infested with these little beetles. They all seemed to be patiently waiting for night fall so they could come out and help themselves to this free meal. These prehistoric like beetles seemed to be adjusting very well to the idea of not having to search too far for a source of food. Here again, the Quartz Hill area comes into the picture of showing unusual beetles.

The Mojave Desert region is a constant source of interesting finds, both flora and fauna. This vast area could well be extended into areas not normally considered a part of the Mojave Desert. The desert extending from Barstow to Needles, is one of constant challenge. This same area could well be broadened North to the California, Nevada border, and South to the Twenty-nine Palms district. The Coleoptera activity of this country side, as well as all Southwestern desert regions, is very spectacular. As population growth increases and desert interest develops, there will no doubt be a striking upsurge in new and interesting finds.

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CONENOSE BUG (*Triatoma*) ANNOYANCE AND *Trypanosoma cruzi* IN GRIFFITH PARK IN 1960

The following data on the occurrence of *Triatoma protracta protracta* in Griffith Park for the summer of 1960 was gathered with the cooperation of the camp personnel at the Griffith Park Boys' and Girls' Camps. The authors especially thank Ann C. Woolf, Melvin C. Carlson, and Arthur L. Gladwill for their continued cooperation.

Table I summarizes the general occurrence of western conenose bugs at the two Griffith Park camps. The insects were collected as specified in the 1957 and 1958 studies (Mehring Jr. and Wood, 1958 Bull. So. Calif. Acad. Sci. 57:39-46, and Wood, 1960 Bull. So. Calif. Acad. Sci. 59:50-52). Live conenose bugs were found from June 20th through September 30th. Forty-one were collected in June, 211 in July, 62 in August, and 50 in September.

During the summer of 1960, 364 bugs were collected from the youth camps, 189 from the Boys' Camp and 175 from the Girls' Camp; 137 were males and 227 were females. If the 1957 and 1958 data is added to these figures, a total of 705 bugs is obtained revealing a sex ratio of 249 ♂ to 456 ♀ or 64.7% females.

The number of bugs reported over the three year period has varied from summer to summer. In 1957, 240 bugs were captured, in 1958, 101 were taken, and in 1960, 364. These differences were probably due to two factors. The variation in the interest and cooperation of camp personnel would have a direct effect upon the number of bugs reported. Temperature, however, seems to be the major factor in stimulating the flight of *Triatoma* from the wood rat houses to human habitations. A sustained high temperature over a period of a few days results in a rapid increase in the number of bugs collected. Eighty four *Triatoma* were collected from the two camps, over a period of only 6 days, when the daily high temperatures ranged from 100° to 92° (July 19 through July 24, 1960).

The infection rate of bugs with *Trypanosoma cruzi* has remained relatively constant from the 1957 study through the 1960 study, reported here. In 1960, 227 of the 364 bugs taken were examined for *T. cruzi*; of these 58 or 25.6% were positive. At the Boys' Camp 125 of the 189 bugs collected were examined and 43 or 34.4% were found to be infected, while at the Girls' Camp 102 of the 175 collected were examined and 15 or 14.7% were positive for *T. cruzi*. The three combined studies show that 533 of the 705 bugs were examined and of these 146 or 27.4% were infected. At the Girls' Camp 197 were examined with 20 or 10.1% positive, while at the Boys' Camp 336 were examined and 126 or 37.5% were infected. These rates of infection are significant in that they reveal the existence of continued human contacts with bugs having a high enough natural infection rate with *Trypanosoma cruzi* to make possible the contaminative transmission of Chagas' disease.

One case of a severe reaction to the feeding of *Triatoma*, on September 23, 1960, was reported to the senior author. The case occurred in a home located near the boundary of Griffith Park at the bottom of a chaparral covered slope. Upon investigation, 1 ♂ *Triatoma* was found in a dresser drawer; 2 first instars that had recently fed were found on the bedroom rug; and 1 first instar that had not yet taken a blood meal was found in a cardboard box under the bed. Fecal deposits on the wall at the head of the bed, and in a box under the same bed indicated the feeding of *Triatoma* over a period of time. — Peter J. Mehringer, Jr., Dept. of Botany, Los Angeles State College, Los Angeles 32, California; Sherwin F. Wood, Life Sciences Dept., Los Angeles City College, Los Angeles 29, California; and Robert A. Anderson, 532 Olmsted, Glendale, California.

TABLE 1
1960 Summer Collection of *Triatoma p. protracta*
from Griffith Park Youth Camps

| SOURCES | Boy's Camp | | | | | | Girl's Camp | | | | | |
|------------------|------------|-----|-------|----|------|----|-------------|-----|-------|------|---|---|
| | Coll. | | Exam. | | Inf. | | Coll. | | Exam. | Inf. | | |
| | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | | |
| Director's Home | 6 | 12 | 3 | 8 | | 6 | 28 | 48 | 15 | 34 | 4 | 4 |
| Caretaker's Home | 3 | 6 | 2 | 6 | 1 | 1 | | 1 | | | | |
| Lodge Building | | | | | | | | | | | | |
| Office | 5 | 10 | 2 | 5 | 1 | 2 | 2 | | 1 | | | |
| Kitchen | 7 | 5 | 7 | 4 | 1 | | | 1 | | 1 | | |
| Cook's Quarters | 3 | 1 | 2 | | | | | | | | | |
| Dining Hall | 15 | 23 | 8 | 12 | 1 | 7 | 2 | 4 | 2 | 3 | | |
| First Aid Room | 5 | 6 | 1 | 5 | 1 | 1 | 2 | | 2 | | | |
| Entry Hall | 5 | 13 | 3 | 9 | 1 | 4 | | | | | | |
| Fireplace | 2 | | 2 | | | | | | | | | |
| Pantry | 1 | 3 | 1 | 2 | | 2 | | | | | | |
| Restroom | 3 | 5 | 3 | 4 | 2 | 2 | | 1 | | 1 | | |
| Porch | 1 | 2 | 1 | 1 | | | | | | | | |
| Utility Room | | 1 | | 1 | | 1 | | | | | | |
| Unknown | 3 | 3 | 3 | 3 | 1 | | 2 | 2 | 1 | 1 | | |
| Cabin #1 | | 1 | | 1 | | 1 | 3 | 4 | 3 | 3 | | |
| Cabin #2 | 1 | 1 | | 1 | | 1 | 4 | 11 | 1 | 1 | | 1 |
| Cabin #3 | | 1 | | | | | | | | | | |
| Cabin #4 | | | | | | | 2 | 1 | 1 | | | |
| Cabin #5 | | 1 | | | | | 3 | 3 | 3 | 3 | | |
| Cabin #6 | 1 | 3 | | 2 | | 2 | 3 | 11 | 1 | 7 | | |
| Cabin #7 | | 4 | | 4 | | 2 | | 1 | | | | |
| Cabin #8 | | | | | | | 3 | 2 | | | | 1 |
| Cabin #9 | 1 | | | | | | | 3 | | 2 | | 1 |
| Cabin #10 | 1 | | | 1 | | | | | | | | |
| Cabin #11 | | | | | | | | 4 | | 3 | | 1 |
| Cabin #12 | | | | | | | 2 | 3 | 1 | 2 | | 1 |
| Cabin #13 | 1 | 1 | 1 | 1 | | | | | | | | |
| Cabin #15 | 1 | 2 | | 1 | | | | | | | | |
| Cabin #16 | 1 | 1 | | 1 | | | | | | | | |
| Cabin # unknown | 3 | 3 | 1 | | | | 1 | 2 | | 1 | | |
| Grounds | 2 | 1 | | 1 | | 1 | 2 | 2 | 1 | 1 | | |
| Pioneer Area | | | | 1 | 3 | | 1 | 3 | 1 | 2 | | |
| Garage | 4 | 2 | 3 | 2 | | 1 | | | | | | |
| Counselors' Tent | | 1 | | 1 | | 1 | | | | | | |
| Parking Lot | 1 | | 1 | | | | | | | | | |
| Campfire | | | | | | | 1 | | 1 | | | 1 |
| Crafts Building | | | | | | | 1 | 2 | | 2 | | |
| Swimming Pool | | 1 | | 1 | | | 1 | 3 | 1 | | | |
| TOTALS: | 76 | 113 | 47 | 78 | 8 | 35 | 61 | 114 | 33 | 69 | 6 | 9 |

HOWARD RICE HILL

1889 - 1961

Howard Rice Hill, Fellow and Honorary Life Member of the Southern California Academy of Sciences, passed away at the Daniel Freeman Hospital, Los Angeles, on May 23, 1961, after a few months' illness.

Howard was born in Chicago, Illinois on July 19, 1889, the son of Edgar Preston Hill and Harriette Rice Hill. In 1894, Howard and his family moved to Portland, Oregon, where his father, a Doctor of Divinity, was pastor of the First Presbyterian Church for sixteen years. On the family's ranch on the Columbia River, Howard developed his first interest in nature — studying the birds and other animals of the land, and the fish of the river and of the nearby ocean. He completed his basic education in Portland, and graduated from the Portland Academy. He then moved to Chicago where, at the Chicago Latin School, he studied Greek, Latin and French. He obtained a B.A. degree at Carroll College in Waukesha, Wisconsin, in 1913, and an M.S. degree at the University of Illinois in 1916.

Further study at the University was interrupted by the first world war, as he was called to work for the U. S. Department of Agriculture in charge of fish research in the Gulf of Mexico and along the Atlantic Coast. Part of his work involved the instruction of fishermen in the refrigeration of fish so that it might be substituted for meat in the civilian diet in order to make more meat available for the soldiers overseas.

In June, 1919, he married Elizabeth Raycraft, a college sweetheart. In 1921, service with the U. S. government having terminated, the Hills took up residence in Long Beach, California. Here Howard first began the collecting and identifying of shells. In August, 1922, he joined the staff of the Los Angeles Museum where he remained until his retirement in August, 1959. From 1931 to 1936, he attended night and Saturday classes at the University of Southern California while carrying on his Museum duties by day. In this way he earned his Ph.D. degree, majoring in zoology, with a doctoral dissertation concerning the linguatulid parasites.

Dr. Hill's activities during his thirty-seven years' service to the Los Angeles Museum were many and varied. Starting as Fieldman, he had experience in the collecting of fossils as well as living animals; he began the collection of amphibians and reptiles for the Museum; he was, for a time, in charge of Mineralogy. But first and foremost in his interest was marine life, and, in 1944, he became the Museum's first Curator of Marine Zoology. Under his curatorship, the collection of marine invertebrates reached the



DR. HOWARD RICE HILL

number of 125,000 sets. Aside from his technical accomplishments, Dr. Hill had a spirit of friendliness that endeared him to the many persons who sought his advice on all phases of the work to which he had devoted his life. He was particularly popular with the young students who enrolled in his Saturday classes in Marine Zoology (conducted under the Museum Student Program), and with both young and adult members of the Pacific Shell Club, which he organized at the Museum during the war to help those with a non-technical interest become better acquainted with shells. His Museum handbooks, on amphibians and reptiles, and on common shells of Los Angeles County (coauthored by Pauline

Tompkins) have proved very popular with students and nature study groups. Articles by Dr. Hill have appeared in the Bulletin of the Southern California Academy of Sciences, Nautilus, Nature Magazine, the Museum Association's Quarterly, and the early Museum Graphic.

Following his retirement from the Museum, Dr. Hill was very active to within a few months of his death, as a lecturer, as a consulting zoologist in helping to arrange the shell collection and exhibits at the museum in Avalon, Catalina, and, as newly elected Chairman of the 1961 convention of the Pacific Division of the Malacological Union, in plans for the June meeting of this year, which he did not live to attend.

Dr. Hill joined the Southern California Academy of Sciences in June, 1932, and served the Academy in various official posts — as Secretary, Vice President, President, and member of the Board of Directors and Advisory Board. This loyal service was acknowledged in September, 1957, when he was voted an Honorary Life Member. He was also a member of many other scientific societies, including two honorary scientific fraternities, Sigma Xi and Phi Sigma. He had been a loyal member of Immanuel Presbyterian Church of Los Angeles for 39 years, and was an elder at the time of his death. At this church his many friends and relatives gathered on May 27 to pay him final tribute.

Hildegarde Howard



PROCEEDINGS OF THE ACADEMY

Annual Meeting

The 1961 annual meeting of the Academy held at Long Beach State College on May 19th was a successful event in the minds of those attending. There were more than 150 registered for the scientific sessions with a total of 50 papers being presented. It was a full and stimulating day for all concerned. This year the program committee hopes to improve on the scheduling of concurrent papers so that conflicts of interests will be lessened.

There were over one hundred in attendance at the annual dinner meeting which featured a provocative lecture by Dr. George C. Kennedy on current theories as to the "Origin of Continents, Mountain Ranges and Ocean Basins."

The success of the meeting was largely due to the hard work of the program committee, particularly the local committee, and

the Academy is grateful for the complete cooperation received from the personnel of the Administrative and Science staffs of Long Beach State College.

For the annual meeting this year the Academy has accepted an invitation to meet at Cerritos College in Norwalk, California on Saturday, May 12, 1962. It is anticipated that by meeting on a Saturday some conspicuous conflicts inherent in a week-day meeting will be eliminated.

SCIENTIFIC NOTES

In our Academy "Bulletin" of January-April, 1961 on page 44, I described the egg and larva of a moth that has heretofore been held in California collections under the name *Fernaldella fimetaria*. A. R. Grote, in 1883 gave the name *partitaria* to another species in the same genus, the type taken in Arizona. In the McDunnough Check List of 1938 *partitaria* is placed as a race of *fimetaria*.

Recently I received a comment on this matter from our fellow Academy member, Carl W. Kirkwood which convinces me that my published record of the egg and first larval instar of *F. fimetaria* should refer to *F. partitaria* (Grote).

I quote a portion of Carl Kirkwood's letter:

"Your notes on *Fernaldella fimetaria*, I believe will apply to *partitaria* rather than *fimetaria*. Although Dr. McDunnough listed *partitaria* as a race of *fimetaria*, they are in reality two distinct species. Besides genitalic differences *fimetaria* is somewhat larger and darker with the male antennae sparsely and shortly pubescent. Records are from Texas, Oklahoma, Kansas, Nebraska and Missouri. *Partitaria* is smaller and lighter with the male antennae having more and larger ciliae. Records from Utah, Arizona, and California, and probably occurs in New Mexico and Colorado."

Carl also reports the introduction of a moth into British Columbia from Europe. His note on this reads:

"*Sterrha dimidiata* Hufn. should be added to our list of North American species. This is a European species and was apparently introduced on Vancouver Island, British Columbia, sometime prior to 1954. Richard Guppy of Wellington, from whom I received the specimens tells me that it is rather common there, and that the oldest specimen he has was taken in 1954, but says that he only started collecting Geometrids a year or two before that."

One member of this genus has been reported as feeding on dried vegetation, including herbarium specimens. Let us hope that the new immigrant has no such bad habits and that it is content to remain in the north.

John A. Comstock

SOUTHERN CALIFORNIA ACADEMY OF SCIENCES

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