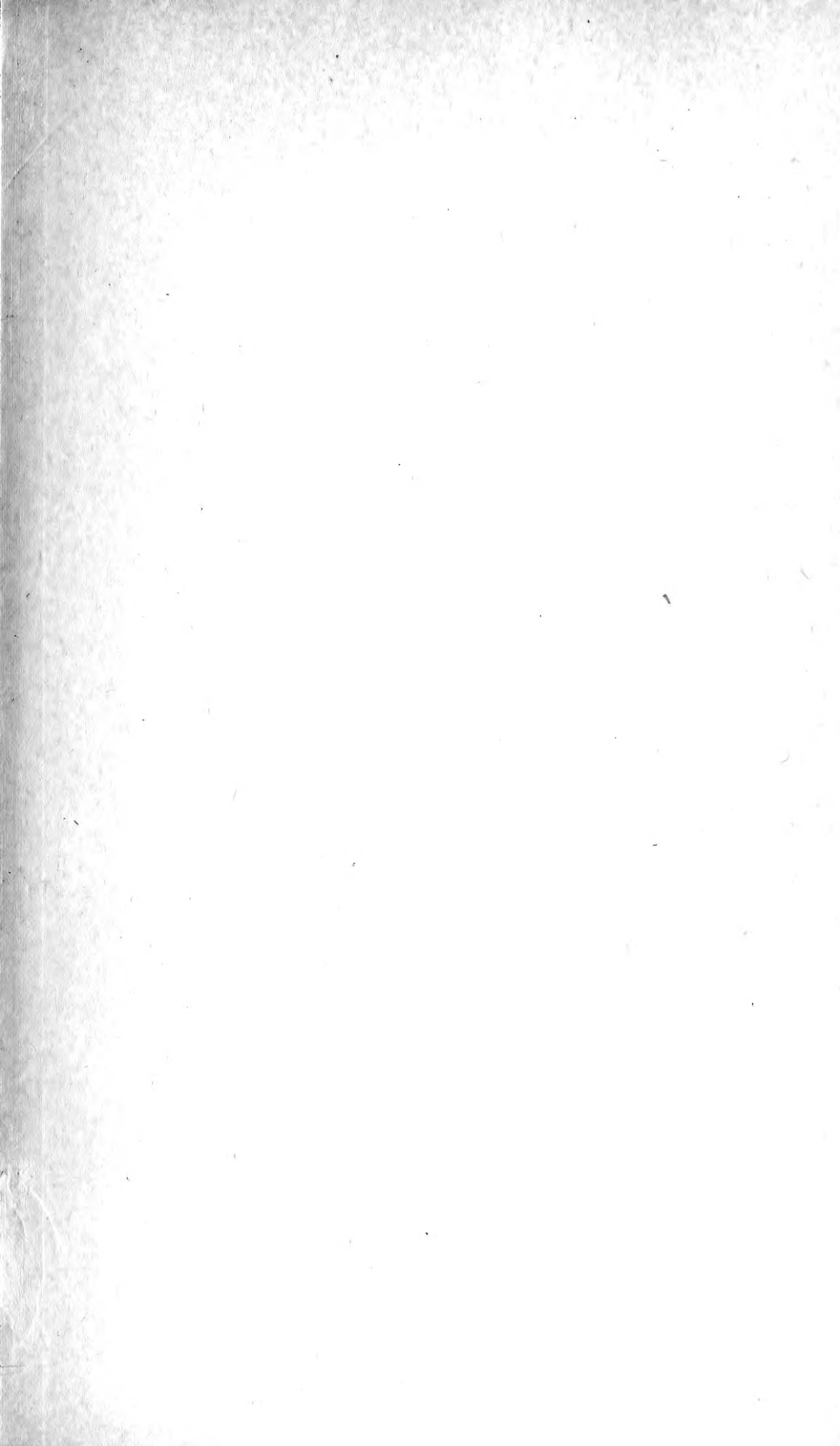
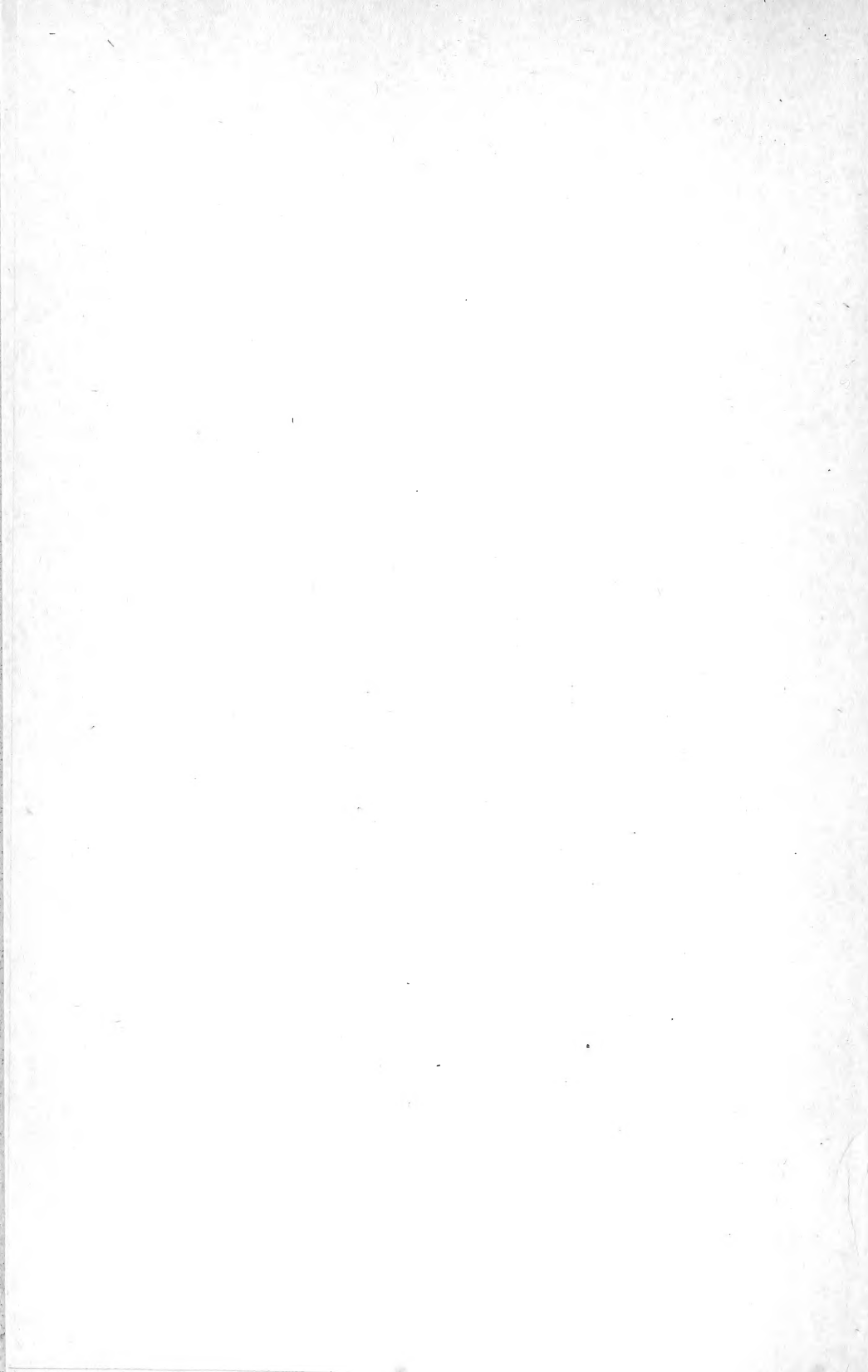


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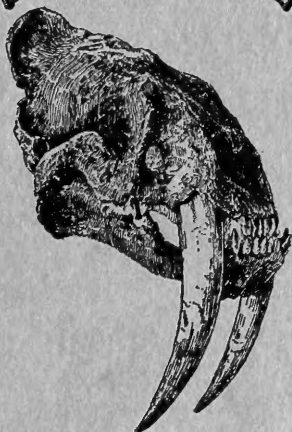




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CONTENTS

Page

CONTRIBUTIONS FROM THE LOS ANGELES MUSEUM- CHANNEL ISLANDS BIOLOGICAL SURVEY:

18. A STREPSIPTEROUS PARASITE OF A LEAF HOPPER WITH DESCRIPTIONS OF RELATED SPECIES FROM THE SAME HOST GENUS—
W. Dwight Pierce - - - - - 1

19. CTENUCHA BRUNNEA STRETCH, ON SANTA ROSA ISLAND—
John A. Comstock and Charles M. Dammers - - - - - 11

- DISTRIBUTION OF ARTIFACTS BY NATURAL MEANS—
Arthur Woodward - - - - - 13

- ON A COLLECTION OF POLYCHAETA FROM SOUTHERN
CALIFORNIA—E. and C. Berkeley - - - - - 16

2035
10-10-41
94-43

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CONTRIBUTIONS FROM THE
LOS ANGELES MUSEUM - CHANNEL ISLANDS
BIOLOGICAL SURVEY18. A STREPSIPTEROUS PARASITE OF A LEAF HOPPER,
WITH DESCRIPTIONS OF RELATED SPECIES
FROM THE SAME HOST GENUS

By W. DWIGHT PIERCE

On West Anacapa Island, Sta. Barbara Co., California, on August 21, 1940, George P. Kanakoff took a green leaf hopper, *Xerophloea vanduzeei* Lawson, which was found to be parasitized by two male pupae of a new parasite belonging to the genus *Diozocera* Pierce (1911), which is now transferred to the family Halictophagidae Pierce (1908), superfamily Halictophagoidea Pierce (1908), order Strepsiptera Kirby (1813).

There are a number of interesting points to discuss before considering the technical descriptions.

1. The host genus *Xerophloea* Germar (1839) contains flat-headed, green leaf hoppers, and belongs to the subfamily Gyponinae Ashmead (1890), family Cicadellidae VanDuzee (1916), of the order Homoptera (DeGeer) Westwood (1840). The genus has been monographed by P. B. Lawson in Pan-Pacific Entomologist 7(4):159-164, and contains 13 species very closely related, separated by very superficial characters; which were until recently all considered to be one species *X. viridis* (Fabricius 1794).

2. The fact that we can find specific differences in the parasites indicates that there are distinct species of *Xerophloea*.

3. The genus *Xerophloea*, and its parasites of the genus *Diozocera* are very widely distributed across North America, in the West Indies and South America. This would indicate an ancient relationship, and also that there are probably many more parasites to be found.

4. We can now differentiate three distinct species of *Diozocera*.

5. Due to a faulty specimen the genus *Diozocera* was incorrectly described, and its name is now meaningless, even though under the International Rules we must continue to use it. The family Diozoceridae being based upon this faulty diagnosis is no longer needed, and the genus is transferred to the family Halictophagidae, which is composed entirely of leaf hopper parasites.

6. A careful correlation study of the structure of the male cephalotheca, or head cap of the puparium, which is the last larval head, proves some very interesting points in the morphology of the insect head, at least the head in the pupariate orders.

a. The gnathocephalon area, which includes mouth opening, mandibles, and maxillae, is definitely the terminal segment, for it is completely surrounded by the procephalon of Crampton, which includes the eyes, antennae, genae and mentum. This fact has been overlooked in my previous descriptions of males and male cephalothecae. In the genus *Diozocera* this fact is clearer than in the other genera and families, but is nevertheless the rule for all Strepsiptera known to me.

b. Crampton (1935) in his *Principles of Insect Morphology* (pp. 100-104) considers the procephalon as the terminal segment, and the gnathocephalon as between the procephalon and prothorax. The present study indicates that the gnathocephalon is composed of a dorsal sclerite with mandibles, and a ventral sclerite with maxillae, with the mouth opening between. The "procephalon" is the second segment, with the dorsal sclerite bearing labrum, and antennae; the pleural sclerite the eyes; the ventral sclerite the mentum and its appendages (labium) which are absent in the Strepsiptera. The labium is therefore a part of the venter of procephalon.

c. A study of many of Crampton's figures indicates that such an interpretation can also apply to Coleoptera and Orthoptera, but in these orders the gnathocephalon integuments are internal. Certainly in the Rhynchophora the gnathocephalon is terminal to the procephalon.

d. In my 1936 paper, *The Position of the Strepsiptera in the Classification of Insects* (Ent. News. 47:257-263) I showed numerous linkages between the Strepsiptera, Diptera, Coccoptera and Aleurodoptera, the pupariate orders. Another linkage can now be added. Outside of this group I do not know of any cases in which the gnathocephalon tissues are external. But in the Pyrgotidae, as illustrated by Curran (1934) in *North American Diptera*, p. 269, the gnathocephalon area is almost an exact picture of the same area in *Diozocera*, except that the mouthparts are internal. The Dipterous family Nymphomyidae, which has so many structures resembling Strepsipterous structures, leaves no doubt whatever that the gnathocephalon is terminal to the procephalon, as shown in Tokunaga's (1935) figures in *Philippine Journal of Science* 56(2):127-214.

e. Setting aside therefore all previous descriptions of the male cephalotheca as far as terminology is concerned, we can now describe the present species in complete accord with the general morphological terminology used by Crampton.

The clear area containing mandibles and maxillae and mouth opening is the *gnathocephalon*. The heavier chitinized area completely surrounding this is the *procephalon*.

The gnathocephalon is bounded dorsally by a straight suture between the eyes, which is medianly arched. The arched portion is truly epistomal suture. Crampton calls the suture between the parietals and gnathocephalon the subgenal suture, and divides it into pleurostomal suture dorsal to the mandibles, and hypostomal suture ventral to the mandibles. To be more exact in this case we may call the entire suture between the eyes *epistomal suture*, as it is above the mouth, with the median arch as the *frontal arch*; the continuation of this margining the eyes as *pleurostomal suture*; and the posterior margin the *hypostomal suture*; with the large process into gnathocephalon, the *mentum*.

This area includes five differentiated parts: a pair of mandibles, which apparently are functional; a pair of maxillary rudiments; and a median plate immediately above the mouth and below the frontal arch, the exposed part of the pharynx, which we will for the present call the pharyngeal plate. The edge of the mouth opening lies between this and the tip of the mentum.

The procephalon is transverse, almost straight on dorsal edge; broadly rounded at sides, convex ventrally; and the whole cephalotheca is evenly rounded dorso-ventrally. The dorso-parietal zone lies between the eyes above the epistomal suture, and includes the antennal rudiments, and a subtriangular median frontal zone indicated by fine punctures, and the remainder may be called vertex. The eye zones are lateral, nonfunctional, bordered exteriorly by the genal area which passes ventrad behind the hypostomal suture, and merges into the decapitated pyramidal mentum. An occipital suture defines a very narrow occipital zone beginning opposite the posterior tips of the gnathocephalon, and enclosing the vertex. In conformity with Crampton's nomenclature, the posterior continuation of the occipital zone, which is not marked off by a suture, but is a little lighter in color than the mentum, can be called the submentum. This area is anteriorly truncate and posteriorly arcuate.

GENUS DIOZOCERA Pierce (1911) redefined.

Dioxocera Pierce (1908). Proc. Ent. Soc. Wash. 9 (1-4):76, 81.

Error in transcription.

(1909). Bull. U. S. Nat. Mus. 66:163. Error repeated.

Diozocera Pierce (1911). Proc. U. S. Nat. Mus. 40 (1834):504.

Correction.

This change was ratified by Opinion of the International Commission of Zoological Nomenclature, in Opinion 36, July 1911.

The genus was described from a male extracted from its puparium in the host, and was not in good condition, apparently having 2-branched antennae, and 3-jointed tarsi, and was consequently made the type of the family Diozoceridae Pierce (1911). A restudy of the type by E. A. Chapin indicates that the terminal joints of the antennae are missing. We can now consider the genus as true Halictophagid, on account of the new *Anacapa* species.

The single species was parasitic on *Xerophloea viridis* (sens. lat.) in Grenada and St. Vincent.

In order to better describe the new *Anacapa* specimens, the writer has restudied the paratypes in his personal collection, and is depositing all specimens herein described, in the collection of the Los Angeles Museum.

Generic description:

Halictophagidae: parasites of the Gyponine genus *Xerophloea*, having eight jointed antennae, with five flabellated joints; and three jointed tarsi. Male head more or less enclosing laterally the prothorax and mesothorax; prescutum and scutellum separated by folds of scutum.

DIOZOCERA INSULARUM (Pierce 1908) Pierce (1911).
(Figures 1, 18)

Dioxocera insularum Pierce (1908).

Diozocera insularum Pierce (1911).

For comparison with the other species the cotype slides were restudied.

Cotype Female. Grand Ance (South End) Grenada, B.W.I., from ♀ *Xerophloea viridis* (sens. lat.). Cephalothorax transverse, rounded from base to apex, with margin broken by mandibles at apical angles. Breadth 0.2805 mm.; width of transverse slit 0.187 mm.; breadth at outer mandibular angles 0.187 mm.; distance between mandibles 0.085 mm.; length from spiracles to apex 0.204 mm.; from transverse slit to apex 0.1445 mm.; from mouth opening to apex 0.0425 mm. Ratio of breadth to length 1.37:1; ratio of breadth at spiracles to distance between mandibles 3.3:1. The mandibles are transverse, with a round outer angle, and sharp recurved tooth at inner angle (fig. 1); length 0.034 mm., breadth 0.0425 mm. Transverse slit rounding quadrate. Spiracles lateral.

DIOZOCERA INSULARUM var. VINCENTI new subspecies.
(Figs. 2, 7, 14, 15.)

Type Female: St. Vincent, B.W.I., from ♀ *Xerophloea viridis* Fabr. (sens. lat.), H. H. Smith coll. Cephalothorax

breadth 0.272 mm.; width of transverse slit 0.2295 mm.; breadth at outer mandibular angles 0.170 mm.; distance between mandibles 0.102 mm.; length from spiracles to apex 0.204 mm.; from transverse slit to apex 0.136 mm.; from mouth opening to apex 0.034 mm. Ratio of breadth to length 1.33:1; ratio of breadth at spiracles to distance between mandibles 2.66:1. (Fig. 2.)

This specimen differs enough from the Grenada specimen to require a subspecies name until such time as large series either demonstrate its specificity, or that both fall within the range of variation of a single species.

Cotype Male cephalotheca: In the same host were two ♂ puparia, the cephalothecae differing in size. They measure respectively as follows: Cephalotheca breadth 0.731 and 0.646 mm.; length 0.408 and 0.391 mm.; length of epistomal suture 0.408 and 0.374 mm.; greatest width of gnathocephalon 0.510 and 0.4675 mm.; ratio of width to epistomal suture 1.25:1 in both cases. Diagonal distance from epistomal-pleurostomal angle to anterior angle of mentum 0.170 and 0.136 mm.; width of mentum at apex 0.068 and 0.068 mm.; at base 0.323 and 0.272 mm. Distance between mandibles; outer points of condyles 0.306 and 0.272 mm.; inner points 0.119 and 0.119 mm.; width of mandibles 0.051 and 0.0425 mm. Distance between maxillae 0.170 and 0.170 mm. Distance between antennae, outer margins 0.357 and 0.323 mm.; between inner margins 0.238 and 0.2295 mm.; ratio of these measurements 1.4:1 and 1.5:1. Distance from most remote point on hypostomal margin to lateral angle of frontal arch 0.255 and 0.255 mm. Distance from epistomal-pleurostomal angle to mentum through center of maxilla 0.1445 and 0.153 mm. Ratio of these last two measures of the gnathocephalon 1.66:1 and 1.76:1.

Antennae diagonal, elliptical. Mandibles darker than surrounding area, with round prominence and acute inner tooth (fig. 7). Maxillae oblique. Mentum strongly constricted just before apex to width of pharyngeal tube. Pharyngeal plate transverse elliptical, clear.

The outline of the mentum is quite different in the three species as may be seen from the photomicrographs (figs. 14, 15).

DIOZOCERA ARGENTINAE, new species. (Figs. 3, 8, 10 11).

Described from one male cephalotheca, and an imperfect female from a leaf hopper, which was determined, perhaps incorrectly as *Xerophloea viridis* Fabr., from Carcaraña, Argentina, collected by Lawrence Bruner.

Male cephalotheca: breadth 0.807 mm.; length 0.467 mm. Length of epistomal suture, or anterior width of gnathocephalon 0.408 mm.; greatest width of gnathocephalon 0.561; ratio of the second to the first 1.37:1. Diagonal distance from epistomal-

pleurostomal angle to anterior angle of mentum 0.170 mm.; width of mentum at apex 0.102 mm., and at base 0.425 mm. Distance between mandibles, outer points of condyles 0.306 mm.; inner points 0.119 mm.; width of mandible 0.051 mm. Distance between maxillae 0.1785 mm. Distance between antennae, outer margin 0.340 mm., inner margin 0.238 mm.; ratio 1.42:1. Distance from most remote point on hypostomal margin to lateral angle of frontal arch 0.289 mm.; distance from epistomal-pleurostomal angle to mentum through center of maxilla 0.187 mm.; ratio of these two dimensions of gnathocephalon 1.54:1.

The front is faintly suggested by tiny punctures. The antennae are obliquely elliptical with a cluster of tiny punctures in an elliptical zone in the outer posterior sector. Mandibles yellow, with a round prominence, and sharp inner recurved tooth (fig. 8.) Maxillae oblique, elliptical with an inner ring, indicating second segment. Pharyngeal plate chitinized, wider than long in the proportion 7:5; margin of mouth opening minutely crenulate. Mentum convexly rounded, short of mouth opening, exposing the apex of the more constricted pharyngeal tube. (Figs. 8, 10, 11.)

Female: The female is in two fragments, but otherwise perfectly describable. Cephalothorax transverse, obtusely angled at apical angles and also at apex. Breadth 0.374 mm.; width of transverse slit 0.154 mm.; breadth at out apical angles 0.255 mm.; distance between mandibles 0.102 mm. Length from spiracles to apex 0.2295 mm.; from transverse slit to apex 0.1785 mm.; distance from base of mouth opening to apex 0.0595 mm. Ratio of breadth at spiracles to distance between mandibles 3.66:1. Ratio of breadth to length 1.6:1. The mandibles are on apical margin but not at apical angles, transverse, blunt, sharply concave in middle with acute tooth (fig. 3); length 0.034 mm., breadth 0.0399 mm. Mouth opening broadly oval. Transverse slit broadly arcuate, slightly angulate posteriad at middle. Spiracles ventral. Immediately behind the transverse slit the body is greatly enlarged to fit into the host.

This species differs from *D. insularum* very distinctly by the angulate form of the cephalothorax; the position of the mandibles in the female; the mandibles, and the shape of the mentum and gnathocephalon in the male cephalotheca.

DIOZOCERA COMSTOCKI, new species. (Figs. 5, 6, 9, 12, 13)

Named in honor of my friend and associate Dr. John Adams Comstock, Director of Science of the Los Angeles Museum, under whose direction the Channel Islands Survey is being conducted.

Described from two male pupae in the first and last segments of a ♀ *Xerophloea vanduzeei* Lawson taken on West Anacapa

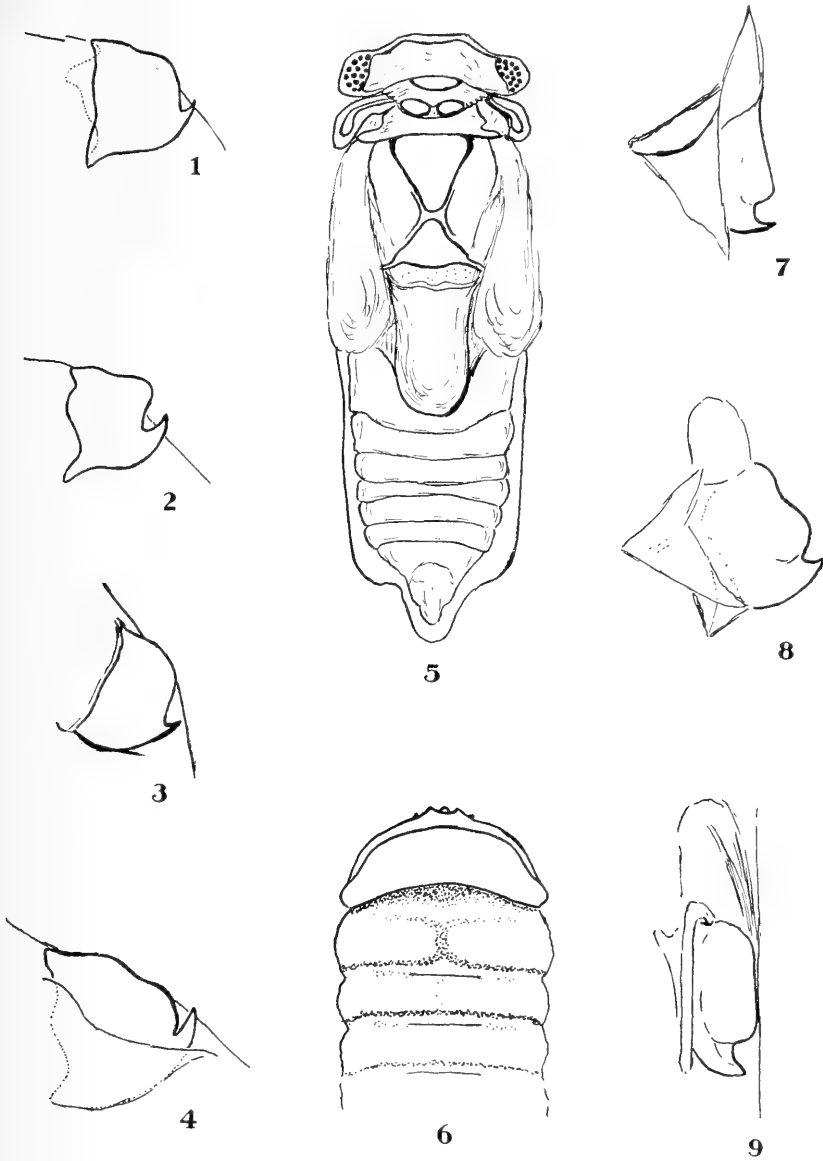


PLATE 1

For explanation of figures, see page 10.

Island, August 21, 1940, under *Atriplex semibaccata*, by George P. Kanakoff.

Male: One pupa is so far advanced that the male dorsal characters are clearly seen through the pupal skin. The other pupa is too young. Head broad, transverse. Antennae with five flabellations, about equal in length. Pronotum a transverse disk completely enclosed by head and mesothorax. Mesonotum appears to be composed of a transverse prescutum, a divided scutum, and transverse scutellum. The metathorax consists of a keystone-like prescutum, which is narrowly separated from the scutellum by a bridge uniting the large lateral sclerites. The scutellum is basally widest, with a narrow projection to the posterior wing attachment; in front of this the sides are parallel for a short distance and then rapidly oblique to the rounded apex. The postlumbium is about half the length of scutellum, of thinner texture, and closely minutely granulate. The postscutellum is with the postlumbium as long as the anterior portion of the methathorax.

On the sternum each segment is divided by a median line.

Male cephalotheca. Breadth 0.7735 mm. and 0.7565 mm.; length 0.408 mm. and 0.442 mm. Length of epistomal suture, or anterior width of gnathocephalon 0.3995 mm. and 0.391 mm.; greatest width of gnathocephalon 0.527 mm. and 0.5355 mm.; ratio of the second to the first measurement 1.31:1 and 1.36:1. Diagonal distance from epistomal-pleurostomal angle to anterior angle of mentum 0.170 mm. and 0.1615 mm.; width of mentum at apex 0.102 mm. and 0.102 mm.; and at base 0.323 mm. and 0.340 mm. Distance between mandibles, outer points of condyles 0.323 mm. and 0.3145 mm.; inner points of condyles 0.102 mm. and 0.102 mm.; width of mandibles 0.051 mm. and 0.051 mm. Distance between maxillae 0.187 mm. and 0.187 mm. Distance between antennae, outer margins 0.374 mm. and 0.357 mm., inner margins 0.255 mm. and 0.221 mm.; ratio 1.45:1 and 1.61:1. Distance from most remote point on hypostomal margin to lateral angle of frontal arch 0.2805 mm. and 0.289 mm.; distance from epistomal-pleurostomal angle to mentum through center of maxilla 0.1615 mm. and 0.153 mm.; ratio of these measurements of gnathocephalon 1.73:1 and 1.88:1.

Antennae diagonal, suboval, truncate at inner end; central zone with cluster of pores. Mandibles orange color with dark brown condyles, armed with acute curved tooth on inner angle (fig. 9). Maxillary area slightly darker, oblique, with concentric rings. Mentum divided into two zones, a broad basal zone with sides subparallel for one-third the length, thence strongly diagonal; anterior zone sharply separated from basal by concave dark zone, margins less distinct; a quadrate area darker, reaching mouth opening. Pharyngeal area hemispherical and of different color from all other areas, gray brown. The frontal area is marked by two roughened zones (figs. 12, 13).



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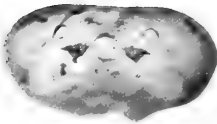
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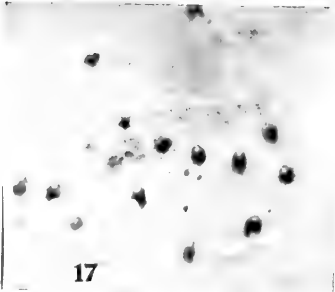
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18

PLATE 2

For explanation of figures, see page 10.

DIOZOCERA COMSTOCKI ELSEGUNDINIS, new subspecies
(Figs. 4, 16, 17).

Until such time that we have both sexes from the type localities we cannot be positive that the female described below belongs with the males described from Anacapa Island, hence for safety it is necessary to give this subspecific name.

Described from one female extracted from the last segment of a female *Xerophloea vanduzeei* on *Franseria bipinnatifida*, collected by W. Dwight Pierce, on the El Segundo sand dunes, Los Angeles Co., Cal., July 13, 1938.

Female: Cephalothorax breadth 0.340 mm.; width of transverse slit 0.272 mm.; breadth at outer mandibular angles 0.221 mm.; distance between mandibles 0.119 mm. Length from spiracles to apex 0.221 mm.; from transverse slit to apex 0.187 mm.; from mouth opening to apex 0.051 mm. Ratio of breadth to length 1.54:1; ratio of breadth at spiracles to distance between mandibles 2.85:1.

The specimen was broken at left anterior corner (fig. 16). The mandibles have a rounded outer angle and sharp recurved tooth at inner angle (fig. 4). The abdominal skin is minutely, densely covered with conical transparent papillae, interspersed with many dark cylindrical setigerous tubercles; these measuring 0.015 mm. in length by 0.012 mm. breadth, and the setae measure 0.06 mm. in length (figs. 16, 17).

ILLUSTRATIONS

Plate 1:

- Fig. 1. Mandible of ♀ *Diozocera insularum* from Grenada.
2. Mandible of ♀ *D. insularum vincenti* from St. Vincent.
3. Mandible of ♀ *D. argentinae* from Argentina.
4. Mandible of ♀ *D. comstocki elsegundinis* from El Segundo, Cal.
5. Dorsum of ♂ pupa of *D. comstocki* from Anacapa Isl., Cal.
6. Dorsum of ♂ puparium of *D. comstocki*.
7. Mandible of ♂ cephalotheca of *D. insularum vincenti* from St. Vincent.
8. Mandible of ♂ cephalotheca of *D. argentinae* from Argentina.
9. Mandible of ♂ cephalotheca of *D. comstocki*.

Plate 2:

- Fig. 10. Cephalotheca of ♂ *D. argentinae*.
11. Enlargement of face of ♂ cephalotheca of *D. argentinae*.
12. Cephalotheca of ♂ *D. comstocki*.
13. Enlargement of face of ♂ cephalotheca of *D. comstocki*.
14. Cephalotheca of ♂ *D. insularum vincenti*.
15. Enlargement of face of ♂ cephalotheca of *D. i. vincenti*.
16. Anterior portion of ♀ *D. comstocki elsegundinis*.
17. Enlargement of portion of fig. 16 marked by arrow to show tubercles.
18. Anterior portion of ♀ *D. insularum*.

19. CTENUCHA BRUNNEA Stretch, ON SANTA ROSA ISLAND

By JOHN A. COMSTOCK and CHARLES M. DAMMERS

A number of larvae of the Arctiid moth, *Ctenucha brunnea* were taken on Wild Rye, in Ranch Canyon, Santa Rosa Island, by Mr. Chris Henne, during the twelfth expedition of the Channel Islands Biological Survey of the Los Angeles County Museum. They were collected April 1, 1941, and were reared to maturity in the Museum laboratory. No life history notes were made owing to the fact that the authors of this paper had previously compiled the data as hereinafter recorded.

In June, 1933, Mr. M. L. Walton supplied a number of eggs which were secured from gravid females taken in Griffith Park, Los Angeles.

The eggs are laid in a group on *Elymus L.* The egg is hemispherical, pale lemon-white in color, with a concave base.

The young larvae took readily to Johnson Grass, and were raised on both this and Wild Rye.

Larva; 1st instar. Length, extended 3/16". Body ground color, pale yellowish buff. There is a narrow mid-dorsal line, ranging in color from a pale maroon to a grey. A dorso-lateral band of silver-white runs longitudinally, and a stigmatal line of the same lustrous character is present.

Six longitudinal rows of hair tufts occur on each side, arranged as shown on Fig. A of Plate 3. Each tuft arises from a brown tubercle. Each tuft in the uppermost three rows is composed of several short white hairs and a single long brown hair. Those of the three lower rows contain white hairs only.

Spiracles, black. Abdomen, concolorous with body. Legs, colorless, with brown points. Prolegs, colorless, with pale brown crochets.

2nd instar. Length, extended 5/8." The ground color of the body is greyish. The dorso-lateral band is yellow-ochre, and the lateral line is soiled white. The hairs in all of the tufts are increased in number.

In the 3rd instar the larva assumes the color of the mature larva.

Mature larva. Length, extended 1 1/4".

Ground color of body, pale slate-grey. Mid-dorsal band, dark grey. A narrow lemon-white band occurs sub-stigmatally.

All of the tufts are composed of pale buff hairs. The tips of the hairs on the three upper rows are pale brown. The tufts that are placed sub-stigmatally are very small. All tufts arise from dark yellow raised tubercles. On the third and eleventh segments the uppermost half of the 2nd tufts on each side are dark brown, and are joined together giving the appearance of a

single central dark brown tuft, as will be noted in Fig. B of Plate 3.

Spiracles, black. Abdomen, pale slate-grey. Legs, brown, with lighter joints. Prolegs, soiled white, with brown crochets.

Head, dull yellow, with brown mouth parts. Ocelli, brown, and completely obscured by long buff hairs arching over from the first two segments.

Two very long pale brown hairs arise from the top of the third segment, and similar paired hairs also occur on the top of the eleventh and caudal segments.

Pupation takes place on the food plant in a loosely woven silken cocoon, in which the larval hairs are incorporated. All of the larvae pupated between August 15th and Sept. 15, 1933.

Pupa. Length, $\frac{5}{8}$ ".

Ground color, bright chestnut. The fore-half of each segment has a broad, irregular brown-black band. The thorax and head are marked with brown-black bands, stripes and blotches as shown on Fig. C of Plate 3. On the wing cases these brown-black markings tend to follow the lines of the veins. The leg sheaths are lined in the same manner.

Minute short colorless hairs are grouped in bunches on the body.

Imagos began hatching on Sept. 3, 1933, and continued to emerge for some time thereafter. Several pairs from this hatch copulated, and continued mating and remating for some time. The females made no attempt to oviposit until the sexes were separated. The resultant eggs from these matings began hatching Sept. 22, 1933. Whether these larvae would have perished, or gone on to maturity was not ascertained.

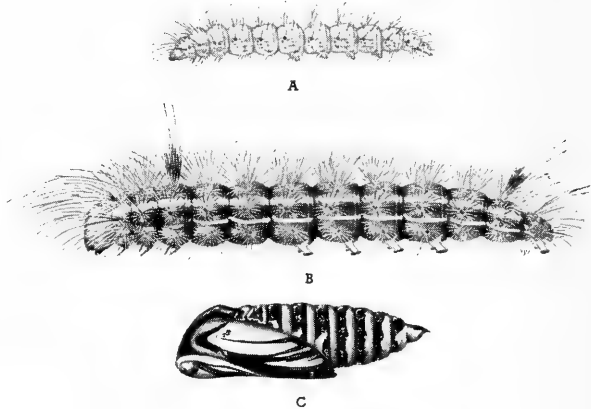


PLATE 3

Larva and pupa of *Ctenucha brunnea*.
a. Larva, first instar, enlarged x 8. b. Mature larva, enlarged x $2\frac{1}{2}$. c. Pupa, lateral aspect, enlarged x 2.

Reproduced from painting by C. M. Dammers.

DISTRIBUTION OF ARTIFACTS BY NATURAL MEANS

By ARTHUR WOODWARD
Director of History, Los Angeles County Museum

Occasionally archeologists encounter stray arrow points or spear heads on sites which are apparently not indigenous to the area in which they are found. The most frequent explanation of such sports are that they are "trade pieces". No doubt many specimens were transported by primitive traders from one tribe to another over long distances, but this explanation does not cover all aspects of the situation.

In November 1933, Mr. L. C. Barnard of Los Angeles brought into my office in the Los Angeles County Museum, a bone arrow head $9\frac{1}{2}$ inches in length, of Eskimo origin, which he had obtained from the breast of a mallard duck at Hank's Duck Club about 40 miles north of Bakersfield. The missile was of the type used by the Eskimo living at the mouth of the Coppermine River, Canada. It had entered the bird at the lower edge of the breast and lay lengthwise in the flesh. A cystoid growth, which ornithologists estimated had taken about one year to form, encased the point. Hence, it would appear that this arrow had been discharged at the mallard by an Eskimo hunter from the rear, a year, or more, previously, as the bird was about to rise from the water. The short wooden shaft had been shaken loose of the sinew wrappings of the bone point, and the bird had survived until shot down in southern California.

This first hand bit of evidence of the transportation of arrow heads by game birds in modern times caused me to wonder if similar occurrences might not have been recorded in previous years.

A search of orthodox anthropological literature failed to reveal any papers on the subject, although one finds items, particularly in Plains Indian accounts, of buffalo being killed with arrows in them. Emigrants crossing the plains mention this fact. In such instances we cannot be certain of the provenience of the missiles imbedded in the flesh and bones of the animals, hence, aside from the fact that the animals have carried arrow heads and musket balls for years, there is no indication of the actual origin of such items.

I then examined files of old sporting magazines and found several references relating to this subject.

In the magazine *Recreation* for July, 1897, I encountered the first article referring to such an occurrence, thus:

A CURIOSITY

'On October 20, 1871, a farmer living in Lake County, Indiana, shot a brant and on picking it up remarked to his companion that it must have 'fallen on a snag'. Further examination revealed the fact that the supposed snag, which protruded from either side of the breast, was a bone arrow head, 9 inches in length and $\frac{5}{8}$ of an inch in width. The brant had carried this weapon so long that it was firmly imbedded in bone and flesh as though nature had intended it as a part of the anatomical structure of the bird.

Where the arrow passed through the bone, a callous growth tightened about it and the skin was smoothly drawn where the ends were exposed to view. A strange part of the story is that the bone arrowhead is of Eskimo make, such as those people employ in bringing down birds and use nowhere outside of the Arctic regions.

This goes to prove that the bird was at one time a resident of that country. When shot by the Indiana farmer the brant was in fine condition and was the sturdy leader of a flock.

While the wound was not in a vital part it is likely that if the arrowpoint had been made of steel or other metal the bird would have died from blood poisoning."

This brief item was accompanied by a black and white drawing of the breast bone of the bird perforated by the arrow head. Here then was an almost identical case which had been noted 62 years prior to the California incident. The arrowhead as illustrated was virtually the same type in shape and length. See Plate 4.

Knowing that one such reminiscence usually calls for another I searched further and in two subsequent issues of the same publication, I found other brief paragraphs recording similar discoveries.

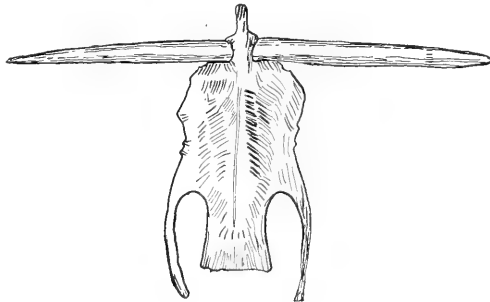


PLATE 4

Eskimo bone arrow head imbedded in breast bone of brant.

H. R. Gould of Tacoma, Washington, writing in the October 1897 issue of *Recreation* spoke of having seen a brant brought to him by an Alaskan native which had a bone arrowhead thrust between the bones of the right wing of the bird. Gould did not mention the Alaskan locale of this find but the record is interesting in that it must have been found in an area where bows and arrows were not used, otherwise the discovery of such an artifact imbedded in a bird or animal would not have excited the curiosity of the native who found it.

A third instance was reported by A. S. Doane of Coinjock, North Carolina, in the November 1897 issue of the same magazine.

"2 swans were killed here, in the Currituck sound, a few years ago, each of which had a flint arrow-head embedded between its shoulders and well covered with flesh, showing the missiles had been there for some time."

No identification was made of the last two arrowheads but it is quite likely that they, too, were of Eskimo origin.

It must be remembered that these are only a few definitely recorded instances of missiles carried by birds, but when one considers the annual migrations of both birds and some of the larger game animals, particularly the buffalo, caribou, etc., and the abilities of such mammals as bear, elk, moose, deer, mountain lions, etc., to absorb either arrowheads or bullets without apparent loss of energy, the probability of the distribution of primitive chipped artifacts by this means must not be overlooked. This factor, I believe, should definitely be taken into consideration when seeking an answer to the sporadic discoveries of the Folsom type points which have been reported in different, widely separated areas, unaccompanied by definite camp sites directly attributed to Folsom man.

Archeologists working on sites in the Plains area along the migration routes of the buffalo or, let us say on village sites located on ancient lake beds, or for that matter on any body of water which might be along the flyway of migratory game birds, should keep in mind this possibility of uncovering artifacts non-indigenous to the region in which they are working. Further research in this field is desirable. A study of the migratory habits of birds and mammals and an integration of archeological research with that of the mammalogist and the ornithologist might produce some highly interesting results.

ON A COLLECTION OF POLYCHAETA FROM SOUTHERN CALIFORNIA

By E. and C. BERKELEY

At intervals during the past few years Prof. G. E. MacGinitie, of the Kerckhoff Marine Laboratory, Corona Del Mar, California, has sent us specimens of Polychaeta collected by him in the vicinity of his laboratory, or at points not more than a few miles distant. This is the source of most of the material described in this paper. In addition some of the specimens were collected by Dr. MacGinitie at other localities in Southern California. Yet others by Dr. W. G. Hewatt, of the Texas Christian University, at Santa Cruz Island during the summer of 1939 and kindly submitted by him to us for report. Forms taken both intertidally and by dredge are included. Notes indicating the depth of dredging operations did not always accompany the specimens, but the depth is given in the following pages when known and the locality at which each species was collected is stated unless this was Corona Del Mar or the vicinity. If no statement to the contrary appears the species under discussion in the notes which follow was collected intertidally.

The collection comprises 154 species. Thanks to the pioneer work of Johnson, Moore and Chamberlin and, more recently, to that of Treadwell, Hartman and others, the polychaete fauna of the Californian coast is fairly well known. Nevertheless the present collection contains 45 species, or varieties, new to the coast, of which 9 are new to science. Types of the new species and varieties are in the authors' collection.

The following is a complete list of the species represented; those we believe to be new to California are indicated by an asterisk:

APHRODITIDAE

- Aphrodite armifera* Moore
- Aphrodite brevitentaculata* Essenberg
- Aphrodite refulgida* Moore

POYNOIDAE

- Lepidonotus coelorus* Moore
- Thormora (Lepidonotus) johnstoni* (Kinberg)
- Harmothoe imbricata* (Linné)
- Harmothoe hirsuta* Johnson
- **Harmothoe lunulata* (Delle Chiaje)
- **Malmgrenia nigralba* Berkeley
- Halosydna insignis* Baird
- Halosydna johnsoni* (Darboux)
- Lepidametria gigas* (Johnson)
- Arctonoe vittata* (Grube)
- Arctonoe pulchra* (Johnson)

ACOETIDAE

- Panthalis pacifica* Treadwell.
- **Polyodontes maxillosus* Ranzani
- Peisidice aspera* Johnson

SIGALIONIDAE

- **Sigalion ovigerum* Monro
- **Psammolyce spinosa* Hartman
- Sthenelais tertiaglabra* Moore
- Sthenelais fusca* Johnson
- **Sthenelanella atypica* sp. n.

CHRYSOPETALIDAE

- Chrysopetalum occidentale* Johnson
- Palaenotus chrysolepis* Schmarda

AMPHINOMIDAE

- Chloeia pinnata* Moore
- Eurythoe paupera* (Grube)
- Eurythoe* sp.?
- Euphrosyne arctia* Johnson
- Euphrosyne hortensis* Moore

PHYLLODOCIDAE

- Phyllodoce ferruginea* Moore
- **Phyllodoce (Anaitides) madeirensis* Langerhans
- Eumida sanguinea* (Oersted)

SYLLIDAE

- Syllis armillaris* Malmgren
- Syllis elongata* (Johnson)
- **Syllis hyalina* Grube
- **Syllis fasciata* Malmgren
- **Syllis gracilis* Grube
- **Trypanosyllis gemmipara* Johnson
- Odontosyllis phosphorea* Moore
- **Odontosyllis polycera* (Schmarda)
- **Odontosyllis parva* Berkeley

HESIONIDAE

- Podarke pugettensis* Johnson
- **Loandalia fauveli* sp. n.

NEREIDAE

- Nereis pelagica* Linné
- Nereis callaona* (Grube)
- Platynereis dumerilii* (Audouin & Milne-Edwards), var. *Agassizi*
- Nereis pseudoneanthes* Hartman
- Nereis neonigripes* Hartman
- Nereis vexillosa* Grube
- Nereis procera* Ehlers

NEPHTHYDIDAE

- Nephtys caecoides* Hartman
- **Nephtys dibranchis* Grube

SPHAERODORIDAE

- **Ephesia gracilis* Rathke

GLYCERIDAE

- Hemipodia borealis* Johnson
- Glycera capitata* Oersted
- **Glycera gigantea* Quatrefages
- Glycera rugosa* Johnson
- **Goniada maculata* Oersted
- Glycinde armigera* Moore

EUNICIDAE (LEODICIDAE)

- Eunice biannulata* Moore
Eunice siciliensis Grube
**Eunice vittata* (Delle Chiaje)
Eunice enteles Chamberlin
Marphysa sanguinea (Montagu)
Rhamphobrachium longisetosum Berkeley
Onuphis elegans (Johnson)
Onuphis eremita Audouin & Milne-Edwards
**Onuphis eremita* Audouin & Milne-Edwards var. *parva* var. n.
Onuphis irridescens (Johnson)
Onuphis nebulosa Moore
Diopatra ornata Moore
Diopatra californica Moore
Hyalinoecia tubicola (O. F. Müller)
Lumbrinereis erecta Moore
**Lumbrinereis latreilli* Audouin & Milne-Edwards
Lumbrinereis impatiens Claparède
Lumbrinereis inflata Moore
**Lumbrinereis ligulata* sp. n.
Drilonereis filum Claparède
Arabella attenuata Treadwell
Arabella iricolor (Montagu)
**Arabella geniculata* (Claparède)
Arabella semimaculata Moore
**Dorvillea (Staurocephalus) rudolphii* (Delle Chiaje)

ARICIIDAE

- **Aricia macginitii* sp. n.
Haploscoloplos kerguelensis (McIntosh)
Nainereis laevigata (Grube)

SPIONIDAE

- **Scololepis indica* Fauvel
Nerinides acuta (Treadwell)
Laonice cirrata (Sars)
Prionospio pinnata Ehlers
**Polydora giardi* Mesnil

CHAETOPTERIDAE

- Chaetopterus variopedatus* Rénier
**Mesochaetopterus rickettsii* sp. n.

CIRRATULIDAE

- Cirriformia (Audouinia) tentaculata* (Montagu)
Cirriformia (Audouinia) luxuriosa (Moore)
Tharyx sp.?
**Chaetozone spinosa* Moore var. *corona* var. n.
Dodecaceria pacifica (Fewkes)

CHLORAEMIDAE

- Flabelligera commensalis* Moore
Stylarioides inflata (Treadwell)
Stylarioides papillata (Johnson)
Stylarioides plumosa (O. F. Müller)
Stylarioides eruca (Claparède)

SCALIBREGMIDAE

- Oncoscolex pacificus* (Moore)

OPHELIIDAE

- Ophelia limacina* (Rathke)
Armandia brevis (Moore)
Travisia gigas Hartman
Travisia brevis Moore
Polyophthalmus pictus (Dujardin)

CAPITELLIDAE

- Notomastus giganteus* Moore
**Dasybranchus caducus* Grube var. *tumbricoide*s Monro

ARENICOLIDAE

- Arenicola cristata* Stimpson

MALDANIDAE

- **Clymene (Euclymene) grossa* Baird var. *newporti* var. n.
**Ariothella rubrocincta* (Johnson) var. *complexa* var. n.
Asychis disparidentata Moore

AMMOCHARIDAE

- Ammochares fusiformis* (Delle Chiaje)

SABELLARIIDAE

- Sabellaria californica* Fewkes
Sabellaria cementarium Moore
**Sabellaria spinulosa* Leuckart var. *alcocki* Gravier

STERNASPIDAE

- Sternaspis fossor* Stimpson.

AMPHICTENIDAE

- Pectinaria belgica* (Pallas)

AMPHARETIDAE

- Ampharete arctica* Malmgren
Schistocomus hiltoni Chamberlin
Amage anops (Johnson)
Amphicteis gunneri (Sars)
**Samytha bioculata* Moore

TEREBELLIDAE

- **Amphitrite cirrata* (O. F. Müller)
Terebella californica Moore
Eupolymnia crescentis Chamberlin
**Pista cristata* (O. F. Müller)
Pista alata Moore
Pista fratrella Chamberlin
Thelepus setosus (Quatrefages)
Terebellides stroemi Sars
Loimia montagui (Grube)
**Streblosoma bairdi* (Malmgren)

SABELLIDAE

- Demonax leucaspis* Kinberg
Pseudopotamilla ocellata Moore
Branchiomma mushaensis Gravier
**Branchiomma burrardum* Berkeley
**Branchiomma roulei* Gravier
**Myxicola aesthetica* Claparède
Myxicola infundibulum Rénier
Chone infundibuliformis Kröyer

SERPULIDAE

- Serpula vermicularis* Linné
Hydroïdes norvegica (Gunnerus)
Hydroïdes uncinata (Philippi)
Salmacina dysteri (Huxley) var. *tribranchiata* (Moore)
**Apomatus timsii* Pixell
**Protula tubularia* (Montagu)
**Spirobranchus spinosus* Moore
**Crucigera websteri* Benedict
**Spirorbis marioni* Caullery & Mesnil

FAMILY APHRODITIDAE

APHRODITE ARMIFERA Moore

Moore, 1910, p. 371; Hartman, 1939A, p. 20.

Aphrodite raripapillata Essenberg, 1917, p. 413.

Seven specimens, the largest of which is 38 mm. long, the smallest only 8 mm. Dredged in 5 to 17 fms.

The spurs on the ventral neurosetae are conspicuous in the smaller specimens, but in the larger ones they are less frequent and in some they are entirely absent. Otherwise the specimens agree closely with Moore's description. *A. raripapillata* is differentiated from *A. armifera* by little but the absence of spurred ventral neurosetae and these are very readily overlooked. We regard the species as synonymous.

APHRODITE BREVITENTACULATA Essenberg

Essenberg, 1917, p. 411.

A single specimen in which the palps are lacking. Dredged "off Balboa".

APHRODITE REFULGIDA Moore

Moore, 1910, p. 376; Hartman, 1939A, p. 23.

Six specimens dredged in 5 fms. The largest is about 37 mm. long, the smallest less than 10 mm.

FAMILY POLYNOIDAE

LEPIDONOTUS COELORUS Moore

Moore, 1903, p. 412; Hartman, 1938A, p. 108, (*with synonymy*).

Ten specimens. Two from holdfast of kelp, two dredged in Monterey Bay, (one in 50 to 60 fms., the other in 16 fms.), and six from Santa Cruz Is. in 20 fms.

THORMORA (LEPIDONOTUS) JOHNSTONI (Kinberg)

Monro, 1928A, p. 556; Hartman, 1939A, p. 50.

Halosydna lagunae Hamilton, 1915, p. 235.

Four specimens, two of which are from Santa Cruz Is., agree exactly with Hamilton's description of *Halosydna lagunae*, which is undoubtedly *Thormora johnstoni*. The genus *Thormora* is readily distinguished by the two types of notosetae. Monro records the species from Panama and gives good figures of the elytron and of both types of notosetae. As Hamilton points out, this species bears a very striking superficial resemblance to *Halosydna insignis* Baird.

HARMOTHOE IMBRICATA (Linné)

Fauvel, 1923, p. 55.

Four specimens. Two dredged in 12 to 17 fms. off Corona Del Mar, have the almost smooth elytra and setae with reduced transverse ridges characteristic of the commensal form of this

species. One is heavily pigmented black and the other lightly brown. The other two, from Santa Cruz Is., one of them dredged in 15 fms., are of the normal non-commensal form.

HARMOTHOE HIRSUTA Johnson

Johnson, 1897, p. 182; Monro, 1928A, p. 558; Hartman, 1939A, p. 51.

Three specimens, one of them from Santa Cruz Is. The anterior eyes are large and, though situated laterally, they extend on to both the dorsal and ventral surfaces of the prostomium. The large tubercles on the elytra are as Johnson and Hartman describe, only in the case of the first few pairs are they simple and spine-like as figured by Monro (1928A, p. 559, fig. 8).

HARMOTHOE LUNULATA (Delle Chiaje)

Fauvel, 1923, p. 70; McIntosh, 1900, p. 342.

One of the four examples agrees very closely with the descriptions of this species given by Fauvel and McIntosh. The other three, which were taken from tubes of *Mesochaetopterus rickettsii* n. sp., with which they were doubtless commensal, are smaller and differ in the following particulars:

1. The dorsal cirrus is very long, quite smooth and gently tapered.
2. The setae are all finer and softer than in the species or in any variety of it we know. The majority of the neuropodial setae are bidentate, only a few of the most dorsal of them have very fine simple tips. The notopodial setae are finer and softer than those of the neuropodium.

The general form of the setae in both rami is as McIntosh figures (1900, pl. 39, figs. 12 to 16).

On the basis of the differences enumerated the form commensal with *Mesochaetopterus* might well be regarded as a new variety of *H. lunulata* were it not undesirable to add yet another to the many varieties already recorded (see Fauvel, 1923, p. 72). The species is known to be a very variable one. Monro (1928A, p. 559) described the variety *pacifica* from the Panama region, but there seems to be no record of it further north in the Pacific area.

MALMGRENIA NIGRALBA Berkeley

Berkeley, 1923, p. 213.

A single specimen, dredged in 5 to 15 fms. off Santa Cruz Is. Superficially this form resembles *Harmathoe lunulata* very closely, but that species has the lateral tentacles inserted ventrally, instead of sub-terminally as in the present form, and has not the distinct netting on the elytra which characterizes *M. nigralba*.

HALOSYDNA INSIGNIS Baird

Moore, 1910, p. 329.

Polynoe brevisetosa (Kinberg), Johnson, 1897, p. 167.

Polynoe insignis (Baird), Johnson, 1901, p. 387.

Moore (1908 and 1910) has drawn attention to the great variability of this species in coloration, nature of elytra, form of dorsal cirrus, and other characters. We have ourselves commented on its near approximation, if not identity, with *H. johnsoni* Darboux (= *H. californica* Johnson), elsewhere (1939, p. 325). Typically *H. insignis* is characterised by the possession of elytra heavily and irregularly marked with dark pigment, stout dorsal cirri abruptly constricted distally and ending in fine tips, neurosetae with simple hooks, and notosetae mostly curved and coarse, in contrast with *H. johnsoni* which, typically, has elytra with a netted groundwork and comparatively little pigmentation, slender and gradually tapering dorsal cirri, neurosetae with bifid tips, and notosetae mostly straight and fine.

The great majority of the large number of specimens in this collection (several of which are from Santa Cruz Is.) attributable to either of these species possessed the above characters in a variety of combinations. We have separated them according to the degree of agreement with one or other of the two types, but we believe the separation to be an artificial one and that all should be comprised within a single species. Only 7 out of some 50 specimens examined agreed in all particulars with *H. insignis*, whilst 4 had a majority of the characters of that species. The remainder had a majority of *H. johnsoni* characters, but only 3 agreed in all particulars with that species.

In more southerly waters specimens agreeing in most, or all, particulars with *H. johnsoni* seem to be commoner than those agreeing more closely with *H. insignis*. In a collection from Mexico on which we recently (1939) reported all were of the former type. *H. johnsoni* has not been recorded, and does not seem to occur, off the coast of British Columbia or in more northerly waters. In this region complete, or very close, conformity with the *H. insignis* type is general. Both types are found both free living and as commensals, particularly with terebellids. They both tend to assume the same modifications, such as multiplication of segments and elytra, smoother and thinner elytra, less coloration, reduction or absence of notosetae, and neurosetae with much reduced transverse ridges, in the latter condition.

The evidence seems to point to a transition from the typical *H. insignis* to the typical *H. johnsoni* proceeding from north to south along the west coast of North America, with a region in the neighborhood of Southern California characterised by a pre-dominance of intermediary types.

Ehlers (1901) identifies *H. insignis* Baird with *H. patagonica* Kinberg; Seidler (1923) and Hartman (1939A) return it to the species *H. brevisetosa* Kinberg, in which Johnson (1897) originally placed it.

HALOSYDNA JOHNSONI (Darboux)

Hartman, 1938A, p. 34 (*with synonymy*).

This is by far the commonest polynoid in the collection and is represented by both the free-living and the commensal forms. Most of the specimens were taken in the intertidal zone, but some were dredged. Several are from Santa Cruz Is.

As we noted under *H. insignis* the majority of the specimens do not conform in all particulars with the type, only 3 out of 50 examples so conforming. Those ascribed to this species had a majority of *H. johnsoni* characters, the other characters being those of *H. insignis*.

Prof. MacGinitie reports the species occurring as a commensal with *Polynices lewisii*, *Kellettia kellettii*, and *Bursa californica*, as well as with terebellids (usually *Thelepus setosus* Quatrefages).

Johnson (1901) changed the specific name of this species from *reticulata* to *californica* on the ground that the former name was pre-occupied. Seidler (1923) returns it to *reticulata*; Monro (1928A) also retains the older name. Hartman (1939A) points out that Darboux substituted the specific name *johnsoni* for *reticulata* earlier than Johnson's revision.

LEPIDAMETRIA GIGAS (Johnson)

Hartman, 1939A, p. 47 (*with synonymy*); Berkeley, E. and C., 1939, p. 325.

A single specimen. Commensal with *Thelepus setosus* Quatrefages.

ARCTONOE VITTATA (Grube)

Hartman, 1939A, p. 116 and 1939A, p. 30 (*with synonymy*).

Two specimens from Santa Cruz Is., dredged in 2 to 3 fms., have smooth, transparent, almost colorless, elytra with entire edge which nearly cover the dorsum. There is no pigment band across segments 7-8. One is about 15 mm, long and consists of 38 setigers. The other is incomplete.

The specimens do not fully agree with the descriptions of *Arctonoe vittata* in that the dorsal cirri extend well beyond the ends of the setae, notosetae are well represented throughout the body, and a few of the bifid supra-acicular neurosetae, characteristic of the first setigers, persist to the end. Moreover, many of the hooks of the sub-acicular neurosetae, though of the form peculiar to *Arctonoe*, are distinctly fringed. We have encountered the last two characters, though in a less degree, in other examples, classified as *Halosydna lordi*, from the Nanaimo region.

We have little doubt the present specimens are correctly ascribed despite these deviations, all of which are in characters

which are modified in adaptation to commensal life in typical representatives of the genus *Arctonoe*. The specimens probably represent the non-commensal form of the species.

ARCTONOE PULCHRA (Johnson)

Hartman, 1938A, p. 116.

Polynoe pulchra, Johnson, 1897, p. 177.

Halosydna pulchra, Moore, 1908, p. 329; Berkeley, 1923, p. 212.

Lepidasthenia pulchra, Treadwell, 1937, p. 144.

A single specimen, put up with a specimen of *Loimia montagui* (Grube), with which it was, presumably, commensal. It has the irregular arrangement of the elytra after XXIII which Johnson describes and which led Treadwell to place the species in the genus *Lepidasthenia*. Hartman (1938A) places it, together with *A. tuberculata*, *A. fragilis*, and *A. vittata*, all of which are usually found as commensals and have other characters in common, in Chamberlin's genus *Arctonoe*.

The species occurs commonly as a commensal with echinoderms. We know of no previous record of its association with a terebellid.

FAMILY ACOETIDAE

PANTHALIS PACIFICA Treadwell

Treadwell, 1914, p. 184; Hartman, 1939A, p. 87.

Three anterior ends and a median portion dredged in 12 to 15 fms. Excepting in the presence of eyes there seems little to differentiate this species from the European *P. oerstedii* Kinberg. Fauvel (1932, p. 39) regards *P. jogasimae* Izuka, which has well defined eyes, as synonymous with *P. oerstedii* and points out that the ocular characters of the latter species are very variable.

POLYODONTES MAXILLOSUS Ranzani

Fauvel, 1923, p. 97 and 1932, p. 35.

An anterior fragment, dredged in 7 to 8 fms., consisting of 25 setigers, agrees, so far as comparison can be made, with the description given by Fauvel. The fragment is 17 mm. wide at its widest point. The first foot points slightly forward, as in *P. melanonotus* (Grube), but in all other respects, particularly in the characters of the setae, the presence of branchiae from the thirteenth foot, and of pockets on the elytra, agreement with *P. maxillosus* is close.

PEISIDICE ASPERA Johnson

Johnson, 1897, p. 184.

A single specimen taken in Monterey Bay in 16 fms. has 21 pairs of elytra. Otherwise agreement with Johnson's description is exact.

FAMILY SIGALIONIDAE

SIGALION OVIGERUM MONRO

Monro, 1924, p. 47 and 1936, p. 103.

Four specimens, three of which were dredged in 12 to 17 fms. None complete posteriorly. The largest, which is about 3 mm. wide, as preserved, agrees closely with Monro's description and has the characteristic ovigerous elytra in the posterior region. The others, which are about 2 mm. wide, differ in that they have very distinct eyes and, just posterior to them, there is a median tentacle narrower and slightly shorter than the very small lateral tentacles. In these specimens the elytra in the posterior region are characteristically carried on tall and massive elytophores, but they are not ovigerous. In none of the specimens have setae corresponding to Monro's figure (1936, p. 104, fig. 12d) been made out. In their place are multi-articulate bristles with obscure articulation between shaft and blade, but the shafts have not "fist-shaped" terminations.

We do not regard the presence of the median tentacle in the smaller specimens as excluding them from the genus *Sigalion* since they agree closely with it in all other respects and similar cases of the occurrence of such a tentacle in members of the genus have been recorded elsewhere (Berkeley, E. & C., 1939, p. 328). Augener's genus *Eusigalion* seems to be unnecessary (see Hartman, 1939A, p. 57).

PSAMMOLYCE SPINOSA Hartman

Hartman, 1939A, p. 72.

Two specimens, both incomplete posteriorly, dredged in 20 fms. at Santa Cruz Is. agree in a majority of characters with this species, but in some resemble *Ps. fimbriata* Hartman (1939, p. 74) more closely. The elytra do not cover the tips of the parapodia and their marginal papillae are much longer at the outer edge than elsewhere. The superior neurosetae have long spinose regions at the ends of the shafts. In these respects the specimens resemble *Ps. spinosa*. On the other hand the shape of the cirratophore of the median tentacle and the position of the eyes are, on the whole, in accordance with Hartman's figure (Pl. 20, fig. 245) of the prostomial region of *Ps. fimbriata*, but lateral tentacles are very clearly visible on the dorsal side of the first setiger, which she does not show. The pilose nature of the ventrum and the arrangement of filiform papillae on the ventral side in the anterior region of the body, as well as the concentration of long papillae on the ventral surface of the parapodia, are in accordance with the description of *Ps. fimbriata*.

On the whole we seem to have here a form linking Hartman's two species and suggesting that they are all variants of one form.

STHENELAIS TERTIAGLABRA Moore

Moore, 1910, p. 395.

Sthenelais hancocki, Hartman, 1939A, p. 65.

A large number of specimens of this species are in the collection, some from Monterey Bay. All were dredged in depths varying from 12 to 33 fms.

The compound neuropodial setae with spirally fringed shafts (Moore, 1910, pl. 33, fig. 117), which occur in the anterior setigers, have, in most cases, bifid tips, but the secondary tooth is sometimes not readily seen. Moore draws attention to the uncertainty of this character in the case of the multiarticulate setae with smooth shafts. The heavy setae with short unjointed appendages (Moore, 1910, pl. 33, fig. 119) which Moore says occur "behind XXX" may be as far forward as XXV, but in some cases are not present until LXV, or even nearer the anal extremity. Therefore, in specimens which are incomplete posteriorly, the absence of this seta cannot be relied upon as a diagnostic character. The pigment-deposit on the elytra is a deep rusty red in some specimens, little more than a brownish shading in others, and it may be anything between these extremes.

There seems to be no significant character differentiating *St. hancocki* Hartman from *St. tertiaglabra*. Both are described from Monterey Bay and we believe them to be synonymous.

STHENELAIS FUSCA Johnson

Johnson, 1897, p. 185; Hartman, 1939A, p. 61.

One complete and one incomplete specimen, dredged in 20 to 33 fms.

STHENELANELLA ATYPICA sp. n.

Several specimens dredged off Balboa and at Newport Bay; depth unrecorded. Two off Corona Del Mar in 12 to 17 fms.

These all agree with *St. uniformis* as described by Moore (1910, p. 391) except in one significant particular. The characteristic neurosetae, on the basis of which the genus is differentiated from *Sthenelais*, are not present in the second to the fourth setigers. In these setigers the shafts and ends of the neurosetae are not fused and they approximate to those typical of *Sthenelais*. They are of three kinds. Falcigers with smooth ended, rather heavy shafts and rather long unindentate end-pieces (fig. 1). Compound setae almost as heavy as the falcigers with long bi- or tri-articulate unindentate end-pieces and smooth shafts (fig. 2). Similar, but more slender, setae with heavily fringed ends to the shafts and longer end-pieces (fig. 3). These last may be bidentate in the second setiger. These setae are rapidly modified in more posterior setigers until, at the sixth to the tenth setiger, all have assumed the forms described and figured by Moore for *St. uniformis*.

The agreement of these specimens with *St. uniformis* was so close in every other particular that we had been inclined to attribute them to that species and to regard Moore's specimen as either imperfect or imperfectly described. The recent redescription of *St. uniformis* by Hartman (1939A, p. 69), based on many specimens, which confirms the implication of Moore's description with regard to the setae of the first setigers, leads us to doubt this assumption and to give the present specimens specific rank. However, it seems not unlikely that *St. uniformis* and *St. atypica* represent no more than phases of one species.

Long delicate threads emerge from the parapodia, beginning at the 15th setiger, similar to those described by Treadwell (1914, p. 184) and Hartman (1939A, p. 69) in the case of *St. uniformis*. We agree with the latter author as to their interpretation.

FAMILY CHRYSOPETALIDAE

CHRYSOPETALUM OCCIDENTALE Johnson

Johnson, 1897, p. 161; Monro, 1933A, p. 19.

Two specimens dredged in 12 fms. We are inclined to agree with Monro that there seems no sufficient reason for separating this species from *C. debile* Grube.

PALEANOTUS CHRYSOLEPIS Schmarda

Monro, 1933A, p. 19; Hartman, 1939B, p. 8; 1940, p. 201.
Heteropale bellis Johnson, 1897, p. 163.

A single specimen "from hydroid-barnacle mass on bottom of boat".

FAMILY AMPHINOMIDAE

CHLOEIA PINNATA Moore

Moore, 1911, p. 239; Monro, 1933A, p. 7; Berkeley, E. and C., 1939, p. 323.

Two small specimens, one about 12 mm. long, the other only half this length. The former dredged in 55 fms. in Monterey Bay, the latter in 15 fms. off Corona Del Mar.

Gills began on the fourth setiger and are as described by Moore. Both specimens have the purplish pigment area in front of the lateral tentacles, which Monro regards as characteristic, and have no distinct dorsal markings. We have given reasons elsewhere (1939) for doubts as to the validity of the separation of this species from *C. viridis* Schmarda.

EURYTHOE PAUPERA (Grube)

Ehlers, 1901, p. 33; Chamberlin, 1918, p. 173; Berkeley, E. and C., 1935, p. 767.

Eurythoe californica, Johnson, 1897, p. 159.

Twenty-four specimens, nineteen of which are from Santa Cruz Is. The specimens are all small, but can be identified by the form of the caruncle and by the setae.

EURYTHOE sp. ?

A single specimen from Santa Cruz Is. cannot be assigned to a species with any confidence since it is small and has the proboscis extended, which makes determination of the prostomial characters difficult. It differs from the foregoing (*E. paupera*) in setal characters, the most outstanding of which is the presence of bifid neurosetae with long serrate tips such as are figured for *Pareurothoe borealis* (Sars) by Okuda (1938, p. 80, fig. 2g).

EUPHROSYNE ARCTIA Johnson

Johnson, 1897, p. 159.

Three specimens from Monterey Bay in 55 fms. The caruncle reaches to the posterior edge of V.

EUPHROSYNE HORTENSIS Moore

Moore, 1905, p. 534.

One small specimen from Santa Cruz Is.

FAMILY PHYLLODOCIDAE

PHYLLODOCE FERRUGINEA Moore

Moore, 1909_B, p. 337.

A single specimen. Dredged off Balboa; depth unrecorded.

PHYLLODOCE (ANAITIDES) MADEIRENSIS Langerhans.

Fauvel, 1923, p. 150; Monro, 1933A, p. 21.

Several specimens, four of which were dredged in 7 to 20 fms., one of them in Monterey Bay. Four are from Santa Cruz Is.

Many of the specimens are small, but an individual from La Jolla is 150 mm. long. As Monro points out (1933A) *P. medipapillata* Moore, which is recorded from California, resembles this species closely, but they differ in that there are setae on III in *P. medipapillata*, none in *P. madeirensis*.

EUMIDA SANGUINEA (Oersted)

Fauvel, 1923, p. 166; Berkeley, 1924, p. 289.

A single specimen from Santa Cruz Is.

FAMILY SYLLIDAE

SYLLIS ARMILLARIS Malmgren

Fauvel, 1923, p. 264.

Four specimens "from boat bottom"; one from Santa Cruz Is.

SYLLIS ELONGATA (Johnson)

Moore, 1909_B, p. 236; E. and C. Berkeley, 1938A, p. 41.

Pionosyllis elongata, Johnson, 1901, p. 403.

Two specimens, both from Santa Cruz Is., have transverse bands of pigment across the dorsum of the first few anterior segments. Otherwise agreement is good.

SYLLIS HYALINA Grube

Fauvel, 1923, p. 262; Monro, 1933A, p. 30; Hartman, 1939B, p. 10.

Two specimens, both from Santa Cruz Is. Hartman records the species from Galapagos, Monro from Panama. *S. prolifera*, which is recorded from the Nanaimo region (Berkeley, 1923, p. 207), is probably the same species (see Fauvel, 1923, p. 263 and 1935, p. 300). With the present record its distribution throughout a considerable length of the coast of N. W. America is indicated.

SYLLIS FASCIATA Malmgren

Malmgren, 1867, p. 161; Fauvel, 1934, p. 304.

Two specimens, both from Santa Cruz Is. This is the form reported from the Nanaimo region (Berkeley, 1923, p. 205), with some doubt, as *S. borealis*. It is characterized by a light rusty-brown coloration of the dorsum of the anterior region, long slender articulated dorsal cirri, compound setae with unindentate end-pieces of moderate length, and rather heavy simple spines in the posterior parapodia.

SYLLIS GRACILIS Grube

Fauvel, 1923, p. 259; Monro, 1933A, p. 30.

A single example from Santa Cruz Is., dredged in 20 fms. The species is characterized by the presence of true ypsiloid setae in the median parapodia. *S. palifica* Ehlers and *S. longissima* Gravier are, as far as we know, the only other species of Syllis which have these setae. These two species are almost identical except in point of size. Ehlers (1901, p. 92) suggests that *S. longissima* may be no more than the giant form of *S. palifica*. The present species is differentiated from both by having fewer articles in the dorsal cirri of the median region, which are regularly alternated long and short, and bidentate compound setae.

TRYPANOSYLLIS GEMMIPARA Johnson

Johnson, 1901, p. 405; Berkeley, 1923, p. 207; Berkeley, E. and C., 1938A, p. 42.

Two specimens, both from Santa Cruz Is. This species has not been reported previously south of Puget Sound.

ODONTOSYLLIS PHOSPHOREA Moore

Moore, 1909B, p. 327; Berkeley, E. and C., 1938A, p. 42.

A large number of typical specimens, all dredged, some in 12 to 17 fms.; in the case of the others there is no record of the depth. A single specimen, collected intertidally at Santa Cruz Is., approximates to the variety *nanaimoensis* Berkeley.

ODONTOSYLLIS POLYCERA (Schmarda)

Monro, 1933A, p. 36.

A single specimen from Santa Cruz Is. The species is distinguished by the slate-grey colour of the dorsal surface, the very large and deeply pigmented occipital flap, and the characters of the pharynx.

ODONTOSYLLIS PARVA Berkeley

Berkeley, 1923, p. 208.

Four specimens from Santa Cruz Is. This species was described from a single incomplete specimen and has not been recorded since. There is, however, nothing to add to the original description from a consideration of the present specimens. The anal cirri have not remained intact in either of them. One has swimming-bristles well developed.

FAMILY HESIONIDAE

PODARKE PUGETTENSIS Johnson

Johnson, 1901, p. 397; Gravier, 1909, p. 622; Okuda, 1936A, p. 413.

Several specimens, dredged in 7 fms. One specimen is marked "commensal with *Patiria miniata*." One from Santa Cruz Is.

The original description has been amplified by Gravier and again by Okuda. The species is common in the Nanaimo region. Gravier records it from Peru and Okuda from Japan. It is thus of wide distribution in the Pacific area.

LOANDALIA FAUVELI sp. n.

A single complete specimen in three pieces, from mud-flats, Newport Bay. There is some difficulty in measuring these fragments and in counting the segments, since the median and posterior ones are much twisted and the anterior one is enclosed in a piece of a tightly-fitting annulated tube resembling that of a Phyllochaetopterid. Approximately, the three pieces measure jointly 125 mm. and consist of 300 segments. The width is barely 1 mm. at the widest point. The body is pearly white throughout, the anterior portion being strikingly iridescent.

In general morphological characteristics the form resembles *Loandalia aberrans* Monro (1936, p. 193). The head is similar, but, whereas Monro was unable to differentiate the buccal segment from the prostomium, there appears to be a definite groove separating them in the present form. The first six setigers are broader and shorter than those which follow and are deeply furrowed longitudinally, giving this region the appearance of a thorax. In this region there are no notopodia (fig. 4).

The first parapodium bears a single colourless bristle. From the second to the end of the body denticulate bristles, exactly like

those figured by Monro for *L. aberrans* (1936, p. 194, fig. 34g) are present. From the seventh setiger back a notopodium occurs bearing a single heavy colourless spine (fig. 5). More posteriorly this spine is accompanied, in some parapodia, by two very fine capillary setae extending well beyond the lobe and lying completely parallel to one another throughout their length. In each case the termination of these setae is obscured by a small mass of detritus and the form cannot be made out (fig. 6).

The last three setigers and the pygidium are abruptly much smaller than the preceding segments, which may indicate regeneration. The pygidium, so far as can be made out, is a rounded lobe bearing three small papillae, but no anal plate, such as is figured by Monro for *L. aberrans*.

Monro's species is the only representative of the genus *Loandalia* previously described. The present species differs from it most outstandingly in the entire absence of branchiae.

Prof. Fauvel was kind enough to examine our specimen. In connection therewith he writes us as follows: "In my paper (Annélides Polychètes de l'Annam, 1935, p. 333, fig. 6) I made a mistake. What I wrongly figured as a back part of *Telehsapia* is really the head of a *Loandalia*, very likely the same as your specimen and, curiously enough, found also among, but not in, tubes of Phyllochaetopterids. Latterly I met with another anterior end amongst Polychaeta from the "Siboga" expedition. I am now satisfied that *Loandalia* and *Telehsapia* are both of them aberrant Hesionids."

Prof. Fauvel has recently (1939, p. 39) published the substance of these remarks. We take pleasure in naming the present species after him.

FAMILY NEREIDAE

NEREIS PELAGICA Linné

Fauvel, 1923, p. 336.

Several typical specimens, some dredged in 13 to 17 fms. A number of them from Santa Cruz Is.

NEREIS CALLAONA (Grube)

Ehlers, 1901, p. 108; Hartman, 1940, p. 227.

Nereis heterocirrata Treadwell, 1931, p. 1.

Nereis eucapitis, Hartman, 1936A, p. 468; 1938B, p. 14.

Two specimens, both from Santa Cruz Is.

PLATYNEREIS DUMERILII (Audouin and Milne-Edwards)

var. *Agassizi* Ehlers.

Monro, 1933A, p. 44.

Nereis agassizi, Ehlers, 1868, p. 542; Johnson, 1901, p. 399.

Several specimens; a number of them from Santa Cruz Is. The majority dredged in 5 to 20 fms. The spotted phase described by Treadwell (1914) as *Nereis notomacula* is plentifully represented. The fusion of the paragnaths of the proboscis, which distinguishes the genus *Platynereis*, is much more apparent in some of the specimens from Santa Cruz Is. than in those from farther south. We have pointed out elsewhere (1935, p. 769) that irregularity in this respect is characteristic of the variety *Agassizi*. In the same paper we recorded the occurrence of an individual in which a number of the specialized crotchet setae which characterize the variety were present in the notopodium, instead of the usual one or two. This condition is common in many of the examples from Santa Cruz Is.

NEREIS PSEUDONEANTHES Hartman

Hartman, 1936A, p. 470.

Two specimens, both from Santa Cruz Is.

NEREIS NEONIGRIPES Hartman

Hartman, 1936A, p. 471.

Fourteen specimens, one of which was dredged in 5 fms. All are from Santa Cruz Is.

NEREIS VEXILLOSA Grube

Ehlers, 1868, p. 573; Johnson, 1901, p. 399; Moore, 1909B, p. 244; Berkeley, 1924, p. 290.

Five specimens from Santa Cruz Is. Monro (1933, p. 42) quotes Moore's description of this species as "the Pacific representative of *Nereis limbata*". He points out that the latter species is a synonym of *N. succinea* and considers that *N. vexillosa* is no more than a variety of it.

Apart from its greater size and the invariable absence of group V of the paragnaths in *N. vexillosa*, which Monro recognises as differentiating characters, we are inclined to doubt the similarity for the following additional reasons:

1. The superior dorsal parapodial lobe is much longer and more cylindrical in the median and posterior regions of the body in *N. vexillosa* than in *N. succinea*.
2. The heavy homogomph notopodial setae of the posterior parapodia have smooth spindle-shaped end-pieces in *N. vexillosa*, quite unlike the hooked, hirsute, asymmetrical ones in *N. succinea*. (See Fauvel, 1923, p. 347, fig. 135, l.)
3. The heterogomph setae are also distinctly dissimilar (see Johnson, 1901, pl. 4, fig. 37 and Fauvel, 1923, p. 347, fig. 135m).

NEREIS PROCERA Ehlers

Ehlers, 1868, p. 557; Johnson, 1901, p. 400; Berkeley, E. and C., 1935, p. 768.

A few typical specimens, dredged in 5 to 17 fms. One, from Santa Cruz Is., is incomplete and its identification doubtful.

FAMILY NEPHTHYDIDAE

NEPHTHYS CAECOIDES Hartman.

Hartman, 1938c, p. 148.

Nephtys assimilis Oersted, Berkeley E. and C., 1935, p. 770.

A number of examples, one of which was dredged in 5 fms. off Santa Cruz Is. Two types are represented, differing only in the character of the setae. In the majority of the specimens the setae are all as described for the species, in others they are in part long and silky and the specimens resemble *N. caeca* Fabricius, var. *ciliata*, differing mainly in the characters of the proboscis. This is probably the epitokous form of *N. caecoides*.

In one individual, which is otherwise of the normal type, the first branchia is present on the third setiger and the characteristic prostomial markings are not present, but agreement in other respects is reasonably good.

NEPHTHYS DIBRANCHIS Grube

Monro, 1933, p. 56; Hartman, 1938c, p. 146.

One complete specimen and several fragments dredged in 20 fms. off Santa Cruz Is. This appears to be the most northerly record of the species.

FAMILY SPHAERODORIDAE

EPHESIA GRACILIS Rathke

Fauvel, 1923, p. 377.

Two specimens, dredged in 20 fms. off Santa Cruz Is. *E. papillifer* (Moore) which is recorded from California (Moore, 1909b, p. 333) and from the Nanaimo region (Berkeley, 1927, p. 412), differs from the present species in little but the absence of the setae of the form figured by Fauvel (fig. 148f).

FAMILY GLYCERIDAE

HEMIPODIA BOREALIS Johnson

Johnson, 1901, p. 411.

Five specimens, all from Santa Cruz Is.

GLYCERA CAPITATA Oersted

Fauvel, 1923, p. 385.

Two specimens, both dredged; one in 67 fms., in the case of the other the depth is unrecorded.

GLYCERA GIGANTEA Quatrefages

Fauvel, 1923, p. 387.

A single small specimen. This has the three-lobed parapodium characteristic of young forms of the species (see Fauvel, 1923, p. 389). The branchiae are all retracted.

GLYCERA RUGOSA Johnson

Johnson, 1901, p. 409.

Several specimens. Some dredged in 7 to 17 fms., others collected intertidally.

GONIADA MACULATA Oersted

Fauvel, 1923, p. 392; Hartman, 1940, p. 251.

Two specimens, one incomplete. Both dredged; depth unrecorded. The complete specimen is the smaller and is only about 30 mm. long, the other would probably have measured about 50 mm. when complete. They are thus both small representatives of the species, but are typical in other respects.

GLYCIDNE ARMIGERA Moore

Moore, 1911, p. 307.

A single specimen; dredged; depth unrecorded.

FAMILY EUNICIDAE (LEODICIDAE)

EUNICE BIANNULATA Moore

Moore, 1904, p. 487; Berkeley, E. and C., 1939, p. 335.

Eunice longicirrata, Webster, *var.*, Hartman, 1938D, p. 97.

A single specimen. Hartman (1938E, p. 11) confirms the above synonymy.

EUNICE SICILIENSIS Grube

Fauvel, 1923, p. 405.

Nicidion edentulum, Ehlers, 1901, p. 130.

Two specimens. The first, taken amongst roots of *Phyllospadix*, is a large one in several pieces which are considerably curled and their length cannot be measured. The width is about 4 mm. over the setae. It agrees in all respects with the descriptions of the species except that there is a slight branching of a few of the branchiae. In this it approaches *Palolo* (*Eunice*) *pallidus* Hartman (1938D, p. 99), but it differs from that species in having three acicula in some of the anterior segments. In the latter character it resembles *E. paloloides* Moore. We are inclined to think that these characters are variable and that both the latter species should be regarded as variants of *E. siciliensis*.

The second specimen, which is from Santa Cruz Is., dredged in 10 fms., is incomplete posteriorly and small, measuring barely 1.5 mm. in width. It agrees in all respects except that there is

no sign of branchiae. *Nicidion edentulum* Ehlers is thus characterized and is generally regarded as the juvenile form of *E. siciliensis*.

EUNICE VITTATA (Delle Chiaje)

Fauvel, 1923, p. 404.

Two specimens, dredged in 5 fms., agree closely with the descriptions except that only one inter-segmental red line can be made out. Monro (1933, p. 61) lists the species from Panama, but it has not been recorded previously from the Californian coast. *E. hawaiiensis* Treadwell, known from that region, comes very near it, differing mainly in its more complex branchiae.

EUNICE ENTELES Chamberlin

Chamberlin, 1918, p. 175.

Leodice monilifer Chamberlin, 1919A, p. 11 (Hartman, 1938D, p. 97).

Four specimens, all from Santa Cruz Is.

MARPHYSA SANGUINEA (Montagu).

Fauvel, 1923, p. 408; Ehlers, 1868, p. 360.

Marphysa californica Moore, 1909B, p. 25.

Four specimens, one of which is much larger than the other three. This specimen is about 11 mm. wide at the widest point and has a regenerated posterior region. The branchiae have from 4 to 6 branches. When fully developed these are definitely pectinate as figured by Ehlers (1868, pl. 16, fig. 8).

RHAMPHOBRACHIUM LONGISETOSUM Berkeley

Berkeley, E. and C., 1938B, p. 428.

Two anterior fragments dredged in 17 fms. and 33 fms. respectively.

ONUPHIS ELEGANS (Johnson)

Johnson, 1901, p. 406; Berkeley, E. and C., 1935, p. 771.

Five specimens, dredged in 12 to 17 fms. The species comes very near to *O. holobranchiata* Marenzeller, which is recorded only from Japan.

ONUPHIS EREMITA Audouin and Milne-Edwards

Fauvel, 1923, p. 414; Berkeley, E. and C., 1935, p. 771.

Two typical specimens.

ONUPHIS EREMITA, var. PARVA var. n.

A number of specimens dredged in 12 to 17 fms., none of which are quite complete, agree in general morphological characters with *O. eremita*, but are far too small for that species, though they are sexually mature. The largest is 18 mm. long for

54 segments and 1.5 mm. wide at the widest point. The change from simple to compound branchiae occurs at any point between the 23rd and 30th setiger, varying in different specimens. The pectinate branchiae have 4 to 5 branches. Minute eye-spots are present.

The ground colour of the variety, as preserved, is deep ivory with conspicuous iridescence and there are brown bands on the anterior segments which are broken further back.

ONUPHIS IRIDESCENS (Johnson)

Northia iridescens, Johnson, 1901, p. 408.

Several specimens, one of which was taken in Monterey Bay. All dredged in 12 to 17 fms.

ONUPHIS NEBULOSA Moore

Moore, 1911, p. 269; Monro, 1933A, p. 76.

Four specimens, all incomplete posteriorly, dredged in 12 to 17 fms. They are all about 1 mm. wide. The modification of the larger compound tridentate crotchet of the anterior segments into a heavier simple one, which persists long after the fine compound crotchets have been replaced by capillaries, is characteristic of this species. Moore found that this modified crotchet persisted until the 14th setiger, after which there was a gap of a few segments before the bidentate crotchets appeared. Monro recorded the tridentate crotchets up to the 17th setiger and the bidentate ones on the 18th.

In two of our specimens in which we have determined the point of transition we find the last tridentate crotchet on the 13th and 14th setigers respectively. In both cases a pair of bidentate crotchets appears in the immediately succeeding segment. Evidently there is some variation in this respect.

DIOPATRA ORNATA Moore

Moore, 1911, p. 273; Berkeley, E. and C., 1939, p. 338.

A large number of specimens, all dredged in 5 to 17 fms., one from Santa Cruz Is., belong to the genus *Diopatra*. Many of them are fragmentary. They vary in width from 2 mm. to 8 mm. and are up to 170 mm. in length.

We ascribe all but four of them to this species in spite of the fact that there is a great deal of variation in respect of at least three characters which are commonly regarded as specifically diagnostic. These are the relative length of the dorsal and ventral cirri of the first setiger, and the first occurrence of gills and of heavy ventral crotchets respectively. The gills may begin on the 5th or 6th somite and the crotchets anywhere from the 16th to the 30th, and the incidence of neither seems to bear any relation to the size of the individual concerned. In the light of

the variation in these characters it becomes difficult to differentiate this species from *D. californica* Moore. The comb-setae form the best basis of differentiation. In *D. californica* they have a small number (7 or 8) of very coarse teeth (Moore, 1904, pl. 37, fig. 5), in *D. ornata* there are numerous (upwards of 20) very fine ones (Moore, 1911, pl. 18, fig. 82). The nature of the acicula also affords some guide. In the former species they are pliable, usually bent, and may be dark tipped; in the latter they are more rigid and have no dark tips.

Fragments of two kinds of tube accompany the material. The commoner kind has a rather thick wall of sandy mud with smoothly rounded transverse corrugations. The other is constructed of thin membranous material heavily beset with pieces of detritus, chiefly fragments of seaweed, and very little shell, set quite irregularly.

DIOPATRA CALIFORNICA Moore

Moore, 1904, p. 484.

The four specimens ascribed to this species were all dredged; the depth is unrecorded. They are differentiated from *D. ornata* in the manner indicated in the preceding paragraph. *D. ornata* is, apparently, a very much commoner species in the region covered by this collection than *D. californica*.

HYALINOECIA TUBICOLA (O. F. Müller)

Fauvel, 1923, p. 421.

Hyalinoecia juvenalis, Moore, 1911, p. 277.

A large number of specimens, all dredged in depths varying from 7 to 67 fms. and ranging in length up to about 70 mm. have enabled us to study the variation within this species in some detail. Capillaries may or may not occur in the first three setigers. The crotchets of these setigers may be either pseudo-compound, as figured by Moore for *H. juvenalis*, (1911, pl. 18, fig. 89), or simple, as figured by Fauvel for *H. tubicola* (1923, p. 421, fig. 166p), or both may occur together. The condition in this respect seems to bear little relation to the size of the individual. The gills start at about somite 19 in the smaller individuals, at about somite 22 in the larger ones.

Having regard to these variations it would seem that there is no justification for separating *H. juvenalis* from the older species.

LUMBRINEREIS ERECTA Moore

Moore, 1904, p. 490.

A number of specimens of various sizes. Most of them are taken from amongst roots of *Zostera* and *Phyllospadix*. Two are from Santa Cruz Is. The longest complete example measures 240 mm. In most cases the capillary setae extend only to about

the 75th setiger, but in two of them they persist to the end of the body. Moore says the capillaries cease at the 50th setiger. Dr. Hartman has recently examined the co-types of *L. erecta* deposited at the Philadelphia Academy of Science and finds that the specimens all have capillaries in some parapodia to the end of the body (*private communication*).

LUMBRINEREIS LATREILLI Audouin and Milne-Edwards

Fauvel, 1923, p. 431.

Four specimens, three collected intertidally at Santa Cruz Is., the fourth dredged in 16 fms. in Monterey Bay.

LUMBRINEREIS IMPATIENS Claparède

Fauvel, 1923, p. 429; Berkeley, E. and C., 1935, p. 772.

A single small specimen "from holdfast of seaweed". *L. zonata* Johnson is probably a synonym of this species (see Hartman, 1938E, p. 12).

LUMBRINEREIS INFLATA Moore

Moore, 1911, p. 289.

Lumbrinereis cervicalis Treadwell, 1922, p. 176.

A single specimen dredged in 20 fms. off Santa Cruz Is.

LUMBRINEREIS LIGULATA sp. n.

A number of specimens, dredged in 12 to 17 fms. None are quite complete, but both anterior and posterior portions are represented in an almost entire condition. The largest specimen has a maximum width of about 3 mm., the smallest about 1 mm.

The prostomium is pointed, almost as long as the first three segments, and has well defined nuchal organs. The buccal segment is only a little longer than the succeeding one. The lobes of the most anterior parapodia are short and rounded, the posterior longer than the anterior. Farther back both lobes lengthen considerably and in the median region they become extremely elongated and continue so to the posterior end. In the median and posterior regions the lobes are quite slender and of equal length. They resemble almost exactly those of the parapodium of *L. biflaris* Ehlers (1901, pl. 18, fig. 6). At the posterior end of some of the smaller specimens these lobes are so long relative to the width of the body as to meet across the dorsum.

Simple bladed setae occur in the first 80 setigers. These are accompanied by compound crotchets in the first 50 setigers. Five or six of these crotchets are present in the first few setigers. Their number gradually decreases in more posterior ones and from the 25th setiger to the 50th, they are gradually replaced by simple crotchets which persist to the end of the body. The

bladed setae and both the compound and simple crotchets resemble very closely those of *L. latreilli* (Fauvel, 1923, p. 431).

The occurrence of compound crotchets in the first 50 setigers differentiates this species from the other three with both the lobes of the median and posterior parapodia elongated which have been described from the west coast of N. America. These are *L. bifilaris* Ehlers, *L. bifurcata* McIntosh, and *L. bicirrata* Treadwell. In the characters of the parapodia and the setae *L. ligulata* unites those of *L. bifilaris* and *L. latreilli*. In the structure of the jaws it differs from both, the principal difference being that in M2 there are usually only three teeth on either side. Occasionally a fourth small tooth appears on one side. The dental formula is as follows: 3+3-4; 1+1; 1+1.

DRILONEREIS FILUM (Chaparède)

Fauvel, 1923, p. 436; Monro, 1933A, p. 88.

Drilonereis falcata, Moore, 1911, p. 298.

A single specimen dredged in 20 fms. off Santa Cruz Is. Monro points out the similarity of this species to *D. falcata*. We regard them as synonyms.

ARABELLA ATTENUATA Treadwell

Treadwell, 1906, p. 1172.

One anterior and two posterior fragments, dredged; depth unrecorded. The species is distinguished by the very broad, bluntly rounded aciculum projecting for some distance from the tip of each parapodium. The specimens are small, averaging only about 1 mm. in width.

ARABELLA IRICOLOR (Montagu)

Fauvel, 1923, p. 438.

Arabella mimetica Chamberlin, 1919A, p. 12.

Eight specimens, seven of which are from Santa Cruz Is. The form of the first maxilla distinguishes this species from the nearly allied *A. geniculata*. Our suggestion (1932, p. 313) that *A. mimetica* is synonymous with this species is confirmed by Hartman (1938E, p. 12) after re-examination of Chamberlin's type.

ARABELLA GENICULATA (Claparède)

Fauvel, 1923, p. 439.

A single specimen taken from roots of *Phyllospadix*. The specimen is unusually large, measuring 340 mm. in length and 6 mm. in width. No eyes can be made out. This is probably a matter of age.

ARABELLA SEMIMACULATA (Moore)

Aracoda semimaculata Moore, 1911, p. 295.

Arabella munda, Chamberlin, 1919B, p. 258.

Two specimens from *Zostera* roots and "rocky shore" Corona Del Mar, respectively, and a large number from similar situations at Santa Cruz Is. Amongst the latter is a specimen 500 mm. long and several approximate to this length. This is much longer than any of Moore's examples of *A. semimaculata* or of Chamberlin's specimen of *A. munda* which Hartman (1938E, p. 12), after examining the type, regards as the same species. Eyes can be made out only with difficulty, or not at all, in the larger specimens. In smaller ones they are clearer and the outer ones are larger than the inner.

We have separated this species from *A. iricolor* by the peculiar digitate, obliquely directed, lobes of the posterior parapodia. This seems to be the only character upon which a distinction can be based and we are by no means sure it is a valid one since we find amongst a large number of specimens examined, of approximately equal size, that the character is developed in varying degree and it is possible to arrange a series of intermediaries connecting those with the almost typical *iricolor* foot with those with the foot characteristic of *semimaculata*.

DORVILLEA (STAUROCEPHALUS) RUDOLPHII (Delle Chiaje)

Fauvel, 1923, p. 446.

A single specimen. Hartman (1938D, p. 101) has described a nearly allied species *D. articulatus* from California from which the present specimen differs in the particulars stressed in her description (p. 102).

FAMILY ARICIIDAE

ARICIA MACGINITII sp. n.

This fine *Aricia* is described from a single specimen from the mud-flats, Newport Bay. It is about 210 mm. long, with a maximum width of about 5 mm. in the thoracic region. This region is flattened, whilst the abdomen is rounded. There are 29 thoracic setigerous segments. Gills start on the 5th setigerous segment. They are lanceolate throughout the body and attain their greatest size at about the mid-region, where the bases meet across the dorsum.

In the thoracic region the dorsal ramus of the parapodium has a lanceolate cirrus and a bundle of slender camerated capillary setae. The ventral ramus is a flattened vertical pad with a narrow elongated lamella bearing from 11 to 16 long conical papillae. Immediately adjacent to the row of papillae is a close row of many subuluncini (fig. 7) and anterior to this row are three or four rows of deep yellow crotchets with strongly bent and rounded tips (fig. 8). No capillaries could be found in the ventral ramus.

From the 12th setigerous segment to the end of the thoracic region the most anterior row of crotchets is replaced by a row

of very heavy brown spines about twice as thick as the crotchets and projecting very little. Most of these are straight rods and have square or rounded ends, but, judging by a few which were observed just emerging from the parapodium, this is a condition of wear and they have bluntly pointed tips when unworn (fig. 9). There are about 20 of these heavy spines in the 13th setigerous segment and they gradually decrease in number as the lobe bearing them shortens, in more posterior segments.

Dense rows of ventral papillae begin on the 14th setigerous segment and continue to the 34th. From the 20th to the 32nd setigerous segment the rows are double.

In the abdominal region the parapodium carries a long dorsal cirrus, a bundle of dorsal setae, similar to those occurring in the thorax, and an erect bilobed ventral ramus with shorter, but similar, capillaries. There is no intermediary cirrus and no forked setae could be made out.

The pygidium is well defined and the anus is surrounded by a rugose ring (fig. 10). The preserved specimen has neither colour nor markings.

The replacement of the entire anterior row of neural crotchets by heavy straight spines in the parapodia of the posterior region of the thorax, coupled with the absence of ventral capillaries in the thorax and that of both intermediary cirrus and forked setae in the abdominal region, differentiates this species from others of the genus.

A. johnsoni Moore and *A. nuda* Moore are the only members of the genus previously described from the coast of California. Both differ from the present species in significant particulars. We name it with pleasure after Prof. G. E. MacGinitie.

HAPLOSCOLOPLOS KERQUELENSIS (McIntosh)

Monro, 1936, p. 160.

Scoloplos kerqueleensis, McIntosh, 1885, p. 355.

Scoloplos elongata, Johnson, 1901, p. 412.

Scoloplos acmeceps, Chamberlin, 1919A, p. 15.

A single specimen agrees with Monro's amended description of this species. *Scoloplos elongata* appears to differ in no particular from this description. Hartman (1938E, p. 13) finds, after examination of the type, that *Scoloplos acmeceps* is a synonym of *Scoloplos elongata*.

NAINEREIS LAEVIGATA (Grube)

Fauvel, 1927, p. 22; Berkeley, E. and C., 1932, p. 313.

Nainereis robusta, Moore, 1909B, p. 262.

Nainereis longa, Moore, 1909B, p. 264; Berkeley, 1927, p. 413.

Seven specimens taken from roots of *Zostera* and *Phyllospadix*. Four of them from Santa Cruz Is.

FAMILY SPIONIDAE

SCOLEPIS INDICA Fauvel

Fauvel, 1928, p. 93 and 1932, p. 170.

Two anterior and three median fragments, from Mission Bay, San Diego, agree with Fauvel's descriptions in every particular except that the crotchets are tridentate in the more posterior segments of the median fragments. The species has been recorded previously only from India.

NERINIDES ACUTA (Treadwell)

Spio acuta, Treadwell, 1914, p. 199.

This species, originally described from two anterior fragments collected at San Diego, California, and not since recorded, is represented in the collection by five specimens, four of which are complete. The absence of a branchia on the first setigerous segment necessitates transference of the species to the genus *Nerinides*. We are able to amend the original description from the more complete material in the following particulars.

There is a triangular thickening at the base and on the dorsal side of each tentacle somewhat similar to the sheath described by Okuda in *N. papillosus* (Okuda, 1937, p. 219), but less complex (fig. 11).

The lobe of the ventral remus in the posterior parapodium is very long and extends vertically to a narrow notch which divides it from the dorsal remus. The setae are confined to the basal end of the lobe and below them is a small projection (fig. 12).

Ventral crotchets start at about the 30th setiger. They are bi-dentate and have hoods with a terminal aperture (fig. 13).

The anus is terminal and below it is a turgid flange the edge of which is entire (fig. 14).

The presence of setae in both rami of the first setiger of this species differentiates it from other members of the genus.

LAONICE CIRRATA (Sars)

Fauvel, 1927, p. 38; Berkeley, E. and C., 1936, P. 474.

Spionides japonicus. Moore, 1907, p. 204.

Spionides foliata, Moore, 1923, p. 182 (*vide* Hartman, 1936B, p. 32).

Several specimens, one of which is from Monterey Bay and one from Santa Cruz Is. All dredged in 12 to 17 fms.

PRIONOSPIO PINNATA Ehlers

Ehlers, 1901, p. 163; Fauvel, 1932, p. 173.

Paraprionospio tribranchiata, Berkeley, 1927, p. 415.

Prionospio alata, Moore, 1923, p. 185.

Several specimens, dredged in 12 to 17 fms., one of which has two tongue-like processes emerging from the mouth and projecting laterally. We have occasionally observed this in ex-

amples from the Nanaimo region and we mention it here because these processes are at first glance liable to be mistaken for frontal horns such as occur in *Scololepis*.

In the description of *Paraprionospio tribranchiata* it is surmised that the species may prove to be a synonym of *Prionospio pinnata*. We can now confirm this synonymy and we follow Söderström (1920, p. 228) and Fauvel in considering Caullery's genus *Paraprionospio* unnecessary.

POLYDORA GIARDI Mesnil

Mesnil, 1896, p. 195; Fauvel, 1927, p. 50.

A single specimen, incomplete posteriorly, dredged in 20 fms. off Santa Cruz Is., agrees, so far as can be determined, with this species.

Branchiae begin on the 10th setiger. Dorsal setae are present on the 1st setiger, and the characters of the setae of the 5th setiger are in accordance with Mesnil's description.

Originally recorded from France, this species seems to have been noted since only from Ireland (Southern, 1914, p. 104).

FAMILY CHAETOPTERIDAE

CHAETOPTERUS VARIOPEDATUS Rénier

Fauvel, 1927, p. 77.

Two specimens, one of them small.

MESOCHAETOPTERUS RICKETTSII sp. n.

One complete, but badly preserved, specimen, in several pieces, and an anterior portion are in this collection. Another anterior portion, from Ensenada Estuary, Mexico, had previously been sent to us by Mr. E. F. Ricketts, who also sent eight similar fragments from Newport Bay, California, in 1932. All these anterior portions consist of the anterior region of the body and a variable number of the most anterior segments of the median region.

The following description is based upon a consideration of all the material at our disposal.

In size, in superficial appearance, and in general morphological structure, the species resembles *M. taylori* Potts. The fragments of the only complete specimen measure jointly about 333 mm. in length and the greatest width, at the first segment of the median region, is about 10 mm. Some of the anterior fragments are wider than this and evidently belong to larger animals.

The prostomium is low and rounded. The peristomium is large, erect, flaring and unpigmented. Its dorsal lobes do not cover the prostomium which is, therefore, clearly visible on the dorsal surface. The peristomial tentacles are grooved and 30 to 40 mm. long and there is no trace of a second pair of tentacles. The anterior region consists of 9 to 13 setigers. It is about 16 mm. long in the complete specimen. It differs in no essential

character from the same region in other members of the genus. The modified setae of the 4th setiger resemble those of *M. minuta* (Potts, 1914, p. 964, fig. 4B), whilst the remainder of the notopodials are like those of *M. taylori* (Potts, 1914, p. 965, fig. 5A),

The median region consists of 21 setigers and is about 110 mm. long in the complete specimen. None of the setigers are as elongated as they are in other members of the genus. The first is about the length of the whole anterior region and more posterior ones are increasingly shorter. At the posterior end of the 2nd and of every succeeding setiger of this region the walls of the ciliated groove bear on each side a small semi-circular expansion. The flaps so formed are held more or less vertically. These represent the very much larger and more complicated expansions found, similarly situated, in other members of the genus and we take it that their presence characterizes the median region. The dorsal surface of all the segments in this region is coated with dark brown glandular tissue forming close transverse furrows and the white lateral frill characteristic of *M. taylori* is not present. The notopodia are all alike throughout the region and are unilobed triangular processes supported by bundles of fine capillaries with flattened ends (fig. 15). The uncini in this region are somewhat variable, but generally resemble those of *M. taylori* as figured by Potts (1914, p. 962, fig. 3).

The posterior region measures about 208 mm. and consists of some 80 setigers, so far as can be made out in the poor condition of preservation of the only entire specimen. The transition from the median to the typical abdominal segments is more gradual in this species than in other members of the genus. The notopodia carry about three capillaries each with sickle-shaped ends extending freely (fig. 16) and these are present to the end of the body. The uncini are essentially similar to those of the median region.

The tube is thin and smooth and covered with a sparse coating of sand. It may extend for more than a metre. It resembles that of *M. taylori* in both these respects.

The genus *Mesochaetopterus* was established by Potts (1914) for the two species *M. taylori* and *M. minuta*. Since then two others, *M. alipes* Monro, and *M. japonicus* Fujiwara, have been added. The number of median segments in these four species consists, in accord with the generic description, of "2 or 3 elongated segments". In the present species there appears to be 21 of these. Since we have only the one specimen with this region complete we are unable to say whether this number of median segments is constant. In all other respects it is so typical a *Mesochaetopterus* that we place it within the genus though this may involve modifying the generic definition to include species with a greater number of median segments than those described hitherto.

We take pleasure in naming the species after Mr. E. F. Ricketts.

FAMILY CIRRATULIDAE

CIRRIFORMIA (AUDOUINIA) TENTACULATA (Montagu).

Audouinia tentaculata, Fauvel, 1927, p. 91; Berkeley, E. and C., 1935, p. 772 (with synonymy).

Several specimens, many of which are from Santa Cruz Is. Hartman (1936B, p. 31) suggests the generic name *Cirriformia* in place of *Audouinia* which, she points out, is preoccupied.

CIRRIFORMIA (AUDOUINIA) LUXURIOSA (Moore)

Moore, 1933B, p. 1055.

Cirratulus luxuriosus, Moore, 1904, p. 493.

Several specimens. The species is distinguished by the gradually increasing distance between branchia and notopodium from the anterior to the posterior region of the body. In the anterior segments they are almost in contact. Posteriorly the branchia assumes an almost mid-dorsal position. The only other species of which we know in which this arrangement occurs is *A. semicincta* Ehlers, which may be a synonym.

THARYX SP.?

One specimen, dredged in 12 to 17 fms. It is incomplete posteriorly, less than 1 mm. wide, and the segments are very short and crowded. The prostomium is conical. There are no eyes. Only stumps of the tentacular filaments and branchiae, or scars of attachment showing where they have been, remain. There are 4 achaetous anterior segments which have no indication of having carried branchiae. The fifth segment is the first setiger and carries on its anterior border the remains of a pair of tentacular filaments and of a pair of branchiae. Succeeding setigers have each a pair of branchiae for at least the anterior half of the fragment.

Throughout the length of the fragment the dorsal setae are long, smooth hair-like capillaries, whilst the ventral setae have serrated blades and are drawn out to fine tips. In the anterior region they are much longer than posteriorly and are alternately long and short in the rows, the longer ones having very extended tips (fig. 17). In the posterior region the ventral setae are more nearly of one length in the rows and are broader, more curved, and more coarsely serrated (fig. 18).

We know of no *Tharyx* which has setae of this peculiar type.

CHAETOZONE SPINOSA Moore, var. CORONA var. n.

Chaetozone spinosa, Moore, 1903, p. 468.

Four specimens, dredged in 12 to 17 fms., one of which is complete, except that only a few branchiae remain. One of the others is an anterior fragment with most of the branchiae attached, and two have only a few branchiae and no caudal ends.

The complete specimen is about 18 mm. long and 1.5 mm. wide. The largest of the others is nearly 2 mm. wide. All are thus considerably smaller than the type of Moore's species.

Like the stem species the variety *corona* is characterized by the presence of stiff spines, together with very long, fine, capillary setae throughout the body in both rami. The capillaries agree closely with Moore's description and figure (pl. 26, fig. 73), but the spines in the anterior region have no delicate tips. They are all alike throughout the body and resemble those Moore describes for posterior segments only (pl. 26, fig. 74). Moreover the variety has a pair of well-defined crescentic eyes placed laterally on the prostomium.

DODECACERIA PACIFICA (Fewkes)

Moore, 1909B, p. 268; Berkeley, E. and C., 1932, p. 314.

A number of typical specimens.

FAMILY CHLORAEMIDAE

FLABELLIGERA COMMENSALIS MOORE

Moore, 1909B, p. 286.

Several specimens taken from amongst the spines of the sea-urchin *Srongylocentrotus purpuratus*.

The rami of the parapodia are widely separated and the notosetae are in fan-shaped bunches extending over the dorsum. The body is quite free from mucus investment, sand, or mud. These characteristics differentiate it from *F. affinis* Sars (c.f. Monro, 1933B, p. 1056).

STYLARIOIDES INFLATA (Treadwell)

Trophonia inflata. Treadwell, 1914, p. 213.

A large number of specimens dredged in 5 to 16 fms., some in Monterey Bay. One from 20 fms. off Santa Cruz Is. All agree closely with Treadwell's description, assuming that he has mistaken the dorsal for the ventral side of the animal. This seems probable from the position he gives the hooks. The species is distinguished by the fringes of large papillae on the margins of the somites in the anterior region and the longitudinal lines of similar papillae on either side of the body. Many of the specimens have the anterior region of the body inflated in the manner described by Treadwell, but regarded by him as possibly due to preservation.

STYLARIOIDES PAPILLATA (Johnson)

Trophonia papillata, Johnson, 1901, p. 416.

Six small specimens, only one of which is accompanied by a record of its origin. This was dredged in 12 to 17 fms. off Corona Del Mar.

STYLARIOIDES PLUMOSA (O. F. Müller)

Fauvel, 1927, p. 116.

Several small specimens, most of them in poor condition. One dredged in Monterey Bay in 55 fms., the remainder off Corona Del Mar in 5 to 17 fms.

The species is differentiated from *St. papillata* by the shorter and less conspicuous setae and papillae. Otherwise, as Monro points out (1933B, p. 1059) they are not easy to distinguish.

STYLARIOIDES ERUCA (Claparède)

Fauvel, 1927, p. 119.

Trophonia capulata, Moore, 1909B, p. 284.

A number of specimens, all, except one, dredged in 5 to 17 fms. One from Santa Cruz Is. The distribution of the papillae seems to be the only character differentiating this species from *Trophonia capulata* Moore, which was described from a single specimen. The coating of sand makes it difficult to determine the exact arrangement of the papillae.

FAMILY SCALIBREGMIDAE

ONCOSCOLEX PACIFICUS (Moore)

Berkeley, 1930, p. 68.

Schleroechilus pacificus, Moore, 1909B, p. 282; Ashworth, 1915, p. 415.

Two examples of this rare and interesting species; one incomplete posteriorly. Both from Santa Cruz Is. The characters of the species and the grounds on which it is placed in the genus *Oncoscolex* have been given by one of us elsewhere (Berkeley, 1930, p. 68).

There has been some confusion in the interpretation of the genus *Oncoscolex* which Hartman (1938E, p. 14) has clarified in redefining Chamberlin's genus *Kebuita*. *Oncoscolex heterochaetus* Augener belongs to this latter genus.

As Ashworth points out the present species agrees in general with *Oncoscolex dicranochaetus* Schmarda. However, the shape of the body is not vermiform as in that species (see Schmarda, 1861, pl. 26, fig. 206), but resembles that of *Scalibregma inflatum* Rathke.

FAMILY OPHELIIDAE

OPHELIA LIMACINA (Rathke)

Fauvel, 1927, p. 132; Hartman, 1938D, p. 107.

Four specimens.

ARMANDIA BREVIS (Moore)

Ammotrypane brevis, Moore, 1906, p. 254 and 1908, p. 354; Treadwell, 1922, p. 179.

Armandia brevis, Hartman, 1938D, p. 102.

Armandia bioculata, Hartman, 1938D, p. 105.

Several specimens from Balboa beach and "off Balboa". Others from "tide-pool", Monterey Bay. They agree closely with Treadwell's modified description of *A. brevis* Moore except that in some cases prostomial eyes are more or less clearly visible; a point not mentioned by either Moore or Treadwell.

Hartman differentiates the species *A. bioculata* from *A. brevis* on this character, and on the different shape of the lateral eyes, the absence of a branchia on the last setiger, and the different type of pygidium. In a large number of specimens of *A. brevis* from B. C. waters which we have examined the lateral eyes vary considerably in size and shape in different individuals, the branchiae extend to the last setiger, but the last pair is in some cases quite vestigial, and the pygidium is as Hartman describes for *A. bioculata* and Treadwell (1922, p. 179, and fig. 37, p. 181) had already described for *A. brevis*. In the type specimen of *A. brevis* the pygidium was evidently imperfect. We regard *A. bioculata* as a synonym of *A. brevis*.

TRAVISIA GIGAS Hartman

Hartman, 1938D, p. 103.

Four specimens, the largest, collected on sandy shore, Newport Bay, is about 75 mm. long and 10 mm. wide at the widest point. The other three dredged in 12 to 17 fms.

This species has a pygidium with six long digitiform anal cirri. Three species of *Travisia* which have this character had been described earlier, *T. japonica* Fujiwara, *T. pupa* Fauvel (non Moore), and *T. chinensis* Monro (non Grube). These are very near to each other and Fauvel (1936, p. 77) considers them identical. The present species differs from all three in the form of the pygidium (in spite of its having six long cirri) and in the broad leaf-like lappets of the parapodia of the posterior region.

TRAVISIA BREVIS Moore

Moore, 1923, p. 220.

Four specimens, three of which were dredged in 55 fms. in Monterey Bay, the fourth taken "off Balboa".

POLYOPHTHALMUS PICTUS (Dujardin)

Fauvel, 1927, p. 137; Hartman, 1939B, p. 18.

Three specimens from Santa Cruz Is.

FAMILY CAPITELLIDAE

NOTOMASTUS GIGANTEUS Moore

Moore, 1906, p. 227; Fauvel, 1932, p. 194; Berkeley, E. and C., 1935, p. 772.

One specimen, from Annaheim Slough, incomplete posteriorly; a number of caudal ends of unrecorded origin. The speci-

men from Anaheim Slough is about 7 mm. wide across the thoracic region. Moore did not observe the genital pores. The present specimen has these on the first 17 abdominal segments. An example we recorded from Elkhorn Slough, California, had 13, whilst Fauvel's specimen, from Puri, India, had only 9. Presumably the number of pores which may be functional at any one time may vary.

DASYBRANCHUS CADUCUS Grube var. LUMBRICOIDES MONRO
Monro, 1933B, p. 1059.

A single example measures about 5 mm. in width and 300 mm. in length, but it is incomplete posteriorly. The notopodial uncini of the anterior abdominal segments form an almost continuous band on the dorsum, as described and figured by Monro. The abdominal crotchets are as figured by Fauvel (1927, p. 148) for the stem species.

The only significant particular in which this variety seems to differ from *D. glabrus* Moore (1909B, p. 280) is that in the latter there is no interramal break in the line of uncini in the first twelve abdominal segments.

FAMILY ARENICOLIDAE
ARENICOLA CRISTATA Stimpson

Fauvel, 1927, p. 163.

Two specimens.

FAMILY MALDANIDAE

CLYMENE (Euclymene) GROSSA Baird var. NEWPORTI var. n.

One complete example and two fragments, one anterior and the other posterior, which seem to belong together. The characters are those of the stem species except the following:

1. The edges of the twelve lappets formed by the notching of the posterior border of the cephalic plate are not finely denticulate.
2. There are two non-setigerous pre-anal segments.

Pennate, as well as limbate, setae occur in our specimens and are not described by Ehlers in *Cl. grossa* (1901, p. 190), but this was probably an oversight.

Cl. tropica Monro (1928B, p. 97) differs from the present variety in having the lappets of the posterior border of the cephalic plate separated to form coarse teeth, in having only one pre-anal segment, and in the detailed character of the uncinus. We agree with Fauvel (1939, p. 4) that *Cl. tropica* should be regarded as no more than a variety of *Cl. grossa*.

AXIOTHELLA RUBROCINCTA (Johnson) var. COMPLEXA var. n.

Two complete examples and some fragments. The variety differs from the stem species (see Johnson, 1901, p. 418) in the following particulars:

1. The cephalic plate has three or four irregularly placed lateral notches on each side of the flaring rim.
2. The nuchal organs are straight and long extending over seven-eighths of the length of the plate.
3. There is a low collar on the anterior margin of the 4th setiger.

The collar on the 4th setiger is quite definite and not to be confused with the telescoping effect often found in the stem species (c.f. Arwidsson, 1922, p. 29 and Monro, 1937, p. 310). It is best seen when the animal is fully extended.

We follow Monro in placing the species in the genus *AxiotHELLA*, basing the characterization of this genus on the presence of uncini in the anterior segments, and disregarding the presence of the collar on the 4th setiger. The characters of this variety lend support to Monro's view.

ASYCHIS DISPARIDENTATA Moore

Maldane disparidentata, Moore, 1904, p. 494 and 1923, p. 237.

Two entire specimens and two fragments, dredged in 12 to 17 fms.

FAMILY AMMOCHARIDAE

AMMOCHARES FUSIFORMIS (Delle Chiaje)

Berkeley, 1930, p. 67.

Owenia fusiformis, Fauvel, 1927, p. 203.

Ammochares occidentalis, Johnson, 1901, p. 420.

Four specimens taken "off Balboa" and one from Santa Cruz Is.

FAMILY SABELLARIIDAE

SABELLARIA CALIFORNICA Fewkes

Moore, 1909B, p. 293.

A large number of specimens, several of which are from Santa Cruz Is. Nine of the latter were dredged in 5 fms. The species is readily distinguished by the black recumbent median series of paleae which cover the inner series (Moore, pl. 9, fig. 66).

SABELLARIA CEMENTARIUM Moore

Moore, 1906, p. 248.

Three specimens, one dredged in 12 fms. off Corona Del Mar, the other two which are small, in Monterey Bay in 5 fms.

As Monro points out (1933B, p. 1064) this species is probably unique in the genus in having the paleae of the inner series stouter and more spoon-shaped than those of the middle series (see Moore, pl. 12, fig. 45).

SABELLARIA SPINULOSA Leuckart var. ALCOCKI, Gravier

Fauvel, 1927, p. 211.

A single specimen dredged in 12 fms., is certainly attributable to this variety. A second one is doubtful since the anterior end is regenerating.

FAMILY STERNASPIDAE

STERNASPIS FOSSOR Stimpson

Moore, 1908, p. 358 and 1909A, p. 144; Berkeley, 1930, p. 69.

A large number of specimens, dredged in 5 to 17 fms.

FAMILY AMPHICTENIDAE

PECTINARIA BELGICA (Pallas)

Fauvel, 1927, p. 220.

Six specimens, dredged; depth unrecorded. This is the species previously recorded by us (1935, p. 773) as *P. auricoma*. As in the former specimens examined the uncinus in these has fewer large teeth than is usually recorded for that of *P. belgica*, but it agrees in all other respects. Ehlers (1901, p. 205) records *P. belgica* from the Magellan region with uncini having 5 teeth, which is the number commonly occurring in our specimens.

FAMILY AMPHARETIDAE

AMPHARETE ARCTICA Malmgren

Malmgren, 1865, p. 364; Moore, 1908, p. 348 and 1923, p. 200; Berkeley, 1929, p. 311; Okuda, 1936B, p. 153.

A large number of specimens dredged in 8 to 17 fms. Two from Monterey Bay in 16 fms. and three from Santa Cruz Is. in 2 to 7 fms.

Genus SCHISTOCOMUS Chamberlin CHAR. EMEND.

Like *Sosanopsis* in having tentacles, in lacking postbranchial spines, in bearing fifteen pairs of fasciae of capillary setae and four pairs of branchiae. It differs from that genus in having the branchiae of two types, one pair being of the ordinary, smooth, simple, subulate form and the other three with the edges divided, two pinnately, bearing two close series of lamellar branches, and one with an essentially single series of branches in the genotype.

Genotype *S. hiltoni* Chamberlin.

SCHISTOCOMUS HILTONI Chamberlin

Chamberlin, 1919A, p. 17; Fauvel, 1932, p. 219.

Seven specimens dredged in 5 to 17 fms. One from Santa Cruz Is. collected intertidally. The genus *Schistocomus* was set up by Chamberlin for this species and defined as having no tentacles. Fauvel described a specimen from Madras of which he says "the buccal tentacles are very likely lacking". Of the eight

specimens in the present collection four show no sign of tentacles externally and, in this condition, agree exactly with Chamberlin's and Fauvel's descriptions. In the other four specimens, which agree in all other respects, tentacles are present. The degree of extension of the tentacles varies between the individuals; in one case they can only just be seen emerging from the mouth, in another the buccal membrane is fully extended and bears a large number of long and smooth tentacles. When the tentacles are thus extended the head region no longer has the truncated appearance which characterizes individuals in which they are retracted.

This observation renders necessary the above modification of the definition of the genus. The presence of tentacles brings the genus very near to *Sosanopsis* Hesse, but it is differentiated from that genus by the presence of two kinds of branchiae.

AMAGE ANOPS (Johnson)

Moore, 1923, p. 210; Berkeley, 1929, p. 310.

Sabellides anops, Johnson, 1901, p. 424.

Two specimens dredged in 12 to 17 fms. As has been previously pointed out (Johnson, 1901 and Berkeley, 1929) this species resembles *A. auricula* Malmgren very closely and it is doubtful whether the two should be regarded as separate.

AMPHICTEIS GUNNERI (Sars)

Fauvel, 1927, p. 231; Okuda, 1938, p. 101.

Two specimens, dredged in 12 to 17 fms., both without branchiae. *A. glabra* Moore (1905, p. 849) seems to be this species.

SAMYTHA BIOCULATA Moore

Moore, 1906, p. 253.

Amage bioculata, Fauvel, 1932, p. 218.

Two specimens dredged in 12 to 17 fms. Branchiae are lacking in both, but the scars indicate that they were arranged as Moore describes. Eyes could be distinguished, but only with difficulty. In one specimen most of the uncini are 6-toothed, a few 5-toothed; in the other this condition is reversed.

FAMILY TERESELLIDAE

AMPHITRITE CIRRATA (O. F. Müller)

Fauvel, 1927, p. 251.

This is a poorly preserved and incomplete specimen, only part of the thoracic region being present. It agrees in all comparable particulars. The species has been recorded previously only from more northerly latitudes and not from the west coast of N. America, but there seems little to differentiate it from *A. radiata* Moore (1905, p. 858 and 1908, p. 350) from Alaska.

TEREBELLA CALIFORNICA Moore

Moore, 1904, p. 496.

One poorly preserved specimen. Monro (1933B, p. 1072), quoting Hesse, suggests doubtfully that this form may be a *Neoleprea* since "the notopods begin on the 3rd segment (?)". However, Moore (p. 498) states that they begin on IV and this is borne out both by the present specimens and others we have examined from California.

EUPOLYMNIA CRESCENTIS Chamberlin

Chamberlin, 1919B, p. 265.

A number of specimens, dredged in 12 to 17 fms. Monro (1933B, p. 1072) suggests that this species is synonymous with *E. nebulosa* (Montagu). Hartman (1938E, p. 17) regards Chamberlin's species as valid and has summarized the main points of difference between the two. Examination of the present specimens confirms her findings.

PISTA CRISTATA (O. F. Müller)

Fauvel, 1927, p. 266.

Four specimens. One taken "off Balboa" (depth unrecorded), two off Corona Del Mar in 12 to 17 fms., and one in Monterey Bay in 55 fms. The species has been recorded from Alaska, British Columbia and Washington, but, apparently, not farther south on the west coast of N. America.

PISTA ALATA Moore

Moore, 1909B, p. 273; Monro, 1933B, p. 1066.

Thirteen typical specimens. The majority are in tubes constructed of fine sandy mud, but in one case the tube is coated with shelly material.

PISTA FRATRELLA Chamberlin

Chamberlin, 1919A, p. 18.

Four poorly preserved specimens. Two dredged in Monterey Bay in 50 to 60 fms.; the others from "holdfast of kelp" (origin unrecorded).

THELEPUS SETOSUS (Quatrefages)

Fauvel, 1927, p. 273; Berkeley, E. & C., 1939, p. 342.

Two specimens, one of them from Santa Cruz Is. The specimen from Newport Bay had *Lepidametria gigas* (Johnson) with it as commensal.

In our 1939 paper we expressed the opinion that *Th.setosus* (Qfges) was identical with *Th.crispus* Johnson. More recently we have examined some specimens of the latter species and have satisfied ourselves that this opinion is erroneous. The differences are discussed in a paper on the polychaeta of Western Vancouver Island and the Queen Charlotte Islands now in preparation.

TEREBELLIDES STROEMI Sars

Fauvel, 1927, p. 291.

Four specimens, dredged in 5 to 17 fms. The average length of the specimens is about 35 mm.

LOIMIA MONTAGUI (Grube)

Marenzeller, 1884, p. 205; McIntosh, 1922, p. 147;
Berkeley, E. & C., 1935, p. 773.

Two small, badly preserved specimens. Most of the thoracic uncini are 5-fanged, some 6-fanged. The uncinus has no pronounced sub-rostral tooth. A note with one of the specimens records that *Parapinnixia affinis* was found with it as commensal. The other had a specimen of *Arctonoe pulchra* (Johnson) put up with it, which, presumably, was also a commensal. This is an unusual association.

STREBLOSOMA BAIRDI (Malmgren)

Fauvel, 1927, p. 275.

Thirteen specimens, three of which are from Santa Cruz Is. Seven of the specimens are only 5 to 10 mm. long and not more than 1 mm. wide. We regard these as young forms of *S. bairdi* rather than mature individuals of *S. crassibranchia* Treadwell (1914, p. 208), which is a small form and is recorded from the collection of the University of California with locality of origin indicated as uncertain, because of the forms of the capillaries and uncini.

One of the larger specimens is in its tube, which is very fragile, heavily whorled, and incrustated with fine particles of micaceous sand. A single example of this species has been recorded from Friday Harbour, Washington (Weese, 1932); except this we know of no previous record from the N. E. Pacific area.

FAMILY SABELLIDAE

DEMONAX LEUCASPIS Kinberg

Monro, 1933B, p. 1075 (*with synonymy*).

Two small specimens from Santa Cruz Is. This is the form recorded from Alaska (Bush, 1904, p. 200) and from the Nanaimo region (Berkeley, 1930, p. 70) as *Parasabella media* Bush. It is characterized by the broadly lanceolate setae which accompany the bladed capillaries in the thoracic notopodium.

PSEUDOPOTAMILLA OCCELATA Moore

Moore, 1905, p. 559; Hartman, 1938E, p. 26 (*with synonymy*).

A number of specimens some of which are very small. All from Santa Cruz Is.

BRANCHIOMMA MUSHAENSIS Gravier

Monro, 1933B, p. 1078 (*with synonymy*).

A single specimen from rocky shore, La Jolla. The tube is incrustated with coarse shelly sand.

BRANCHIOMMA BURRARDUM Berkeley

Berkeley, 1930, p. 71.

Two small, but typical, specimens dredged in 50 to 60 fms. in Monterey Bay. Both have the spatulate thoracic setae which characterize the younger forms of this species.

Monro suggests (1933B, p. 1078) that this species and *B. bioculatum* Ehlers may be synonymous, but, judging by Ehler's (1887, p. 260) description of the latter, there are differences in the number and character of the eyes, in the shape of the collar lobes, and in that of the thoracic uncini.

We are unable to follow the suggestion of synonymy of the present species with *Pseudopotamilla splendida* Moore which is made by Hartman (1938E, p. 27) since the latter species has no eyes.

BRANCHIOMMA ROULEI Gravier

Gravier, 1909, p. 655.

Two specimens; one from "holdfast of seaweed", the other dredged in 12 to 17 fms.

MYXICOLA AESTHETICA (Claparède)

Fauvel, 1927, p. 344.

Two specimens dredged in Monterey Bay in 5 fms.

MYXICOLA INFUNDIBULUM (Rénier)

Fauvel, 1927, p. 342.

Myxicola pacifica Johnson, 1901, p. 431.

Myxicola monacis Chamberlin, 1919A, p. 20.

Three specimens, 50 mm., 70 mm., and 85 mm. long respectively. The points of differentiation between *M. monacis* and *M. pacifica* described by Chamberlin seem to come within the limits of variation. Both agree with *M. infundibulum*. Hartman (1938E, p. 19) confirms this.

CHONE INFUNDIBULIFORMIS Kröyer

Fauvel, 1927, p. 334.

A single small specimen. We recorded this species from Elkhorn Slough, California (1935, p. 774). This was the first record from the west coast of N. America. It has been found since in the Nanaimo region.

FAMILY SERPULIDAE

SERPULA VERMICULARIS Linné

Fauvel, 1927, p. 351.

Serpula columbiana, Johnson, 1901, p. 432.

A single specimen from Santa Cruz Is.

HYDROIDES NORVEGICA (Gunnerus)

Fauvel, 1927, p. 356; Rioja, 1925, p. 83.

A few almost straight tubes from "piling at Newport Bay". From these we were able to extract one complete and one incomplete animal. The complete specimen agrees closely with the descriptions of this species given by Fauvel and Rioja.

HYDROIDES UNCINATA (Philippi)

Fauvel, 1927, p. 357.

A single example from "holdfast of seaweed".

SALMACINA DYSTERI (Huxley) var. TRIBRANCHIATA (Moore)

Monro, 1933B, p. 1090.

Filograna tribranchiata, Moore, 1923, p. 250.

Several tube masses from Corona Del Mar, Monterey Bay, and Santa Cruz Is. Some dredged in 5 to 17 fms. Most of the tubes were empty, but a few animals extracted from material from each locality have the distinctive character Moore described.

APOMATUS TIMSII Pixell

Pixell, 1912, p. 787.

A single specimen dredged in 50 to 60 fms. in Monterey Bay. *A. ampulliferus* Philippi seems to differ from this species only in the more anterior incidence of the thoracic bladed sickle setae characteristic of the genus.

PROTULA TUBULARIA (Montagu)

Fauvel, 1927, p. 382.

A single specimen taken from the gravity tank of the salt water system of the laboratory at Corona Del Mar. Monro (1933B, p. 1088) records a variety *balboensis* of this species from Panama which differs very little from the stem species. Excepting this, the species has not been recorded from the N. E. Pacific, but there are two records of it from Japan (Fauvel, 1936, p. 89 and Okuda, 1938, p. 104), in both cases from aquarium tanks.

SPIROBRANCHUS SPINOSUS Moore

Moore, 1923, p. 248.

Sixteen specimens, eleven of which are from Santa Cruz Is. The operculum is as described by Moore except that, in the case of some of the specimens from Santa Cruz Is., the armature is more complex, consisting of four long compound spines and two short spiny bosses. There are two kinds of collar setae, characteristic bayonet-shaped ones and the small tapering spines described by Moore. The former type were doubtless lost from his specimen. Monro (1933B, p. 1080) surmises this to have been the case and suggests that *S. spinosus* is identical with *S. giganteus* Pallas, a widely distributed species of warmer seas. This

would seem probable but that no specimen of *S. spinosus* is yet known which approaches the size of *S. giganteus*. The latter is said to reach a length of some 80 mm. Moore's specimen of *S. spinosus* was 23 mm. long and the largest in this collection is between 25 and 30 mm.

CRUCIGERA WEBSTERI Benedict

Benedict, 1886, p. 550.

One specimen from "boat bottom," Newport Bay. Monro (1933B, p. 1079) suggests that *C. zygophera* Johnson may be a synonym of this species. We do not think this is the case. We have examined many specimens of *C. zygophera* and find that the number of radii of the operculum, though variable, never exceeds 30. In the present species there are, according to Benedict, about 50, and this is approximately the number in our specimen. The projections on the stem of the operculum are entirely different in the two species. In *C. zygophera* there are three, two long and equal ones projecting laterally and a third on the opposite side of the stem which is little more than a boss and may be concave. In *C. websteri* there are four, all of about equal length and all projecting laterally forming a symmetrical cross, as figured by Benedict (Pl. 21, fig. 24). Finally, the tubes differ materially. That of *C. zygophera* varies from an almost smooth condition to an angulated one of more or less complexity, but there are never definite serrated ridges such as characterize that of *C. websteri*.

SPIROBIS MARIONI Caullery and Mesnil

Caullery and Mesnil, 1897, p. 199.

Several specimens from an aquarium tank at the laboratory, Corona Del Mar. Agreement with this species is good except that the operculum is somewhat simpler than it is represented in Caullery and Mesnil's figure. This shows a rather heavy central column, which is represented in our specimens by only a low boss.

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DESCRIPTION OF FIGURES

- Figs. 1 to 3. *Sthenelanelia atypica* sp. n. Neurosetae from 2nd setiger.
 Fig. 4. *Loandalia fauveli* sp. n. Anterior region.
 Fig. 5. *Loandalia fauveli* sp. n. Eighth setiger.
 Fig. 6. *Loandalia fauveli* sp. n. Notopodium of posterior region.
 Fig. 7. *Aricia macginitii* sp. n. Subuluncinus.
 Fig. 8. *Aricia macginitii* sp. n. Crotchet.
 Fig. 9. *Aricia macginitii* sp. n. Spine.
 Fig. 10. *Aricia macginitii* sp. n. Pygidium.
 Fig. 11. *Nerinides acuta* (Treadwell). Base of tentacle.
 Fig. 12. *Nerinides acuta* (Treadwell). Posterior parapodium.
 Fig. 13. *Nerinides acuta* (Treadwell). Ventral crotchet.
 Fig. 14. *Nerinides acuta* (Treadwell). Pygidium.
 Fig. 15. *Mesochaetopterus rickettsii* sp. n. Anterior portion of median
 region.
 Fig. 16. *Mesochaetopterus rickettsii* sp. n. Tip of notopodial capillary
 from posterior region.
 Fig. 17. *Tharyx* sp.? Long ventral seta from anterior region.
 Fig. 18. *Tharyx* sp.? Ventral seta from posterior region.

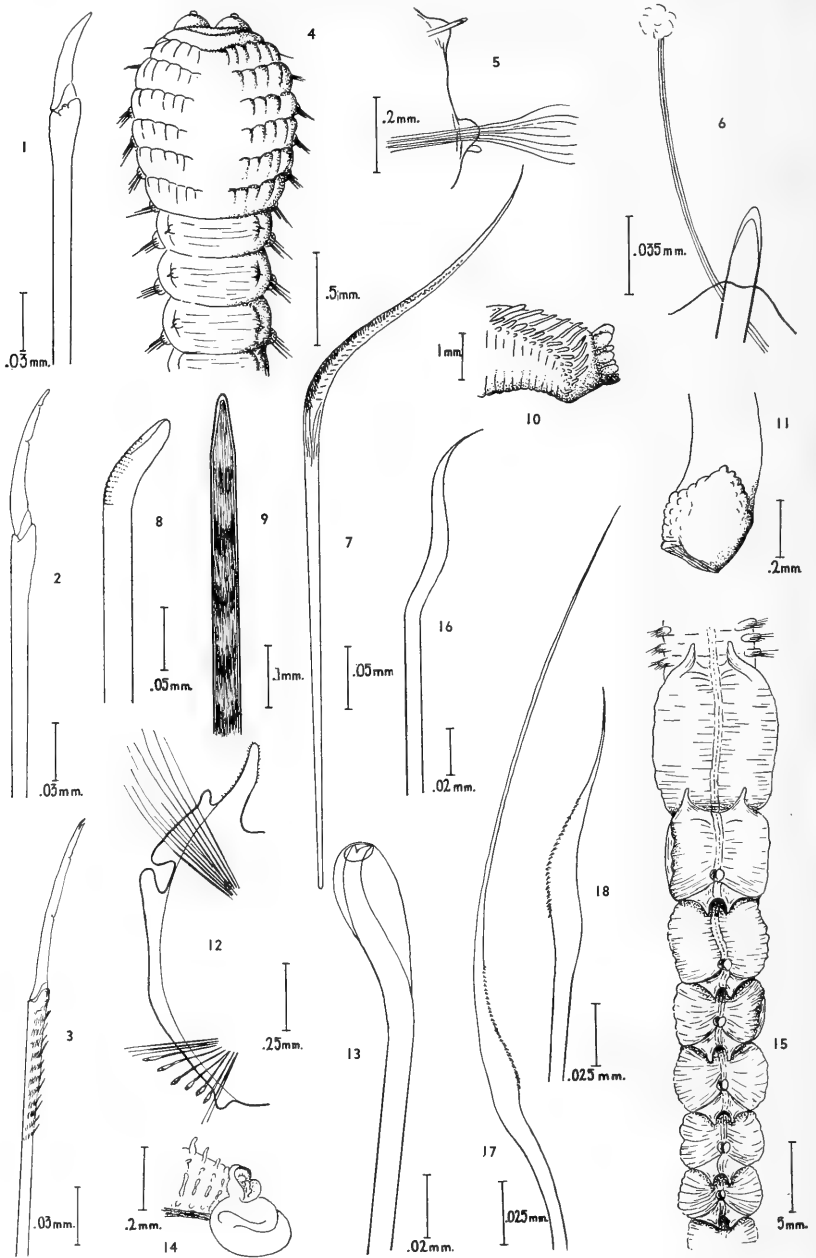


PLATE 5

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Part 2

CONTENTS

Page

A LIST OF THE ANTS OF CALIFORNIA WITH NOTES ON
THEIR HABITS AND DISTRIBUTION—Arnold Mallis 61

CONTRIBUTIONS FROM THE LOS ANGELES MUSEUM -
CHANNEL ISLANDS BIOLOGICAL SURVEY:

20. THREE NEW FLEAS—G. F. Augustson 101

21. NEW PLANTS FROM THE CHANNEL ISLANDS—M. B. Dunkle 108

THE LARVA OF POLITES MANATAAQUA—V. G. Dethier 109

LIFE HISTORY OF RAPHIA CINDERELLA (LEPIDOPT.)

—John A. Comstock 111

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A LIST OF THE ANTS OF CALIFORNIA WITH NOTES
ON THEIR HABITS AND DISTRIBUTION

By ARNOLD MALLIS

INTRODUCTION

California, within her ample borders, contains areas of the greatest topographic and climatic diversity. Her seashores, her deserts, her mountains, her valleys, all support a fauna and flora that have been a constant source of joy to those individuals who delight in an abundant Nature. Ants, ever six-legged children of opportunity, respond to this diversity with an abundance of individuals and a profusion of forms.

It is to the foremost "ant-man" of our time, the late Dr. William Morton Wheeler, that we must acknowledge a debt of gratitude for much of our information on the ants of California. Although Dr. Wheeler was extremely interested in the California *Formicidae*, as evidenced by the number of his visits to this state, he naturally could devote his talents to but restricted areas, and thus, there are still great expanses where not a stone has been upturned or a nest excavated by that bipedal anteater, the myrmecologist.

Others, such as G. Mayr, T. Pergande, C. Emery, A. Forel, W. M. Mann, C. W. Woodworth, P. Leonard, M. R. Smith, W. S. Creighton, A. C. Cole, Jr. and the author, have concerned themselves with the ants in California to a lesser or greater degree. Yet, despite the efforts of all these, the lacunae in our knowledge of the California *Formicidae* are amazingly wide and abysmally deep.

In the pages to come, the writer proposes to summarize the available information on the ants of California, and wherever possible, to enlarge these contributions with his own observations. Where there is but one locality record for an ant in California, with the exception of the type localities, it would appear advisable to question the presence of this ant in California until further verification.

Invaluable aid was given to the author in the preparation of this annotated list by the eminent ant authority, Dr. M. R. Smith. The writer is also greatly indebted to Prof. E. O. Essig for constantly encouraging him in his studies on the ants. Drs. W. S. Creighton and A. C. Cole, Jr., kindly classified a number of the ants. Mr. J. Schwartz, who accompanied the author on his many collecting trips, as well as numerous other individuals recorded in the following pages, all rendered valuable service by the collections that they made.

NOTES ON THE ANTS

FAMILY FORMICIDAE

Subfamily DORYLINAE

Genus *Eciton* Latreille

Eciton (*Acamatus*) *californicum* Mayr

The nomadic army or legionary ants are for the greater part collected in the vicinity of Sacramento and the San Francisco Bay District. They are most active during the night when they prey upon insects gathered about lights. The writer has observed them to invade and pillage the nests of *Tetramorium caespitum* (L.). In rare instances they have been known to enter homes in Sacramento. For more extensive notes on the habits of this species, see Mallis (1938b.).

Localities: Palo Alto (H. Heath), Sacramento (Sewell), Davis (A. Mallis).

Eciton (A.) *leonardi* Wheeler

Three workers were taken by P. Leonard on Point Loma, near San Diego. This is the type locality.

Eciton (A.) *minus* Cresson

The winged males are often collected around lights in Southern California on warm summer evenings.

Localities: Alhambra (A. Mallis and J. Schwartz), Monrovia (J. Schwartz).

Eciton (A.) *opacithorax* Emery

Locality: Las Cruces Mts. (H. Heath).

Eciton (A.) *sumichrasti* Norton

Our only information on the occurrence of this ant in California is the statement by P. Leonard (1911) that the workers of this species raided a nest of *Myrmecocystus mexicanus mojave* Wheeler in Point Loma, near San Diego. A later notation cites the fact that his ants were classified by Wheeler.

Subfamily PONERINAE

Genus *Stigmatomma* Roger

Stigmatomma pallipes oregonense Wheeler

This ant, in the two instances that it was collected, was found beneath stones in moist and shaded situations. The two collections resulted in the capture of only 3 ants.

Localities: Napa Co. (A. Mallis), Berkeley Campus (J. MacSwain).

Genus *Ponera* Latreille

Ponera ergatandria Forel

J. Schwartz and the author collected this ponerine species under two rocks near Devil's Gate Dam, Pasadena. The soil was very moist, and the rocks were situated where much leaf mold had accumulated. Although the ground beneath the rocks was dug up, the nest was not found.

Ponera trigona var. *opacior* Forel

The author found this ant around the foundations of two homes in Bakersfield. In one case it was present in the moist soil beneath leaf mold that had accumulated near the foundation. The ants made small openings, about the size of a pinhead, in the ground. When these were excavated, the nest was not found, but 7 workers were collected.

Localities: Weed (A. C. Cole, Jr.), Bakersfield (A. Mallis).

Subfamily PSEUDOMYRMINAE

Genus *Pseudomyrma* Guérin

Pseudomyrma pallida (F. Smith)

E. P. Van Duzee collected this ant by beating willow.

Localities: Potholes, Imperial Co. (E. P. Van Duzee), Ukiah (F. H. Wymore), San Diego Co.

Subfamily MYRMICINAE

Genus *Pogonomyrmex* Mayr

Pogonomyrmex (*P.*) *barbatus* var. *nigrescens* Wheeler

J. Schwartz and the author found a nest of this variety in an unshaded area near a cultivated field some 10 miles south of Riverside. Within a radius of 18 in. there were 5 entrances, each about $\frac{1}{2}$ in. in diameter. There were no craters around any of the entrances. The ants were rather mild compared to some other species in the genus. *Thysanura* were found running in and out of the entrance.

Pogonomyrmex (*P.*) *barbatus curvispinosus* Cole.

This subspecies was collected in Riverside by A. C. Cole, Jr.

Pogonomyrmex (*P.*) *barbatus rugosus* Emery

Cole (1934) notes that the external evidence of the nests of this subspecies is merely a flat disc of gravel or sand, around which the ants clear the vegetation.

Type Locality: San Jacinto (T. Pergande).

Localities: Riverside (H. J. Quayle), Elsinore (C. F. Baker), Lakeside, Palm Springs, Jacumba (Wheeler), Needles (F. M. Carpenter), Victorville (E. C. Jaeger), San Diego (J. D. S.), Point Loma (P. Leonard), Perris (J. C. Bradley), Goffs (Cockerell).

Pogonomyrmex (*P.*) *californicus* (Buckley)

This is the ant whose sting is so respected by the inhabitants of Southern California. It constructs nests of low flat craters

some 6 in. across, or simple holes in the ground, and are usually found in dry arid country. The workers are very pugnacious, especially on hot days, and when disturbed near the nest. Cole (1932b) observed them harvesting seeds in the Mojave Desert in the early morning and late evening hours. They will also work at night. During the midday the nest will be closed with sand or pebbles and the ants will be found in shallow chambers from one to several feet beneath the surface of the soil. The dealated queens are often seen running about on the soil in July.

Localities: Lakeside, Claremont, Arroyo Seco, Pasadena, Needles, Coyote Wells, Saugas, Laguna Beach, Jacumba (Wheeler), San Jacinto (Pergande), Point Loma (P. Leonard), Upland, Lompoc, Mission, San Diego (J. C. Bradley), San Pedro (Cockerell), Altamont (McLane), Long Beach (H. Andrews), Mojave (Cole), Carbon Canyon (J. Schwartz), Borego Valley (J. Rayner), Los Angeles (A. Mallis), San Gabriel Canyon, Big Tujunga Canyon, Newhall, Alhambra (A. Mallis), Sierra Valley.

Pogonomyrmex (P.) californicus var. *hindleyi* Forel

Type Locality: Escondido (E. Hindley).

Locality: Elsinore (Craft).

Pogonomyrmex (P.) californicus estebanius Pergande

This beautiful ant with the blackish abdomen was found conveying seeds to a nest situated at the base of a shrub. There was no mound, and the sand was piled several inches from the nest opening which was irregular in shape and $\frac{1}{2}$ in. in diameter. The nest was located in the sandy soil of an open, arid country. Cole (1934) noted that brood and seed chambers were often interspersed throughout the mounds, and that the winged forms, particularly the males were found in a nest during July.

Localities: Mojave, Needles, Palm Springs, Hidden Springs Canyon, Little San Bernardino Mts. (Wheeler), Victorville (Jaeger), Otis, Mojave Desert, Perris, Indio (J. C. Bradley), El Centro (Cornell Expedition), Big Bear Lake (G. Ferguson), Ludlow (A. C. Cole, Jr.), Sherwin Hill, near Bishop (R. M. Bohart), near Palmdale (A. Mallis and J. Schwartz), Coachella Valley.

Pogonomyrmex (P.) californicus longinodis Emery

T. Pergande collected the types in the Colorado Desert of California.

Pogonomyrmex (P.) californicus maricopa Wheeler

Localities: Needles (Wheeler), Brawley (J. C. Bradley), El Centro (Cornell Univ. Exped.).

Pogonomyrmex (P.) desertorum Wheeler

Cole (1934) observed a colony in the sandy soil along the Colorado River, near Needles, Calif.

Pogonomyrmex (P.) huachucanus Wheeler

A nest of this species was found by Cole (1934) in the

Mojave Desert near Needles. He observed that the nest consisted of a minute crater mound in the sand, and that the colony was small and the workers were sluggish.

Pogonomyrmex (P.) occidentalis Cresson

Locality: Weed (A. C. Cole, Jr.).

Pogonomyrmex (P.) salinus Olsen

Soda Springs, Bridgeport, is the type locality for this species, and the ant was collected by E. C. Jaeger.

Pogonomyrmex (P.) subdentatus Mayr

The author observed this ant in Davis. The queens were most abundant during February, March, April, and October when they were seen excavating nests in the soil. The nests are mere holes in the ground without any craters. Apparently the colonies are not as populous as some of our other forms. Although the queens may be found in great numbers at certain times of the year, the number of colonies are very few due to the depredations of the Argentine ant. The females are often seen walking around in a very curious manner with their abdomens curled far beneath them. The workers are not very aggressive, and harvest seeds from the neighboring weeds. They will at times sink their mandibles into a leaf, shake it, and thus force the nearby seeds to fall earthwards. On one occasion they were observed to be quite active during noon hour of a cold day in November.

Localities: San Jacinto (H. Heath), Pacific Grove (J. C. Bradley), Palo Alto (W. M. Mann), Davis (T. W. Cook), Laguna Beach (Wheeler), Mojave, Tehachapi (A. C. Cole, Jr.), Grant (Silvestri), Long Beach (H. Andrews), Davis (A. Mallis).

Pogonomyrmex (P.) subnitidus Emery

Cole (1934) found a small mound on a gently-sloping hillside in the Mojave Desert.

Type Locality: San Diego Co. (T. Pergande).

Localities: Mt. Lowe, Arroyo Seco near Altadena, Tejon Pass, Del Mar, Warren's in San Diego Co. (Wheeler), Los Gatos Canyon, Diablo Range (J. C. Bradley), La Jolla (C. T. Brues), Mojave Desert (A. C. Cole, Jr.).

Genus MYRMICA Latreille

Myrmica (M.) bradleyi Wheeler

The writer found the craters of this ant in Yosemite Valley. The perfectly shaped mounds which are about $\frac{1}{2}$ in. in height were situated in unshaded, sandy soil. This species is also known to nest beneath rocks. As a whole, it appears to be a slow-moving ant that is easily collected.

Type Locality: Alta meadows, in Tulare Co. (J. C. Bradley).

Localities: Glacier Point in Yosemite, 8000 feet, and Tallac near Lake Tahoe, 6000 feet, (Wheeler), Yosemite Valley, Bass Lake in Madera Co. (A. Mallis).

Myrmica (M.) brevinodis var. *sulcinodoides* Emery

Localities: Lake Tahoe, 6000 feet (Wheeler), Sisson (Silvestri).

Myrmica (M.) parasitica Creighton

Creighton (1934) collected the types on Polly Dome, 8600 feet, on the Tioga Pass Road in Yosemite National Park. The nest was found in a gravel pocket, and the following notes are his: "When first discovered only five *parasitica* workers were taken since, at that time, the author had nothing with which to excavate the nest. These five workers together with a number of workers of the host, *bradleyi*, were taken back to camp alive and the relations between the two species observed. These were to every appearance perfectly normal, the *parasitica* workers taking their share of the activities and being treated as ordinary nest mates by the *bradleyi* workers". "As the matter stands it is impossible to state with certainty whether the new species is a slave maker or a temporary social parasite."

Myrmica (M.) scabrinodis schencki var. *tahoensis* Wheeler.

Wheeler (1917a.) collected the types at Lake Tahoe (Tallac, Angora Lake, Glen Alpine Springs, Fallen Leaf Lake). He observed that the colonies were small and that they are to be found under stones in shady places.

Genus STENAMMA Westwood

Stenamma brevicorne diecki Emery

Locality: Pacific Grove (H. Heath).

Stenamma brevicorne heathi Wheeler

Wheeler (1915) described the types from a single colony collected in King's River Canyon by H. Heath. He believes that this form may possibly rank as a distinct species when the winged forms are collected.

Stenamma brevicorne sequoiarum Wheeler

H. Heath who collected the types of this subspecies found them nesting under stones among the large redwood trees in Muir Woods.

Stenamma nearcticum Mayr

There is no information concerning this ant other than the type locality, which is California.

Genus APHAENOGASTER Mayr

Aphaenogaster (A.) patruelis bakeri Wheeler

Wheeler (1904) described this subspecies from the workers of two colonies collected by C. F. Baker on Catalina Island in the spring of 1904.

Aphaenogaster (A.) patruelis willowsi Wheeler

Wheeler (1934a) described this subspecies from ants collected on San Nicolas Island, one of the Santa Barbara Islands off California. M. Willows was the collector.

Aphaenogaster (A.) subterranea occidentalis Emery

This subspecies is widely distributed throughout the State from sea level to 6000 feet, and was found by the author at an altitude of 3000 feet at Bass Lake, Madera Co., beneath pine needles. The ants were slow, and when disturbed, hid in crevices.

Localities: Pacific Grove, Mt. Tamalpais, Yosemite, Lake Tahoe (Wheeler), Palo Alto, King's River Canyon (H. Heath), Corte Madera Creek, Santa Cruz Mts. (W. M. Mann), Yuba City (T. D. Urbahms), Colusa (A. Mallis), Mountain View.

Genus NOVOMESSOR Emery

Novomessor cockerelli (Ern. Andre)

Cole (1934) states that they are common in the deserts near Barstow, Ludlow, and Tehachapi where they construct large, rude, crater nests of pebbles with a single, large, irregular nest entrance.

Genus VEROMESSOR Forel

Veromessor andrei (Mayr)

Veromessor andrei (Mayr) ranges from the extreme north of California to as far south as San Diego, and usually in less arid country than *V. pergandei* (Mayr). As a rule it constructs no craters, although crater mounds may be found near Bakersfield, Calif. J. Schwartz and the author observed this species emerging in enormous numbers from a nest situated between the crevices of a boulder well-imbedded in the ground. This boulder was located in rocky, hilly country. The workers of *andrei* do not approach the pronounced polymorphism found in *pergandei*. These ants forage in long, often winding files, and gather seeds which they store in their nests. A ring of chaff often surrounds their nest entrance. Mann (1911b) found the ant cricket, *Myrmecophila oregonensis* Bruner, and the Scarabs *Cremastochilus pilisicollis* Horn and *Cremastochilus schaumii* Lec. as their guests.

Type Locality: California.

Localities: Antelope in Sacramento Valley (C. D. Cook), Berkeley, La Jolla, San Ysidro, Tejon Pass (Wheeler), Claremont (C. F. Baker), Edendale, Perris, Ramona, Whittier (J. C. Bradley), Eldridge (J. A. Kusche), Laguna Beach (E. O. Essig), Palo Alto (H. Heath and I. McCracken), Point Loma, San Diego (Wheeler), Riverside (H. J. Quayle), Santa Catalina Island (C. F. Baker), Weaverville (W. S. Creighton), Sacramento, Tehachapi, Bakersfield, Sequoia Nat'l Park (A. C. Cole, Jr.), Brentwood (A. Mallis), Pico Canyon near Newhall, Carbon Canyon in Orange Co. (A. Mallis and J. Schwartz), Descanso, Santa Isabel, San Jacinto.

Veromessor andrei castaneus Wheeler and Creighton

Wheeler (1934) collected a large series of workers at Jacumba, and San Diego, in Southern California, which are the type localities.

Veromessor andrei flavus Wheeler and Creighton

The types were collected by Wheeler (1934) at Jacumba in Southern California.

Veromessor chamberlini (Wheeler)

Wheeler (1915) described this species from 18 workers collected by R. V. Chamberlin on Santa Cruz Island, off the coast of California.

Veromessor pergandei (Mayr)

The beauty of this jet-black, patent-leather-colored ant when active in the field, will always arouse the admiration of the collector. The workers vary greatly in size, and form crater-like nests with one or several large oblong or oval openings in very arid, and often adobe-like soil. These nests are often, but not always, surrounded by a ring of chaff, and Wheeler (1934) has found them to extend to a depth of 2 feet. The ants move swiftly and are active during the hottest time of the day in regions where the summer temperatures may go as high as 130° F. While they move in long files, they may be observed collecting seeds from the desert shrubs. In the field they will often run into some species of *Pogonomyrex*, and the contact does not reveal the slightest hostility on the part of either ant. Apparently they are better adapted for dry-arid conditions than *V. andrei* (Mayr) as is evidenced by their desert distribution. The author has on occasions observed a small *Tenebrionid* emerging from the nest of this insect.

Type Locality: California.

Localities: Mojave (J. C. Bradley and A. Wetmore), Apple Valley (E. C. Jaeger), Santa Barbara (F. E. Clements), Palm Springs, Needles, Lakeside, Claremont, (W. M. Wheeler), Coachella Valley (S. F. Light), Elsinore (C. F. Baker), Otis, Perris (J. C. Bradley), Victorville (W. S. Creighton), Fresno (C. W. Woodworth), Corona (F. Platt), Borego Valley in Little Colorado Desert (J. Rayner), Barstow, Ludlow (A. C. Cole, Jr.), Bakersfield (A. Mallis), Palm Canyon (A. Mallis and J. Schwartz), Salton Sea, San Jacinto, Moore Canyon, Menifee, San Diego Co. (No Collector).

Veromessor stoddardi (Emery)

Type Locality: San Diego Co. (Pergande).

Locality: Jacumba near Mexican border (W. M. Wheeler).

Genus PHEIDOLE Westwood

Pheidole (*Ph.*) *barbata* Wheeler

Wheeler (1908a) described this species from a single soldier and several workers that he collected from a small crater nest on the Mojave desert near Needles.

Pheidole (*Ph.*) *californica* Mayr

The tiny workers and the soldiers with their comparatively huge heads are frequently found in California. They nest under stones, boards, in oak galls, and are known to form small craters

in the sandy soil. Cole (1934) notes that this ant is a true harvester for he found seeds stored in the nest, and chaff around the crater peripheries. Mann (1911b) observed that *Solenopsis molesta* (probably var. *validiuscula* Emery) shares the nest with this ant. A Staphylinid guest, *Conosoma heathi* Wasmann also occurs here.

Type Locality: San Francisco.

Localities: Palo Alto (H. Heath, W. M. Mann, W. M. Wheeler), Brookdale, Santa Cruz Island (R. V. Chamberlin), Needles (A. C. Cole, Jr.), Devil's Gate Dam, Pasadena (A. Mallis, J. Schwartz, H. Taylor), Griffith Park in Los Angeles (A. Mallis and H. Taylor), Ukiah in Mendocino Co. (No Collector).

Pheidole (Ph.) californica var. *incenata* Wheeler

H. Heath collected the types (soldiers and workers) at Palo Alto, Calif.

Pheidole (Ph.) californica var. *satura* Wheeler

Wheeler (1915) described this variety from workers and soldiers collected on Santa Cruz Island, California, by R. V. Chamberlin, and at Palo Alto, California, by H. Heath.

Pheidole (Ph.) californica oregonica Emery

Cole (1934) found a small colony of these ants nesting under a flat rock near Weed, California.

Pheidole (Ph.) grallipes Wheeler

J. Schwartz and the author found a nest at the very base of a shrub on a sandy arid slope in Mint Canyon. The entrance to the nest was an irregular opening about 1 in. by 1½ in. in diameter, and somewhat hidden by the branches of the shrub. Upon disturbing the nest, the workers commenced to appear, but they made no attempt to sting. Later, two soldiers were captured. The nest was so situated that the excavated earth sloped downwards several inches from the entrance. Pergande described the above species as *Ph. susannae* race *longipes*, which name Wheeler found to be preoccupied.

Localities: La Jolla (H. Andrews), San Jacinto (Emery), Lakeside (Wheeler), Mint Canyon in Los Angeles Co. (A. Mallis and J. Schwartz).

Pheidole (Ph.) hyatti Emery

Pheidole hyatti Emery, commonly known as the "big-headed" ants, are often a pest in Southern California, and in the Sacramento and San Joaquin Valleys. They invade the kitchens, and are usually found foraging around the sink. *Solenopsis xyloni maniosa* Wheeler, when present, may drive *hyatti* from the vicinity and then invade the house in their stead. The big-headed ants nest under the siding and in and around cracks in the concrete steps. Out in the field they are very commonly found nesting under rocks, and may form crater nests about the roots of

chaparral. *Terapus infernalis* (Fall), a Histerid, is often found as a guest in the nests of this ant.

Localities: San Jacinto (Pergande), Catalina Island (C. F. Baker), Livermore (G. Ferguson), Griffith Park in Los Angeles, E. Bakersfield (A. Mallis), Devil's Gate Dam, Pasadena (A. Mallis and J. Schwartz).

Pheidole (*Ph.*) *hyatti solitanea* Wheeler

Wheeler (1915) described this subspecies from some workers and soldiers that he collected on Point Loma, near San Diego, and from a soldier and three females collected in the same locality by P. Leonard. The writer collected the workers in Griffith Park in Los Angeles.

Pheidole (*Ph.*) *xerophila pacifica* Wheeler

The habits of this ant are known only from Wheeler's (1915) notes which are presented here: "Described from numerous specimens of all four phases taken at Pasadena and Lakeside, Southern California, during late November, 1910. The colonies were found on dry, unshaded hills in small crater nests, the periphery of which was often covered with the discarded chaff and seed, proving that the species is a harvester. Only a few soldiers were found in each nest. The presence of males and winged females in late November shows that these phases are probably retained in the nests throughout the winter as in *Prenolepis imparis*, *Camponotus americanus* etc., and that the nuptial flight as in these ants probably occurs in the very early spring."

Type Locality: Pasadena and Lakeside (Wheeler).

GENUS CREMATOGASTER LUND

Crematogaster (*Atopogyne*) *lineolata laeviuscula* var. *californica*
Emery

J. Schwartz and the author found enormous numbers of this ant clinging in a cluster to the underside of a stone in a rather rocky area. Another colony was located beneath the bark of a recently-felled poplar in Bakersfield during the month of December. Many of the ants appeared to be incapacitated by the cold and some of the ants were evidently dead. One live male was collected. The workers were seen emerging from the tunnels made by Cerambycid larvae. There were a number of living bark beetles and many dead workers of *Solenopsis xyloni* var. *maniosa* Wheeler under the bark of the same tree trunk.

Type Locality: Encinitas and Los Angeles (Pergande).

Localities: Auburn (L. S. Jones), Pacific Grove (W. M. Mann), Bakersfield (A. Mallis), Big Dalton Canyon near Glendora (A. Mallis and J. Schwartz).

Crematogaster (*A.*) *lineolata laeviuscula* var. *clara* Mayr

Locality: Laguna Beach (E. O. Essig).

Crematogaster (*A.*) *lineolata coarctata* Mayr

The author discovered a nest of this species beneath a rock

in Griffith Park, Los Angeles, during the month of December. But one main entrance hole was visible. The ants clung to the underside of the stone in one huge cluster. When separated, the ants were sluggish; this was undoubtedly due to the cool weather that prevailed at this time. J. Schwartz and the author collected another colony of these ants beneath a boulder in Eaton's Canyon, and this time there were five entrance openings into the soil. Each of these entrances were approximately $\frac{3}{8}$ in. in diameter. Two winged males, two myrmecophilous weevils, and one ant cricket were found in the nest with these ants.

Localities: Palo Alto (W. M. Mann), Oakland Hills (E. C. Van Dyke), Berkeley, Muir Woods, Napa Valley, Griffith Park in Los Angeles (A. Mallis), Eaton's Canyon in Altadena (A. Mallis and J. Schwartz).

Crematogaster (A.) vermiculata Emery

Type Locality: Los Angeles (Pergande).

Genus *Monomorium* Mayr

Monomorium (M.) minimum (Buckley)

In all probability, this tiny black ant was much more prominent until the advent of the Argentine ant. In California it is not very commonly found to invade homes as it does in the East. Essig (1926) states that they construct nests with small craters in the soil, or in rotten wood, and that they are common in the San Francisco Bay region. The writer has come upon their tiny craters, approximately $1\frac{1}{2}$ in. to 2 in. across in the Berkeley Hills where they were in a dry unshaded area.

Localities: Mojave Desert (Cole), Claremont (M. R. Smith).

Monomorium (M.) minimum var. *ergatogyna* Wheeler

Wheeler (1904) named this ant from a series of workers collected by C. F. Baker on Catalina Island, California. The workers are smaller than the typical *minimum* and the females are ergatoid, that is, they lack all signs of ever having had wings. Although this variety has been reported from the mainland of California, it is possible that in some instances it has been confused with the typical *minimum*.

Type Locality: Catalina Island, California (C. F. Baker).

Localities: Berkeley, Mt. Tamalpais (A. Mallis), Los Angeles (A. Mallis and J. Schwartz), Sonoma Co. (S. F. Bailey).

Monomorium (M.) pharaonis (L.)

Although the writer has no definite locality records of this cosmopolitan ant, it is believed to occur in this State.

Genus *Solenopsis* Westwood

Solenopsis (S.) geminata rufa Jerdon

Wheeler (1908a) states that this subspecies occurs in small numbers in the sandy soil along the Colorado River near Needles,

California. *Solenopsis geminata* var. *diabola* Wheeler is a synonym of the above subspecies.

Solenopsis (Diplorhoptrum) molesta (Say)

The records of this ant in California probably refer for the most part to the very common variety *validiuscula* Emery.

Locality: Glendale (A. W. Smith).

Solenopsis (D.) molesta var. *validiuscula* Emery

It is this ant that is a common pest in homes in California, often invading the kitchen through crevices around the sink. Here it feeds on greases, meats, and cheese. In the fields it may be very common in moist grassy situations or beneath rocks in sandy, and arid areas. The males and females were observed in Los Angeles towards evening in the month of June, in great mating flights. Several pair *in copula* were seen upon the ground. On another occasion during the month of July the author observed them in enormous numbers on blades of grass in a lawn on the campus in Davis; here the neuters were very excited since workers of *Eciton californicum* Mayr were carrying off many of the sexual forms. Mann (1911b) observed *Solenopsis molesta* (Say) (probably var. *validiuscula* Emery) in nests with *Tapinoma sessile* (Say), *Camponotus sansabeanus maccooki* Forel, and *Prenolepis imparis* (Say) (probably var. *californica* Whlr.), as well as in their own independent nests.

Type Locality: Los Angeles and San Jacinto (Pergande).

Localities: Sacramento (H. H. Kieffer), Oakland Hills (E. C. Van Dyke), Madison in Yolo Co. (B. E. White), Glendale (A. J. Basinger), Fairfield (S. F. Bailey), Davis, Los Angeles (A. Mallis), Little Tujunga Canyon (A. Mallis and J. Schwartz), Santa Inez Mts. near Santa Barbara (No Collector).

Solenopsis (D.) texana catalinae Wheeler.

Wheeler (1904) described this subspecies from several workers and dealated females collected by C. F. Baker on Catalina Island, California, during the spring of 1904.

Solenopsis (S.) xyloni McCook

Locality: Fenner (A. C. Cole, Jr.).

Solenopsis (S.) xyloni var. *aurea* Wheeler

Locality: Visalia (Wheeler)

Solenopsis (S.) xyloni var. *maniosa* Wheeler

Of all the native ant pests in California, this is probably the most important. For a detailed account of its depredations and its control, see Mallis (1938c). It is widespread throughout Southern California and the interior valleys of California where it ranges at altitudes below 2000 feet. In the past it was undoubtedly much more common around cities until driven away by the Argentine ants. In the field it will be found nesting under stones, cow chips, and under wood debris, or it may form sponge-like crater nests in arid areas or about the base of some plant.

Around homes it may establish itself in cracks and crevices in the concrete foundation or steps, or directly under the home near the furnace. The ants tend Homopterous insects, and feed on foods and crops of all kinds. Because of their efficient sting they are very greatly respected. Swarming occurs most commonly from May through September, but the winged forms may be seen long before or long after this period. Their nests harbor many interesting Staphylinid myrmecophiles.

Type Locality: San Ysidro, near Santa Barbara (Wheeler).

Localities: Pasadena, Claremont, La Jolla, San Diego, Needles (Wheeler), Los Gatos, Mt. Diablo Range (J. C. Bradley), Whittier (H. J. Quayle), Visalia (Culbertson), Eaton's Canyon, Fresno, Brookdale, Friant (R. V. Chamberlin), Davis, Antioch, Capay, 1500 feet, Putah Canyon, Bakersfield (A. Mallis), Big Tujunga Canyon in Los Angeles Co., near Newhall, Mint Canyon, Palm Canyon, Los Angeles (A. Mallis and J. Schwartz), Alhambra (B. Hall), Fenner, Needles (A. C. Cole, Jr.), Jacinto Barranca (J. C. Bradley).

Genus LEPTOTHORAX Mayr

Leptothorax acervorum canadensis var. *calderoni* Forel

Wheeler (1917a) states that the variety *calderoni* is common in nests in the bark of large pine logs and stumps often in close association, almost approaching symbiosis, with the ant *Camponotus herculeanus* var. *modoc* Wheeler.

Type Locality: Lake Tahoe (Wheeler).

Leptothorax andrei Emery

Mann (1911b) collected very small colonies in Palo Alto where they were either associated with *Formica rufibarbis* var. *occidua* Wheeler, or formed independent nests.

Leptothorax eldoradensis Wheeler

Wheeler (1915) described this species from two workers that were collected by J. C. Bradley on the summit of Mt. Wilson, near Pasadena, California.

Leptothorax nevadensis rudis Wheeler

Wheeler (1917a) described the workers and one queen from several small colonies he found beneath the edges of stones in Tenaya Canyon, Yosemite Valley, and Angora Peak, 8600 feet near Lake Tahoe.

Leptothorax nitens Emery

Wheeler (1903a) states that H. Heath found a colony of this species hibernating in a termite burrow in the ground at Pacific Grove, California.

Leptothorax nitens var. *heathi* Wheeler

According to Wheeler (1903a) H. Heath found a colony nesting under a stone at Pacific Grove; this is the type locality.

Leptothorax nitens var. *mariposa* Wheeler

The workers of this variety were collected by Wheeler

(1917a) under the edges of stones in dry places in Tenaya Canyon, Yosemite Valley, the type locality.

Leptothorax rugatulus var. *mediorufus* Wheeler

Type Locality: Lake Tahoe (Tallac, Glen Alpine) and Camp Curry, Yosemite Valley (Wheeler).

Locality: Volcano Creek in Southern California (J. C. Bradley).

GENUS TETRAMORIUM Mayr

Tetramorium caespitum (L.)

According to Essig (1926) this species is fairly common in Central California along the Sacramento and San Joaquin Rivers. The author once observed them in combat with *Eciton californicum* Mayr in Davis. It nests in cracks and crevices along sidewalks. Quite a number of moundless nests in sandy soil about $\frac{1}{4}$ in. in diameter were observed along the sides of the approach leading to the Sacramento River Bridge. The ants are slow-moving, and tend aphid and other honeydew-secreting insects. Essig (1926) notes that they injure many truck crop plants, and that they will also store grass seeds and feed on animal matter.

Localities: Sacramento, Davis (A. Mallis).

GENUS CYPHOMYRMEX Mayr

Cyphomyrmex rimosus var. *comalensis* Wheeler

Woodworth (1910b) notes that this very small soil-colored ant grows a fungus in the excrement of caterpillars, in nests under rocks and logs in the dense shade of trees and shrubs. Their nests are to be found along the banks of dry and flowing streams and irrigation ditches in Southern California. It is a rather rare ant, and probably occurs for the most part in the arid regions near the Arizona border.

Locality: Southern California (Woodworth).

Cyphomyrmex wheeleri Forel

Although there are no notes from California on this species, Wheeler (1907c) found this ant in Texas where it occurs in areas of great aridity, and always under stones. "Each colony comprises only a few dozen workers and a single dealated female except during the spring and early summer, when one finds also several callow workers, males and females and a variable number of eggs, larva and pupa. The workers are nocturnal, at least during the warm seasons of the year, a peculiarity which is indicated by their yellow color. They are very slow in their movements and readily "feign death". Males and females were collected by Wheeler during the month of June.

Locality: Three Rivers (Culbertson).

GENUS ATTA Fabricius

Atta (M.) versicolor Pergande

Wheeler (1907c) states that this ant builds craters of coarse sand in arroyo beds. During the intense heat of midday the

ants do not leave the nest, but towards evening they will slowly move in long files and cut and carry the leaves from nearby desert shrubs. The colonies consist of but a few hundred workers who cultivate fungus gardens.

Localities: Yucca (Wheeler), Mojave Desert (A. C. Cole, Jr.).

Subfamily DOLICHODERINAE
Genus LIOMETOPUM Mayr

Liometopum apiculatum luctuosum Wheeler

This subspecies is commonly found above altitudes of 4000 feet and appears to be associated with pine trees. The writer collected them from a dying western yellow pine (bug tree) from which sap was exuding due to the attacks of *Dendroctonus* sp. This is a very active and pugnacious form.

Localities: Baldy Peak in the San Gabriel Mts., 6500 feet (Brewster, Joos, Crawford); Tenaya Canyon in Yosemite, 5000 feet (Wheeler); Lake Tahoe (Calderon); St. Helena (O. T. McClay); Yosemite Park, 4000 feet (A. Mallis); Hackamore, Modoc Co. (No Collector).

Liometopum occidentale Emery

The author has found this ant to be very widely distributed throughout the State, in the lowlands about Sacramento, in the foothills of Southern California, and at 6000 feet on Mt. Baldy. It dwells under the bark and in the cavities of trees, and is extremely common along the sides of streams where it attends aphids and other honeydew-secreting insects. At times the ants may be a pest in homes by invading these in a constant annoying stream, apparently attracted by some food or other. These ants are very pugnacious, and readily swarm over any individual that disturbs them. They bite and then spray an irritating fluid into the wound; this colorless fluid is discharged when they raise their abdomens. The queens come to light in May, and have been found beneath bark. The Mirid, *Dacerta inflata* Uhler, will often be found running in the trails of this species, which it superficially resembles in color and structure.

Type Locality: San Jacinto, 1533 feet, (Pergande).

Localities: Pasadena, Yosemite, 4000 feet, Wawona (Wheeler), Baldy Peak in the San Gabriel Mts. (Brewster, Joos, and Crawford), Claremont (C. F. Baker and W. M. Wheeler), Coalinga, below 500 feet, Ontario, Alpine (J. C. Bradley), San Diego (Calif. Dept. Agr.), San Bernardino Co. (G. Ferguson), Santa Cruz (E. O. Essig), Bass Lake in Madera Co., Capay, Davis, Putah Canyon (A. Mallis), Devil's Gate Dam in Pasadena, Big Dalton Canyon near Glendora, Big Tujunga Canyon in Los Angeles Co., Eaton's Canyon, Mt. Baldy, 6000 feet, Arroyo Seco in Pasadena, Pico Canyon near Newhall, Base of Mt. Baldy, 1500 feet (A. Mallis and J. Schwartz), Carrville in Trinity Co. (F. Platt), Fort Seward (B. E. White), Mendocino Co. (J. Helfer), Sacramento, (A. C. Cole, Jr.).

Genus DORYMYRMEX Mayr

Dorymyrmex pyramicus (Roger)

This very widely distributed species in California forms small crater-like nests about two to four inches across. In the lowlands, the nests are to be found in hard, vegetation-free soil, or in dry sandy areas; however, at Bass Lake, altitude 3000 feet, the nest was found some 75 feet from the lake in a grove of western yellow pine. The author has observed this *Dorymyrmex* tending mealybugs on succulents, and in all probability they attend aphids and other scale insects. In Davis, the ants foraged until the end of November, and then disappeared during the rainy season, only to emerge at the end of February. During the hot summer months the ants cease all outside activity during the midday hours. The sexual forms were seen preparing for mating flights at the beginning of March; and the queens were found excavating their nests in April.

Localities: Davis, Bass Lake in Madera Co., Capay, Griffith Park in Los Angeles, Putah Canyon (A. Mallis), near Newhall, near Palmdale (A. Mallis and J. Schwartz), Glendale (Cockerell).

Dorymyrmex pyramicus var. *bicolor* Wheeler

Previous to the advent of the Argentine ant, this variety was an annoying house ant in Southern California. It makes small crater mounds up to six inches across in dry, hard, arid soil in the lowlands of California. At times the ants become pests due to their habit of tending Homopterous insects on ornamentals. The author reduced them in numbers by placing poison-syrup containers in those areas where they were accustomed to forage. The control is accomplished not so much by the toxic material in the syrup as by the ants drowning in enormous numbers in each of the poison cans. They have been observed attacking *Pogonomyrmex californicus* (Buckley) in enormous numbers, and in Bakersfield heaps of *Solenopsis xyloni maniosa* Wheeler were often found at the base of their crater mounds. It should be noted that *D. pyramicus* (Roger), the typical form, which hides during midday in the warm season, was not found in so hot and arid a region as Bakersfield. Whereas, the var. *bicolor* which is fast and active even in the hot sun, occurred in great abundance in this area. The dealated queens were captured in Davis during the months of April and May. One male was captured in Brookside Park in Pasadena during the month of December while emerging from the nest entrance.

Localities: San Pedro (Cockerell), Glendora, Needles (Wheeler), Whittier, Dinuba (E. O. Essig), Mojave, near Sequoia Nat'l Park (A. C. Cole, Jr.), Davis, Bakersfield, Hollywood, Fresno, Putah Canyon (A. Mallis), Big Tujunga Canyon, Carbon Canyon in Orange Co., Brookside Park in Pasadena, Morongo Valley in San Bernardino Co. (A. Mallis and J. Schwartz).

Dorymyrmex pyramicus var. *niger* Pergande

Locality: Fresno (E. O. Essig).

Genus IRIDOMYRMEX Mayr

Iridomyrmex humilis Mayr

In 1905 the Argentine ant, *Iridomyrmex humilis* Mayr was first reported in California, and since that time it has become one of our most important and widely distributed household and farm pests. It is strictly a water-loving ant and is limited in its distribution by its moisture requirements, and by an inability to thrive where it cannot be protected from long periods of cold weather, such as is encountered at the higher altitudes. The ants in the more humid portions of the State, and those around our artificially watered regions, have been driven out by the irresistible Argentine ant; whereas, those ants that live in the more arid, or at the higher altitudes, have no competition from the Argentine ant. For more complete information on this species, see Eckert and Mallis (1937), and Mallis (1938a).

Locality: Throughout the State where sufficiently moist and not too high.

Iridomyrmex pruinosus var. *analis* (Ern. Andre)

In all probability this ant is more common than the collections show, for it has possibly been confused with *Forelius* Spp. and *Iridomyrmex humilis* Mayr. It differs from the latter in its paler color, its more noticeable odor upon being crushed, and in not confining its foraging to distinct trails.

Locality: Orange County Park (A. C. Davis).

Iridomyrmex pruinosus (Roger)

Localities: Needles (A. C. Cole, Jr.), Mt. Wilson (J. C. Bradley).

Genus FORELIUS Emery

Forelius foetidus (Buckley)

The nests of this species are often found beneath boulders in arid, sandy regions. They may also make crater nests of fine white sand some 3 inches across and $\frac{1}{2}$ inch high. Several of these nests are often in close proximity to one another, and each nest may contain many queens. Apparently they are extremely xerophilous since the forage in long definite trails in the hot summer sun, in desert areas.

Localities: Lake Elsinore (Bottel), Bakersfield (A. Mallis), Pico Canyon near San Fernando, near Riverside (A. Mallis and J. Schwartz).

Forelius maccooki Forel

Locality: Mojave (A. C. Cole, Jr.).

Genus TAPINOMA Forster

Tapinoma sessile (Say)

Tapinoma sessile (Say) is a common ant in California, and has been collected from sea level to 7000 feet. This ant nests

under rocks, in wood excavated by termites and fungi, beneath the rim covers of beehives where it does the bees no harm, and in homes where it may become an important household pest. The nest contains many queens, and huge numbers of workers and immature young. According to Woodworth (1910b) this species was much more common before the advent of the Argentine ant, and this observer further states that they have an odor that "is produced by a liquid secretion which can be ejected from the abdomen as an appreciable drop and which is used in its contests with the Argentine species. As long as the supply of this secretion lasts the *Tapinoma* has no difficulty in keeping the Argentine off, but after having put four or five of the Argentines out of the combat in this way finally the *Tapinoma* is put to rout and the Argentines are invariably victorious, because they always attack in sufficient numbers." Besides invading houses, these ants make pests of themselves by attending aphids on fruit trees and ornamentals. At times the workers may be seen with turgid gasters looking like the repletes of our honey ants, but of course much smaller. The winged sexuals, as well as the wingless females were found beneath the top board of a beehive in May, in Davis. Mann (1911b) noted that *Solenopsis molesta* (Say) (probably var. *validiuscula* Emery) nests with *T. sessile* (Say). The ant cricket, *Myrmecophila oregonensis* Bruner has been found in their nest.

Localities: San Jose, Palo Alto (H. Heath), Lompoc, Mt. San Jacinto, Harris, Humboldt Co., and summit of Mt. Wilson (J. C. Bradley), Whittier, Azusa (H. J. Quayle), Yosemite, Lake Tahoe (Wheeler), McCloud (Silvestri), Lookout Mt. (Cockerell), Julian (U. S. Biological Survey), Weed, Sequoia Nat'l Park (A. C. Cole, Jr.), Carrville, Trinity Co. (F. Platt), Geyserville, Sonoma Co. (S. F. Bailey), Alameda Foothills (W. M. Gifford), Soquel Road in Madera Co., 6000 feet, Bass Lake in Madera Co., Davis, Brentwood, in Sonoma Co., Mt. Baldy, 7000 feet (A. Mallis), Big Tujunga Canyon in Los Angeles Co., Devil's Gate Dam in Pasadena (A. Mallis and J. Schwartz), Griffith Park in Los Angeles (A. Mallis and H. Taylor).

Subfamily CAMPONOTINAE
Genus PRENOLEPIS Forel

Prenolepis (*P.*) *imparis* var. *californica* Wheeler

This is the variety that is so common in California where it evidently prefers the moister situations. These ants have been collected from sea-level to 4000 feet. The ants usually nest beneath boulders where the soil is moist. They are active in cool weather long after other species have ceased foraging. The workers tend aphids on all kinds of coniferous and deciduous plants and will also feed on fruit buds and succulent tissue of fruit and ornamental plants. Some of the workers gorge themselves so much on nectar and honeydew that their abdomens become greatly enlarged and amber in color. The males are seen swarming in great numbers during February, March, and April.

Mann (1911b) found *Myrmecophila oregonensis* Bruner and *Solenopsis molcsta* (Say) (probably var. *validiuscula* Emery) in the nest of this variety.

Type Locality: Stanford University (H. Heath, W. M. Mann, C. F. Baker).

Localities: San Jose (H. Heath), Marin Co., Eldridge, Sonoma Co. (J. A. Kusche), Piedmont, Berkeley (J. C. Bradley), mountains near Claremont (C. F. Baker), Santa Cruz Island (R. V. Chamberlin), Point Loma near San Diego (P. Leonard), Santa Inez Mts., San Ysidro, near Santa Barbara, Pasadena, Mt. Lowe, Yosemite Village (W. M. Wheeler), Santa Paula (H. J. Quayle), Portola, La Verne (E. Becker), Placerville, Berkeley Foothills, Bass Lake in Madera Co., 3000 feet, Davis, Grass Valley, Putah Canyon, Eaton's Canyon near Altadena (A. Mallis), Devil's Gate Dam in Pasadena, Big Dalton Canyon near Glendora, Base of Mt. Baldy, 1500 feet (A. Mallis and J. Schwartz), Woodland (L. M. McQuestin), San Diego (A. J. Basinger), Newport (Davis), Kenwood, Calistoga in Napa Co. (S. F. Bailey).

Genus LASIUS Fabricius

Lasius (*L.*) *brevicornis* Emery

Localities: San Jacinto, Lake Tahoe (Wheeler).

Lasius (*L.*) *brevicornis* var. *microps* Wheeler

Type Locality: Yosemite Village, 4000 feet (Wheeler).

Lasius (*Acanthomyops*) *interjectus californicus* Wheeler

Type Locality: Palmer's Canyon, San Gabriel Mts., near Claremont (F. Grinnell).

Lasius (*A.*) *latipes* Walsh

The ants of this species nest in rather dry, sunny places.

Localities: Mt. Tamalpais (C. G. Hewitt), Mountain View (W. M. Wheeler).

Lasius (*L.*) *niger alienus* var. *americanus* Emery

Locality: Glacier Point in Yosemite, 8000 feet (Wheeler).

Lasius (*L.*) *niger* var. *neoniger* Emery

J. J. duBois and the author collected this variety on a tree, which the ants were ascending, probably in order to attend honeydew-secreting insects. Their queens were very abundant during the summer months in Davis.

Localities: Lake Tahoe (Wheeler), Giant Forest (J. C. Bradley), Davis (A. Mallis and J. J. duBois), McCloud (No Collector).

Lasius (*L.*) *niger* var. *sitkaensis* Pergande

Ants of this variety are widely distributed throughout the Canadian Zone.

Localities: Giant Forest, 6500 feet (J. C. Bradley), Lake Tahoe, 6000-7000 feet, Camp Curry and Glacier Point, 4000-8000 feet, Yosemite (Wheeler), King's River Canyon (H. Heath), Carrville in Trinity Co. (F. Platt), Caspar (J. Helfer).

Lasius (C.) umbratus subumbratus Viereck

Locality: Angora Peak near Lake Tahoe, 8000 feet (Wheeler).

GENUS MYRMECOCYSTUS Wesmael

Myrmecocystus lugubris Wheeler

J. C. Bradley sent some of these ants to Wheeler (1909a) from Otis, in the Mojave Desert; this is the type locality. As several of the ants were in a semi-replete condition, it is thought that they are honey-storing ants.

Myrmecocystus melliger depilis Forel

Locality: Needles in Mojave Desert (Wheeler).

Myrmecocystus melliger lomaensis Wheeler

This subspecies was described by Wheeler (1912b) from six workers, three repletes and two females taken by P. Leonard on Point Loma, near San Diego, California.

Myrmecocystus melliger mimicus Wheeler

The subsp. *mimicus* Wheeler constructs crater nests with circular openings about 1 in. in diameter. These ants work during the day, prey upon insects, and are not known to have repletes.

Localities: Goshen Junction (J. C. Bradley), Riverside, Whittier, Mojave Desert (No Collector).

Myrmecocystus melliger mimicus var. *californicus* Cole

Type Locality: Weed (A. C. Cole, Jr.)

Myrmecocystus melliger semirufus Emery

The nests are common in and around Bakersfield in burnt-over, adobe-like, vacant lots. There are no mounds about the nest, but the sand is piled in flat heaps several inches from the nest entrance. The opening to one nest was approximately $\frac{1}{2}$ in. in diameter and somewhat oval. This nest had no guard of workers around the entrance, and it was entirely free of stones and chaff. Around the entrances of some other nests rings of chaff and the dismembered bodies of *Veromessor pergandei* (Mayr), *Pogonomyrmex* sp., and *Solenopsis xyloni maniosa* Wheeler, were found in great abundance. At times they construct regular craters about their nest entrances. This subspecies is very active, diurnal, and difficult to capture. They appeared to be attending aphids on some prostrate weeds.

Type Locality: San Jacinto (Pergande).

Localities: Needles (Wheeler), Point Loma near San Diego (P. Leonard), Morongo Valley (H. Green), Lodi (H. H. Kiefer), E. Bakersfield (A. Mallis).

Myrmecocystus melliger semirufus var. *testaceus* Emery

Some five miles from Bakersfield in an arid sandy area devoid of vegetation, a nest of this species was found. The semi-circular crater was some 5 in. high, and there was but a single entrance, about $\frac{1}{2}$ in. in diameter. However, when this nest was observed two days later, two entrances, about 1 in. apart were seen. The ants vary greatly in size, forage during midday, and move rapidly over the surface of the sand. One ant was observed conveying the abdomen of a honey bee towards the nest.

Type Locality: San Jacinto (Pergande).

Localities: Claremont (C. F. Baker), Perris (J. C. Bradley), Bakersfield (A. Mallis), Mojave Desert (No Collector).

Myrmecocystus mexicanus Wesmael

Leonard (1911) discovered a nest in the soil of disintegrated shale. There were many semi-repletes moving about the galleries, and about eight laying females. The females were friendly with one another. According to Leonard, "It is quite common to find dead insects, termites, flies, etc., lying among the larvae, and in wild nests two to three repletes hanging from the ceilings of the nursery chambers. Sometimes the larger larvae remain for a long time with their heads thrust into the thoraces of dead flies, devouring the muscular tissue." This species shows a preference for moister soil where it is available.

Locality: Point Loma near San Diego (P. Leonard).

Myrmecocystus mexicanus horti-deorum McCook

For a very detailed account of this ant, see McCook (1882).

Localities: Claremont (W. A. Hilton), near Needles (A. C. Cole, Jr.), El Centro in Imperial Co. (No Collector).

Myrmecocystus mexicanus mojave Wheeler

The notes on this subspecies are from Leonard (1911) who studied these insects at Point Loma near San Diego. The entrance hole to their nest was comparatively large, being the size of a "ten cent piece". Repletes occurred some four inches below the surface of the soil. Repletes were nocturnal, predacious on other insects, and attended aphids and gathered nectar from flowers. The legionary ants, *Eciton* (*A.*) *sumichrasti* Norton raided their nest in June. Leonard states, "I have seen the ants at work at 9 p. m. in the pouring rain at a temperature as low as 44° Fahr. They do not leave their holes until about half an hour after sunset." During a hot dry spell in August the ants stayed underground. Their large entrance was closed with little clods of earth. The queens were obtained in the middle of October through simulating the effect of nightfall by covering the entrance of the nest with a box.

Type Locality: Ontario, California (J. C. Bradley).

Localities: Colorado and Mojave Deserts (Wheeler), Point Loma (P. Leonard), Pasadena (E. Grinnell), Claremont (C. F. Baker), Sunland (J. Schwartz).

Genus POLYERGUS Latreille

Polyergus rufescens breviceps Emery

The habits of these "amazon" ants were studied in great detail by Wheeler (1916b) at Fallen Leaf Lake, 7000 feet, near Lake Tahoe during the summer of 1915. This subspecies dwells under logs and small flat stones, and makes forays to the nests of *Formica fusca* L. var. where they capture the pupae. These are carried back to the nest, and in the adult stage they become slaves of the *breviceps*. The females in a winged or dealated condition would, in some instances, accompany the workers on their raids. Should the ants to be plundered show any resistance, they are quickly dispatched by the amazons, who pierce the heads of workers with their ice-tong mandibles. Wheeler found winged males and females in the nest during July.

Localities: Santa Cruz (H. Heath), Kern Lake (J. C. Bradley), Fallen Leaf Lake and Glen Alpine near Lake Tahoe (Wheeler), Soquel Road in Madera Co., 6000 feet (A. Mallis).

Polyergus rufescens breviceps var. *silvestrii* Santschi

Type Locality: Yosemite (Silvestri).

Polyergus rufescens breviceps var. *umbratus* Wheeler

Wheeler (1915) described this variety from a single colony collected by H. Heath at Brookdale, California, and the slave ant that accompanied it belonged to *Formica fusca* near the var. *argentea* Wheeler.

Type Locality: Brookdale, California (H. Heath).

Polyergus rufescens laeviceps Wheeler

These "amazons" were collected by Wheeler (1915) on the slopes of Mt. Tamalpais near San Francisco where they raided the nest of *Formica subpolita* Mayr, and plundered their brood.

Type Locality: Mt. Tamalpais (Wheeler).

Localities: Laws (A. Wetmore), Fallen Leaf Lake near Lake Tahoe (No Collector).

Genus FORMICA Linnaeus

Formica (*F.*) *cinerea* var. *lepida* Wheeler

Type Locality: Blue Lake in Humboldt Co. (J. C. Bradley).

Localities: Lemon Cove in Tulare Co. (J. C. Bradley), Los Angeles (A. Mallis).

Formica (*F.*) *cinerea* var. *neocinerea* Wheeler

Their irregular nest mounds are often found in dry, hard soil, usually devoid of vegetation in the Sacramento and San

Joaquin Valleys as well as in Southern California. The winged apterous females were fairly common during the month of March in Davis. Although this variety is actively predacious on other insects, it will often attend aphids and other honeydew-secreting insects. In citrus orchards they may become important pests due to their habit of tending mealybugs and scale insects, and protecting these from their natural parasites. Moreover, they will at times invade homes. The Argentine ant has forced them from much of their former territory. This variety is often confused with *F. pilicornis* Emery which it closely resembles. *Hetaerius tristriatus* Horn is a guest in the nest of this ant.

Localities: San Jose (H. Heath), Palo Alto, Santa Cruz Mts. (W. M. Mann), Mesa Grande, Russian River (J. C. Bradley), Antioch, Davis (A. Mallis).

Formica (F.) fusca L.

This, one of the most widely distributed of all ants, occurs in the United States, in Canada, and in North and Central Eurasia. In California the species occurs in the mountains at altitudes above 4000 feet, and forms rather large colonies. The timid workers nest under stones or logs, or in small earthen mounds, and are often the hosts for other parasitic *Formica*.

Localities: Kern Lake (J. C. Bradley), Lake Tahoe, 6200-9000 feet (Wheeler), Camp Curry and Glacier Point in Yosemite, 4000-8000 feet, Muir Woods, Mt. Tamalpais (Wheeler).

Formica (F.) fusca var. *argentea* Wheeler.

The variety *argentea* is rare at the lower altitudes where it occurs in damp locations, and is more commonly found at elevations above 7000 feet. Mann (1911b) found the Histerids, *Hetaerius strenuus* Fall and *Hetaerius tristriatus* Horn in their nests.

Localities: Palo Alto (H. Heath), Corte Madera Creek, Santa Cruz Mts. near Palo Alto (W. M. Mann) Harris, Humboldt Co. (J. C. Bradley), Angora Peak near Lake Tahoe (Wheeler).

Formica (F.) fusca var. *blanda* Wheeler

According to Wheeler (1917a) the species recorded from California are probably not this variety at all.

Localities: Yosemite Valley (J. C. Bradley), and Lemon Cove in Tulare Co. (No Collector).

Formica (F.) fusca var. *gelida* Wheeler

Wheeler (1913) found the variety *gelida* nesting under stones, in logs in woods, and in shady canyons, at high altitudes just below the timberline.

Localities: Alta Peak in Sequoia Nat'l Park, 9,500-11,000 feet, Blue Lake in Humboldt Co. (J. C. Bradley), Fallen Leaf

Lake near Lake Tahoe (Wheeler), and Upper Echo Lake (E. O. Essig).

Formica (F.) fusca var. *marcida* Wheeler

This is an alpine variety like *gelida* and Wheeler (1917a) states that J. C. Bradley, who collected some of these ants, noted that they nested under a stone from which the snow had recently receded. The quick and agile workers hide under the stones and in the moss, and the nests are found at the timber line.

Localities: Summit of Angora Peak near Lake Tahoe, 8650 feet (Wheeler).

Formica (F.) fusca var. *neorufibarbis* Emery

Ants of the above variety, according to Wheeler (1917a), that have been recorded from California may be referable to the variety *gelida*. The ant cricket, *Myrmecophila oregonensis* Bruner occurs in the nest of this ant.

Localities: Lake Tahoe, 6000-7000 feet, and Glacier Point in Yosemite (Wheeler).

Formica (F.) fusca var. *subaenescens* Emery

These ants are commonly found at altitudes above 8000 feet in the various mountains of the State where they nest under stones. The Scarabaeid beetle *Cremastochilus kochi* Lec. is found in the nests of this form.

Localities: King's River Canyon, 8000 feet (H. Heath), Alta Peak in Sequoia Nat'l Park, 9500-11000 feet (J. C. Bradley), Angora Peak near Lake Tahoe, 8600 feet (Wheeler), McCloud and Yosemite (Silvestri), Camp Kelly on Mt. Baldy 8500 feet (A. Mallis and J. Schwartz).

Formica (F.) fusca var. *subsericea* Say.

According to Wheeler (1913) the colonies of this ant "are often rather large, nest in sunny places under stones or in low, flat 'beds,' or mounds, often a meter or more in diameter." This variety is an exceedingly timid ant, and is often a slave of other *Formica*. Essig (1926) states it attends plant lice in California.

Localities: Mojave Desert near Bakersfield (A. C. Cole, Jr.), El Dorado Co. (W. M. Gifford).

Formica (F.) manni Wheeler

Locality: Owens Lake (H. F. Wickham).

Formica (F.) microgyna californica Wheeler

Type Locality: Glen Alpine Springs near Lake Tahoe, 6500 feet (Wheeler).

Formica (F.) microgyna californica var. *hybrida* Wheeler

Type Locality: Angora Peak near Lake Tahoe, 6500 feet (Wheeler).

Formica (F.) microgyna rasilis var. *pinetorum* Wheeler

Wheeler (1917a) notes that this variety has rather populous colonies that live under stones and logs, and that the nests are banked with vegetable detritus.

Type Locality: Angora Peak near Lake Tahoe, 7500-8600 feet (Wheeler).

Formica (F.) neogagates lasioides var. *vetula* Wheeler

This is a fairly common ant at Lake Tahoe, and Wheeler (1913) found it to be the summer host of the Staphylinid, *Xenodusa montana* Casey.

Localities: Giant Forest in Sequoia Nat'l Park, 6000-7000 feet (J. C. Bradley), Pacific Grove (H. Heath), Fallen Leaf Lake near Lake Tahoe, 6000-8000 feet, and Glacier Point in Yosemite, 8000 feet (Wheeler), Mt. Tamalpais State Park (A. Mallis).

Formica (F.) perpilosa Wheeler

Cole (1934) came upon this species in the periodical river bottoms of the Mojave Desert where they constructed nests with low mounds, or with craters at the bases of shrubs. These active ants have populous colonies.

Localities: Mojave Desert, in periodical river bottoms (A. C. Cole, Jr.), Hemet (A. J. Basinger).

Formica (F.) pilicornis Emery

The habits of *F. pilicornis* Emery are very similar to those of *F. cinerea* var. *neocinerea* Wheeler. However, the latter does not inhabit such arid areas as does the subspecies *pilicornis* which is commonly found under large boulders in the dry sandy arroyos of Southern California, especially along the foothills. Wheeler (1913) states that they form scattered nests in and around El Cajon Valley. The feeding habits of this subspecies are similar to those of *neocinerea* Wheeler. Often many queens, winged and dealated, may be found under one boulder, and J. Schwartz and S. Shalevitz collected 43 queens under one stone during the month of December near Riverside.

Type Locality: San Jacinto and Tres Pinos (Pergande).

Localities: Mount Pinos (F. Grinnell), Point Loma in San Diego Co. (P. Leonard and Wheeler), Arroyo Seco in Pasadena, Lakeside (Wheeler), Escondido in San Diego Co., Jacumba (J. C. Bradley), Claremont (C. F. Baker), Lake Merced near San Francisco (F. X. Williams), Salinas (L. S. Selvin), Glendale (Cockerell), Pasadena (H. C. Fall), Mojave Desert near Barstow (A. C. Cole, Jr.), Fish Canyon near Monrovia, Soledad, Ridge Route (A. Mallis), Riverside (J. Schwartz and S. Shalevitz).

Formica (F.) rufa var. nr. *coloradensis* Wheeler

According to Mann (1911b), several mounds along Corte Madera Creek in Marin Co. were seen. The nests contained the ant guest *Batrisus zephyrinus* Casey, a pselaphid, and *Myrmecophila oregonensis* Bruner.

Formica (F.) rufa obscuripes Forel

Mound nests of small sticks, leaves, and pine needles occurring at altitudes between 4000-7000 feet in the mountains of the northern part of the State are built by this subspecies. It ranges up and down the trees where it attends honeydew-secreting insects, and where it preys upon any insect that comes its way. As these ants are very pugnacious, they will readily attack intruders who disturb them near their nesting sites. *Formica rufa aggerans* Wheeler is a synonym of the above subspecies.

Localities: Tallac near Lake Tahoe (Wheeler), McCloud (No Collector).

Formica (F.) rufibarbis var. *gnava* Buckley

Ants of this variety are recorded from the more arid southeastern part of the State where it has been collected beneath large flat rocks. Wheeler (1913) notes that it is very aggressive, and that it nests under stones and in nests without craters. These ants occur at low altitudes in shady canyons. Although the populous colonies resemble the variety *occidua*, they have a bronzy appearance when seen in masses.

Localities: Needles (Wheeler), Coachella Valley in Riverside Co. (No Collector).

Formica (F.) rufibarbis var. *occidua* Wheeler

Large colonies of this variety are often found beneath stones in open unshaded areas. The workers are fiercely aggressive and predacious on other insects, and the author has seen them bearing workers and sexual forms of subterranean termites in great numbers towards the nest. They have also been observed guarding a long slit-like entrance near a sidewalk from the equally pugnacious *Liometopum occidentale* Emery. At times one may come upon them while they are conveying their brownish cocoons, or when they transport their fellow workers by grasping them by the mandibles. Apparently they are active throughout the year, the weather permitting. In certain instances they become annoying through their habit of attending honeydew-secreting insects on cultivated and ornamental plants. Mann (1911b) discovered colonies of the ant *Leptothorax andrei* Emery to be associated with this ant under stones. Histerid ant guests *Hetaerius wheeleri* Mann and *Hetaerius californicus* Horn are at times found clinging to the underside of stones that harbor the colonies of this variety.

Type Locality: Palo Alto (T. Heath and W. M. Mann).

Localities: Pasadena, San Ysidro near Santa Barbara, Palmer's Canyon, San Gabriel Mts. (Wheeler), Mt. Wilson, Three Rivers, Sissons, Berkeley, Wild Cat Canyon near San Pablo, Lemon Cove in Tulare Co. (J. C. Bradley), Los Angeles (F. Grinnell), San Jose (H. Heath), Santa Cruz Island (R. V. Chamberlin), Sacramento, Weed (A. C. Cole, Jr.) Davis, Berkeley (A. Mallis), Pico Canyon near San Fernando (A. Mallis and J. Schwartz), Niles Canyon (J. F. Lamiman), Calaveras Co. (W. M. Gifford).

Formica (F.) sanguinea subnuda Emery

This alpine species, as far as is known, forms large slaveless colonies in California.

Localities: Fallen Leaf Lake and Glen Alpine Springs near Lake Tahoe (Wheeler), Sugar Pine in Madera Co. (J. C. Bradley).

Formica (F.) sibylla Wheeler

Wheeler (1913) states that he observed "Numerous colonies, each comprising a rather small number of workers and nesting in craters 6 to 8 inches in diameter in sandy soil fully exposed to the sun. The workers, who run very rapidly, were seen outside the nests only during the early morning and late afternoon hours of the hot days of July and August."

Localities: Yosemite Valley, 4000 feet to Glacier Point, 8000 feet; and Tallac near Fallen Leaf Lake and the Moraine east of Angora Park (Wheeler), Huntington Lake (H. Green).

Formica (F.) subpolita Mayr

Is common at low altitudes (especially in the San Francisco Bay Region), but it may ascend up to 6400 feet in Southern California. This species is known to nest under stones in grassy places. The writer found them moving over hot sidewalks in Yosemite Valley during the month of June. Such honeydew-secreting insects as aphids and mealybugs are attended by these ants. Wheeler (1913) found many small colonies of this timid ant on the seashore near Point Joe, at Pacific Grove. Coccids, the pseudoscorpion, *Chelanops dorsalis* Banks, and the histerid, *Hetaerius tristriatus* Horn have been found in their nests.

Type Locality: San Francisco.

Localities: Mt. Tamalpais (Wheeler), Pacific Grove (H. Heath, W. M. Mann, W. M. Wheeler), Mount Lowe, summit 6400 feet (H. J. Quayle and W. M. Wheeler), Palo Alto, Corte Madera Creek (W. M. Mann), Felton, Santa Cruz Mts. (J. C. Bradley), King's River Canyon (H. Heath), Baldy Peak in the San Gabriel Mts. (Brewster, Joos, Crawford), Muir Woods, Berkeley Hills, Anaheim Landing (A. Mallis), Sierra Nevada, Marin Co., Goat Island, San Gregorio (No Collector).

Formica (F.) subpolita camponoticeps Wheeler

The author found this ant foraging around a building at 3000 feet in the San Bernardino Mts. Numerous nest entrances were widely distributed in a rather shaded situation. There were no nest craters apparent here. Ants of this subspecies were also found foraging in a dry stream bed, and were seen ascending willow branches, probably to attend aphids. Wheeler (1917a) found them nesting under stones on the dry slopes of a canyon wall near Yosemite Village. The nests contained workers of varying size.

Localities: Yosemite Village, 4000 feet, (Wheeler), Mt. Tamalpais (Cockerell), Camp Seeley in the San Bernardino Mts., 3000 feet (A. Mallis and J. Schwartz).

Formica (F.) truncicola integroides Emery

Wheeler (1917a) observed the populous colonies of this subspecies in the woods beneath large accumulations of vegetable detritus about stumps and logs in Tallac and Fallen Leaf Lake, Lake Tahoe.

Type Locality: Coastal Mts. of California.

Localities: San Gabriel Mts. near Claremont (C. F. Baker), Felton in Santa Cruz. Mts., 300-500 feet, Santa Cruz Beach, Giant Forest (J. C. Bradley). Loma Prieta in Santa Cruz Mts., 3800 feet (V. L. Kellog), King's River Canyon (H. Heath), Corte Madera Creek (W. M. Mann), Pine Lake (J. D. Johnson), Lake Tahoe (Wheeler), Carrville in Trinity Co. (B. Hall), Timber Mts. in Modoc Co. (No Collector).

Formica (F.) truncicola integroides var. *haemorrhoidalis* Emery

This variety nests under and in stumps and logs, and Wheeler (1913) states that it fills the interstices of these with vegetable detritus. The colonies are encountered in pine woods on the tops of mountains. The presence of this ant in California may be questioned at the present time.

Locality: Mt. Whitney in Inyo Co., 8300 feet (J. J. du Bois).

Formica (F.) truncicola integroides var. *propinqua* Wheeler

According to Wheeler (1917a) *propinqua* is to be found in the hot moraine region between Fallen Leaf Lake and Lake Tahoe whereas the variety *tahoensis* prefers the elevations around 7000 to 7500 feet.

Type Locality: Lake Tahoe (Tallac, Glen Alpine Springs, Fallen Leaf Lake, Angora Peak) (Wheeler).

Formica (F.) truncicola integroides var. *subfasciata* Wheeler

Type Locality: Mills Creek Canyon, Wilson Peak, 7500 feet, San Bernardino Mts., Southern California (F. Grinnell).

Formica (F.) truncicola integroides var. *tahoensis* Wheeler

The habits of this form are similar to those of the variety *propinqua*, although it does occur at a slightly higher altitude.

Type Locality: Lake Tahoe (Tallac, Glen Alpine Springs, Fallen Leaf Lake, Angora Peak) (Wheeler).
Locality: Angel's Peak near Lake Tahoe (E. P. Van Duzee).

Genus CAMPONOTUS Mayr

Camponotus (Myrmentoma) anthrax Wheeler

Wheeler (1917a) named this ant from a colony that he found nesting under a stone at an altitude of 1000 feet in the Santa Inez Mts., near Santa Barbara.

Camponotus (M.) caryae (Fitch)

Localities: Glen Alpine Creek near Lake Tahoe (E. P. Van Duzee), Angora Peak near Lake Tahoe, 7000 feet, Shasta Co. (Wheeler), St. Helena (O. T. McClay).

C. caryae nearcticus Emery is a synonym of the above.

Camponotus (M.) caryae var. *essigi* M. R. Smith

This ant was found foraging along the shore in debris in a salt marsh area. It was very alert and difficult to catch.

Type Locality: Lagunitas (E. O. Essig).

Localities: Antioch, Davis (A. Mallis).

Camponotus (M.) caryae discolor Buckley

Locality: Coronado (A. Leing).

Camponotus (M.) caryae discolor var. *clarithorax* Emery

J. Schwartz and the author collected the winged females, 2 males, numerous workers, and the immature forms in the center of a very moist and decayed willow trunk which was about 1 foot in diameter. These ants have also been collected in an oak gall, and Leonard (1911) found them in the stems of manzanita at Point Loma.

Type Locality: San Jacinto and Los Angeles (Pergande).

Localities: Point Loma in San Diego Co. (P. Leonard), Whittier (H. J. Quayle), Felton in the Santa Cruz Mts., Three Rivers, Santa Inez Mts. near Santa Barbara (J. C. Bradley), Spanish Canyon near Monrovia (A. Mallis), Davis (B. E. White), Sacramento (J. J. duBois).

Camponotus (M.) caryae discolor var. *cnemidatus* Emery

Woodworth (1910) records this ant in his list, but its presence in California is doubtful since it is an eastern species.

Camponotus (M.) caryae minutus Emery

Locality: Bass Lake at altitude of 6000 feet (A. Mallis).

Camponotus (M.) caryae subbarbatus Emery

Locality: Los Angeles (Pergande).

Camponotus (T.) fumidus var. *fragilis* Pergande

This pale ant was sent in from the hot and arid Coachella Valley where it invaded a house at night, and thereby annoyed the residents.

Camponotus (M.) herculeanus var. *modoc* Wheeler

Very large colonies of this common mountain ant will usually be found in stumps and in the rotten centers of butts of fir trees. It often follows the decayed wood in the stumps, but does little damage to the living tissue. These ants are pugnacious and can bite viciously when annoyed. At times they will work from nearby stumps into the timber of houses; the attack occurring for the most part on the sunny side. They are more common in the northern part of the State where they occur in the mountains at an altitude commencing at 3000 feet.

Localities: King's River Canyon (H. Heath), Marin County, Fallen Leaf Lake, Giant Forest, Alta Meadow Trail (J. C. Bradley), Sierra Nevada (American Mus. Nat. Hist.), Tahoe City (A. Fenyès), Upper Echo Lake (E. O. Essig), Modoc Co., 5000 feet (A. Mallis), Carrville in Trinity Co. (F. Platt), Nevada Falls in Yosemite (T. Williams), Yosemite Village, 4000 feet to Glacier Point, 8000 feet and Lake Tahoe, 6000 to 9000 feet, (Wheeler), Sequoia Nat'l Park (A. C. Cole, Jr.), Sierra Nat'l Forest, McCloud (No Collector).

Camponotus (M.) herculeanus pennsylvanicus (DeGeer)

Santschi (1909) records this species from McCloud and Yosemite, but this is in all probability the preceding species since *pennsylvanicus*, as far as is known, does not extend its range as far west as California.

Camponotus (M.) hyatti Emery

This is a somewhat rare ant in California which Cole (1934) states he found on the moist slopes of the Mojave Desert.

Type Locality: San Jacinto (E. Hyatt).

Localities: Fort Seward (K. F. Wilson), Palo Alto (W. M. Mann), moist slopes of Mojave Desert (A. C. Cole, Jr.).

Camponotus (M.) hyatti var. *bakeri* Wheeler

Type Locality: Catalina Island (C. F. Baker).

Camponotus (M.) laevigatus (F. Smith)

The species *laevigatus* (F. Smith) is common at high altitudes throughout the State, and its large colonies are to be found in dry stumps or logs. *Myrmecophila oregonensis* Bruner is a common guest in the nest of this ant.

Localities: Yosemite, Sierra Nevada, Sierra Valley, San Jacinto Mts., 6000 feet (F. Grinnell), Baldy Peak in San Gabriel Mts. (Brewster, Joos, Crawford), Blue Lake, Humboldt Co., Felton in Santa Cruz Mts., Alta Peak, 9500-11000 feet, Giant Forest to Marble Fork, Sissons (J. C. Bradley), McCloud, Castle Crag (A. Fenyès), Yosemite Village, Tallac near Lake Tahoe (Wheeler), Carrville in Trinity Co. (F. Platt), Mt. Baldy (A. Mallis and J. Schwartz).

Camponotus (M.) sansabeanus dumetorum Wheeler

According to Wheeler (1910d) this subspecies appears to be the dominant insect of the chaparral up to an altitude of

2000 feet in the San Gabriel and Santa Inez Mts. of Southern California, which is the type locality. Its nests, which are in the form of flat craters, vary from a few inches to a foot in diameter, and are to be found among the bushes. During the warm summer days these ants remain in the nest. *C. maculatus* var. *berkeleyensis* Forel is a synonym of the above species.

Type Locality: San Gabriel and Santa Inez Mts. up to 2000 feet (Wheeler).

Locality: Berkeley (No Collector).

Camponotus (M.) sansabeanus maccooki Forel

Large colonies are to be found beneath rocks in moist habitats, and are common in and about Sacramento and the San Francisco Bay Region. The large, pretty, reddish-yellow and black queens are commonly captured by collectors. The Scarab, *Cremastochilus planatus* Lec., and the ant cricket, *Myrmecophila oregonensis* Bruner are guests in the nest of this ant.

Localities: Palo Alto (H. Heath and W. M. Mann), San Jose, Alameda Co., Marin Co. (H. Heath), San Ysidro, Carpinteria, Tenaya Canyon in Yosemite, 5000 feet, Pasadena (Wheeler), Ukiah in Mendocino Co., Berkeley (J. C. Bradley), Point Loma near San Diego (P. Leonard), Grant (Silvestri), Weed, Tehachapi (A. C. Cole, Jr.), Woodland (J. J. duBois), Sonoma Co. (S. F. Bailey), Davis (A. Mallis), Descanso (No Collector.)

Camponotus (M.) sansabeanus vicinus Mayr

It is this *Camponotus* and its varieties that are commonly encountered under stones in rather dry, sunny places. The ants are very widely distributed throughout the State in both lowlands and the mountains. The winged forms may be found in the nest at practically any time of the year.

Localities: Tenaya Canyon in Yosemite, 5000 feet, and Lake Tahoe (Tallac, Glen Alpine Springs and moraine east of Angora Peak, 6000-7000 feet, San Gabriel Mts. near Claremont, Point Loma near San Diego, Palmer's Canyon near Claremont, Mt. Lowe, 5000 feet (Wheeler), Alpine, Alameda, Harris, Humboldt Co., Felton in Santa Cruz Mts. (J. C. Bradley), San Jacinto Mts., 6000 feet (F. Grinnell), Palo Alto (W. M. Mann), Bass Lake in Madera Co., 3000 feet (A. Mallis).

Camponotus (M.) sansabeanus vicinus var. *infernalis* Wheeler

Localities: Tenaya Canyon and Camp Curry in Yosemite, 4000-5000 feet, Lake Tahoe, 6000-7000 feet, Wilson Peak in San Bernardino Mts., 7500 feet (Wheeler), Santa Cruz Mts. (J. C. Bradley), Palo Alto (W. M. Mann), Carrville in Trinity Co., 2400-2500 feet (F. Platt).

Camponotus (M.) sansabeanus vicinus var. *luteangulus* Wheeler

J. Schwartz and S. Shalevitz collected a colony of this variety, including queens, workers, one winged male, and the immature stages, in a very wet stump, during the month of Feb-

ruary, in the Arroyo Seco, Pasadena. When the nest was opened, the ants were unable to move until warmed by the sun. The nest was composed of some eight chambers, and these were crowded with queens, workers, and the immature forms. Each chamber was approximately 1 in. long and about $\frac{3}{4}$ in. wide, with interconnecting galleries between the chambers. A colony of subterranean termites were situated in the same log immediately on the outside of the ant excavations.

Localities: Mt. Home (H. Green), Arroyo Seco in Pasadena (J. Schwartz and S. Shalevitz).

Camponotus (M.) sansabeanus vicinus var. *maritimus* Wheeler

Localities: Santa Cruz Island (R. V. Chamberlin), Santa Cruz Mts. and Santa Inez Mts. near Santa Barbara (Wheeler), Catalina Island (C. F. Baker), Pacific Grove and San Jose (H. Heath).

Camponotus (M.) sansabeanus vicinus var. *nitidiventris* Emery

Notes on this form in California are lacking, however, in the Rockies it is known to occur on the high plains and slopes.

Localities: Catalina Island (C. F. Baker), Santa Rosa in Marin Co. (H. Green).

Camponotus (M.) sansabeanus vicinus var. *plorabilis* Wheeler

Localities: Pacific Grove (H. Heath), Beckwith, 5000 feet (No Collector).

Camponotus (M.) sansabeanus vicinus var. *semitestaceus* Emery

Type Locality: Plumas Co., 5000 feet (Pergande).

Localities: San Jacinto Mts. (F. Grinnell), Claremont (Metz), Friant (R. V. Chamberlin), Ramona (J. C. Bradley), Mt. Wilson, 2000 feet (No Collector)

Camponotus (M.) sansabeanus vicinus var. *subrostrata* Forel

Type Locality: Lake Tahoe, California.

Camponotus (M.) ocreatus Emery

Type Locality: Panamint Mts. in California (Pergande).

Camponotus (C.) yogi Wheeler

According to Wheeler (1915), *yogi* was described from a single major and minor worker taken by P. Leonard from a hollow twig of manzanita near the Raja Yogi Institute on Point Loma near San Diego. Wheeler further states that, "This species is unlike any of our other North American *Camponoti*. It clearly approaches the species of *Colobopsis* and should, perhaps, be included in that subgenus."

N. B. Emery in his fascicles on the *Formicidae* in the "*Genera Insectorum*" noted a number of ants as occurring in California when as a matter of fact they are known only from Lower (Baja) California, Mexico.

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KEY TO THE SUBFAMILIES AND GENERA OF ANTS
IN CALIFORNIA

(Modified after W. M. Wheeler, 1910)

1. Cloacal orifice ventral, slit-shaped; sting well developed or vestigial; abdominal pedicel consisting of one or two segments 2
 - Cloacal orifice terminal, circular, surrounded by fringe of hairs; abdominal pedicel consisting of only a single segment; no constriction between the first and second gastric segments
..... Subfamily *Formicinae* (*Camponotinae*)
2. Sting developed; sometimes very small but nevertheless exerted; abdominal pedicel consisting of one or two segments; when of only one there is a distinct constriction between the first and second gastric segments 3
 - Sting vestigial; abdominal pedicel consisting of a single segment; no constriction between the first and second gastric segments; anal glands which produce a secretion with a peculiar rancid-butter odor ("Tapi-noma odor") are often present
..... Subfamily *Dolichoderinae*
3. Abdominal pedicel consisting of a single segment; gaster with a distinct constriction between its first and second segments; frontal carinae separated or close together; when close together they are dilated to form oblique or horizontal laminae partly covering the insertions of the antennae Subfamily *Ponerinae*
 - Abdominal pedicel consisting of two segments in the California species4
4. Frontal carinae very close together, almost vertical, not at all covering the antennal insertions. Eyes always very small or absent; tropical and subtropical
..... Subfamily *Dorylinae*
 - Frontal carinae of a different conformation and covering the antennal insertions; eyes rarely vestigial or absent 5
5. Clypeus not extending back between the frontal carinae; antennae 12-segmented Subfamily *Pseudomyrmicinae*
 - Clypeus almost always extending back between the frontal carinae; in the opposite case the antennae are 11-segmented Subfamily *Myrmicinae*

Subfamily PONERINAE

- Mandibles long and slender, with coarse bidenticulate teeth *Stigmatomma*
Mandibles of a different conformation *Poncra*

Subfamily DORYLINAE

- Reddish ants; army ants *Eciton*

Subfamily PSEUDOMYRMINAE

- Elongated pale reddish bodies; comparatively large eyes;
present in reeds and on plants *Pseudomyrma*

Subfamily MYRMICINAE

1. Postpetiole articulated to the dorsal surface of the gaster
which is flattened dorsally, more convex ventrally,
and acutely pointed *Crematogaster*
Postpetiole inserted at the anterior end of the gaster
which is of the usual shape 2
2. Antennae 11-segmented; without a distinct club, or with
a club consisting of only a single segment 3
Antennal club consisting of several segments, or the an-
tennae not 11-segmented 5
3. Hairs scale-like and appressed *Cyphomyrmex*
Hairs of a different conformation 4
4. Thoracic dorsum with three or more pairs of spines or
tubercles *Atta*
Thoracic dorsum of a different conformation 5
5. Antennae with a 2-segmented club; antennae 10-segment-
ed; epinotum unarmed *Solenopsis*
Antennal club, when developed, with more than two seg-
ments 6
6. Posterior margin of clypeus elevated in the form of a
welt or ridge bordering the antennal fossa in front;
antennae 12-segmented *Tetramorium*
Posterior border of clypeus not thus elevated 7
7. Antennae 11-segmented 8
Antennae 12-segmented 9

8. Thorax and petiole without any traces of teeth or spines; very small ants, 1-1.5 mm. in length *Monomorium*
 Epinotum armed with spines or teeth; mesoepinotal constriction faint or lacking *Leptothorax*
9. Workers strongly dimorphic, usually without intermediates connecting the extreme forms; antennal club 3-segmented, longer than the remainder of the funiculus Pheidole
 Workers monomorphic or polymorphic, i.e. with mediae intermediate between the major and minor forms; antennal club indistinct or shorter than the remainder of the funiculus 10
10. Last three antennal segments much shorter than the remainder of the funiculus and not forming a distinct club 11
 Last three antennal segments forming a distinct club nearly as long as the remainder of the funiculus 16
11. Thoracic dorsum more or less impressed at the mesoe-pinotal suture; promesonotal suture usually distinct .. 13
 Thoracic dorsum without any traces of suture or impression 12
12. Workers very slender, and extremely long-legged; uncommon in California *Novomessor*
 Workers of usual conformation; very common in California *Pogonomyrmex*
13. Posterior tibial spurs pectinate (under high magnification) *Myrmica*
 Posterior tibial spurs simple 14
14. Small species, with vestigial eyes and two keels on the clypeus *Stenammas*
 Medium-sized species, with well-developed eyes and no keels on the clypeus 15
15. Workers monomorphic; length of workers for most part less than 5 mm.; not xerophilous ... *Aphaenogaster*
 Workers at least feebly polymorphic; length of workers for most part over 5 mm. (excepting workers minor of *Veromessor pergandei* (Mayr)); usually xerophilous *Veromessor*
16. Clypeus armed with a pair of ridges which project forward in the form of teeth, rarely without teeth, but then the epinotum is quite unarmed; mesoepinotal suture marked; very small ants, 1-1.5 mm. in length *Monomorium*

Clypeus of a different conformation; rarely 2 toothed,
 but then the mesoepinotal suture is indistinct.....
 *Leptothorax*

Subfamily DOLICHODERINAE

1. Scale of petiole very small, strongly inclined forward,
 or even altogether absent 2
 Scale of petiole more or less inclined but well-developed 3
2. Scale of petiole small but indistinct; pale red color *Forelius*
 Scale vestigial or absent; dark brown or black color.....
 *Tapinoma*
3. Epinotum with a conical elevation *Dorymyrmex*
 Epinotum without a conical elevation 4
4. Body not conspicuously hairy or pubescent; ocelli ab-
 sent *Iridomyrmex*
 Body densely pubescent; ocelli usually present in large
 workers *Liometopum*

Subfamily FORMICINAE (CAMPONOTINAE)

1. Workers polymorphic *Camponotus*
 Workers not polymorphic 2
2. Clypeal fossa separated from antennal fossa; antennal
 scapes and tibiae without erect hairs; mesonotum
 strongly constricted and subcylindrical *Prenolepis*
 Clypeal fossa confluent with the antennal fossa 3
3. Segments 2-5 of the funiculus shorter or not longer than
 the succeeding segments; ocelli usually absent; max-
 illary palpi 6-segmented *Lasius*
 Segments 2-5 of the funiculus longer than the succeeding
 segments; ocelli distinct 4
4. Fourth segment of maxillary palpi longer than the fifth
 *Myrmecocystus*
 Fourth segment of maxillary palpi shorter than the fifth 5
5. Mandibles with broad, dentate, masticatory border; very
 common in California *Formica*
 Mandibles narrow, falcate and pointed; uncommon in
 California *Polyergus*

CONTRIBUTIONS FROM THE LOS ANGELES MUSEUM
- CHANNEL ISLANDS BIOLOGICAL SURVEY

No. 20 THREE NEW FLEAS (SIPHONAPTERA)

By G. F. AUGUSTSON

Research Associate, Allan Hancock Foundation,
University of Southern California

Preliminary work on the ectoparasite material collected by members of the Channel Island Biological Survey has uncovered fleas apparently new to science, which are here described and illustrated. All illustrations were completed with the aid of a camera lucida, all measurements with an ocular micrometer.

The writer at this time wishes to express his appreciation to all members participating in this survey, particularly to Dr. John A. Comstock, Dr. W. D. Pierce, and Mr. J. C. von Bloeker, for their considerate cooperation and constant aid.

DOLICHOPSYLLIDAE

OPISODASYS NESIOTUS n. sp.

Male (Holotype)

HEAD. Frons somewhat angulate, frontal notch weakly indicated. Preantennal region with two rows of bristles, 7 irregular medium bristles in upper row, 3 much larger bristles in the lower row. Postantennal region with one row of 4 subequal, medium bristles, and one much larger between the first bristle of the above row and the antennal groove. Labial palpi slightly shorter than fore coxa.

BODY AND LEGS. Pronotum with 10 ctenidia on a side. Two antepygidial bristles, the medial two-thirds longer than the outer. All tarsal segments, as well as rest of all leg segments, as in other members of the genus.

MODIFIED ABDOMINAL SEGMENTS. Best identified by accompanying illustrations of modified abdominal segments composing the genitalia (Plate 6, figs. 4 and 5). This species differs here from the closely related *O. keeni* in that the movable finger is of shorter length compared to the height of the process of the clasper; in that the anterior face of the finger is more deeply concave, and upper and lower posterior angles of same are more evenly rounded; and in that the lower spiniform of the finger is more attenuated and somewhat curved downward; and in that the VIII sternite has 2 terminal bristles, and a bifurcated membranous flap.

Female (Allotype)

HEAD. Frons more evenly rounded than in male, frontal notch as in male. Upper row of preantennal bristles 5 only, lower row as in male. Postantennal region with one row of 2 medium bristles and one weaker bristle, with large bristle between row and antennal groove as in male.

BODY AND LEGS. Three antepygidial bristles, the upper one-third that of the middle, the latter slightly longer than the lower. Pronotum and legs as in male.

MODIFIED ABDOMINAL SEGMENTS. Sternite VII differing from that of *O. keeni* in the much deeper sinus, protruded lower lobe, and in the number and arrangement of the bristles (Plate 6, fig. 3).

Holotype: Male, number 1939-582 L. A. M., from *Peromyscus maniculatus elusus* Nelson and Goldman; collector, J. C. von Bloeker; location, Santa Barbara Island, California, May 28, 1939. Deposited in the Los Angeles County Museum, Los Angeles, California.

Allotype: Female, number 1939-1120 L. A. M., from *Peromyscus maniculatus sanctaerosae* von Bloeker; collector, J. C. von Bloeker; location, Santa Rosa Island, Santa Barbara County California, August 8, 1939. Deposited by the Los Angeles County Museum, Los Angeles, California.

Type Host: *Peromyscus maniculatus elusus* Nelson and Goldman.

Type Locality: Santa Barbara Island, Los Angeles County, California.

Paratypes: 35 males, 28 females in the Los Angeles County Museum Collection. 5 males, 6 females in author's collection (distribution and host records to follow in a later report).

Measurements: length, male (holotype) 3 mm.; length, female (allotype), 2.4 mm.

Discussion. The wide distribution over the Channel Islands gives this parasite its name from the Greek word for "Islander."

The position and diagnosis of fleas of the genus *Opisodasys* has recently been greatly strengthened by Dr. William Jellison's excellent report, "Opisodasys Jordan 1933, A Genus of Siphonaptera," Jour. of Parasitology, Oct., 1939, Vol. XXV, No. 5, pages 413-420, plates I-III. Also by Dr. I. Fox's still more recent "A New Opisodasys From Idaho (Siphonaptera: Dolichopslidae)," Ent. News, Vol. LII, No. 2, pages 45-46, 4 figs. The latter in-

cludes a key (males only) into which *O. nesiotus* can be incorporated as follows (last portion only):

- 5. Sternal plate VIII with one apical bristle *O. keeni*
- Sternal plate VIII with two apical bristles *O. nesiotus*
- Sternal plate VIII without an apical bristle *O. enoplus*

HYSTRICHOPSYLLIDAE

CATALLAGIA VONBLOEKERI n. sp.

Male (Holotype)

Frons well rounded, the peglike frontal notch prominent. Preantennal region with two rows of bristles, 4-5 medium bristles in the upper row, 3 much stouter bristles in the lower. Postantennal region with three rows of bristles 4-6 in each, all at an oblique angle to the occiput. Pronotum with 13 ctenidia. Labial palpi six segmented, not reaching apex of fore coxa. Three antepygidial bristles, the outer two subequal, one-half the length of the middle. Best identified by the modified abdominal segments. Sternite IX close to *C. chamberlini*, differing in the blunt, not curved, first tooth of the apical group, presence of a spine like bristle in this group, and a small plateau area (Plate 6, fig. 1).

Female (Allotype)

Chaetotaxy of head as in male, frons more gently rounded. Pronotum with 13 ctenidia. Three antepygidial bristles, the one most proximal to the medial line one-half the length of one most distal, which in turn is one-half the length of the middle bristle. Style tapering slightly from base to apex, the total length exceeding the width of the base by two and one-half times. Sternite VII close to that of *C. decipiens*, differing in the weaker upper lobe and in the number of bristles on a side—*C. decipiens* having 6-7 large bristles in the posterior row, 12-14 small bristles in the anterior row, *C. vonblockeri* with 5-6 in posterior row, and only 3-4 in the anterior row (Plate 6, fig. 2).

Holotype: Male, number 1939-1120 L. A. M., from *Peromyscus maniculatus sanctacrosae* von Blocker; collector, J. C. von Blocker; location, Santa Rosa Island, California; August 8, 1939. Deposited in the Los Angeles County Museum, Los Angeles, California.

Allotype: Female, number 1939-1120 L. A. M. (as above). Deposited in the Los Angeles County Museum, Los Angeles, California.

Type Host: *Peromyscus maniculatus sanctacrosae* von Blocker.

Type Locality: Santa Rosa Island, Santa Barbara County, California.

Paratypes: 1 male, 1 female, number 1939-1120 L. A. M. (as above). Deposited in the Los Angeles County Museum, Los Angeles, California.

Measurements: length, male (Holotype) 1.7 mm.; length, female (Allotype) 2.2 mm.

Discussion: The species is named in honor of Mr. J. C. von Bloeker, Mammalogist, Los Angeles Museum. To facilitate comparison of this new *Catallagia* and other west coast members of the genus the reader is referred to Dr. C. A. Hubbard's fine review "West Coast *Catallagias*" Pac. Univ. Bull., Vol. XXXVII, No. 3, May, 1940.

ISCHNOPSYLLIDAE

MYODOPSYLLOIDES new genus

Head like that of *Myodopsylla*; differing in the slightly attenuate frons with a weak indentation above the oral flaps, the single row of four bristles in the postantennal region, and the fewer number of small bristles in the preantennal region. Maxilla truncate. Labial palpi six segmented. Metaepimerum longer than high, with only two stout bristles and one medium bristle on the posterior margin, making a total of seven bristles in all on a side; with only a single vertical bar. Metanotum with six minute teeth on its dorsal, posterior margin. Six similar teeth on first abdominal tergite, four on second, and two on third. Other vestiges of ctenidia lacking. Abdominal tergites with internal incassations, particularly evident in segments two and three of females and one to seven inclusive in males. Abdominal sternites without incassations. Clasper of males knob-like posterior to manubrium. Spermatheca of females with globular head not much thicker than curved tail (Plate 7).

Genotype: *Myodopsylloides piercei* Augustson.

MYODOPSYLLOIDES PIERCEI n. sp.

Male (Holotype)

HEAD. Eye vestigial, anterior lower portion with a small hook like process. Preantennal region with one very long bristle just above the eye, three medium bristles continuing row obliquely toward outer angle of frons. Anterior to this row 4-5 scattered small bristles. Postantennal region with one row of four bristles. Posterior margin of occiput with six medium bristles and two small bristles. In addition three bristles of different sizes on the process of the union of the margin of the occiput and antennal groove. Genal process sharply pointed, heavily pigmented. Oral flaps large, subequal, the inner slightly longer and more pointed than the outer (Plate 7, fig. 4).

BODY AND LEGS. Pronotal ctenidium of ten slender spines on a side. A single antepygial bristle. Outer surface of all tibiae with a single row of subequal bristles. Hind tarsus V with six pair lateral plantar bristles, the first pair dislocated toward the medial line, the last pair slender.

MODIFIED ABDOMINAL SEGMENTS. Base of sternite VIII very broad; outer portion acutely rounded, with many long bristles curved at their ends, and two patches of small stout bristles along the outer ventral boarder of same. Clasper greatly constricted at its union with manubrium forming a knot-like structure. Finger small, completely hidden by clasper. Base of sternite IX weak, fusing with that of VIII, divided into two posterior processes, the ventral short with an outer row of many short bristles, the upper long with a single normal bristle.

Female (Allotype)

HEAD. As in male.

BODY AND LEGS. Pronotum as in male. Tibia as in male. A single antepygidial bristle as in male. Hind tarsus as in male.

MODIFIED ABDOMINAL SEGMENTS. Sternite VII somewhat sharply angulate, without sinus. Bursa copulatrix weakly doubled, curved. Sternite VIII with 16-17 stout bristles. Ventral edge of Sternite X not distinctly angulate, with 5-6 stout bristles. Style length about two and one-half times its greatest width, with one long terminal bristle, one much shorter slightly below, and another somewhat longer than the second and slightly below and opposite (Plate 7, fig. 3).

Holotype: Male, number 1939-1068c L. A. M., from *Antrozous pallidus pacificus* Merriam; collector, J. C. von Bloeker; location, Santa Cruz Island, California, August 17, 1939. Deposited in the Los Angeles County Museum, Los Angeles, California.

Allotype: Female, number 1939-1068c L. A. M., (as above). Deposited in the Los Angeles County Museum, Los Angeles, California.

Type Host: *Antrozous pallidus pacificus* Merriam.

Type Locality: Santa Cruz Island, Santa Barbara County, California.

Paratypes: 2 females, number 1939-1068c (as above). Deposited in the Los Angeles County Museum, Los Angeles, California. 3 males in the writer's collection, number 38-6 GA, from *Antrozous pallidus pacificus* Merriam; collector, G. Augustson; location, Santa Cruz Island, California. August 8, 1938. Also one male in writer's collection, number 39-36 GA, from *Corynorhinus rafinesquii intermedius* Grinnell; collector, G. P. Ashcraft; location, Santa Cruz Island, California, August 19, 1939.

Measurements: length, male (Holotype) 2.5 mm.; length, female (Allotype) 3.2 mm.

Remarks: Named in honor of Dr. W. D. Pierce, Senior Curator of Entomology, Los Angeles Museum.

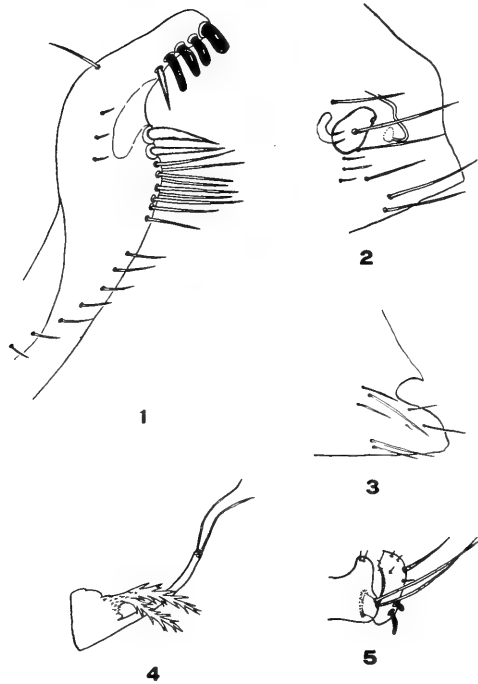


PLATE 6

- Fig. 1. *Catallagia vonbloekeri* Aug., sternite IX, male.
Fig. 2. *Catallagia vonbloekeri* Aug., sternite VII, female.
Fig. 3. *Opisodasys nesiotus* Aug., sternite VII, female.
Fig. 4. *Opisodasys nesiotus* Aug., sternite VIII, male.
Fig. 5. *Opisodasys nesiotus* Aug., movable finger, male.

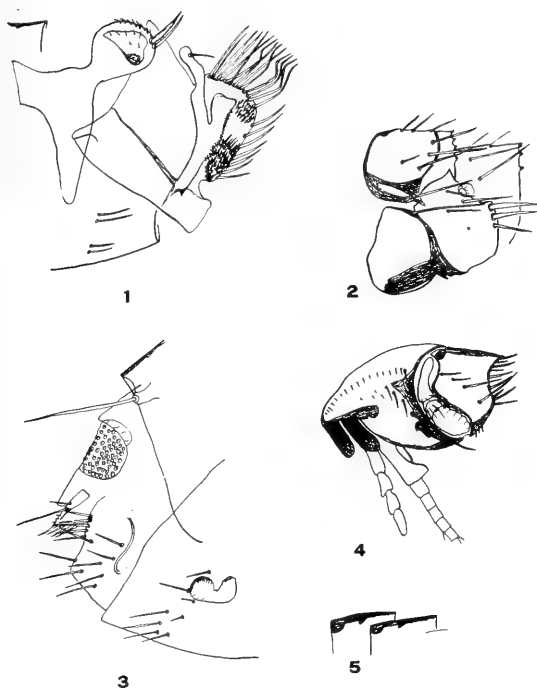


PLATE 7

Fig. 1. *Myodopsylloides piercei* Aug., male genitalia.

Fig. 2. *Myodopsylloides piercei* Aug., metanotum, metaepimerum, first abdominal tergite, male.

Fig. 3. *Myodopsylloides piercei* Aug., posterior extremity of female.

Fig. 4. *Myodopsylloides piercei* Aug., head of male.

Fig. 5. *Myodopsylloides piercei* Aug., abdominal tergites II and III, male.

No. 21. TWO NEW PLANTS FROM THE CHANNEL
ISLANDS OF CALIFORNIA

By M. B. DUNKLE

A NEW MIRABILIS FROM SAN CLEMENTE ISLAND

During the second expedition of the Los Angeles Museum-Channel Islands Biological Survey to San Clemente Island a new variety of *Mirabilis laevis* (Benth.) Curran was collected. The plants were growing on an eastern-facing grassy slope at the mouth of Chinetti Canyon at Pyramid Cove. They were growing here and at other points about Pyramid Cove interspersed with plants of *Mirabilis laevis* (Benth.) Curran variety *cedrosensis* (Standl.) Munz. The plants were collected in full bloom on April 3, 1939, Dunkle No. 7234.

The two varieties appeared quite distinct in the field and further study and comparison has brought out other differences. The new variety presents a much wider departure from the species than does the other variety on San Clemente.

Mirabilis laevis (Benth.) Curran var. *cordifolia* Dunkle var. nov. Stems sparsely, short viscid puberulent, and with a few short harsh hairs; leaves broadly cordate-ovate; calyx very light pinkish-red, spreading, 5 to 8 mm. long.

Caulibus viscido-puberulis, brevibus paucisque et villis duris, brevibus, paucis; foliis cordato-ovatis latis; calyce roseis, patentibus, 5-8 mm. longis.

A NEW ADENOSTOMA FROM SANTA ROSA ISLAND

During the 1939 expedition of the Los Angeles Museum-Channel Islands Biological Survey to Santa Rosa Island an interesting new variety of *Adenostoma fasciculatum* H. & A. was collected in the Torrey Pine grove about three miles south of the Vail Ranch, Dunkle No. 8496, August 7, 1939. It was abundant in that particular locality.

This shrub differed from the species in forming broad, low mats and in having much shorter leaves, and petals. The inflorescence consisted of single sub-globular flower clusters. Many kinds of shrubs assume this decumbent form on exposed headlands, but this locality was well protected.

Adenostoma fasciculatum H. & A. variety *prostratum* Dunkle,
var. nov.

Plant low, decumbent and spreading, forming broad mats, 5 to 90 cm. high; stems woody, glabrous; leaves linear, fascicled, glabrous, 3 to 7 mm. long; flowers in compact, sub-globose clusters; bracts 1.5 mm. long; calyx 2 mm. long; petals white, .5 to 1 mm. long.

Plantae humilis; caulibus decumbentibus, ligneis, 5-90 cm. altis; foliis linearis, fasciculatis, glabris, 3-7 mm. longis; inflorescentia conglomerata; bracteis 1.5 mm. longis; calyce 2 mm. longis; petalis albis, .5-1 mm. longis.

THE LARVA OF *POLITES MANATAAQUA* HARR.

By V. G. DETHIER

John Carroll University, Cleveland, Ohio

This skipper is nowhere very common. Several gravid females were taken in Franklin, N. H., during June. Egg laying was completed by the end of the first week in July. Since descriptions of the egg and first instar larva have appeared elsewhere, they are omitted below.

SECOND INSTAR: Head height .8 mm.; head width .75 mm. Head black with whitish hairs shorter and more numerous than in first instar. Irregular corrugations. Body 5.5 mm. long. Pure white before eating. After eating, dull dark green mottled with greenish white. Dorsal line dull dark green. Scattering of many short black hairs. First pair of legs fuscous. Remaining legs and underside clear bluish green, at times almost blue white.

THIRD INSTAR: Head height 1.25 mm.; head width 1.2 mm.



PLATE 8

Mature larva of *Polites manataaqua* Harr. Approximately x 5.

Head dull black with many crowded coarse punctations which change to rough parallel ridges in the region of the clypeus and labrum. These are more or less parallel to the long axis of the head. Whitish hairs more numerous. Body 7.5 to 11 mm. long. General appearance light dull olive green. Some specimens present a rusty appearance due to a background of doe skin color. Body usually with dull white mottling on a dull olive green background. Dull olive green dorsal line due to a lack of mottling in that area. Anal plate darker olive brown. Covered with short black hairs.

FOURTH INSTAR: Head height 2 mm.; head width 1.8 mm. Head dull black. Sculpturing as in foregoing instar but more pronounced. Covered with numerous short tawny hairs. Body length 13.5 to 18 mm. Darker than before, almost chocolate in color. Dull white mottling on brown to olive background. Anal plate shiny and darker due in part to more closely applied black tubercles. General appearance dull dark olive brown. Short black hairs scattered over entire body. Shield, spiracles, and legs black.

FIFTH INSTAR: Head height 3 mm.; head width 2.8 mm. Head dull black. Same as above. Stout, short, tawny hairs more numerous. Body length 20 to 24 mm. Body dark chocolate in general appearance. Soiled white mottling on chocolate background. Prolegs and ventum pallid. Numerous short spine-like tawny hairs on body, arising from black tubercles. Concentrated on the transverse folds of the body. Transverse folds thus appear darker than surrounding areas. Hairs on edge of anal plate but slightly longer than those on general surface of body. Spiracles, legs, and shield black.

This species is apparently single brooded in the vicinity of Franklin, New Hampshire. Adults appeared in June, and eggs were laid on July 4. Larvae emerged July 26 the egg stage hav-



PLATE 9

Head of mature larva of *P. manataaqua* Harr. Front view.
Approximately x 10.

ing lasted twenty-two days. The first instar required fifteen days, moults occurring August 10; the second instar, twelve days with moults August 22; the third instar, ten days with moults September 1; the fourth instar, thirty-one to forty days or all winter.

This species usually hibernates in the fourth instar and probably at times in the third. It does not seem possible that it could pass the winter as a chrysalis because the later instars consume so much time that the first frost arrives when the insect is in the fourth instar. Animals which were reared indoors could be induced to continue development. Thus several moulted into the fifth instar on October 1 and 10 and November 5, 11, and 19. For these animals the longest time recorded for the completion of the fourth instar was eighty days.



LIFE HISTORY OF RAPHIA CINDERELLA SM.

By JOHN A. COMSTOCK

Egg, 1.4 mm. diameter by about .75 mm. high. In form it is a flattened cone, with the micropyle inconspicuous and not depressed and the base very flat. The surface bears a number of low ridges starting at the circumference and converging toward the base. These begin as some 36 at the outer edge, and rapidly pinch out as they approach the micropylar area. These ridges are very irregular in size and height, and are somewhat nodular in appearance, but there are no regular cross striations or subsidiary horizontal ridges as in many Noctuid eggs.

In nature the female deposits her eggs on the bark of poplar, laying them singly or in groups of two or three. Each egg is pressed into a small depression, and is evidently worked over by the caudal end of the abdomen, causing a number of scale fragments and specks of bark and debris to adhere to the egg surface, thus helping to camouflage it. The flattened appearance of the egg is undoubtedly due to this caudal "dressing down," as eggs which were laid on a mesh were forced through the interstices where they could not be reached, and in consequence were much more spherical and clean. It may be noted that eggs so deposited hatched as readily as did the flattened ones.

The color of the egg is, at first a light green, changing shortly to a soiled gray.

Larva, first instar; length, 2 mm. Color, a uniform light yellow, slightly translucent. Head much larger than body segments. Ocelli, black. A few colorless setae occur on head and body. Mouth parts, yellow-brown. Legs and prolegs concolorous with body. There are four pair of prolegs, but the two forward pair are short and non-functional, and the gait is therefore that of a looper.

Penultimate instar. Length 23 mm.

Head, light green, sparsely sprinkled with short white setae. Ocelli; the upper two, black, the remainder yellow-green. Mouth parts, white, edged with black.

Body; translucent olive-green, the typical segment being crossed transversely by two rows of bright yellow spots, each bearing a minute black seta. In the mid-dorsal area of the second segment there is a pair of cone-shaped processes, yellow at the base shading to orange in the center, and flecked with blackish brown over the tips. On the same segment there is a small round raised orange spot in the stigmatal area, tipped with orange, in the center of which is a black pupil. The fourth segment bears a curving orange stripe, beginning laterally about 1 mm. above the spiracle, arching dorsally and also inclining more posteriorly on the segment, thus forming a curved line. This line has a pair of orange spots near the mid-dorsal area, resting on and extending forward from it. The orange of this pair of spots is streaked and etched with a number of irregular black dashes.

A similar line, and a pair of spots also occurs on the eighth segment, and again on the eleventh, but the latter bears smaller orange spots with much reduced black etching.

The anal prolegs are margined posteriorly with yellow, this margin topped with a bar of orange-pink.

Abdomen; green. Legs; green, tipped with black. Prolegs; green, all four pair being functional. Crochets, brown. Spiracles; light yellow, narrowly margined with brown.

Final instar. Length, 30 mm.

Body color, same as in the last instar, as is also the head. The curved orange stripe arching over the dorsum on the second, eighth and eleventh segments is narrower, and has lost the prominent pair of spots attached to its frontal margin, their places being taken merely by a pink edging of the yellow line at that point.

The prominent pair of cone-shaped processes on the second segment are relatively reduced in size, and are tipped only with pink.

Otherwise the larva appears as in the penultimate instar.

Plate 10 illustrates the mature larva.

The cocoon is spun in a crevice of the poplar bark. It is hard and firm, and the surface texture and color, together with the bits of bark and dirt incorporated in it, serve as an admirable camouflage. It is, in fact, almost impossible to distinguish the cocoon from irregularities in the bark.

Dyar has described the mature larva, cocoon, and pupa of *Raphia coloradensis* (Can. Ent. XXVI, (1) 17, 1894), and Thaxter records the larva of *R. frater*. in *Papilio*, Vol. 3, p. 13, 1883. No other references to the early stages of members of this genus occur in the literature, to our knowledge.

Dyar lists aspen and cottonwood as foodplants. (Proc. U. S. Natl. Mus. XXVII, 808, 1904.)

Our series of imagines shows emergence in every month from February to July, both inclusive.



PLATE 10

Mature larva of *Raphia cinderella*,
dorsal aspect, enlarged x 1½.

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Part 3

CONTENTS

	<i>Page</i>
SOME NOTES ON THE DISTRIBUTION RECORDS OF LITTLE KNOWN SO. CALIF. ECHINODERMS—Fred C. Ziesenhenné - -	117
THE PHYLOGENETIC POSITION OF THE STREPSIPTERA AS DETERMINED BY THE FIRST LARVA—W. Dwight Pierce - -	121
THE BIONOMICS OF PTINUS CALIFORNICUS, A PREDATOR IN THE NESTS OF BEES—E. G. Linsley and J. W. MacSwain -	126
A NEW FLEA FROM THE MOJAVE DESERT—G. F. Augustson -	138
SOME NEW CALIFORNIA SIPHONAPTERA—G. F. Augustson -	140
ECTOPARASITE-HOST RECORDS FROM THE SIERRAN REGION OF EAST-CENTRAL CALIFORNIA—G. F. Augustson - - -	147
THE ALLOTYPE OF GEUSIBIA ASHCRAFTI—G. F. Augustson -	157
NOTES ON LOXOPHORA DAMMERSI—John A. Comstock - - -	160
CONTRIBUTIONS FROM THE LOS ANGELES MUSEUM - CHANNEL ISLANDS BIOLOGICAL SURVEY:	
22. A NEW SUBSPECIES OF WHITE-FOOTED MOUSE FROM THE ANACAPA ISLANDS, CALIFORNIA—Jack C. Von Bloeker - - -	161
23. A NEW SHREW FROM SANTA CATALINA ISLAND, CALIFORNIA—Jack C. Von Bloeker - - - - -	163
24. THE LARVA AND PUPA OF TRICHOCLEA EDWARDSI—John A. Comstock and Christopher Henne - - - -	165
IN MEMORIAM: WILLIAM A. SPALDING - - - - -	167

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SOME NOTES ON THE DISTRIBUTION RECORDS OF LITTLE KNOWN SOUTHERN CALIFORNIA ECHINODERMS

By FRED C. ZIESENHENNE
Allan Hancock Foundation
The University of Southern California

During the past two years much of the research work of the Velero III, Hancock Foundation research ship, of The University of Southern California, has been carried out in the waters of Southern California.

In the materials collected were three little known species of brittle stars and two species of sea urchins that have been observed and studied. The results of such a study proved so interesting that some of the most unusual observations and new distribution records are presented. In addition, the descriptive characteristics of the little known species are included to help the marine collectors distinguish the rare from the more common California forms.

The most unusual of the brittle stars collected is the unique *Astrophiura permira* Sladen (1878, p. 401). This brittle star differs from other species by the development of an "awning" between the arms, leaving only the short unmodified arms projecting beyond the "awning". In general it resembles a miniature umbrella minus the handle. From the general appearance and pentagonal shape it might easily be mistaken for the young of the common orange peel star *Asterina miniata* (Brandt) of the California Coast.

The basal arm segments of this brittle star are fused together, forming a pentagonal "asteroid" body around the distal margins of the disk proper. The basal side armplates are long, broad and flat; they fuse with the corresponding side armplates of the adjoining arm to form a solid interradial "awning", which collectively build the pentagonal body. The distal borders of the interradial pentagonal body are hemmed with small modified armspines that are soldered together, fence-like. The tentacle pores are found only on the arm segments within the pentagonal body. The free arms extending beyond the "awning" are very short and abortive, consisting of reduced side armplates bearing armspines, but lacking upper and under armplates and tentacle pores.

This peculiar "sucking disk" pentagonal body is especially well adapted for holding the animal on smooth, flat rock surfaces, where it lives attached to rocks in an environment similar to that of the common chitons, limpets and abalones of the intertidal zone. The large basal tentacles and the pentagonal body with

the "fence" of fused armspines increases the efficiency of the animals to adhere to smooth surfaces and in addition forms a shield to protect the underside from attacks of smaller enemies.

These specimens are the first to be recorded from the eastern Pacific Ocean and the only specimens recorded from either of the American Coasts. With the exception of two individuals, the few specimens known to science have been collected in the south Atlantic Ocean along the coast of South Africa, Agulhas Bank and Cape St. Blaize.

Dr. H. L. Clark (1923, p. 355) reports the type was taken at Madagascar and the other specimen was dredged in the Sagami Sea of Japan. The California specimens were dredged by the *Velero III* in 230 fathoms of water, rocky bottom, six miles east of Long Point, Santa Catalina Island, May 3, 1941.

This species can be readily distinguished from the other California brittle stars by its unique structures and pentagonal shape.

Another little known California brittle star, *Ophioncus granulatus*, was described by J. E. Ives (1898, p. 143) as a new genus and species of the family *Ophiodermatidae* from material collected by Mr. W. N. Lockington somewhere on the West Coast of America. The type was lost and the actual locality had never been established. The *Velero III* dredged two specimens in 41-43 fathoms, rock and sponge bottom, one mile northwest of Anacapa Island, California, March 16, 1941.

The short arms and large disk are likely to confuse it with the young of the common brittle star, *Ophioplocus esmarki* Lyman, from which it differs by having a single upper armplate and disk granulations. From the other California brittle stars, *Ophioncus granulatus* Ives, can readily be distinguished by its large, swollen, convex granulated plates that cover the upper surface of the disk.

New to the mainland of California is the brittle star, *Ophiocnida hispida* Le Conte, a common tropical shallow water species, which was collected on the inside of the San Pedro breakwater at low tide, Nov. 30, 1940. Ordinarily this species ranges from the Gulf of California to Peru. McClendon (1909, p. 46) reported one specimen collected by W. H. Dall on Santa Catalina Island.

It can readily be distinguished from other California shallow water brittle stars by the smooth, delicate spines covering the disk, the three pairs of mouth papillae and the three, short, stubby, smooth armspines.

The low tides of the fall of 1940 and winter of 1941 have exposed a tropical shallow water sea urchin new to the California fauna. Dr. H. R. Hill of the Los Angeles County Museum sent a specimen to the Allan Hancock Foundation for identification. It was a large adult, *Arbacia incisa* A. Agassiz, a common tropical intertidal urchin that ranges from Peru north to

Cerros Island, Lower California, and had not been reported north of Cerros Island. About fifteen large adults are known to have been taken by various local collectors in Newport Bay. Mr. and Mrs. F. L. Grouard of Santa Ana were among the first to collect *Arbacia incisa* and presented specimens to the Allan Hancock Foundation and the Los Angeles County Museum. Mr. E. B. Sprague of Santa Ana and a few other collectors have taken *Arbacia incisa* in Newport Bay. Dr. W. A. Hilton of Pomona College reports one of his students using a diving helmet collected an *Arbacia incisa* off Laguna Beach.

On one of the lowest January tides Mrs. F. L. Grouard, Mr. and Mrs. E. B. Sprague, Mr. Gustav Augustson and the writer shore collected in Newport Bay. Only one *Arbacia incisa* was taken and it was kept alive and studied for over a week in the laboratory, during which time colored stills and colored motion pictures were taken. *Arbacia incisa* can be distinguished from the other California sea urchins by the broad naked interambulacral areas, the spines which are few and short on the upper test, becoming numerous and longer on the lower portion of the test, and the flattened, even concave, chisel-like tips of the lower test spines.

In addition to *Arbacia* a number of *Centrostephanus coronatus* (Verrill) were collected. This is another shallow water tropical sea urchin commonly found in the Gulf of California and the Mexican Coast. Previously Grant and Hertlein (1938, p. 16) reported this species from Corona Del Mar and Newport Bay. Mr. Steve A. Glassell donated a specimen to the Allan Hancock Foundation, which had been collected at Corona Del Mar in 1931 on the site now covered by the east Newport Harbor Breakwater. Mr. V. E. Brock, while diving for fishes in Fisherman's Harbor, Santa Catalina Island, collected a series of adult *Centrostephanus coronatus*.

Centrostephanus coronatus can be distinguished from the other California sea urchins by its exceedingly long, fragile, white and purple banded armspines and the short spines on the soft buccal membrane surrounding the mouth.

The days collecting at Newport Beach yielded the following echinoids:

1. *Arbacia incisa* A. Agassiz.
2. *Centrostephanus coronatus* (Verrill)=long spined urchin.
3. *Strongylocentrotus franciscanus* (A. Agassiz) = red urchin.
4. *Strongylocentrotus purpuratus* (Stimpson) = purple urchin.
5. *Lytechinus pictus* (Verrill)=snow ball urchin.
6. *Lytechinus anamesus* H. L. Clark=brown spotted urchin.
7. *Dendraster excentricus* (Eschscholtz)=common sand dollar.

The only other common Southern California intertidal echinoid that was not collected is *Lovenia cordiformis* A. Agassiz, the common sea mouse. Collecting seven species of echinoids, three species of holothurians, three species of sea stars and four species of brittle stars at one locality is a new record for Southern California waters.

The warm water of the past two winters might account for the occurrence of so many tropical species on the Southern California Coast. Apparently *Centrostephanus coronatus* Verrill, is well established in California waters as it has been collected over a period of years from different localities and the young have been taken along with adults to indicate some reproduction has taken place. *Arbacia incisa* A. Agassiz, does not seem to be established in local waters as only the adults have been collected. Dredging in deeper water might produce immature individuals of this species.

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THE PHYLOGENETIC POSITION OF THE STREPSIPTERA AS DETERMINED BY THE FIRST LARVA

By W. DWIGHT PIERCE

In all of his studies in the interesting order Strepsiptera the writer has contended that the order bears little, beyond the superficial, resemblance to the Coleoptera, the only other insect order with metathoracic wings. There are many important characters to bear out this contention: the first larva, the pupariate development, the structure of the thorax; the structure of the eyes, the nervous system, etc. As time permits the arguments will be presented on each of these points, for it appears that there are still students who regard Strepsiptera and Coleoptera as from the same phylogenetic stem.

In the present paper the evidences will be deduced showing that superficial resemblance in the first larva is not a valid argument for placing two orders together. The fact that two groups pass through a cycle of hypermetamorphosis is not a proof of close relationship.

Our first approach to the problem must be to determine the relative time and phylogenetic period of origin of the triungulinid or planidium form of larval structure. If this were only to be found in Coleoptera and Strepsiptera there would be some ground for thinking that perhaps it tokened relationship.

But the triungulinid or planidium type of insect larva is a much older form than the insect group as a whole. It is therefore a type which might occur anywhere in the insect world, as it truly does. In fact it also occurs in Myriapoda, Crustacea, Echinoderida, Polychaeta and Linguatulida.

1. *Anamorphosis.*

If one should look carefully at the illustrations in any great textbook of zoology, as for example Korschelt and Heider's (1893) *Lehrbuch der Vergleichenden Entwicklungsgeschichte der Wirbellosen Thiere* (K. & H.), he would see the gradual approach to our planidium type of larva starting clear back in the beginning of Coelomata.

One has to search far back in the world of more primitive forms for the beginnings of metamorphosis, in which the adult creature differs considerably from its first phases after the egg.

For example in *Aurelia aurita* (K. & H. p. 66) we find several phenomena of considerable importance to our argument. This form belongs in the Cnidaria Scyphomedusae. Family Aureliidae.

From the free living planula it passes into a fixed larval stage, develops tentacles and then begins segmentation, and we are interested to find that the new segments appear between the

tentacle or head end and the fixed base, and always behind all previously formed segments, except the fixed base.

Snodgrass (1938) in his *Evolution of the Annelida, Onychophora and Arthropoda*, (Smiths. Misc. Coll. 97 (6)(S)), has shown that this growth zone in free animals is in the mesodermal teloblast, occurring, for example, in the larval polychaetes, in front of the pygidium of the trochophore larva (S. p. 27). He shows that the first step in metamorphosis is segmentation into three segments of the original area behind the trochus, which apparently defines the head, and in front of the pygidium and mesodermal teloblast. These three segments remain fixed in subsequent development, as new segments appear in front of the teloblast.

This same kind of development or addition of segments, which has been called anamorphosis, occurs in the Myriapoda, in *Polyxenus*, *Glomeris*, *Polydesmus*, *Strongylosoma* and *Julus* in the Diplopoda, and *Pauropus* in Pauropoda; all beginning in a larva with a thorax with three pairs of legs, and a pygidial area. (K. & H., pp. 734-743). Additional segments are developed from the prepygidial area, behind the last leg bearing segment; and each of these segments is provided with a pair or two of legs.

2. *Differentiation of Head, Thorax and Abdomen.*

By this close resemblance of Myriapod with Polychaete larval development we can assume with considerable degree of accuracy that the initial area between trochus, which defines the posterior margin of the head, and the pygidium is the part which becomes the thorax in insects.

The part behind the thorax is the abdomen, which starts with a pygidium and prepygidial teloblastic area, and adds segments by development from the prepygidial segment, in front of that zone.

This type of growth is well exemplified in the Diplopod *Polyxenus anacapensis* Pierce. (Pierce 1940. Bull. So. Cal. Ac. Sci. 39 (2) 158-171). (P.) These little creatures start with only head, thorax, prepygidium and pygidium and are hexapod in the first stage; but the addition of segments by anamorphosis increases the leg-bearing sternites to 13. When mature they have the form characteristic of insect first larvae of the triungulinid or planidium type.

Thus while we are accustomed to considering the thorax as a part originating in Insecta, we can see that the same part of the body was differentiated in Polychaeta and Myriapoda and probably in all phylogenetic steps between the worms and the insects.

3. *The Planidium or Triungulinid Type of Larva.*

That phase of metamorphosis which takes place in the larva after emergence from the egg in the lower classes, known as anamorphosis, is completed in the insect egg. Consequently

practically all insects of the planidium type start larval life with the full quota of 10 to 12 abdominal segments, the development of these segments having taken place in the egg.

But we must recognize that the general type of form of the planidium larva is to be found in many lower groups, and the resemblance is so pronounced that one might have difficulty in placing his specimen without examination of the appendages.

Thus we see the form in the genus *Nerilla* of the Archianellida (S 31); in the echinoderid worm, *Echinoderes masudai* Abe (Yoshio Abe, 1930. Jour. Sci. Hiroshima Univ. ser. B. div. 1, vol. 1 (3):40-44); the larva of *Microniscus* in Isopoda (O. Pesta, 1933. Zool. Anz. 104 (0/10):277); the larva of *Pinnotherion vermiforme* Giard and Bonnier in Isopoda, Entoniscidae (Miss D. Atkins, 1933. Proc. Zool. Soc. London. 1933 (2): 319-363); in all larval Coccidae; some larval Thysanoptera; in larval Phylloxera of the Aphidoptera; in all larval Eucharidae of the Hymenoptera, as for example *Coccophagus gurneyi* Comp. (Curtis P. Clausen, 1940. Entomophagous Insects, p. 15) (C).

Clausen points out that this type of larva occurs in all parasitic Perilampidae of the Hymenoptera; all known Cyrtidae, and certain Tachinidae and Sarcophagidae in Diptera; all Strepsiptera; and in the Ripiphoridae and Meloidae in Coleoptera.

We may add that the type occurs from first larva sometimes into maturity in Scolopendrella of the Symphyla; Acerentomon of the Protura; Campodea of the Rhabdura; Machilis of the Archaeognatha; Lepisma of the Zygentoma; most Blattariae; Grylloblatta of the Notoptera; Zorotypus of the Zoraptera; Hemimerus of the Diploglossata; all Isoptera; Mallophaga and Anoplura.

It is then a widely distributed form type of very primitive origin. The existence of the form proves nothing as to its relationship.

4. *Caudal cirri or bristles.* One of the most outstanding characteristics of many representatives of the planidium type is the presence of one or two pair of caudal cirri or bristles, which are usually simple, but sometimes jointed. From a study of the primitive Polychaete type (S 27) we find that the cirri originate in the pygidial area beyond the teloblastic growth zone. We note these cirri in *Nerilla* (S 21), *Echinoderes* (Abe), *Microniscus* (Pesta), *Pinnotherion* (Atkins), *Agriotypus* (C 96), *Perilampus* (C 220), *Pterodontia flavipes* of the Cyrtidae (C 365), all Strepsiptera, Ripiphoridae, Meloidae, *Asterochiton vaporariorum* in the Aleurodoptera; *Icerya* in the Coccoptera; in Protura, Symphyla, Archaeognatha, Zygentoma, Rhabdura, Blattariae, Notoptera, Diploglossata, and Zoraptera. In *Polyxenus* (P) and in Dermestid larvae of the Coleoptera, caudal brushes take the place of the cirri; but the study of *Polyxenus* shows that they belong to the primitive pygidial area behind the growth zone just as the cirri in Polychaeta.

5. *Legs.* The presence or absence of legs does not define the planidium type. Legs are not present in the Polychaeta, or Archiannelida, in Echinoderes, Agriotypus, Perilampus, or Pterodontia.

More than six legs are present in Microniscus, Pinnotherion; Polyxenus, and Scolopendrella; and abdominal leg rudiments or analogues are found in Acerentomon, Machilis and Lepisma.

Among the insects the first larvae of some Meloidae have three tarsal claws; those of Icerya and Ripiphorus one claw; but the Strepsiptera larvae have no tarsal claws.

6. *Ornamentation of body segments.* In a great many of the planidium forms the body segments are clad with rows of spines, bristles, or highly complex scales and bristles. Such vestiture may be found in Strepsiptera, Meloidae, Ripiphoridae, Dermestidae, Cyrtidae, Agriotypidae, Perilampidae, Polyxenidae.

In Polyxenidae, Dermestidae and Cyrtidae the hairs or scales are very complex.

7. *Mouth parts.* The mouth parts of the different planidium types are quite diverse. Mandibles are present in Isopoda, Symphyla, Archaeognatha, Zygentoma, Rhabdura, Blattariae, Notoptera, Diploglossata, Zoraptera, Coleoptera, Hymenoptera and Strepsiptera. Maxillae are present in all but the Strepsiptera.

While the Strepsipterous larvae have mandibles they are lateral, and of little or no value, except possibly as breakers for entering the skin of the host. On the other hand the mandibles of the Meloid *Epicauta vittata* (C5 66) are very powerful and functional.

The mouth parts of Polyxenus are greatly modified and of an intermediate type between biting and sucking. The mouth parts of Protura, and Pterodontia are retractile sucking, and of Asterochiton and Icerya of external sucking type.

8. *Eyes.* The eyes are absent in the larvae of Agriotypus, Pterodontia and Echinoderes.

In Protura the eyes are simple; in Meloidae sometimes double.

In Microniscus, Pinnotherion, Ripiphoridae, and Strepsiptera the eyes consist of clusters of lenses.

In the other insect forms the eyes are usually of the normal compound type.

9. *Antennae.* The antennae are well developed in the first larvae of Microniscus, Icerya, Ripiphoridae and Meloidae; but scarcely discernible in the first larvae of Strepsiptera, Cyrtidae, Agriotypidae and Perilampidae.

10. *Parasitism.* The occurrence of parasitic life in association with the planidium type of larvae is interesting. Excluding

the Protura, Symphyla, Archaeognatha, Zygentoma, Rhabdura, Notoptera, Blattariae, Diploglossata, Mallophaga, Anoplura and Zoraptera in which the planidium type persists from first larva to maturity we then come to those creatures in which there is a difference between first larva and adult. The larva of *Pinnotherion vermiform* in the Entoniscidae has head, thorax and ten abdominal segments, with seven pairs of peraeopods. It greatly resembles a Strepsipteran larva. The adult male has six pairs of peraeopods, but the female is a completely degenerate vermiform sac, parasitic on *Pinnotheres pisum* (Atkins).

As in *Pinnotherion* the majority, if not all Strepsiptera, have a typical planidium larva, which in its later parasitic life completely degenerates, and the female remains a vermiform sac, while the male matures as a fully equipped, winged insect, emerging from a puparium, the last larval skin.

The scale insects, order Coccoptera, are not truly parasitic, except that the planidium-like crawlers become fixed to the plant host tissues, and the adult female is like a great sac, but the male issues as a fully equipped, winged insect, emerging from a puparium, the last larval skin.

The first larva of *Pterodontia flavipes* in the Cyrtidae is a typical planidium, but in its parasitic life on its spider hosts it becomes maggot-like; then pupates in its last larval skin or puparium and matures as a winged fly; both sexes being winged.

The first larvae of Ripiphoridae and Meloidae are more modified in form, but might be called planidium-type. They pass through successive stages of larval development, pupate and mature in both sexes as fully equipped, winged insects.

11. *Conclusion*: On the basis of the existence of a first larva, of the planidium type, there is no reason for assigning the Strepsiptera to a position near Coleoptera, or any other order. The existence of legs in the planidium groups the Strepsipterous larva with the Coccid, Ripiphorid and Meloid larvae; but does not prove relationship.

On the basis of hypermetamorphic development the Strepsiptera cannot be assigned to a particular position, because hypermetamorphosis with numerous changes of form occurs among parasitic Isopoda, Coleoptera, Hymenoptera, Diptera and Strepsiptera.

However, when we look among hypermetamorphic insects for those with planidium first larvae, more or less degenerate later larvae, larviform mature females, and perfect males issuing from last larval skins or puparia, we find that we can group Strepsiptera larvae with the legless Diptera, Cyrtidae and the hexapod Coccidae.

We may leave our argument at this point to take up at another time other characteristics of the Strepsiptera, which aid us in finding their position in the Insecta.

THE BIONOMICS OF PTINUS CALIFORNICUS, A DEPREDATOR IN THE NESTS OF BEES

By E. G. LINSLEY and J. W. MACSWAIN
University of California

The habits of our native North American ptinids are practically unknown. A few species are thought to breed in bark or dead twigs, others in the roots of dry grass. As far as is known to the writers, there is no published life history of any native species and what is known of ptinid biology has generally been derived from a study of the species injurious to stored food and plant products. For this reason it has seemed worthwhile to make known the habits of *Ptinus californicus* Pic, a species which lives as a depredator¹ in the nests of wild bees. Although the association of ptinids with bees has been previously recorded for a few European species, this appears to be the first time it has been observed for any American form.

HISTORICAL BACKGROUND

Ptinus sexpunctatus Panzer was apparently the first species taken in association with bees. As early as 1872, Bedel recorded its capture at the nest entrances of *Megachile muraria* (Retzius). Later Fowler (1889) stated that it is "also said to have been taken in humblebees' nests in some numbers" but apparently this observation has never subsequently been confirmed. The most commonly recorded hosts for *sexpunctatus* are bees of the genus *Osmia*. Nicolas (1892) was one of the first to call attention to this fact and he interpreted the relationship as follows: "Le *Ptinus sexpunctatus* . . . n'attaque jamais une créature vivante et ne dépouille aucun être . . . ; hôte tranquille, plaisable, il s'établit dans les loges des Osmiers pour s'approprier le miel contenu dans ces cellules, mais il ne se décide à agir ainsi qu'autant que celle-ci est déserte; que l'habitation vide de larves est un logis abandonné où la succulente moisson se moisirait bientôt." More recently, Chevalier (1923) has discussed its habits in the nests of *Osmia rufa* (Linn.) and concluded that it devoured the remains of bees and honey. However, in view of the habits described below for *Ptinus californicus*, it would seem highly desirable that the habits of *Pt. sexpunctatus* be re-investigated before these conclusions are accepted at their face value. *Ptinus sexpunctatus* has been recorded from the nests of the following bees: *Megachile muraria* (Retzius) (Bedel, 1872; Redtenbacher, 1874), *Megachile willughbiella* (Kirby), (Maneval, 1929),

¹ Literally, one who plunders or pillages, a spoiler, a robber. Biologically, a species which lives at the expense of the food store of another species, usually, but not necessarily, bringing about its death.

Osmia rufa (Linn.) (Chevalier, 1923; Hamm, 1924; Maneval, 1929; Maréchal, 1932), *Osmia cornuta* (Latr.) (Marechal, 1932), *Osmia emarginata* Lep. (Enslin, 1925; Maneval, 1929), *Osmia villosa* (Schenck) (Maneval, 1929), *Osmia mitis* Nylander (Maneval, 1929), *Hoplitis adunca* (Panzer) (Maneval, 1929), *Chelostoma nigricorne* (Nylander) (Maneval, 1929) and ?*Bombus* sp. (Fowler, 1889).

Ptinus fur (Linn.), one of the spider beetles of commerce, has also been found in the nests of bees. It has been recorded from the nests of *Osmia tridentata* Dufour and Perris by Enslin (1925) and *Chelostoma maxillosa* (Linn.) by Maréchal (1932). Neither author was able to determine the exact relationship of the ptinid to the bee but Maréchal believed that it fed upon pollen. *Ptinus fur* has also been taken from the nests of *Vespa crabro* Linn. (Hüsing, 1935).

The most complete account of a species of *Ptinus* living in the nest of a bee is that of Cros (1932). He records the capture of *Ptinus vaulogeri* Pic in the nests of *Osmia longispina* Perez under conditions strikingly similar to those under which the present writers found *Ptinus californicus*. Unfortunately, however, Cros was unable to carry his studies to their logical conclusion and left many important questions unanswered.



PLATE 11

Adult ♂ (left) and ♀ (right) of *Ptinus californicus* Pic. x 8.

Two other significant ptinid records may be cited. Arnhart (1929) and Brassler (1929) have both recorded *Ptinus raptor* Linn. from pollen in the hives of the honeybee in Europe and Rayment (1935), *Ptinus exulans* Er. from deserted hives in Australia.

PTINUS CALIFORNICUS Pic

Ptinus (*Gynopterus*) *californicus* Pic, 1900, Exchange, 16:89; Pic, 1903, Bull. Soc. Ent. France, 1903:340; Fall, 1905, Trans. Am. Ent. Soc., 31:119.

Male: Form elongate, subparallel-sided, moderately robust; integument dark brown to brown, head, prothorax, legs, and antennae brown to rufous, elytra with four, irregular, transverse patches of white, prostrate hairs. *Head* with vertex above antennal bases densely clothed with coarse, white, prostrate hairs; lower face clothed with suberect, brownish hairs; antennae nearly attaining apex of elytra, segments three to seven gradually increasing in length, segments seven to ten subequal in length, about four times as long as broad, ultimate segment longest. *Pronotum* subglobular, constricted at base, sides of disk tuberculate; surface densely granulate, opaque, sparsely clothed with suberect brownish pubescence; scutellum densely clothed with prostrate white hairs; pro-, meso-, and metasterna thinly clothed with prostrate, pale hairs; metasternum with median groove moderately broad, extending over nearly posterior two-thirds; legs moderately elongate, slender, clothed with prostrate white hairs. *Elytra* with strong strial punctures, intervals wider than striae; setae of strial punctures minute, lying within the punctures, those of intervals brownish, longer than width of strial punctures; elytral pattern consisting of transverse, irregular, sub-basal and subapical patches of coarse, prostrate, scale-like white hairs on elytral intervals and usually a small subsutural patch at apex. *Abdomen* with sternites one to four uniformly, thinly clothed with prostrate white hairs, fifth sternite broadly rounded at apex, surface more sparsely clothed with white hairs than preceding sternites. Length 4-5.5 mm.

Female: Form more robust than male; antennae distinctly shorter than body, outer segments shorter, more slender, less than three times as long as broad; median groove of metasternum confined to posterior one-half. Length 4.5-6 mm.

Recorded distribution: California, Nevada, Colorado, Utah, British Columbia.

The adult of this species may be readily distinguished from others in our fauna by its large size, coloration, and the short elytral pubescence. It appears to be related to the Old World species *Ptinus quadrisignatus* and *Pt. sexpunctatus*.

SUMMARY OF LIFE HISTORY OF *PTINUS CALIFORNICUS*

Hosts

In the areas under observation by the writers, *Ptinus californicus* is most commonly found in the nests of *Osmia lignaria* Say more rarely in the nests of *Osmia exilis* Sandhouse and *Anthophora edwardsii* Cresson.

Osmia lignaria is very widely distributed in North America and in many parts of its range it is one of the earliest and commonest of the Spring *Osmia*. It nests in a wide variety of habitats but shows a marked preference for burrows of other bees and wasps either in the ground or in hollow twigs. It also utilizes the tunnels of beetles and other wood borers in old stumps and logs. However, when no previously prepared burrows are available it constructs its own nests and usually selects dry soft sand of cliffs or banks for its nesting site. Such nests are lined with mud, a procedure which is omitted when burrows of other insects are used. However, in the latter case the individual cells are separated by mud plugs and two plugs are used to close the entrance. These plugs are formed of mud pellets which are manipulated by the mandibles and have a granular appearance. As the cells are completed, they are individually provisioned with pollen. A variety of pollens are used but in any one cell the pollen is usually from a single plant species. In the main locality studied the flower most commonly utilized was *Amsinckia*. The pollen mass, which normally fills about one-third of the cell, is worked in compactly but the surface is rough and moderately loose. When provisioning has been completed the female inserts an egg by the posterior end a little to one side of the middle. The young larva remains in the original position of the egg and feeds on surface pollen. It develops rapidly and completes its growth within a few weeks. When mature, it spins a tough silken cocoon with a characteristic Osmiine mammillate end. Within this cocoon the prepupal larva remains inactive until fall, at which time it pupates and shortly transforms into an adult. The latter spends the winter within the cocoon and emerges in early spring (late February and early March) and the male precedes the female by a week or ten days (for instance by Feb. 11, 1940 and Feb. 16, 1941, all the males had left their cocoons and were ready for emergence but none of the females had yet opened their cocoons). After emergence the adult females are active and provisioning new cells until early June. During this period cells may be found with *Osmia* larvae in all stages of development. Each female provisions several series averaging about three cells each (minimum one cell, maximum six cells).

Osmia exilis is more limited in distribution than *O. lignaria* and has thus far been found only in central and southern California. It is an early spring species but the adults do not emerge until a week or so after those of *lignaria*. Like the latter they

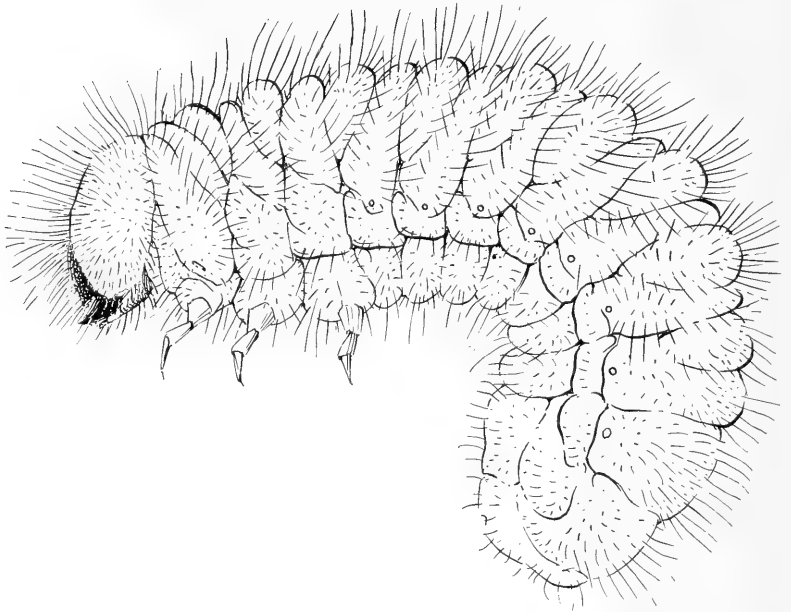


PLATE 12
Larva of *Ptinus californicus* Pic. x 18.

prefer to nest in old burrows or natural crevices and rarely dig their own tunnels. They are, however, much smaller than *lignaria* and in order to fill the old burrows which they appropriate it is necessary to build groups of cells. These cells are complete, although adjacent cells may share a common wall. Unlike *lignaria* the nest cavity itself is not closed by mud plugs. The average size of the cells of *exilis* is 4 x 8 mm.

Anthophora edwardsii is a common and widely distributed species occurring along the Pacific Coast of North America, in early spring. It constructs a linear series of cells which are typical of the genus *Anthophora*. There is, however, no turret projecting from the opening as is usual for many other species. At Pittsburg the nests of this bee are scattered as in *O. lignaria* and there are no evident gregarious nesting tendencies. The average size of the cells of *edwardsii* is 11 x 18 mm.

Localities Under Observation

Although *Osmia lignaria* is a common and widely distributed species and several nesting areas have been encountered by the writers, only one of these localities was infested with *Ptinus*. This site extends along a stream bank in the hot, dry, foothill region three miles south of Pittsburg, Contra Costa County, California. The cliffs along this stream bed are formed of a hard conglomerate of clay and sandstone and rise to a height of

thirty or forty feet. During the season when the *Osmia* and *Ptinus* are active the surface is moist and comparatively easily excavated but during the summer it becomes extremely hard and very resistant to weathering. Along these cliffs most of the available sites are used by *Osmia lignaria* but in any one year only about half of these are infested with *Ptinus*. This appears to be due to the fact that the cliffs have been broken up by erosion into a series of isolated habitats which prevent the contagious type of infestation which would be possible if these habitats were contiguous. During the summer and early fall these same cliffs are used as nesting areas by *Anthophora stanfordiana* Cockerell, *Sceliphron servillei* Saussure and several species of *Odynerus*.

Activities of the Adult

Ptinus californicus passes the winter as an adult in a cocoon within an *Osmia* cell. In the laboratory individuals may be removed from their cocoons at any time during the winter and if proper conditions are provided feeding, copulation and oviposition will follow immediately. Emergence normally occurs in February and March under field conditions. This involves two distinct steps. The first is emergence from the cocoon and usually occurs concurrently for all of the individuals in a single bee cell. Secondly, after a delay of a week or ten days, a circular hole is cut near the side of the cell plug and through it all of the ptinids escape to the surface of the ground. Sometimes this involves passing through a series of cells, both occupied and unoccupied, and in each case, where necessary, similar holes are cut in the plugs encountered. Under laboratory conditions neither mating nor oviposition could be induced without first providing food and moisture. In no case, either in the laboratory or in the field, was any evidence obtained to indicate that mating ever takes place in the natal cell. Males and females associated together in bee cells or capsules under optimum conditions of temperature and humidity showed no inclination to mate and females isolated after such confinement failed to lay eggs. On the surface of the ground or in relatively unconfined places mating occurs very readily providing the light intensity is low and food and water are available or have been previously consumed. The reaction to a low light intensity is very marked and as a result the adults spend the daylight hours in cracks and crevices in the bank, in bee cells, or beneath objects on the ground. Surface activity begins late in the afternoon (normally about 4 p.m.) and continues after dark. Mating takes place immediately upon contact of the sexes and disturbed pairs make no attempt to re-locate each other. The period of copulation is short (frequently less than two minutes) but may be repeated several times (with the same or with a different individual). Both sexes are winged but no individuals were ever observed in flight in the field. Even on the surface of the ground, the adults are much less active and

agile than many other species of ptinids and have difficulty in walking upon smooth surfaces or righting themselves if turned on their backs. When disturbed they readily "feign death." In the field, the average life of the adult after emergence appears to be about six weeks, but under laboratory conditions this period may be prolonged to three or even four months.

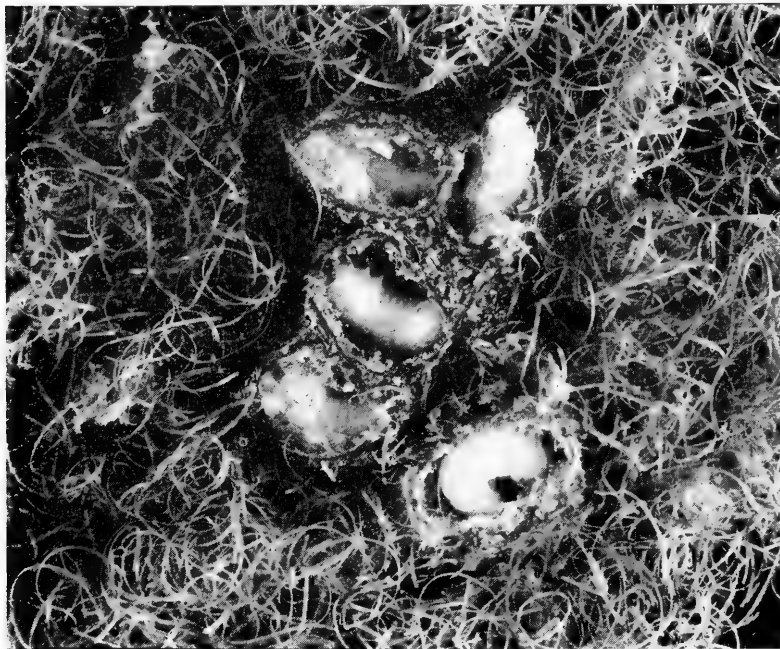


PLATE 13

Larvae and pupae of *Ptinus californicus* Pic within cocoons in mass of fecal strands.

Oviposition normally follows from six to ten days after mating and takes place only in the presence of larval food. The eggs are laid directly in the uncompleted cell of the host bee. Access to the cell is gained in the evening when the cell is occupied by the bee for the night. The host bee apparently makes no attempt to interfere with the activities of the ptinid and the latter may remain in the cell series for several days. The eggs are forced into crevices of the pollen mass or placed between the pollen mass and the cell wall. There are usually five or six eggs to a cell. Each female lays from forty to fifty eggs and is thus capable of infesting several different cells. Under laboratory conditions the incubation period of the eggs varied from eighteen to twenty days but in the field it is probably longer (mean temperature difference between field and laboratory was about 10° C.)

Activities of the Larva

The first instar larvae of *Ptinus californicus* are active and begin to feed upon the surface of the pollen mass immediately after hatching. They grow rapidly and during the second and third instars they become enveloped by long, shred-like, strings of fecal material. This material surrounds the *Osmia* larva and prevents it from obtaining pollen. When the full complement of *Ptinus* larvae is present the *Osmia* invariably dies in an early instar, usually while still attached to the egg fragment. Occasionally, however, but a single ptinid will develop in a cell, and under such conditions both the ptinid and the *Osmia* may successfully reach maturity. As the ptinid larvae grow they hollow out a feeding cavity in which they normally remain until they complete their development. The first instar usually lasts about two weeks, the total feeding period about two and one-half months. Only five larval instars were definitely recognized. Under laboratory conditions the total feeding period varied greatly depending on a wide range of factors (particularly amount of food, moisture, and temperature). The larval food, like that of the adult, consists primarily of pollen. However, the larvae also eat their exuvial skins, rarely dead insects, and may be reared to maturity in flour or corn meal.

When larval feeding is completed, the interior of the feeding cavity is strengthened by means of a silk-like, adhesive, secretion to form a pupal cell. This chamber is usually cemented against the side of the bee cell so that when removed it is not entire. However, when the population of ptinids within the cell is great enough to consume all of the pollen store, the cocoon may be constructed within the fecal strands. The pupal period

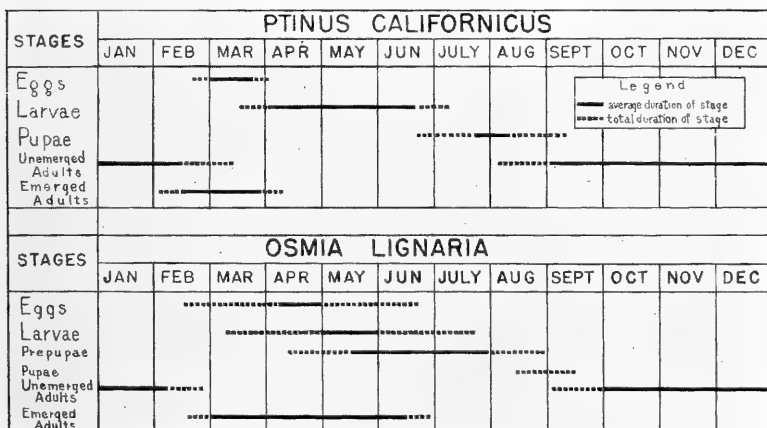


PLATE 14
Comparison of life cycles of *Ptinus californicus* Pic and
Osmia lignaria (Say)

is from sixteen to twenty days, (mean 17 days). The number of larvae present in a cell determines to some extent the size of the resultant adults and in over-crowded cells the adults tend to be smaller.

Natural Enemies

Natural enemies appear to have but little effect upon the population of *Ptinus californicus*. Only one parasite was observed, a chalcidoid species² which also occurs on *Osmia exilis* but not on *O. lignaria* or *Anthophora edwardsii*. Parasitized *Ptinus* have, however, been found in the nests of all three species. The percentage of parasitism is low, less than 1% in the series studied. Mold, which kills a large percentage of the bees, has little effect upon *Ptinus californicus*.

Among the predators feeding on *Ptinus* are two spiders, *Tarentula kochi* and *Latrodectes mactans*, and the common fence lizard, *Sceloporus occidentalis*. None of these, however, can be considered important factors.

The dermestid *Anthrenus scrophulariae*, although it cannot be classed as a parasite or predator, is, however, indirectly responsible for the death of many *Ptinus*. The larvae gain access to the cells and chew open the *Ptinus* cocoons, causing a premature emergence. When this occurs in the fall or winter the *Ptinus* frequently die within the bee cell.

Associated Parasites, Predators, and Scavengers

In the Pittsburg locality, about forty percent of the cells provisioned by *Osmia lignaria* are infested with *Ptinus*. Early in the season, however, this percentage is much higher since the cells provisioned after the middle of April are practically all free from infestation. Next to *Ptinus*, the most serious enemy of *O. lignaria* is mold, and during the seasons of 1939-1941 the average loss amounted to 10% of the cells provisioned. The dermestid, *Anthrenus scrophulariae*, accounts for an additional loss of 2%. It frequently causes the death of the *Osmia* by opening up the cell and exposing the bee to the outer environment. Normally a scavenger, the dermestid thrives on the detritus of old burrows and is thus frequently walled in by the *Osmia* when they make use of the old tunnels for a new series. The larvae, and possibly the adults also, in escaping to the surface, gain access to inhabited cells and indirectly cause the death of the occupants. In the case of cells occupied by *Ptinus*, the dermestids chew open the pupal cells and cause pre-mature emergence of adults. This also frequently results indirectly in death and thus provides food for the dermestid. Bombyliid primary larvae (*Anthrax* sp. near *fur* O. S.) may be found in a high percentage of *Osmia* cells but none have been observed to complete their life cycle.

² According to Mr. A. B. Gahan who kindly examined this species, it apparently represents a new genus and species.

Apparently some condition in the *Osmia* cell is unfavorable to these flies which commonly survive on the Anthophorid population.

In *Osmia exilis* the percentage of loss from *Ptinus* is low, between 2.5 and 3%. In addition, due to the small size of the pollen store, only one individual of *Ptinus* normally develops in a cell. Mold is also a less serious enemy than in the case of *lignaria* and the percentage of cells found destroyed was only 5%. The dermestid *Anthrenus scrophulariae* accounts for 1% loss, acting the same as in the case of *lignaria*. However, the most serious enemy of *O. exilis* in this locality is a chrysidid, *Chrysis (Chrysurā)* sp., and during the seasons studied this species infested 15% of the cells. One additional parasite, the chalcidoid mentioned above, accounted for an additional 4% loss.

Anthophora edwardsii suffers even less from *Ptinus* than does *O. lignaria* and *O. exilis* and the percentage of cells infested was not more than 1%. Its most serious enemy is mold which accounts for a loss of 48% of all of the cells provisioned. An additional 10% are parasitized by a bombyliid, *Anthrax* sp. (near *fur* O. S.). *Melecta (Melectomorpha) californica* Cress., *Dasy-mutilla aureola* Cresson, and *Anthrenus scrophulariae*, each account for an additional 2% loss, and *Meloe franciscana* Van Dyke, for a loss of 1%.

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[*C. quadridentata* (Bethyridae), a parasite of *Sitodrepa panicea*, experimentally parasitized *Ptinus tectus*]

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[Biological notes and descriptions of immature stages of Ptinidae, including *Ptinus sexpunctatus* and *Pt. fur*]

A NEW FLEA FROM THE MOJAVE DESERT
(CALIFORNIA)

By G. F. AUGUSTSON

Allan Hancock Foundation
University of Southern California

Among some interesting material recently received by the writer from J. C. Couffer of the Los Angeles Museum appears two fleas not only new to science, but in addition representing a genus here before unknown to southern California.

Thanks are due to J. C. von Bloeker, Jr. for his diagnosis of the host involved.

Family HYSTRICHOPSYLLIDAE

Delotelis mohavensis n. sp.

Holotype Female

HEAD. Eye absent; frontal tubercle peg-like, high up on frons, weakly indicated; angle of frons somewhat acute; maxilla acuminate, short; labial palpi equal in length to fore-coxa; pre-antennal region with five rows of stout bristles, three bristles in lower four rows, five in extreme upper row, a single bristle between rows four and five, one and two; postantennal region with three rows of bristles in all, two in the most anterior row, four in each following row; setae on second segment of antenna one-half the length of the club; no genal ctenidium.

THORAX, ABDOMEN, AND LEGS: Pronotal ctenidium of nine slender spines on a side; eight small teeth on first abdominal tergite only; three antepygidial bristles, the middle slightly longer than the equal outer and inner; style long, slender tapering from apex to base with a single, medium, ventro-lateral seta; sternite X flap-like as in *D. telegoni*, broader at its posterior extremity than in *D. telegoni*; sternite VII without a sinus; spermatheca with a broad arm as in *D. telegoni*; tarsi five of all legs with five pairs of lateral plantar bristles and a sixth pair placed mediad to first pair; hind-coxa rather small, without inner patch of bristles or spines.

Allotype Male

HEAD: Labial palpi, maxilla as in female; eye absent; frontal tubercle as in female, somewhat more clearly indicated; bristles of preantennal region as in female; bristles of postantennal region as in female with exception of one less bristle in middle row; no genal ctenidium.

THORAX, ABDOMEN, AND LEGS: Pronotal ctenidium as in female; first abdominal tergite with eight small teeth; three antepygidial bristles, the middle two-thirds longer than the subequal outer and inner; eighth tergite reduced; clasper large, roughly triangular, with one long seta midway along its upper, straight edge, the base of the finger cutting short its posterior angle; finger thumb-like, slender, with two small spiniforms on its upper posterior angle; sternite IX conspicuous, cleaver-shape, with one short, stout bristle on its upper margin; sternite VIII absent; tarsi and rest of legs as in female.

Holotype: A female collected by J. C. Couffer, 10 miles southeast Mojave, Kern County, California, Oct. 5, 1941, from *Neotoma lepida lepida* Thomas. Deposited in the Allan Hancock Foundation, University of Southern California, No. 41-189a.

Allotype: A male, collected and deposited as above.

Type Host: *Neotoma lepida lepida* Thomas.

Type Locality: Mojave, Kern County, California.



PLATE 15

Fig. 1. *Delotelis mohavensis* Aug., posterior extremity, holotype female.

Fig. 2. *Delotelis mohavensis* Aug., head, holotype female.

Fig. 3. *Delotelis mohavensis* Aug., clasper, finger, sternite IX, allotype male.

SOME NEW CALIFORNIA SIPHONAPTERA

By G. F. AUGUSTSON

Allan Hancock Foundation
University of Southern California

For the past three summers the writer has had the pleasure of working with Dr. R. L. Rutherford, School of Dentistry, University of Southern California, on a survey of parasites of small mammals and birds collected in the Central High Sierra mountain range of California. Of the many interesting ectoparasites collected there are three fleas apparently new to science that are here described and illustrated, besides the allotype of one already known species.

Family PULICIDAE

Callistopsyllus deuterus Jordan 1937

Allotype Male

HEAD: Frontal notch prominent, peg-like; eye absent; pre-antennal region with two rows of bristles, an upper row of four medium bristles, a lower with four very long bristles; maxillae acuminate; labial palpi three-fifths the length of the fore-coxa; postantennal region with one row of two bristles of medium size, and one longer bristle between this row and posterior antennal groove.

THORAX AND ABDOMINAL SEGMENTS: Pronotal ctenidium of sixteen slender spines; first abdominal tergite with eight small teeth, second with four, third with two; three antepygial bristles, the middle twice the length of the outer and three times the length of the inner; tergite VIII reduced to a short cone-shaped structure with a few scattered bristles; finger large, protruding well beyond rest of genitalia, two short, well separated spiniforms at apex; sternite IX with upper posterior portion blade-like, the upper outer margin well covered with setae; sternite VIII vestigial, a wing-like, weakly chitinized, veined structure remaining.

LEGS: Tarsus V of all legs with five pair of lateral plantar bristles, the first pair dislocated mediad between the second pair; coxae without inner bristles.

Allotype: A male, collected by Rutherford, 8/10/41, at Mammoth Lakes, Mono County, California, from *Peromyscus maniculatus sonoriensis* (Le Conte). Deposited in the Los Angeles County Museum, Los Angeles, California.

Paratypes: 6 males, retained by writer, host listings and other data to follow in a later report.

Remarks: The writer wishes to thank Dr. C. A. Hubbard for his original aid in the diagnosis of this interesting parasite.

Family DOLICHOPSYLLIDAE
Monopsyllus eutamiadis n. sp.
Holotype Female

HEAD: Frontal notch present, small, acuminate; preantennal region with two rows of bristles, four small bristles in the upper row, three much longer bristles in the lower row; four small setae above the eye along the antennal groove; maxillae sharply acuminate; genal process short, somewhat heavily chitinized; labial palpi equal in length to fore-coxa; eye large, darkly pigmented; postantennal region armed with three bristles along the antennal groove, the middle bristles much longer than the other two; a row of small setae along the posterior margin of the antennal groove.

THORAX AND ABDOMINAL SEGMENTS: Pronotal ctenidium of sixteen rather sharply pointed spines; first three abdominal tergites with four small teeth, fourth with three; three antepygidial bristles, the middle twice the length of the equal outer and inner bristles; style short, thick, one-and-one-half times longer than its greatest width, one long terminal bristle, two shorter, lateral bristles; sternite VII very diagnostic, a deep sinus high in the free margin forming an acute upper lobe, fixed margin with numerous bristles, seven long bristles in the posterior row, and twelve smaller ones immediately anterior; spermatheca sausage-shaped, slender.

LEGS: Tarsi and rest of legs as in other members of the genus.

Allotype Male

HEAD: Frontal notch as in female but much higher up on the frontal angle; chaetotaxy of preantennal and postantennal regions as in female; palpi, eye, and maxillae as in female.

THORAX AND ABDOMINAL SEGMENTS: Pronotal ctenidium of sixteen pointed spines; two small teeth on upper posterior angle of metanotum, four on first four abdominal tergites, and three on the fifth; a single long antepygidial bristle; tergite VIII sharply rounded on its dorso-posterior angle, with seven bristles on the same area and two in the ventro-posterior area; clasper slender, half-moon shaped with a long, thumb-like process falling

slightly short of the total length of the finger; the finger very diagnostic, with three spineforms as in *M. eumolpi* but without the concave anterior margin; sternite IX with a single lobe on the ventral portion of the free arm, the upper portion long, slender; sternite VIII long, finger-like as in *M. eumolpi* but with smaller and fewer bristles along its lateral margin, and two terminal bristles.

LEGS: Tarsi and rest of legs as in other members of the genus.

Holotype: A female, collected by Rutherford and Augustson, 8/27/41, at Cascade Valley, Fresno County, California, from *Eutamias quadrivittatus inyoensis* Merriam. Deposited in the Los Angeles County Museum, Los Angeles, California.

Allotype: A male, collected and deposited as above.

Paratypes: 3 females, 2 collected as above, 1 by Augustson, 7/22/41, at Mammoth Lakes, Mono County, California, from *Eutamias quadrivittatus inyoensis* Merriam. All retained by writer.

Type Host: *Eutamias quadrivittatus inyoensis* Merriam.

Type Locality: Cascade Valley, Fresno County, California.

Remarks: This new species is closely related to the *M. eumolpi* group and perhaps should be referred to subspecific rank within this group. The writer bases his specific diagnosis on sternite VII of the female and shape of the clasper and finger in the male. The species name is derived from *Eutamias*, which appears to be the normal host of this parasite.

Family HYSTRICHOPSYLLIDAE

Catallagia rutherfordi n. sp.

Holotype Female

HEAD: Frontal notch prominent, peg-like; preantennal region with two rows of bristles, the upper with six small bristles, the lower with three very long bristles, a small bristle situated immediately above the eye between the two rows; eye vestigial as in other members of the genus; maxillae acuminate; genal process short, sharp; labial palpi slightly shorter than fore-coxa, postantennal region with two rows of bristles with five in each row of uniform size except the most proximal to the antennal groove in the lower row which is very much larger and longer; three small setae only along the posterior margin of the antennal groove.

THORAX AND ABDOMINAL SEGMENTS: Pronotal ctenidium of twelve bluntly pointed spines; first abdominal tergite with four small teeth, second with five, third with four, fourth with two; three antepygidial bristles, the middle one-third longer than the outer and one-half longer than the inner; style slender, tapering base to tip, length equal to two-and-one-half times its greatest width, one stout terminal bristle, one much smaller lateral bristle immediately below; sternite VII as in *C. decipiens* but with a deeper sinus forming a more acute lobe on the free margin; bursa copulatrix roughly "S" shaped; spermatheca as in *C. decipiens* and related species but somewhat narrower, and with the neck of the appendix extending much deeper into the body.

LEGS: Tarsi and rest of legs as in other members of the genus.

Allotype Male

HEAD: Frontal notch in same position and shape as in female; eye, maxillae, palpi, and chaetotaxy of head as in female.

THORAX AND ABDOMINAL SEGMENTS: Pronotal ctenidium of twelve spines as in female; first abdominal tergite with two small teeth, second with four, third with two, fourth with two; three antepygidial as in female; modified abdominal segments composing genitalia as in other members of the genus except sternite IX, this structure with four stout, black teeth at its apex, the most terminal very blunt, spatulate, twice as thick as the pointed, lower three, immediately below a cluster of bristles of three long, medial, and four much smaller outer.

LEGS: As in other members of the genus.

Holotype: A female, collected by Rutherford and Augustson, 8/15/14, at Tully's Hole, Fresno County, California, from *Microtus montanus dutcheri* Bailey. Deposited in the Los Angeles County Museum.

Allotype: A male, collected by writer, 8/14/40, at Mammoth Lakes, Mono County, California, from *Peromyscus maniculatus sonoriensis* (Le Conte). Deposited as above.

Paratypes: 2 females, 1 male collected by Rutherford, 6/1/41, at Mammoth Lakes, Mono County, California, from *Peromyscus maniculatus sonoriensis* (Le Conte). All retained by writer.

Type Host: *Microtus montanus dutcheri* Bailey.

Type Locality: Tully's Hole, Fresno County, California.

Remarks: This new species is named in honor of Dr. R. L. Rutherford, to whom the writer is greatly indebted for many fine collecting opportunities.

Phalacropsylla monticola n. sp.

Holotype Female

HEAD: Frontal notch absent; preantennal region with two rows of bristles, the upper of four small bristles, the lower with four much larger; eye absent, its normal position somewhat darkly chitinized; genal comb consisting of two unequal, overlapping, furrowed teeth, the upper shorter and broader than the lower; genal process blunt, not prominent; maxillae very long, sharply acuminate; labial palpi equal in length to fore-coxa; post-antennal region with one row of three bristles, the middle much longer and more proximal to the posterior antennal groove than the other two; a row of small setae along the posterior antennal groove; second segment of antenna with a row of short bristles not exceeding third section of club.

THORAX AND ABDOMINAL SEGMENTS: Pronotal ctenidium of twelve, long, rather bluntly pointed spines; first two abdominal tergites with two small teeth on each; three antepygial bristles, the middle one-fourth longer than the outer and two-thirds longer than the inner; style slender, tapered, with one long terminal bristle and two rather large bristles immediately below in a descending order; sternite VII with a deep sinus between lobes of equal length but unequal shape, the upper terminating abruptly in a downward, rounded end, the lower ending sharply, ventral fixed portion with two rows of bristles, the posterior row with four long bristles, the anterior row with seven small bristles; spermatheca small, pear-shaped, the appendix slender, curved half-way down body; bursa copulatrix only slightly angulate.

LEGS: All tarsi V with five pairs of lateral plantar bristles with the first pair dislocated mediad between the second pair; hind-coxa with a number of scattered, thin, medium length setae, and a patch of much shorter setae, in the inner apical anterior half.

Allotype Male

HEAD: No frontal notch; genal comb, maxillae, labial palpi chaetotaxy as in female.

THORAX AND ABDOMINAL SEGMENTS: Pronotal ctenidium as in female; abdominal tergite one with two small teeth, two with three, three with two; three antepygial bristles, the middle

one-half longer than the outer and two-thirds longer than the inner; tergite VIII with its upper margin freely covered with bristles, postero-dorsal angle acutely rounded; finger arm-like, rounded at its apex, extending ventrally beyond its insertion, scattered setae along the outer margin; clasper large, process protruding well above insertion of finger, no acetabular bristles; sternite IX paddle-shaped in its free posterior portion, the upper end flattened on top, bulging laterally with a cluster of twelve very stout, medium length bristles in the upper posterior margin, midway below a row of various sized setae on the lateral margin; sternite VIII absent; sternite VII slanted upward giving the entire posterior end a cone-shaped arrangement.

LEGS: Tarsi and rest of legs as in female.

Holotype: A female, collected by Rutherford and Augustson, 8/23/41, at Tully's Hole, Fresno County, California, from *Ochotona schisticeps muiri* Grinnell and Storer. Deposited in the Los Angeles County Museum, Los Angeles, California.

Allotype: A male, collected and deposited as above.

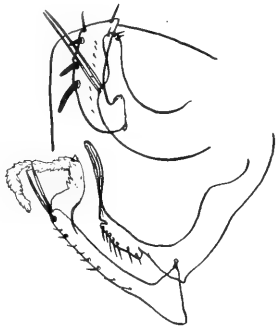
Type Locality: Tully's Hole, Fresno County, California.

Remarks: The distinguishing features of this new species from *P. paradisea* is most evident in sternite VII of the females; in the latter the sinus is shallow, the upper lobe being much more prominent than the lower. The males differ principally in the number and arrangement of the upper bristles of sternite IX.

EXPLANATION OF PLATE 16

(See page 146)

- Fig. 1. *Monopsyllus eutamiadis* Aug., genitalia, allotype male.
Fig. 2. *Monopsyllus eutamiadis* Aug., sternite VII, spermatheca, holotype female.
Fig. 3. *Callistopsyllus deuterus* Jord., genitalia, allotype male.
Fig. 4. *Phalacropsylla monticola* Aug., sternite VII, bursa copulatrix, spermatheca, holotype female.
Fig. 5. *Catallagia rutherfordi* Aug., sternite VII, bursa copulatrix, spermatheca, holotype female.
Fig. 6. *Catallagia rutherfordi* Aug., sternite IX, allotype male.
Fig. 7. *Phalacropsylla monticola* Aug., head, allotype male.
Fig. 8. *Phalacropsylla monticola* Aug., genitalia, allotype male.



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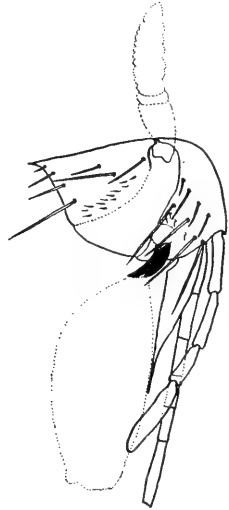
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PLATE 16

ECTOPARASITE-HOST RECORDS FROM THE SIERRAN REGION OF EAST-CENTRAL CALIFORNIA

By G. F. AUGUSTSON

Allan Hancock Foundation,
The University of Southern California

INTRODUCTION

In the last four summers the writer has been conducting a survey of ectoparasites found on small mammals and certain birds occurring on the eastern slope of the Central Sierra Nevada Range. Some interesting distributional records have come to attention in the course of this study not only of interest to the parasitologist, but to the mammalogist as well.

The plan of treatment in this paper is as follows: For the sake of brevity a "List of Localities" at which field operations were carried on is presented to give the complete locality data and to avoid repetition of county names and elevations in the parasite-host list below. The catalog numbering system used is the year, lot number, and, if more than one species of parasite occurred from the particular host, a lower case letter for each. For example: "Mammoth Creek; Aug. 21, '40-112" equals Mammoth Creek, 8300 feet altitude, Mono County, California; August 21, 1940-no. 112 (only one parasite species record for this host on this date); "Mono Lake, Aug. 23, '40-124a" equals Mono Lake, 8000 feet altitude, Mono County, California; August 23, 1940-no. 124, 1st parasite species record for this host on this date, second record, is, then, 124 b, etc.

The writer wishes to express his sincere appreciation to Dr. R. L. Rutherford of the School of Dentistry, University of Southern California, for his kind hospitality in extending generous accommodations at his high sierra lodge and for his able assistance in the field as well. Unless otherwise indicated below, all specimens of both ectoparasites and host representatives were collected by Dr. Rutherford and the writer. All mammal skins-with-skulls, bird skins and ectoparasite specimens (except as indicated in preliminary papers) have been deposited in the collections of the Allan Hancock Foundation.

Thanks also are due to G. P. Ashcraft and J. C. von Bloeker, Jr., for identifying the host species involved.

LIST OF LOCALITIES

Benton Crossing, 7,500 feet, Mono County.
Casa Diablo, 8,000 feet, Mono County.
Cascade Valley, 8,000 feet, Fresno County.
Duck Pass, 10,500 feet, Mono County.

Dusy Lakes, 11,500 feet, Fresno County.
Horse Heaven, 10,000 feet, Fresno County.
Mammoth Creek, 8,300 feet, Mono County.
Mammoth Lakes, 8,300 feet, Mono County.
Mammoth Meadows, 10,300 feet, Mono County.
Mammoth Mountain, 9,500 feet, Mono County.
Mono Lake, 8,000 feet, Mono County.
South Lake, 9,500 feet, Inyo County.
Tully's Hole, 9,500 feet, Fresno County
Yosemite, 5,500 feet, Mariposa County.

ECTOPARASITE-HOST LIST

Class INSECTA

Order COLEOPTERA

Family STAPHYLINIDAE

Leptinillus aplodontiae Ferris

Host: *Aplodontia rufa californica* (Peters).

Mammoth Creek; Aug. 21, '40-112, 4 ♀ ♀, 2 ♂ ♂. (Determination by W. D. Pierce.)

Order DIPTERA

Family HIPPOBOSCIDAE

Lynchia fusca (Macquart)

Host: *Asio wilsonianus* (Lesson).

Mono Lake; Aug. 23, '40-124a, 6 ♀ ♀. (Verified by J. Bequaert.)

Ornithoica confluenta (Say)

Host: *Asio wilsonianus* (Lesson).

Mono Lake; Aug. 23, '40-124b, 7 ♀ ♀. (Verified by J. Bequaert.)

Order ANOPLURA

Family HAEMATOPINIDAE

Enderleinellus suturalis Osborn

Host: *Citellus (Callospermophilus) lateralis chrysodeirus* (Merriam).

Tully's Hole; Aug. 23, '41-106c, 3 ♀ ♀, 2 ♂ ♂.

Host: *Ochotona schisticeps muiri* Grinnell and Storer.

Duck Pass; Aug. 22, '41-100f, 1 ♀.

Hoplopleura acanthopus (Burmeister)

Host: *Sorex obscurus obscurus* Merriam.

South Lake; Aug. 22, '38-17, 1 ♀.

Host: *Peromyscus maniculatus sonoriensis* (Le Conte)

South Lake; Aug. 22, '38-18a, 1 ♀.

Mammoth Lakes; Aug. 10, '41-94e, 8 ♀ ♀, 4 ♂ ♂.

Host: *Microtus montanus dutcheri* Bailey.

South Lake; Aug. 22, '38-15c, 10 ♀ ♀, 6 ♂ ♂.

Tully's Hole; Aug. 25, '41-113d, 6 ♀ ♀, 1 ♂.

- Host: *Microtus mordax sierrae* R. Kellogg.
Mammoth Lakes; Aug. 22, '40-113b, 1 ♀.
Tully's Hole; Aug. 23, '41-104e, 12 ♀ ♀, 1 ♂.
- Hoplopleura hesperomydis* (Osborn)
Host: *Peromyscus maniculatus sonoriensis* (Le Conte).
Tully's Hole; Aug. 23, '41-103f, 21 ♀ ♀, 10 ♂ ♂.
Mammoth Lakes; Aug. 28, '41-122c, 1 ♀.
- Hoplopleura sciuricola* Ferris
Host: *Citellus beldingi beldingi* (Merriam).
Mammoth Lakes; Aug. 8, '39-14b, 6 ♀ ♀, 4 ♂ ♂.
Host: *Eutamias quadrivittatus inyoensis* Merriam.
Casa Diablo; Aug. 22, '40-117c, 2 ♀ ♀.
Duck Pass; Aug. 22, '41-101c, 1 ♀.
Tully's Hole; Aug. 23, '41-105f, 2 ♀ ♀.
Host: *Tamiasciurus douglasii albolimbatus* (Allen).
Mammoth Lakes; July 31, '39-12g, 7 ♀ ♀, 5 ♂ ♂.
- Neohaematopinus laeviusculus* (Grube).
Host: *Citellus beldingi beldingi* (Merriam).
Dusy Lakes; Aug. 24, '38-19, 7 ♀ ♀, 5 ♂ ♂.
Host: *Citellus (Otospermophilus) beechevi fisheri* (Merriam).
Casa Diablo; Aug. 23, '40-123c, 5 ♀ ♀, 2 ♂ ♂.
Host: *Peromyscus maniculatus sonoriensis* (Le Conte).
South Lake; Aug. 22, '38-18b, 1 ♀.
- Neohaematopinus marmotae* Ferris
Host: *Marmota flaviventor sierrae* A. H. Howell.
Mammoth Lakes; July 26, '41-92b, 1 ♀.
Duck Pass; Aug. 22, '41-99b, 3 ♀ ♀, 1 ♂.
- Neohaematopinus pacificus* Kellogg and Ferris
Host: *Eutamias quadrivittatus inyoensis* Merriam.
Tully's Hole; Aug. 23, '41-105d, 1 ♀.
- Neohaematopinus sciurinus* (Mjoberg)
Host: *Tamiasciurus douglasii albolimbatus* (Allen).
Mammoth Lakes; July 31, '39-12h, 13 ♀ ♀, 16 ♂ ♂.
Horse Heaven; Aug. 24, '41-110c, 2 ♀ ♀, 3 ♂ ♂.
Host: *Microtus mordax sierrae* R. Kellogg.
Tully's Hole; Aug. 23, '41-104, 1 ♀.
Host: *Sylvilagus nuttallii grangeri* (Allen).
Benton Crossing; Aug. 22, '40-118c, 1 ♀.
- Polyplax auricularis* Kellogg and Ferris
Host: *Citellus (Callospermophilus) lateralis chrysodeirus* (Merriam).
Tully's Hole; Aug. 23, '41-106b, 1 ♂.
Host: *Tamiasciurus douglasii albolimbatus* (Allen).
Tully's Hole; Aug. 25, '41-112f, 1 ♀.
Host: *Peromyscus maniculatus sonoriensis* (Le Conte).
Mammoth Lakes; Aug. 10, '41-94f, 1 ♂.

Polyplax serrata Ferris

Host: *Eutamias quadrivittatus inyoensis* (Merriam).

Tully's Hole; Aug. 23, '41-105e, 1 ♂.

Host: *Microtus montanus dutcheri* (Bailey).

Tully's Hole; Aug. 25, '41-113e, 6 ♀ ♀, 1 ♂.

Order SIPHONAPTERA

Family PULICIDAE

Callistopsyllus deuterus Jordan

Host: *Eutamias quadrivittatus inyoensis* Merriam.

Tully's Hole; Aug. 23, '41-105a, 2 ♀ ♀.

Host: *Peromyscus maniculatus sonoriensis* (Le Conte).

Mammoth Lakes; Aug. 3, '39-13, 2 ♀ ♀, 1 ♂; June 1, '41-61b, 4 ♀ ♀, 1 ♂; Aug. 2, '41-93b, 13 ♀ ♀, 2 ♂ ♂; Aug. 10, '41-94b, 1 ♀, 3 ♂ ♂; Aug. 15, '41-95a, 6 ♀ ♀, 3 ♂ ♂; Aug. 28, '41-122a, 1 ♀.

Host: *Microtus montanus dutcheri* Bailey.

Tully's Hole; Aug. 25, '41-113b, 2 ♀ ♀.

Host: *Microtus mordax sierrae* R. Kellogg.

Tully's Hole; Aug. 23, '41-104b, 1 ♀.

Cediopsylla inaequalis interrupta Jordan.

Host: *Lepus townsendii townsendii* Bachman.

Mammoth Lakes; July 5, '40-83, 1 ♀.

Host: *Sylvilagus nuttallii grangeri* (Allen).

Mammoth Lakes; July 5, '40-84, 7 ♀ ♀.

Family DOLICHOPSYLLIDAE

Amphalius necopinus Jordan

Host: *Ochotona schisticeps muiri* Grinnell and Storer

Tully's Hole; Aug. 23, '41-107c, 4 ♀ ♀, 5 ♂ ♂.

Horse Heaven; Aug. 24, '41-109b, 1 ♂.

Duck Pass; Aug. 27, '41-120c, 1 ♂.

Host: *Ochotona schisticeps albata* Grinnell.

Dusy Lakes; Aug. 23, '38-8b, 1 ♀, 3 ♂ ♂.

Mammoth Lakes; July 26, '41-91b, 1 ♀, 3 ♂ ♂.

Ceratophyllus niger C. Fox.

Host: *Dryobates villosus orius* Oberholser.

Benton Crossing; Aug. 18, '40-104, 6 ♀ ♀, 1 ♂.

Diamanus montanus (Baker)

Host: *Citellus beldingi beldingi* (Merriam)

Mammoth Lakes; July 22, '41-84a, 3 ♀ ♀.

Host: *Citellus (Otospermophilus) beecheyi fisheri* (Merriam).

Casa Diablo; Aug. 21, '40-110a, 8 ♀ ♀; Aug. 22, '40-122a, 5 ♀ ♀, 2 ♂ ♂; Aug. 23, '40-123a, 15 ♀ ♀, 10 ♂ ♂.

Host: *Citellus (Callospermophilus) lateralis chrysodeirus* (Merriam).

Mammoth Lakes; Aug. 13, '40-92a, 1 ♀; Aug. 29, '40-140a,

3 ♀ ♀, 1 ♂ ; July 25, '41-87a, 10 ♀ ♀, 14 ♂ ♂ ; Aug. 17, '41-97a, 3 ♀ ♀, 1 ♂ .

Mammoth Mountain; Aug. 15, '40-101a, 4 ♀ ♀ .

Benton Crossing; Aug. 27, '40-102a, 1 ♀ , 1 ♂ .

Casa Diablo; Aug. 21, '40-111a, 3 ♀ ♀ ; Aug. 22, '40-116a.

3 ♀ ♀, 1 ♂ .

Cascade Valley; Aug. 27, '41-119c, 2 ♀ ♀, 6 ♂ ♂ .

Mono Lake; Aug. 29, '41-126, 7 ♀ ♀, 3 ♂ ♂ .

Host: *Tamiasciurus douglasii albolimbatus* (Allen).

Cascade Valley; Aug. 27, '41-118a, 1 ♂ .

Host: *Ochotona schisticeps albata* Grinnell.

Dusy Lakes; Aug. 23, '38-8a, 2 ♀ ♀, 2 ♂ ♂ .

Geusibia ashcrafti Augustson

Host: *Ochotona schisticeps muiri* Grinnell and Storer.

Duck Pass; Aug. 22, '41-100a, 3 ♀ ♀, 4 ♂ ♂ ; Aug. 27, '41-102a, 1 ♂ .

Tully's Hole; Aug. 23, '41-107a, 1 ♀ , 1 ♂ .

Horse Heaven; Aug. 24, '41-109a, 4 ♀ ♀, 1 ♂ .

Cascade Valley; Aug. 27, '41-116a, 2 ♀ ♀, 3 ♂ ♂ .

Host: *Ochotona schisticeps albata* Grinnell.

Dusy Lakes; Aug. 23, '38-8c, 17 ♀ ♀ .

Mammoth Meadows; Aug. 27, '40-136b, 3 ♀ ♀ .

Mammoth Lakes; July 26, '41-91a, 3 ♀ ♀ .

Malarcaeus bitterrootensis (Dunn and Parker)

Host: *Peromyscus maniculatus sonoriensis* (Le Conte).

Mammoth Lakes; Aug. 10, '41-94d, 1 ♂ .

Megabothris abantis (Rothschild)

Host: *Tamiasciurus douglasii albolimbatus* (Allen).

Horse Heaven; Aug. 24, '41-110a, 1 ♀ .

Mammoth Lakes; Aug. 28, '41-123c, 1 ♀ .

Host: *Peromyscus maniculatus sonoriensis* (Le Conte).

Mammoth Lakes; July 5, '40-82b, 1 ♂ ; Aug. 14, '40-93b, 1 ♀ ; Aug. 22, '40-114b, 1 ♂ .

Host: *Microtus montanus dutcheri* Bailey.

Tully's Hole; Aug. 25, '41-113c, 2 ♀ ♀, 3 ♂ ♂ .

Mammoth Lakes; Aug. 28, '41-121a, 1 ♀ , 1 ♂ .

Host: *Microtus mordax sierrae* R. Kellogg.

Tully's Hole; Aug. 23, '41-104c, 3 ♀ ♀, 1 ♂ .

Cascade Valley; Aug. 27, '41-115, 1 ♂ .

Host: *Zapus pacificus alleni* Elliot.

Tully's Hole; Aug. 23, '41-102, 1 ♀ , 1 ♂ .

Megarhroglossus procus Jordan and Rothschild

Host: *Sorex (Neosorex) palustris navigator* (Baird).

Tully's Hole; Aug. 24, '41-111, 1 ♀ , 1 ♂ .

Host: *Tamiasciurus douglasii albolimbatus* (Allen).

Mammoth Lakes; July 21, '39-12c, 7 ♀ ♀, 1 ♂ .

Host: *Peromyscus maniculatus sonoriensis* (Le Conte).

Tully's Hole; Aug. 23, '41-03b, 1 ♀ .

Host: *Ochotona schisticeps muiri* Grinnell and Storer.

Duck Pass; Aug. 22, '41-100b, 1 ♀, 1 ♂; Aug. 27, '41-120b, 1 ♂.

Tully's Hole; Aug. 23, '41-107b, 3 ♀ ♀.

Cascade Valley; Aug. 27, '41-116b, 4 ♂ ♂.

MegarthroGLOSSUS divisus (Baker)

Host: *Tamiasciurus douglasii albolimbatus* (Allen).

Tully's Hole; Aug. 25, '41-112b, 1 ♂.

Monopsyllus ciliatus mononis (Jordan)

Host: *Marmota flaviventor sierrae* A. H. Howell.

Mammoth Lakes; July 26, '41-92c, 1 ♂.

Host: *Citellus beldingi beldingi* (Merriam).

Mammoth Lakes; July 22, '41-108b, 1 ♂.

Host: *Eutamias alpinus* (Merriam).

Tully's Hole; Aug. 24, '41-108b, 1 ♂.

Host: *Eutamias quadrivittatus inyoensis* Merriam.

Mammoth Lakes; July 22, '41, 83a, 1 ♀, 3 ♂ ♂.

Tully's Hole; Aug. 23, '41-105b, 1 ♀, 1 ♂.

Cascade Valley; Aug. 26, '41-114b, 1 ♀; Aug. 27, '41-117d, 1 ♀.

Host: *Tamiasciurus douglasii albolimbatus* (Allen).

Mammoth Lakes; July 31, '39-12b, 8 ♀ ♀, 3 ♂ ♂; Aug. 20, '41-98a, 4 ♀ ♀; Aug. 28, '41-123b, 3 ♀ ♀.

Horse Heaven; Aug. 24, '41-110b, 1 ♀.

Tully's Hole; Aug. 25, '41-112d, 2 ♀ ♀, 1 ♂.

Cascade Valley; Aug. 27, '41-118c, 1 ♀, 2 ♂ ♂.

Monopsyllus eumolpi eumolpi (Rothschild)

Host: *Citellus beldingi beldingi* (Merriam).

Mammoth Lakes; Aug. 8, '39-14a, 1 ♂.

Host: *Citellus (Callospermophilus) lateralis chrysodeirus* (Merriam).

Casa Diablo; Aug. 22, '40-116b, 1 ♀.

Host: *Eutamias alpinus* (Merriam).

Mammoth Meadows; Aug. 29, '40-138a, 1 ♀.

Tully's Hole; Aug. 24, '41-108a, 1 ♀.

Host: *Eutamias quadrivittatus inyoensis* Merriam.

Benton Crossing; Aug. 18, '40-105, 8 ♀ ♀, 4 ♂ ♂; Aug. 22, '40-120, 1 ♂.

Casa Diablo; Aug. 22, '40-117a, 3 ♀ ♀, 2 ♂ ♂.

Mammoth Lakes; July 22, '41-83b, 1 ♀.

Duck Pass; Aug. 22, '41-101b, 1 ♂.

Tully's Hole; Aug. 23, '41-105c, 1 ♀, 2 ♂ ♂.

Cascade Valley; Aug. 26, '41-114a, 1 ♀, 1 ♂; Aug. 27, '41-117b, 2 ♀ ♀.

Monro Lake, Aug. 29, '41-125, 3 ♀ ♀, 1 ♂.

Host: *Tamiasciurus douglasii albolimbatus* (Allen).

Tully's Hole; Aug. 25, '41-112e, 1 ♀.

Cascade Valley; Aug. 27, '41-118b, 1 ♂.

Host: *Sylvilagus nuttallii grangeri* (Allen).

Mammoth Lakes; July 5, '40-84b, 1 ♀.

Monopsyllus eutamias Augustson

Host: *Eutamias quadrivittatus inyoensis* Merriam.
Mammoth Lakes; July 22, '41-83c, 1 ♀.
Cascade Valley; Aug. 27, '41-117a, 3 ♀ ♀, 1 ♂.

Monopsyllus wagneri wagneri (Baker)

Host: *Eutamias quadrivittatus inyoensis* Merriam.
Cascade Valley; Aug. 27, '41-117c, 1 ♂.

Host: *Peromyscus maniculatus sonoriensis* (Le Conte).

Mammoth Lakes; June 1, '40-76a, 3 ♀ ♀, 1 ♂; July 5, '40-82a, 4 ♀ ♀, 2 ♂ ♂; July 6, '40-85; 1 ♀, 1 ♂; Aug. 12, '40-91a, 2 ♀ ♀, 1 ♂; Aug. 14, '40-93a, 1 ♀, 1 ♂; Aug. 22, '40-114a, 1 ♀; June 1, '41-61a, 4 ♀ ♀, 3 ♂ ♂; July 23, '41-85a, 3 ♂ ♂; Aug. 10, '41-94a, 12 ♀ ♀, 11 ♂ ♂; Aug. 15, '41-95b, 2 ♀ ♀, 5 ♂ ♂; Aug. 28, '41-112b, 4 ♀ ♀, 2 ♂ ♂; Aug. 29, '41-124b, 12 ♀ ♀, 14 ♂ ♂.

Host: *Microtus mordax sierrae* R. Kellogg.

Tully's Hole; Aug. 23, '41-104d, 1 ♀, 1 ♂.

Host: *Ochotona schisticeps muiri* Grinnell and Storer.

Duck Pass; Aug. 22, '41-100d, 1 ♀.

Tully's Hole; Aug. 23, '41-107d, 3 ♀ ♀, 1 ♂.

Host: *Sylvilagus nuttallii grangeri* (Allen).

Mammoth Mountain; Aug. 15, '40-100, 1 ♂.

Opisodasys enoplus (Rothschild)

Host: *Tamiasciurus douglasii albolimbatus* (Allen).

Mammoth Lakes; July 31, '39-12i, 1 ♀.

Opisodasys keeni (Baker)

Host: *Peromyscus maniculatus sonoriensis* (Le Conte).

Mammoth Lakes; Aug. 12, '40-91b, 1 ♀.

Tully's Hole; Aug. 23, '41-103d, 1 ♂.

Orchopeas nepos (Rothschild)

Host: *Bassaricus astutus raptor* (Baird).

Yosemite; Nov. 12, '39-38a, 2 ♀ ♀, 1 ♂. Collector, J. E.

Cole.

Host: *Peromyscus maniculatus sonoriensis* (Le Conte).

Mammoth Lakes; July 23, '41-85b, 1 ♀.

Host: *Tamiasciurus douglasii albolimbatus* (Allen).

Mammoth Lakes; July 31, '39-12a, 58 ♀ ♀, 52 ♂ ♂; July 23, '41-86a, 6 ♀ ♀, 1 ♂; Aug. 20, '41-98b, 20 ♀ ♀, 20 ♂ ♂; Aug. 28, '41-123a, 31 ♀ ♀, 24 ♂ ♂.

Yosemite; Dec. 26, '39-34a, 27 ♀ ♀, 7 ♂ ♂. Collector,

J. E. Cole.

Tully's Hole; Aug. 25, '41-112c, 3 ♀ ♀.

Host: *Ochotona schisticeps muiri* Grinnell and Storer.

Duck Pass; Aug. 22, '41-100e, 1 ♀.

Oropsylla idahoensis (Baker)

Host: *Citellus beldingi beldingi* (Merriam)

Mammoth Lakes; Aug. 14, '40-96, 1 ♀.

Host: *Citellus (Callospermophilus) lateralis chrysodeirus* (Merriam).

Mammoth Mountain; Aug. 15, '40-101b, 1 ♀.

Mammoth Lakes; July 26, '41-89b, 10 ♀ ♀, 6 ♂ ♂; Aug. 17, '41-97b, 5 ♀ ♀.

Cascade Valley; Aug. 27, '41-119b, 3 ♀ ♀, 1 ♂.

Host: *Eutamias quadrivittatus inyoensis* Merriam.

Duck Pass; Aug. 22, '41-101a, 1 ♀.

Host: *Tamiasciurus douglasii albolimbatus* (Allen).

Mammoth Lakes; July 31, '39-12d, 1 ♀.

Thrassis howelli (Jordan)

Host: *Marmota flaviventer sierrae* A. H. Howell.

Mammoth Meadows; Aug. 29, '40-142a, 14 ♀ ♀, 7 ♂ ♂.

Mammoth Lakes; July 26, '41-92a, 4 ♀ ♀, 11 ♂ ♂.

Duck Pass; Aug. 22, '41-99a, 28 ♀ ♀, 17 ♂ ♂.

Host: *Citellus (Otospermophilus) beecheyi fisheri* (Merriam).

Casa Diablo; Aug. 22, '40-122b, 1 ♀, 3 ♂ ♂.

Host: *Ochotona schisticeps muiri* Grinnell and Storer.

Duck Pass; Aug. 22, '41-100c, 1 ♀.

Family HYSTRICHOPSYLLIDAE

Catallagia rutherfordi Augustson

Host: *Tamiasciurus douglasii albolimbatus* (Allen).

Mammoth Lakes; Aug. 28, '41-123d, 2 ♂ ♂.

Host: *Peromyscus maniculatus sonoriensis* (Le Conte).

Mammoth Lakes; June 1, '41-61c, 1 ♂; Aug. 10, '41-94g, 1 ♀; Aug. 15, '41-95c, 1 ♀.

Delotelis telegoni (Rothschild)

Host: *Peromyscus maniculatus sonoriensis* (Le Conte).

Mammoth Lakes; Aug. '41-93d, 1 ♀.

Epitedia wenmanni (Rothschild)

Host: *Peromyscus maniculatus sonoriensis* (Le Conte).

Mammoth Lakes; June 21, '40-76b, 1 ♂; Aug. 2, '41-93c, 1 ♀.

Peromyscopsylla selenis (Rothschild)

Host: *Citellus (Callospermophilus) lateralis chrysodeirus* (Merriam).

Tully's Hole; Aug. 23, '41-106a, 1 ♀.

Cascade Valley; Aug. 27, '41-119a, 1 ♀, 1 ♂.

Host: *Tamiasciurus douglasii albolimbatus* (Allen).

Tully's Hole; Aug. 25, '41-112a, 1 ♀.

Host: *Microtus montanus dutcheri* Bailey.

Tully's Hole; Aug. 25, '41-113a, 18 ♀ ♀, 10 ♂ ♂.

Host: *Microtus mordax sierrae* R. Kellogg.

Tully's Hole; Aug. 23, '41-104a, 22 ♀ ♀, 6 ♂ ♂.

Peromyscopsylla ravalliensis (Dunn & Parker)

Host: *Peromyscus maniculatus sonoriensis* (Le Conte).

Mammoth Lakes; Aug. 10, '41-94c, 3 ♀ ♀, 1 ♂; Aug. 29, '41-124a, 1 ♂.

Tully's Hole; Aug. 23, '41-103a, 2 ♀ ♀, 2 ♂ ♂.

Phalacroscylla monticola Augustson

Host: *Ochotona schisticeps muiri* Grinnell and Storer.

Tully's Hole; Aug. 23, '41-107e, 1 ♀, 1 ♂

Class ARACHNIDA

Order ACARINA

Family ARGASIDAE

Ornithodoros hermsi Wheeler

Host: *Citellus (Callospermophilus) lateralis chrysodeirus* (Merriam).

Cascade Valley; Aug. 27, '41-119d, 2 larvae.

Host: *Savornis sayus sayus* (Bonaparte).

Benton Crossing; Aug. 22, '40-119, 2 larvae.

Otobius lagophilus Cooley

Host: *Sylvilagus nuttallii grangeri* (Allen).

Benton Crossing; Aug. 22, '40-118b, 1 ♀.

Family IXODIDAE

Dermacentor andersoni Stiles

Host: *Homo sapiens sapiens* Linnaeus.

Mammoth Lakes; July 4, '40-81, 1 ♂; July 7, '40-87, 1 ♀.

Host: *Citellus beldingi beldingi* (Merriam).

Mammoth Lakes; July 22, '41-84d, 1 nymph.

Host: *Citellus (Otospermophilus) beecheyi fisheri* (Merriam).

Casa Diablo; Aug. 21, '40-110d, 2 nymphs, 7 larvae; Aug. 22, '40-122c, 5 nymphs, 1 larva; Aug. 23, '40-123b; 14 nymphs, 3 larvae.

Host: *Citellus (Callospermophilus) lateralis chrysodeirus* (Merriam).

Mammoth Lakes; Aug. 13, '40-92b, 2 larvae; July 25, '41-87b, 4 nymphs; July 26, '41-89c, 20 nymphs, 4 larvae.

Casa Diablo; Aug. 21, '40-111b, 1 ♀, 1 ♂, 11 nymphs, 33 larvae; Aug. 22, '40-116c, 1 nymph; Aug. 22, '40-121b, 1 ♀, 3 nymphs, 21 larvae; Aug. 29, '40-140b, 7 nymphs.

Host: *Eutamias quadrivittatus inyoensis* Merriam.

Casa Diablo; Aug. 22, '40-117b, 2 nymphs.

Host: *Tamiasciurus douglasii albolimbatus* (Allen).

Mammoth Lakes; July 23, '41-86b, 1 nymph.

Host: *Peromyscus maniculatus sonoriensis* (Le Conte).

Mammoth Lakes; Aug. 13, '40-92b, 21 larvae.

- Host: *Microtus mordax sierrae* R. Kellogg.
Mammoth Lakes; Aug. 22, '40-113a, 5 larvae.
Host: *Lagurus curtatus* (Cope).
Mammoth Lakes; Aug. 14, '40-94, 9 larvae.
Host: *Erethizon epixanthum epixanthum* Brandt.
Mammoth Lakes; May 24, '40-68, 1 ♂. (Determination by
F. C. Bishopp); July 26, '41-90; 5 ♀ ♀, 9 ♂ ♂.
Host: *Ochotona schisticeps muii* Grinnell and Storer.
Duck Pass; Aug. 22, '41-100j, 1 larva.
Host: *Ochotona schisticeps albata* Grinnell.
Mammoth Lakes; July 26, '41-91c, 9 nymphs.
Host: *Sylvilagus nuttallii grangeri* (Allen).
Benton Crossing; Aug. 17, '40-103, 1 nymph. Aug. 22, '40-
118a, 6 nymphs, 1 larva.
- Ixodes angustus* Neumann
Host: *Bassariscus astutus raptor* (Baird)
Yosemite; Nov. 12, '39-38b, 2 nymphs. Collector, J. E. Cole.
Host: *Tamiasciurus douglasii abolimbatus* (Allen).
Mammoth Lakes; July 31, '39-12e, 9 ♀ ♀, 1 ♂, 13 nymphs,
30 larvae.
Host: *Ochotona schisticeps muii* Grinnell and Storer.
Duck Pass; Aug. 22, '41-100i, 1 nymph.
Cascade Valley; Aug. 27, '41-116c, 1 nymph.

Family DERMANYSSIDAE

- Liponyssus occidentalis* Ewing
Host: *Citellus (Callospermophilus) lateralis chrysoideirus*
(Merriam).
Tully's Hole; Aug. 23, '41-106c, 1 ♀.
Host: *Microtus montanus dutcheri* (Bailey)
Tully's Hole; Aug. 25, '41-113i, 1 ♂.
Host: *Ochotona schisticeps muii* Grinnell and Storer.
Duck Pass; Aug. 22, '41-100h, 2 ♀ ♀.
- Liponyssus pacificus* Ewing
Host: *Eutamias alpinus* (Merriam).
Mammoth Meadows; Aug. 29, '40-138b, 8 ♀ ♀.
- Tetragonyssus microti* Ewing
Host: *Sorex vagrans amoenus* Merriam.
South Lake; Aug. 22, '38-16b, 2 ♀ ♀.
Host: *Sorex obscurus obscurus* Merriam.
South Lake; Aug. 22, '38-16a, 1 ♀.
Host: *Microtus montanus dutcheri* Bailey.
South Lake; Aug. 22, '38-15a, 13 ♀ ♀.
Tully's Hole; Aug. 25, '41-113j, 10 ♀ ♀, 6 ♂ ♂.
Host: *Microtus mordax sierrae* R. Kellogg.
Tully's Hole; Aug. 23, '41-104h, 24 ♀ ♀, 1 ♂.

Family PARASITIDAE

Euhaemogamasus oregonensis Ewing

Host: *Tamiasciurus douglasii albolimbatus* (Allen).

Mammoth Lakes; Aug. 20, '41-98c, 13 ♀ ♀.

Host: *Microtus montanus dutcheri* Bailey.

Tully's Hole; Aug. 25, '41-113g, 4 ♀ ♀.

Geneiadolaelaps californicus Ewing

Host: *Citellus (Otospermophilus) beecheyi fisheri* (Merriam).

Casa Diablo; Aug. 22, '40-122d, 1 ♀.

Host: *Citellus (Callospermophilus) lateralis chrysodeirus* (Merriam).

Mammoth Mountain; Aug. 15, '40-101c, 1 ♀.

Benton Crossing; Aug. 17, '40-102b, 15 ♀ ♀.

Tully's Hole; Aug. 23, '41-106d, 20 ♀ ♀.

Host: *Tamiasciurus douglasii albolimbatus* (Allen).

Mammoth Lakes; July 31, '39-12f, 2 ♀ ♀.

Host: *Microtus montanus dutcheri* Bailey.

Tully's Hole; Aug. 25, '41-113h, 1 ♀.

Mammoth Lakes; Aug. 28, '41-121b, 1 ♀.

Host: *Microtus mordax sierrae* R. Kellogg.

Mammoth Lakes; Aug. 22, 40-113c, 2 ♀ ♀.

Haemogamasus liponyssoides Ewing

Host: *Microtus montanus dutcheri* Bailey.

Tully's Hole; Aug. 25, '41-113f, 7 ♀ ♀, 2 ♂ ♂.

Host: *Microtus mordax sierrae* R. Kellogg.

Tully's Hole; Aug. 23, '41-104g, 3 ♀ ♀, 1 ♂.

THE ALLOTYPE OF *GEUSIBIA ASHCRAFTI*
AUGUSTSON 1941

By G. F. AUGUSTSON

Allan Hancock Foundation,
University of Southern California

Some months ago the writer published his diagnosis of the holotype female (Bull. So. Calif. Acad. Sci. 39:203) of this very interesting parasite. Since that time there apparently has arisen some uncertainty among Siphonapterists as to its correct generic position. Fortunately this writer has been able to uncover some males undoubtedly strengthening his original diagnosis. It is hoped that the following description and illustrations will substantiate this opinion.

GEUSIBIA ASHCRAFTI Augustson 1941

Syn: *Augustsonius ashcrafti* (Aug.) Hubbard, Pac. Univ. Bull. 37:3.

Allotype Male

HEAD: Frontal notch prominent; preantennal region with two rows of bristles, the upper row with seven medium bristles starting well up on the anterior margin of the antennal groove, one similar bristle between the upper and lower row along the antennal groove, the lower row of three stout, long bristles well above eye; numerous very small setae scattered among the two preantennal rows. Eye large, elliptical to panduriform, heavily pigmented. Maxillae sharply acuminate. Labial palpi one-half the length of the fore-coxa. Postantennal region with two rows of bristles in which the most proximal bristles to the antennal groove are much the larger. Posterior border of antennal groove with many small setae.

THORACIC AND ABDOMINAL SEGMENTS: Pronotal ctenidium of eighteen spines. Two small teeth on metanotum and first two abdominal tergites. Three antepygidial bristles, the middle four times longer than the outer, and three times longer than the inner. Tergite VIII sharply rounded dorsally with nine or ten long bristles along its apical margin, and five or six short spine-like bristles mixed in among them, anterior dorso-lateral condylus present as in *G. torosa*. Finger large, lower two-thirds thicker more heavily pigmented than upper third, the former round the latter flattened into a hoofed-shaped structure with one medium posterior bristle and numerous small setae along the entire anterior margin of finger. Clasper with short, round upper process and a very long lower process. Sternite IX with two posterior lobes, the upper spoon-shaped, the lower knob-like, both freely covered with setae. Sternite VIII very diagnostic, very large, well rounded ventrally with ventral rod-like incrustation forming a large "V" as in *G. torosa*, posterior apical angle feebly chitinized with an open crown of fifteen to twenty spiniforms curved posteriorly (without subspiniforms).

LEGS: Tibia and tarsal segment I of all legs densely hirsute with minute setae on dorso-posterior margins besides usual long bristles. Hind-coxa one-half times longer than broad, in apical half of anterior inner margin some slender setae.

ALLOTYPE: A male, collected by the writer, Cascade Valley, Fresno County, California, August 27, 1941, from *Ochotona schisticeps muiri* G. and S. Deposited in the Los Angeles County Museum, Los Angeles, California.

PARATYPES: Nine males, host listings and locality records to follow in a later report. Two specimens retained by writer, the remainder to be distributed later.

REMARKS: On the basis of the foregoing analysis it should be apparent that Dr. Hubbard's new genus for this parasite can not stand. It should also be evident that it cannot be referred

to *Odontopsyllus* Baker or *Frontopsylla* Wagner and Joff but should be referred to *Geusibia* Jordan on the comparative morphology of sternite eight, the tibia, tarsi, as well as other significant details.

The writer has encountered few more interesting problems than the discovery of this parasite, and the subsequent addition to our American flea fauna of a genus heretofore unknown on the North American continent.

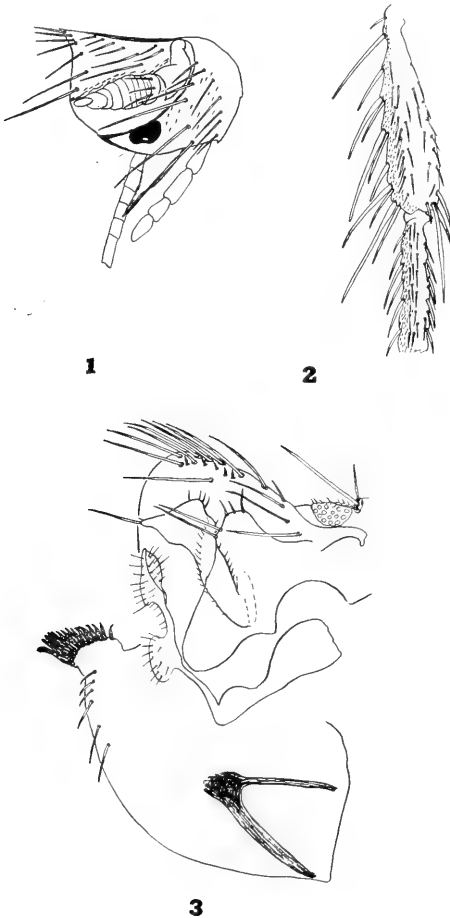


PLATE 17

Fig. 1. *Geusibia ashcrafti* Aug., head, allotype male.

Fig. 2. *Geusibia ashcrafti* Aug., tibia, tarsus I, allotype male.

Fig. 3. *Geusibia ashcrafti* Aug., genitalia, allotype male.

NOTES ON LOXOPHORA DAMMERSI Van Duzee

By JOHN A. COMSTOCK

This interesting little Fulgorid was described by Mr. Van Duzee in the Pan Pacific Entomologist, Vol. 10, p. 191, 1934, from material collected by Commander C. M. Dammers.

The species is quite common on *Agave deserti* Engelm., but it is difficult to capture on account of its agile movements, and the fact that it quickly secretes itself at the base of the fleshy agave leaf, where, on account of the rows of "teeth" along the edges of the leaves, it is almost impossible to reach it.

Comm. Dammers has made an excellent painting of this handsome little bug, which we take pleasure in reproducing on Plate 18.

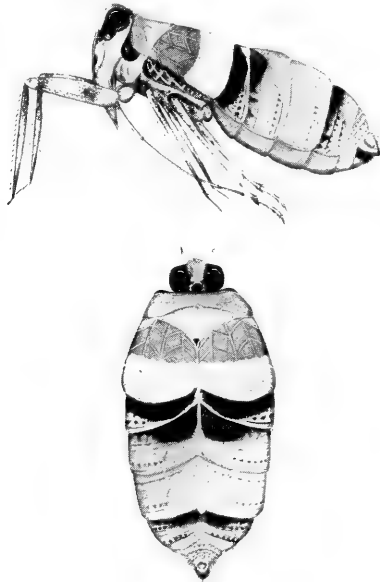


PLATE 18

Loxophora dammersi enlarged
approx. x 10.

Reproduced from painting by
Comm. C. M. Dammers.



ERRATUM

Part 1 of this Volume: on page 2, lines 7, 13, 24 and 46, and page 3, lines 6 and 32, for Crampton, read Snodgrass. On page 11, line 1, for Arctiid, read Amatid.

Editor.

CONTRIBUTIONS FROM THE LOS ANGELES MUSEUM
- CHANNEL ISLANDS BIOLOGICAL SURVEY

No. 22—A NEW SUBSPECIES OF WHITE-FOOTED
MOUSE FROM THE ANACAPA ISLANDS, CALIFORNIA

By JACK C. VON BLOEKER, JR.

For some years past it has been known that white-footed mice occur on the Anacapa group of the northern Channel Islands of California. In his *Review of the Recent Mammal Fauna of California* (Univ. Calif. Publ. Zool., vol. 40, no. 2, p. 175, Sept. 26, 1933), J. Grinnell referred the white-footed mouse of Anacapa Island, on the basis of probability as no specimens were available, to the race *Peromyscus maniculatus santacruzae*, described from Santa Cruz Island. Therefore, one of the primary objectives of the ninth Expedition of this survey was to secure a series of the Anacapa mice. Ample material was procured in August, 1940, and the results of the subsequent study indicate that the Anacapa form represents a recognizable geographic race, heretofore undescribed. It may be known and diagnosed as follows:

PEROMYSCUS MANICULATUS ANACAPAE, subsp. nov.

Anacapa Islands White-footed Mouse

TYPE: Male adult, skin and skull, no. 7335, Los Angeles County Museum, from Fish Camp, West Anacapa Island, Ventura County, California, August 17, 1940, collected by Jack C. von Bloeker, Jr., orig. no. 11850.

DISTRIBUTION: Occurs on East, Middle, and West Anacapa Islands, Ventura County, California.

DIAGNOSIS: A moderately large (see measurements), long-tailed, darkly colored race of the *Peromyscus maniculatus* group; skull strongly built, moderately slender zygomata much tapering anteriorly, rostrum long and tapered (moderately broad basally and narrowed anteriorly).

COMPARISONS: Similar to *Peromyscus maniculatus santacruzae*, but color averages darker dorsally, with less brown and lacking reddish tinge of adults of *santacruzae*; hairs of tail shorter and less profuse; total length and tail shorter; skull shorter and narrower throughout. Compared with *Peromyscus maniculatus sanctaerosae*, darker and less brown in dorsal color; total length

longer and with longer and less profusely haired tail; skull longer and narrower, with zygomatic arches more tapered anteriorly, interparietal wider. Differs from *Peromyscus maniculatus streator* in darker dorsal color; tail more heavily haired and averages longer; hind foot averages slightly longer and ears smaller; skull averages longer and narrower throughout, with zygomatic arches and rostrum more tapered anteriorly. Distinguishable from *Peromyscus maniculatus gambelii* in darker dorsal color and larger size throughout.

COLOR (using color terms from Ridgway's *Color Standards and Color Nomenclature*, 1912)—Type: Dorsal hairs with terminal portions black, narrow subterminal bands light drab, broad basal portions deep mouse gray; ventral hairs deep mouse gray basally, broadly tipped with white; black tips of latero-dorsal hairs and cheek hairs shorter than those of back, giving an effect of lighter drab coloration; a small patch of clay color hairs at ventral base of tail; ears near blackish brown, narrowly edged with cinereous hairs; hairs of upper surface of feet white; tail bicolor, dorsal hairs blackish brown, ventral hairs white.

MEASUREMENTS: (in millimeters)—Averages and extremes of ten adults (7 males and 3 females), paratypes: Total length, 180 (172-188); tail, 85 (80-88); hind foot, 22 (21-23); ear, from notch, 17 (16-18). Skull: Greatest length, 26.1 (25.8-26.4); condylobasal length, 23.2 (22.9-23.5); zygomatic breadth, 12.7 (12.5-13.0); interorbital breadth, 4.1 (3.9-4.2); interparietal, 9.4 x 2.6 (9.2 x 2.4 - 9.6 x 2.8); length of nasals, 10.5 (10.3-10.8); maxillary toothrow, 3.8 (3.6-4.0).

SPECIMENS EXAMINED: Eighty-nine, as follows: *West Anacapa Island*—Fish Camp, 11; Middle Saddle, 800 feet altitude, 2; Middle Peak, 875 feet altitude, 1; Anacapa Peak, 930 feet altitude, 2; Cherry Canyon, 350 feet altitude, 1; Oak Canyon, 450 feet altitude, 2; *Middle Anacapa Island*—Old Ranch Landing, 37; *East Anacapa Island*—U. S. Lighthouse Reservation, 33.

REMARKS: Paratypes of this new race are to be deposited in the United States National Museum, the Museum of Vertebrate Zoology, and the Allan Hancock Foundation.

No. 23—A NEW SHREW FROM SANTA CATALINA
ISLAND, CALIFORNIA

By JACK C. VON BLOEKER, JR.

On several occasions at meetings of participating members of the Los Angeles Museum-Channel Islands Biological Survey, in the course of discussions concerning plans and prospects for future work on the islands, George Willett predicted that shrews would be found on one or more of the larger islands, such as Santa Catalina and Santa Cruz. For my own part I must confess that, although I was familiar enough with the topography of the islands to know that certainly there appeared no valid reason why shrews could not exist there, I was still skeptical that one would ever be found on any of the Channel Islands group. It was with no little surprise then, on April 25, 1941, when I received a special delivery package containing a shrew from Miss Ruth B. Eaton, a school-teacher at Avalon, California. A letter sent by Miss Eaton the day before stated that she had a small animal which had been captured alive in Avalon Canyon and that she thought it might be a shrew. She wrote that it refused to eat in captivity and appeared to be becoming weak—and that if it died she would send it to the museum for identification. Apparently the animal died soon afterward, because her letter arrived at 10 A. M. and the shrew at noon of the same day. The specimen, although "soft" in the abdominal region, was otherwise in good condition and was immediately prepared as a study skin-with-skull by the writer.

Comparison of this shrew with other known Californian species of *Sorex* has revealed that it apparently represents an hitherto unknown member species of the *Sorex ornatus* group of shrews. It is a pleasure to name the new species in honor of the man who predicted its existence, my good friend and counselor, George Willett. It may be known and is characterized as follows:

Sorex willetti, sp. nov.
Santa Catalina Island Shrew

TYPE: ♂ adult, skin and skull, no. 7400, Los Angeles County Museum, from Avalon Canyon, Santa Catalina Island, Los Angeles County, California, April 25, 1941, collected by Miss Ruth B. Eaton, orig. no. 14085JvB.

DISTRIBUTION: Known only from the type locality.

DIAGNOSIS: A moderately large (see measurements), darkly colored, long-tailed shrew of the *ornatus* group, pelage hair brown dorsally and pale smoke gray ventrally; tail bicolor, fuscous above, pale smoke gray below; skull long and relatively narrow, brain-case comparatively high (ratio, height to breadth of cranium, 62.6%, rostrum long and narrow.

COMPARISONS (color comparisons made with specimens taken at approximately the same time of year): Compared with *Sorex ornatus ornatus*, darker dorsally and paler ventrally; external measurements about equal; skull longer and slightly broader though proportionately narrower; cranial height, interorbital breadth, and maxillary breadth slightly greater; maxillary tooth row longer. Differs from *Sorex ornatus salicornicus* in darker dorsal and paler ventral coloration; all measurements larger throughout. In comparison with *Sorex ornatus relictus*, color lighter; total length and tail longer, head and body length actually and relatively shorter; skull larger and relatively narrower throughout.

COLOR (color terms from Ridgway's *Color Standards and Color Nomenclature*, 1912): Type—Dorsal hairs with basal portions dark plumbeous, subterminal bands hair brown, apical portions black; ventral hairs dark plumbeous basally, broadly tipped with pale smoke gray; tail bicolor, dorsal hairs of tail fuscous, ventral hairs of tail, hairs of upper surface of feet and nasal vibrissae pale smoke gray.

MEASUREMENTS (in millimeters): Type—Total length, 104; tail, 43; hind foot, 12; ear, from notch, 5. Skull (teeth slightly worn)—Condylobasal length, 17.6; palatal length, 7.2; cranial breadth, 8.3; height of cranium, 5.2; interorbital breadth, 3.8; maxillary breadth, 5.1; maxillary tooth row, 6.6.

SPECIMEN EXAMINED: One, the type.

REMARKS: Inasmuch as only one specimen representing this form is at present available for study, subspecific designation of *Sorex willetti* at this time would appear unsatisfactory. If, and when, additional material comes to hand, it may be possible to demonstrate intergradation with *Sorex ornatus* through individual variation.

No. 24—THE LARVA AND PUPA OF TRICHOCLEA
EDWARDSI SM.

By JOHN A. COMSTOCK and CHRISTOPHER HENNE

This Phalaenid moth was taken in considerable numbers by members of the Survey on San Nicolas Island in July, 1939, and in small numbers as follows: San Clemente Island, April, Nov., and Dec., 1939; Santa Rosa Island, Aug., 1939; Anacapa Island, Aug., 1940.

Larvae were secured on San Nicolas Island April 26 1940, by beating, from *Atriplex leucophylla* Dietr. These salt bushes were growing on a sandy strip near Coral Harbor, on the north shore of the Island. The example from which our notes were made gave forth an imago on June 11, 1940.

Mature larva: sub-cylindrical, robust; body ground color, pale green, with faint whitish green "etching", giving a frosted appearance. Skin faintly translucent, with the circulatory tube of the mid-dorsal area showing through as a darker line of green. Sub-dorsal and dorso lateral whitish stripes run longitudinally, beginning on the first thoracic segment, and terminating close to the caudal area. These stripes are bordered with dark green. The uppermost is the most conspicuous, but both are relatively less boldly defined than is the case with many noctuid larvae.

A few small dark punctae occur laterally, above the infra-stigmatal fold. Each is surmounted by a fine dark seta. Similar punctae occur dorsally on the next to last segment, and also on the anal segment, where they are rather numerous.

Scutellum, straw colored, with two outwardly convex dark colored dashes on either side. True legs, and prolegs, somewhat lighter than body ground color. Spiracles, dark brown.

Head, straw color, with a few brownish specks. Mandibles, nearly black.

The mature larva is illustrated on Plate 19.

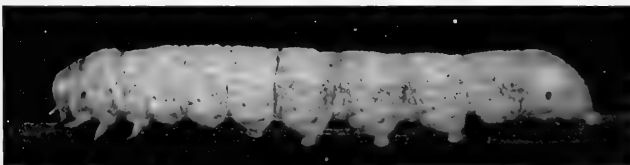


PLATE 19
Larva of *Trichoclea edwardsi* Sm.
enlarged approximately x 4.

Pupa: Fusiform; smooth and glistening. Immediately following transformation from the larva it is a unicolorous light tan, with a dark mid-dorsal stripe on the abdominal segments. The color changes as it ages, becoming darker in the abdominal region, with a correspondingly greater contrast of the segmental sutures, the legs and antennal sheaths. The eyes are brownish-black. Just prior to hatching the pupa takes on a dark reddish brown color.

The wing cases extend approximately two-thirds the distance to the caudal extremity. The ends of the leg shields merge and form a ridge mid-ventrally, their tips terminating beyond the edges of the wing cases.

The eye cases are large, and slightly protruding. Spiracles, dark brownish black.

The cremaster is composed of a small slightly raised laterally ridged plate, located on the ventral surface of the caudal extremity. Two spines, approximately 1 mm. in length occur on this plate. On some examples, these spines are bifurcate at the tips. A small depression is located in front of the cremaster, and anterior to that is a small chitinous ridge.

Several examples were measured, the average length being 19 mm., and the average width through the middle, 6 mm.

The pupa is figured on Plate 20.



PLATE 20
Pupa of *Trichoclea edwardsi*
enlarged approx. x 4.

IN MEMORIAM: WILLIAM A. SPALDING

William A. Spalding, last of the pioneer group who helped to found the Southern California Academy of Sciences, died at his residence, 2434 Gates Street, Los Angeles, on September 7, 1941, at the mature age of 88.

Mr. Spalding was one of the active members in the Southern California Science Association, which was the precursor of the Academy. His name was signed to the original list of Academy founders, and he served in 1897-'98 as its second President. Also, from 1909 to 1913 he filled the same office. It was during this period that he was most active in acquiring for the Academy the collection of prehistoric animal remains which were eventually to form the major attraction of the Los Angeles Museum.

The Academy excavations at Hancock Park were carried to completion during his administration, as was also the founding of the Los Angeles Museum of History, Science and Art. He was appointed by the Academy (together with Holdredge O. Collins) to serve on the first Board of Governors of the Museum.

Mr. Spalding served on the first Board of Freeholders, which drew up the city charter. He was early associated with Gen. Harrison Gray Otis, founder of the Los Angeles Times. His authorship of the noted historical work "History of Los Angeles City and County" has earned for his name an enduring place in California annals.

William A. Spalding was born in Ann Arbor, Michigan, Oct. 3, 1852, the son of Ephraim Hall and Jane Spalding. He was graduated from his brother's commercial college in Kansas City, and for four years was associated with the Kansas City Journal. Later he returned to Ann Arbor, and entered the University of Michigan, but cut short his course to come to Los Angeles in 1874, when he joined the staff of the Daily Herald. In 1879 he became business manager of the Herald and later was associated with the Evening Express as City Editor.

Shortly thereafter he moved to Sierra Madre to raise citrus fruits, and it was during this period that he wrote the authoritative work "The Orange; Its Culture In California."

Returning to journalism in 1886 he became City Editor of The Times. He subsequently was vice-president of the Times-Mirror in which he had purchased an interest.

Appointed to the post of State Commissioner of Building and Loan Associations in 1893, he served in the position for four years and then returned to Los Angeles to join a syndicate which bought a controlling interest in the Los Angeles Daily and Weekly Herald.

As manager of that paper he remained head of that publication until 1899.

Mr. Spalding was regarded as the "father" of civil service in the city, having served eight years as Secretary of the Municipal Civil Service Commission, from 1899 to 1907. From 1920 to 1924 he again served the Commission as a member. He was one of the founders of the California Fruit Growers Exchange, and was a member of numerous scientific, historical and patriotic organizations.

In 1875 he married Ellen Mary Dennison, and to their union were born eight children, of whom Mrs. Gregory Groff and Mrs. Wilfred T. Cooper are the only survivors. Mrs. Spalding died in 1936.

Mr. Spalding retained his keen mental faculties, and cultivated his many intellectual interests to the end. He was respected and beloved by all who knew him, and his passing removes one of the stalwarts from the ranks of the Academy, and leaves a void that no one can fill.



PLATE 21

WILLIAM A. SPALDING
1852 — 1941

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Bulletin, Southern California Academy of Sciences

Vol. XL, 1941

INDEX OF SUBJECTS

- A New Flea from the Mojave Desert (California)138
- A New Mirabilis from San Clemente Island108
- A New Shrew from Santa Catalina Island, California163
- A New Subspecies of White-footed Mouse from the Anacapa Islands, California161
- Adenostoma fasciculatum prostratum*109
- anacapae*, *Peromyscus maniculatus*161
- Ants of California, List of the .. 61
- argentinae*, *Diozocera* 5
- Aricia macginitii* 40
- atypica*, *Sthenelanelia* 26
- brunnea*, *Ctenucha* 11
- Callistopsyllus deuterus*140
- Catallagia rutherfordi*142
- Catallagia vonbloekeri*103
- Chaetozone spinosa corona* 45
- cinderella*, *Raphia*111
- Clymene grossa newporti* 49
- comstocki*, *Diozocera* 6
- Contributions from the Los Angeles Museum-Channel Islands Biological Survey ... 1, 101, 161
- cordifolia*, *Mirabilis laevis*108
- corona*, *Chaetozone spinosa* 45
- Ctenucha brunnea* Stretch on Santa Rosa Island 11
- Delotelis mohavensis*138
- deuterus*, *Callistopsyllus*140
- Diozocera* 3
- Diozocera argentinae* 5
- Diozocera comstocki* 6
- Diozocera comstocki elsegundinis* 10
- Diozocera insularum* 4
- Diozocera insularum vincenti* 4
- Distribution of Artifacts by Natural Means 13
- Echinoderms, Some Notes on117
- Ectoparasite-host Records from the Sierran Region of East-central California147
- elsegundinis*, *Diozocera comstocki* 10
- eutamiadis*, *Monopsyllus*141
- fauveli*, *Loandalia* 30
- Geusibia ashcrafti*, The Allotype of157
- In Memoriam William A. Spalding167
- insularum*, *Diozocera* 4
- ligulata*, *Lumbrinereis* 38
- Life History of *Raphia cinderella*111
- List of the Ants of California with Notes on their Habits and Distribution 61
- Loandalia fauveli* 30
- Loxophora dammersi*, Notes on.....160
- Lumbrinereis ligulata* 38
- macginitii*, *Aricia* 40
- Mesochaetopterus rickettsii* 43
- Mirabilis laevis cordifolia*108
- mohavensis*, *Delotelis*138
- Monopsyllus eutamiadis*141
- monticola*, *Phalacropsylla*144
- Myodopsylloides*104
- Myodopsylloides piercei*104
- nesiotus*, *Opisodasys*101
- newporti*, *Clymene grossa* 49
- Notes on *Loxophora dammersi*160
- On a Collection of Polychaeta from Southern California 16
- Onuphis eremita parva* 35
- Opisodasys nesiotus*101
- parva*, *Onuphis eremita* 35
- Peromyscus maniculatus anacapae*161

Phalacroscylla monticola	144	Sthenelanelia atypica	26
piercei, Myodopsylloides	104	Strepsipterous Parasite of a	
Polites manataaqua, The		Leaf Hopper with Descriptions	
Larva of	109	of Related Species from	
prostratum, Adenostoma		the Same Host Genus	1
fasciculatum	109	The Bionomics of <i>Ptinus Cali-</i>	
Ptinus californicus, The Bion-		formicus, a Depredator in the	
omics of	126	Nests of Bees	126
Raphia cinderella, Life		The Larva of <i>Polites</i>	
History of	111	manataaqua Harris	109
rickettsii, Mesochaetopterus	43	The Phylogentic Position of	
rutherfordi, Catallagia	142	the Strepsiptera as Deter-	
Some New California		mined by the First Larva	121
Siphonaptera	140	Three New Fleas	101
Some Notes on the Distribution		<i>Trichoclea edwardsi, the Larva</i>	
Records of Little Known		and Pupa of	165
Southern California Echino-		Two New Plants from the	
derms	117	Channel Islands of California	108
Sorex willetti	163	vonbloekeri, Catallagia	103
Spalding, William A: In		willetti, Sorex	163
Memoriam	167		

New varieties and species indicated in bold face type.

INDEX OF AUTHORS

Augustson, G. F.	101, 138, 140, 147, 157	Linsley, E. G.	126
Berkeley, E. and C.	16	MacSwain, J. W.	126
Comstock, John A. ...	11, 111, 160, 165	Mallis, Arnold	61
Dammers, Charles M.	10	Pierce, W. Dwight	1, 121
Dethier, V. G.	109	von Bloeker, Jack C., Jr.	161, 163
Dunkle, M. B.	108	Woodward, Arthur	13
Henne, Christopher	165	Ziesenhenne, Fred C.	117



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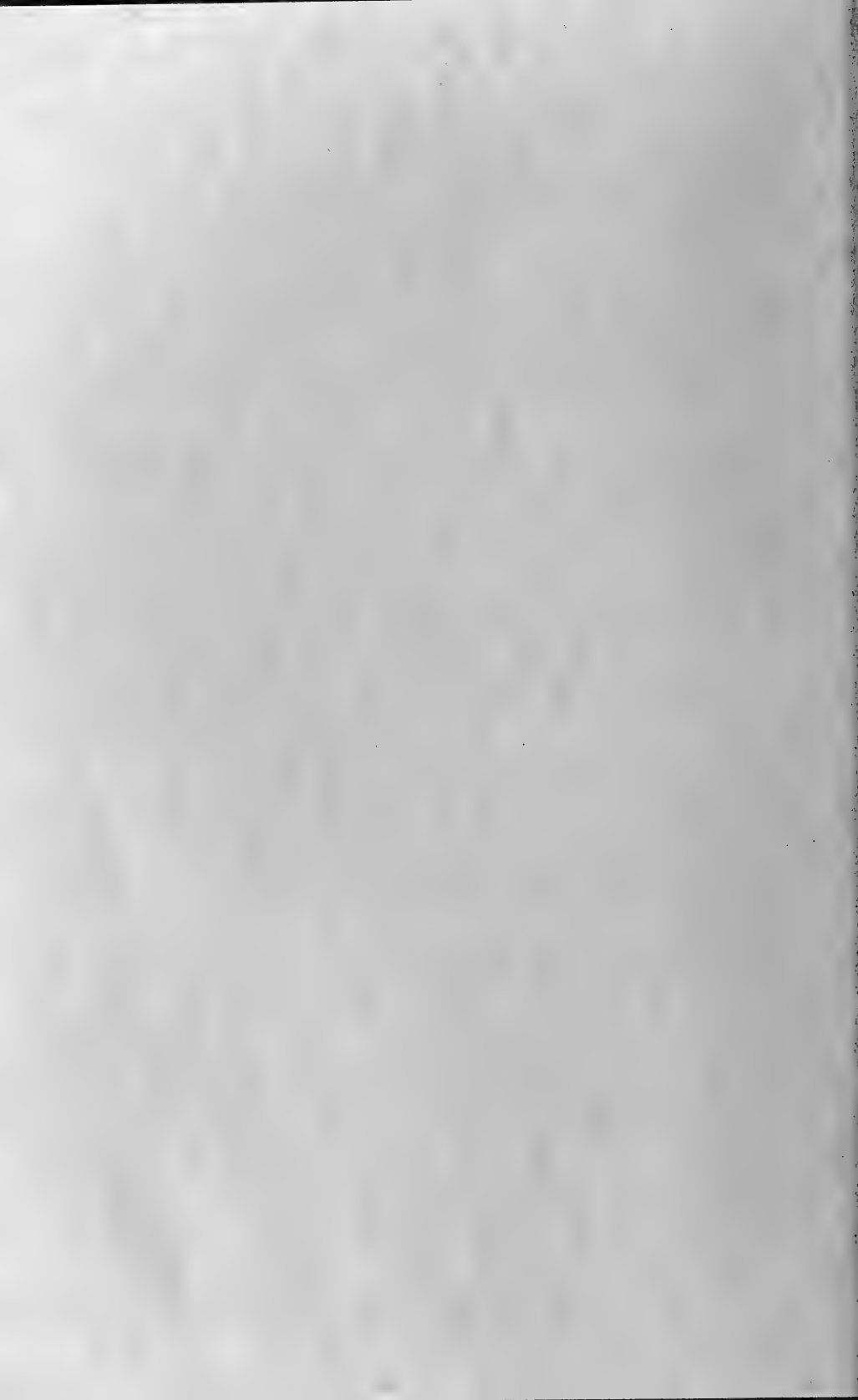
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Vol. XLI

January-April, 1942

Part 1

CONTENTS

Page

SEVEN NEW GENERA OF THYSANOPTERA FROM AUSTRALIA AND NEW ZEALAND. Dudley Moulton 1

FAUNA AND FLORA OF THE EL SEGUNDO SAND DUNES 1

12. UTILIZATION OF THE BEACH WIDOW PARASITE AND FURTHER DATA ON SPIDERS AND PARASITES 1

13. AMPHIBIANS AND REPTILES OF THE DELTAS. Jack C. von Ibold, Jr. 1

THE ALLTYPE OF AMPHISPYLLA NEOTOME L. FOX, 1906 (SIPHONAPTERA: DOLICHOSYLLIDAE). G. E. Agoston 1

NOTES ON THE LARVA AND CHRYSALIS OF POLLIXES THEMISTOCLES LATR. V. G. Bohner 1

NOTES ON THE LIFE HISTORIES OF TWO CALIFORNIA MOTHS. John A. Comstock and Charles M. Bennett 1

BRIEF NOTES ON TWO RECENTLY DESCRIBED SPECIES OF MOPHA (LEPIDOPTERA). L. J. Bolling 1

A NEW TREE-TAILED BAT FROM TEXAS. Kenneth F. Sauer 1

A REVIEW OF THE NORTH AMERICAN WEDDY HELIOTROPES. Joseph Ewan 1

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SEVEN NEW GENERA OF THYSANOPTERA FROM
AUSTRALIA AND NEW ZEALANDBy DUDLEY MOULTON
Redwood City, California

This paper includes the description of six new genera of Thysanoptera from Australia and one new genus from New Zealand. They include unique forms as evidenced by the development of the head in *Emprosthiothrips* and the shape of the tube in *Adrothrips* and *Dunatothrips*. The specimens were received years ago but it has not been possible to give them proper attention until the present time. I wish to express my thanks to the men far away in Australia who collected and forwarded this material to me. All types in author's collection.

Superfamily PHLAEOTHRIPOIDEA Hood, 1915.

Family PHLAEOTHTRIPIDAE Uzel, 1895.

Subfamily PHLAEOTHTRIPINAE Karny, 1921.

Tribe HOPLOTHTRIPINI Priesner, 1927.

SUNAITIOTHRIPS, new genus.

(Sunaitios—accessory, referring to the accessory spine on posterior angle of prothorax.)

Genotype: *S. fuscus*, new species.

DESCRIPTION OF GENUS: Head 1.7 longer than wide, cheeks almost straight, parallel, distinctly roughened, with a slight collar-like thickening at base; vertex flattened, dorsum with weak transverse lineation; a pair of small setae behind posterior ocelli, two pairs of postoculars placed well back from eyes, the outer pair near sides of head, the inner placed somewhat back of the others. Eyes large, oval, slightly protruding at sides; ocelli large, anterior ocellus directed forwards, posterior pair bordering anterior inner margins of eyes. Antenna 1.7 longer than head, 8-segmented, all distinctly separated, 3 and 4 broadly clavate, 3 with one sensecone, 4 with three sensecones; 8 broadly joined to 7. Mouthcone rounded, reaching three-fourths across prosternum, labrum pointed.

Prothorax only moderately enlarged, without markings, sutures complete; antero-marginal setae reduced, other long, with blunt tips, the accessory seta between each pair on posterior angles also well developed though varying in length. Fore femora greatly enlarged and fore tarsus armed with a long, curved tooth in both sexes. Wings broad, of even width, without venation, fore pair with double fringe hairs, these separated and matched with alternate fringes. Abdomen normal; tube .6 as long as head

and slightly more than twice longer than width at base, with straight sides.

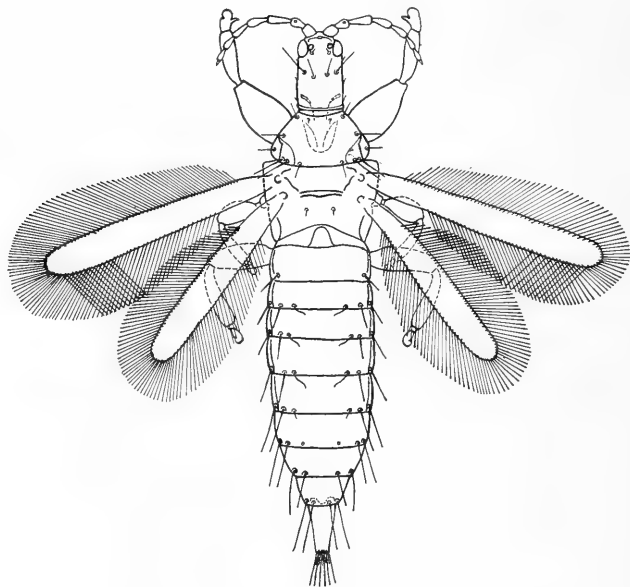
This genus is near *Megeugynothrips* Priesner but separated by more clavate antennal segments three and four, the development of the accessory spines on posterior angles of pronotum, the presence of double fringe hairs on fore wings and the shorter and heavier tube. In *Tetrachaetothrips* Bagnall, also with two pairs of postoculars, antennal segments three to five are narrower in basal half and swollen distally, accessory spines on pronotum are not specially developed and the tube is longer and narrower.

SUNAITIOTHRIPS FUSCUS Moulton, new species.

(Plate 1)

Holotype female: Color brown with last abdominal segments nearly black, legs brown with fore tibiae and tarsi yellowish; antennal segments 1, 7 and 8 dark brown, 2 to 6 mostly yellow but darkened distally; wings clear, slightly washed with brown in the middle, setae clear to yellow.

Total body length 2.62 mm.; head length 0.382 mm., width 0.22 mm.; prothorax length 0.19 mm., width including coxae 0.47 mm., without coxae 0.382 mm.; mesothorax width 0.558 mm., tube length 0.22 mm., width at base 0.102 mm. at tip 0.058 mm. Antennal segments length (width) I, 50 (48); II, 66 (40); III, 110 (46); IV, 113 (46); V, 100 (43); VI, 86 (36); VII, 80 (30); VIII, 43, total 660 microns. Length of spines: post-



Sunaitiuthrips fuscus Moulton (♂)
Enlarged approxim. x 29.

ocellars 26, outer postoculars 150, inner 133-143; on anterior angles of pronotum 100, midlaterals 133, outer on posterior angles 160, inner 153-166, intermediate accessory spines 73-120, on ninth abdominal segment 176, at tip of tube 147 microns.

This species is especially characterized by the long, parallel-sided head, distinctly roughened cheeks, two pairs of postocular spines, the development of the accessory spines on the posterior angles of the prothorax, the broad clear wings, fore pair with about seventeen double fringe hairs matching other fringes alternately and by the relatively short, stout tube. Abdominal segments three to six each with one pair of sigmoid spines.

Type material: Holotype female, allotype male, and three paratype females taken by Mr. A. M. Lea. (Nos. 3083, 3084, 3085).

Type locality: Cairns District, South Australia.

HEPTATHRIPS, new genus.

(Hepta—seven, referring to the 7-segmented antenna)

Genotype: *H. tonnoiri*, new species.

Head 1.7 longer than wide, flattened in front, cheeks smooth and straight; diverging behind; postoculars long, pointed, placed rather close to inner, posterior angles of eyes, cheek spines minute; eyes moderately large, slightly produced; ocelli small. Antenna 7-segmented, 3 elongate clavate with two sensecones, 4-7 pediculate, the latter without sign of dividing suture. Mouthcone reaching to near posterior margin of prosternum, broadly rounded, labrum pointed.

Prothorax transverse; anterior margin nearly straight and posterior margin only weakly convex, all setae minute except pair at posterior angles, these long, pointed. Fore femora only moderately thickened, fore tarsus armed with a curved tooth, other legs slender. Wings broad, fore pair with a long series of double fringes. Abdomen stout with long, pointed setae only on distal segments and a single pair of sigmoid setae on segments 2 to 7. Tube .86 as long as head, moderately slender, noticeably reduced only in distal fifth.

This genus belongs in the *Cryptothrips* group of the *Hoplothripini* but is clearly defined by its 7-segmented antenna. It approaches *Mathetethrips* Moulton in the shape of the head but this latter genus has an 8-segmented antenna. It appears to be most closely related to *Zaliothrips* Hood but is different in many ways.

HEPTATHRIPS TONNOIRI, new species.

(Plate 2)

Holotype female: Color blackish brown with only fore tibiae and all tarsi lighter; wings washed with brown; prominent spines clear to yellowish.

Total body length 3.5 mm.; head length 0.44 mm., width behind eyes 0.264 mm., near posterior margin 0.32 mm.; prothorax length 0.22 mm., width not including coxae 0.50 mm.; mesothorax width 0.54 mm.; tube length 0.38 mm. Antennal segments length (width) I, 46 (46); II, 90 (46); III, 133 (50); IV, 106 (46); V, 106 (46); VI, 83 (43); VII, 90 (40); total 660 microns. Setae on posterior angles of prothorax 133, on ninth abdominal segment 280, at tip of tube 300 microns.

Head 1.7 longer than wide behind eyes but only 1.37 longer than width near posterior margin; cheeks smooth and straight; eyes longer on dorsal than on ventral surface; mandibles examined after dissection, pointed and grooved. Prothorax without median thickening, sutures complete. Fore wings with about 33 double fringe hairs.

Type material: Holotype female and three paratype females taken July 11, 1928 by Mr. A. F. Clark (No. 2954).

Type locality: Nelson, New Zealand.

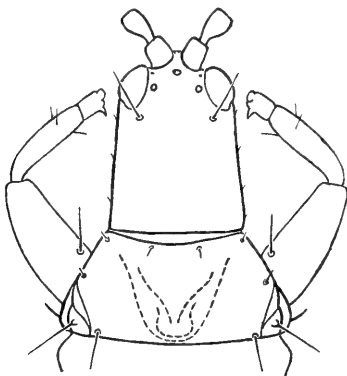


PLATE 2
Heptathrips tonnoiri Moulton.
Head and prothorax ♀.
Enlarged approxim. x 56.

ADROTHRIPS, new genus.
(Adros—stout.)

Genotype: *A. aureus*, new species.

Head slightly longer than wide, broadly angular in front, cheeks slightly and evenly arched, almost smooth; dorsum coarsely and indistinctly reticulate; postoculars wanting; eyes moderately large, joining cheeks evenly, dorsal and ventral lengths equal; ocelli small, anterior in position; antennae 8-segmented, 1.5 longer than head, 3 elongate connate and without sensecones, 4 and 5 elongate clavate the latter swollen and produced at tip on ventral side, 6-8 closely joined; mouthcone reaching two-thirds over prosternum, narrowed and pointed.

Prothorax longer than head, strong, with normal setae which are short and infundibuliform. Fore femora greatly enlarged, fore tibiae stout, each with a blunt, spine-bearing tubercle at tip within, fore tarsi stout, each armed with a strong tooth; middle and hind legs short and stocky; wings clear, without sign of venation, without double fringe hairs. Abdomen heavy, lateral setae with widely dilated tips; segments 2 to 7 each with two pairs of sigmoid setae, the anterior in each case smaller than the posterior pair. Tube 0.6 as long as head, of unique shape, at base being as wide as long, with sides abruptly constricted at the middle thence narrowing gradually to the rounded tip, the anterior and wider half with three or four irregular transverse rows of transparent pits.

The genus resembles *Dermothrips* Bagnall in the rather close union of the three distal segments of antennae but would seem to be more closely related to *Eucoenothrips* Bagnall in most characters. The unique shape of the tube sets it apart from other known genera.

ADROTHRIPS AUREUS, new species.

(Plate 3)

Holotype female: Clear light-brownish yellow with distal two-thirds of tube shaded orange to orange-brown, with a black

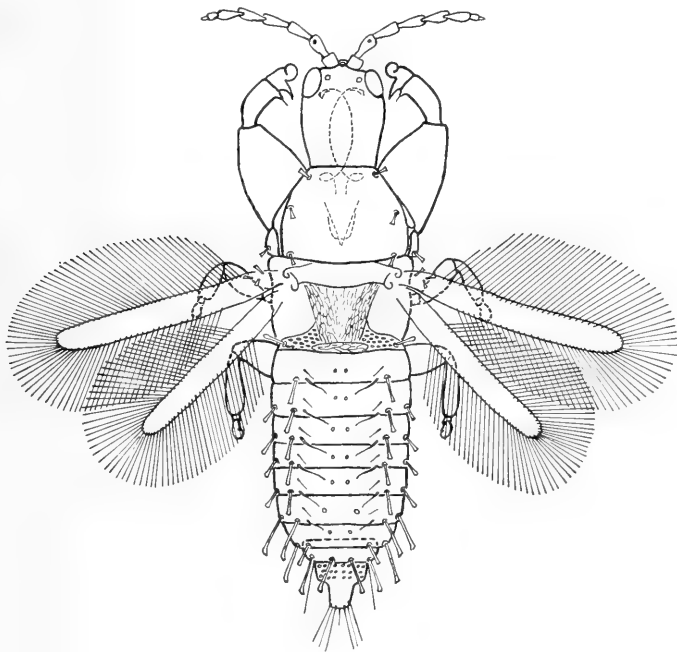


PLATE 3
Adrothrips aureus Moulton (♀).
Enlarged approxim. x 60.

spot on each tarsus, end of mouthcone black; antennal segments 1 to 4 clear yellow, 5 shading to light brown, 6-8 brown; wings and spines transparent.

Total body length 1.47 mm.; head length 0.260 mm., width 0.205 mm.; prothorax length 0.260 mm., width not including coxae 0.367 mm.; pterothorax width 0.352 mm.; abdomen width 0.396 mm., tube length 0.132 mm., width at base 0.132 mm., at end of broadened base 0.102 mm., at beginning of narrower distal half 0.073 mm., at end 0.044 mm. Antennal segments length (width) I, 33 (36); II, 56 (33); III, 60 (26); IV, 66 (30); V, 63 (26); VI, 53 (30); VII, 33 (22); VIII, 16, total 364 microns.

With the characters of the genus but especially to be noted are its short, stocky form, the golden yellow color, the absence of postocular setae, other normal setae short and with widely dilated tips. There are two pairs of pointed signoid setae on abdominal segments 2 to 7, the posterior pair on each segment being much stronger than the anterior pair. The shape of the tube, broad in basal half, narrowed in distal half and the basal part with transverse rows of pits are unique.

Type material: Holotype female and two paratype females taken on *Carmarina*, May 16, 1931 by Mr. S. E. Flanders (No. 4712).

Type locality: Ivanhoe, Australia.

SPILOTHRIPS, new genus.

(Spilos—speckled, referring to the variegated color.)

Genotype: *S. varicolor*, new species.

Head about as long as wide, almost semicircular in front to back of eyes, cheeks straight, almost parallel or slightly widened posteriorly; posterior part of dorsum indistinctly reticulate; postoculars wanting; eyes moderately large, subovate, joining cheeks evenly; ocelli large, anterior in position; antenna 8-segmented, 3 elongate connate, 5 and 6 with oblique tips, 7 and 8 closely joined, 3 with one sensecone; mouthcone short and broad, with rounded tip.

Prothorax more than twice wider than long, with a single short infundibuliform seta on each posterior angle and another on coxa, all other setae reduced. Fore legs enlarged, fore tarsus armed with a short, stout tooth, larger and stronger in male than in the female. Wings wanting. Abdomen elongate, increasing in size only slightly near the middle, reduced abruptly at segment 8, this with a noticeable swelling on either side. Tube 0.8 as long as head and about twice longer than basal width, with straight sides, slightly constricted at tip. In the male the abdomen is reduced gradually beyond the third segment. Two pairs of sigmoid setae on abdominal segments 2 to 7 are not especially strong.

This genus belongs in the short-headed, wingless group of the *Hoplothripini* Priesner and is most closely related to *Scopaeothrips* Hood. In this latter genus however the front of the head is produced between the eyes and separated from them by deep grooves also there are two pairs of infundibuliform setae behind the eyes, one pair on anterior angles and two pairs on posterior angles of prothorax. In this new genus the front of the head is broadly rounded, there are no setae on the head and only a single pair on the posterior angles of prothorax.

SPILOTHRIPS VARICOLOR Moulton, new species.

(Plate 4)

Holotype female: Light orange-yellow predominating; head darkened with brown especially around eyes, mesothorax likewise darkened at the sides with a lighter brown transverse connecting streak, second abdominal segment dark brown in anterior half, this band fades to light brown in the middle; abdominal segments 3 to 8 with a gray-brown spot on either side; tube abruptly orange in basal two-thirds, blackish brown in distal third; antennal segments 1 to 5 clear yellow with 5 darkened at tip, 6 lighter in basal half, 7 and 8 blackish brown; all setae clear to yellowish.

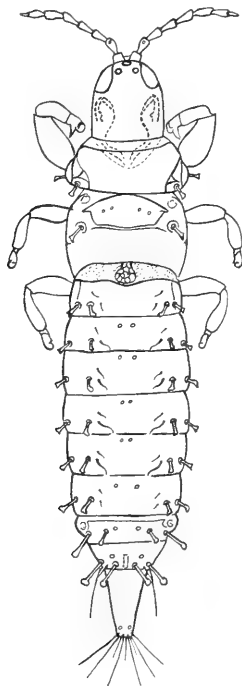


PLATE 4

Spilothrips varicolor Moulton (♀)
Enlarged approxim. x 52.

Total body length 1.75 mm.; head length 0.205 mm., width 0.205 mm.; prothorax length 0.150 mm., width including coxae 0.352 mm.; mesothorax width 0.323 mm.; width of abdomen at fourth segment 0.367 mm.; length of tube 0.16 mm., width at base 0.088 mm. Antennal segments length (width) I, 40 (36); II, 50 (33); III, 60 (30); IV, 53 (30); V, 43 (26); VI, 50 (24); VII and VIII 73, total 336 microns.

Type material: Holotype female, allotype male and one paratype female taken in blossoms of acacia in June, 1933 by G. W. Wickens. (No. 5561.)

Type locality: Bridgetown, West Australia.

BRITHOTHRIPS, new genus.

(Brithos—heavy, referring to the strong fore body structure.)

Genotype: *B. fuscus*, new species.

Head 1.5 longer than wide, broadly rounded in front, cheeks straight, roughened, emarginate behind eyes; postoculars wanting, cheek setae inconspicuous. Eyes subovate, slightly protruding; ocelli large, anterior in position; antenna 7-segmented, short, compact, not as long as head 3 subconical, 4-6 subglobose, pediculate; 7 small with an incomplete suture before extreme tip; 3 with one sensecone. Mouthcone short, rounded, extending about one-third over prosternum.

Thorax heavy, prothorax as long as head, pronotum somewhat shield-shaped, with incomplete median dorsal thickening; setae short, transparent, with widely dilated tips, one pair on anterior and two pairs on posterior angles; fore legs massive, fore tibiae and tarsi short and heavy, fore tarsus unarmed in female with a strong tooth in the male. Wings short, transparent, fringe hairs rather widely separated, fore pair with double fringes. Abdomen reduced gradually beyond second segment; tube .6 as long as head, twice longer than basal width, with almost straight sides; terminal hairs longer than tube.

This genus belongs in the gall-forming *Kladothrips* Froggatt group of the *Hoplothripini* but is distinctive because of the lack of armature on the fore legs especially in the female. The antennal segments are similar in form to the wingless *Thaumatothrips* Karny. The genus may be compared with *Stegothrips* Hood, also with a 7-segmented antenna but the structure of the forebody is different.

BRITHOTHRIPS FUSCUS, new species.

(Plate 5)

Holotype female: Color uniformly yellowish brown, fore tibiae and tarsi also third antennal segment clear yellow; tube dark brown in median portion; wings and setae transparent.

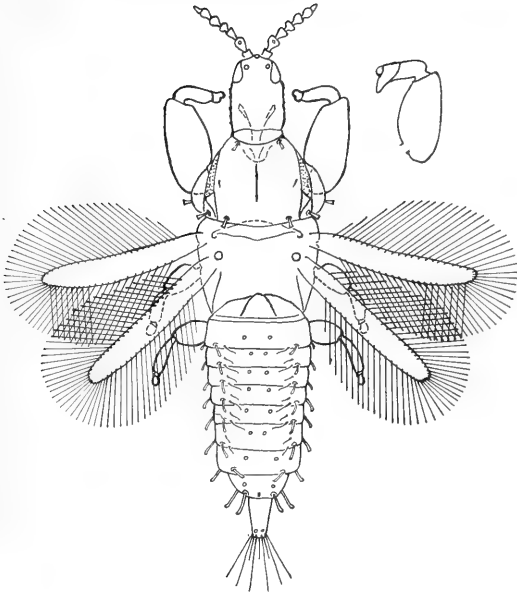


PLATE 5

Brithothrips fuscus Moulton (♀)

Upper right hand figure, right fore leg of ♂

Enlarged approxim. x 47.

Total body length 1.68 mm.; head length 0.260 mm., width near middle 0.176 mm.; prothorax length 0.260 mm., width without coxae 0.382 mm., with coxae 0.470 mm.; pterothorax width 0.440 mm.; width of abdomen at second segment 0.396 mm.; length of tube 0.160 mm., width at base 0.080 mm. Antennal segments length (width): II, 43 (43); III, 40 (40); IV, 33 (40); V, 33 (40); VI, 40 (36); VII, 40 (26); total 250 microns.

With the characters of the genus. This species is distinctive because of the relatively heavy structure of the fore body, large but unarmed fore legs in the female, in the male with a strong tarsal tooth, the short, compact, 7-segmented antenna, lack of any prominent setae on head, the short, transparent setae on prothorax, these with widely dilated tips and the short transparent wings, the fore pair with six or seven double fringes. Sides of abdomen with short setae like those on the thorax also segments three to seven each with two pairs of sigmoid setae; terminal hairs longer than tube.

Type material: Holotype female and three paratype females taken in acacia galls in April, 1929 by Mr. R. J. Greenfield (No. 3526); allotype male taken on *Acacia oswaldi*, June 2, 1928 by Mr. W. W. Froggatt (No. 2951).

Type locality: South Australia.

Tribe PLECTROTHRIPINI Priesner.

DUNATOTHRIPS, new genus.

(Dunatos—powerful; referring to the powerful body structure.)

Genotype: *D. armatus*, new species.

Head almost spherical but constricted neck-like posteriorly; postoculars apparently wanting, cheeks with a few minute spines; eyes large, subovate, occupying two-fifths of the head's length, somewhat smaller on ventral side; ocelli moderately large; sense area on second antennal segment placed near middle, (antennae broken at second segment); mouthcone short, broadly rounded, reaching half over prosternum.

Thorax very strong and heavy, head and thorax longer than abdomen, pterothorax wider than abdomen; all normal setae on prothorax reduced except pair on posterior angles, these short, clear and with dilated tips, the inner pair smaller than the outer; fore legs exceedingly strong, fore femora with a horn-like projection on inside near base and a smaller process on inside at tip, inner tip of fore tibia with a similar process, fore tarsus with a stout tooth; intermediate and hind legs much smaller. Wings wanting. Abdomen short and compact, the first five segments of about equal width but noticeably narrower than pterothorax, segments 6 to 9 gradually reduced; tube slightly longer than basal width, with straight and parallel sides for about three-fifths its length, the distal two-fifths broadly rounded. Median dorsal setae on ninth segment as long or longer than tube, pair at angles more than twice longer, the third pair on ventral side reduced to short spurs; the two major dorsal setae at tip of tube are enlarged, black and curved pincer-like in basal half, these cross and curve S-shaped at about their middle, other terminal hairs are darkened but straight.

DUNATOTHRIPS ARMATUS, new species.

(Plate 6)

Holotype (sex not determined): head and thorax brownish black, abdomen black; all femora, middle and hind tibiae nearly

black, lighter only at joints, fore tibiae brown, darkened on outer margins; tarsi including the large teeth also the processes on fore femora clear yellow; antennal segments 1 and 2 black.

Total body length: 2.13 mm.; head length 0.338 mm., width 0.308 mm.; prothorax length 0.308 mm., width including coxae 0.530 mm., without coxae 0.440 mm.; pterothorax length 0.514 mm., width 0.588 mm.; abdomen length including tube 1.0 mm., width near middle 0.558; tube length 0.117 mm., width at base and near middle 0.088 mm. Length of setae on posterior angles of prothorax 70, on coxae, 66, dorsal on ninth abdominal segment 173, ventral spurs 56 microns.

With the characters of the genus. This genus and species is especially characterized by its strong head and thorax, the noticeably smaller abdomen with its short, rounded tube and pincer-like and blackened setae at tip; also the absence of prominent setae on head and prothorax, except the posterior pair, and the enlarged and armed fore legs. Setae on the posterior angles of

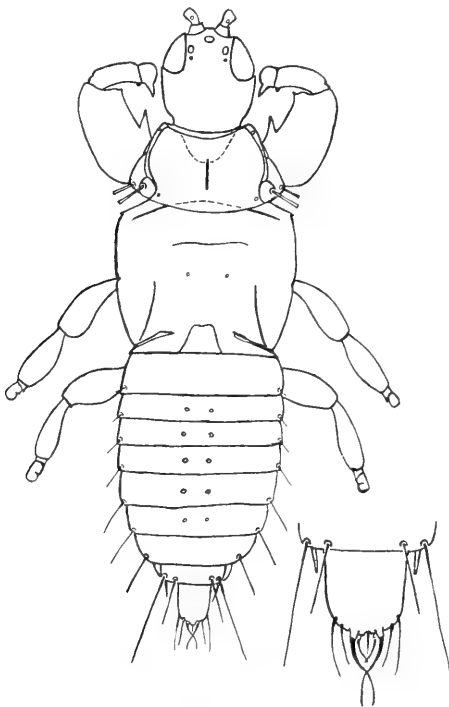


PLATE 6

Dunatothrips armatus Moulton (♂ ♀ ?)
(Lower right hand figure, tube of same)

abdominal segments are moderately short, clear to yellowish in color and have blunt to dilated tips.

Type material: One specimen, sex not determined because of intense black color, taken by Mr. A. M. Lea (No. 3112).

Type locality: Ooldea, Australia.

Subfamily MEGATHRIPINAE Priesner, 1927

Tribe COMPSOTHRIPINI Priesner, 1927

EMPROSTHIOTHRIPS, new genus.

(Emprosthios—fore, front, referring to the head projection.)

Genotype: *E. niger*, new species.

Head broadly produced in front of eyes, this process occupying approximately one-fourth the total length of the head and two-thirds as wide, measured from fore margins of eyes, the head length and width are about equal; cheeks parallel to near base where they are constricted neck-like, conspicuously roughened; head without postocular or other setae. Eyes joining cheeks evenly behind, narrowly produced on ventral side. Antenna 8-segmented, 2 broadest, conspicuously bent outward at pedicel, 3-6 broadly clavate, 7 and 8 closely joined, 3 with one sensecone. Mouthcone short and rounded.

Thorax reduced, prothorax explanate at sides, all normal setae wanting; pterothorax much shorter but slightly wider than prothorax. All legs small and without armature. Wings wanting. Abdomen broadly ovate, without setae except extremely small ones on posterior angles of segments 8 and 9; tube slender, with straight sides, terminal hairs extremely short, approximately as long as width of tube.

Male somewhat smaller, legs similar and without armature; without setae except a blunt-tipped pair on posterior angles of ninth abdominal segment, hairs at end of tube approximately twice longer than terminal width of tube.

EMPROSTHIOTHRIPS NIGER, new species.

(Plate 7)

Holotype female: Color jet black including legs and antennae except only pedicels of segments 3 and 4 which shade to brown.

Total body length 2.24 mm.; head length including process 0.352 mm., length of process from front margins of eyes 0.088

mm.; width of process 0.184 mm., width across cheeks 0.264 mm.; prothorax length 0.220 mm., width 0.426 mm.; width of abdomen at fourth segment 0.411 mm.; tube length 0.205 mm., width at base 0.088 mm.

Allotype male: Total length 2.12 mm.; width of process 0.147 mm., width across cheeks 0.227 mm., width of prothorax 0.308 mm., width of abdomen 0.441 mm. Antennal segments length (width) I, 33 (36); II, 82 (46); III, 80 (33); IV, 63 (36); V, 60 (36); VI, 53 (33); VII, 53, VIII, 26; total 430 microns.

This species is particularly characterized as noted in the generic description by the broadly produced head, the stout and bent second antennal segment, with sense area near tip, segment 3 with one sensecone and segments 7 and 8 closely joined, the small and unarmed legs, explanate prothorax, the absence of wings and the absence of all normally developed body setae.

Type material: Holotype female (No. 3142), and allotype male (No. 3108) taken by Mr. A. M. Lea.

Type locality: Lucindale, South Australia.

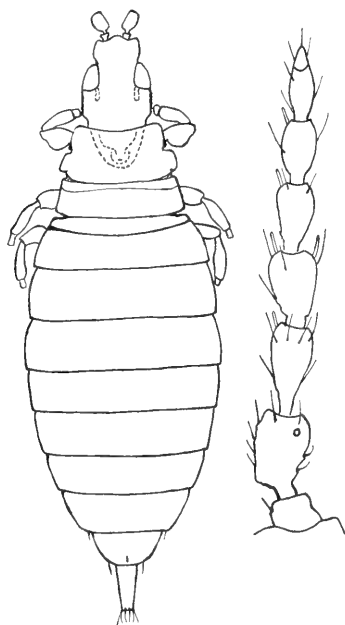


PLATE 7

Emprosthiothrips niger Moulton (♀)
(Right hand figure, right antenna of ♂)

FAUNA AND FLORA OF THE EL SEGUNDO SAND DUNES

12. UTILIZATION OF THE BLACK WIDOW PARASITE, AND FURTHER DATA ON SPIDERS AND PARASITES

By W. DWIGHT PIERCE

No arthropod in the west has a higher interest to the general public than the Black Widow Spider, *Latrodectus mactans* (Fabricius 1775) Walckenaer 1837. This spider, which is yearly becoming more abundant, and has in some places reached alarming proportions, is known to be the most highly toxic of all venomous creatures so far recorded, based on weight for weight comparisons of toxicity. Its rapid spread is no doubt due to lack of proper checks and balances. Consequently when a new parasite is found it becomes an item of great interest.

One of the most important products of the El Segundo sand dune survey has proven to be the egg parasite, *Baeus californicus* Pierce 1938, reared from the egg sacs of the Black Widow, from one little dune bowl on the shore side just within the Playa del Rey zone of the dunes. Research this year shows a great diminution of the black widow in the type location of the parasite, but also proves that the parasite does not occur anywhere else. Its ability to get out of this dune bowl is handicapped by the almost barren sands surrounding it. How it got there and whence it came is still a mystery, but it is probably an introduction through the washing ashore of something containing a parasitized egg ball. It probably came from some part of tropical America.

THE SPIDER CAMPAIGN

In August 1939 at the request of Dr. C. E. Pemberton of the Hawaiian Sugar Planters' Association, 15 parasitized egg balls were sent to Hawaii. From these, he and his assistants were able to rear and release in the sugarcane fields 32,500 parasites, between August 21, 1939 and April 1, 1940. As a result of their studies C. E. Pemberton and J. S. Rosa published an excellent report in the Hawaiian Planters' Record, 1940. 44(2):73-80, with 4 figs., entitled Notes on the life history of *Baeus californicus* Pierce, an egg parasite of the Black Widow. In this bulletin they describe the egg and larva of the parasite and give considerable biological data.

In the spring of 1941, Dr. D. T. Fullaway, Territorial Entomologist of Hawaii wrote asking for more parasites to release in other sections of the islands.

In order to fill this request it was necessary to recover the parasite in the field and then obtain fresh spider egg balls to propagate them. There was no time to go into the field to collect egg balls sufficient for that work, and no help available for its accomplishment.

On May 30, 1941 the writer and Carl Snyder visited the type locality on the sand dunes. We scoured the dunes for Black Widows, formerly so abundant, and found it exceedingly difficult to find any on the seaward side where the parasites were originally found. Finally in the original or type site, a small dune bowl with two small clumps of cactus, we found two parasitized egg balls, and also found one adult *Baeus* ♀ under a cardboard near a Black Widow, apparently waiting for her to deposit her eggs. This female was taken and placed with a fresh egg ball, the same day. To find such a tiny creature in the field is a very unusual event.

From this May 30 material, by laboratory breeding, 14,124 parasites have been bred during the summer of 1941, and this report is largely to detail the facts learned. On June 6, 1941 with Chris Henne and George P. Kanakoff another dune survey for egg balls was conducted, and none were found, but under the same cardboard waiting on the same female spider were two of the tiny *Baeus* females. They were left to take care of her offspring.

Then came the happy inspiration, which has taught us the power of the press, and the eagerness of the public to cooperate. A simple statement that Black Widow egg balls were needed for the purposes of ascertaining the present distribution of parasitism, and to enable the writer to propagate parasites for shipment to Hawaii, resulted in a continuous flow of egg balls and spiders into the Museum over a four month period. Had it not been for the volunteer help of several High School boys, Dick Maris of San Pedro, Martin Dickerson of El Segundo, Evert Schlinger of Glendale, and Morton Kasner of Los Angeles, it would have been impossible to have taken care of the letters, visitors and materials sent in; all additional to the ordinary Museum routine.

As a practical result of this cooperation of the public three shipments of parasitized eggs, comprising 49 colonies, were made by air mail to Hawaii for propagation purposes, and at first report over 3000 parasites had been released.

Then notice was given to the public that any one bringing in fresh egg balls would be given a small colony of parasites for release on their place. The response was very gratifying and 134 colonies representing 3934 parasites have been released in probably over 150 premises. We had to disappoint some applicants, because of our inability to raise more parasites, under the cramped conditions of the work. Each person was given from 20 to 50 parasites, all females, with instructions to open the

tubes and let them jump out in close vicinity to spider nests. A check-up on results will be conducted in the spring.

The practise of such small releases was first utilized by the author with success, with other parasites in the sugarcane fields of Occidental Negros, where many small colonies of parasites were started over the entire area of the Company's holdings. This gave the parasites unrestricted room and abundance of hosts worked for rapid increase, and the results were very gratifying.

The little *Baeus* is an excellent parasite for such methods of propagation. The females are fertilized before issuing from the egg ball. If a single female *Baeus* finds an egg ball in the right condition, she will enter and oviposit in all of the eggs within, if she has time. In 20 to 25 days there will be several hundred female *Baeus* hunting for egg balls. The whole success of the work depends on the presence and abundance of Black Widows.

The parasites can live many days, as they have been kept over 120 days in tubes in the laboratory at ordinary temperatures, with only the moisture of wet raisins for nourishment.

We should find next year that many of these releases were successful and that the parasite has been established in the County.

As a result of the request for egg balls, specimens were received from 60 localities in California, from San Mateo and Newman in the North to Blythe, the Imperial Valley and San Diego in the South; but also from one locality in Arizona, three in Texas and one in Georgia. Letters were received from North Dakota, Connecticut, Georgia, Alabama, Mississippi, Kentucky, and Texas regarding the spider. Newspapers, magazines and radio carried the message over the nation.

Many people sent other kinds of spiders and egg balls, and some of the information gleaned was of considerable value to us. We will first briefly consider some of these spiders, several of which are also sand dune inhabitants.

THE FALSE WIDOW, *TEUTANA GROSSA* (Koch)

There is one spider often mistaken for the Black Widow, which is often found in the same web, and sometimes the egg balls of both are associated. They are deadly enemies.

We have known the other spider for several years as the False Widow and have recently learned through the determination of Dr. W. J. Gertsch, of the American Museum of Natural History, New York, that this spider, *Teutana grossa* (C. Koch 1838) Simon 1881 (= *Theridion nitidum* Holmberg 1875, *Teutana zonata* Cambridge 1899), has not yet been officially recorded from California. It is well known in Mexico and Central America.

Our records from this summer's survey show its presence in the following California localities: Arlington, Bloomington, El Segundo, Glendale, Glendora, Hawthorne, Hollywood, LaVerne, Long Beach, Los Angeles, Pasadena, Redondo, San Bernardino, San Pedro, Torrance, Venice, Whittier, and Yucaipa.

The False Widow in its adult color is almost as black as the Black Widow with a slight purplish hue to the thorax and legs, and a reddish suffusing at base of abdomen beneath, but without the red hour glass. When one has a true Black Widow without the hour glass he might easily mistake it for *Teutana*. In its younger stages the color is entirely different and the thorax is light colored. We hope that a full report on its life history can be rendered later.

This spider belongs to the Theridiidae, same family as the Black Widow, and its potentiality as a poisonous spider is unknown. Its web is similar, but its egg balls are of white silk, very loosely meshed, so that the eggs are visible within. The balls are much smaller than the *Latrodectus* balls, usually not more than 8 or 10 mm. in diameter. The developmental period is shorter, one lot having issued in 20, and another in 28 days from oviposition.

When spiderlings, or adults, of the two species were placed together, the victor in 8 out of 10 cases was the *Teutana*. Both spiders are cannibalistic.

During the season's survey, 141 *Teutana* egg balls were received, and there was absolutely no parasitism. Sowbugs were found as prey in a number of cases.

THE DOMESTIC SPIDER, *THERIDION TEPIDARIORUM* (C. Koch)

A few people sent the small brown egg balls of *Theridion tepidarium* C. Koch 1841. These were received from Playa del Rey on the sand dunes, Los Angeles and Glendale.

The egg balls are oval, not more than 8 mm. long, of soft brown silk and well rounded when full, but shrunken like deflated footballs when hatched. The egg period is 9-14 days in September. In the 13 balls received there was no parasitism.

THE LYNX SPIDER, *PEUCETIA VIRIDANS* (Hentz)

We received 7 egg balls of the Green Lynx spider, *Peucetia viridans* (Hentz 1845) Banks 1898, which is also one of the sand dune species. These egg balls are hemispherical of tough silk, but vary in color from pale green to olive green, yellow brown, and purplish brown; measuring 12-14 mm. in diameter, and 9-12 mm. in height; and are usually roughened in surface with knots of silk. The female closely guards her egg ball, and also her gregarious colony of young.

Egg balls came from El Segundo, Los Angeles, El Monte and Santa Ana, Cal., and none were parasitized.

On September 26, 1938 a female Peucetia bit a girl on the finger, causing a considerable swelling and much pain.

THE SILVER SPIDER, ARGYOPE ARGENTATA (Fabricius)

Another spider of the sand dune area is the silver spider, *Argyope argentata* (Fabricius 1775) Koch 1839, which makes a large irregular shaped, more or less flattened, cookyshape, angulate egg case of green silk, darker above, and more golden green below. Three egg cases were taken by George P. Kanakoff at Santa Ana, Orange County, which were heavily parasitized by Diptera, but one yielded an Ichneumonid, and two yielded Chalcid hyperparasites, as yet undetermined.

THE GOLDEN GARDEN SPIDER, ARGYOPE AURANTIA (Lucas)

Also on the sand dunes is the golden garden spider *Argyope (Miranda) aurantia* Lucas 1833, which makes a large hard-cased reddish brown spherical or teardrop-shaped egg ball, measuring up to 30 mm. in diameter. Only 4 of these balls came in from Santa Ana and El Monte, and none have yielded parasites.

THE BANDED GARDEN SPIDER, ARGYOPE TRIFASCIATA (Forskål)

Also among the sand dune spiders is the banded garden spider *Argyope (Metargyope) trifasciata* (Forskål 1775) Simon 1895, which makes a kettle shaped egg case of creamy-colored silk, measuring 15 mm. in diameter by 9 mm. in height. One ball from El Segundo was not parasitized.

THE BIRD-DROPPING SPIDER, MASTOPHORA CORNIGERUM (Hentz)

Of the spiders not yet recorded from the sand dunes several have yielded parasites. Most interesting of these is the bird-dropping spider, *Mastophora cornigerum* (Hentz 1850) Holmberg 1876, which looks so much like a bird's dropping. Its egg balls are spherical, with a tough pedicel attached to a solid object, and are mottled black and white, measuring 7-10 mm. in diameter.

These were received from Los Angeles only, and 3 proved to be parasitized out of a total of 16. The parasite is a species of *Gelis*. This parasite oviposits through the silken ball, and its larvae feed upon the eggs.

THE ORB-WEB SPIDER, *ARANEA GEMMA* (McCook)

From the large loose-meshed dark brown silken egg balls of *Aranea gemma* (McCook 1888) Comstock 1912 parasites were recorded in 3 out of 11 balls. These parasites had all issued, and only the puparia were present, but they appear to be *Pseudogaurax signata* (Loew 1876). The number of parasites per ball was 29, 49, 57.

THE BLACK WIDOW, *LATRODECTUS MACTANS* (Fabricius)

The black widow egg balls were interesting. While all are creamy in color, there is a great difference in texture and size. Some have a thick soft silk, others a tough hard silk. From some localities they were very thin and sometimes showed the eggs within, while the majority are hardened by a final varnish-like coating and entirely conceal the eggs. While it was not always true, the thin-shelled balls were more likely to contain infertile eggs.

The act of oviposition was observed once. This female began about 11 o'clock to spin an inverted cup or umbrella, hanging by a few threads from its center. At 11:35 the umbrella was finished. It was quite shallow. She then began to eject upward her egg case, all fluid, and this was finished in 7 minutes, and the ejected ball of liquid eggs measured 6 x 8 mm. Six minutes later it had lengthened to 5 x 12 mm. By 11:55 she had formed by stretching the umbrella downward, and spinning a single thread mesh, a complete ball separated by about 2 mm, all around from the eggs. At 11:58 the separate eggs were visible. At 12:00 the ball was entirely closed, and she began adding thickness, and tamping on the final varnish silk. At 1:15 the eggs were invisible. At 1:55 the ball was complete, elliptical, measuring 9 x 13 mm.

Egg balls were received and used in the following studies from the following 65 localities:

ARIZONA: Salome.

CALIFORNIA: Fresno Co.: Coalinga.

Imperial Co.: El Centro.

Kern Co.: Bakersfield, Fellows, Lost Hills, Taft (4).

Los Angeles Co.: Alhambra, Altadena, Arcadia, Baldwin Park, Beverly Hills, Burbank, Downey, Eagle Rock, El Monte, El Segundo, Encino, Gardena, Glendale, Glendora, Hawthorne, Hollywood, Huntington Park, La Verne, Long Beach, Los Angeles, Malibu Lake, Manhattan Beach, Maywood, Montebello, Orangewood Riviera, Pacoima, Pasadena, Playa del Rey,

Pomona, Redondo, Reseda, Roscoe, Rosemead, Sandbergs, San Fernando, San Gabriel, San Pedro, Saugus, Southgate, Tarzana, Van Nuys, Venice, Wilmar. (44)

Orange Co.: Fullerton.

Riverside Co.: Blythe, Coachella, Thermal. (3)

San Bernardino Co.: Bloomington, San Bernardino. (2)

San Mateo Co.: San Mateo.

San Diego Co.: San Diego, Summit. (2)

Stanislaus Co.: Newman.

GEORGIA: Camp Stewart.

TEXAS: Legion, San Ygnacio, Woodsboro.

The size of the egg varies considerably as shown below:

Length of Egg Ball		Width of Egg Ball
Size mm.	Number of Cases	Number of Cases
8	0	5
9	0	11
10	9	30
11	19	34
12	23	26
13	28	14
14	24	11
15	22	13
16	12	7
17	15	3
18	11	2
19	8	0
20	3	0
21	0	0
22	1	0
23	2	0

Of the total of 900 balls examined, 77 were sterile. Many balls yielded only one to ten or more spiders, the remainder being sterile. Of the total, 381 or 42.33% had hatched, but since their contents told the story desired they are included in the estimate of parasitism occurring in the present and near past. Dermestid beetles usually destroy old balls, so we can assume that the empty ones were not too old to be counted.

The total hatch from unparasitized egg balls varied greatly and we may summarize it by groupings of 50 to show that a normal biological curve exists. Completely sterile balls are not counted.

Number of Spiders Per Egg Ball	Number of Cases Recorded	Grouped By Hundreds
1- 49	13	
50- 99	8	21
100-149	10	
150-199	16	26
200-249	23	
250-299	34	57
300-349	24	
350-399	25	49
400-449	19	
450-499	14	33
500-549	9	
550-599	4	13
600-649	3	
650-699	2	5
700-749	1	
750-799	1	2

The mathematical mean based on 62,903 spiders in 206 balls is 305 per egg ball.

The five highest counts were 766, 749, 689, 654, 640, but Lawson (1933) recorded a maximum of 917 spiders from a ball.

No definite correlation could be seen between number of spiderlings and size of balls except that at 13 mm. width the greatest capacity was possible and, roughly, each increase of 1 mm. in width diameter increased the mean potential capacity by 30 to 40 eggs. Rather, we found considerable difference in the size of the spiderlings issuing from the balls. There was no opportunity to make this interesting measurement.

The actual occurrence of parasitism in nature is very low.

Bacus californicus was recovered only from the type location on the seaward side of the El Segundo sand dunes at the edge of Playa del Rey.

Pseudogaurax signata was recovered from:

Kern Co.: Taft.

Los Angeles Co.: Downey, El Monte, Glendale, Los Angeles, Malibu Lake, Pacoima, Reseda, Rivera, San Fernando, San Pedro, Tarzana, Van Nuys, Wilmar.

Riverside Co.: Blythe, Coachella.

San Bernardino Co.: Bloomington.

San Diego Co.: Summit.

Stanislaus Co. : Newman.

In previous years we had bred this parasite also from El Segundo, Los Angeles, Van Nuys.

Of 823 fertile balls received and recorded in 1941 only 42, or 5.10%, were parasitized. From 22 of the 42 parasitized balls spiders also issued.

The actual developmental period of the spider before issuance from the egg ball was determined absolutely in 9 cases as 21, 23, 23, 23, 24, 26, 26, 28, 39 days.

THE FLY PARASITE, PSEUDOGAURAX SIGNATA (Loew 1876)

This fly deposits elongate, corrugated, white eggs on the outside of the egg ball, and the fly larvae enter and feed upon the eggs. The number of eggs on the outside is quite likely to exceed the number of puparia found within. The eggs measure 2.05-2.46 mm. in length and 0.190 mm. in greatest width.

The number of fly puparia found in the balls is quite variable.

Number of Puparia Per Ball	Number of Cases Observed
1- 4	14
5- 9	7
10-14	5
15-19	4
20-24	4
25-29	6
30-34	0
35-39	1
40-44	1
45-49	1

The maximum number was 48, and the arithmetical mean 13 per egg ball.

The flies can live long periods when supplied with a moistened raisin. The raisins must be dipped in water about every 3 days. Maximum longevity recorded to date is 71 days.

The fly has been bred in our laboratory from *Latrodectus mactans* and *Aranea gemma* egg balls.

As to the parasitism by *Pseudogaurax* the total returns from egg balls were counted in 24 cases, with the resultant yield 622 spiders, 126 flies, total 748; or 83.15% spiders, 16.85% flies. If we consider 305 spiders to be the normal hatch per ball, the spider yield should have been 7320, on which basis the spider yield was only 8.49% of what it should be and hence the parasitic kill was 91.51%.

THE WASP PARASITE, *BAEUS CALIFORNICUS* (Pierce)

A large number of cases of parasitism by the tiny wasp have been observed from both field and laboratory infestation.

Since the first finding in 1938 there have been taken only 9 egg balls parasitized in the field, and all from one spot on the sand dunes. These have yielded the following data, which are of value for comparison with the laboratory behaviors to be recorded:

Number of parasites per ball: 184, 207, 232, 236, 274, 275, 361, 396, 401, mean 285.

Number of females per ball: 229, 264.

Number of males per ball: 25, 36.

Number of spiders issuing per ball: 0, 0, 0, 0, 1, 2, 5, 12, 16.

Total yield per ball: 185, 207, 236, 248, 275, 279, 361, 403, 408.

Percentage of parasitism per ball: 93.54, 97.05, 98.2, 99.4, 99.5, 100.0, 100.0, 100.0, 100.0; mean field parasitism 98.71%.

In laboratory parasitism we cannot expect as high a percentage of parasitism, because there are too many artificial factors concerned. It is quite apparent that the parasites will only attack egg balls that are in proper condition. In most cases they will not enter an infertile ball, or a ball that is much beyond three days old. The parasites use their antennae in a careful survey before entry, sometimes taking several hours, although they may enter perfectly fresh balls within 5 minutes.

The Hawaiian finding that fertilization takes place before issuance is corroborated by the fact that the majority of females used in the propagation never had contact with males after issue; that the majority of egg balls exposed were parasitized; that the males always issue last, and several days after the bulk of the females; that females are, with one exception mentioned below, in the majority. To show this the total issuance of parasites is grouped as to the number issuing on successive days of observation:

Day of Issue	Females	Males	Total
1st	3274	32	3306
2nd	3726	129	3855
3rd	1116	165	1281
4th	449	208	657
5th	160	234	394
6th	98	76	174
7th	125	39	174
8th	31	16	47
9th	30	22	52
10th	13	5	18
11th	10	1	11
12th	1	0	1
13th	1	0	1
14th	1	1	2
15th	0	1	1

The number of parasites per egg ball in all laboratory tests is as follows:

Number of Parasites Total	Number of Cases	Number of Females	Number of Cases	Number of Males	Number of Cases
0- 49	12	0- 49	12	0- 9	30
				10- 19	23
				20- 29	12
				30- 39	5
				40- 49	2
50- 99	7	50- 99	9	50- 59	1
				60- 69	0
				70- 79	0
				80- 89	0
				90- 99	0
100-149	4	100-149	6	100-109	1
				110-119	0
				120-129	0
				130-139	1
150-199	18	150-199	19	150-199	0
200-249	9	200-249	13	200-249	0
250-299	14	250-299	9	250-299	0
300-349	7	300-349	6	300-349	0
350-399	2	350-399	0	350-399	0
400-449	1	400-449	1	400-449	0

The percentage of sexes is predominantly female. Of 14,167 parasites, 12,854 or 90.72% were females, and 1,383 or 9.28% males.

The highest record of males was 135, or 45.31% out of 298 parasites. One single case of 43 males, 100%, occurred in September-October, the offspring of a female 27 days old, requiring 29 days to first issuance, which may indicate parthenogenesis.

The lowest percentage of males was 2, or 1.02% out of 198 parasites.

The highest record of parasites per ball is 417, of which 402 were females, 15 males, 96.40% ♀, 3.60 ♂.

In most of the cases 2 or more parasites were placed with the egg balls and the total offspring was divided by the number of females to give the offspring per female. But in a few cases a single parasite was used. From this we learn that the maximum number of offspring per female so far proven is 160. But since in many cases probably only one or two females may do the work, the maximum production recorded (417) is the maximum potential of the female.

The prorated offspring obtained may be grouped as follows:

Total Number Offspring	One Parasite	Two Females		Three Females		Four Females		Five Females	
	Cases	Mean per Parent	Cases	Mean per Parent	Cases	Mean per Parent	Cases	Mean per Parent	Cases
1- 49	1	1- 24	4	1- 16	3	1- 12	4	1- 9	0
50- 99	0	25- 49	5	17- 33	1	13- 24	0	10-19	1
100-149	1	50- 74	0	34- 49	1	25- 37	1	20-29	0
150-199	0	75- 99	8	50- 66	3	38- 49	3	30-39	1
200-249	0	100-124	6	67- 83	4	50- 62	1	40-49	1
250-299	0	125-149	6	84- 99	3	63- 74	2	50-59	0
300-349	0	150-174	3	100-116	4	75- 86	2	60-69	0
350-399	0	175-199	0	117-133	2	87- 99	0	70-79	0
400-449	0	200-224	0	134-146	0	100-112	1	80-89	0
Balls	2		32		21		14		3
Females	2		64		63		56		18

The age of the females may affect fertility and so we again group the results by the ages of the females at time of admission to egg ball.

Mean No. Offspring per Female	Number of cases produced by females of certain ages																Total
	1 day	2 day	3 day	4 day	5 day	6 day	7 day	8 day	9 day	10 day	11 day	12 day	13 day	14 day	27 day		
1- 49	0	2	2	1	0	2	4	1	5	0	3	5	0	0	1	26	
50- 99	2	3	2	1	3	2	1	4	4	1	2	1	0	2	0	28	
100-149	0	0	2	0	4	5	1	2	0	0	0	1	0	1	0	16	
150-199	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	2	
Total	2	5	6	2	7	10	6	7	9	1	6	7	0	3	1	72	

This proves that the ability to reproduce lasts at least 27 days, and that within this period there is very little difference in potency.

In April, 1942, two broods issued as offspring of females 81 and 93 days old, and one female 118 days old has entered an egg ball and is expected to have offspring. This proves the ability to overwinter and carry fertility for 3-4 months.

The developmental period of the parasites was determined in 72 cases, and is distributed as follows:

June 1-15: 24 days (5), 25 days (1), 26 days (1).

June 16-30: 20 days (1), 21 days (9), 22 days (13), 23 days (7), 24 days (6), 28 days (1).

July 1-15: 20 days (5), 21 days (7), 22 days (6), 26 days (1).

July 16-31: 20 days (1), 22 days (1), 25 days (1).

August 1-31: 20 days (4), 24 days (1).

September 1-30: 29 days (1).

The parasites begin to issue before the spiders, but continue issue over a longer period, consequently the total period of development of the parasite is just a day or two shorter than the embryonic development of the spider.

Starting with one female and two field parasitized egg balls we have artificially parasitized 72 egg balls, and have obtained 12,854 female and 1,313 male, or a total of 14,167 parasites, and 2,559 spiders, which gives a sum total issuance of 16,726. This translated into percentages gives us 90.72% females and 9.28% males, and 84.70% parasitism.

The mean yield per laboratory parasitized egg ball is 178 ♀, 18 ♂ Baeus, and 35 spiders—total 231.

It can easily be seen that if there were many spider egg balls present, the rate of multiplication at even 178 ♀ per egg ball, and 30 days per generation, could lead to millions of Baeus in a season. But the Black Widow is not so abundant that we can expect many balls to be within reach of a maturing parasite

generation. Even though there are enough parasites to handle all the egg balls present at a given time, they do not attack the spiders, and consequently there will be new balls as long as the spiders live, which may be several years.

Therefore to get our desired results, the parasites must be able to live long enough to gap the periods between spider egg ball depositions. In general the spiders do not oviposit between October and March. This means a 6 months waiting period for the parasites.

The *Baeus* females are wingless and must find hosts by walking and jumping, so their rate of distribution without human assistance would be quite slow. While they are very spry, in tube confinement some are killed by the spiderlings, but many males meet this fate, because their wings get caught by the spider silk.

The agility of the females is best measured by the jump, and 31 measurements were made on yellow paper, with a mean jump of 37.6 mm., maximum of 57 mm.; 20 jumps on rougher cardboard averaged 38.25 mm., maximum 67 mm.; and 6 jumps on cement floor averaged 46.4 mm., maximum 57 mm. The longest jump is 95 times the mean length of a female.

They are easily handled even when free on white paper, because with a brush they can be quickly guided into the tube. A moistened raisin, remoistened every 3 days will keep them alive some time. Certain of the parasites were actually recorded for longevity, and 26 have lived beyond 100 days, the record being 120 days to date. The mean longevity of 839 females was 34.19 days. These records are far in excess of any obtained previously, as I first recorded the longevity as 10-14 days, and the Hawaiian work raised it to 20 days.

Adults were placed in a refrigerator at 32°-40° F. and at the end of 9 days were still alive, but in the continuation of this experiment the temperature fell to 24 and none survived.

The final consideration regarding the *Baeus* was whether it would parasitize other spider eggs besides those of *Latrodectus mactans*. It has been tested with fresh egg balls of *Teutana grossa*, *Theridion tepidariorum*, and *Mastophora cornigerum*. In no case would they enter the balls. The developmental period of the first two is too short for the *Baeus*.

WEIGHING THE TWO PARASITES

In resumé the points in favor of the propagation of *Baeus* over *Pseudogaurax* are as follows:

1. *Pseudogaurax signata* Loew has been known since 1876, and has been recorded as a parasite of *Latrodectus mactans* since 1896, but in Southern California it has only achieved a status of 4.8% parasitism in 1941, and out of 60 California localities it

was only recovered from 20. It may be considered an established species with very sparse distribution.

2. *Pseudogaurax signata* is now known to attack *Aranea angulata* Linnaeus, *A. gemma* (McCook), *Argyope aurantia* Lucas, and *Latrodectus mactans* (Fabricius), and is suspected of attack on other species.

The *Baeus californicus* Pierce has up to date refused to oviposit in the egg balls of any other species.

Since most spiders are beneficial with no drawbacks, we prefer a parasite confined to the objectionable *Latrodectus*.

3. When an egg ball is parasitized it will yield from 1 to 40, mean 13, *Pseudogaurax*; but on the other hand it will yield from 1 to 417, mean 285, *Baeus*. Therefore for every parasitized egg ball the *Baeus* has an advantage of 22:1.

The rate of reproduction for *Baeus* is therefore considerably higher than for *Pseudogaurax*, even though the developmental periods are about the same. Although not yet worked out for *Pseudogaurax* there can be little doubt that its fecundity, or egg-laying power per female is far below that of *Baeus*.

4. When *Baeus* attacks an egg ball the parasitism in the field runs from 93 to 100%, mean 98.71%, of the eggs. But *Pseudogaurax* being merely a larval predator on the eggs does not often account for all the spider eggs, and in such cases is usually overstocked. We have estimated the actual kill to average 91.51%. The actual parasitic kill is therefore in favor of *Baeus*.

5. The ratio of issuing spiders to parasites from parasitized egg balls is 5 spiders to 1 *Pseudogaurax*; but it is 49 *Baeus* to 1 spider.

6. *Pseudogaurax* has the advantage in locomotion over *Baeus* and is at present spread over a greater area in California, but of course we don't know whence the *Baeus* came. It is probably a Central American introduction.

7. *Pseudogaurax* lays its eggs externally and is hence not immune to egg parasites, although these have not yet been demonstrated.

8. *Baeus* can be propagated in the laboratory at a rate at least 12 times as fast as *Pseudogaurax*. As for example, we reared 14,167 *Baeus* parasites from 72 egg balls, but at the normal yield for *Pseudogaurax* we could only have reared 923 flies from the same number of balls. Releasing fertilized females in lots of 25 we could have started 514 colonial nuclei with the *Baeus*, but only 18 colonial nuclei with *Pseudogaurax*. This is a 28:1 advantage for the rapid propagation of *Baeus* over *Pseudogaurax*.

13. AMPHIBIANS AND REPTILES OF THE DUNES

By JACK C. VON BLOEKER, JR.
Allan Hancock Foundation
University of Southern California

Few areas of comparable size in the immediate coastal region of California are hosts to such a great variety of life forms as have been found at El Segundo Sand Dunes. The present paper, a result of observations carried on in this general region intermittently over a long period of time, beginning in August, 1931, deals with the three species of amphibians and sixteen species of reptiles known to occur in the vicinity of the dunes.

Certain biological principles governing animal distribution are readily illustrated in the herpetological fauna of the area. Amphibians, by their very nature being largely dependent upon the presence of more or less permanent pools or streams of fresh water, are consequentially poorly represented in the dune area. Indeed, were it not for the occurrence of nearby Ballona Creek, at least one, and probably two, of the species (the *Hyla* primarily, and the *Bufo*) would not be found in this area at all. An abundance of decaying leaves, rotting boards, and piles of dead brush, serving as they do to conserve moisture, adequately provides the necessary dampness for *Batrachoseps*. Without doubt, the influence of the sea in keeping the area moist through the incidence of fog and heavy dewfall is an important factor in producing the amount of humidity required for existence of all three amphibian species in this area.

Conditions in the dunes are especially favorable for most of the reptilian species found there. The sandy nature of the soil makes the area particularly adaptable to such types as *Uta*, *Sceloporus*, *Phrynosoma*, and *Anniella*. The presence of grassy areas with convenient hiding-places under dead brush, boards, and debris is an attraction to such forms as *Gerrhonotus*, *Eumeces*, and *Diadophis*. The brushland and heavily weed-grown portions of the dune region provide suitable cover for *Masticophis*, *Coluber*, *Pituophis* and *Lampropeltis*. Here again, as with the amphibians, Ballona Creek exerts its influence in providing at least part of the habitat requirements for some of the reptiles. Particularly referred to are *Thamnophis* (two species) and *Clemmys*. Fortunately, because of the danger that might otherwise be presented to picnickers and school children in this locale, the lack of large rocky areas in the dune region probably

accounts for the rarity of *Crotalus* here. At least two of the forms herein included (*Lichanura* and *Clemmys*) may be regarded as "accidentals" until such time when further records of them from this area may be available.

An adequate food supply for this herpetological assemblage is ever present in the form of an abundance of rodent life for the larger snakes and veritable legions of insects for the smaller snakes, the lizards, and the amphibians.

In the pages that follow, specific accounts are given of the occurrence of cold-blooded vertebrates as found in the course of this survey. In addition to the writer, the members of the sand dunes survey group who have contributed notes and collected specimens of the species herein reported are: Drs. John A. Comstock, W. Dwight Pierce, and Robert L. Rutherford, Miss Frances L. Cramer, Mrs. Dorothy Pool, and Messrs. Chris Henne, Lloyd M. Martin, Gus F. Augustson, Karl Snyder, and J. Ernest Lewis. To all of these fine field workers the writer wishes to express his sincere appreciation for their helpful coöperation and their respective contributions to the present study.

CHECK-LIST

Class AMPHIBIA—Salamanders, Toads and Frogs

Order CAUDATA—Newts and Salamanders

Family PLETHODONTIDAE—Terrestrial Salamanders

Batrachoseps attenuatus attenuatus (Eschscholtz). Slender Salamander

Order SALIENTIA—Toads and Frogs

Family BUFONIDAE—True Toads

Bufo boreas halophilus Baird and Girard. California Toad

Family HYLLIDAE—Tree-toads or Tree-frogs

Hyla regilla Baird and Girard. Pacific Tree-toad

Class REPTILIA—Lizards, Snakes and Turtles

Order SQUAMATA—Lizards and Snakes

Suborder SAURIA—Lizards

Family IGUANIDAE—Common Lizards

Uta stansburiana hesperis Richardson. California Brown-shouldered Lizard

Sceloporus occidentalis biseriatus Hallowell. Western Fence Lizard

Phrynosoma blainvillii blainvillii (Gray). Southern California Horned Lizard

Family ANGUIDAE—Alligator Lizards

Gerrhonotus multicarinatus webbii (Baird). San Diegan Alligator Lizard

Family ANNIELLIDAE—Footless Lizards

Anniella pulchra Gray. Silvery Footless Lizard

Family SCINCIDAE—Skinks

Eumeces skiltonianus (Baird and Girard). Western Skink

Suborder SERPENTES—Snakes

Family BOIDAE—Boas

Lichanura roseofusca Cope. California Rosy Boa

Family COLUBRIDAE—Common Snakes

Diadophis amabilis modestus Blanchard. Southern Ring-necked Snake

Masticophis flagellum frenatus (Stejneger). Red Racer

Coluber constrictor mormon (Baird and Girard). Western Yellow-bellied Racer

Pituophis catenifer annectens (Baird and Girard). San Diegan Gopher Snake

Lampropeltis getulus boylii (Baird and Girard). Boyle King Snake

Thamnophis sirtalis infernalis (Blainville). Pacific Garter Snake

Thamnophis hammondi (Kennicott). California Garter Snake

Family CROTALIDAE—Rattlesnakes

Crotalus viridis oreganus (Holbrook). Pacific Rattlesnake

Order TESTUDINATA—Turtles and Tortoises

Family TESTUDINIDAE—Common Turtles and Tortoises

Chelmyx marmorata (Baird and Girard). Pacific Mud Turtle

SPECIES ACCOUNTS

I. AMPHIBIANS

Batrachoseps attenuatus attenuatus (Eschscholtz)

Slender Salamander

Occasionally found in spring under damp boards, rocks, or debris on the meadow slope of the dune and in the meadow proper. In the drier portion of the year these animals undoubtedly take refuge in deep rodent burrows in order to escape desiccation. As a point of evidence for this belief it may be well to here record that one individual of this species was found 33 inches below the surface of the ground in a pocket gopher burrow excavated by the writer on June 5, 1932, in the meadow area.

Their chief enemies are snakes, notably garter snakes, ring-necked snakes, and racers. Alligator lizards and skinks, as well as certain birds, are also known to prey on them.

The food consists of the smallest of insects visible to the human eye.

Bufo boreas halophilus Baird and Girard

California Toad

Present throughout the year in the entire area from the strand to and including the meadow. In summer, individuals aestivate in damp sand beneath the protecting shade of low-growing bushes, such as the ragweed (*Franseria bipinnatifida*).

As may be implied from the racial name, *halophilus*, this subspecies is quite tolerant of saline conditions in the environment, whereas most amphibians are not so adapted. On February 15, 1938, one was found hiding in sand at the edge of the strand less than thirty yards from the high tide line of the ocean. Here the sand was considerably moist from the saline spray of waves pounding on the shore.

Experiments in the laboratory reveal the toad to be entirely insectivorous.

Enemies of the toad are few in the sand dune area. Because of the presence of dermal poison glands, they are ensured safety from molestation by mammals through the factor of being unpalatable to the mammalian tongue. Young toads are sometimes preyed upon by great blue herons, sparrow hawks, roadrunners, garter snakes, gopher snakes, king snakes, racers, and alligator lizards.

Hyla regilla Baird and Girard

Pacific Tree-toad

Present in the meadow proper in great numbers in the wet winter of 1931-32 and in spring, 1932. Rarely encountered in this region on other occasions.

Presumably representatives of this species wander into the sand dune area from Ballona Creek, in the vicinity of Playa del Rey, the nearest body of water suitable for tree-toads to complete their early metamorphic stages in.

Their chief enemies in the sand dune area are alligator lizards, racers, garter snakes, great blue herons, roadrunners, and shrikes.

From our observations the food comprises insects exclusively.

II. REPTILES

Uta stansburiana hesperis Richardson

California Brown-shouldered Lizard

Common on the dunes from the fore-dune area to and including the meadow slope, occasional in the meadow. Found chiefly in the vicinity of rocks, bushes, or old boards where cover can be rapidly reached whenever danger threatens.

Chief enemies of this lizard in the sand dune region are the yellow-bellied racer, gopher snake, king snake, rattlesnake, sparrow hawk, burrowing owl, and shrike. Occasionally they are fed upon by white-footed mice and wood rats as attested by fragments found in the nests of these rodents.

They feed on the larvae of beetles, and adult flies, gnats, beetles, etc.

Sceloporus occidentalis biseriatus Hallowell

Fence Lizard

Abundant on the dunes from the embryonic dune area to and through the meadow. Dry open brushland appears to afford optimum habitat conditions, but the fence lizard is found commonly throughout the region covered in this study, with the exception of the barren strand and ocean beach.

Individuals are frequently found in summer, sunning themselves on the larger limbs of shrubs, such as coyote brush (*Baccharis pilularis*), lemonade-berry sumac (*Rhus integrifolia*), or wild buckwheat (*Eriogonum fasciculatum*). Often they may be observed in the performance of the curious though characteristic "push-up exercise", which may serve as a temperature regulation act. They are apparently exclusively insectivorous.

We have no definite evidence of species preying upon this lizard in the sand dune region, but suspect the larger snakes, sparrow hawk, burrowing owl, roadrunner, and shrike may be classed as enemies.

Phrynosoma blainvillii blainvillii (Gray)

Southern California Horned Lizard

The horned lizard, or "horned toad" as it is popularly called, is one of the commonest reptiles of the sand dune region. It is encountered most frequently on top of the large dune, but occurs throughout the area from the embryonic dunes through the meadow.

Often individuals are found with all but their heads covered with sand, lying in wait for their arthropod prey which they pick

off the surface of the ground with rapid thrusts of their sticky tongues. The habit of covering the body with sand is also believed to be a protective measure to escape desiccation during the heat of midday.

Captive individuals have been observed in the process of burying themselves in this manner. It is accomplished by rapid undulatory sideward movements of the flattened body, a few hurried kicks of loose sand thrown over the back, followed by downward thrusts of the legs. Slight up-and-down motions arrange the sand in such a way as to give it the appearance of having been undisturbed. When the body is thus completely hidden from view, the head resembles a small jagged rock, or burr, lying on the ground.

Evidence that the shrike may be regarded as an enemy of this lizard is afforded by an immature *Phrynosoma* found impaled on a pointed branch of a dead California croton (*Croton californicus*), October 26, 1939. Other predators known to feed on horned lizards are: sparrow hawk, barn owl, burrowing owl, roadrunner, badger and gray fox. Some snakes probably also prey on them, though we have no supporting evidence for this belief from the sand dune survey.

The food comprises insects, chiefly ants—though many other insect types are fed upon.

Gerrhonotus multicarinatus webbii (Baird)

San Diegan Alligator Lizard

Common in grass-covered ravines and other grassy areas of the dunes and meadow. Frequently found under boards, rocks, and in old brush-piles in the meadow area and in the vicinity of the old dump on the top of the dune.

Captive specimens fed readily on sow-bugs, mealy worms, wire-worms, ants and small tenebrionid beetles. Also one large individual devoured a large *Batrachoseps* and a small *Uta* placed in its cage one afternoon, and swallowed two small footless lizards on another occasion.

King snakes, great blue herons, sparrow hawks, and road-runners appear to be their chief enemies.

Anniella pulchra Gray

Silvery Footless Lizard

Very abundant throughout the dune region. Has been the most frequently encountered species of reptile in the course of our survey. Presumably normally active only at night, specimens were found by our field workers usually while they were engaged

in sifting sand in search of arthropods from the bases of plants. When thus disturbed, these lizards made violent attempts to escape. If placed on sandy ground they would rapidly disappear from view by swiftly burrowing downward.

Individuals retained in captivity refused to eat and seldom lived more than two months. In their normal habitat the food is apparently insects.

Its enemies are unknown, though, as mentioned above, a captive alligator lizard devoured two small *Anniellas* one day.

Eumeces skiltonianus (Baird and Girard)

Western Skink

Apparently rare in the sand dune region. Four examples were taken, one each on the following dates: April 17, August 21, September 26, and October 17, all in the meadow proper under boards and rocks.

Notes on enemies and food of this lizard in the sand dune region are lacking, but records from other localities indicate they are strictly insectivorous.

Lichanura roseofusca Cope

California Rosy Boa

Rare. One specimen, taken by the writer, May 1, 1932, about midway up on the meadow slope of the dune, was identified as of this species by Dr. Howard R. Hill.

This is a most surprising record, as the rosy boa is normally an inhabitant of brush-covered valleys and mountains. It is possible that the individual was an escape from some small boy's menagerie in the neighborhood, yet there is a nearby coastal record from Topanga Canyon in the Santa Monica Mountains and it is not impossible to believe that the brush-covered meadow slope of the El Segundo sand dunes may be a suitable habitat for this species, which never appears to be abundant wherever found.

Diadophis amabilis modestus Blanchard

Ring-necked Snake

Quite common throughout the dune area, except on the strand. Frequently found under boards and rocks, and occasionally found buried in loose sand, similarly to *Anniella pulchra*.

While the ring-necked snake is chiefly insectivorous in diet, it is also known to feed on *Batrachoseps* and young lizards of small size, killing the latter by constriction. On occasion *Dia-*

dophis may be cannibalistic, feeding on its own kind, a few examples of this nature being already on record.

The largest specimen taken on the dunes to date measured 17 inches long. It was found April 2, 1939, in the dune complex on top of the largest dune near a patch of tuna cactus (*Opuntia littoralis*). A perfect cast skin found July 11, 1939, under a clump of tuna cactus in the fore-dune area measured 14 inches in length. Larger individuals are on record from other regions in southern California.

We have no data on enemies of this snake in the sand dunes region.

Coluber constrictor mormon (Baird and Girard)

Western Yellow-bellied racer

Uncommon in the sand dunes region. Three specimens have been taken to date, all on the meadow slope of the dune, as follows: August 16, August 29, and February 17.

Racers are known to feed on salamanders, young toads, tree-frogs, small lizards, young birds and bird eggs, and small mice.

Masticophis flagellum frenatus (Stejneger)

Red Racer

Though not found in the area covered by this survey as yet, one individual was captured on the south bank of Ballona Creek, one mile north of Playa del Rey, on March 13, 1932, by the writer. It is not unreasonable to expect to find it in the brush-covered portion of the meadow region.

Pituophis catenifer annectens (Baird and Girard)

San Diegan Gopher Snake

Probably the most common snake of the sand dune region. Occurs from the edge of the strand to and throughout the meadow area. This species plays an important role as a check on the increase of small mammals, chiefly rodents.

A specimen captured September 4, 1931, in the meadow near the base of the dune, measured five feet seven inches long from the tip of its snout to tip of tail. Dissection of the alimentary canal of this individual revealed that it had swallowed 3 adult and 4 immature pocket gophers, 1 harvest mouse, and 2 meadow mice shortly before it was collected. Another gopher snake taken April 10, 1932, on the meadow slope of the dune, contained 1 silky-haired pocket mouse, 1 coarse-haired pocket mouse, 1 parasitic mouse, 4 white-footed mice, and 2 harvest

mice. It was somewhat smaller than the September-taken specimen, measuring only four feet ten inches in length.

Chief enemy of this snake is man, the exterminator.

Lampropeltis getulus boylei (Baird and Girard)

Boyle King Snake

Fairly common from the established foredune area to and including the meadow

This is probably the greatest natural enemy of all reptiles of the sand dune region as well as being an important controlling agent in limiting increase of rodents of the dunes. They kill their prey by constriction and are capable of devouring and digesting animals of greater size than themselves, both in length and in diameter. One individual, resenting capture, bit the writer several times before it was safely put away in a collecting bag.

Thamnophis sirtalis infernalis (Blainville)

Pacific Garter Snake

Fairly common in the sloughs of the Playa del Rey region and occasionally found in the meadow area of the sand dune region.

This species feeds on tadpoles, young toads, tree-toads, and small fish. Occasionally it may feed on small lizards, harvest mice, pocket mice, and shrews.

Thamnophis hammondi (Kennicott)

California Garter Snake

Occasional in winter and spring in the meadow. Individuals probably wander up to the dune region from Ballona Creek and sloughs of the nearby Playa del Rey salt-marsh.

This is a thoroughly destructive species with few, if any, redeeming characteristics. Its food comprises earthworms, tadpoles, salamanders, toads, frogs, and fish.

Bogert (this bulletin, vol. 29, Jan.-Apr., 1930, p. 12) records a specimen from Ballona Creek which gave birth to 16 young on September 8, 1928.

Crotalus viridis oreganus (Holbrook)

Pacific Rattlesnake

Rare. One specimen taken by the writer, April 11, 1932, at the meadow base of the dune. This individual was captured

as it was attempting to swallow a silky-haired pocket mouse caught in a trap set the previous evening. The trap prevented the rattler from completely swallowing the mouse and, in its resultant helpless condition, the snake was easily picked up and thrust into a bag. Dissection at the museum revealed that the alimentary tract of this snake contained 3 Jerusalem crickets, 1 California toad, 1 pocket gopher, 1 harvest mouse and 2 meadow mice.

Clemmys marmorata (Baird and Girard)

Pacific Mud Turtle

A common inhabitant of Ballona Creek. Occasionally individuals may wander into the sand dune region, as evidenced by one that was found slowly walking along in an old road rut in the meadow on February 13, 1932.

SUMMARY

A study of the amphibians and reptiles of El Segundo Sand Dunes area has been made. The presence of 3 amphibian species and 16 reptilian species in that area has been revealed. Of these, at least four and probably five are influenced in their occurrence here by the presence of nearby Ballona Creek, though the influence of the ocean also seemingly affects the occurrence of these same five plus one more. Four species of reptiles find optimum conditions for their burrowing habits because of the sandy nature of the soil. Three more are attracted because of the existence of grass-covered areas with convenient hiding-places from enemies and the sun. The brush-covered and heavily weed-grown portions of the dunes provide an attraction to four additional reptilian species. The lack of hiding places of the "right kind" seemingly accounts for the apparent rarity of one species and two others are, for the time being, considered mere accidental stragglers into the area.

As regards food habits, the three amphibians and five of the reptiles are apparently exclusively insectivorous. Of the remaining reptiles, one may be classed as omnivorous and the rest feed chiefly on vertebrates and occasionally on insects. The carnivorous habits of at least four of the reptiles warrants their being classed as beneficial to man as aids in maintaining a check on the increase of harmful rodents. The same is true of the exclusively insectivorous species as checks on the insects. Two of the reptilian species may be classed as harmful, one because of its danger to man through its poisonous bite and the other because its food habits cause it to prey on beneficial species. Fortunately, these two types are comparatively rare in the area. The remainder may be classed as harmless in so far as man's interests are concerned.

THE ALLOTYPE OF AMPHIPSYLLA NEOTOMAE I.
FOX, 1940 (SIPHONAPTERA: DOLICHOPSYLLIDAE)

By G. F. AUGUSTSON
Allan Hancock Foundation
The University of Southern California

Among many fine fleas recently obtained by the writer from K. E. Stager, Mammalogist, Los Angeles Museum, is a species known from males only. So little literature is available concerning this particular ectoparasite it seems advisable to the writer to present his analysis of it at this time, following it with a brief discussion of previous work on the genus *Amphipsylla* to which it belongs.

FAMILY DOLICHOPSYLLIDAE

AMPHIPSYLLA NEOTOMAE I. FOX, 1940

Allotype Female

HEAD: Frontal notch present, acuminate, about half way from angle of frons; eyes distinctly reduced, weakly pigmented; labial palpi five segmented, slightly shorter than fore-coxa; max-

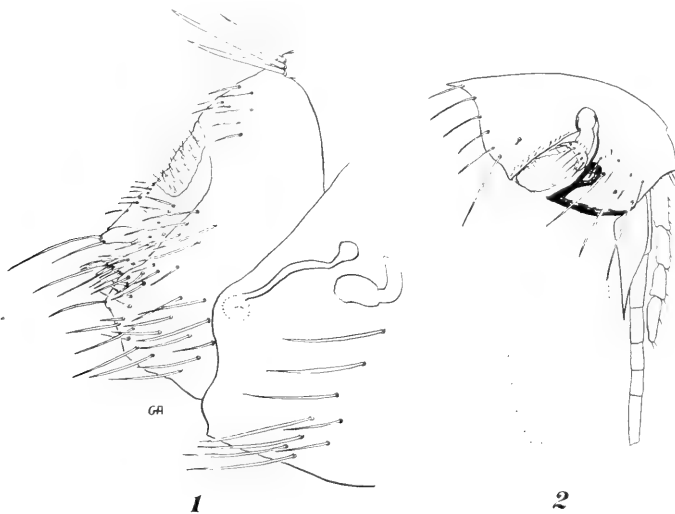


PLATE 8

Fig. 1. *Amphipsylla neotomae* I. Fox, posterior extremity, allotype female.

Fig. 2. *Amphipsylla neotomae* I. Fox, head, allotype female.

illa acuminate; genal process rather sharp, somewhat heavily chitinized along borders of process; preantennal region with two rows of bristles, three large bristles in lower row, four smaller in upper row; postantennal region with only marginal bristles and one small (broken) bristle; posterior margin of antennal groove with a row of small setae; bristles on second segment of antennae short, about one-third length of club.

THORAX, ABDOMEN AND LEGS: Pronotal ctenidium of eleven slender, pointed spines on a side, metanotum with three small tergal teeth, none on first abdominal tergite, three on second, two on third; three antepygial bristles, the middle one-fourth longer than the outer, one-third longer than inner; style short, thick, with a single long, terminal bristle and one two-thirds as long dorso-ventral; sternite X angulate, thickly beset with bristles; sternite VII broad, with a broad, shallow sinus midway; bursa copulatrix very diagnostic, prominent, a slightly undulate, uniform "tube" with one end enlarged into a bulb-like structure; spermatheca barrel-shape, with a sharply curved tail; legs as in other members of the genus, the lateral bristles on tibia and tarsi of all legs being thick and heavily pigmented.

Allotype: a female taken by K. E. Stager from *Spilogale gracilis arizonae* Mearns at Carrizo Creek, Riverside County, California. Deposited in the U. S. National Museum.

Paratype: a female taken by K. E. Stager from same host as above at Riverside Mountains, Riverside County, California. Retained by writer.

Additional Records: a male taken with the paratype. Also a male taken by the same collector and location as above from *Bassariscus astutus* subsp.

Discussion: the original description of *A. neotomae* I. Fox appears on page 273, Jour. Wash. Acad. Sci., vol. 30, no. 6, 1940. Previously Dr. Fox described *A. ewingi* (Proc. Ent. Soc. Wash., vol. 42, pp. 64-65). This constituted the first known *Amphipsylla* record from North America. The records as obtained by K. E. Stager gives a new southern and eastern extension to those already known with additional host information.

The genus *Amphipsylla* Wagner is an interesting one. The armature of the male genitalia is similar with the exception of *A. neotomae*, in this species the finger differs greatly from other members of the genus. The females are more constant, there being only a small difference in the shape of the spermatheca and bursa copulatrix to distinguish *A. matis* Jordan (Nov. Zool., vol. 35, p. 164) from *A. neotomae*.

The presence of *Amphipsylla* in our Western flea fauna further strengthens the opinions of various Siphonapterists of the close relationships of western Nearctic fleas to the Palearctic. Wagner ("The Fleas of British Columbia." *Can. Ent.*, vol. 68, p. 194, 1936) states "in comparing them (western nearctic) with Palearctic fauna we find a certain number of species which coincide with species of East-Asia and genera which distinctly reminds one of the Asiatic ones. . . . I take the liberty of noting in the list of fleas of British Columbia some instances of the parallelism between its aphanipterological fauna and that of Asia." Jordan (1929) has likewise noted this close relationship. The addition of *Geusibia* Jordan by the writer (*Bull. So. Calif. Acad. Sci.*, vol. 39, pp. 203-4, 1940) to our western Nearctic fauna is beyond doubt also a convincing factor in this remarkable relationship.



NOTES ON THE LARVA AND CHRYSALIS OF *POLITES THEMISTOCLES* LATR.

By V. G. DETHIER

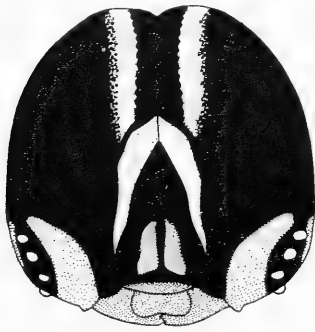
John Carroll University, Cleveland, Ohio

Previous descriptions of the fully grown larva of *Polites themistocles* Latr. are based almost wholly on a single specimen reared by Fletcher (Scudder, 1889). Last year when twenty-three of these larvae were bred to maturity, certain very conspicuous characters of diagnostic value were noted which were not mentioned in the early account. Since this species may be recognized easily by characteristic patterns on the head and anal plate, it is felt that these should be brought to attention.

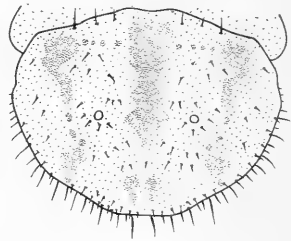
LAST INSTAR: Head height 2.6 mm.; head width 2.5 mm. The ivory to light sienna color pattern which is sometimes faintly indicated in the preceding instar becomes conspicuous here (Plate 9, fig. A). Most prominent of the entire design are the four median stripes. On either side of the coronal suture a stripe extends from the vertex to the tops of the adfrontals. The remaining two include the adfrontals and are in the shape of an inverted "V". The former are usually irregular in outline and of equal width throughout; the latter, sharply defined and tapering toward the mandibles. The ocelli are surrounded by a circular area of the same color. Frequently there are two darker less conspicuous elongate patches on the clypeus. In all of these

areas there is an absence of the deep black punctations which are primarily responsible for the black to piceous background color of the head. Scattered over the entire surface are very small, short, fine, fuscous hairs.

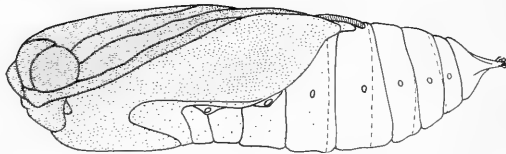
Body 22 mm. long. Usually the greenish tinge common to younger larvae is absent at this stage. Instead the body is brownish yellow to chocolate. When it is possible to make comparisons, it may be seen that larvae of *P. themistocles* are darker than those of *Poanes hobomok* Harr. or *Polites mystic* Scud. but lighter than *Polites manataaquia* Harr. The general body surface is marked only by faint dusky mid-dorsal and suprastigmatal lines. It is evenly covered with short spiny black hairs. Shield and spiracles piceous. The most distinctive markings occur on the anal plate. This brown design on a light sienna background



A



B



C

PLATE 9

- A. Front aspect of head of the last instar larva of *Polites themistocles* Latr., approximately x 16.
- B. Dorsal aspect of the anal plate of same.
- C. Lateral aspect of the chrysalis of same, approximately x 5.

varies slightly from individual to individual but not sufficiently to offset its diagnostic value. Three more or less distinct lines or sets of spots are visible. Plate 9, fig. B represents an average condition.

CHRYsalis: Length 16 mm. Wing pads soiled green. Region of eyes and mouthparts green but more heavily suffused with fuscous. Remainder of body soiled cream to very light brown. Long fine white hairs numerous except on wing pads. They are longest on the head and most numerous dorsally. Those on the posterior margins of the abdominal segments are directed caudad. The tongue case extends but slightly beyond the tips of the wing pads. Other characters are indicated in Plate 9, fig. C.

This species may be distinguished from *Polites peckius* Kby. which it closely resembles in many respects by the color designs of the head and anal plate. In the head region the markings of *P. themistocles* are less outstanding, less extensive, and darker than those of *P. peckius*. The chrysalids of the two species may be separated on the basis of the relative length of the tongue case in each and the color.

From the coast of Maine northward this skipper is usually single brooded. Adults appear on the wing during late June or early July in great numbers. Eggs are laid during July, and the larvae pupate early in October. Most hibernate in this stage. The individuals studied here emerged sixteen days after pupation (October 18). Probably this represented an abortive second brood, for one or two individuals were also observed in the field at this time. Thus it is conceivable that areas in which an abortive second brood is found represent the transition part of the range where the double brooded and single brooded conditions overlap. For this species it would lie near latitude 44.



NOTES ON THE LIFE HISTORIES OF TWO CALIFORNIA MOTHS

By JOHN A. COMSTOCK and CHARLES M. DAMMERS

NEOTERPES EPHELIDARIA Hulst.

Larvae of this species were secured by the junior author in San Antonio Canyon, Los Angeles County, Calif., July 1, 1934 on Chicalote or Thistle Poppy (*Argemone platyceras* var. *hispida* Prain).

Mature larva: length, extended, 22 mm.

Body, cylindrical, stoutest at the caudal end and tapering gradually toward the head. It is of the characteristic geometrid

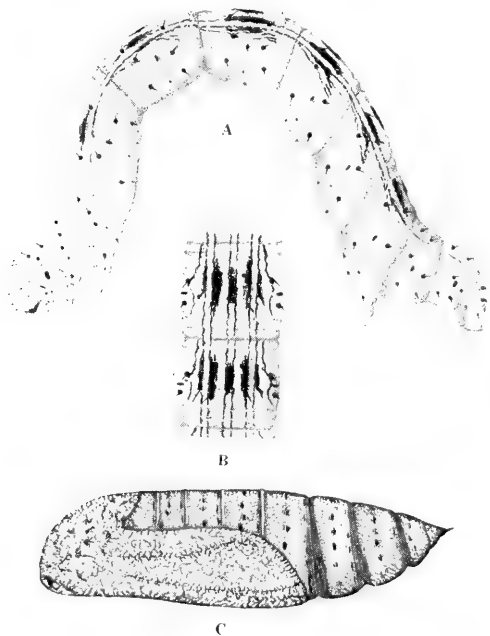


PLATE 10

Larva and pupa of *Neoterpes ephelidaria*.
Enlarged approxim. x 4.

A. Larva, lateral aspect.

B. Typical segments of larva, dorsal aspect.

C. Pupa, lateral aspect.

Reproduced from painting by Charles M. Dammers.

or "measuring worm" type, with a single pair of prolegs and anal prolegs, and is illustrated on Plate 10, fig. A.

Ground color of body, pale gray-green. There are a series of irregular broken longitudinal black lines on the upper half of the body. These are intensified and more pronounced on the center of each segment. Considerable variation occurs in the amount and intensity of these markings, some examples having mere tracés, while in others they are heavy and distinct.

Subdorsally on the center of each segment there is a bright lemon yellow patch. The infrastigmatal fold is a very pale gray-green. Abdominal surface, concolorous with the dorsum, and bearing a few black specks.

Spiracles, black, with a lemon yellow patch inferior to each of them.

Legs, soiled yellow. Prolegs, gray-green; crochets brown.

Each segment bears twelve short black setae arising from large round black dots.

Head: yellowish white, and bearing a few black specks from each of which arises a short black hair.

Pupation occurs on the surface of the soil in a light silken cocoon into which is incorporated soil particles. The first example pupated July 6, 1934, and the first moth emerged July 19.

Pupa: length, 13 mm.

Ground color, buff-mauve, heavily mottled and spotted with black markings, disposed as shown on Plate 10, fig. C., and covered with a light powder. Spiracles, black.

The larvae are parasitized by a Tachinid of a species not as yet determined.

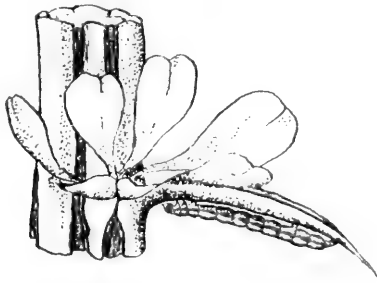


PLATE 11

Larva of *Barnesiata ritaria* at rest under thorn of Ocotillo.

Natural size.

Reproduced from painting by Charles M. Dammers.

BARNESIATA RITARIA Grossbeck.

This species has been reported heretofore chiefly from Arizona but will undoubtedly be found to occur throughout the entire range of its larval foodplant, Ocotillo (*Fouquieria splendens* Engelm.)

Larvae were secured north of Shaver's Well, Riverside County, Calif., on September 1, 1935. The caterpillars may be secured when the Ocotillo is in full leaf by bending over a stem and giving it a sharp tap with a stick. The larvae then lower themselves on a thread of silk. The distribution of the larvae in the Shaver's Well district was not general.

During periods of rest the larva assumes a position on the under side of the Ocotillo thorn, as shown in Plate 11. At the time when our examples were collected it was noted that the bases of the plants were surrounded by numerous droppings too large to have come from the *Barnesiata* larvae, which points to there being some other species also feeding on the same plant earlier in the season.

Mature larva: length, extended, 24 mm.

The body is cylindrical and of about equal girth throughout. It is of the usual geometrid type. The color and intensity of markings is quite variable but can be described generally as follows:

Body ground color, pale greenish white. A broad crenulated mid-dorsal band of dark purple extends from the first to the eleventh segments. A broad yellowish white longitudinal band is present above the infrastigmatal fold. This bears numerous crenulated dashes or broken lines of brown. The area between this band and the mid-dorsal band is covered with numerous dark purple crenulated dashes or broken lines, longitudinally placed. In some examples this series of markings extends only half way up the side of the larva and then gives place to pale mauve lines or dashes of a similar character. In others, the markings on this upper area are olive-brown, while in extreme examples there is only a single dark purple line on the upper edge of the lower band and the remainder of the area is pale greenish white.

The infrastigmatal fold is soiled white with a dark purple lower margin.

Abdomen, pale greenish white, streaked with a few faint olive-brown crenulated lines.

Spiracles, white with broad black margins.

Legs, soiled white, with pale brown tips. Prolegs, pale greenish white. Anal prolegs, pale greenish white, heavily spotted with dark purple, the crochets dark brown.

The points usually given over to setae are represented (apparently) only by raised purple spots, there being twelve to each segment. A few white hairs occur on the legs and anal flap.

Head: greenish white, heavily blotched on the upper half with dark purple, and spotted on the lower half with the same color.

Ocelli, black. Mouth parts, brown. Spinnarets, soiled white and very conspicuous. A few white hairs occur on the lower portion of the face.

Pupation took place under the soil, the first specimen pupating September 7.

Pupa: length, 9 mm. The color is a uniform rich chestnut. The form is stout and short, and the surface is heavily rugose, as will be noted in the illustration, Plate 12, fig. C.

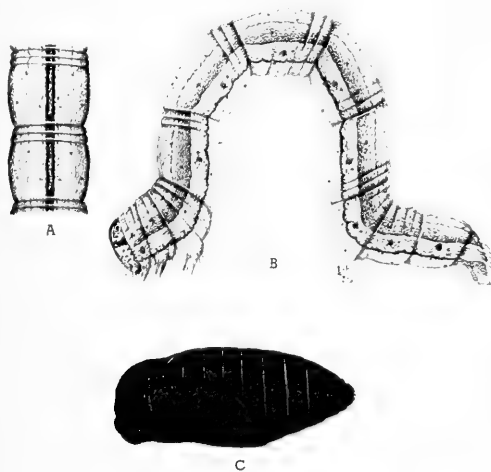


PLATE 12

Larva and pupa of *Barnesiata ritaria*. Enlarged approxim. $\times 3\frac{1}{2}$.

- A. Two typical segments of larva, dorsal aspect.
- B. Larva, lateral aspect.
- C. Pupa, lateral aspect.

Reproduced from painting by Charles M. Dammers.

BRIEF NOTES ON TWO RECENTLY DESCRIBED SPECIES OF MOMPHA (LEPIDOPTERA)

By L. J. BOTTIMER

In a paper on North American microlepidoptera (Bull. So. Calif. Acad. Sci., vol. 39, pp. 87-89, 1940) Mr. August Busck described two species of *Mompha* reared by the writer. Information on the type series of *M. capella* was not published thru accidental loss of one page of the manuscript. Mr. Busck has suggested that the writer furnish the missing data and add rearing notes on both species that might be of interest.

MOMPHA BOTTIMERI Busck

Foodplants—*Crocianthemum corymbosum*, *C. carolinianum*, and *C. arenicola*.

The type was reared from *C. corymbosum*, May 29, 1937.

Dr. A. N. Tissot and the writer found all three species of plants growing together near Newnan's Lake, a few miles east of Gainesville, Florida. He assisted in collecting the infested material. Paratypes have been sent to Dr. Tissot for the University of Florida collection, and others to Dr. E. P. Darlington.

MOMPHA CAPELLA Busck

Altar expanse, 8-10 mm.

Type—U. S. Nat. Mus. No. 54053.

Habitat—Long Island, New York, and New Jersey.

Foodplants—*Crocianthemum propinquum* and *C. canadense*.

The type is from Massapequa, Long Island, and was reared from *C. propinquum*, July 8, 1937.

The 130 or more paratypes were reared during July as follows:

New York—Hicksville and Massapequa, from *C. propinquum*, the larvae developing mainly in the seed capsules, altho from the latter locality one adult was obtained from a tie in the leaves.

New Jersey—Mt. Misery and Marmora, from larvae in seed capsules of *C. canadense*; Haddon Heights, 2 adults from larvae in leaf ties on same host.

Paratypes have been deposited in the collections of University of Florida and Dr. E. P. Darlington.

Plants of the genus *Crocianthemum* have two kinds of flowers. Both of the hosts of *Mompha capella* have large petaliferous flowers early in the summer which produce many-seeded capsules. Later in the year much more numerous, smaller apetalous flowers develop and these produce similar but smaller capsules having few seeds. Altho a large number of the smaller capsules of *C. canadense* have been examined, no *Mompha* larvae were found.

A NEW FREE-TAILED BAT FROM TEXAS

By KENNETH E. STAGER

Los Angeles County Museum, Los Angeles, California

A recent study of Texan Chiroptera has resulted in the discovery of a form that appears to be new. The species is here described.

TADARIDA TEXANA, sp. nov.

Texan Free-tailed Bat.

Type: Female adult, skin and skull, no. 6064, Los Angeles County Museum, from Ney Cave, 20 miles north of Hondo, Medina County, Texas, August 5, 1938. Collected by Kenneth E. Stager, original number 759.

Range: Known only from the type locality.

External characters: Slightly larger than *Tadarida mexicana*. Ear is noticeably larger and broader. When laid forward reaches to the end of rostrum. Compared with a series of female skins of *Tadarida mexicana*, all external measurements of *Tadarida texana* average greater. The ear character and the longer tibia tends to separate the species from *Tadarida cynocephala*.

Cranial characters: Skull similar to that of *Tadarida mexicana*, but with measurements averaging slightly greater. *Tadarida texana* shows the tendency for reduction of number of lower incisors as do other members of the *brasiliensis* group. Of twelve skulls examined, all have two incisors on each side of the lower jaw instead of three, with one exception which has a third incisor present on the left side, making a total of five.

Color: Type, summer pelage: Dorsal area "Sayal Brown" (of Ridgway); ventral area, lighter; near "Tawny Olive" (of Ridgway). Examination of series, including type, shows a color range from near "Tawny Olive" to shade slightly darker than "Sayal Brown." Membranes, ears, and tail are a deep black.

Measurements: Average of 12 adult females from the type locality: Total length 95.3 (102-91); tail 38.0 (44-33); foot 9.9 (10.5-9); ear 19.0 (20-18); tibia 12.7 (13.5-11.5); radius 42.0 (43-41). Skull: Average of 12 adult females from type locality: Greatest length 16.7 (17.3-16.1); zygomatic breadth 9.8 (11.1-9.5); interorbital breadth 4.0 (4.2-3.7); breadth of braincase 8.1 (8.5-7.8); basilar length 13.7 (14.3-13.4); maxillary toothrow 7.0 (7.2-6.1); breadth at canines 4.2 (4.5-4.0); length of mandible 11.6 (12.3-11.1); mandibular toothrow 7.1 (7.4-7.0).

Remarks: The very decidedly "golden" color of the pelage of *Tadarida texana* immediately separates it from *Tadarida mexicana*. The latter has a color range from "Chaetura Black" to "Mummy Brown."

The colony from which the species was secured, conservatively numbers into the millions of individuals and apparently consists of two species, *Tadarida texana* and *Tadarida mexicana*. All specimens of *Tadarida texana* examined proved to be adult females. Of individuals observed, approximately 50% of colony appeared to be *Tadarida texana*.

Specimens examined: Twelve skins with skulls and one alcoholic. Type specimen in Los Angeles County Museum collection, eleven skins and one alcoholic, paratypes in Stager collection, Los Angeles County Museum.



A REVIEW OF THE NORTH AMERICAN WEEDY HELIOTROPES

By JOSEPH EWAN

University of Colorado, Boulder, Colorado

When a plant species of the temperate zone is considered by authors to be conspecific with a species described from material taken in the tropics the situation may well bear investigation from the taxonomic standpoint. This thesis has been reemphasized in the instance of the well-known weedy *Heliotropium curassavicum*. The North American plants in some areas differ widely from the plant described from the shores of the Caribbean basin under that name. To be sure T. D. A. Cockerell (1902), P. A. Rydberg (1903) and A. A. Heller (1904) each in turn pointed out the distinctions existing between the continental North American plants and the "true" *Heliotropium curassavicum* L. The species was first described by Linnaeus in 1753 under binomical nomenclature, though the plant was included in the works of at least six pre-Linnean writers, one even using the specific epithet "curassavicum" in allusion to its habitat on the island of Curacao of the Dutch West Indies, off the Venezuelan coast. The present review of the taxonomic status of these weedy heliotropes attempts to draw attention to the natural floristic ranges which characterize each of the two species recognized herein.

Unfortunately the type of Linnaeus's *Heliotropium curassavicum* has not been available. Specimens for comparison with the Linnean collection(s) were submitted by the present writer in 1939 to Mr. S. Savage, Assistant Secretary of the Linnean Society, but the present international conflict had already necessitated the removal of the specimens to underground vaults. Nevertheless, it seems desirable to report upon the status of the problem as it now stands. There are adequate pre-Linnean references to correlate with modern collections from the Caribbean region to distinguish the concept.

It is a pleasure to acknowledge the assistance cordially tendered by Dr. Weibel of deCandolle's Herbarium at Geneva, Superintendent R. E. Dean, Royal Botanic Gardens, St. Clair, Port-of-Spain, Trinidad, and of Director J. Sydney Dash, Georgetown Botanic Gardens, Georgetown, British Guiana, in the prosecution of this study. Of the five herbaria consulted in this country that at Colorado College has been especially valuable for the Tatnall Herbarium now incorporated there.

The North American weedy heliotropes fall taxonomically into two species with two subspecies each, having almost perfectly discrete distributions, and separable by characters of the calyx, and supporting vegetative characters of habit and leaf. True *Heliotropium curassavicum*, as interpreted by modern collections from the Caribbean region, does not occur natively north of Mexico, so far as can be determined, but has been collected at several points along the Atlantic coast as a waif, at least formerly to be attributed to the agency of ballast or shipping waste for its introduction into this country. Perhaps typical *Heliotropium curassavicum* may be brought to our shores, especially the Gulf Coast, through importations of bananas and other produce today. Yet even these naturalized specimens of the Linnean species differ by small but recognizable characters from the Caribbean plants. In particular the United States collections seen have a more bushy upright habit, the branches being more leafy and freely branching, in contrast to the elongated stems of the Caribbean plants.

Related to this tropical heliotrope is a plant of Texas and New Mexico, described by Cockerell as *Heliotropium xerophilum*, named for its xeric habitat of our interior plains and river valleys in distinction to the strand plant that he knew in Jamaica. Prof. Cockerell tells me that he found an oligotrophic bee on *H. xerophilum* at Juarez, Mexico, and, since oligotropes are obligatory in their feeding habits and would not ordinarily visit introduced plant species, this points to biotic evidence of the indigeneity of this heliotrope. From an examination of the extremes of the series, *Heliotropium xerophilum* would be separated at once from the tropical *H. curassavicum*. Yet these two plants are connected by fundamental calyx characters, and separable only upon such vegetative characters as leaf width and habit, two characters which are highly variable in Texan collections of undoubted *H. xerophilum*. Accordingly, the latter species is here placed with the tropical strand plant as a subspecies. *H. curassavicum xerophilum* ranges north as far as the fortieth parallel in Colorado, and west to the New Mexico-Arizona state line. It is most abundant along the Rio Grande Valley of the Gulf coast.

Heliotropium spathulatum is the second species in North America, with a Pacific Coast subspecies *oculatum*. Together they form a distribution pattern shared with dozens of Great Basin phanerogams and *H. spathulatum oculatum* encroaches upon the coastal plains evidently at points of entry from the Great Basin, such as the Mohave Desert and the Modoc County semi-desert of California. *Heliotropium spathulatum* is a truly showy-flowered species, with the limb of the corolla spreading in the manner of the Peruvian garden shrubby heliotropes. This is not true of the tropical strand plant *H. curassavicum*. Edward Graham, who has seen the tropical species on the coast of British

Guiana, describes the flowers as "funnel-form, blue or white," and "about 4 mm. broad" (Annals Carnegie Mus. Pittsburgh 22:240. 1933.). The leaves of the northern *Heliotropium spathulatum*, and somewhat less so of the Pacific Coast *H. spathulatum oculatum*, are spatulate, not narrowly lanceolate to strictly linear as in the species *H. curassavicum*. When the elder William Jackson Hooker wrote upon the first collection made of *Heliotropium spathulatum*, under an earlier name, he said (1838): "the leaves are much broader than in any specimens I have seen of *H. curassavicum*." The fundamental character separating the two species is, however, one of the calyx, as expressed in the accompanying key.

Heliotropium spathulatum oculatum was first described by Heller (1904) with the comment, "strange as it may seem, this plant has long passed as *H. curassavicum*, a tropical and semi-tropical plant whose habitat is sea beaches. It is a plant with long slender branches, narrow leaves, small white flowers, and bears little resemblance to our inland species." It is unfortunate, as will be clarified later in this paper, that Heller chose an atypical collection of this widespread Pacific Coast subspecies when characterizing his *H. oculatum*. Sufficient collections of this subspecies have been seen, however, to clearly delimit its range of variation. It occurs on both sides of the barrier ranges separating the desert and coastal plain in southern California.

The North American representatives of this species-group may be keyed as follows:

Sepals spreading or reflexed early or upon maturation of nutlets to form a star-like flat disc persistent after seed dispersal; outer seed coat of nutlets peeling off to expose ridges on back and usually fine intercostal wrinkles; spikes elongating in fruit, very slender, often more or less arcuate or caudate; calyx mostly less than 2 mm. long.

Leaves strictly linear (i.e. one line or 2 mm. wide), numerous and close set upon the stems up to and subtending the inflorescences; spikes geminate or axillary and then solitary; calyces long adherent upon the roughened rachises of the spike
 1. *Heliotropium curassavicum*

Leaves narrowly lanceolate or spatulate at times, 2-5 mm. wide, uniformly borne along the stems; spikes naked, geminate or often ternate or quinate; calyces more or less deciduous from the rather smooth rachis
 2. *Heliotropium curassavicum xerophilum*

Sepals permanently erect or ascending (even in dried post-anthesis condition), sometimes cupulate or subglobose by an incurving of sepals in age; outer seed coat of nutlets adherent; spikes little if at all elongating in fruit, Phacelia-like with a straight but ultimately scorpioid tip, not caudate; calyx 2.0-3.5 mm. long.

Middle cauline leaves lance-ovate, 6-20 mm. wide, rounded or apiculate at apex; corolla rather showy, 6 to 8 (or 10) mm. broad, usually clear white 3. *Heliotropium spathulatum*

Middle cauline leaves elliptic-lanceolate to linear, mostly 2-7 (seldom as much as 8 or 10) mm. wide, acute at apex; corolla 4-6 mm. broad, usually porcelain white with an uneven bluish tinge 4. *Heliotropium spathulatum oculatum*

1. HELIOTROPIUM CURASSAVICUM L., Sp. Pl. 130. 1753, based on colls. from maritime tropical America, the specific name adopted from Morison's *Historia Pl.* 3:452, t. 31, fig. 12, 1680. the polynomial, resting on garden plant, seed from Jamaica. Also based on *Heliotropium indicum procumbens glaucophyllon, floribus albis* of Plukenet, *Almagestum* 182. t. 36. fig. 3. 1696; *Heliotropium americanum procumbens, facie lini umbilicati* of Hermannus, *Paradisus* 183. t. 183. 1698, as to illustrated works, but the preLinnean authority upon which Grisebach, *Fl. Brit. West Ind. Isl.* 486. 1864, rests the name is the fourth reference given by Linnaeus, that of Sloane, *Voyage* 1:213, t. 132, fig. 3. 1707, the polynomial resting on good desc. of Jamaican plant, figure good. The Linnean type(s) have not been seen.

Apparently indigenous as a strand plant from the Bahamas (Cat Isl., Fortune Isl., and Inagua, *vide* A. S. Hitchcock, *Fourth Ann. Rep. Mo. Bot. Gard.* 109. 1893), Isle of Pines (*vide* O. E. Jennings, *Annals Carn. Mus. Pittsburgh* 11:237. 1917), Jamaica (*vide* Grisebach, *op. cit.*), Antigua (*vide* Grisebach, *op. cit.*), Barbados, October, 1869, *without collector* (Trinidad Bot. Gard. Herb. no. 1853); St. Thomas (*vide* deCandolle, *Prodr.* 9:538. 1845), Venezuela (Margarita Isl. and Tortuga, *vide* J. R. Johnston, *Contr. Gray Herb. n.s.* 37: 251. 1909), and British Guiana (seashore, *Jenman* 4466, and Berbice, April 1906, *A. W. Bartlett*).

From the Caribbean region it has emigrated almost throughout the tropics, until it is now characterized as "common to tropical countries." Localities in both hemispheres where it has become naturalized are enumerated by deCandolle (l.c.) and Grisebach (l.c.). Of interest to us is its spread northward along the

Atlantic seaboard. Authentic collections seen are: Thorn Point near Milford, Delaware, 16 VII 1896, *Communs & Tatnall* (Colo. Coll. Herb.); Norfolk, Va., without date, ex *Wm. Canby*. It is of interest that Thomas Nuttall records what must surely be this plant from Harpers Ferry, where it was apparently adventive prior to 1818! (*Genera N. Am. Pls.* 1:112.). Alphonse deCandolle records this heliotrope among those plant species naturalized at great distances in his *Geographie Botanique Raisonnee* (1855, 736) from Montpellier, Narbonne and Collioure, in France. He there refers the species to a North and Middle American origin.

In short, *Heliotropium curassavicum* occurs within our borders as a stray adventive along the seacoasts from Delaware southward.

2. HELIOTROPIUM CURASSAVICUM XEROPHILUM (Ckll.) Nels. & Macbr., var., Bot. Gaz. 61:35. 1916, based on *H. xerophilum* Ckll., Bot. Gaz. 33:379. 1902, in turn based on T. D. A. Cockerell coll., 3 XII 1901, from Albuquerque, N. M., in U. S. Nat. Herb. Authentic material, labelled in Cockerell's hand, from Roswell, N. M., VIII 1902, at Rocky Mt. Herb. studied.

Saline situations on the plains or bottomlands, from State of Puebla, Mexico, northward to Chaves Co., New Mexico. Representative colls.: Mexico: State of Puebla, Tehuacan plains, 5000 ft., *Pringle* 6757 (atypical for its nearly mustard yellow corolla, the leaves finely tessellate beneath). Texas: Neueces Co.: Corpus Christi, *Heller* 1515. Bexar Co.: San Antonio, *Clemens* 306; Laredo, *K. K. Mackenzie* 9; betw. Tahoka and Odonnell, *E. L. Reed* 3709. New Mexico: Dona Ana Co.: Mesilla Valley, 3800 ft., 2 VIII 1907, *Wootton*. Chaves Co.: Roswell, *F. S. & E. S. Earle* 257.

3. HELIOTROPIUM SPATHULATUM Rydb., Bull. Torrey Club 30:262. 1903, based on *R. S. Williams* 542 from Great Falls, Montana, at New York Bot. Gard. Authentic material, Great Falls, 22 VI 1889 (type taken in 1890), *R. S. Williams s. n.*, at Rocky Mt. Herb. studied. *H. curassavicum* var. *obovatum* DC., Prodr. 9:538. 1845, based on David Douglas coll., 1830, from "Columbia River," Oregon, according to label on type in deCandolle's Herb. at Geneva. According to Dr. Weibel, assistant at Conservatoire et Jardin Botaniques, Geneva, the type agrees well with *Kennedy* 1765 in the Herbarium Delessert; it agrees favorably also with *Goodding* 212, Casper, Wyo., and *Hcristis s. n.*, Berkeley, environs of Denver, 1 VIII 1916, which were submitted for comparison. By detailed study of Dr. Weibel there can be little doubt but that deCandolle's var. *obovatum* is the same as Rydberg's *H. spathulatum*. His conclusion is as follows: "Les exem-

plaires de l' *Heliotropium spathulatum* Rydberg examines ne sont par identiques en ce qu'il concerne la forme des feuilles a la plante decrite par deCandolle comme *Heliotropium curassavicum* v. *obovatum* DC." *Heliotropium curassavicum sensu* Hook., Fl. Bor. Am. 2:81. 1838, as to Douglas coll. from "vallies of the Blue Mts. (far removed from the sea)", not L. (1753). Hooker comments: "in one of my specimens from Mr. Douglas's last journey, the leaves are nearly an inch broad, and the spikes quaternate and quinate." He further comments, "in all, the leaves are much broader than in any specimens I have ever seen of *H. curassavicum*." Rydberg, l.c., failed to state the Hooker estimate fully enough to make his views clear. From deCandolle's statement as to the source of his Douglas specimen, it seems certain that Hooker's material from Douglas is the same as that which served as the type basis for deCandolle's var. *obovatum*. Hooker and deCandolle had portions of the same Douglas collection.

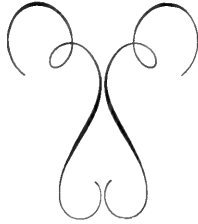
Great Basin region of eastern Washington and Oregon, south to northern Nevada and Utah, to southern Colorado, and east to the edge of the high plains in Wyoming and Montana. Representative colls.: Washington: Moses Lake, VII 1893, *Sandberg & Leiberg s. n.* Oregon: Camp Creek, base of Steins Mt., *Cusick* 2042. Nevada: no. Humboldt Co., 10 VII *Percy Train*. Utah: upper Moapa Valley, *Maquire & Blood* 1526. Colorado: San Luis Lakes, *Ramaley* 12222; Grover, *Earl L. Johnston* 1132; Berkeley, near Denver, 1 VIII 1916, *W. Heustis*; Sloans Lake, n. Denver, VII 1887, *A. Eastwood*; Julesburg, 22 VI 1905, *W. Heustis*. Wyoming: Casper, *Natrona Co., Gooding* 212.

4. HELIOTROPIUM SPATHULATUM OCULATUM (Heller) Ewan, comb. nov., subsp. based on *H. oculatum* Heller, *Muhlenbergia* 1:58. 1904, in turn based on *Heller* 5813, from "sand along the Russian River at Healdsburg, Sonoma Co., Calif." Isotype at Rocky Mt. Herb. studied. *H. curassavicum* var. *oculatum* (Heller) Johnston, ex. Tides., *Proc. Biol. Soc. Wash.* 48:42. 1935.

Along the coast of California northward but spreading interiorly to the south, reaching the Colorado River in the vicinity of Needles, and ascending the drier desertward slopes of the San Bernardino Mts. to 6700 feet. Representative colls.: California: Mendocino Co.: *H. E. Brown* 927. Alameda Co.: Alameda, *W. P. Gibbons* 295 (Colo. Coll. Herb.); San Joaquin Co.: 7 mi. e. Manteca, *Keck* 1313. Los Angeles Co.: San Pedro, *Cockerell s. n.*; Los Angeles, *Geo. B. Grant* 554; Pallett Creek, w. Mohave Desert, *Peirson* 3542. Orange Co.: Smeltzer, *Ewan* 4205. Riverside Co.: Lake Elsinore, 1300 ft., *Munz & Harwood* 3377, *Epling & Ewan* 7614; San Bernardino Co.: Lost Lake, Lone Pine Can-

yon, San Gabriel Mts., 2700 ft., *Wheeler* 2147; Baldwin Lake, San Bernardino Mts., *vide* Munz, Man. S. Calif. Bot. 419, 1935; Twenty-nine Palms, 2050 ft., *Ewan* 3076. San Diego Co.: Del Mar, *Macbride & Payson* 780. Imperial Co.: betw. Calipatria and Niland, - 175 ft., *Ewan* 4080. Nevada: Clark Co.: across Colorado R. from Ft. Mohave, *Robbins* 8511 (Univ. Colo. Herb.); St. Thomas on Muddy R., *Goodding* 691. Arizona: Mohave Co.: Ft. Mohave on Colorado R., *Junius Henderson* 8621 (Univ. Colo. Herb.). These last collections from Nevada and Arizona are more or less intermediate between *H. spathulatum* and the subsp. *oculatum*, this region being the zone of overlap between the ranges of the two heliotropes.

This subsp. *oculatum* has been reported from Santa Catalina Island by Munz, l.c., but I have not seen any insular collections.



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" 19, " 4, 192050	1.00
" 20, " 1, 1921	2.00	4.00
" 20, " 2, 1921	2.00	4.00
" 20, " 3, 1921	2.00	4.00
" 21, " 1, 1922	2.00	4.00
" 21, " 2, 1922	1.00	2.00
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OBSERVATIONS ON VECTORS OF CHAGAS' DISEASE
IN THE UNITED STATES. I. CALIFORNIA¹

By SHERWIN F. WOOD

Department of Life Sciences, Los Angeles City College, Los Angeles, California

HISTORICAL

Since the discovery of *Trypanosoma cruzi* in Brazil by Carlos Chagas (1909), this Pan-American blood and tissue protozoön parasite of man has become an increasingly important clinical entity in the Americas. Although unable to prove the exact identity of the parasite, Kofoid and McCulloch (1916) were the first to make observations on this trypanosome in the United States in the western cone-nosed bug, *Triatoma protracta* (Uhler) from California.

A complete account of the recovery and correct identification of this parasite was reported by Fae Donat Wood (1934a) and excerpts of this work appeared in the following publications: Kofoid and Donat, (1933a, 1933b, 1933c); F. D. Wood, (1934b, 1934c).

Kofoid and Whitaker (1936) recorded another source of naturally infected insects from Arizona. S. F. Wood (1938) reported a second locality for naturally infected insects in California. Packchianian (1939, 1940) found two localities for the recovery of naturally infected insect vectors from Texas. S. F. Wood (1941a, 1941b, 1941c) reported one new locality for recovery of naturally infected insects in Arizona, one in New Mexico, and five in Texas.

INSECT AND MAMMAL CARRIERS

As is indicated in Table 1, three insect vectors of *Trypanosoma cruzi* have been recovered from California although up to the present only one of these cone-nosed bugs, *Triatoma protracta* (Uhler), has been proven to harbor *Trypanosoma cruzi* in this state.

The first source of naturally infected insects was Murray Canyon near San Diego (F. D. Wood, 1934a). The second locality reported by S. F. Wood (1938) was Eaton Canyon, near Pasadena.

Recently (Wood, 1942b), naturally infected *Triatoma protracta* have been recovered from human habitations at Trimmer Springs and O'Neals in California, and from wood rat nests

¹The writer wishes to thank Dr. John A. Comstock, Dick Dalton, Dick DeFussi, LeGrand Goodsell, Ted Hansen, Tom Loeber, John McManus, John Morrissey and Kenneth Stager for collection of insects and mammals, and William H. Fletcher and María Quirós for checking the Spanish summary.

in Griffith Park, Los Angeles, California. Due to the fact that there is some doubt as to the source of the O'Neals specimens, additional collections will have to be made in that area to verify the previous findings. Thus, there are now four, or possibly five, known localities in California for the recovery of *Triatoma protracta* naturally infected with *Trypanosoma cruzi*. As is shown in Table 2, of 1,063 cone-nosed bugs collected in California, 816 were examined and 204 or 25 per cent were found infected with *Trypanosoma cruzi*.

In addition to the uninfected localities previously reported (Wood, 1941b), *Triatoma protracta* (Uhler) has been collected at Calaveras Dam, near Livermore, Alameda County, Frazier Mountain Park, Ventura County, and Glen Ivy Hot Springs, near Corona, Riverside County.

Wood and Wood (1937) and Wood (1941c) have reported their findings in a survey of 218 California mammals examined for blood parasites, especially trypanosomes. The examination of 135 additional mammals from California is here reported. Fresh blood from the ear (Rodentia) or wing (Chiroptera) was examined and in only a few instances were stained smears studied. Therefore, in all probability, a number of intracellular blood parasites were overlooked.

Trypanosoma peromysci Watson was found in 1 Gambel white-footed mouse (*Peromyscus maniculatus gambelii*) collected December 29, 1937 in Mill Creek Canyon, San Bernardino County; 1 female southern parasitic mouse (*Peromyscus californicus insignis*) collected April 30, 1939, near Simi, Ventura County; and 1 male Rowley white-footed mouse (*Peromyscus boylii rowleyi*) collected June 20, 1940, near Lebec, Kern County. *Trypanosoma vespertilionis* Battaglia was recovered from 4 female Hollister bats (*Myotis occultus*) collected June 1, 1940, at Blythe, Riverside County.

The following California mammals were negative for blood parasites: 1 *Didelphis virginiana virginiana*, 5 female *Myotis yumanensis yumanensis*, 32 female *Myotis occultus*, 1 *Myotis californicus californicus*, 1 female *Myotis subulatus melanorhinus*, 1 female *Nycteris borealis teliotis*, 1 male and 2 female *Antrozous pallidus pallidus*, 9 male and 11 female *Tadarida mexicana*, 1 female *Thomomys bottae nigricans*, 1 male *Perognathus longimembris bangsi*, 1 male *Perognathus spinatus rufescens*, 1 *Dipodomys deserti deserti*, 13 male and 5 female *Peromyscus californicus insignis*, 1 *Peromyscus maniculatus* subsp.?, 10 male 6 female and 1 undetermined *Peromyscus maniculatus gambelii*, 3 male and 1 female *Peromyscus maniculatus sonoriensis*, 1 male and 1 undetermined *Peromyscus truei truei*, 2 female *Peromyscus truei martirensis*, 4 male, 4 female and 2 undetermined *Neotoma lepida lepida*, 3 male, 1 female and 2 undetermined *Neotoma fuscipes macrotis*.

Therefore, despite extensive search for *Trypanosoma cruzi* in mammals in California it has been recovered up to the present time in only one San Diego wood rat (*Neotoma fuscipes macrotis*) as reported by F. D. Wood (1934c). As has been pointed out previously by S. F. Wood (1941c), the trypanosome from Hollister's bat may prove to be *Trypanosoma cruzi*.

REACTIONS OF MAN TO THE FEEDING OF CONE-NOSED BUGS

In previous publications (1941c, 1942a), the writer has pointed out the great variation in reactions of man to feeding of various species of blood-sucking *Triatoma*. Through the courtesy of Dr. Ralph H. Smith of the University of California at Los Angeles, some interesting notes are here recorded on the reactions of man to the feeding of *Paratriatoma hirsuta* Barber. The writer (Wood, 1941b) has recently shown that this Reduviid bug can experimentally transmit *Trypanosoma cruzi* but as yet no naturally infected *P. hirsuta* have been found.

Concerning this insect, Mrs. "T" from Boron, California, wrote Dr. Smith the following on July 6, 1939: "This neighbor was bitten two years ago and again last year by one of these insects. We have looked at them through a strong magnifying glass and notice a sort of projection in front of the mouth which I suppose it sticks in and seems to suck blood, for I have seen them full of blood like a tick. The neighbors' little girl was also bitten and in each case the effect was the same. The person bitten could see no lump or mark at first, only wake up in the night and felt sick, heart palpitating, lips swollen and in one case stomach full of lumps like hives.—For a couple of days more, the people bitten felt sick and a lump appeared where the insect had bitten or stung. These insects come in the night and especially seem to know where the bedrooms are for they stay on the ceiling then drop on the bed later." In an additional letter of August 2, 1939, she writes, "The first two years we were here we did not notice any of the Reduviid bugs, nor did we hear of anyone being bitten. There were no sheep grazing or watering here those two years. In the early spring of 1937 the sheep came, I believe that year these sheep were from Mexico. Then my neighbor was bitten by this insect and we found a number of them a short time after the sheep left, say in June and July. In 1938 and this year also we noticed the same thing, after the sheep had gone on, these bugs began to appear. It is probably only a coincidence. There are hundreds of chipmunks all over, as well as a good number of pack rats. If, as you stated, the Reduviid bugs feed on rodents it is reasonable to suppose that is where they get their meals. We seldom see one in daylight, but they have the uncanny habit of remaining on the ceiling directly over a bed, then when anyone lies on that bed the bug drops down. A young man stopped in one day when we had a live one here and said in Arizona where he came from they called those insects 'Walapai tigers.'" In a communication of July 11, 1940, Mrs.

"T." stated that "Several people have been bitten lately and made ill." Such cases as these further emphasize the importance of knowing more about these blood-sucking bugs in relation to man in the southwest.

Recently one live female *Triatoma protracta* Uhler was brought to me for identification. This specimen was taken from the bed of Mrs. "U." near Corona, California. In a letter of October 10, 1941, she writes the following: "The first attack was July 4th. An acute and complete case of hives broke out over my entire body in about an hour's time. I was bitten several times and finally caught one of the bugs in the act. This was over a period of a couple of months.—The places bitten swell very quickly and then there is a rapid spread of hives. There is a high local temperature. A great deal of discomfort is felt from the swellings, itching and burning, and actual pain is felt when they occur on the palms of the hands and on the feet. These just keep recurring indefinitely. A very bitter taste, but odorless, comes to the surface of the skin. I felt light-headed or slightly dizzy and a tightening or pressure of the region of the heart, and a weary feeling follows."

On May 31, 1941, the writer visited Mr. Fred Reynolds at Trimmer Springs, Fresno County, California. His residence was a one-story, square-shaped house consisting of a concrete wall for about the first four feet with screening all around from the top of the wall to within one foot of the roof. He reported that within the past few years he saw as many as 5 *Triatoma* (probably *protracta*) or as he called them, "kissing bugs," on the screen at night. This was the largest number he ever observed at one time. A young woman resident of the region reported being bitten by "kissing bugs" at least "once every three months."

In a recent communication from Mr. Reynolds (See also "S." Wood, 1942a), from whom the writer has received three infected bugs and four negative bugs during 1941 the reaction to the bite of *Triatoma protracta* was recorded as follows: "I am sending you a bug today that bit me twice last night. Once on the hip and once on the forearm. It poisoned me some although the bite did not swell as much as some have. I itched all over and broke out in a rash wherever there was a tenderness such as under my arms." On July 5, 1941, concerning a neighbor from whose residence the writer found one bug infected out of four received, Mr. Reynolds writes as follows: "He says that he finds them around his bed nearly every morning. He seems to be nearly immune to their poison as he often finds them full of blood but seldom feels a bite." On December 8, 1941, he wrote the following: "I missed a good chance to send you some (cone-nosed bugs) about a month ago. The woman who lives in the stone cabin—found a whole nest of them. She said there were about twenty, mostly small ones, in an old glove.—When the first cold weather came and we all had good fires quite a few came out."

On July 30, 1941, the writer fed adults of *Triatoma rubida* on Mr. and Mrs. L. L. Farnham and son, Dick Farnham, who have all been exposed to *Triatoma longipes* naturally infected with *Trypanosoma cruzi* at the Alvarado Mine in Arizona. One female *rubida* fed on Dick Farnham's left index finger and another fed on Mrs. Farnham's right fourth finger. Two female *rubida* were fed on Mr. Farnham, one on the right fifth finger and one on the arm near the right elbow. All claimed they could feel a "tickling" sensation as soon as the triatoma's proboscis made contact with the blood vessel. No local reddening or swelling at the site of the bite was experienced by Dick or Mr. Farnham. Mrs. Farnham reported that she felt a definite pricking sensation at the site of the bite followed by a burning sensation during most of the time the bug was feeding. Mrs. Farnham's finger and arm showed a slight reddening at the sight of the bite some time after the bugs ceased feeding but there was no swelling.

XENODIAGNOSIS

The writer has used clean, uninfected, and in most instances, laboratory-raised bugs to determine the presence of *Trypanosoma cruzi* in native mammals after the method of Brumpt (1914). Both Mr. Fred Reynolds and the writer have been exposed to feeding of naturally-infected cone-nosed bugs. Xenodiagnosis of Mr. Reynolds on July 24, 1941, and of the writer on July 23, 1940, was negative.

A negative xenodiagnosis was obtained for the following rodents: 3 male and 1 female *Neotoma fuscipes macrotis*, 4 male and 2 female *Peromyscus californicus insignis* and 1 male *Thomomys bottae bottae*. One female *Peromyscus californicus insignis* harboring *Trypanosoma peromysci*, on which 12 small *Triatoma protracta* nymphs were fed, was negative for *Trypanosoma cruzi*.

One male Hollister's bat, *Myotis occultus*, infected with *Trypanosoma vespertilionis* as previously reported (Wood, 1941c) gave a negative xenodiagnosis. On June 4, 1940, two female *Myotis occultus* infected with *Trypanosoma vespertilionis* were fed on by 41 small nymphs of *Triatoma protracta*. All of these bugs were negative when examined 52 days later.

The *Triatoma rubida*, as reported above, which fed on Mr. and Mrs. L. L. Farnham and Dick Farnham were all negative on the 20th day.

DISCUSSION

The occurrence of *Trypanosoma cruzi* Chagas in *Triatoma protracta* from O'Neals and Trimmer Springs extends the range of this trypanosome in insect vectors in the United States some 200 miles northward into the great interior valley of California or to approximately 37° Latitude North. Mazza and Rendon (1941) state that the northern limit of distribution for *Triatoma protracta* is 41°30' Latitude North. They also report human

cases from as far south in Argentina as 39° Latitude South but indicate that the insect vectors, *Triatoma infestans* and *Eutriatoma patagonica*, range as far as 41° and 46° Latitude South, respectively. Gasic and Bertin (1940) and Bertin (1940) report that cases of Chagas' disease and infected *Triatoma infestans* found up to the present time in Chile are all to the north of 34° Latitude South. If there are human cases at the southern end of the range of distribution of this Pan-American blood and tissue parasite of man, it might be suspected that human infections exist near the northern limits of its range, especially in areas where close contacts with man have been discovered as at Trimmer Springs, California and the Alvarado Mine, near Congress Junction, Arizona.

The writer feels that in the past too much emphasis has been placed upon the severity of man's reaction to the bite of *Triatoma*. Investigations of localities where *Triatoma* actively invades human dwellings and feeds on many people reveal the fact that most people report no reaction to the bite of the insect. It is only in the few cases of individuals who have a marked sensitivity to the salivary secretions of the insects or a marked fear of the insects that reactions to the bite have been reported (Wood, 1941c). Only very few of the people who react at all report their condition to local physicians. However, many of these same people, when questioned on the subject, recall various past experiences with the bugs. In some instances, they report that at first the bites bothered them severely but now they do not feel them although they still find the bugs in their beds. Thus, these individuals who show no reaction of any kind to the bite of *Triatoma* are probably of greater value as potential cases of Chagas' disease because they are less apt to avoid contact with the bugs than are persons who are hypersensitive to the bites.

SUMMARY

Four, and possibly five, localities are reported for *Trypanosoma cruzi* in *Triatoma protracta* from California. Of 816 cone-nosed bugs examined from California, 204 or 25 percent were infected. Reactions of man to feeding of cone-nosed bugs are recorded. Xenodiagnosis, for determining the presence of *Trypanosoma cruzi* in native mammals and man, has so far yielded negative results.

SUMARIO

Cuatro, posiblemente cinco localidades, son señaladas para el *Tripanosoma cruzi* en el *Triatoma protracta* de California. De 816 ejemplares, recojidos en California y examinados, 204 o sea un 25 por ciento, fueron encontrados infectados. Son estudiados las reacciones en el hombre a la picadura del *Triatoma*, cuando éstos han sido experimentalmente alimentados sobre ellos. El xenodiagnóstico, para determinar la presencia del *Tripanosoma cruzi* en los mamíferos de las zonas infectadas y en el hombre, han dado, hasta ahora, resultados negativos.

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TABLE 1

Insect Vectors of *Trypanosoma cruzi* collected and examined in the United States.

VECTOR	CALIFORNIA	ARIZONA	NEW MEXICO	UTAH	TEXAS	TOTAL BUGS COLLECTED	TOTAL BUGS EXAMINED FOR TRYPANOSOMES	NUMBER INFECTED	PER CENT INFECTED
<i>Triatoma protracta</i>	1050	45	111	58		1264	998	206	20.64
<i>Triatoma protracta woodi</i> ...		26	105		358	489	415	20	4.81
<i>Triatoma rubida</i>	1	1081	7		5	1094	407	4	0.98
<i>Triatoma longipes</i>		485				485	230	26	11.30
<i>Triatoma gerstaeckeri</i>					55	55	54	3	5.55
<i>Triatoma heidemanni</i>					13	13	13	0	0.00
<i>Triatoma sanguisuga</i>					10	10	10	0	0.00
<i>Triatoma indictiva</i>			3		1	4	4	0	0.00
<i>Paratriatoma hirsuta</i>	12	15				27	22	0	0.00
TOTALS	1063	1652	226	58	442	3441	2153	259	12.02

TABLE 2

United States Insect Vectors Infected with *Trypanosoma cruzi*

STATE	NUMBER COLLECTED	NUMBER EXAMINED	NUMBER INFECTED	PER CENT INFECTED
California.....	1063	816	204	25.00
Arizona.....	1652	699	28	4.00
New Mexico.....	226	208	2	0.96
Utah.....	58	51	0	0.00
Texas.....	442	379	25	6.59



A NEW SUBSPECIES OF *FOXELLA IGNOTA*
(BAKER) FROM CALIFORNIA (SIPHON-
APTERA: DOLICHOPSYLLIDAE)

By G. F. AUGUSTSON

Allan Hancock Foundation. The University of Southern California

The writer is once more in receipt of many fine ectoparasite specimens collected by J. C. Couffer of the Los Angeles County Museum. From this material appears some fleas apparently new to science which are here described and illustrated. Final determination of the host involved was made by J. C. von Bloeker, Jr.

FAMILY DOLICHOPSYLLIDAE

FOXELLA IGNOTA COUFFERI n. subsp.

Holotype Female

HEAD: Frontal notch small; maxillae acuminate; labial palpi slightly shorter than fore-coxa; genal process blunt, lightly chitinized; eye low, vestigial; preantennal region with two rows of bristles, the lower row with four of irregular length, upper row with eight bristles also of irregular length, numerous small setae mixed in between both rows; postantennal region with two bristles, one well up along the antennal groove, the other at the posterior corner of the antennal groove, many small setae along the posterior border of the antennal groove.

THORAX, ABDOMEN, AND LEGS: Pronotal ctenidium of ten slender spines on a side; metanotum with one, slender tergal tooth; first three abdominal tergites with two tergal teeth on each; three antepygidial bristles, the middle slightly longer than the outer, one-third longer than the inner; style short, abruptly terminated at apex, its length not exceeding twice its greatest width, one long terminal bristle, two dorso-lateral bristles the most distal of which is rudimentary, four ventro-lateral bristles of equal length; sternite VII very diagnostic, without a sinus, a single long, blunt to square, lower lobe; spermatheca globular, with a right-angle arm, at the end of which is a small appendix; legs as in other members of the genus.

Allotype Male

HEAD: Frontal notch, labial palpi, maxillae, eye, as in female; preantennal region with two rows of bristles as in female, more uniform, with only three bristles in upper row; postantennal region as in female (upper bristles broken in type).

THORAX, ABDOMEN, AND LEGS: Pronotum with a ctenidium of nine slender spines on a side; tergal teeth as in female; a single long, slender antepygidial bristle; modified abdominal segments very diagnostic, the finger is long, slender, of uniform width from base to apex, the process of the clasper long, acuminate, reaching to three-fourths the length of the finger; sternite VIII evidently close to *F. i. albertensis*, from which it differs in the fewer number of bristles along its ventral margin and the sharper, shorter free angle above the terminal bristles; legs as in other members of the genus.

Holotype: A ♀ collected from *Thomomys altivallis* Rhoads by J. C. Couffer near Big Bear Lake, San Bernardino County, California, July 2, 1942. Deposited in the Allan Hancock Foundation, The University of Southern California, Los Angeles, California.

Allotype: A ♂ collected and deposited as above.

Paratype: A ♀ collected and deposited as above.

Type Host: *Thomomys altivallis* Rhoads.

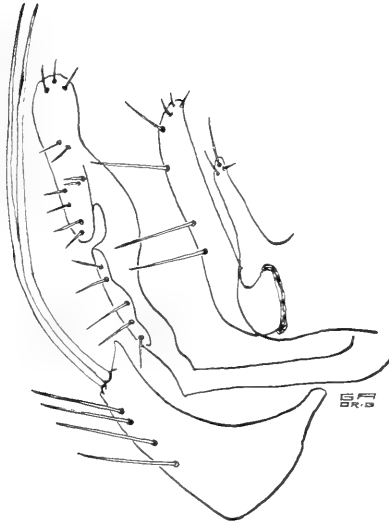
Type Locality: 2 miles east Big Bear Lake, San Bernardino Mountains, San Bernardino County, California.

Remarks: As already referred to, this subspecies is close to *F. i. albertensis* Jordan and Rothschild, 1915. However, little difficulty should be experienced in separating these two subspecies on the basis of their modified abdominal segments.

The writer takes great pleasure in naming this new subspecies in honor of J. C. Couffer, one of our most promising young Mammalogists in the Pacific Southwest.



1



2

PLATE 13

Fig. 1. *Foxella ignota coufferi* Augustson, sternite VII, spermatheca, holotype female.

Fig. 2. *Foxella ignota coufferi* Augustson, clasper, finger, sternites IX, VIII, allotype male.

A NEW CALIFORNIAN SPECIES OF *TIMEMA*
(PHASMODEA: TIMEMIDAE) WITH
ZOOGEOGRAPHICAL NOTES

By E. R. TINKHAM

Federal Aid Division, Arizona Game and Fish Commission

The discovery of a fourth and new species of *Timema* Scudder (1895) from California, and the fifth for the genus, adds new interest to this unusual and archaic insect genus. *Timema* is of considerable zoogeographical interest in that it appears to be a relict member of an almost extinct fauna that was formerly widespread throughout the region of the Southwest. The advent of the desert was probably responsible for extirpation of much of this ancient fauna and today only remnants survive in Arizona. This same fauna is much more widespread in southern California.

One of the facts substantiating this statement is *Timema* itself. Formerly known only from the western slopes of the mountains of southwestern California, a new species of *Timema* was recently described from southeastern Arizona. This was found on the summit of Mt. Wrightson (9,432 feet in height) of the Santa Rita range, some 45 miles southeast of Tucson, by Mr. Robert Flock of the Entomology Department of the University of Arizona. Mr. Morgan Hebard named this *Timema ritensis*, in 1937. Since that time Mr. Owen Bryant has taken this species at high elevations in the Santa Catalina Mountains some 60 miles north of Mt. Wrightson. Because of the antiquity of the genus there is a possibility that *T. ritensis* or new species may be found in the Pinal Mountains, the chaparral country west of Prescott or in the Hualpai Mountains, in areas typical of its environment in California and southeastern Arizona. Certain mountain ranges in southern Nevada probably contain unknown species of *Timema*. Thus in time we may expect to have a series of *Timema* species whose composite distribution will extend from southeastern Arizona to southwestern California and which will represent piers of the ancient land bridge connecting these two areas faunistically in the palaeohistory of the Southwest.

Much the same zoogeographical feature is exhibited by the small, short antennaed, narrow-faced grasshoppers belonging to the family Eumastacidae. The discovery of a new genus of Eumastacids by Dr. E. D. Ball from the mountains of southeastern Arizona and named *Eumorsea balli* by Hebard in 1937,

lends further support to the existence of this ancient fauna. *Eumorsea* is now known from the Santa Rita, Pinaleno and Huachucas Mountains, the latter being the type locality. Two other Eumastacid genera are known, *Morsea* from northwestern Arizona to southern California and *Psychomastax*, discovered on Mt. Charleston, ranging from southwestern Nevada to California. Thus we see that *Eumorsea* is probably a connecting link between the Nearctic Eumastacidae as represented by *Morsea*, *Psychomastax* and *Eumorsea* and the many other genera such as *Eumastax*, *Lethus*, *Episactus*, etc., of the Neotropical world. The discontinuous distribution represented by *Timema* and the three Nearctic Eumastacid genera are living representatives of a former ancient fauna extending from southeastern Arizona to southwestern California.

Further the discovery of a new species of *Timema* from the edge of the desert in California affords evidence as to the ability of this genus to adapt itself to changing climatic conditions. It is highly probable that additional new species of *Timema* will come to light in southern California and central Arizona as interest increases and more exhaustive insect surveys are made in these regions.

The writer wishes to thank Dr. Bohart of the Entomology Department of the University of California in Los Angeles for permission to study the types of the new species. To Dr. W. Dwight Pierce, Entomologist of the Los Angeles County Museum especial thanks are due for submitting to the writer a large collection of *Timemas* from which interesting notes on taxonomy, distribution and host plants have been made to augment our present knowledge of the genus.

Key to the Males of TIMEMA Scudder

1. Dextral cercus with an acute apex2
 Dextral cercus with a divided apex3
2. Intra-dextral process with small teeth on the outer margin with process above base narrowed to blunt apex. Sinistral cercus very broad in middle and base *boharti* n. sp.
 Intra-dextral process without teeth but with large rounded hump on the outer margin with process above base bluntly triangular. Sinistral cercus narrow at base with moderately large interno-median arcuate flange *podura* Strohecker
3. Dextral cercus with acutely bifurcate apex. Intra-dextral process more or less straight, not strongly incurved..4

- Dextral cercus with rounded bifurcate apex. Intra-dextral process angled and strongly incurved sinistral with broad truncate apex *ritensis* Hebard
4. Sinistral cercus with one large interno-median spur. Apex of intra-dextral process not squarely truncate but acute with its outer margin devoid of teeth
..... *chumash* Hebard
- Sinistral cercus with small interno-basal and subapical teeth. Apex of intra-dextral process squarely truncate and outer margin armed with a few scattered teeth *californicum* Scudder

Key to the Females

1. Penultimate tergite produced2
Penultimate tergite not produced but short and evenly rounded with slight central sinuation. Subgenital plate with apex well rounded. Size very large
..... *boharti* n. sp.
2. Distal margin feebly bilobate. Subgenital plate almost flat, broad and acutely pointed. Color greenish.....
..... *californicum* Sc.
Distal margin not feebly bilobate but convex or truncate 3
3. Distal margins rather broadly truncate. Subgenital plate strongly convex, acutely pointed with apex narrowly rounded. Coloration buffy profusely flecked and mottled with light gray and black *podura* Strohecker
Distal margin convex or narrowly rounded. Subgenital plate moderately narrow with acute apex slightly rounded. Coloration green *chumash* Hebard

The female of *T. ritensis* Hebard has not been described.

The literature and distribution of the various species is reviewed below with new notes added from the *Timema* material assembled by the Los Angeles County Museum.

TIMEMA CALIFORNICUM Scudder (Plate 14, fig. 6):

1895. *Timema californicum* Scudder. Can. Ent. 27:30 (Santa Cruz, Cal.).

1903. *Timema californicum* Caudall. Proc. U. S. Nat. Mus., 26:883, pl. 67, fig. 5, pl. 68, fig. 7 (in pt.) (♂, ♀, Santa Cruz Mts., Cal.).

1903. *Timema californica* Caudell. Ent. News, 14:316 (juv. ♀, Humboldt Co., Cal.).

1908. *Timema californicum* Redtenbacher. Insektenfam. Phasmiden, p. 88 (no additional mat.).

1913. *Timema californica* Caudell. Proc. U. S. Nat. Mus., 44:613 (no new mat.).

1920. *Timema californicum* Hebard. Ent. News 31:127, fig. 1.

1937. *Timema californicum* Hebard. Trans. Amer. Ent. Soc., 63:349 (Ross, Marin Co., Cal.).

Hebard in 1920 listed many new localities for this species.

Los Angeles County Museum material: 9 ♀, 3 ♀ nymphs, Pine Canyon, California, June 1-22, 1941 (C. Henne; on *Cercocarpus* and *Ceanothus*). The measurements for these specimens fall within the range given by Hebard as: males, body length 12.5-14.5 mms., pronotum 1.9-2.7 mms., and caudal tibiae 3.4-3.7 mms.; females, body length 17.7-20.8 mms., pronotum 2.4-3.1 mms., and caudal tibiae 4.2-6.0 mms.

Specimens in the Los Angeles County Museum collection, especially prepared to retain their natural colors are a beautiful viridian. Some specimens show a divergence towards the females of *T. chumash* by the obliteration of the feebly bilobate apex of the penultimate tergite which is supposed to characterize this species. The females of this species are further characterized from those of *chumash* by the broader head and pronotum which has the lateral margins less convergent forward. The head viewed in lateral profile is more strongly convex and raised above the level of the eye, than observed in *chumash*.

The range of this species is now known to extend from Bair's Ranch on Redwood Creek in Humboldt County southward to Monterrey and Los Angeles County. It has also been taken in the Sierra from Kings River in Fresno County and the vicinity of Lake Tahoe. *Ceanothus* and Mountain Mahogany *Cercocarpus* and fir trees are the known hosts of this species.

TIMEMA CHUMASH Hebard (Plate 14, fig. 4):

1903. *Timema californica* Caudell, (in pt. not of Scudder 1895). Proc. U. S. Nat. Mus., 26: 883, pl. 58, fig. 7a (♂, ♀ Los Angeles Co.).

1920. *Timema chumash* Hebard. Ent. News, 31: 130131, fig. 2 (♂, ♀ Los Angeles Co., Cal.).

1937. *Timema chumash* Hebard. Trans. Amer. Ent. Soc., 63: 349 (San Jacinto Mts.).

Los Angeles County Museum Material: 5 ♀, Bouquet Canyon, Los Angeles Co., June 12, 1938 (L. M. Martin). 2 ♂ nymphs, 4 ♀ nymphs, Cloudburst, Los Angeles Co., Aug. 7, 1941 (C. Henne; *Quercus dumosa*). 1 ♀, Baldy Mesa, Cajon Pass, San Bernardino Co., June 13, 1937 (J. A. Comstock).

One of the females from Bouquet Canyon has a slight emargination in the penultimate tergite and is practically indistinguishable from females of *T. californicum* although the head and pronotum in this species is narrower and the head above the eyes shallower. In the male nymph a semitransparent integumentous fold encloses the dextral cercus and the intradextral process and also a similar fold covers the sinistral cercus. By careful examination of the underlying structure, the species of the male nymph, if not too small, can be determined.

Hebard gives the following measurements for this species: males, body length 13.5-14.0 mms., pronotum 2.4-2.4 x 3.0-3.7 mms., caudal tibiae 4.0-4.3 mms.; females, length 20.0-21.0, pronotum 2.7-3.0 x 3.9-4.0 mms., caudal tibiae 4.8 mms.

T. chumash is known from the mountain systems of Los Angeles County east to the edge of desert at Palm Springs and northeast to Cajon Pass.

Quercus dumosa appears to be the only known host plant.

TIMEMA PODURA Strohecker (Plate 14, fig. 3):

1936. *Timema podura* Strohecker. Ent. News, 267, fig. 1 and 2.

Los Angeles County Museum material: 1 ♂, 1 ♀, 1 ♀ nymph, Keen Camp, San Jacinto Mts., California, May 17-June 12, 1939 (J. G. Shanafelt; on *Ceanothus*.) 1 ♂, Los Angeles Co., (J. A. Comstock). 3 ♀, Pine Canyon, Los Angeles Co., June 22, 1941 (C. Henne; on *Cercocarpus*). 1 ♂ nymph, 3 ♀, 3 ♀ nymphs, Pine Cove, San Jacinto Mts., California, May 23, 1939 (J. G. Shanafelt).

The general coloration of the females is buffish, profusely flecked with pale gray and heavily mottled with irregular black streaks and markings. The male is more yellowish with the dorso-lateral abdominal stripe and the thoracic markings black suffused with lighter flecking over the entire body surface.

Measurements for this species are as follows: males, body length 13-14 mms., pronotum 2.0-2.1 x 2.7-2.9 mms., caudal tibiae 3.4-4.0 mms.; females, body length 18.4-22.0 mms., pronotum 2.5-2.9 x 3.2-3.9 mms., caudal tibiae 3.4-4.0 mms.

Formerly known only from the Sequoia National Park and the Greenhorn Mountains the new records reported above extend the range of *T. podura* south through the southern Sierra Nevada to the San Jacinto mountains.

The new records also provide us with the first information on the host plant of this species. These are *Ceanothus* or Buck Brush and *Cercocarpus*, the Mountain Mahogany, two common shrubs of the Californian mountains.

TIMEMA RITENSIS Hebard (Plate 14, fig. 2) :

1937. *Timema ritensis* Hebard. Trans. Amer. Ent. Soc., 63:349, Pl. 21, fig. 1 (summit Mt. Wrightson, Santa Rita Mts.).

The discovery of *Timema* in southeastern Arizona came as a distinct surprise. This interesting species, known as yet only in the male sex, was found on the narrow rocky summit of Mt. Wrightson of the Santa Rita Mountains at an elevation of 9,432 feet. Mr. Robert Flock of the Entomology Department of the University of Arizona found it on the steps of the lookout cabin. Since its discovery Mr. Owen Bryant of Tucson has collected several specimens from high elevations near Mt. Lemmon in the Santa Catalina Mountains north of Tucson. Size of male type: body length 12.7 mms., pronotum 2.0-3.7 mms. in width, caudal tibiae 4 mms. The host plant of this species is not known.

TIMEMA BOHARTI n. sp. (Plate 14, figs. 1 and 5) :

A large species showing closest relationship to *T. podura* Strohecker and distinguished in the male sex by its very large size and striped grey coloration. The male genitalia is quite distinct from all the other species. Left or sinistral cercus very broad in the middle; right or dextral cercus arcuate with acutely pointed apex somewhat similar to that in *podura* but quite distinct from the bifurcate apices of *californicum* Scudder and *chumash* Hebard and the bilobate apex of *ritensis* Hebard. The intra-dextral process is quite distinct from the four known species. The female is distinguished by its very large size and grey striated appearance, and the short convexly rounded penultimate tergite of the abdomen with a slight central sinuation in its posterior margin.

Holotype: ♂, Borrego Desert, March 23, 1941 (James Oetzel; collected in grass). Measurements: body length 17.0; pronotum 2.2 x 3.5 broad; caudal femur 3.8; caudal tibiae 4.0 mms. Male taken "in copulo" with female type. Holotype deposited in the collection of the Entomology Department of the University of California in Los Angeles.

Description: Form normal, head broad and flat with small, circular, faceted, weakly globular eyes. Antennae placed well in front of the eyes, the basal segment large. Internal margin of the antennal sockets strongly and smoothly keeled running posteriorad to near the internal margin of the eyes. Pronotum about one and one-fourth times as broad as long; greatest breadth at the posterior angles; sides straight. Mesonotum narrower than the pronotum with gently convex sides. Metanotum with lateral margins strongly convex; wing scars evident on the meso- and metanota. Abdomen narrowing apically, considerably narrower than the nota.

Genitalia: Sinistral cercus broadest in the middle and apically well rounded; internal margin with large medio-internal flange with apex well rounded and bearing ventrally a rounded ridge. A small internal basal swelling on the dorsal surface indicates the remains of a tooth. Dextral cercus arcuate with broad, acutely terminated apex and with a medio-dorsal ridge. Internal process of dextral cercus flat and broad, internal margin concave, outer margin convex in basal half with 3 or 4 small prominent teeth in the apical half. Apex blunt with deflexed rounded process. Supra-anal plate minutely triangular and located near the base of the left cercus. Subgenital plate with apical margin strongly convex. Ventral keels of all femora smooth; ventral keels of all tibiae unspined but hairy; limbs heavy for the genus.

Coloration: Dorsum of body glossy and smooth, pale grey with fine striations of dark grey running longitudinally of the body. Ventral surface pale grey with paired grey stripes laterally on each segment. Legs pale grey with heavy black marks apically and basally on the caudal femora and caudal tibiae respectively and scattered dots on the dorsum of the caudal tibiae. Antennae pale brownish.

Allotype: Same data as holotype and taken "in copulo" with it.

Measurements: Body length 29.0, pronotum 3.0 x 4.2 broad, caudal femur 4.0, caudal tibiae 4.5, antennae 14 mms. Allotype deposited with the holotype.

Description: Paler and duller than the holotype, striated with purplish grey in pattern similar to that of the male type. Antennae more speckled than in the type with 22 segments beyond the long basal segment; segments 3 to 9 small and segments 10 to 22 elongate. Ventral surface pale pinkish grey with sparse speckling of grey. Sternites with pit-like depressions between the middle and hind legs. Aside from its much larger size the female is closely similar to the male.

Genitalia: Supra-anal plate with a slight central sinuation on the posterior margin; antepenultimate segment with posterior margin truncate. Subgenital plate with lateral margins parallel in the basal half, then strongly converging to a well rounded apex. Cerci very large and broad with the internal dorsal and ventral margins minutely serrate. Valvulae strongly recurved in the apical portion, acuminate pointed and hidden under the subgenital plate.

This species is named in honor of Dr. Bohart of the Department of Entomology of the University of California in Los Angeles who has most kindly permitted the author to study and describe this new form.

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Strohecker

1936. The genus *Timema* Scudder, with the Description of a New Species (Orthoptera, Phasmidae, Timeminae). Ent. News. 47: 126-132, figs. 1 & 2.

EXPLANATION OF PLATE 14

See page 80.

(All figures greatly enlarged)

1. *Timema boharti* n. sp. Male Holotype. Borrego Desert, California. Dorsal view of male genitalia.
2. *Timema ritensis* Hebard. Male. Type. Old Baldy (Mt. Wrightson), Santa Rita Mts., Arizona. Dorsal view of distal portions of abdomen and its appendages (enlarged and redrawn after Hebard).
3. *Timema podura* Strohecker. Male. Type. Sequoia National Park, California. Dorsal view of male genitalia enlarged and redrawn after Strohecker.
4. *Timema chumash* Hebard. Male. Type. Los Angeles County, California. Dorsal view of male genitalia enlarged and redrawn after Hebard.
5. *Timema boharti* n. sp. Female. Allotype. Borrego Desert, California. Lateral view of apex of abdomen and terminal organs.
6. *Timema californicum* Scudder. Male. Type. Santa Cruz, California. Dorsal view of male genitalia, enlarged and redrawn after Hebard.

THE PRESERVATION OF COLOR IN SOFT ORTHOPTERA

By W. DWIGHT PIERCE

In the foregoing article on *Timema*, Mr. Tinkham refers to the preservation of the green color in *Timema californicum*.

When this beautiful green species is killed and dried normally it shrivels up and the green is largely lost. The insects are very soft, and one desires to keep not only the full form but also the color.

When they are killed in cyanide and then placed in alcohol, it only takes a few hours to completely remove all of the green. If placed in 70% alcohol for one hour, 95% alcohol one hour, and xylol 24 hours; or placed in xylol only for 24 hours, we retain not only form but color. For this reason it is now our policy to use this method for all green soft bodied insects.

For *Stenopelmatus* with no perishable colors, we run the specimens through the three solutions for 24 hours each and then pin.

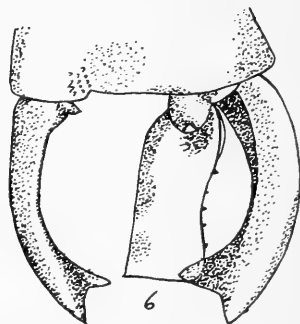
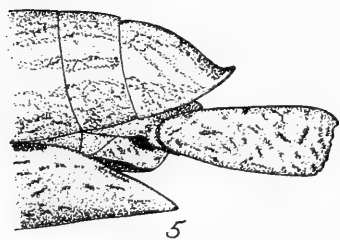
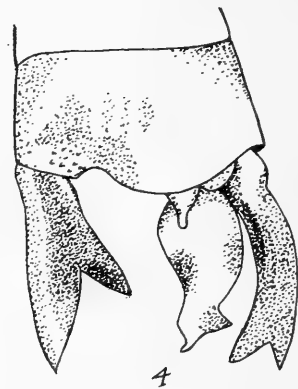
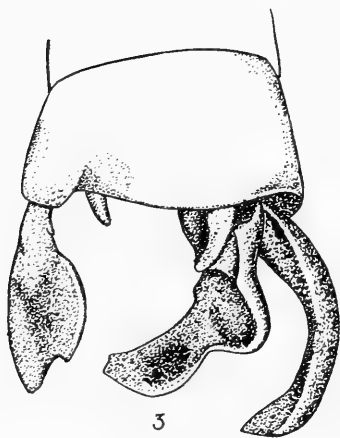
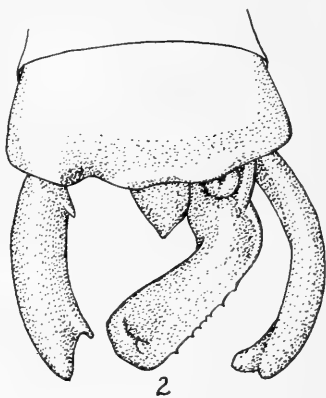
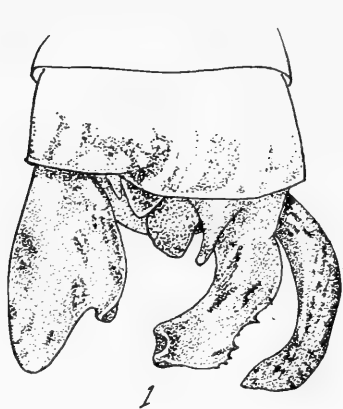


PLATE 14

CONTRIBUTIONS FROM THE LOS ANGELES MUSEUM
- CHANNEL ISLANDS BIOLOGICAL SURVEY

No. 25. A NEW PHALAENID MOTH FROM THE
CHANNEL ISLANDS

By DON MEADOWS

During the second expedition of the Los Angeles County Museum - Channel Islands Biological Survey on San Clemente Island, April 1-8, 1939, specimens of a Noctuid moth were collected which were recognized as being closely related to *Zosteropoda hirtipes* Grote. Study of the specimens and the preparation of genitalia slides indicate that the species is new, and it is so described.

ZOSTEROPODA CLEMENTEI spec. nov.

The species conforms with the description of the genus set up by Grote (Bull. Buff. Soc. Nat. Sci., II, 67, 1874) in all respects but one; the genus *Zosteropoda* is described as having fringes of longer scales along the internal, median, and sub-costal veins on the upper surfaces of the secondary wings. This characteristic is absent or only faintly evident in *clementei*, a fact of only relative importance, however, since examination of a long series of *Z. hirtipes* shows that this character is not constant even in the genotypic species. Grote's description was made from a single male collected in California by Henry Edwards. A study of the genitalia of both species shows their close relationship.

Primary wings, upper surface: Variable in color from light straw yellow to ochrous yellow. Transverse posterior line a faint amber line beginning on costa three-quarters of the distance from the base of the wing and extending obliquely outward to R5, thence downward to C1, then obliquely inward to lower margin about three-fifths of the distance from base. The line forms a series of distinct brown dots as it crosses each vein. In some specimens only the dots are visible. The transverse anterior line is a more or less distinct crescent of brownish dots bending outward. The reniform is a sagittate cloud of brown pointing inward. From the reniform to the transverse posterior line, between M1 and M2, the wing is shaded with the same color as the reniform. The terminal band is a series of brownish dots between each vein. In some specimens the pat-

tern is clear and well defined, in others only a few faint specks mark the transverse lines. Under surface: Concolorous, somewhat lighter in shade than superior surface. Reniform a small dusky spot. Veins are distinct.

Secondaries. Upper surface straw yellow to greyish white, always distinctly lighter in shade than primaries. Larger scales on anal veins slightly darker than rest of wing. Lower surface same color as superior surface, sometimes with a light brown discal spot.

Collar, umber brown to deep yellow, darker in color than primaries.

Thorax and Abdomen, concolorous with primaries. Scales on thorax long and silky.

Expanse, 30-32 mm.

Type Locality: Chinetti Cabin, Pyramid Cove, San Clemente Island, California, April 4-5, 1939.

Holotype, male, April 4, 1939.

Allotype, female, April 5, 1939.

Holotype, allotype, paratypes 1 to 14 and 23 to 60, in collection Los Angeles County Museum. Paratypes 15 to 22 in author's collection.

One hundred and four specimens of *Z. clementei* were collected at light in a small canyon a hundred yards east of the old Chinetti cabin, San Clemente Island by Mr. Lloyd Martin and the author. Although lights were in operation every night during the expedition the new species was taken on two evenings only. Rain, heavy winds or moonlight put a stop to insect flight soon after sundown.

During November and December, 1939, the Fifth Expedition of the Survey was on San Clemente Island. A base was established at Horse Cove, two miles west of the Chinetti Cabin. Between November 10 and December 5 seven more specimens of *clementei* were collected at Horse Cove by Mr. George Willett and Mr. Jack von Bloeker. The fall specimens show no variation from the spring specimens.

On Santa Catalina Island *Z. hirtipes* is double brooded, appearing in March and April and October to December. *Z. clementei* probably follows the same cycle. *Z. hirtipes* is common on Santa Catalina, but has not been taken on San Clemente Island.

No. 26. A NEW RACE OF *ARACHNIS PICTA* FROM
SANTA CATALINA ISLAND

By JOHN A. COMSTOCK

In our series of *Arachnis* from the Channel Islands of southern California we noted, some time ago, two examples from Santa Catalina Island that had certain features differentiating them from mainland forms. At the time our material was too scanty to venture any final conclusions.

When J. F. Gates Clarke was preparing his paper on the genus¹ we sent him most of this island material. He segregated those from Anacapa Island as a distinct race under the name *insularis* and very kindly consented to publish his description in our series of Island papers.²

Mr. Clarke commented at the time on the distinctness of the Catalina Island race and generously suggested that if later additional material became available I should publish it.

Subsequent collecting on Santa Catalina Island turned up a few larvae, which were bred to maturity by Christopher Henne, which now makes possible the fulfillment of Mr. Clarke's suggestion.

The first examples of this race to be brought to our attention were collected by Prof. Don Meadows, and donated to the Los Angeles County Museum collection. It is altogether fitting therefore to designate this race:

Arachnis picta MEADOWSI new subspecies.

Similar to *Arachnis picta insularis*, but showing a much greater preponderance of the gray scaling on the upper side of the forewing, and a consequent reduction of the white areas. The outer half of the wing (except in the costal and apical area) is nearly a solid light uniform gray except for an occasional broken wavy narrow white line. It is therefore much less contrastingly banded than any other race of *picta*.

On all examples there is a small white triangle near the outer end of the lower median nervule.

There is almost no trace of the black edging of the gray bands which are so markedly a feature of typical *picta*.

On the secondaries, the broad gray bands edged with darker gray are wider than the pink bands, much as they are in *insularis*.

¹ Proc. Nat'l. Mus. 91: 3123, 59 - 73, 1941.

² Bull. So. Calif. Acad. Sciences, 39: 3, p. 187, 1940.

On the thorax a narrow soiled gray median longitudinal stripe is almost obscured by the wide gray bands on each side of it. These latter are narrowly margined with black. This narrow margining is much more contracted than is the case with any other species or subspecies of *Arachnis*.

The patagium is gray, narrowly margined with black. The area under the patagium is white. Collar lappets, gray, narrowly edged with black, margined anteriorly and laterally with white, and posteriorly with orange.

In all other respects this race closely approximates *A. picta insularis*.

The differentiating features are clearly brought out in the accompanying cut (Plate 15) in which are shown the holotype and allotype of *meadowsi*, and two paratypes of *insularis*.

Described from forty males and nine females, as follows:

Holotype ♂, Santa Catalina Island, Cal., emerged October 4, 1941, collected by C. Henne.

Allotype ♀, Santa Catalina Island, Cal., emerged April 20, 1941, collected by C. Henne.

Paratype No. 1, ♂, Santa Catalina Island, Cal., emerged July 12, 1941, collected by C. Henne.

Paratype No. 2, ♂, Avalon, Santa Catalina Island, Cal., October 2, 1931, collected by Don Meadows.

Paratype No. 3, ♂, Avalon, Santa Catalina Island, October 4, 1932, collected by Don Meadows.

Paratype No. 4, ♀, Santa Catalina Island, Cal., emerged July 8, 1941, collected by C. Henne.

Paratype No. 5, ♀, Santa Catalina Island, Cal., emerged October 16, 1941, collected by C. Henne.

Paratype No. 6, ♀, Santa Catalina Island, Cal., emerged July 31, 1941, collected by C. Henne.

Paratype Nos. 7 to 52, all collected at Avalon, Santa Catalina Island, various dates, by Don Meadows.

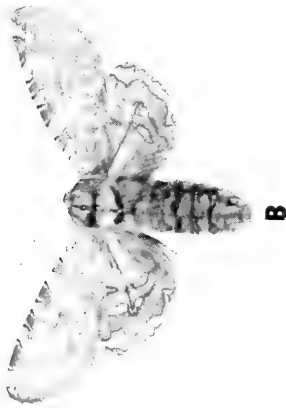
Holotype, allotype and several paratypes in the collection of the Los Angeles County Museum. Paratypes will be deposited in the National Museum, Washington, the Canadian National Museum, Ottawa, and the collection of Don Meadows, Long Beach, Calif.

All of our reared specimens of *A. picta meadowsi* were raised to maturity on *Plantago*.

Arachnis picta insularis Clarke has thus far been recorded from Santa Rosa Island and Santa Cruz Island, in addition to the type locality, Anacapa Island.



A



B



C



D

PLATE 15

- A. *Arachnis picta meadoursi* Comst., holotype ♂. Alar expanse 38 mm.
B. *Arachnis picta meadoursi* Comst., allotype ♀.
C. *Arachnis picta insularis* Clarke, paratype ♀.
D. *Arachnis picta insularis* Clarke, paratype ♂.

All figures slightly enlarged.

NOTES ON THE LIFE HISTORY OF TOLYPE GLENWOODII BARNES

By JOHN A. COMSTOCK and CHRISTOPHER HENNE

Tolyte glenwoodii was first described by Dr. Barnes in the Canadian Entomologist, vol. 32, p. 47, 1900 from examples collected at Glenwood Springs, Colorado.

We were at first inclined to think our southern California specimens were *Tolyte lowriei* B. & McD. in view of the fact that the type locality of the latter is the Santa Cruz Mts., Calif. To make certain, examples were submitted to the National Museum. Mr. Carl Heinrich very kindly compared them with types in the Barnes collection and determined them as *glenwoodii*.

Larvae were secured by the junior author from *Cercocarpus betuloides* (by beating). They were taken on June 6, 1941, in Pine Canyon, Lake Hughes area, Los Angeles County, and were raised to maturity in the laboratory. Eggs were laid by an infertile female.

Egg: Oval, jet black. Length, 1.55 mm. Width, 1.25 mm.

The surface is covered by a network of low reticulated walls, enclosing irregular cells, the floors of which are flat. They are laid on the foodplant in small clusters, four or five to a group, and are much obscured by a covering of long white hair-like scales, derived from the caudal end of the abdomen of the female. These hairs are adherent to the egg surface, and are removed with difficulty. Plate 16 shows a single egg with its covering of hairs partly removed, and Plate 17 illustrates an egg group with the hairs intact.



PLATE 16

Egg of *Tolyte glenwoodii*
enlarged approxim. x 20.

Photo courtesy Los Angeles County Museum.



PLATE 17

Egg mass of *Tolyte glenwoodii*
on bud of *Cercocarpus*.
Slightly enlarged.

Photo courtesy Los Angeles County Museum.

MATURE LARVA: Average length 45 mm. Width at 2nd and 3rd segments, 10 mm.

The body is sub-cylindrical, the ventral surface being flat. It is thickest through the thoracic area, and tapers gradually to a comparatively narrow and flat cauda. Body color, predominantly a dark mouse-gray, with an admixture of fine wavy black, tan and light gray lines on dorsal and lateral surfaces. The latter are discernible only with a lens. In the mid-dorsal area the light gray lines predominate; wherever present, these light gray lines give the appearance of fine tangled pile.

Two rows of dual tubercles occur sub-dorsally, a pair to each segment. The largest is semi-translucent, buff and shiny. This is topped by five short glistening black hairs, set in a tuft.

The smaller adjoining tubercle is placed inferiorly to the larger one, and is of a burnt orange shade. It does not contain hairs, but is off-centered with black. Elongated tubercles occur in the vicinity of the infrastigmatal fold. These are striated with black, and each carries a tangle of long fine gray silky hair. The tip of each tubercle is light gray, unmarked, and bears a tuft of long stiff glistening black hairs. There are two of these tubercles to each segment (one on each side). The dorsal area is sparsely covered with black pile, which carries over to the lateral surface, gradually becoming thicker and lighter in color until it appears nearly white on the lower part of the lateral area.

The infrastigmatal fold contains a few black shadings.



A. PLATE 18 B.

Mature larva of *Tolyte glenwoodii* enlarged approx. x 2.
A. Dorsal aspect. B. Lateral aspect.

Photo courtesy Los Angeles County Museum.

A conspicuous mark occurs dorsally on the third thoracic segment, placed transversely. This consists of three sub-ovate white spots with a narrow black transverse bar placed anteriorly to them. This bar is adjacent to a pair of tubercles which are larger than those that occur dorsally on the other segments. These are penciled with black. The tubercles on the first thoracic segment, and the edge of the segment bear long gray hairs which arch anteriorly over the head, and the cauda contains similar hairs arching posteriorly.

The tubercles on the caudal segments are grey rather than burnt orange.

At the base of the four prolegs on the ventral surface there are four dark bluish-slate sub-quadrangle spots. The remainder of the ventral surface shades from a grayish salmon to a pink-salmon. The bases of the prolegs shade from salmon to gray. The prolegs are fringed outwardly with fine gray hair, and the crochets are tan, bordered with grayish-white. True legs, glistening orange-tan.



PLATE 19

Cocoon of *Tolyte glenwoodii* on branch
of *Cercocarpus betuloides*.

Spiracles, light orange-tan.

Head narrower than first thoracic segment; concolorous with body. Mandibles, glistening orange-tan.

The larva is illustrated in dorsal and lateral aspect on Plate 18.

The larva of *Tolyte glenwoodii* is a nocturnal feeder, resting in the day time flat against a small branch of the foodplant. It resembles very closely the color and mottling of the bark, and is an excellent example of protective coloration.

COCOON: This is spun on a small branch of the foodplant, the base being carried around the twig. Its color and texture exactly resembles the branch, and gives the appearance of a spindle shaped gall. The accompanying illustration (Plate 19) clearly demonstrates these features. Dr. Fitch, in his Second Report² has penned an interesting description of the cocoon of *T. laricis* which could very well substitute for the one we are here considering.

² Second Rep. Ins. N. Y. p. 265, 1856.

With reference to the ovum, Prof. French states³ that the egg of *Tolyte velleda* is chestnut brown; and Blackmore⁴ records the egg of *T. dayi* as being dark olive green. As we have previously stated, the egg of *T. glenwoodii* is jet black.

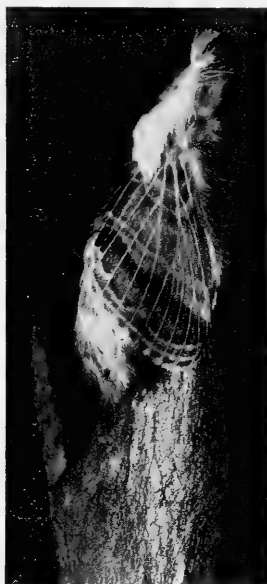


PLATE 20

Tolyte glenwoodii in characteristic
pose, resting above cocoon.

Photo courtesy Los Angeles County Museum.

³ Can. Ent. 22; 255; 1890.

⁴ Can. Ent. 52; 267; 1920.

NOTES ON THE METAMORPHOSES OF TWO CALIFORNIA MOTHS

By JOHN A. COMSTOCK and CHARLES M. DAMMERS

Aseptis binotata f. *curvata* Grt.

This subspecies was described by Grote¹ from specimens taken in Mendocino County, Calif. We have examples showing a distribution from the northern boundary to San Diego. All of these are distinguished by the reduction in size and the narrowing of the light ochreous spot lateral to the reniform, which serves to differentiate the form from typical *binotata*, as already pointed out by Dyar.² The typical insect is the larger form occurring on Vancouver Island, in which the ochreous spot is well developed and oval.

Dyar² has described the egg and mature larva. Our notes can add a few details, and include illustrations not heretofore available.

Several larvae were collected in Devil's Canyon, San Bernardino Mts., San Bernardino County, Calif., on April 15, 1931, feeding on *Ribes*. An additional specimen was collected by the senior author on oak, and raised to maturity.

Mature larva: Length, 25 mm. Body cylindrical, thickest from the 6th to 8th segments, tapering gradually towards head and cauda. Ground color, vivid green, sparingly speckled with white dots and broken crenulated lines. A mid-dorsal white line runs the length of the body. This is margined with a darker green. There is a distinct sub-stigmatal light yellow line, bisected in the center by a narrow red line, the latter interrupted at each segmental juncture. Dyar speaks of this red line as edging the yellow line superiorly, but our examples show it to be centered in the yellow line.

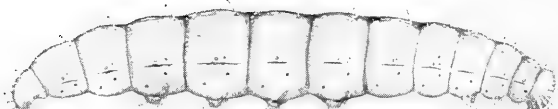
The segmental junctures are shaded with yellow. Abdominal surface concolorous with the remainder of body. Spiracles, yellow, with narrow black margins. Legs, translucent green. Prolegs and anal prolegs, green. Crochets pink. Setae, white, each one arising from a black puncta, and disposed as shown in Plate 21, fig. B.

¹ Bull. Buffalo Soc. Nat. Sci. 2: 157, 1874.

² Proc. U. S. Nat'l. Mus. 27: 810, 1904.



A



B



C

PLATE 21

Larva and pupa of *Aseptis binotata curvata*.

A. Two typical segments in dorsal aspect.

B. Mature larva, lateral aspect.

C. Pupa, lateral aspect.

Enlarged approx. x 3.

Reproduced from painting by Charles M. Dammers.

Head, vivid green, with indistinct white blotches on the upper half of cheeks; sparingly covered with white setae.

Pupation takes place on the foodplant in a light silken cocoon formed by drawing the leaves together.

Pupa: Length, 16 mm. Color, uniform mauve-brown.

Fusiform, the anterior half stout; posterior half tapering evenly and gradually to cauda. Head, rounded. Eyes not prominent. Spiracles, small and darker in color than the body. Surface, smooth.

The pupa is illustrated on Plate 21, fig. C.

Emergence of the moths occurred late in May, 1931. Examples taken at light in July and August, throughout various portions of the state, may indicate a second brood.

ALYPIA RIDINGSI Grt.

Two examples of the larvae of this species were collected by Mr. M. L. Walton in Mason Valley, San Diego County on April 30, 1933, feeding on *Oenothera bistorta* Nutt. These failed to pupate, but in May, 1938 and in May, 1939 Mr. J. Haney col-

lected several larvae in all instars on Box Springs Grade, Riverside County, feeding on the seed pods of *Eulobus californicus* Nutt. These were reared on a garden variety of Evening Primrose.

Subsequently many ova and larvae were collected by the senior author in the Lovejoy Buttes of the Mohave Desert, Los Angeles County, and several examples were carried through to the pupal stage. These were all taken on *Oenothera dentata* v. *Lembert*¹ recorded *Clarkia rhomboidea* Dougl. as the foodplant.

EGG: Subspherical, flattened at the base. There are some 36 to 40 vertical raised ridges, running from the base toward the micropyle, many of which pinch out in the upper quarter of the egg. These ridges are "crinkly" along their sides, but they do not form definite cross ridges.

Micropyle, minute, not depressed.

The egg is yellow-orange, with a number of round brown spots scattered over the surface. It is about two-thirds as tall as it is broad. We failed to record the measurements.

LARVA: First instar. Length, 1.25 mm. Head case, .32 to .34 mm. wide

Body color, uniform yellow, with a large number of dark spots, symmetrically placed, each one of which bears a black seta. A small dark scutellum occurs on the first thoracic seg-

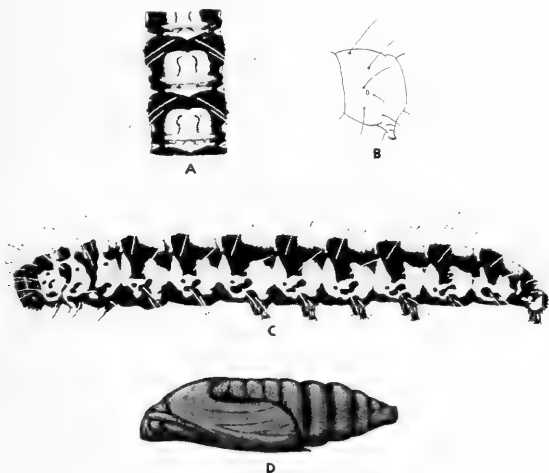


PLATE 22

Larva and pupa of *Alypia ridingsi*.

- A. Dorsal view of typical segments.
- B. Typical segment, lateral view, showing arrangement of setae.
- C. Mature larva, lateral aspect.
- D. Pupa, lateral aspect.

Enlarged approx. x 2.

Reproduced from painting by Charles M. Dammers.

¹ Entom. News, 4, 303, 1893.

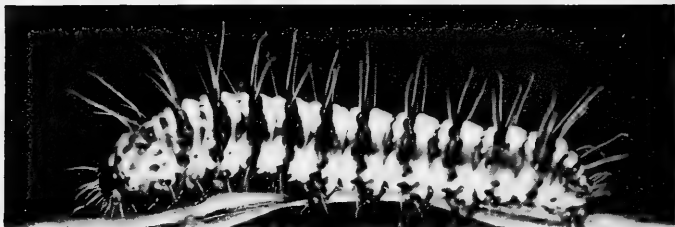


PLATE 23

Mature larva of *Alypia ridingsi*.

Enlarged x 2.

Photo courtesy Los Angeles County Museum.

ment. Head, strongly bilobed, jet black. Ocelli, translucent, colorless. Length of instar, five to six days.

Second instar. Length, 5 mm. Head case, .45 to .51 mm. wide.

The upper half of the larva is reddish brown except for the white circlets at the base of each papillus. In the stigmatal area there is a broad longitudinal white line. The abdomen is yellow-brown. Legs, black. Prolegs and anal proleg mottled white and red-brown on the proximal segment, black on the two distal segments.

On the second and third segments in the mid-dorsal line are two raised black papillae (one to a segment) bearing black setae.

The bases of these papillae are surrounded by white circlets.

Similar papillae are developed in a longitudinal row each side of the median line. A third row is present lateral to the last, a fourth row in line with the stigmata, and a fifth row sub-stigmatally.

Head mottled brownish black and yellow, clothed sparingly with short black setae.

Length of instar, three days. The larva consumes the entire skin after ecdysis.

Third instar. Length, prior to moulting, 7 mm. Head case, .60 to .74 mm.

The larva is similar in appearance to the second instar except that the upper half of the body is a dark chocolate-brown, the wide stigmatal white line is tinged with yellow, the setae are white, and the legs, prolegs and anal proleg black.

Length of instar, three to four days.

Fourth instar. Head case, 1. to 1.16 wide.

On each side of the mid dorsal area of the body there is a row of large black papilliform tubercles, each bearing a long

white seta. Around the base of each papillus there is an area of chalky white giving the appearance of a wide mid-dorsal longitudinal band. Lateral to this there is a broad longitudinal band of dark reddish brown spotted irregularly and sparingly with white. On this band are two rows (longitudinally placed) of black papillae bearing long white setae. Inferior to this there is a wide yellow stigmatal band carrying two more rows of white setae on black papillae. Inferior to this is another dark reddish brown area with two rows of setae and papillae of the same character as those above. Abdomen, predominantly reddish brown. Spiracles, black. Legs, black. Prolegs, glistening black on proximal two-thirds and white on distal third. Crochets, black.

Head, mottled blackish brown and yellow, clothed with long white setae.

From this instar on the rate of growth of the several larvae varied to such a degree that it was impossible to record the number of days represented in each instar.

Fifth instar. The colors and markings in this instar are practically the same as for the sixth. Head case, 1.76 wide.

Sixth instar. Length, 32 mm. Head case not measured.

Body, smooth and cylindrical, tapering slightly at both ends.

Ground color, mauve-black, shading off to a mauve-brown at the segmental junctures. Mid-dorsally in relation to each segmental juncture there is an irregularly shaped large silver-white quadrant, with two narrow mauve-brown bands on it.

In the stigmatal area there is an irregular broad white longitudinal band, bearing black spots. This band develops upward extensions on each side of the segmental junctures, and these extensions are blotched with yellow. Mid-dorsally on the first segment there is an orange bar.

Abdomen, light mauve-brown, in some examples nearly white with brown spots. Legs, black. Prolegs, mauve brown, with black ends. Crochets, brown. Spiracles, black.

A number of moderately long white setae are scattered over the body. These all arise from black papillae, all of which are located only on the black bands and spots. The arrangement of these setae on the typical segment is illustrated on Plate 22, fig. B.

Head, predominantly black, but with a subquadrate yellow spot in the center of the clypeus, and a pair of sub-triangular small yellow spots above it. There is a third small yellow spot below and back of the ocelli. Labrum, light yellow. Base of antennae, light yellow, the distal segments black. Ocelli, black. A few short white setae are scattered over the head. The mature larva is illustrated on Plates 22 and 23.

When the period of pupation was reached our larvae became very restless and moved about for several days. They made no effort to pupate in the soil, or in debris that was furnished them. The junior author finally supplied pieces of reed into which they immediately burrowed. The senior author furnished sections of yucca and cork with equal success. A pupal chamber is cut, and the cavity completely covered with chewed fragments. Pupation occurred in late May.

PUPA. Length, ♂, 21 mm. Greatest width, 6 mm. Fusiform, the head and cauda somewhat squared. Color, a uniform pale chestnut. The abdominal segments are highly rugose along their central portions, and many of the raised processes terminate in low points. The intersegmental junctures of those segments which are movable are smooth. The surfaces of the thorax and wing cases are finely granular in texture. Plate 22, fig. D, and Plate 24 give the shape and structural characters of the pupa and obviate the necessity of further description. It will be noted that the cremaster is flat and shield-shaped, much as is that of *Euthisanotia brevipennis*, which is another species that burrows into reeds before pupation.

One of our examples emerged June 8. The species is on the wing from late March to early May, and is apparently single brooded.

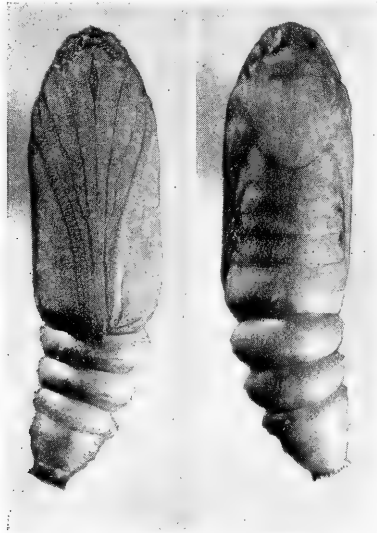


PLATE 24

Pupa of *Alypia ridingsi*
Ventral and dorsal aspects.
Enlarged approx. x 2½.

Photo courtesy Los Angeles County Museum.

LIFE HISTORY DATA ON HELMINTHOGLYPTA TUDICULATA (BINNEY)

By WILLIAM MARCUS INGRAM and HELEN M. ADOLPH
Mills College, California

The observations included here are based on two adult *Helminthoglypta tudiculata* (Binney) collected August 27, 1941, at Newport Beach, California. These were found aestivating with three others of the same species beneath water carried debris, which consisted of branches and dead grasses, fifty yards from the shore of the upper "lake" of Balboa Bay.

The two mollusks were transported to the Mills College zoological laboratory. They were placed in an aestivation chamber until November 24, 1941; on this date they were removed to a terrarium. The terrarium floor was covered with loam soil which was kept moist throughout the observation period. The terrarium was maintained at room temperature (68°F - 74°F) in a semi-dark corner of the laboratory. The snails were fed on lettuce.

From November 24, 1941, to March 20, 1942, data were collected on copulation behavior, egg laying activity, eggs, hatching, and young. It is believed that the information on these phases of the life cycle of this snail are the first to be reported in the literature.

COPULATION BEHAVIOR

The snails were recorded copulating on three different occasions; it is quite possible that unobserved copulation occurred for it was impossible to observe the snails over continual twenty-four hour periods.

The first observed copulation took place on November 29, 1941, five days after they had emerged from aestivation. The two snails approached each other "head on"; each had its atrial sac everted before contact was made. The elongate everted atrial sac displaced the head to the left. On contact each individual thrust its atrial sac into the vagina of the other with the first attempt. The copulation continued for one hour and twenty-two minutes. During copulation the snails were observed filing at each other's heads with their radulae. It is not unlikely that

sexual stimulation is accomplished by this means, for Pilsbry (1939) states, "The darts do not seem to be detached during mating. In the large number of *Helminthoglyptidae* I have dissected I have never found them loose in the tissues." After the two snails separated the atrial sac of each remained extended to its full extent for thirteen minutes; following this time lapse the atrial sac was gradually retracted; in two hours it finally disappeared through the genital aperture.

On January 10, 1942, the snails were again observed copulating. One of the snails rested on its apical whorls with its body held free in the air. The other snail approached crawling over the substratum; when contact was made with the prostrate snail, the active snail everted its atrial sac and immediately attempted to copulate but without success. After fourteen attempts, the active *Helminthoglypta* finally succeeded in thrusting its atrial sac into the vagina of the other. Although the atrial sac of the prostrate snail was protruded just before the other's atrial sac was thrust into its vagina, no mutual union by atrial sacs took place. The copulation continued for thirty-five minutes. When the atrial sac of the active *Helminthoglypta* was withdrawn a mass of mucous issued from the vagina of the prostrate snail. The atrial sacs were completely withdrawn inside the genital openings of each snail within a twenty-five minute period.

On January 14, 1942, the two snails copulated a third time. The copulation was mutual. The contact and withdrawal times were not observed, but the copulation was continual for approximately twenty-three hours.

EGG LAYING

The first egg mass was deposited on January 21, 1942. This mass possibly resulted from the mutual copulation of November 29, 1942. The mass was buried one-half inch below the soil surface; the entrance and withdrawal channel was plugged with soil. One hundred and ten eggs were in the mass. The snail was not observed laying.

The second egg mass was deposited on January 27, 1942. The snail was not observed in the process of egg laying. The mass was one inch beneath the surface, and was in a chamber approximately two inches deep by an inch broad. The eggs were closely packed together; they numbered one hundred and seventeen.

The third egg mass was observed being deposited beneath the soil on February 3, 1942. The snail extended its anterior body

region one inch from the shell. By working its head from side to side the snail thrust it one inch beneath the soil. The snail continued laying eggs for twenty-three hours, from 9:00 a. m. on February 3 to 8:00 a. m. February 4. The eggs were uncovered after the snail had withdrawn its body from beneath the soil; the chamber in which the egg mass rested measured approximately an inch in depth and two and one-half inches in width. The size of this chamber and the one above indicates that this *Helminthoglypta* moves its head about beneath the soil while depositing eggs. The eggs were scattered about in the chamber and were mixed with soil particles; mucus was absent from the egg mass. Eighty-eight eggs were present.

On February 7, 1942, the other snail was noted depositing eggs. This snail had stretched its anterior body region one and one-half inches beneath the soil surface. The egg laying process continued for fifteen hours. There were fifty-one eggs in a chamber an inch deep by an inch broad. A half inch of soil covered the eggs.

A fifth egg mass was laid on February 18, 1941. Sixty-five eggs were found one-half inch beneath the soil surface in a chamber two inches deep by three inches in breadth. The snail was not observed depositing the eggs.

Unfortunately it was not possible to discern which of the snails laid the first two egg masses nor the fifth, for they were not observed in the process of egg laying. Egg masses three and four were laid by different snails.

Unlike many of the eastern land snails, this western species buries its eggs beneath the soil; by so doing the survival rate of this species is certainly enhanced. Eggs deposited above the ground would soon become desiccated in the dry region which this *Helminthoglypta* inhabits. A number of land snails living in shielded forest regions in New York State, where the forest floor is moist and shielded from the sun's rays, have been observed scattering their eggs at random on the forest floor. These New York snails are, *Triodopsis albolabris* (Say), *Triodopsis tridentata* (Say), *Triodopsis dentifera* (Binney), *Mesodon thyroidus* (Say), *Stenotrema fraternum* (Say), *Haplotrema concavum* (Say), *Discus cronkhitei catskillensis* (Pilsbry), and *Zonitoides arborcus* (Say). However, the eggs are typically deposited beneath or in wet-rot logs and beneath thick leaf mold. The placing of eggs beneath the soil by the above named species seems to be a rarity.

EGGS

The spherical eggs of *Helminthoglypta tudiculata* are of uniform size when laid; their diameter is 2 mm. The eggs are initially translucent; after approximately seven days they become opaque. The egg membrane is elastic; the egg color is white.

HATCHING

The young snails break through the egg membrane by pressure exerted on it by the foot and by filing with the radula. Newly hatched young remain beneath the soil from fourteen to twenty-five days before venturing to the soil surface. Newly hatched snails measure 2.25 mm. in diameter. The hatching times, summarized in the table below, varied from nineteen to twenty-five days.

DATE LAID	DATE HATCHED	INCUBATION PERIOD (days)
January 21	February 19	19
January 27	February 16	20
February 3	(destroyed)	..
February 7	March 2	23
February 18	March 15	25

DESCRIPTION OF YOUNG

The following description is based on newly hatched snails with a diameter of 2.25 mm. Shell, translucent, brown; entire dorsal surface of shell covered by short stiff hairs; the hairs occur on the ventral surface and extend into the umbilicus. The hairs in the umbilicus are one-third as long as those covering the rest of the shell. The mantle edge is without pigment; the body is pigmented with black.

No mention of the hirsutness of the species in any stage of its development is made by Pilsbry (1939). Webb (1941) omits it from a list of twelve *Helminthoglypta* known to be hirsute.

The shell hairs completely disappear about the twenty-second day after hatching. The young snail at this time measures approximately 3 mm. The shell is greyish brown. It is likely that the shell hairs are scraped off, or become loose to fall off later, from the young's wanderings beneath the soil surface.

DISCUSSION AND SUMMARY

In the hermaphroditic *H. tudiculata* copulation may be mutual or only one individual may act as the male. Filing with the radula seems to be a method of sexual stimulation, since Pilsbry (1939) indicates that darts are not used.

From a known three copulatory acts between two snails five lots of eggs were laid. It is known that each individual participated in egg laying. The number of eggs in the five egg masses tended to decrease in number as successive masses were deposited. Although the environmental conditions of the terrarium were constant throughout the observation period, the incubation period of the eggs gradually increased from the first mass, nineteen days, to the last, twenty-five days. The eggs were all deposited beneath the soil; a factor which would increase a snail species survival rate in dry climates. The eggs have an elastic egg membrane and measure 2 mm. in diameter when laid.

The young snails break through the egg membrane by means of the foot and radula. On hatching they have a diameter of 2.25 mm. The young are initially hirsute. After approximately twenty-two days the hirsutness is lost. The young snails remain beneath the soil from fourteen to twenty-five days.

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COMPARATIVE OBSERVATIONS OF THE MATING HABITS OF THREE CALIFORNIA LANDSNAILS

By GLENN R. WEBB

(*Mollusca, Gastropoda, Pulmonata, Helminthoglyptidae.*)

The present paper is a superficial study of the mating habits of captive specimens of three species of California landsnails, with special reference to the anatomy and functioning of the sex-organs. The study was occasioned as follows:

During investigations of the mating habits of Polygyrid landsnails, it was considered expedient to become familiarized with the anatomy and habits of allied groups. Accordingly, efforts were made to secure live specimens of these types. Among the species thus obtained were *Helminthoglypta californiensis* (Lea), *H. dupetithouarsi* (Deshayes), and *H. umbilicata* (Pilsbry). As the mating habits of none of the species of this genus seemingly have been described, it appears useful to publish the data resulting from this survey study. From what little was accomplished, it seems clear that such data may have value in helping to determine inter-species relationships within this difficult genus. West coast malacologists might well explore the potentialities of this field.

The specimens used in this study were obtained from the following sources: The *californiensis* and *dupetithouarsi* specimens were collected in Monterey County, California, by Mr. Emery P. Chace. The exact locality for the former is given¹ as "Sand dunes near city dump about 3 miles north of Monterey," and for the latter ". . . open pine grove near Point Pinos." The *H. umbilicata* were collected by Mr. Ernest N. Wilcox at Santa Margarita, San Luis Obispo County, California.² I am also indebted to Mr. Tucker Abott and Mr. Tom Burch for various assistances. I wish to thank these persons for making this study possible.

The method of securing the to-be-presented data was essentially one of observation, and the cages were kept under as continuous watch as possible. Much of the anatomic data was furnished by the cadavers of specimens killed in coitus. To obtain such mating-anatomies it is necessary to plunge the living, copulating specimens into boiling water. By quickly coagulating the tissues, this procedure minimizes any retraction of the organs from their previous positions. The accompanying figures are

¹ Collector's label.

² More detailed locality cit. in *Naut.* 54:3, p. 122.

from free-hand drawings and are somewhat diagrammatic; the figures are not equally enlarged.

THE ANATOMY OF THE FUNCTIONING SEX-ORGANS: The following description of the form and functions of the extruded sex-organs, in conjunction with the figures of Plate 25, pertain to all three species. The differentia will be dealt with separately under the mating habits of the respective species.

1. The atrial-sac (AS): This is protruded as a long, hollow, more or less horn- or sausage-shaped body; its cavity contains the dart-sac (DS) apically and the descending common mucous-duct (CMD) which terminates at the dart-sac. The mucous-glands (MG) and their upper loop-like ducts (UMD) also descend more or less completely into the cavity of the everted atrial-sac. These component structures—atrial sac, dart sac, and mucous-glands and ducts—actually form an organ as functionally discrete as the penis. To facilitate description, I shall term this structure the dart-organ (DO).

The dart-organ plays an important part in the mating procedure of these three species. Early in the courtship it is protruded in the form described and its subsequent random twistings soon bring its tip against some part of the prospective mate-animal's body. When this occurs, the tip is firmly appressed to that part and the dart is exerted. As has been anticipated by Pilsbry (p. 67)³ the dart is not left lodged in the tissues it pierces but is almost immediately retracted. The stimulus provided by the dart-prick often is sufficient to cause the victim to cringe or, early in the courtship, to pivot.⁴ The dart-organ continues to function more-or-less constantly throughout the mating. It is most employed in the early and final stages. After coitus commences, the dart-organ is often retracted completely for short periods—thus functioning independently of the penis. Strangely enough, the length and worm-like mobility of the dart-organ in these species allow it to be curled about other parts of the extruded organs at will.

During its functioning, the internal structures of the dart-organ are obscurely visible through the thin atrial-sac wall. At such times the descended parts of the upper loop-like ducts of the mucous-gland can be observed pulsating like a heart, while each twisting or lengthening of the entire dart-organ results in re-adjustive movements of the common mucous-duct and, to lesser degree, the glands and upper ducts. The pulsations of the upper mucous-ducts are seemingly of peristaltic character and appear

³ Pilsbry, H. A., 1939, *Land Mollusca of N. America*. Phil. Acad. Nat. Sci., Monograph 3, pt. 1, pp. 1-573.

⁴ ie: Turn away, crawl a short distance, turn-about, and rejoin the mate in a new head-on position.

sometimes to involve the mucous glands themselves. When the dart is protruded the pulsations become especially vigorous. The common mucous-duct is apparently non-pulsatile.

The presence of pulsations in these parts of the dart-organ stimulate conjecture that at least one function of the inner dart-organ structures, may be of hydrostatic nature closely associated with the protrusion of the dart and maintenance of turgor in the entire dart-organ. Whether or not a lubricatory function⁵ is also involved is problematic.

2. Penis: The figures indicate the approximate form of this organ; it functions in a Helicid manner.⁶

3. Female-organs: The female-organ, or part of the sex-organs akin to a vagina, is formed almost entirely by an expansion of the basal portion of the spermathecal duct (BSD).⁷ During coitus the penis occupies the vagina-cavity and the spermatophore is discharged probably therein.

MATING-HABITS. Descriptions of the mating-habits of the species follow. Because the procedure is quite similar among them, only the particulars in which a species appears to differ are cited subsequent to the description of *californiensis*. The orientation of the mating animals in the cage is seemingly a matter of chance, and specimens have been observed to mate successfully resting on the floor of the cage, clinging to the vertical cage-sides, or hanging up-side-down from the cage cover-glass.

Helminthoglypta californiensis (Lea), Pl. 25, fig. A: The paired-off animals approach each other head-on, the dart-organ of each now becomes everted—if not already so—and extended toward the prospective mate. It then commences functioning in the manner already described. The first contacts between the animals are of short duration and are interrupted by temporary retreats occasioned by pivoting-acts. A supplementary stimulation sometimes results from one or both animals biting the other about the foreparts, including the extruded organs.

After a variable number of re-contacts between the animals, in which are repeated the procedures just described, they become sufficiently excited to protrude the penis. Because of the more-or-less head-on position of the animals during the beginning of each new contact, the penis of one animal touches the extruded organs of the other. When this occurs, the penis is moved slowly about in a probing manner until it encounters the vagina-orifice of the mate-animal. This generally does not occur at the first attempt but only after a number of tries following additional re-contacts between the specimens. The ulti-

⁵ A function at least implied by current terminology.

⁶ As in *Helix* species.

⁷ The oviduct opens into one side of the "vagina" but appears to be non-functional in the mating process as its orifice has been found to be closed in mating-anatomies.

mate result is the commencement of coitus. Once one specimen commences copulation, its mate subsequently reciprocates the act. It seems that the beginning of coition by one animal increases the ease with which the yet unengaged specimen is enabled to make the movements necessary for achieving the same result.

During coition, the pairing animals of *californiensis* slowly rotate in a clockwise direction with their bodies bent in alternate, crescentic positions. Sometimes this position is attained even before the specimens become engaged in coitus. In this species coitus has been observed to last from two to four hours. It appears to be reciprocal invariably although individuals may commence or discontinue the process independently of each other.

The anatomy of the extruded sex-organs of *californiensis* present certain distinctive features upon comparison with the next two species: (1) The fully everted dart-organ is proportionately longer⁸ and smaller tipped; (2) the penis is only one-third as long as the dart-organ; and (3) the upper loop-like ducts of the mucous-glands descend completely into the fully everted dart-organ. In figure A is shown a dissected mating-anatomy. Of particular interest is the large bladder-like body (BB). The exact nature of this body was undetermined; a similar structure was found in a *dupetithouarsi* mating anatomy. In a like category are the problematic mesenteric-like tissues (MT) found about the mucous-glands and ducts. Only one of the mucous-glands is shown in the figure.

In relation to the next two species, seemingly, the only peculiarity in mating-procedure reflected by these anatomic differences was the to-be-expected greater reach and mobility of the dart-organ. This allowed the fully everted organ to be extended behind the body-pillar⁹ of the mate-animal when the latter assumed a crescentic body-position. The bulk of the fully extended dart-organ is rather astonishing.

Helminthoglypta umbilicata (Pilsbry), Pl. 25, fig. B: This species differs from the preceding in the moderate length¹⁰ and blunt tippedness of the everted dart-organ. In the relatively few mating-anatomies examined, the dart-organ seemed rather spindle-shaped; this is not apparent in life. The loop-like ducts of the mucous-glands descend but slightly, if at all, into the everted dart-organ. In part this seems to be because the upper portions of the proportionately smaller dart-organ is nearly completely filled by the descent of the large mucous-gland,¹¹ and also because of a seeming attachment of parts of the upper mucous-ducts to non-descending structures within the body cavity. The penis is about half as long as the dart-organ in mating-anatomies.

⁸ Twenty-seven to thirty-five mm. in living animals.

⁹ The inter-connection between the foot and the permanently shell enclosed viscera.

¹⁰ About 18-23 mm. in living animals.

¹¹ Larger both actually and relative to the size of the dart-organ than in *californiensis*.

Coitus has been observed to last from one-half to somewhat less than three hours in this and the next species. Mating *umbilicata* specimens have not been observed to attain the pronounced crescentic body-position characteristic of *californiensis*, and only rarely do mating animals perform rotations.

As has been implied already, the moderate length of the dart-organ restricts its posteriorad field of action in both *H. umbilicata* and *H. dupetithouarsi*. The failure of the upper mucous-ducts to descend to any extent into the dart-organ seems to result in no observable difference in the latter's functioning—aside from preventing observation of the former through the dart-organ wall.

Helminthoglypta dupetithouarsi (Deshayes), Pl. 25, fig. C: This species seems essentially like *umbilicata* in both mating-habits and anatomy. Since the specimens used in these observations were larger in both shell and body than the *umbilicata* specimens, the greater size observed of the organs in *dupetithouarsi* are not considered significant.

In contrast to *umbilicata*, mating *dupetithouarsi* specimens not uncommonly rotated and sometimes assumed an almost crescentic body-position.

DISCUSSION: From the preceding it can be seen that the mating-habits of these species follow the typical Helicid pattern. In the species studied, which are said to possess no verge, the penis functions in the orthodox manner. The absence of a verge in these species, if true, seems not to prevent the penis from functioning normally. In writing of the *Helminthoglyptidae*, Pilsbry¹² has stated:

“The atrium is much enlarged in *Cepolis*, *Monadenia*, and *Helminthoglypta*, the dart sac inserted upon it, but in the first two the penis has a verge . . . and apparently still functions. In *Helminthoglypta* the penis contains no verge and appears not to be evertable, that function being taken over by the long atrial sac . . .”

As shown by his figures,¹³ Pilsbry's conclusions were probably based on the appearance of the everted organs of non-pairing animals. While such specimens frequently evert the dart-organ, usually the penis is not protruded greatly (if at all) until the specimen finds a mate. Further, although the atrium-sac is evertable, it functions as a secondary sex-organ of excitation rather than as an intromittant organ as implied by Pilsbry. This is made quite evident from the fact that coitus may continue after the dart-organ has been retracted completely.

¹² *L. Moll. of N. Amer.*, p. 66.

¹³ *Ibid.*, fig. 32.

SUMMARY: In considering the conclusions presented in the following summary, it should be remembered that the findings pertain solely to the species studied and that they are based on the observation of a limited number of captive specimens.

1. Comparative observations were made of the mating-habits and anatomy of the functioning sex-organs of captive specimens of *Helminthoglypta californiensis* (Lea), *H. dupetithouarsi* (Deshayes), and *H. umbilicata* (Pilsbry).

2. The basic form and functioning of the sex-organs of these species are similar.

3. The basal part of the spermathecal duct functions as a vagina, the penis as the intromittant organ, and the freely mobile dart-organ¹⁴ as a secondary sex-organ of excitation.

4. Despite the reputed absence of a verge in these species, the penis is evertible; in the literature the contrary has been suggested as true for species of this genus.

5. The upper loop-like ducts of the mucous glands appear to pulsate. It is herewith suggested that they, and associate structures, may function as a hydrostatic organ.

6. The mating procedures of these species, aside from the form and functioning of the dart-organ, are of the typical Helicid pattern.

7. Coitus lasts from one-half to more than three hours among these species; it seemingly is invariably reciprocal.

8. Considerable dissimilarities in the mating-anatomies, and slight variations in mating procedure were noted between *H. californiensis* and the other two species; practically no differences were found between *H. dupetithouarsi* and *H. umbilicata*.

EXPLANATION OF PLATE 25. See page 108.

A.* Mating-anatomy of *Helminthoglypta californiensis* (Lea), the longitudinally slit atrial-sac wall is shown spread open with the inner structures of the dart-organ in place.

B.* Mating-anatomy of *H. umbilicata* (Pilsbry).

C. Showing two mating-anatomies of *H. dupetithouarsi* (Deshayes) yet in position of coitus. The lower anatomy has been dissected out; the dart-organ is partially retracted.

Explanation of symbols: AS (atrial-sac); BB (bladder-like body); BSD (basal portion of spermathecal duct); CMD (common mucous-duct); DO (dart-organ); DS (dart-sac); MG (mucous-gland); MT (mesenteric-like tissue); P (penis); UMD (upper mucous-duct); V (vagina or BSD).

¹⁴ Defined on p. 103, paragraph 2.

* The penis-retractor has been omitted from these figs.

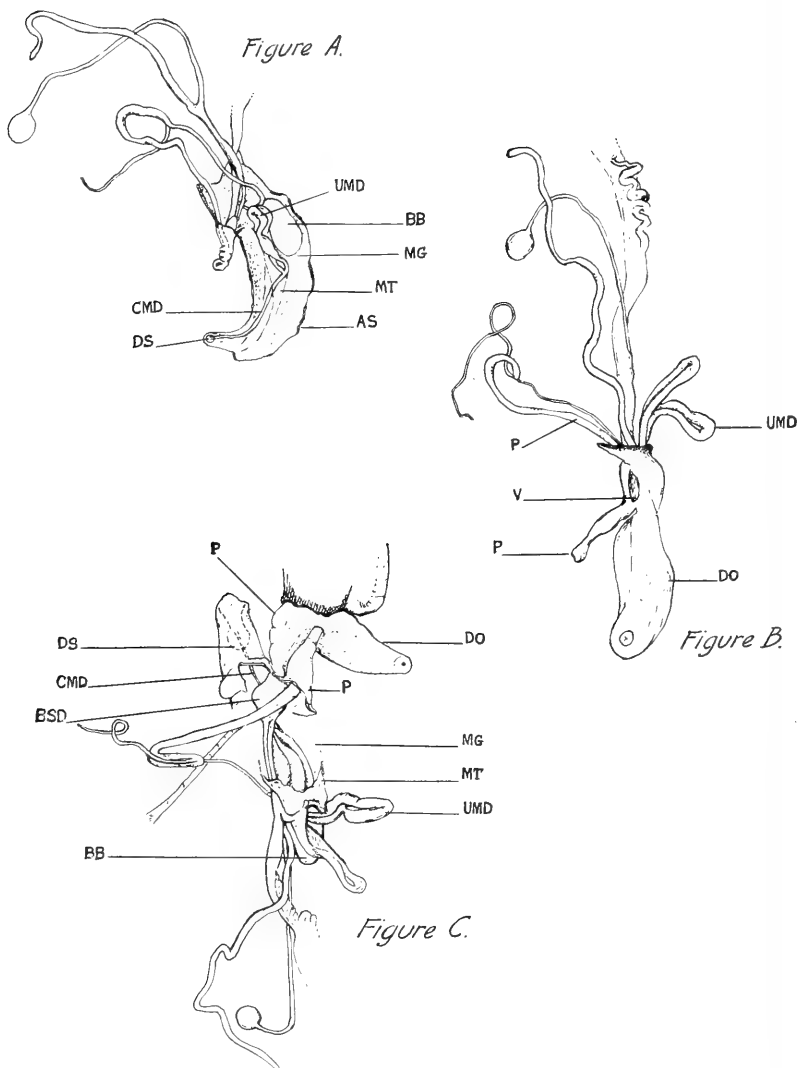


PLATE 25



WILLIAM WARREN ORCUTT
(1869-1942)

William Warren Orcutt,¹ a member of the Southern California Academy of Sciences for thirty-five years, died on April 27, 1942. He was born in Concord, Dodge County, Minnesota, seventy-three years ago. At the age of twelve he moved with his parents, John Hall Orcutt and Adeline Marion Warren Orcutt, to Santa Paula, California. Here he attended public school and the Santa Paula Academy, enrolling in 1891 in the first class of a then new institution of higher education, Stanford University. During his college career he majored in civil engineer-

¹I am indebted to Mr. Earl B. Noble of the Union Oil Co. of California for the biographical data relating to Mr. Orcutt.

ing and geology, but found time also to demonstrate his prowess on the track and in football. He played on the varsity eleven with Walter Camp as coach, and was a member of the team whose business manager was Herbert Hoover.

After graduation Mr. Orcutt returned to Santa Paula, practicing his engineering profession and becoming also U. S. Deputy Surveyor. He became associated with the Union Oil Company in 1898, and was at various times general superintendent for the San Joaquin Valley division, then manager of the geological and land departments of the company, chief engineer, and finally vice-president of this company in 1922, which position he continued to hold until he retired in 1939. Thus his life encompassed a good portion of the pioneering and subsequent history of the petroleum industry in southern California.

He early appreciated the value of geological studies in exploring for oil, and conducted such investigations himself, particularly in the San Joaquin Valley, Santa Maria basin, and in the Los Angeles area. It was in the latter region that he noted the occurrence of fossil animal remains in the asphalt beds of Rancho La Brea. This led later to the excavation of the brea beds by several institutions including the University of California, Southern California Academy of Sciences, and the Los Angeles County Museum. It is not difficult to appreciate the great service rendered to geology and paleontology by Mr. Orcutt in thus re-awakening interest of scientists in this significant locality after that interest had lain dormant and neglected for a quarter of a century. Among the many extinct kinds of creatures described from these famous deposits was a species of coyote named *Canis orcutti* in Mr. Orcutt's honor.

Mr. Orcutt was an honorary member of the American Association of Petroleum Geologists. He was also a life member of the American Society of Civil Engineers. The town of Orcutt, Santa Barbara County, was named for him, as was also Orcutt, Colorado. A municipal park in the San Fernando Valley likewise bears his name.

In business affairs Mr. Orcutt led a very active life. He was a director of the Union Oil Company, Semi-Tropic Fruit Exchange, Cal-Ore Mining and Development Company, La Merced Heights Land and Water Company, and the Midway Petroleum Company. At the time of his death he was president of the Canoga Citrus Association, International Development Company, Pioneers Petroleum Society of California, and chairman of the Advisory Board to Local Selective Service Board No. 176.

His widow, Mary Logan Orcutt, a son, John Logan Orcutt, and a daughter, Mrs. Jeremiah D. Maguire, survive him.

CHESTER STOCK

CARL SUMNER KNOPF

Some men leave buildings and great estates, while others leave a line of verse, a book of thought, a few disciples who understand, appreciate, and try to follow. Such a one of the latter type was Carl Sumner Knopf. On September twentieth, 1889, somewhere in a maternity ward in Columbus, Ohio, one more baby voice was added to the infant chorus of that community. On that day the voice of Carl Sumner Knopf first vibrated against human eardrums; a voice that for fifty-two years was to exert an influence on the world and, perchance, for all eternity its echo will be at work. Dr. Knopf's father was a nursery man, consequently young Carl was early surrounded with things of beauty and artistry. Mrs. Knopf firmly believes that this had a great part to play in the development of the esthetic appreciation of the man who was later to be a college president. As a boy his hobby was playing a pipe organ at the Christian Church in Columbus, Ohio. He aspired to be a professional organist. It was because of these talents that after moving to Los Angeles he met one who had a mutual interest. That one was Florence Nelson; who, because she was asked to "be nice to the new boy in the University Church" coyly said to him, "Welcome to University Church." Recalling the incident Carl used to say, "that finished him." Florence Nelson apparently not only welcomed Carl to University Church, but also to her heart. Young Knopf at first entered business with his father and then decided he wanted to go on into college. He entered University of Southern California, where he received his Bachelor of Arts, his Master of Arts degrees. While in school he had a little church at Rancho Englewood. The first year after he graduated he married Florence Nelson. He was called later to a little church at Westland, Los Angeles; he then went to Yale for two years where he received his Bachelor of Divinity degree in 1915. The interdenominational interest expressed itself when the young preacher was a student at New Haven, where he preached in Congregational and Presbyterian churches. He returned to the University of Southern California to work as colleague to Dr. John G. Hill who had inspired Carl to enter the teaching ministry. Shortly thereafter the dark clouds of the first world war enveloped what was assumed to be civilization. Young Professor Knopf, had ideas and

ideals, he did not believe in compromising them; so, that accordingly, along with many others, he paid the price and found himself without a teaching position. Dr. R. D. Hunt of the University of Southern California, then stretched out his understanding arm to Carl and said, "Don't worry, we'll find a place for you to continue your teaching profession!" That place was Fullerton, California where he taught history as well as philosophy and psychology. Then came the year of the Centenary of the Methodist Church. Bishop Leonard asked him to return to the Methodist church, as Area Secretary. Then came the call to return to his real field, the teaching ministry. He returned to the department of the school of religion of the University of Southern California where for almost a decade he taught, inspired and wove himself into the spiritual and intellectual fiber of Southern California. His reputation as a platform speaker spread from the community to all parts of the nation. From his pen came pamphlets, articles, and eventually books. In 1929, he was called to Yale University, as Professor of Biblical History. This made it possible for him to finish his dissertation by virtue of which he had conferred upon the degree, Doctor of Philosophy. The early thirties saw Carl again busily engaged in his career as lecturer, teacher, and preacher. One of Carl's retreats was down in Laguna Beach, where Carl and Florence had a lot, on which they used to spend week-ends dreaming of "the kind of house they'd build." Slowly the dream materialized into brick and stone and wood and mortar. There upon a rock cliff their beach house clung, looking out over the blue Pacific. It was here that many of Carl's inspirational books were conceived. People of Three Arches Bay at Laguna called him "Doc." They respected him. They admired him. They loved him and the regard was mutual. Those who knew him thought that the happiest years of his life were spent at Laguna Beach. President von KleinSmid used to say, "the reward of work is more work"; and consequently, in 1935 Dr. Knopf was appointed Dean of the School of Religion of the University of Southern California. That was not to be the end of Carl Sumner Knopf's administrative career. In 1941, Willamette University called him to be the successor to Dr. Bruce Baxter who had been elected Bishop of the Methodist church. No one, then, could foresee the whirlwind that was gathering and that one of the unofficial casualties of the war, undoubtedly was destined to be Carl Sumner Knopf. After nine months of service under increasingly difficult circumstances, Carl felt that what he interpreted to be his Christian point of view

on the issue of war seriously jeopardized the institutional welfare of his University. Accordingly, at the annual board meeting President Knopf tendered his resignation to be effective September first, 1942. On Tuesday, June 23, President Knopf lectured to his class on the book of Ecclesiastes, and as if by premonition closed with the words "and the spirit shall return unto God who gave it." A few hours later a great spirit did return to "God who gave it." Carl Sumner Knopf succumbed to a heart attack and his soul joined those of that band of courageous leaders whose love and understanding have wooed humanity into a more divine expression of life.

A reflection of Carl Sumner Knopf, the Christian, is found in the following quotation from an editorial of the "Willamette Summer Collegian" for June 25, 1942: "No one who saw him will forget him as he greeted the radio audience and led the grand march at the Century Ball, showing the friendly, congenial personality which endeared him to those who learned to know him. No one who heard the baccalaureate address could have helped feeling the magnificence of the man and his ability to make the Bible live and apply to everyday life. At this time when his integrity and adherence to principles had made him misunderstood by others, Dr. Knopf showed his tolerance and bigness. No one who ever took a course from him will forget his keen mind or his ability to make his classes sparkle with enthusiasm." Thus comes to a close another chapter in the history of the American teaching ministry. His ideals, his principles, and his work now pass to other hands. It is for those who share his understanding to persevere as "Comrades of the Way."





CARL SUMNER KNOPF

1889-1942

WILLIAM ALANSON BRYAN

Dec. 23, 1875—June 18, 1942

In the passing of William Alanson Bryan on June 18, 1942, the Southern California Academy of Sciences deplores the loss of another outstanding leader from the ranks of that small group of scientists, teachers and administrators who have guided the destinies of the organization for the past several years.

The word "doctor" originally signified a teacher—one who was so well endowed with scholarly attainments as to serve as a fountainhead for the dissemination of knowledge. It was with the respect engendered by this thought, coupled with an affectionate regard, that all of "Dr." Bryan's associates applied this title to him, not infrequently over his protests. Thus he will always be held in the minds of his confreres of the Academy.

Dr. Bryan was born near New Sharon, Iowa, December 23, 1875, the son of William A. and Catherine M. (Pearson) Bryan. He received his elementary education in the public schools of his native state, and in 1896 graduated from Iowa State College with the Bachelor of Science degree.

As a youngster he early showed his love for the natural sciences, and his spare time was always devoted to the study, collection and classification of natural history objects. This led to the accumulation of some ten thousand specimens, which in 1903 he presented to the New Sharon (Iowa) High School.

While still in college he was assistant in the department of Zoology and in 1893 was in charge of the Iowa State College Museum. In 1894 he headed an expedition to Big Stone Lake.

From 1895 to '97 he was special lecturer on museum methods at the University of Minnesota, Indiana University, the University of Chicago, Purdue University, Iowa College and Drake University. From 1898 to 1899 he served as assistant curator of Ornithology at the Field Museum. Late in 1899 he was appointed representative of the United States Department of Ag-

riculture to investigate the fauna of the Hawaiian Islands. During the year 1900 he traveled extensively through America and Europe studying methods of museum administration. From 1900 to 1907 he was Curator of Ornithology of the Bishop Museum in Honolulu.

For ten years (1909-1919) he was professor of Zoology and Geology at the University of Hawaii. It was during this period of his Hawaiian residence that Dr. Bryan made numerous excursions to many of the islands of the far-flung Pacific, studying and collecting birds and other examples of the life of these isolated outposts, which served as the basis for his scientific writings.

The latter include "Key to the Birds of the Hawaiian Group" (1901); "Monograph of Marcus Island" (1903); "Report of a Visit to Midway Island" (1905); "Some Birds of Molokai" (1908); "Natural History of Hawaii" (1915); and several other technical papers. These publications are an enduring monument to his genius. They were, however, only a small part of his scientific activities. In 1907 he organized the Pacific Scientific Institution, and served as its first president, and in 1919-'20 engaged in a scientific expedition to Latin America.

In 1921 Dr. Bryan's contact with the Southern California Academy of Sciences began, when he was appointed Director of the Los Angeles County Museum of History, Science and Art. He became a member of the Academy's Advisory Board at that time, and in 1922 was elected to the Board of Directors. In 1925 he served as President. In all of these posts, his excellent judgment and unselfish expenditure of time were of inestimable value to the Academy.

It was as Director of the Museum that his influence was most widely felt in the community. Dr. Bryan took this position when the institution was housed in the two-story red brick structure facing the rose garden in Exposition Park. Its collections were relatively insignificant, its galleries poorly arranged in many respects for the proper care and display of museum material, and its staff numbered barely a score.

When he retired in 1939 after eighteen years of service the Museum had expanded to an institution of national reputation, with some fifty galleries filled with exhibitions, twenty laborator-

ies, numerous work shops, store rooms, machine shops, lecture rooms and offices. It operated an art school and supervised a park. Its staff numbered in excess of one hundred persons, many of whom were recognized authorities in their special fields.

Only those who were close to Dr. Bryan during these years of pioneer building can know the heavy burdens that his post entailed and the strength of character required to carry them. He was not the type of man to view his responsibilities lightly. The problems of the institution, and those of his staff as well, were carried close to his heart. He lived with and for the Museum.

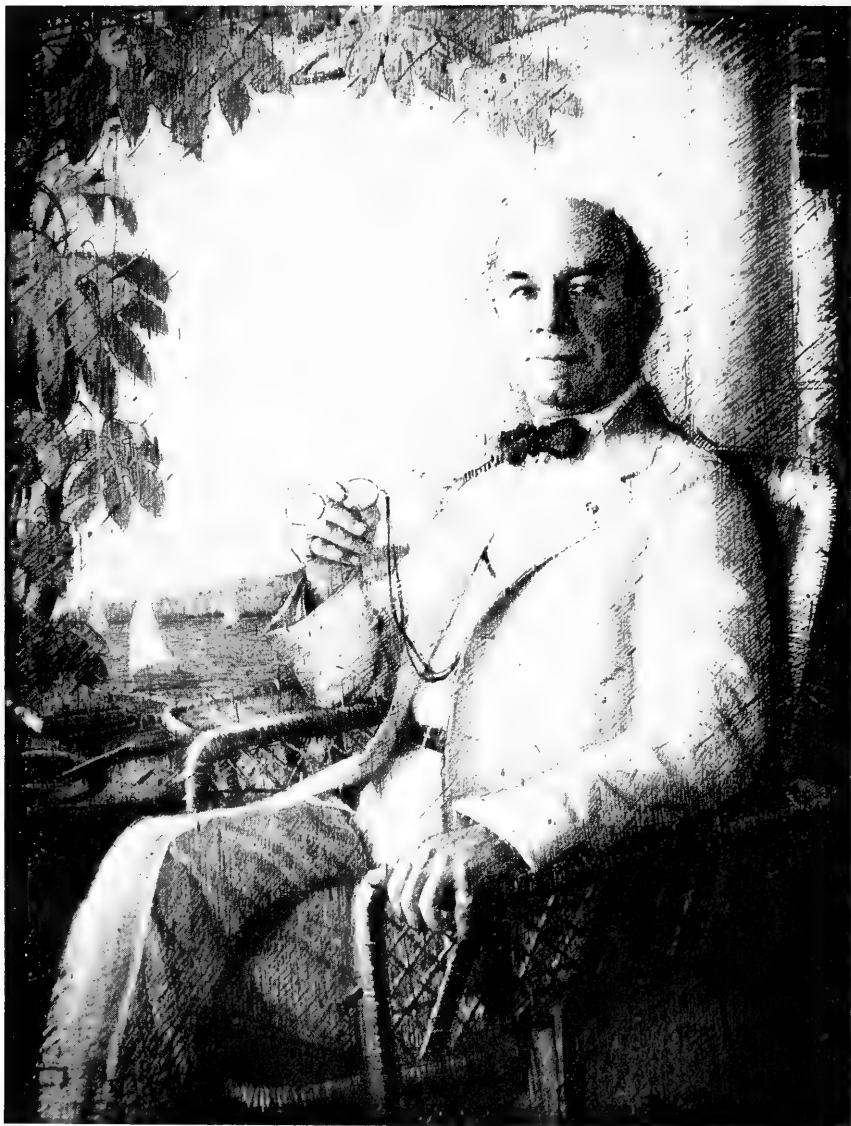
Perhaps the burden was all the more heavy because of his retiring and self-effacing nature. He thought long and prayerfully before coming to decisions. He worked quietly and assiduously for results, avoiding personal publicity, and detesting bal-lyhoo. If he moved with, perhaps, overcaution at times, it was because he preferred to be right rather than spectacular. Always his decisions were made in line with a sterling conscience and a deep desire for the ultimate advancement of the institution he served. No one ever questioned his motives.

His was a gentle, kindly spirit, nurtured in the Quaker associations of his early years. There was nothing of the ruthless executive in his make-up. He never compromised with his conscience, but he preferred to retire from conflicts and avoid dis-sension rather than to engage in battle with forces that he could not respect. His devotion to duty left him little or no time for recreation, and this may have been one factor that brought on the illness which caused his retirement.

Dr. Bryan married Ruth M. Goss of Windom, Minnesota, June 20, 1900. His second marriage was to Elizabeth Jane Letson of Buffalo, N. Y., on March 16, 1909. Elizabeth died February 5, 1919. He married (3rd) June 21, 1921, Maud M. Robinson, who survives him, and to whom the Trustees of the Academy extend their heartfelt sympathy.

A life is abundantly well lived that results in the advancement of human knowledge; when the unblemished standard has never trailed the dust, and the road is lined with hosts of devoted friends.

JOHN A. COMSTOCK



WILLIAM ALANSON BRYAN

1875-1942

PROCEEDINGS OF THE ACADEMY

Season 1941-1942

The officers of the Southern California Academy of Sciences wish to express their gratitude to the membership for its loyal support of the monthly Dinner Meetings through this period of National uncertainty. In spite of the threats of "black-outs," with many attending members now active as air raid wardens, members of State Guard units or engaged in war industries, these meetings have been held with unbroken regularity and with gratifying attendance. The Academy will continue such gatherings of the membership in the season to come, for it feels that the social and intellectual benefits of such meetings in these times of strain, will be of itself a contribution to morale.

We solicit suggestions, for it is the membership that we wish to serve, and your attendance and pleasure will prove our success.

OCTOBER 14, 1941:

An illustrated talk by Dr. H. J. Andrews on "Old Places in Old Mexico," gave stimulus to seekers of profitable travel locations, now so limited in number, to visit our neighbor republic, with its ancient ruins and quaint customs.

Miss Marion Hollenbach of the Los Angeles County Museum staff, presented a talk on Aztec and Precolumbian religion, illustrated with colored lantern slides. The influence of the myths on the art and architecture was clearly explained.

NOVEMBER 11, 1941:

Dr. J. W. Bell gave an illustrated talk on "Why Believe in Genes." The speaker not only covered these frontiers in biological research, but vividly depicted the microanatomy and physiology of the cell.

DECEMBER 9, 1941:

Those attending the dinner listened to President Roosevelt's Address to the Nation, telling of the sneaking Jap attack on Pearl Harbor, as it came over a portable radio provided by the chairman.

The speaker on the evening program was Arthur Woodward, whose subject was "Archeology of the Channel Islands," a review of the fine work done by the recent Los Angeles County Museum Expedition under the speaker's direction. The findings of scientific value in this little known area were clearly shown in the slides, together with the methods used in excavations which have given a far clearer story of the Indians who once densely populated these islands.

JANUARY 13, 1942:

The speaker, Philip Johnston, had lived from childhood with one of the most picturesque of primitive Americans who people The Painted Desert. His talk, illustrated by beautifully colored lantern slides, "My Friends the Navajos," depicted the psychology behind seemingly strange customs and cleverly presented the Indian viewpoint. Folk-songs and fine art in silver and wool were shown.

FEBRUARY 10, 1942:

Dr. T. D. A. Cockerell, nationally known authority on wild life, gave a lecture on "Aspects of Western Natural History," illustrated by rare colored motion pictures showing the flora, fauna and glory of the majestic Canadian Rockies. The high point of the evening was the unusual film in technicolor, of the life history of the Hummingbird, a scientific contribution that none will forget.

MARCH 10, 1942:

A timely and highly informative talk on "Stratigic Minerals" was given by Dr. John Herman, outstanding research chemist and mineralogist, on problems confronting the wartime metallurgist and chemist. The subject was illustrated by specimens.

APRIL 14, 1942:

Robert E. Pugh, Jr., consulting physicist for the Pacific Roentgen Society, gave a fine talk on "Latest Concepts of the Nature of the Atom," describing in popular terms, the highly technical pioneer work on the "stuff" on which matter is made and the use to which this information is put for the benefit of civilization in X-ray, radium emanations and radio research.

MAY 12, 1942:

The Annual Meeting of the Academy was held. Usual reports by officers and committees was followed by a fine lecture by Dr. Howard R. Hill on "Strange Denizens of the Sea," which was illustrated by colored slides and laboratory specimens. Common Tide-pool life was treated in a new light and bizarre creatures from the depths were shown. Almost unbelievable habits and fantastic characters were described.

It is hoped that the season to come will find the members helping to increase the attendance and giving constructive suggestions. Friends of the members are always welcome as guests.

DR. R. H. SWIFT, *President*

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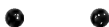
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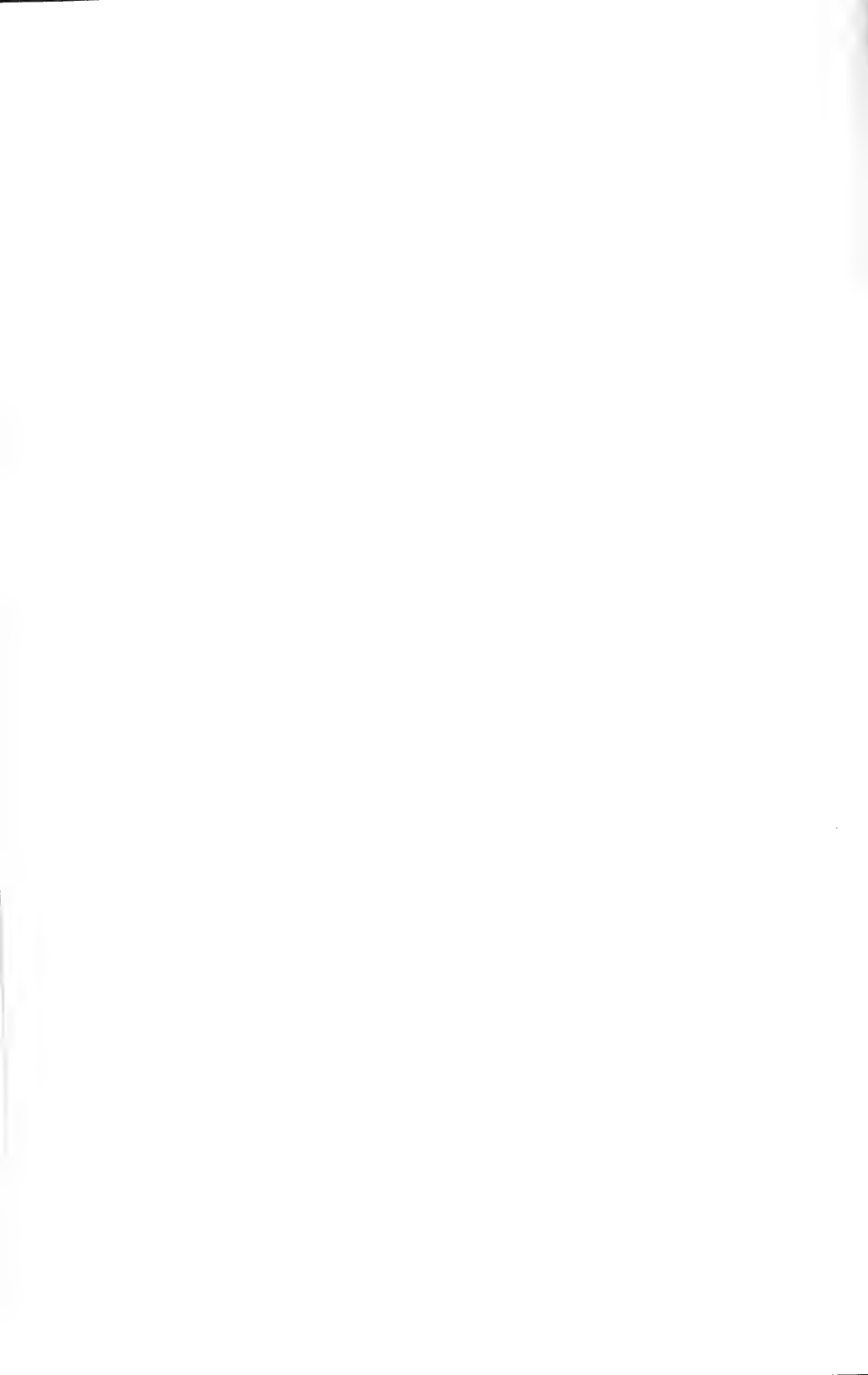
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LOS ANGELES, CALIFORNIA

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Vol. XLI September-December, 1942

Part 3

CONTENTS

Page

- CONTRIBUTIONS FROM THE LOS ANGELES MUSEUM
CHANNEL ISLANDS BIOLOGICAL SURVEY
- No. 7. *Dioryx* of the Channel Islands, Nevada
Mostafa J. M. B. Durrani, *Dioryx* sp. nov. 1942 113
- NOTES ON CALIFORNIA SPIDERS. (Continued by H. B. Beach)
- No. 1. On the Cerebra of *Phidippus grossi* Koch 127
- No. 2. A Spider With a Ventralside of its Palps 137
- NEARCTIC AMMOPLANUS. A. S. F. 1942 141
- NOTES ON THE HAMBLES OF JOE PELLER FROM THE
VICINITY OF YOSEMITE NATIONAL PARK. (Continued by H. B. Beach)
- THE EARLY STAGE OF *ARCENOBATES* FLECK'S, EDV.
John A. Campbell and Charles M. Drake 145
- NOTES ON THE LIFE HISTORY OF *LYGUS* COLEBYON
MOTHES. John A. Campbell and Charles M. Drake 151

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CONTRIBUTIONS FROM THE LOS ANGELES MUSEUM
- CHANNEL ISLANDS BIOLOGICAL SURVEY

No. 27. FLORA OF THE CHANNEL ISLANDS
NATIONAL MONUMENT

By M. B. DUNKLE

The two islands of Santa Barbara and Anacapa, which form the Channel Islands National Monument, have been studied less than the larger islands from the botanical standpoint and as less material has been published, it seems advisable to prepare this list. The writer has made many trips to Santa Barbara Island but has spent only one week on Anacapa. Richard M. Bond and E. Lowell Sumner have recently collected extensively on both Santa Barbara and Anacapa Islands and Mr. Bond has very generously supplied the writer with complete lists of their collecting as well as various notes on the ecology and taxonomy of the island plants. Lists of Anacapa plants by T. S. Brandegee and Lorenzo G. Gates have been included in Miss Eastwood's recent list of Island plants¹. The collections of Ralph Hoffman and those of Bond and Sumner have been made available for study through the courtesy of the Santa Barbara Museum of Natural History. Dr. P. A. Munz has been of invaluable assistance in the matter of certain identifications. The cooperation of other collectors and staff members of the Los Angeles Museum Channel Islands Biological Survey is also gratefully acknowledged. While the report is reasonably complete at the present time, it is yet probable that additional collecting will yield other reports in the future, at least for Anacapa Island.

¹ Alice Eastwood, "The Islands of Southern California and a List of the Recorded Plants," Leaflets of Western Botany, 3:3, pp. 54-78. July, 1941.



PLATE 26
Santa Barbara Island from the east.

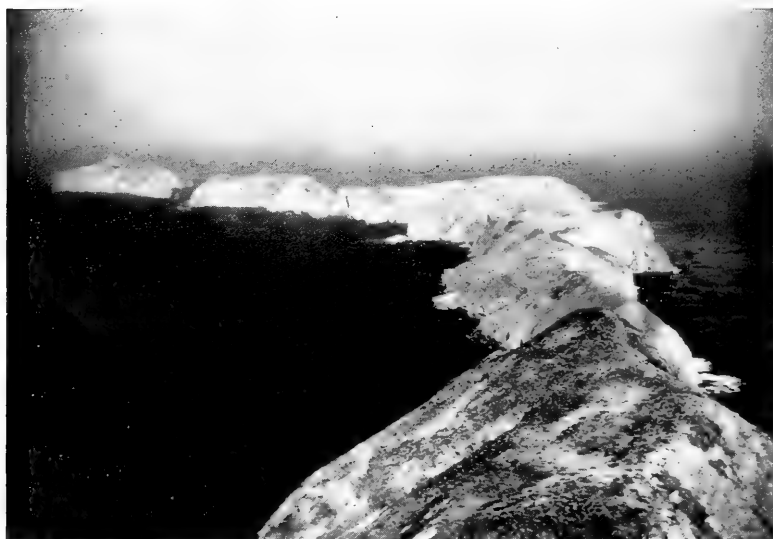


PLATE 27
Anacapa Island from west island.

Santa Barbara Island is a small island lying about 41 miles southwest of Point Vicente. The island contains approximately one square mile, and is surrounded by rugged cliffs. The central part of the Island is traversed by a central, saddle-shaped, north-south ridge from which the surface slopes gently to broad terraces to the east and west. The island has been cultivated and burned over, so that introduced plants occupy much of the terraces and the central ridge. The island is composed largely of volcanic flows, breccia and tuffs. There is a small pleistocene deposit of sediments near the south end at an elevation of about 500 feet. There is no water on the island, and the only mammals are native mice and introduced cats and rabbits. Gulls, cormorants, and pelican nest there in large numbers, while California and stellar sea lions have several rookeries on the narrow beaches. Sea Elephants may occasionally be found there, and sea otters were once numerous but have only been infrequently and rather questionably reported in recent years. The island has no trees or large bushes but *Coreopsis gigantea* dominates much of the island.

Anacapa Island is really a mountain ridge, with only the summit projecting above water, and this narrow ridge is divided by narrow passes into three islands, of which the western is largest and highest. The chain is about five miles long and one half mile wide. Nearly vertical cliffs line the sides so that there are but few landing places. In many places the north and south join in serrate, narrow ridges that are impossible to negotiate. Each of the islands has gently rolling mesas that are covered by grass and low shrubs. The peak on the western island rises to 930 feet. The rocks of the island are mainly intrusives and some volcanic flows, with thick beds of pliocene and pleistocene sediments on the middle island. There is water in only one cave that is accessible only from the sea. The middle island has been grazed at times and some sheep have been on the western island. The eastern island is now overrun by rabbits. There are some very thin sedimentary deposits on the eastern island and considerable water-worn gravel and boulders. The western island has dense suffrutescent growth on the steep slopes and shrub savanna on the terrace. Several groves of small trees are to be found in the northern canyons.

TABLE I
DISTRIBUTION OF ISLAND PLANTS

	TOTAL	NATIVE	EXOTIC	ENDEMIC
Total for both islands	213	145	33	35
Anacapa Island	179	130	25	24
Santa Barbara Island	80	43	21	16
Common to both islands.....	45	27	13	5

The arrangement and nomenclature used in the list follow that used in Munz, *A Manual of Southern California Botany*.

Abbreviations used in the list are as follows:

- A—reported from Anacapa Island.
- B—reported from Santa Barbara Island.
- m—native, occurring also on the mainland.
- i —introduced or exotic plants.
- e —endemic to the Channel Islands and Guadalupe Island.
- abun.—Abundant and usually dominant.
- com.—Common.
- occ. —Occasional.
- loc. —Only one locality known.
- rare —Not found in recent years or very local.

LIST OF REPORTED PLANTS

POLYPODIACEAE

Pityrogramma triangularis (Kauff.) Maxon (Gymnogramme triangularis Kaulf.)	A loc.	m
Pellaea mucronata D. C. Eat.....	A loc.	m
Pellaea andromedaefolia (Kaulf.) Fee.....	A loc.	m
Adiantum Jordani C. Mull.....	A loc.	m
Polypodium vulgare L. var. hesperium (Maxon) Nels. & Macbr.....	A loc.	m
Polypodium californicum Kaulf. var. Kaulfusii D. C. Eat.....	B loc. A loc.	m

NAIADACEAE

Zostera marina L.....	A loc.	m
Phyllospadix Torreyi Wats.....	B loc. A loc.	m

GRAMINEAE

Phalaris minor Retz.....	B loc.	A occ.	i
Stipa pulchra Hitchc.	B occ.	A com.	m
Stipa lepida Hitchc.		A com.	m
Muhlenbergia microsperma (DC) Kunth.....	B com.	A com.	m
Polypogon monspeliensis (L.) Desf.....	B rare		i
Agrostis verticillata Vill.....		A occ.	i
Avena fatua L.....	B abund.	A abund.	i

Melica imperfecta Trin.....	B occ.		m
Distichlis stricta (Torr.) Rydb.			
var. laxa (Vasey) Fawcett & West.	A com.		m
(Distichlis spicata [L.] Greene).			
Lamarckia aurea (L.) Moench.....	B. loc.		i
Poa scabrella (Thurb.) Benth.....	A occ.		m
Festuca octoflora Walt.....	A		m
var. hirtella Piper.....	A		m
Festuca megalura Nutt.....	B com.	A com.	m
Festuca dertonensis (All.)			
Aschers & Graebn.....	A occ.		m
Bromus carinatus Hook. & Arn.....	A com.		m
var. Hookerianus (Thurb.) Shear.	A com.		m
Bromus marginatus Nees.....	B loc.	A occ.	m
Bromus maritimus (Piper) Hitchc.....		A loc.	m
Bromus mollis L.....		A com.	i
(Bromus hordeaceus Auth.)			
Bromus rigidus Roth.....	B loc.	A loc.	i
Bromus rubens L.....	B loc.	A loc.	i
Bromus madritensis L.....		A loc.	i
Bromus Trinii Desv.....		A loc.	i
(Trisetum barbatum Steud.)			
Bromus vulgaris (Hook.) Shear.....	B loc.		m
Bromus laevipes Shear.....		A occ.	m
Bromus sterilis L.....	B loc.		i
Hordeum pusillum Nutt.....		A occ.	m
Hordeum nodosum L.....		A occ.	m
Hordeum murinum L.....	B abun.	A abun.	i
Elymus condensatus Presl.....		A loc.	m

LILIACEAE

Brodiaea capitata Benth.....	B com.	A com.	m
Zygadenus Fremontii Torr.....		A loc.	m

FAGACEAE

Quercus tomentella Engelm.		A loc.	e
---------------------------------	--	--------	---

URTICACEAE

Urtica gracilis Ait.			
var. holosericea (Nutt.) Jeps.....		A loc.	m
Parietaria floridana Nutt.....		A occ.	m

POLYGONACEAE

Eriogonum arborescens Greene.....		A com.	e
¹ Eriogonum nudum Dougl.			
var. grande Jeps.....		A com.	e

¹ Called *E. latifolium* Sm. by Yates, and said to approach this form by Hoffman, 1932a. According to the revision of *Eriogonum* by Mrs. Stokes this form would be *Eriogonum latifolium* Sm. ssp. *grande* (Greene) Stokes.

ERIOGONUM GIGANTEUM Wats. var. COMPACTUM var. nov.

Eriogonum giganteum Wats.
var. compactum var. nov.B com. e

This plant formerly reported as *E. giganteum* Wats. has such differing characteristics from the species as to warrant raising it to the varietal rank. The plant differs from the species in being lower, 4-6 dm. tall, much more compacted and with the pubescence at the base of the plant, the lower side of the leaves, and the inflorescence much more densely white-wooly. The peduncle is first 3-branched, then usually 2-branched, with the ultimate branches very short, .2-2.5 cm. long. The inflorescence is compacted into from 3 to 9 very compacted, subcapitate clusters. The involucre are sessile. Dunkle No. 8704.

A specie differt: humilius, 4-6 dm. alti, congestiusque; caulis basi dense albo-lanatis; foliis infra dense albo-lanatis; inflorescentibus dense albo-lanatis, congestis in 3-9 subcapitata cyma; involucris congestibus, sessilibus.

Pterostegia drymarioides F. & M.B com. A com. m
Rumex crispus L. A occ. i

CHENOPODIACEAE

Aphanisma blitoides Nutt.B occ. m
Chenopodium album L. A occ. i
Chenopodium murale L.B com. A com. i
Chenopodium californicum Wats.B com. A com. m
Atriplex Coulteri (Moq.) Dietr. A occ. m
Atriplex Breweri Wats. A com. m
Atriplex rosea L.B occ. i
Atriplex semibaccata R. Brown.B abund. A abund. i
Atriplex pacifica Nels. A occ. m
(*A. microcarpa* [Benth.] Dietr.)
Salicornia subterminalis Parish. A rare m
Suaeda californica Wats. A occ. m
var. pubescens Jeps.B abund. m

NYCTAGINACEAE

Abronia maritima Nutt. A rare m
Mirabilis laevis (Benth.) Curran.B. loc. A occ. m

AIZOACEAE

Mesembryanthemum chilense Molina. A rare m
(*M. aequilaterale* Haw.)
Mesembryanthemum crystallinum L.B. abund. A occ. i
Mesembryanthemum nodiflorum L.B. abund. A occ. i

PORTULACACEAE

Calandrinia ciliata (R. & P.) DC.			
var. Menziesii (Hook.) Macbr.....	A occ.		m
(C. caulescens H.B.K.)			
Calandrina maritima Nutt.....	B. occ.		m
Montia perfoliata (Donn.) Howell.....	B. loc.	A occ.	m

CARYOPHYLLACEAE

Spergularia macrotheca (Hornem.) Heynh. B. occ.	A com.		m
Silene gallica L.....	B com.	A com.	i
¹ Silene simulans Greene ?.....		A rare	i
Silene laciniata Cav.....		A occ.	m
Silene multinervia Wats.....		A occ.	m

RANUNCULACEAE

Delphinium Parryi Gray.....		A occ.	m
(D. Parryi Gray var. maritimum Dav.)			

BERBERIDACEAE

Berberis pinnata Lag.....		A rare	m
---------------------------	--	--------	---

PAPAVERACEAE

Platystemon californicus Benth.....		A occ.	m
² var. ciliatus Dunkle	B loc.		e
(P. aculeolatus Greene)			
(P. setosus Greene)			
Eschscholtzia elegans Greene.....	B rare	A occ.	c
Papaver heterophyllum (Benth.) Greene.....	B rare	A rare	m

CRUCIFERAE

³ Caulanthus lasiophyllus (H. & A.) Payson..		A occ.	m
(Thelypodium lasiophyllum [H. & A.]			
Greene)			
var. inalienum Rob.		A rare	m
var. ridgidum Rob.....		A rare	m
Lepidium lasiocarpum Nutt.....		A occ.	m
Lepidium nitidum Nutt.....	B occ.	A com.	m
Lepidium pubescens Desv.....		A occ.	i
Erysimum asperum (Nutt.) DC.....		A occ.	m
Brassica nigra (L.) Koch		B rare	i

¹ Munz reports that *S. simulans* is being given subspecific rank in a study now being made of the genus by Hitchcock and Maguire.

² The writer has found only one locality, with one rather variable variety, but *Greene* collected before the fire of 1918, when another type may have been present.

³ Miss Eastwood's list lists the species and Hoffman's list names the two varieties, not subsequently reported.

CRASSULACEAE

<i>Echeveria Greeni</i> (Rose) Berger.....	B loc.	A com.	e
(<i>Dudleya Greenei</i> Rose)			
(Not <i>Cotyledon lanceolata</i> Wats. as called by Yates.)			
<i>Echeveria albida</i> (Rose) Berger.....	B occ.		e
<i>Tillaea erecta</i> H. & A.....	B com.		m

SAXIFRAGACEAE

<i>Heuchera maxima</i> Greene.....		A occ.	e
<i>Ribes malvaceum</i> Sm.....		A rare	m

ROSACEAE

<i>Rubus vitifolius</i> C. & S.....		A occ.	m
<i>Photinia arbutifolia</i> (Ait.) Lindl.....		A loc.	m
<i>Prunus Lyonii</i> (Eastw.) Sarg.....		A loc.	e
(Not <i>P. ilicifolia</i> var. <i>integrifolia</i> as called in Hoffman's catalog.)			

LEGUMINOSAE

<i>Lupinus truncatus</i> Nutt.....		A occ.	m
<i>Lupinus succulentus</i> Dougl.....		A occ.	m
<i>Lupinus bicolor</i> Lindl.....			
var. <i>umbellatus</i> C. P. Smith.....		A occ.	e
<i>Lupinus albifrons</i> Benth.....		A occ.	m
<i>Melilotus indica</i> All.....		A rare	i
<i>Medicago hispida</i> Gaertn.....	B com.	A com.	i
<i>Medicago sativa</i> L.....		A rare	i
<i>Trifolium tridentatum</i> Lindl.....	B occ.		m
var. <i>aciculare</i> McDer.....		A occ.	m
<i>Trifolium gracilentum</i> T. & G.....		A com.	m
var. <i>Palmeri</i> (Wats.) McDer.....	B occ.		e
<i>Trifolium microdon</i> H. & A.....	B com.		m
<i>Lotus strigosus</i> (Nutt.) Greene.....		A occ.	m
¹ <i>Lotus argophyllus</i> (Gray) Greene			
var. <i>ornithopus</i> (Greene) Ottley.....	B occ.		e
<i>Lotus scoparius</i> (Nutt.) Ottley			
var. <i>Veatchii</i> (Greene) Ottley.....		A loc.	e
var. <i>dendroideus</i> (Greene) Ottley.....		A com.	e
<i>Lotus subpinnatus</i> Lag.....		A occ.	m
<i>Astragalus Traskiae</i> Eastw.....	B com.		e
<i>Astragalus Douglasii</i> Gray.....		A occ.	m
<i>Astragalus leucopsis</i> (T. & G.) Torr.....	B ?	A occ.	m
<i>Astragalus Nevinii</i> Gray.....	B ?	A ?	e
<i>Astragalus didymocarpus</i> H. & A.....		A occ.	m

¹ The form of *L. argophyllus ornithopus* on Santa Barbara Island has much shorter peduncles than the typical form on Santa Catalina Island. Peduncles of Catalina form 2-4 cm., Santa Barbara form .5-1.5 cm.

<i>Astragalus miguelensis</i> Greene	A occ.	e
<i>Vicia exigua</i> Nutt.....	A occ.	m
<i>Lathyrus strictus</i> Nutt.....	A occ.	m
(<i>L. laetiflorus</i> Greene)		

GERANIACEAE

<i>Erodium botrys</i> Bertol	B rare	i
<i>Erodium moschatum</i> (L.) L'Her.....	B com.	i
<i>Erodium cicutarium</i> (L.) L'Her.....	B abund. A com.	i

ANACARDIACEAE

<i>Rhus integrifolia</i> (Nutt.) B. & W.....	A occ.	m
<i>Rhus diversifolia</i> T. & G.....	A loc.	m

MALVACEAE

<i>Malva parviflora</i> L.....	B abund.	i
<i>Lavatera assurgentiflora</i> Kell.....	A loc.	e

FRANKENIACEAE

<i>Frankenia grandiflora</i> C. & S.....	A com.	m
--	--------	---

CACTACEAE

<i>Opuntia prolifera</i> Engelm.....	B abund. A occ.	m
<i>Opuntia littoralis</i> (Engelm.) Cockerell.....	B abund. A abund.	m
(<i>O. occidentalis</i> var. <i>littoralis</i> Parish)		

ONAGRACEAE

<i>Zauschneria cana</i> Greene.....	A occ.	m
<i>Oenothera cheiranthifolia</i> Hornem	B rare	m

UMBELLIFERAE

<i>Sanicula arguta</i> Greene.....	A occ.	m
<i>Berula erecta</i> (Huds.) Gov.....	A occ.	m
<i>Daucus pusillus</i> Michx.....	A occ.	m

PRIMULACEAE

<i>Dodecatheon Clevelandii</i> Greene.....	A com.	m
<i>Dodecatheon Hendersonii</i> Gray.....	A occ.	m

CONVOLVULACEAE

<i>Convolvulus occidentalis</i> Gray		
var. <i>macrostegius</i> (House) Munz.....	B abund. A com.	e

POLEMONIACEAE

¹ <i>Gilia gilioides</i> (Benth.) Greene		
var. <i>glutinosa</i> (Benth.) Jeps.....	B occ.	m

¹ Scarce, depauperate, and the identification is uncertain.

<i>Gilia millefoliata</i> F. & M.....	A com.	m
<i>Gilia Nevinii</i> Gray.....	A occ.	e
<i>Gilia multicaulis</i> Benth.....	A occ.	m

HYDROPHYLLACEAE

<i>Nemophila racemosa</i> Nutt.....	B occ.	m
<i>Ellisia chrysanthemifolia</i> Benth.....	A occ.	m
¹ <i>Phacelia floribunda</i> Greene	B com.	e
<i>Phacelia distans</i> Benth.....	A com.	m
<i>Phacelia viscida</i> (Benth.) Torr.....	A occ.	m
<i>Phacelia hispida</i> Gray.....	B occ. A com.	m

BORAGINACEAE

<i>Heliotropium Curassavicum</i> L. var. <i>ocelatum</i> (Heller) Johnston.....	A com.	m
<i>Amsinckia intermedia</i> F. & M.....	B abund. A com.	m
<i>Cryptantha Clevelandii</i> Greene var. <i>hispidissima</i> (Greene) Johnston	B occ. A occ.	m
<i>Cryptantha muricata</i> (H. & A.) Nels. & MacBr. var. <i>Jonesii</i> (Gray) Johnston.....	A occ.	m
<i>Cryptantha maritima</i> Greene.....	B occ.	m
<i>Cryptantha intermedia</i> (Gray) Greene.....	B occ.	m
<i>Cryptantha Traskae</i> Johnston.....	B occ.	e
<i>Plagiobothrys californicus</i> (Gray) Greene var. <i>gracillis</i> Johnston.....	A com.	m
var. <i>fulvescens</i> Johnston.....	A com.	m

LABIATAE

<i>Stachys bullata</i> Benth..... (<i>Stachys acuminata</i> Greene) (<i>Stachys californica</i> Benth.)	A occ.	m
² <i>Salvia mellifera</i> Greene	A com.	m
var. <i>Jonesii</i> Munz.....	A com.	m
<i>Salvia Brandegei</i> Munz.....	A occ.	e

SOLANACEAE

<i>Lycium californicum</i> Nutt.....	B abund.	
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SCROPHULARIACEAE

<i>Linaria canadensis</i> (L.) Dum-Cours. var. <i>texana</i> (Scheele) Pennell.....	A occ.	m
<i>Scrophularia californica</i> Cham. var. <i>catalinae</i> Jeps.....	A occ.	e
<i>Pentstemon cordifolius</i> Benth.....	A rare	m

¹ Only a few of the calyx lobes are pinnate, and in habit resembles *P. distans*.

² While the three forms of *Salvia* can easily be distinguished in the leaf characteristics they are closely related and should probably all be included as varieties of the same species.

¹ Mimulus Flemingii Munz	A com.	e
Castilleja hololeuca Greene.....	A abun.	e
Castilleja Douglasii Benth.....	A com.	m
(C. parviflora Bong. var. californica Zeile)		
(C. californica Abrams)		

CASTILLEJA ANACAPENSIS spec. nov. A occ. e

This interesting plant was taken in full bloom on both the middle and western islands of the Anacapa group during the last week of August. Its late habit of bloom, its broad leaves, its suffrutescent base, and minor differences in the flower mark it as being very distinct from its nearest relative *C. affinis* H. & A.

It is a suffrutescent herb, with slender stems branching from a woody base, erect or decumbent, 1.5-3 dm. high, sparsely glandular-villous; leaves crowded, broadly oblong to oblong-lanceolate, 1.5-4 cm. long, three-lobed; bracts three-lobed, red, 1.5-2 cm. long; calyx deeply divided below, 1.5-2 cm. long, greenish red, corolla yellowish-green and red, 2.5-3.5 cm. long, galea sparsely puberulent, lower lip exserted. Dunkle, Nos. 7639, Aug. 20, 1940; and 7661, Aug. 26, 1940.

Herba suffrutescens; caulibus ramosis ex caudice ligneo, erectis vel decumbentibus, gracilibus, 1.5-3 dm. altis, leviter glandulose-villosis; foliis confertis, latis vel oblongo-lanceolatis, trilobis; bracteis trilobis, rubris, 1.5-2 cm. longis; calyce partito inferiore, 1.5-2 cm. longo, githaginae; corolla 2.5-3.5 cm. longa, flavovirente rubraque, galea leviter puberula, labro inferiore exserte.

PLANTAGINACEAE

Plantago insularis Eastw.....	B occ.	A com.	m
Plantago Hookerina F. & M. var. californica (Greene) Poe.....		A occ.	m
(P. speciosa Morris)			
Plantago maritima L.....	B occ.	4	m

RUBIACEAE

Galium aparine L.....	B com.	A com.	i
Galium angustifolium Nutt. var. foliosum Hilend & Howell.....		A com.	e

CUCURBITACEAE

Echinocystis fabaceae Naud.....		A occ.	m
Echinocystis macrocarpa Greene.....	B com.		m

¹ Wide variations in flower color and form are present.

COMPOSITAE

Tribe *Eupatorieae*

Brickellia californica (T. & G.)..... A occ. m

Tribe *Astereae*

Grindelia rubricaulis DC.
 var. *latifolia* (Kellogg) Steyermark A abund. m
 var. *platyphylla* (Greene)
 Steyermark A com. m

Aplopappus canus (Gray) Blake..... A abund. e
 (*Hazardia cana* [Gray] Greene)
 (H. *Traskiae* Eastw.)
 (H. *detonsa* Greene)
 (H. *serrata* Greene)

Aplopappus venetus (H.B.K.) Blake
 var. *vernonioides* (Nutt.) Munz..... A com. m
 (*Isocoma vernonioides* Nutt.)

Corethrogyne filaginifolia (H. & A.) Nutt.
 var. *latifolia* Hall..... A com. m
 var. *robusta* Greene..... A abund. e

Erigeron sanctarum Wats..... A occ. m

Erigeron glaucus Ker..... A com. m

Erigeron foliosus Nutt.
 var. *stenophylla* (Kellogg) Gray..... A occ. m

Baccharis Douglasii DC..... A occ. m

Baccharis viminea DC..... A occ. m

Baccharis pilularis DC.
 var. *consanguinea* (DC.) C. B. Wolf A com. m

Tribe *Inuleae*

Gnaphalium californicum DC..... A occ. m
 (*G. decurrens* Ives var. *californicum*
 Gray)

Gnaphalium bicolor Bioletti..... A occ. m

Gnaphalium microcephalum Nutt..... A occ. m

Gnaphalium chilense Spreng..... A occ. m

Tribe *Ambrosiaceae*

Franseria bipinnatifida Nutt..... A occ. m

Tribe *Heliantheae*

Encelia californica Nutt. A com. m

Coreopsis gigantea (Kell.) Hall..... B abund. A abund. m

Tribe *Madicae*

Hemizonia clementina Brandg.....	B abund.	A occ.	e
(H. Streetsii Gray)			
Hemizonia fasciculata (DC.) T. & G.)			
¹ var. ramosissima (Benth) Gray.....	B com.		m

Tribe *Helenicæ*

Perityle Emoryi Torr.....	B abund.	A com.	m
(P. Greenei Rose)			
Baeria hirsutula Greene.....	B abund.		m
Baeria chrysostoma F. & M.			
var. gracilis Piper.....		A abund.	m
Eriophyllum Nevinii Gray.....	B occ.		e
Eriophyllum confertiflorum Gray.....		A com.	m
Eriophyllum staechadifolium Lag.			
var. depressum Greene.....		A com.	e
Amblyopappus pusillus H. & A.....	B, abund.	A abund.	m

Tribe *Anthemidæ*

Achillea millefolium L			
² var. lanulosa (Nutt.) Piper.....	B, abund.	A com.	m
Artemisia californica Less.....		A abund.	m
var. insularis (Rydb.) Munz.....	B abund.		e

Tribe *Cichorieæ*

Malacothrix saxatilis (Nutt.) T. & G.)			
var. tenuifolia Gray.....		A com.	m
var. implicata (Eastw.) Hall.....		A com.	e
Malacothrix Clevelandii Gray.....		A occ.	m
Malacothrix foliosa Gray.....	B abund.		e
Microseris linearifolia (DC.) Schultz.....		A occ.	m
(Uropappus linearifolius Nutt.)			
Sonchus tenerrimus L.....		A occ.	i
Sonchus oleraceus L.....	B com.	A com.	i

¹ Not typical and its varietal status is yet uncertain.

² Closely approaches A. M. var. *maritima* Jepson in respect to its short internodes and dense leafiness.

NOTES ON CALIFORNIA SPIDERS

By JEFFERSON H. BRANCH

1. ON THE CULTURE OF THE SPIDER TEUTANA GROSSA KOCH

Life history and biological studies on spiders have frequently been interrupted by a high incidence of death among the spiders before they reached maturity. In a series of experiments undertaken to show the influence of such factors as light, food and temperature on the life history of a spider, considerable success was achieved in raising successive generations of the spider *Teutana grossa* (C. Koch 1838) Simon 1881 (= *Theridion nitidum* Holmberg 1875, *Teutana zonata* Cambridge 1899), the mortality of control groups never exceeding 5%. It seems advisable, therefore, to record the methods used.

Cocoons were placed each in an 8 dram glass vial and loosely stoppered with cotton. Eggs and spiderlings were kept at a mean temperature of 75° F., the minimum and maximum temperatures never varying 8° F. from the mean. The spiderlings were separated three days after issuing from the egg ball and each was placed in a 3 dram vial, stoppered with cotton and given a record number. No cannibalism was observed during these three days. In groups separated immediately after issuing from cocoon, a few deaths occurred during the first molt. The vials were placed on their sides in ordinary tin cookie trays and care was taken so that the vials could not roll. A rolling or unstoppering of the vial during the critical stage of molting is likely to prove fatal to the spider. Spiderlings were fed three fruit flies every fourth day up to their second molt. The *Drosophila* were cultivated in ½ pt. milk bottles. Rapid feeding with a minimum of disturbance to the spiders was accomplished by lightly etherizing a bottle of flies and spreading them on a table where they could be easily separated and brushed into vials. 100 spiders can be fed in 15 minutes by this method. After their second molt, spiderlings were placed in 8 dram vials and the food supply was changed to one house fly every fourth day. There was a sharp rise in mortality at the time of their second molting among those spiderlings which were given daily feedings. It is quite probable that this was due to the daily unstoppering of the vials, which broke the little silk scaffolds from which they suspended themselves for the precarious function of shedding their skins, rather than from over-feeding. This spider does not need water.

* The writer gratefully acknowledges receiving inspiration and direction in this research from Dr. Dwight Pierce of the Los Angeles County Museum.

Oviposition, egg development, and growth rate of spiderlings are influenced considerably by temperature. A noticeable slowing down of these processes occurred with a decrease of a few degrees of temperature from the control mean of 75° F.

Growth rate and mortality remained constant with control groups among those spiders kept in total darkness. Death rate rose sharply among those kept in continuous light. Darkening of the new chitin after ecdysis, occurred the same in those kept in darkness as those kept in light.

2. A SPIDER WHICH AMPUTATES ONE OF ITS PALPI

If thy hand offend thee, cut it off. Mark 9:43.

The observations recorded in this paper were made on fifteen male spiderlings which were received by the Los Angeles County Museum of History, Science and Art, from Evert Schlinger of Glendale, California. He had observed that the mature males of this species had only one palpus.

The spiderlings were raised in the museum laboratory. Dr. W. J. Gertsch of the American Museum of Natural History, New York, identified the mature spiders as *Tidarren fordum* (Keyserling 1884) Chamberlin and Ivie 1934.

The growth of the spiderlings in the early stages followed the general pattern of most spiders of the Family Theridiidae. In the antepenultimate stage a slight swelling of the palpi was noticed. After the penultimate molt the spiders emerged with two large palpi. Plate 28 is a free-hand drawing made by Dr. W. Dwight Pierce of a spider at this stage. Measurements were made of abdomen and sternum in proportion to the size of the palpi, and the relative proportions of those parts of the spider were found to be the same as in the enlarged drawing.

The spiders retain both palpi only a few hours after the penultimate molt. During this time they seem to be annoyed with the new size of their palpi for they frequently stretch and examine them with their legs. In three cases the actual separation of the palpus from the cephalothorax was observed under excellent conditions with a binocular microscope. The procedure was the same. A scaffold of silk was made from which the spider suspended himself, and into which the palpus selected for amputation was secured. The spider turned in a circle under the palpus, at the same time pushing it with its third and fourth pair of legs. The palpus did not turn with the body. In this way the spider actually twisted and pulled off his palpus. The palpus

remained in the silk and the spider took a position a short distance away for a few minutes, apparently resting. He then returned to the palpus and began feeding on it at the former point of attachment. The bulb expanded and contracted a few times while diminishing in size, indicating the action of the spider's pumping stomach. After extracting the juices, the spider rolled the remnant of the palpus over a few times and then cast it aside.

After the next and final molt there is no indication of regeneration at the place of amputation such as would be found in the case of an accidental loss of an appendage.

All of the spiders lost one palpus. Nine lost the right and six lost the left. All of them lost the palpus within a few hours after the penultimate molt. Two died in the effort to withdraw the palpus during the final ecdysis.

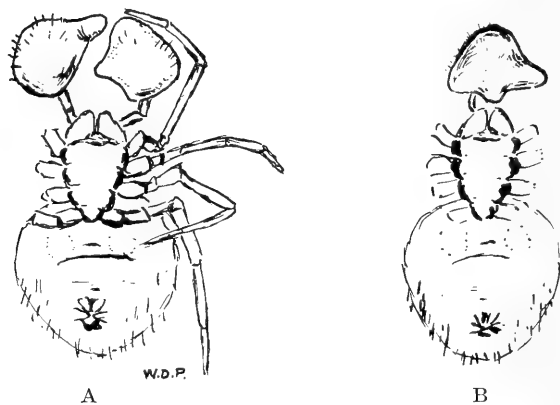


PLATE 28

Tidarren fordum (Keyserling 1884)

Chamberlin and Ivie 1934, enlarged, (A) Shortly after penultimate molt; (B) After amputation.

Drawing by W. Dwight Pierce.

NEARCTIC AMMOPLANUS

(Hymenoptera: Sphecidae: Pempredonini)

By V. S. L. PATE

Cornell University

Over a century ago Herrich-Schaeffer in his *Nomenclator Entomologicus* illustrated and characterized an unnamed genus of small wasps. Subsequently in 1869, Giraud figured and fully described it under the name *Ammoplanus*. Until recently, however, the genus has received little attention, probably because of the extremely small size of the component forms and their relative rarity in collections. Several years ago Dr. P. H. Timberlake of Riverside, California, kindly forwarded to me for study a remarkable collection of *Ammoplanus* and related genera taken by him in southern California. All of these, except *Ammoplanus*, have been reported upon elsewhere.¹ The present paper is a review of the Nearctic species of *Ammoplanus*, based largely upon the southern California material collected by Dr. Timberlake.

AMMOPLANUS Giraud

N. GEN. Herrich-Schaeffer, *Nomencl. entom.* II, p. 53, pl. V, fig. 21, (1840).

AMMOPLANUS Giraud, *Ann. Soc. Ent. France*, (4), IX, p. 469, pl. XII, fig. 1, (1869). Reinhard, *Verh. Zool.—bot. Gesch. Wien*, XXXIV, p. 131, (1885)—Kohl, *Ann. K. K. Naturhist. Hofmus. Wien*, V, p. 61, (1890); [in part]: XI, p. 270, (1896); [in part]. Arnold, *Ann. Transvaal Mus.*, X, p. 58, (1923): XI, p. 41, (1924): XII, p. 118, (1927); [Ethiopian species]—Berland, *Faune de France*, XI, p. 149, (1925): XIX, p. 179, (1928)—Schmiedeknecht, *Hymen. N. u. Mitteleurop.*, Zw. Aufl., pp. 667, (1930)—Brohmer's *Tierwelt Mitteleurop.*, V: 2, *Hymen.*, p. 119, (1930)—Gussakovskij, *Bol. Soc. Españ. Hist. Nat.* XXXI, pp. 437-457, (1931); [rev. Palaearctic species]—Bondroit, *Ann. Soc. R. Zool. Belg.*, LXIII, p. 26, (1932)—Pate, *Trans. Amer. Ent. Soc.*, LXIII, p. 98, (1937); [Nearctic species]: LXIV, p. 390, (1939): *Mem. Amer. Ent. Soc.*, no. 9, p. 7, (1937)—Maréchal, *Bull. & Ann. Soc. Ent. Belg.*, LXXXVIII, p. 397, (1938); [synonymical notes]—Maneval, *Ann. Soc. Ent. France*, CVIII, pp. 78-81, (1939).

¹Cf. Pate: *Studies in the Pempredonine Wasps. II.—Records and descriptions of new forms in the Ammoplanoid Complex from the southwestern United States.* *Trans. Amer. Ent. Soc.*, LXIV, pp. 373-420, (1939).

HOPLOCRABRON De Stefani, Naturalista Siciliano, VI, p. 60, (1886).

GENOTYPE: *Ammoplanus Perrisi* Giraud, 1869.² (By designation of Pate, 1937, Trans. Amer. Ent. Soc., LXIII, p. 98.)

The distinctive venation of the fore and hind wings readily separates *Ammoplanus* from all other Pemphredonine wasps. A key for the recognition of the various genera of this tribe has been presented elsewhere.³

Generic Characters. Minute, more or less fulgid forms. Head subquadrate in anterior aspect, transversely linear-elliptical in dorsal aspect; eyes glabrous, inner orbits subparallel, somewhat arcuate, truncate below; malar space wanting or reduced to a mere line; vertex subquadrately arched and extending above dorsal margins of eyes for about one-half their length; median ocellus situated well above dorsal margin of eyes; temples narrow. Antennae thirteen-segmented in males, twelve-segmented in females, situated low on face on dorsal margin of clypeus, the sockets well separated from each other and from nearest eye margin; scapes cylindrical, ecarinate; flagellum relatively simple. Clypeus short, transverse, usually excised medially and frequently dentate there. Labrum large, usually inflexed, apical margin entire to deeply excised. Mandibles with apices acute and inner margins with a preapical tooth; lower margins entire. Females without a psammophore other than clypeal ammochaetae.

Thorax with pronotum short, transverse, situated below level of mesonotum and narrower than it, rounded and gently declivous anteriorly to level of neck; the tubercles almost attaining tegulae. Mesonotum simple, gently arched anteriorly to level of pronotum; scutellum and postscutellum simple. Mesopleura with prepectus rounded anteriorly; episternal suture vertical or almost so from below tegulae; mesopleural pit usually present; omauli, episternauli, mesopleurauli, hypersternauli and sternauli all absent. Propodeum more or less elongate; posterior face more or less vertical; lateral carinae absent. Mesosternum rounded anteriorly.

Legs relatively simple; hind metatarsi occasionally modified; females usually without a pecten on fore tarsi.

² Reinhard, Kohl and Gussakovskij all recognized the females (but not the males). Giraud described as *wesmaeli* as merely the opposite sex of *Perrisi* Giraud (based on a unique male). Recently, Maréchal has confirmed this but contends the name *wesmaeli* should be applied to the species hitherto known as *perrisi* because *wesmaeli* has page priority over *perrisi*. However, in conformance with Article 28 of the Rules of Zoological Nomenclature, *perrisi* may still be retained as the name for this species.

³ Cf.: Trans. Amer. Ent. Soc., LXIII, pp. 90-93, (1937).

Fore wings with stigma very large, ovate to semicircular; marginal cell very short, oblique, open or closed at apex, costal vein present or absent distad of stigma; submarginal cell elongate; only one transverse cubital vein; cubitus with second abscissa subequal in length to first abscissa; first recurrent vein present; only two discoidal cells. Hind wing with costal vein absent, the costal cell thus open; radial vein vertical or inclivous; median cell closed; anal lobe large, elongate, subequal in length to submedian cell.

Abdomen sessile, oval, more or less depressed. Females with or without a pygidium on last tergite; males never with a pygidium. Males with the apical sternites simple or modified.

Ethology. The only extensive biological data on the habits of any *Ammoplanus* is Maneval's excellent and carefully illustrated recent account of the European *A. perrisi*.⁴ At Puy in France, Maneval found this species utilizing pre-existing fissures within an old dry stone wall for its nests. These were provisioned with immature Thrips, less than a millimetre in length. Apparently the wasp did not paralyze its prey by stinging, but, like other small Sphecoids which prey upon aphids, malaxated it with its mandibles into a completely immobile state. Successive generations continue to use the same fissure for a nesting site, according to Maneval.

In Southern Rhodesia, Arnold discovered *A. consobrinus* nesting in a decayed wooden post at Helenvale; and *A. rhodesianus* in cracks and crannies of an old mud wall at Bulawayo, and in a sandy bank at Sawmills. Because of their small size and lack of any fossorial adaptation, it is unlikely that any *Ammoplanus* ever excavates a burrow, but instead merely utilizes pre-existing crannies in old stone or mud walls, or holes in decayed or rotten posts and logs.

Distribution. The genus *Ammoplanus* is broadly distributed throughout the Holarctic Region, with a few representatives also known from South Africa and one from the island of Madagascar.

Three distinct subgeneric groups are recognizable within the genus.

Key to the Subgenera of AMMOPLANUS

1. Fore wings with the costal vein present distad of the stigma, the radial vein attaining the costal margin and thus closing the marginal cell. Females with a trigonal pygidium on last abdominal tergite; males with the apical abdominal sternites more or less modified; (Holarctic forms).....
.....*Ammoplanus* Giraud

⁴ Maneval, H. Notes sur les Hyménoptères; Sur *Ammoplanus Perrisi* Gir. Ann. Soc. Ent. France, CVIII, pp. 78-81, figs. 106-118, (1939).

- Fore wings with the costal vein absent distad of stigma, the radial vein never attaining the costal margin, the marginal cell thus open.....2
2. Females with a distinct pygidium on last abdominal tergite; males with apical abdominal sternites more or less modified; mesopleura with mesopleural pit small or indistinct; (Nearctic forms).....*Parammoplanus* Pate
- Females without a pygidial area on last abdominal tergite; males with the apical abdominal sternites simple, unmodified; mesopleural pit large and conspicuous; (Old World forms).....*Ammoplanellus* Gussakovskij

Subgenus AMMOPLANUS Giraud

Ammoplanus Giraud, Ann. Soc. Ent. France, (4), IX, p. 469, (1869).

Ammoplanus (*Ammoplanus**) Gussakovskij, Bol. Soc. Españ. Hist. Nat., XXXI, p. 443, (1931); [Palearctic species]—Pate, Trans. Amer. Ent. Soc., LXII, p. 101, (1937); [Nearctic species].

In a subgeneric sense, the name *Ammoplanus* is restricted to those species agreeing with the genotype, *Ammoplanus perrisi* Giraud, in having the costa of the fore wing present distad of the stigma and thus completely closing the marginal cell. In addition, the males have the apical abdominal sternites more or less modified and the females are furnished with a distinct trigonal pygidium on the last abdominal tergite.

Distribution. The nominate subgenus is widely distributed throughout the Palearctic, Nearctic and Ethiopian Regions. At least a dozen species are known from the Palearctic Region, one from South Africa, and seven from North America. With the exception of the eastern Pennsylvania form *unami*, all the Nearctic species known at present are western, largely southwestern, in distribution.

Key to Nearctic Species

1. Males..... 2
 Females..... 4
2. Facial markings deep yellow; antennae short, the scape five-sixths the vertical eye length, the flagellar articles not rounded out beneath; fifth abdominal sternite with the medio-apical prongs separated at base, straight, spinoid and not unciform.....*telli* new species
- Facial markings white or whitish-yellow; antennae long, the scape two-thirds the vertical eye length, the flagellar articles more or less rounded out beneath; fifth abdominal sternite with the medio-apical prongs contiguous at base and unciform..... 3

3. Sixth abdominal sternite with caudal margin broadly retuse medially, on each side of emargination with a short hirsute lobe; pleura subopaque, with longitudinal horizontal striae or aciculations; propodeum with dorsal and lateral faces finely, microscopically granulose, the latter with oblique aciculation; clypeal excision narrower, the latero-apical angles rounded; scape two-thirds the vertical eye length.....

.....*chemehuevi* new species

Sixth abdominal sternite with caudal margin broadly rounded out to obtusely angulate medio-apically, without hirsute lobes laterally; pleura and lateral faces of propodeum nitidous; propodeum with dorsal face finely, transversely rugulose; clypeal emargination broader, the latero-apical angles more or less acute; scape one-half the vertical eye length.....

.....*sechi* new species

4. Clypeus very short, transversely linear, medially with a very wide and shallow subrectangular excision; scape more than four-fifths the vertical eye length; interantennal line two-thirds the antennocular distance.....

.....*loti* new species

Clypeus longer medially than laterally, medially with a subtrigonal to subtrapeziform excision; scape less than three-fourths the vertical eye length

5

5. Clypeus with the median dorsal margin of excision straight, truncate, the lateral margins repand and arcuately divergent; scape seven-tenths the vertical eye length; antennocular line two-thirds the interantennal distance.....

.....*chemehuevi* new species

Clypeus with the median dorsal margin of excision angulate or armed with a distinct tooth.....

6

6. Clypeus with median dorsal margin of excision merely angulate; inner dorsal margins of eyes without an oblique groove; interantennal line distinctly shorter than antennocular distance; (eastern forms: Pennsylvania).....

.....*unami* Pate

Clypeus with median dorsal margin of excision armed with a strong tooth; inner dorsal margins of eyes with an oblique groove; interantennal line distinctly longer than antennocular distance; (western forms).....

7

7. Front without a strong median longitudinal impression; clypeal excision about twice as long as broad, the tooth on median dorsal margin almost as long as the depth of the excision; scape five-eighths the vertical eye length; antennocular line two-thirds the interantennal distance; mesonotum subfulgid, with a fine, relatively close acupuncturation, and with short, aeneous, decumbent, puberulent pubescence; dorsal face of propodeum grandulose

.....*vanyumi* new species.

Front with a strong median longitudinal impression; clypeal excision about as long as broad at base, the tooth on median dorsal margin not more than half as long as depth of excision; scape seven-tenths the vertical eye length; antennocular line seven-eighths the interantennal distance; mesonotum subnitidous, relatively glabrous, with sparse acupuncturation discally and microscopically fine transverse cancellate aciculation posteriorly; dorsal surface of propodeum with fine, irregular, transverse rugulae.....
.....*quabajai* new species

AMMOPLANUS (AMMOPLANUS) LOTI new species

(FIGURE 11)

The extremely narrow, transversely linear clypeus, subrectangularly excised medially, immediately differentiates *loti* from all other Nearctic *Ammoplanus* with the exception of the following montane form *tethi*. But the great disparity in the scapal-eye and interantennal-antennocular ratios is more than sufficient to separate *loti* from that species.

Type. ♀; Riverside, Riverside County, California. April 5, 1934. (P. H. Timberlake; on *Lotus scoparia* [Deerweed].)

Female. 2 mm. long. Black; the following croceous: mandibles except rufous apices, palpi, scapes anteriorly, first three flagellar articles and pedicel beneath. Luteous: fore tibiae on outer faces and all tarsi. Fuscous: tegulae, axillary sclerites, and legs except as noted above. Clypeus castaneous. Wings clear hyaline, iridescent; veins and stigma fuscous, the latter pellucid at base.

Head fulgid, glabrous; subquadrate, longer than broad in anterior aspect; inner orbits arcuate, subparallel to slightly convergent below; vertex subquadrately arched and produced above dorsal margins of eyes for a distance equal to half the vertical eye length; median ocellus situated distinctly above dorsal margins of eyes. Front flat, with microscopically fine longitudinal cancellate aciculation; vertex and temples nitidous, with a very fine, sparse, inconspicuous puberulent pubescence. Antennae with scapes subcylindrical, slightly bowed, nearly seven-eighths (.8568) the vertical eye length; pedicel subcylindrical, glabrous nitidous, twice the length of first flagellar article; flagellum simple, finely puberulent, first segment three-fourths the length of second, ultimate article simple, terete, twice the length of penult segment; interantennal line two-thirds the antennocular distance. Clypeus nitidous, glabrous, transversely linear, one-fourteenth (.0714) the vertical eye length; subrectangularly excised medially almost to bases of antennae, the dorsal margin of excision truncate, edentate, the lateral margins arcuately divergent, the latero-apical angles acute; apical margins of lateral lobes obscurely and shallowly sinuate, and provided with a row of declivent setulae.

Mandibles with apices acute; inner margins with a small blunt, rounded preapical tooth, otherwise edentate; lower margins simple, edentate.

Thorax fulgid, relatively glabrous. Pronotum short, transverse, subopaque, with fine transverse cancellate aciculation, narrower than mesonotum and situated somewhat below level of it, anterior dorsal margin rounded and gently declivous to neck, the tubercles almost attaining tegulae. Mesonotum fulgid, slightly arched anteriorly to level of pronotum; with microscopically fine cancellate sculpture upon which is superposed a few scattered acupunctures, notauli evident anteriorly; scutellum flat, nitidous anteriorly to transversely microscopically aciculate posteriorly, anterior margin with a finely consute furrow; postscutellum flat, nitidous. Mesopleura perfulgid, with faint horizontal aciculation anteriorly to nitidous posteriorly; episternal suture impressed, faintly consute; mesopleural pit small; metapleura nitidous above to obscurely cancellate below. Propodeum with dorsal face glabrous, subopaque, microscopically obgranulate, bisected by a longitudinal carinule, traversed laterally with very fine rugulae; posterior face subfulgid, subnitidous, laterally with a very sparse vestiture of light puberulent hair. Weakly margined dorsally, disc bisected by a shallow sulcus which is widened dorsad to form a shallow pyriform fovea; lateral faces subnitidous.

Legs simple; all tarsi unmodified.

Abdomen suboval, depressed. First three tergites nitidous, glabrous; remainder fulgid, very sparsely pubescent, and with very fine transverse aciculation; ultimate tergite with a well defined trigonal pygidium, the disc subopaque, and furnished with scattered fine, setigerous acupunctures. Sternites subopaque, sparsely and inconspicuously puberulent, with fine transverse aciculation, and sparse scattered acupunctures.

Male. Unknown.

This little vernal form is known only from the unique female described above.

AMMOPLANUS (AMMOPLANUS) TETLI new species

(FIGURE 1)

The croceous maculations and the structure of the antennae and of the medio-apical prongs of the fifth abdominal sternite readily differentiate *tetli* from both *sechi* and *chemehuevi*.

Type. ♀; Tetly Park⁵, San Bernardino Mountains, California. May 23, 1936. (P. H. Timberlake.)

⁵ "Tetly Park is a real estate subdivision name . . . near Crestline, about five miles west of Lake Arrowhead in the drainage basin of the Mohave River." (Timberlake.)

Male. 2 mm. long. Black; the following croceous: mandibles except rufous apices, labrum, palpi, clypeus, front with a subquadrate spot along lower inner orbits for about one-third their length and a subtrigonal one medially between and above antennal sockets, scape, pedicel and first few flagellar articles, fore legs distad of coxae (the femora somewhat lurid), middle and hind tibiae basally at knees, and middle and hind tarsi. Fore coxae stramineous. Flagellum fuscous above. Tegulae and axillary sclerites light brunneous. Apical sternites testaceous. Wings hyaline, iridescent; stigma brunneous, veins testaceous.

Head subfulgid, glabrous or nearly so; subquadrate in anterior aspect, the vertex produced above dorsal margins of eyes for one-half their length. Front flat; with microscopically fine cancellate aciculation to dorsal margins of eyes, above that and including vertex and temples nitidous save for a few scattered acupunctures; inner orbits subparallel, slightly arcuate, without medial or orbital impressions. Antennae reaching about to tegulae; scape straight, subcylindrical, five-sixths the vertical eye length; pedicel one and a half times the length of first flagellar article; flagellum finely puberulent, inconspicuously clavate apically, the segments not rounded out beneath, first two segments subequal in length, ultimate article simple, terete, twice the length of preceding segment; interantennal line one-half the antennocular distance. Clypeus flat, nitidous; transversely linear, very short, one-sixth the vertical eye length; medially with a subrectangular excision almost to bases of antennae, dorsal margin of excision truncate, edentate, lateral margins more or less vertical, latero-apical angles acute; apical margins of lateral lobes obscurely repand. Temples obscurely aciculate, with widely scattered setigerous acupunctures. Mandibles with apices acute; inner margins with a small, blunt, rounded preapical tooth, otherwise edentate; lower margins simple.

Thorax fulgid, more or less glabrous. Pronotum short, transverse, subnitidous, with very faint transverse aciculation; anterior dorsal margin rounded and gently declivous to neck, tubercles almost attaining tegulae. Mesonotum slightly arched anteriorly, notauli evident on anterior fourth, with microscopically fine cancellate aciculation and a few scattered setigerous acupunctures; scutellum and postscutellum flat, glabrous, subnitidous, the former with a finely subconsute furrow along anterior margin. Mesopleura with prepectus obscurely cancellate, remainder subnitidous, episternal suture subconsute, mesopleural pit distinct; metapleura glabrous, subnitidous. Propodeum glabrous; dorsal face subfulgid, bisected by a longitudinal carinule from which diverge a number of transverse to slightly oblique subparallel fine rugulae; posterior face subnitidous, bisected by a sulcus which becomes foveoid above; lateral faces fulgid, with a few oblique to almost vertical striae.

Legs simple, thinly clothed with fine appressed silvery puberulent pubescence; all tarsi unmodified.

Abdomen oval, depressed, fulgid. First five tergites nitidous and glabrous save for a submarginal row of short declivent setulae; remainder sparsely pubescent. Sternites with very fine transverse aciculation, the first five glabrous, remainder sparsely pubescent; fifth sternite with a pair of long, spinoid prongs medio-apically, which are widely separated at base and obliquely divergent caudad, apical margin rounded out between prongs and slightly impressed laterad of them; sixth sternite transverse, convex, apical margin strongly arcuate, slightly produced medio-apically, laterally on each side with a transverse, somewhat oblique, setigerous welt; seventh sternite convex, apical margin entire; eighth sternite elongate linguiform, the apex bluntly pointed, the margins minutely serrulate.

Female. Unknown.

This interesting little montane form is known only from the unique male. Eventually, *tetli* may prove to be the male sex of either *loti* or *vanyumi*.

AMMOPLANUS (AMMOPLANUS) SECHI⁶ new species
(FIGURE 8)

Like *chemehuevi*, the present species has the antennae elongate with the flagellar articles rounded out beneath, the clypeus of the male transversely linear and subtrapezoidally excised medially, and the medio-apical prongs of the fifth abdominal sternite contiguous at base and unciform. But the nitidous pleura, the transversely striate dorsal face of the propodeum, the broader, shallower clypeal excision of the male, the relatively shorter antennal scape, and the different shape of the sixth abdominal sternite stamp *sechi* as a species indubitably discrete from *chemehuevi*.

Type. ♂; Andreas Canyon,⁷ Palm Springs, Riverside County, California. April 24, 1932. (P. H. Timberlake; on *Eriogonum fasciculatum* var. *polifolium* [California Buckwheat].)

Male. 2 mm. long. Black; the following eburneous: mandibles except fulvous apices, palpi, labrum, clypeus, a small trigonal spot along lower inner orbits, scapes anteriorly, pedicel, and all tarsi. Sordid eburneous: flagellum beneath, all tibiae at base and

⁶ After a former Cahuilla site near Palm Springs, California.

⁷ Andreas Canyon is a side canyon of Palm Canyon, about five miles south of Palm Springs. Cf. J. S. Brown: U. S. G. S. *Water-Supply Paper* 490-A, p. 77 and pl. vi, (1920).

apex. Flagellum fuscous above. Fore tibiae infused with luteous medially; apical abdominal sternites testaceous. Wings clear hyaline, iridescent; stigma badeous, veins dilute stramineous.

Head fulgid, subquadrate, glabrous or nearly so. Front with fine microscopic longitudinal cancellate aciculation to dorsal margins of eyes, thence to and including vertex and temples nitidous except for a few widely scattered setigerous acupunctures. Front flat; eyes truncate below, reaching to bases of mandibles, inner orbits subparallel, slightly arcuate, inconspicuously convergent below; vertex arcuately produced above dorsal margins of eyes for one-half their length; median ocellus situated about one-half the length of eyes above their dorsal margins, ocelli in a low triangle, postocellar line about two-thirds the ocellocular distance. Antennae elongate, reaching to beyond tegulae; scape cylindrical, two-thirds the vertical eye length; pedicel cylindrical, twice the length of first flagellar article; flagellum finely puberulent, the segments rounded out beneath, first segment three-fourths the length of second, last article simple, terete, twice the length of preceding segment. Clypeus flat, glabrous, nitidous; transversely linear, laterally one-eighth the vertical eye length, not widened medially but subrectangularly excised for almost two-thirds the clypeal length, dorsal margin of excision truncate, edentate, lateral margins subparallel to somewhat divergent distad, latero-apical angles acute; apical margin of lateral lobes weakly sinuate. Labrum flat, nitidous, glabrous, subquadrate, lateral margins oblique and somewhat convergent distad, truncate apically and retuse medio-apically. Mandibles narrow, sublinear to subfalcate; apices acute; inner margin with a long oblique shoulder running from just before apex almost to base; lower margins simple, edentate.

Thorax fulgid, with very sparse, inconspicuous puberulent pubescence on mesonotum, scutellum and prepectus, mesosternum with a more noticeable vestiture of appressed silvery pubescence. Pronotum nitidous, narrower than mesonotum and situated below level of it, anterior margin rounded and gradually declivous to neck, tubercles almost attaining tegulae. Mesonotum gradually and roundly declivous anteriorly to level of pronotum; with very fine, sparse, setigerous acupuncturation, posteriorly with microscopically fine, transverse aciculation; notauli weakly indicated on anterior fourth; scutellum flat, sculptured like mesonotum, anterior margin with a simple furrow; postscutellum flat, nitidous. Mesopleura with very sparse, fine, setigerous acupuncturation, remainder glabrous and nitidous; episternal suture subconsute; mesopleural pit small; metapleura glabrous, nitidous above, fulgid and obscurely subgranulose below. Propodeum fulgid, glabrous; dorsal face bisected by a fine longitudinal carinule which is obsolescent posteriorly, and laterad of which the surface is finely, transversely rugulose to aciculate; posterior face nitidous, bisected by a sulcus; lateral faces nitidous, glabrous.

Legs simple; with a thin vestiture of fine, appressed, short whitish pubescence; all tarsi simple, unmodified.

Abdomen sessile, oval, depressed, nitidous. Tergites glabrous except for a transverse median and subapical row of very short, widely separated, suberect setulae; last tergite without a pygidium. Sternites with microscopically fine, transverse, cancellate aciculation; first four glabrous save for a submarginal row of short setulae, remainder sparsely pubescent; fifth sternite with apical margin not impressed laterally, medioapically with a pair of stout, spinoid, divergent, unciform prongs whose bases are contiguous; sixth sternite convex, medially with a very faint longitudinal keel, posterior margin entire and very obtusely angulate caudad, medio-apically with a minute, acute button, laterally sparsely hirsute; seventh sternite convex, tumid discally, obscurely retuse medio-apically; eighth sternite elongate, linguiform, apex minutely serrulate and sparsely hirsute.

Female. Unknown.

Specimens examined. Four topotypic, equidatic males have been examined in addition to the type. These paratypes agree with the type in all essential details of livery and structure.

AMMOPLANUS (AMMOPLANUS) CHEMEHUEVI⁸ new species

(FIGURES 5, 6)

This species has the superficial habitus of *sechi* with which it agrees in the elongate antennae with the flagellar articles rounded out beneath, in the general shape of the clypeus, and in the similar unciform medio-apical prongs of the fifth abdominal sternite of the male. Moreover, *chemehuevi* is a vernal species like *sechi*, flying with the latter at the same locality and visiting the same flowers. However, it may be readily differentiated from that form by the horizontally aciculate mesopleura and lateral propodeal faces, the narrower and more deeply excised clypeus of the males, the relatively longer antennal scape, the tumid labral disc, the non-striate dorsal face of the propodeum and the different shape of the sixth abdominal sternite of the male.

Type. ♂; Andreas Canyon, Palm Springs, Riverside County, California, April 24, 1932. (P. H. Timberlake; on *Eriogonum fasciculatum* var *polifolium* [California Buckwheat.])

Male. 2 mm. long. Black; the following eburneous: mandibles except fulvous apices, palpi, labrum, clypeus, a small trigonal spot along lower inner orbits, scapes anteriorly, pedicel beneath.

⁸ After the Chemehuevi Indians of the Colorado Desert in southern California.

Flagellum sordid eburneous beneath. Fulvous: flagellum above, fore tibiae entirely, middle and hind tibiae narrowly at knees, all tarsi. Apical abdominal sternites testaceous. Wings clear hyaline, iridescent; stigma fuscous, veins badeous.

Head fulgid, subquadrate, as long as broad in anterior aspect, glabrous or nearly so. Front flat, lower two-thirds with microscopically fine, longitudinal cancellate aciculation, upper third, vertex and temples nitidous save for a few widely scattered setigerous acupunctures; vertex arcuately produced above dorsal margins of eyes for about one-half their length; ocelli in a low triangle, median ocellus situated well above dorsal margins of eyes, postocellar line two-thirds the ocellocular distance. Eyes truncate below, reaching bases of mandibles, inner orbits subparallel, slightly sinuate with tendency to converge below. Antennae elongate, reaching to tegulae; scapes cylindrical, slightly bowed, two-thirds the vertical eye length; pedicel cylindrical, subequal in length to first flagellar article; flagellum finely puberulent, the segments rounded out below, first two segments subequal in length, last article simple, terete, five-thirds the length of penult segment; interantennal line two-thirds the antennocular distance. Clypeus flat, glabrous, nitidous; transversely linear, laterally one-sixth the vertical eye length; not widened medially but subrectangularly excised there almost to antennal sockets, dorsal margin of excision truncate, edentate, lateral margins vertical and subparallel above becoming arcuately divergent below to the acute latero-apical angles; apical margin of lateral lobes weakly sinuate. Labrum subquadrate, about twice as long as clypeus, tumid discally, lateral margins somewhat oblique and weakly convergent distad, apical margin impressed and retuse medially. Mandibles narrow, sublinear to subfalcate, apices acute; inner margins with a long oblique shoulder running from just before apex almost to base; lower margins simple, edentate.

Thorax fulgid; pronotum narrower than mesonotum and situated below level of it, subnitidous, anteriorly with indistinct transverse aciculation, posterior margin slightly impressed, the anterior dorsal margin rounded and gently declivous to level of neck, the tubercles almost attaining the tegulae. Mesonotum gradually and roundly declivous anteriorly to level of pronotum; notauli evident on anterior fourth; inconspicuously clothed with a very short and sparse light pubescence; anteriorly with microscopically fine longitudinal aciculation becoming transverse and arcuate posteriorly; scutellum and postscutellum sculptured like mesonotum, the former with a subconsute furrow along its anterior margin. Mesopleura subopaque to subfulgid, with longitudinal horizontal aciculation or striae; prepectus with short, sparse, inconspicuous silvery pubescence, the remainder of pleura glabrous; episternal suture subconsute; mesopleural pit small;

metapleura subnitidous. Propodeum glabrous, subfulgid to subopaque; dorsal face very finely subgranulose, bisected by a longitudinal carinule; posterior face nitidous, discally above with a cuneiform fovea, laterally with sparse decumbent puberulent pile; lateral faces microscopically subgranulose, with fine horizontal aciculation.

Legs simple, all tarsi unmodified.

Abdomen sessile, oval, depressed, nitidous. Tergites glabrous except for a transverse, submarginal row of inconspicuous, short, widely separated setulae. Tergites and sternites with indistinct, fine, transverse aciculation; last tergite without a pygidium. Fifth sternite with apical margin not impressed laterally, medio-apically with two, slender, spinoid, divergent unciform prongs which are contiguous at base; sixth sternite flat, trapeziform, posterior margin retuse medially, on each side of which is a small, projecting, sparsely hirsute lobe; seventh sternite convex, apical margin entire and arcuate; eighth sternite elongate linguiform, apex hirsute and very finely serrulate.

Allotype. ♂; Topotypical. Same data as type.

Female. 2 mm. long. Black; the following ochraceous: labrum, palpi, scapes, pedicel, and all tarsi. Mandibles eburneous, apices rufous. Legs fuscous except fore tibiae entirely and middle and hind tibiae at base and apex are dilute testaceous. Otherwise as in male (type) except in the following details:

Head with front bisected below by a low, inconspicuous, longitudinal keel about two-thirds the length of scapes, and broadly, shallowly concave laterad of keel to form weak antennal scrobes. Upper inner orbits without oblique impression. Antennae reaching only to posterior margin of pronotum; scape subcylindrical, slightly dilated at apex, about seven-tenths (.715) the vertical eye length; pedicel one and a half times the length of first flagellar article; flagellum finely puberulent, the segments not rounded out beneath, first two subequal in length, last article twice the length of penult segment; antennocular line two-thirds the interantennal distance. Clypeus nitidous, glabrous, transverse; length laterally one-eighth the vertical eye length, widening mesad to one-fifth the vertical eye length; medially with a subtrapeziform excision, upper margin of which is narrow and truncate, the lateral margins repand, raised, and divergent distad, the disto-apical angles acute. Labrum subquadrate, dic bisected by a low keel, lateral margins oblique and convergent distad, apical margin triangularly excised medially thus making labrum appear bilobed.

Abdomen as in male but apical sternites simple and unmodified. Last tergite with a subequilateral trigonal pygidium, the lateral margins straight, the apex broadly rounded, disc flat, with scattered microscopic setigerous acupunctures, and fulgid.

Specimens examined. In addition to the types, I have examined a male taken by P. H. Timberlake at flowers of *Adenostoma fasciculatum* (Chamiso), June 21, 1938, on the Gavilan plateau, Riverside County, California. This paratype agrees with the type in all essential details of livery and structure.

AMMOPLANUS (AMMOPLANUS) UNAMI Pate
(FIGURE 9)

Ammoplanus (Ammoplanus) unami Pate, Trans. Amer. Ent. Soc., LXIII, p. 101, (1937); [♀ ; Lehigh Gap, Northampton Co., Penna.]

The features differentiating this eastern form from the other members of the subgenus have been presented in the key to species on a preceding page. The male sex of *unami* is still unknown.

Specimens examined. No material other than the type series of three females from Lehigh Gap in eastern Pennsylvania has been seen.

AMMOPLANUS (AMMOPLANUS) VANYUMI⁹ new species
(FIGURE 12)

The present species resembles *quabajai* so closely that it may be easily confused with that form, but the flat unfurrowed front, the different clypeal conformation, the relatively shorter scape and the different antennocular-interantennal ratio easily differentiate *vanyumi* from *quabajai*.

Type. ♂ ; Mouth of Deep Creek (at junction with the Mohave River), San Bernardino Mountains, San Bernardino County, California. May 5, 1936. (P. H. Timberlake; on *Eriodictyon trichocalyx* [Yerba Santa].)

Female. 2.5 mm. long. Black; the following sordid fulvous: scapes, pedicel, first few flagellar articles beneath (remainder of flagellum fuscous), fore femora beneath, and all tarsi. Saturated stramineous: mandibles except rufous apices, and palpi. Legs fuscous. Clypeus castaneous. Wings clear hyaline, iridescent; stigma brunneous, veins dilute ochraceous.

⁹ After the Vanyumi, a division of the Serrano Indians, who formerly inhabited the region of the Mohave River in California.

Head perfulgid, subglabrous; subquadrate in anterior aspect. Front flat, not bisected by a furrow, lower half with microscopic ally fine cancellate aciculation, the upper half and vertex, occiput and temples nitidous save for a few widely spaced setigerous acupunctures. Eyes with inner orbits subparallel, shallowly sinuate, dorsally with a short oblique groove; vertex subquadrate produced above dorsal margins of eyes for over one-half their length, subtruncate behind; ocelli in a subequilateral triangle, median ocellus situated well above dorsal margins of compound eyes. Antennae short, reaching about to tegulae; scapes slender, cylindrical, slightly bowed, five-eighths the vertical eye length; pedicel cylindrical, subequal in length to first flagellar article; flagellum finely puberulent, the segments not rounded out beneath, the second two-thirds length of first, last article simple, terete, subequal in length to two preceding combined; antennocular line two-thirds the interantennal distance. Clypeus flat, glabrous, nitidous; transversely sublinear, laterally one-sixteenth widening mesad to one-eighth the vertical eye length; medially with a subtrapeziform excision almost to bases of antennae, dorsal margin of excision with an elongate, slender, spinoid tooth almost as long as excision is deep, lateral margins arcuately divergent, latero-apical angles acute; apical margin of lateral lobes repand, provided with a submarginal row of declivent setulae. Labrum at least twice as long as median clypeal length; lateral margins oblique, convergent distad, medio-apically with a deep rounded excision thus making it appear bilobed. Mandibles with apices acute; inner margins with a small preapical tooth, basad of which the inner margin is inconspicuously and weakly dilated; lower margins simple, edentate.

Thorax more or less fulgid. Pronotum narrower than mesonotum and situated below level of it; with transverse microscopic aciculation; posterior margin impressed; anterior margin rounded and gently declivous to neck, the tubercles almost attaining the tegulae. Mesonotum subfulgid, gently arched anteriorly to level of pronotum; with an inconspicuous vestiture of very short aeneous hair; with fine, rather close acupunctures superposed on a microscopically fine cancellate sculpture; scutellum flat, sculpture and vestiture like mesonotum, anteriorly with a transverse, distinctly consute furrow; postscutellum glabrous, nitidous. Mesopleura with prepectus subfulgid and with fine, sparse, setigerous acupuncturation, remainder of pleura subnitidous, subglabrous; episternal suture subconsute; mesopleural pit distinct; metapleura glabrous, subnitidous. Propodeum with dorsal face glabrous, subopaque, very finely granulate, bisected by a very fine longitudinal carinule; posterior face glabrous, the disc nitidous and with an elliptical fovea, laterally with sparse acupuncturation and a very thin vestiture of subaeneous puberulent hair; lateral faces subfulgid, glabrous, subgranulose with oblique vertical striae.

Legs thinly clothed with whitish puberulent pile; fore tarsi without a pecten; tibiae not spined; hind tarsi simple.

Abdomen sessile, oval, depressed, fulgid. First five tergites nitidous and glabrous except for subapical rows of short declivent setulae, and sparse whitish pubescence laterally; last tergite with a distinct trigonal pygidium, the disc with fine, scattered, setigerous acupunctures. Sternites with inconspicuous, microscopic cancellate aciculation and sparse pubescence, particularly noticeable on last sternite.

Male. Unknown.

This little form of the Upper Sonoran and Transition Zones of the San Bernardino Mountains is known from only the unique female described above.

AMMOPLANUS (AMMOPLANUS) QUABAJAI¹⁰ new species
(FIGURE 10)

The strongly furrowed front, the different clypeal conformation and interantennal-antennocular ratio, the longer scape, and the more fulgid habitus separate *quabajai* from its closest relative, the preceding form *vanyumi*.

Type. ♀; Waterman Canyon, San Bernardino Mountains, San Bernardino County, California. Elevation, 3800 feet. May 15, 1937. (P. H. Timberlake; on *Ceanothus integerrimus* [White Lilac].)

Female. 2.5 mm. long. Fulgid black; the following sordid fulvous: palpi, scapes, pedicel, basal flagellar articles beneath (remainder of flagellum brunneous), and tarsi. Mandibles ochraceous, apices rufous. Clypeus castaneous. Legs light brunneous. Wings clear hyaline, iridescent; veins and stigma brunneous.

Head perfulgid, subglabrous; subquadrate in anterior aspect. Front bisected by a strong longitudinal impression; with faint and indistinct transverse cancellate aciculation below, above and vertex, occiput and temples nitidous save for a few widely separated setigerous acupunctures. Eyes with inner orbits subparallel, shallowly sinuate, dorsally with a short oblique groove; vertex subquadrately produced above dorsal margins of eyes for at least half their length, subtruncate behind; ocelli in a subequilateral triangle, median ocellus situated well above dorsal margins of eyes. Antennae with scapes slender, subcylindrical, slightly

¹⁰ After a group of the Serrano Indians, called the Quabajai by the Mohave Indians of southern California.

bowed, about seven-tenths (.715) the vertical eye length; pedicel subcylindrical, one and a half times the length of first flagellar article; flagellum finely puberulent, the segments not rounded out beneath, first two segments subequal in length, last article subequal to preceding two combined. Clypeus flat, glabrous, nitidous; transverse, one-sixth the vertical eye length; medially with a subtrapeziform excision almost to bases of antennae, dorsal margin of excision with a slender, spiniform tooth medially, its length about half the depth of clypeal excision, lateral margins arcuately divergent, latero-apical angles acute; lateral lobes with apical margin repand, provided with a submarginal row of declivent setulae. Labrum twice as long a median clypeal length; lateral margins obliquely convergent distad, medio-apically deeply and acutely excised, the lobes subacute distally. Mandibles with apices acute; inner margins with a small preapical tooth, basad of which margin is inconspicuously and weakly dilated; lower margins simple, edentate.

Thorax perfulgid. Pronotum narrower than mesonotum, situated below level of it, subnitidous; dorsal face shallowly concave; rounded and gently declivous anteriorly to level of neck; posterior margin impressed; tubercles almost attaining tegulae. Mesonotum gently arched anteriorly to level of pronotum; subnitidous, with very sparse and scattered setigerous acupuncturation, and posteriorly with indistinct transverse fine cancellate aciculation; scutellum and postscutellum glabrous, nitidous, the former with a weakly consute furrow along anterior margin. Mesopleura subglabrous, subnitidous; episternal suture arcuate, finely consute; mesopleural pit small, distinct; metapleura glabrous, nitidous. Propodeum with dorsal face glabrous, subfulgid, minutely subgranulose, bisected by a strong longitudinal carinule from which diverge transverse, irregular rugulae; posterior face with disc nitidous, bisected by an elongate cuneiform impression, lateral surface minutely acupunctate and with a very thin vestiture of light, puberulent hair; lateral faces glabrous, fulgid, obliquely striate.

Legs thinly clothed with fine white hair; fore tarsi without a pecten; hind tarsi simple; tibiae not spinose.

Abdomen sessile, oval, depressed, perfulgid. First five tergites glabrous and nitidous save for a submarginal row of widely separated, declivent, light, very short setulae; last tergite with a broad, flat trigonal pygidium, the disc with very fine, scattered setigerous acupunctures. Sternites with inconspicuous, microscopic cancellate aciculation and sparse pubescence.

Male. Unknown.

Only the unique female of this little montane form is known.

Subgenus PARAMMOPLANUS Pate

Ammoplanus (*Ammoplanellus*) Pate, Trans. Amer. Ent. Soc., LXIII, p. 103, (1937). (Not of Gussakovskij, 1931.)

Ammoplanus (*Parammoplanus*) Pate, Trans. Amer. Ent. Soc., LXIV, p. 391, (1939).

GENOTYPE: *Ammoplanus* (*Ammoplanellus*) *apache* Pate, 1937. [= *Ammoplanus* (*Parammoplanus*) *apache* Pate.] (Original designation.)

The subgenus *Parammoplanus* is somewhat intermediate in character between the Old World complex *Ammoplanellus* and the nominate group, combining certain features of both, yet quite discrete from each. The wing venation of *Parammoplanus* is similar to that of *Ammoplanellus*, but whereas the females of the latter group lack a pygidial area and the apical abdominal sternites of the males are simple and unmodified, the females of *Parammoplanus* are furnished with a distinct trigonal pygidium on the last abdominal tergite, and the apical abdominal sternites of the males are more or less modified, agreeing in these details with the typical subgenus.

Distribution. The subgenus *Parammoplanus* is a small complex apparently confined to the Nearctic Region. Two species, one of which is separable into two distinct geographic races, are known at present.

Key to the Forms of the Subgenus PARAMMOPLANUS

- | | |
|--|---|
| 1. Males | 2 |
| Females | 4 |
| 2. Labrum transversely subrectangular, the apical margin truncate to retuse medially; (New Mexico to California) | |
| <i>apache</i> Pate | |
| Labrum subquadrate, deeply excised medio-apically and thus apparently bilobed..... | 3 |
| 3. Propodeum with dorsal face bisected by a strong carinule from which diverge on each side oblique subparallel rugulae; scutellum and postscutellum punctate; head with fine cancellate sculpture from clypeus to vertex and beyond, temples and posterior face finely, longitudinally striate; (eastern forms) | |
| <i>lenape lenape</i> Pate | |

Propodeum with dorsal face bisected by a fine carinule laterad of which surface is finely cancellate to transversely

aciculate; scutellum and postscutellum subnitidous; head with cancellate sculpture extending from clypeus only to dorsal margins of eyes, subnitidous above, temples and posterior face nitidous; (western forms).....
.....*lenape olamentke* new subspecies

4. Propodeum with dorsal face fulgid, bisected by a fine carinule and finely, closely transversely striato-aciculate; impression bisecting front strong *apache* Pate

Propodeum with dorsal face subopaque, bisected by a strong carinule, laterad of which surface is microscopically subgranulose and more or less traversed by rugulae.....
.....*lenape olamentke* new subspecies

AMMOPLANUS (PARAMMOPLANUS) APACHE Pate

(FIGURES 3, 4)

Ammoplanus (Ammoplanellus) apache Pate, Trans. Amer. Ent. Soc., LXIII, p. 106, (1937); [♂; Alamogordo, New Mexico].

This is primarily a Sonoran form and ranges widely throughout the southwestern United States from the Upper Rio Grande valley region westward through Arizona to southern California and thence northward as far as the Bay district.

Specimens examined: 15; 14 males, 1 female, as follows:

CALIFORNIA: Tamalpais, Marin Co.; June 20, 1926; (P. H. Timberlake; on *Photinia arbutifolia* [California Holly-Toyon or Christmasberry]): 2 ♂; (O. H. Swezey): 1 ♂. Lone Pine Canyon, San Gabriel Mts.; elevation 6000 ft.; July 21, 1936; (P. H. Timberlake; on *Tetradymia canescens*): 1 ♂. Big Bear Valley, San Bernadino Mts., San Bernardino Co.; July 6-8, 1934; (P. H. Timberlake; on *Apocynum androsaemifolium* [Spreading Dogbane]): 2 ♂; August 8, 1933; (P. H. Timberlake; on *Eriogonum umbellatum*): 1 ♀; August 6, 1933; (P. H. Timberlake; on *Monardella linoides*): 1 ♂. Mill Creek, San Bernardino Mts., San Bernardino Co.; elevation, 4800 ft.; September 27, 1936; (P. H. Timberlake; on *Chrysothamnus nauscosus* [Rubber-rabbitbrush]): 1 ♂. Riverside, Riverside Co.; October 15-26, 1925-34; (P. H. Timberlake; on *Eriogonum gracile* and *E. fasciculatum* [California Buckwheat]): 2 ♂.

ARIZONA: Prescott, Yavapai Co.; elevation about 5400 ft.; August 30, 1930; (P. H. Timberlake; at flowers of *Eriogonum*): 1 ♂.

NEW MEXICO: Alamogordo, Otero Co.; elevation, 4320-4600 ft.; June 6-26, 1902; (H. L. Viereck): 4 ♂.

AMMOPLANUS (PARAMMOPLANUS) LENAPE LENAPE Pate

Ammoplanus (*Ammoplanellus*) *lenape* Pate, Trans. Amer., Ent. Soc., LXIII, p. 104, (1937); [♂; Lehigh Gap, Northampton Co., Penna.].

The nominate subspecies of *lenape* is an eastern race distinguished from the western *olamentke* by a number of features which have been presented in the foregoing key to the forms of *Parammoplanus*. I have seen no material of typical *lenape* other than the type series from eastern Pennsylvania.

AMMOPLANUS (PARAMMOPLANUS) LENAPE OLAMENTKE¹¹
new subspecies

(FIGURES 2, 7)

This western atypical race of *lenape* is distinguished from the nominate eastern subspecies by its more fulgid, finely punctate habitus, more delicately sculptured propodeum, and the nitidous upper front, vertex, temples and posterior face of the head.

Type. ♂; Tamalpais, Marin County, California. June 20, 1926. (O. H. Swezey.)

Male. 2.5 mm. long. Fulgid black; the following stramineous: mandibles except red apices, clypeus, scapes anteriorly. Dilute fulvous; labrum, scapes posteriorly, pedicel, flagellum beneath (fuscous above). Castaneous: fore tibiae and all tarsi. Wings clear hyaline, iridescent; stigma light castaneous, pellucid at base, veins light fulvous.

Head perfulgid; subquadrate, slightly broader than long in anterior aspect; glabrous. Front flat, with microscopically fine cancellate sculpture to dorsal margins of eyes, nitidous above to and including vertex, temples and posterior aspect of head. Eyes with inner orbits subparallel, slightly arcuate. Antennae with scapes two-thirds the vertical eye length; pedicel five-thirds the length of first flagellar article; flagellum simple, the segments not rounded out beneath, first segment three-fourths the length of second, last article twice the length of penult segment; inter-antennal line two-thirds the antennocular distance. Clypeus flat, glabrous, nitidous; transversely linear, about one-seventh (.146) the vertical eye length; medially with a subrectangular excision almost to bases of antennae, excision three and a third times as

¹¹ After the Olamentke, a division of the Moquelumne Indians, who formerly inhabited Marin, Sonoma and Napa counties in California.

broad as deep, the dorsal margin truncate, edentate, lateral margins gently divergent, latero-apical angles acute; apical margin of lateral lobes gently sinuate. Labrum subtrapeziform, flat, lateral margins convergent distad, medio-apically with a deep trigonal excision, the lobes thus formed acute at apex. Mandibles with apices acute; inner margins with a blunt shoulder pre-apically; lower margins simple.

Thorax perfulgid. Pronotum, mesonotum and pleura with a faint and inconspicuous microscopically fine cancellate sculpture; scutellum and postscutellum subnitidous, the former with a minutely consute furrow along anterior margin. Propodeum perfulgid; dorsal face glabrous, with microscopically fine reticulate sculpture and weak transverse aciculation, bisected by a fine carinule; posterior face subnitidous, bisected by a weak furrow, laterally with a few light puberulent hairs; lateral faces glabrous, with a few subvertical striae.

Abdomen perfulgid. Tergites nitidous, glabrous save for a few scattered, very short, light hairs apically. Sternites with a faint, fine, transverse cancellate aciculation; fifth sternite medio-apically with a pair of contiguous, small, broad, flat to slightly unciform processes; sixth sternite convex, apical margin except for an abrupt, broad, shallow excision medially; seventh sternite flatly convex, apical margin evenly arcuate; eighth sternite slender, elongate, linguiform, the apex entire and minutely serrulate.

Allotype. ♀; Topotypical. Same data as type.

Female. 2.5 mm, long. Fulgid black; the following flavofulvous: mandibles except red apices, scapes, pedicel. Castaneous: labrum, clypeus, and palpi. Deep fulvous: fore tibiae, fore and middle tarsi. Otherwise as in type (male) except in the following details:

Head with front bisected by a longitudinal impression running dorsad from clypeus as far as upper orbits.

Thorax with the fine cancellate sculpture somewhat stronger than in male. Propodeum with dorsal face with microscopically fine reticulate sculpture, traversed by very fine and faint rugulae, and bisected by a fine carinule.

Abdomen on last tergite with a sharply defined, broad, flat trigonal pygidium, the disc subnitidous and with a few scattered minute setigerous acupunctures.

Specimens examined: 6; 4 males, 2 females, as follows:

CALIFORNIA: Tamalpais, Marin Co.; June 20, 1926; (O. H. Swezey): 2 ♂, 1 ♀; (type and allotype); (P. H. Timberlake; on *Photinia arbutifolia* [California Holly-Toyon or Christmas-berry]): 1 ♀; (paratype).

MONTANA: Western Montana, on Northern Pacific Railroad train; July 5, 1924; (P. H. Timberlake): 1 ♀; (paratype).

The paratypes agree with the types in all essential details of livery and structural detail, except that the female from western Montana has the transverse rugulae on the dorsal face of the propodeum more strongly developed than in the allotype.

EXPLANATION OF PLATE 29

Anterior aspect of head. (Greatly enlarged. All figures drawn to same scale.)

1. *Ammoplanus (Ammoplanus) tetti* new species. Male (type).
2. *Ammoplanus (Parammoplanus) lenape olamentke* new subspecies. Male (type).
3. *Ammoplanus (Parammoplanus) apache* Pate. Male (type).
4. *Ammoplanus (Parammoplanus) apache* Pate. Female (Big Bear Valley, San Bernardino Mountains, California).
5. *Ammoplanus (Ammoplanus) chemehuevi* new species. Male (type).
6. *Ammoplanus (Ammoplanus) chemehuevi* new species. Female (allotype).
7. *Ammoplanus (Parammoplanus) lenape olamentke* new subspecies. Female (allotype).
8. *Ammoplanus (Ammoplanus) sechi* new species. Male (type).
9. *Ammoplanus (Ammoplanus) unami* Pate. Female (type).
10. *Ammoplanus (Ammoplanus) quabajai* new species. Female (type).
11. *Ammoplanus (Ammoplanus) loti* new species. Female (type).
12. *Ammoplanus (Ammoplanus) vanyumi* new species. Female (type).

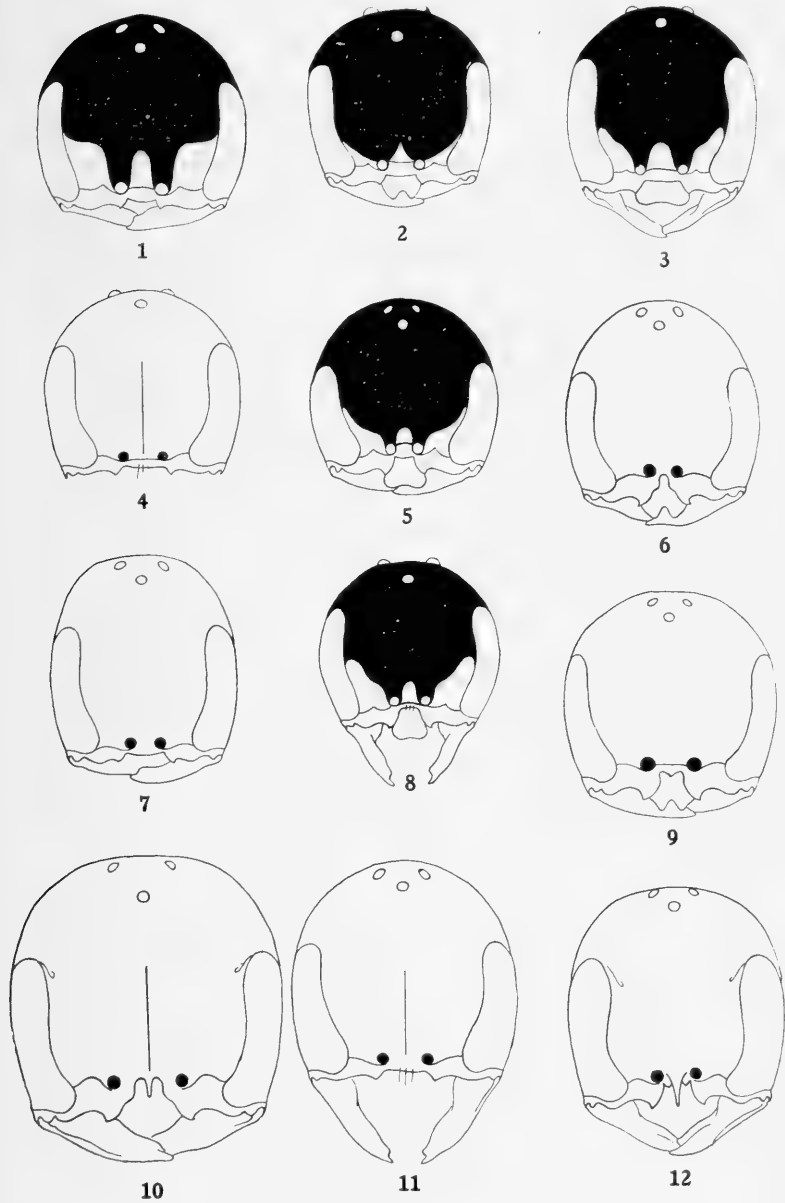


PLATE 29

NOTES ON THE HABITS OF SOME BEETLES FROM THE VICINITY OF YOSEMITE NATIONAL PARK

By E. GORTON LINSLEY
University of California

The following observations were made in May and June 1942 in Madera and Mariposa counties near the south entrance of Yosemite National Park.

Silpha ramosa Say (Silphidae). Adults of this species were found in numbers feeding on dead grasshoppers (*Melanoplus devastator* Scudder) near Friant, Madera Co., on June 5. The grasshoppers were very abundant and doing considerable damage in the area. The silphids were most numerous along roads where the hoppers had been crushed by passing vehicles and along a stream where many had been drowned and washed up on the bank. The writer has also observed both adults and larvae of this species feeding on snails (*Helix aspersa*) on the campuses of the University of California at Berkeley and Los Angeles. This latter habit has been recorded in Europe for *Silpha laevigata* Fab. by Thouless¹ and various other writers and for *S. atrata* Linn. by Heymons et al.²

Trichodes ornatus Say (Cleridae). At Coarsegold, Madera Co., May 12, an unemerged adult was found in a 1941 cell series of *Dianthidium pudicum provancheri* Titus. This is of special interest in view of the fact that in the laboratory *Trichodes* usually requires more than a year to complete its development. On May 29, at Oakhurst, Madera Co., adults were found ovipositing on flower heads of *Allium* and *Brodiaea*. At the same locality on June 8, a female was observed to capture and eat an adult *Anthaxia aeneogaster* Cast. on a flower head of *Wyethia*. The adults of *Trichodes* have generally been regarded solely as pollen feeders.³

¹ Thouless, H. J., 1898, Ent. Mo. Mag., (2)9:18.

² Heymons, R. H. von Lengerken, and M. Bayer, 1927, Zeits. Morph. Okol. Tiere 9:271-312.

³ Boying, A. G. and A. B. Champlain, 1920, Proc. U. S. Nat. Mus., 57(2323): 575-649.

Pleocoma hoppingi Fall (Scarabaeidae). Remains of hundreds of males of this species were found in coyote? feces⁴ along an old abandoned road above Miami Ranger Station, Mari-



PLATE 30

Coyote? feces showing remains of males of *Pleocoma hoppingi* Fall (natural size).

posa County, on May 9 and 12. The feces (Plate 30) were relatively fresh, probably not more than two or three months old, suggesting that this species has a spring, rather than a fall flight period, perhaps emerging with the melting snow. This assump-

⁴ The identification of feces involves a good deal of uncertainty. However, this particular road was frequented by coyotes; an individual was seen on two occasions; coyote tracks were numerous; and the feces resembled those known to have been left by coyotes elsewhere. Raccons were also present in the general area although no evidence of their presence was seen along this particular road. Twelve feces were found to be composed almost entirely of *Pleocoma* remains; two contained fur and remains of a small animal (possibly *Peromyscus*.)

tion was strengthened by finding dead males on the ground as well as remains in the nest of a white-footed mouse (*Peromyscus* sp.) in a white fir log. The writer has already recorded the capture of this species in Yosemite National Park in January and February⁵ and Mr. K. S. Hagen has a specimen from Confidence, Tuolumne Co., taken on February 21, 1941. All specimens taken have been found in areas of mountain misery (*Chamaebatia foliolosa*), tending to confirm R. Hopping's⁶ belief that this plant is its probable host.

Canthon simplex var. *militaris* Horn (Scarabaeidae). This species was found very abundant at the entrances to nests of the ground squirrel *Citellus beecheyi* near Sugar Pine, Madera Co., May 9, 1942. Nearly every active hole had from one to sixteen beetles. The adults were rolling dung from the burrows, a feat which necessitated rolling the balls up at a very sharp angle, sometimes as great as 45 degrees. The dung was usually buried at a distance of from two to six feet from the burrow entrance. On May 19, a herd of cattle moved up the old road near Miami Ranger Station and during the following week the same species was abundant working with cow dung. However, it was noticed that the individuals in this area averaged about 1.0 mm. longer than those found about the squirrel holes. Possibly this was due to the fact that the larvae reared on squirrel dung had a smaller volume or less satisfactory food to grow on (squirrel droppings are smaller than the average sized ball of cow dung used by this species).

⁵ Linsley, E. G., 1941, Pan-Pac. Ent., 17:150.

⁶ Hopping, R., Proc. Pac-Coast Ent. Soc. (62nd Meeting, 1916). p. 137.



THE EARLY STAGES OF
ARCTONOTUS LUCIDUS Bdv.
(Lepidopt.)

By JOHN A. COMSTOCK and CHRISTOPHER HENNE

A gravid female of *Arctonotus lucidus* was taken at Newhall, Calif. by Mr. Claude Smith. Eggs were deposited January 29, 1941 and hatched February 7th. We were unsuccessful in accommodating the young larvae to any of the several plants that were tried.

A second female was secured on January 16, 1942 at the same location. This laid forty-two eggs on the 18th and 19th of January and all of them hatched on the 30th and 31st of the same month.

The young larvae were offered fresh young leaves of the following foodplants, all of which they refused: *Ribes divaricata*, *Saxifraga*, *Juniperus californica*, *Artemisia californica*, *Plantago*, *Salix*, *Viola*, *Prunus illicifolia*, *Lactuca*, *Eriogonum*, *Galium*, and Guadeloupe cypress.

Three species of *Oenothera* were tried, and they finally accepted *O. dentata* v. *campestris* Jepson.

The egg is oval; surface apparently smooth, but under magnification is seen to be finely granular with no surface reticulations. Color: leaf-green. Size approximately 1.12 mm. long X .8 mm. wide.

LARVA.

First instar. Length, prior to first ecdysis, 8 mm. Width, 2 mm. Head case, .65 mm. wide.

Body, cylindrical and smooth. Ground color, light yellow-green, with a slightly lighter shade of the same color on the intersegmental junctures. All surfaces of the body are unicolorous except for a grayish brown shading on the anal extremity (a triangular patch), on the posterior side of the claspers, and on the dorsum of the first segment close to the head. Caudal horn nearly black, proportionately small, slightly recurved forward, and topped by two minute spiculiferous hairs. Legs, blackish. Prolegs concolorous with body but slightly shaded with gray. Spiracles concolorous with body.

A number of short translucent setae are sparingly scattered over the body, discernible only with high magnification.

Head, dull black, covered with minute black setae.

Duration of instar, 13 days.

Second instar. Length, prior to second ecdysis, 16 mm. Width, 3 mm. Head case, 1.1 mm. wide.

Body a uniform green with an olive cast, and covered with minute lighter colored punctations as seen under a lens. Legs, dark olive. Prolegs and crochets concolorous with body. Caudal horn, dark olive green, becoming darker at the tip, and covered with minute spines, discernible with a lens. The triangular patch of grayish brown is still present on the anal extremity. The light colored punctations occurring on the body are generally arranged in transverse rows.

Head, semi-translucent dark olive green with a slightly brownish cast.

Duration of instar, 11 days.

Third instar. Length, 31 mm. Width, 7 mm. Head case, 1.65 mm. wide.

There are two distinct color forms in this instar, with few intergrades. The dark form which is predominant is here first described.

Body a unicolorous dark greenish blue with a gray cast, due to the presence of minute grayish punctations thickly scattered over the surface. Fine transverse ridges occur dorsally and laterally.

A faint somewhat broken subdorsal whitish band originates at the back of the head and terminates at the anal extremity. The caudal extremity is a glistening olive brown, and the same color is carried onto the posterior edge of the anal prolegs and the upper margin of the anus. Caudal horn, black, proportionately small and bearing minute spicules, discernible with a lens. An orange-tan area partly surrounds the base of this horn posteriorly. Scutellum, yellowish tan.

Spiracles, dark blue-gray to black. Legs and prolegs, concolorous with the body in their proximal segments, distal segments and crochets, straw color.

Head, dull tan, with a slight greenish or bluish cast, the cheeks darker. Mandibles, translucent tan.

In this form there is some variation in the ground color, varying from shades of greenish blue with a greyish cast to a blue green.

The subdorsal band also varies considerably in its intensity.

Greenish form: body unicolorous light grass green, with minute white punctations. Subdorsal white band very obscure. Legs and crochets, cream. Caudal extremity concolorous with body, but the caudal horn marked and colored as in the dark form. Spiracles, black.

Head, concolorous with body; mandibles, cream.

Duration of instar, approximately 16 days.

Fourth instar. Length, 55 mm. Greatest width, 10 mm. Head case, 2.6 mm. wide.

Body ground color, black at the beginning of the instar, gradually changing to a dull olive, the abdominal surface (venter) of a lighter shade, and semi-translucent. There is a discontinuous subdorsal narrow white band extending from head to penultimate caudal segment. (This varies considerably in different individuals.)

Dorsal to this there is a pair of minute white points on each segment, placed transversely. The infrastigmatal fold is laved with greenish white forming a rather conspicuous broad discontinuous band. Between this and the subdorsal band there is on each segment (except the first three) a diagonal band of subovate greenish white spots. Each line inclines downward and posteriorly on the segment. Caudal extremity, dark greenish brown, shading into a yellowish tan on the margins of the anal prolegs, the superior margin of the anus laved with greenish white. Legs, glistening orange-tan. Prolegs and crochets, glistening light tan. Scutellum, yellow-tan, bisected by a fine dark olive-green line. Spiracles, orange-tan. That on the first segment is outwardly shaded with black, the remainder placed on conspicuous oval sooty black spots. Caudal horn shorter than in prior instar, glistening black, somewhat rugose, surmounting a yellowish tan circular spot. A few short colorless setae occur on cauda.

Head, proportionately small, unicolorous dull orange-tan, and bearing short colorless setae. Duration of the instar approximately 10 days.

Fifth instar. Length, 65 to 70 mm. Head case, 4 mm. wide. Body, stout, cylindrical, widest and thickest at second segment, tapering acutely to the cauda in the last two segments. The texture of the body surface is smooth and glistening.

Ground color, dull greenish black on the dorsum and lateral surfaces; grey green on the venter.

A series of minute black punctae are regularly and profusely scattered over the dorsum and lateral surfaces, except on the scutellum and around the caudal knob. These punctae are round on the first three or four segments and progressively become more oval in the caudal area. They are barely discernible except under a lens. Each is topped by a single short black spicule. They do not occur on the ventral surface.

A prominent white wide irregular band runs substigmatally the entire length of the body. This tends to turn upward at each segmental juncture and to become continuous with a transverse narrow band that edges each segment anteriorly. These transverse bands are, however, absent on the first to fourth, and the last caudal segments. The black punctae are very conspicuous on these transverse bands and give them a somewhat broken

appearance. In the mid-dorsal area the white transverse bands are broken by a black shading, which gives the appearance of a series of mid-dorsal large black spots.

A narrow white discontinuous longitudinal line occurs dorso-laterally. Between this and the infrastigmatal band there is on each typical segment a diagonal stripe, broken or restricted at the creases. This is conspicuously spotted with the black punctae aforementioned.

A pair of small but conspicuous white spots occurs on each segment (except the three thoracic and last caudal.)

The caudal horn is reduced to a short low keel-like knob, pointing caudally. It is tipped with black, and at the base merges into a yellow cirlet, outside of which is a velvety black annulus.

Scutellum, rugose, dull yellow. Spiracles, dull orange; the one on the first segment ringed with a narrow black cirlet; the second (on 4th segment) resting on a large velvety black patch. Each of the remaining spiracles are located at the antero-inferior edge of a black patch.

True legs, salmon, the tips tinged with brown. Prolegs, pink, with black crochets.

Head and appendages, dull rose. A sparse covering of short brown setae occurs over the face.



A

PLATE 31

B

Larva of *Arctonotus lucidus*, last instar, slightly enlarged.

Photo courtesy Los Angeles County Museum.

There is some variation in the markings of the mature larvae. In certain examples the areas of white are considerably reduced. One example showed a ground color of light olive green, but no specimens in the series of forty under observation showed the grass green that occurred in a minority during the third instar.

Pupation occurred under ground, the larvae burying themselves as deep in the ground as our breeding cages would allow.

Mature larva illustrated on Plate 31.

PUPA. Length, 30 mm. Greatest width, 9.5 mm.

Color, uniform chestnut, slightly darker on last two caudal segments.

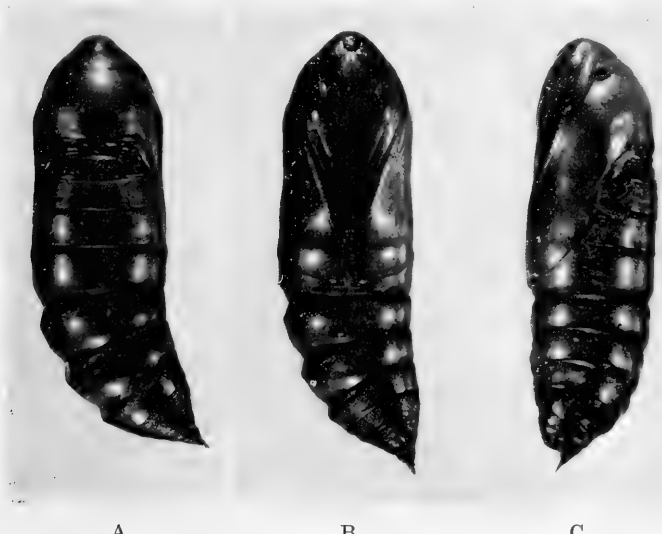
Cylindrical, robust, gently rounded at the cephalic end, and tapering evenly on the last five abdominal segments to the pointed cremaster.

The thoracic and cephalic areas are smooth and glistening, as are also the wing cases. The abdominal segments are pitted along their anterior margins, and the last three caudal segments are pitted over most of their surfaces. The cremaster terminates in a long tapering spine which is bifurcated at the tip. There are two short spurs at its base. Spiracles, dark brown.

No setae are present on any portion of the pupa.

Plate 32 illustrates three aspects of the pupa with sufficient clarity to obviate the necessity of further description.

Arctonotus lucidus is single brooded, and an early flyer being on the wing from late January to March.



A B C
PLATE 32
Pupa of *Arctonotus lucidus*, enlarged approx. x 2.
A. Dorsal aspect. B. Ventral aspect. C. Lateral aspect.
Photo courtesy Los Angeles County Museum.

NOTES ON THE LIFE HISTORIES OF TWO COMMON MOTHS

By JOHN A. COMSTOCK and CHARLES M. DAMMERS

CERAMICA PICTA HARR.

This common moth, popularly known as the "Painted Mamestra," is frequently mentioned in the literature. The larva is known as the "Zebra Caterpillar," and has been recorded as a pest on a wide variety of useful plants and weeds. It apparently shows preference for the *Cruciferae*, but is by no means limited to that family..

Specifically mentioned are cabbage, cauliflower, spinach, celery, beet, turnip, beans, peas, sweet peas, asparagus, apple, plum, orange, mangold, onion, clover, alfalfa, gladiolus, honeysuckle, mignonette, aster, hydrangea, wild black cherry, snowberry, willow, lambs-quarters, pigweed, plantain and Indian hemp. Doubtless the list will be greatly extended as additional records are published.

Holland²⁰ states the moth is limited in range to territory east of the foothills of the Rocky Mountains. It is not generally known that it is found all the way to the Pacific Coast states, although it was reported by Vosler²¹ from Utah and presumably from California in 1913, and Essig²⁴ records it for many of the Western states.

The larva was recorded by Harris¹ as early as 1841, and the life history, with illustrations, was published by Riley⁴ in the Second Missouri Report, 1870. Since that time many notes on the habits and metamorphosis have appeared in numerous works, most of which are now out of print and difficult to obtain. The major portions of these references are restatements of the earlier contributions of Riley and Harris, and the original illustrations of Riley have been reprinted time and again.

Ceramica picta is apparently not as common in California as it is in some of the eastern states and Canada, but it has the potentialities of developing into a serious garden and truck crop pest. It therefore seems advisable to publish brief notes on its life history in a western journal, and to include new and original illustrations.

The junior author of this paper secured a quantity of larvae of this species at San Bernardino, Calif., in October and November of 1929 and 1930. They were feeding on Indian Hemp (*Apocynum cannabinum* L.) and willow, and were reared to maturity.

EGG. This was first illustrated by Brittain²³ in 1918. It is of the characteristic noctuid type, spherical, with numerous fine ridges running from base to micropyle. The eggs are laid in a single layer, in fine even rows close together, usually on the under surface of a leaf of the foodplant.

The young larvae are at first almost black, but they soon assume a green shade. For a short period after hatching they are gregarious, and feed only on the soft green parenchyma of the leaves. Later they separate and feed singly and exposed. When disturbed they curl up and drop to the ground, but do not seek concealment.

MATURE LARVA. Ground color of body, black. In the dorsal area there is a rather wide solid black area in the average example, but occasionally a narrow mid-dorsal lemon yellow line is present.

A relatively wide yellow longitudinal line occurs dorso-laterally, and a similar line runs the length of the infra-stigmatal fold.

Between these two lines the ground color is black, crossed transversely on each segment by several crenulated white lines. In some examples these white lines are wider and the black areas restricted. The larva pictured on Sullivan's colored plate in the Report of the Dept. of Agric., for 1883¹² is of this type as is also Holland's Plate 1, fig. 11²⁰. The latter picture does not show the white striping on the lateral surface which is a characteristic feature.

Below the infra-stigmatal line the abdomen is streaked with black and white, giving something of a zebra-like appearance. There is a shading of carmine along the mid-abdominal area

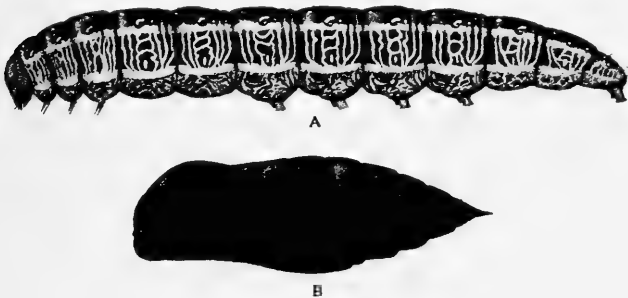


PLATE 33

Mature larva and pupa of *Ceramica picta*, enlarged x 2.

A. Lateral aspect of larva. B. Lateral aspect of pupa.

Reproduced from painting by Charles M. Dammers.

and at the bases of the legs and prolegs. Both the legs and prolegs are of the same carmine shade.

Spiracles, white.

A few short yellow setae are present on each segment. Each of these arises from a small round white dot.

Head; carmine, and sparsely covered with short yellow setae. Mouth parts shaded with black. Ocelli, black.

The mature larva is illustrated on Plate 33.

The conspicuous color and markings of this caterpillar suggest that it represents a case of warning coloration, and it will doubtless be found that the larva possesses certain nauseous properties.

Pupation occurs under the ground, in a loosely woven cocoon into which is incorporated bits of the surrounding materials.

PUPA. Average length, 20 mm. Fusiform, the cauda tapering to a point, and the wing cases extending about $\frac{3}{5}$ th the distance to cremaster. There are apparently no setae on any portion of the chrysalis. The color is a very dark brown.

The pupa is illustrated on Plate 33, fig. B.

The mature insect is illustrated in color on Sullivan's plate above referred to, and also on Holland's Plate XXIII, fig. 34, the latter being a rather poor reproduction.

In the eastern states it is double brooded, but in California it probably produces a greater number of generations.

A few of our larvae were parasitized, but not as many as might have been expected judging from the long list of parasites recorded for the species. These include:

- Microplitis mamestrae Weed (on egg)
- Telenomus heliothides Ashm. (on egg)
- Trichogramma pretiosa Riley (on egg)
- Trichogramma minutum Riley (on egg)
- Limneria annulipes Cr.
- Compsilura concinnata Meig.
- Anetia hyphantriae Tot.
- Winthemia quadripustulata Fab.
- Winthemia rufopicta Bigot
- Enicopsilus purgatus Say.
- Sagaritis dubitatus Cr.

We append below a bibliography covering the more important items bearing on the life history of the species. A number of brief references in the economic literature have been excluded as they deal mainly with the crop damage and methods of control

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LAPHYGMA EXIGUA Hbn.

This common moth has been repeatedly referred to in economic literature owing to the wide variety of useful plants on which the larva feeds. Like many of our common pests it is an importation from southern Europe. The caterpillar is known as the "Beet Army Worm."

The most complete account of its life history thus far published is by Dyar¹, in the Canadian Entomologist for 1894 (as *Laphygma flavimaculata*). Essig² gave brief notes on the metamorphosis in the Monthly Bulletin Dept. of Agr., Calif., in 1913, and recorded the damage caused by the larvae to various crops. This was again reprinted in 1915.³

Chittenden⁴ in Farmer's Bulletin 856 reproduced a drawing of the egg and larva, but the drawing of the egg was inaccurate. In 1926 Essig⁵ briefly described the egg and larva, and the following year Crumb⁶ gave a somewhat more complete description of the mature larva.

In 1929 Campbell and Duran⁷ published an excellent paper on the life history and damage to important truck garden crops, with a bibliography.

In 1930 the same authors⁸ gave a correct description and drawing of the egg.

A number of references have appeared in bulletins and pamphlets of lesser importance during the past two decades, but they add very little to the information recorded by the authors above listed.

Our chief purpose in publishing on the early stages of this moth is to point out the rather wide variation in coloring and markings of the larva, and to present a reproduction of the painting made by the junior author of this paper.

The "Beet Army Worm" occurs in three distinct phases of coloration ranging from green, through rich chestnut brown, to a very dark olive black, with numerous intergradations. In our descriptions we record the intermediate form and the two extremes.

Green type.

Upper half of body, ground color green, longitudinally striped with fine dark green crenulated lines and dashes. In the dorso-lateral region there is a narrow area in which the darker green markings are absent. This gives the appearance of a longitudinal light green line.

The lower half of the body, including abdominal area, is a pale green, blotched with white.

These two contrasting areas meet along the line of the lower margins of the stigmata. At this point there is a narrow longitudinal white stripe, which is tinged with pink immediately in the region of each spiracle. The spiracular openings are white, nar-

rowly margined with black, and outwardly stippled with pink. Above and caudad to each spiracle is a large round white spot

Legs and prolegs concolorous with abdomen.

The head is paler in this form than in the others. See Plate 34, fig. A.

Brown type.

Upper half of body, rich chestnut, striped longitudinally with fine crenulated brown lines. There is a narrow discontinuous dorso-lateral white stripe which is displaced with black on the center of each segment. Extending superiorly from this line at a point on each segment approximately one-third posterior to segmental juncture is an area of fine white stippling.

Below the dorso-lateral stripe and extending down to the infra-stigmatal line the ground color is darker, and is striped with fine longitudinal black lines and dashes.

The infra-stigmatal line is white, and is expanded immediately below each spiracle into a large white spot. There is also an upward extension of this spot caudad to each spiracle.

Below the infra-stigmatal line the body, including abdomen, is a soiled buff overlaid by a mixture of greenish brown and white stippling.

Dark olive-black type.

The dorsal area of the body above the dorso-lateral stripe is greenish yellow, striped longitudinally with narrow crenulated dark green lines and dashes. This area is bisected by a narrow paired mid-dorsal longitudinal black line.

The dorso-lateral is greenish yellow, margined superiorly with black, this margin expanding into a stippled black area on the fore part of each segment.

Below the dorso-lateral line of the body is olive-black, with a few yellow-green dashes. The spiracles are white, and supero-caudad to each one occurs a large round white spot.

The infra-stigmatal line is greenish yellow. Inferior to this a wider longitudinal band of orange, stippled with green. The lower margin of this band is white.

The abdomen is pale olive-green, stippled with white, becoming dark green along the upper edge.

Legs, olive brown. Prolegs, pale green. Crochets, pale brown. Scutellum, black.

Head, olive-black, except for a yellow spot above the ocelli. A sparse covering of setae occur over the head. See Plate 34, figs. B and D.

The discrepancies between the above descriptions and those previously published by various writers is due to the great variability in the larvae.

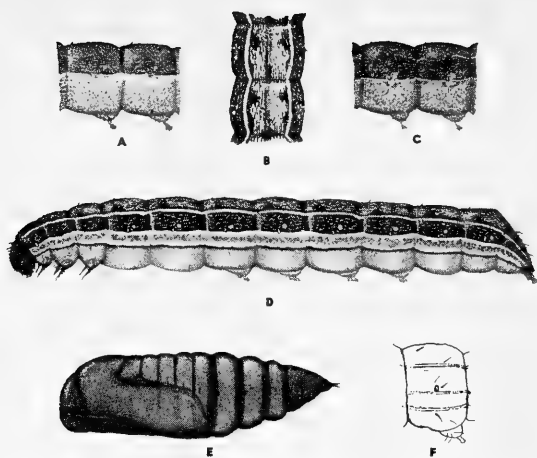


PLATE 34

Larva and pupa of *Lanthygma exigua*, enlarged approx. x 2.

- A. Typical segments of green type of larva, lateral aspect.
- B. Typical segments of dark olive-black type of larva, dorsal aspect.
- C. Typical segments of brown type of larva, lateral aspect.
- D. Lateral aspect of larva, dark olive-black type.
- E. Pupa, lateral aspect.
- F. Typical segment of larva, showing setae.

Reproduced from painting by Charles M. Dammers.

PUPA

Length, 15 mm. Fusiform, the abdomen tapering regularly to the pointed cauda. The surface is smooth and glistening, and apparently bears no setae. Color, light chestnut. When first formed, the wing cases are translucent green, but gradually become concolorous with the body. Spiracles, dark brown. Eyes, deep brown.

Pupation takes place under the soil.

The pupa is shown on Plate 34, fig. E.

The recorded foodplants include sugar beets, garden beets, peas, potato, onion, corn, chili pepper, asparagus, lettuce, cotton, castor bean, wild tobacco, sunflower, lambs quarters, salt bush, grasses, pigweed and mallow. Many other plants will probably be added to this list.

The recorded parasites are *Apanteles grcnadensis* Ashm., *Apanteles laeviceps* Ashm., *Frontina archippivora* Williston, *Campoletidea caradrinae* Vier., and *Ophion bilineatus* Say.

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Bulletin, Southern California Academy of Sciences

Vol. XLI, 1942

INDEX OF SUBJECTS

A New California Species of Timema With Zoogeographi- cal Notes	72	Bryan, William Alanson	115
A New Free-tailed Bat from Texas	49	<i>Canthon simplex militaris</i> Horn	166
A New Phalaenid Moth from the Channel Islands	81	Carl Sumner Knopf	111
A New Subspecies of Foxella Ignota (Baker) from Califor- nia	69	Castilleja anacapensis Dunkle..	135
A Review of the North Ameri- can Weedy Heliotropes	51	<i>Ceramica picta</i> Harr	172
A Spider Which Amputates One of its Palpi	139	chemehuevi, Ammoplanus	151
Adrothrips	4	clementei, Zosteropoda	81
Adrothrips aureus Moulton.....	5	compactum, Eriogonum gigan- teum	130
<i>Alypia ridingsi</i> Grt	92	Comparative Observations of the Mating Habits of Three California Landsnails	102
Ammoplanus chemehuevi Pate	151	Contributions From the Los Angeles Museum — Channel Islands Biological Survey 81,	125
Ammoplanus loti Pate	146	Dunatothrips	10
Ammoplanus quabajai Pate	156	Dunatothrips armatus Moulton	10
Ammoplanus sechi Pate	149	Emprosthiothrips	12
Ammoplanus tetli Pate	147	Emprosthiothrips niger Moul- ton	12
Ammoplanus vanyumi Pate	154	<i>Eriogonum giganteum compac-</i> tum Dunk	130
Amphibians and Reptiles of the Dunes	29	Fauna and Flora of the El Se- gundo Sand Dunes	14
<i>Amphipsylla neotomae</i> I Fox.....	39	Flora of the Channel Islands National Monument	125
anacapensis, Castilleja	135	<i>Foxella ignota coufferi</i> August- son	69
<i>Arachnis picta meadowsi</i> Comst.	83	fuscus, Brithothrips	8
<i>Aranea gemma</i> (McCook)	19	fuscus, Sunaitothrips	2
<i>Arctonotus lucidus</i> Bdv	167	<i>Heliotropium spathulatum ocu-</i> <i>latum</i> (Heller) Ewan	56
<i>Argyope argentata</i> (Fabr)	18	<i>Helminthoglypta tudiculata</i> (Binney)	97
<i>Argyope trifasciata</i> (Forskål)..	18	Heptathrips	3
armatus, Dunatothrips	10	Heptathrips tonnoiri Moulton..	3
<i>Aseptis binotata curvata</i> Grt	91	Knopf, Carl Sumner	111
<i>Baeus californicus</i> Pierce	21, 23	<i>Laphygma exigua</i> Hbn	176
<i>Barnesiata ritaria</i> Grossb	46	<i>Latrodectus mactans</i> (Fabr)	19
boharti, Timema	77	Life History Data on Helmin- thoglypta Tudiculata (Bin- ney)	97
Brief Notes on Two Recently Described Species of Mompha	48		
Brithothrips	8		
Brithothrips fuscus Moulton	8		



loti , <i>Ammoplanus</i>	146	<i>Polites themistocles</i> Latr	41
<i>Mastophora cornigerum</i> (Hentz)	18	Proceedings of the Academy....	119
meadowsi , <i>Arachnis picta</i>	83	<i>Pseudogaurax signata</i> (Loew)	21
<i>Mompha bottimeri</i> Busek	83	quabajai , <i>Ammoplanus</i>	156
<i>Mompha capella</i> Busck	48	Seven New Genera of Thysanoptera From Australia and New Zealand	1
Nearctic <i>Ammoplanus</i>	141	sechi , <i>Ammoplanus</i>	149
<i>Neoterpes ephelidaria</i> Hlsl	44	Spilothrips	6
niger , <i>Emprosthiothrips</i>	12	<i>Spilothrips varicolor</i> Moulton	7
Notes on California Spiders	138	<i>Sunaitiothrips</i>	1
Notes on the Habits of Some Beetles From the Vicinity of Yosemite National Park	164	<i>Sunaitiothrips fuscus</i> Moulton	2
Notes on the Larva and Chrysalis of <i>Polites Themistocles</i> Latr	41	<i>Tadarina texana</i> Stager	49
Notes on the Life Histories of Two California Moths	44	tetli , <i>Ammoplanus</i>	147
Notes on the Life Histories of Two Common Moths	172	<i>Teutona grossa</i> (Koch)	16, 138
Notes on the Life History of <i>Tolyte Glenwoodii</i>	86	The Allotype of <i>Amphipsylla Neotome</i> I Fox	39
Notes on the Metamorphoses of Two California Moths	91	The Early States of <i>Arctonotus Lucidus</i> Bdv	167
Observations on Vectors of Chagas' Disease in the United States	61	The Preservation of Color in Soft Orthoptera	79
On the Culture of the Spider <i>Teutana Grossa</i> Koch	138	<i>Tidarren fordum</i>	139
Orcutt, William Warren	109	Timema boharti Tink	77
<i>Peucetia viridans</i> (Hentz)	17	tonnoiri , <i>Heptathrips</i>	3
Parammoplanus	158	<i>Tolyte glenwoodii</i> Barnes	86
<i>Parammoplanus lenape olamentke</i> Pate	160	Utilization of the Black Widow Parasite and Further Data on Spiders and Parasites	14
<i>Pleocoma hoppingi</i> Fall	165	vanyumi , <i>Ammoplanus</i>	154
		varicolor , <i>Spilothrips</i>	7
		William Alanson Bryan	115
		William Warren Orcutt	109
		Zosteropoda clementei Meadows	81

New varieties and species indicated in bold face type

INDEX OF AUTHORS

Adolph, Helen M.	97	Meadows, Don	81
Augustson, G. F.	39, 69	Moulton, Dudley	1
Bottimer, L. J.	48	Pate, V. S. L.	141
Branch, Jefferson H.	138	Pierce, W. Dwight	14, 79
Comstock, John A.	44, 83, 86, 91, 117, 167, 172	Stager, Kenneth E.	49
Dammers, Charles M.	44, 91, 172	Stock, Chester	110
Dethier, V. G.	41	Swift, R. H.	120
Ewan, Joseph	51	Tinkham, E. R.	72
Henne, Christopher	86, 167	von Bloeker, Jack C. Jr.	29
Ingram, William Marcus	97	Webb, Glenn R.	102
Linsley, E. Gorton	164	Wood, Sherwin F.	61

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