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1966

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FOSSIL ARTHROPODS OF CALIFORNIA. 29.  
SILICIFIED MIOCENE PUPAE OF CERATOPOGONID FLIES

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[1966.]

The work on the interesting silicified Miocene insects found imbedded in nodules, in lake bed strata, in California mountain areas, which must be recovered by acid extraction, is of necessity very slow and painstaking (see Pierce, various dates).

At present I have mounted 7,019 balsam slides of extracted material derived from 2,441 nodules, although a total of 32,898 nodules have been accessioned. Every nodule holds the potential of something new and interesting. The reporting on the findings must be by individual groupings of eggs, larvae, pupae, and adults—as time to work them up is available.

In a group like the blood sucking midges of the family Ceratopogonidae (formerly reported as Heleidae, recently ruled out by the International Commission on Nomenclature), the eggs offer a special problem, for only a few living species are recorded and described. I should state that prior to the early papers in this series, fossil insect eggs were unknown. A total of 38 *Dasyhelea* eggs have been isolated.

The larvae, having never been correlated with pupae and adults systematically, are a distinct problem. A total of 80 dipterous larvae are at hand, but not yet separated to family.

Our wealth lies in 818 dipterous pupae belonging to the Ceratopogonidae (Heleidae), and Chironomidae (Tendipedidae). On these I will begin to report in this article.

There are 60 fossil adults yet to be studied and separated to family, and there are some chances of correlation to the pupae. In nine cases, the adults within the pupa, with abdomen still extended, are being studied.

In no series of fossil insects have all stages of the insects been recovered in such perfect three-dimensional condition, crystal clear, and often manifesting internal organs: intestines, nervous system, brain, and tracheal system. This material may become a foundation stone in paleoembryology, using the term in its broad sense as de-

fined by Hagan (1951:3) as covering all stages of immaturity in an animal.

Considering that only 7.41% of the collected nodules have been studied, it can be seen that we are only in the beginnings of this field. Insect-containing nodules are now known from the Calico Mountains, Mount Frazier, Mount Pinos, Mount Lane, and Death Valley; and unstudied nodules have been found in the Tehachapi and San Gabriel Mountains, and I expect them in at least half a dozen other ranges where boron has been mined. Our great need is for young people trained in systematic biology, geochemistry, and paleontology. This is a real challenge because it will require much patient research in a day when quick results are too often desired.

This report is on the ceratopogonid pupae, which are among the dominant creatures found, along with the dytiscid beetle larvae which presumably preyed upon them, and the anostracan fairy shrimps which no doubt scavenged the bottom. The ceratopogonid larvae perhaps fed upon the algae, or other plant life, and almost every nodule has yielded specimens of plant tissues. The ecological picture is slowly being revealed, nodule by nodule.

According to Wirth (1952), "The pupae are rather inactive, those of the aquatic forms coming to the water surface, working their way to the water's edge, and a short distance up on the shore, or on emergent vegetation, or driftwood just before emergence of the imago . . . The pupal period usually lasts from five to seven days."

It is postulated that volcanic catastrophes repeatedly killed the life in the ancient fresh water lake. The dead pupae lying on the bottom were covered by the calcium carbonate particles that slowly built up the lake bottom. Apparently the remarkable combination of volcanic chemicals instantly killed and preserved the tissues, catalyzing the silica in their bodies to replace the skeleton and organic walls, and converted the tissues into petroleum products.

Often in the same nodule will be the bodies of enemies, the dytiscid larvae. The pupae which we recover are in all stages of their week-long existence, as well as the empty cases of those which had emerged.

So far, slide mounts have been made of 818 dipterous pupae (Ceratopogonidae and Chironomidae) extracted from the nodules: 8 from Mount Frazier, 4 from Mount Pinos, and all others from the Calico Mountains. Of these, 390 pupae have been separated to family and species. Many of the undetermined fragments can be ultimately assigned on careful study of the spiny structure of the abdomen.

The pupae have been assigned to three distinct tribes in two sub-families: *Dasyheleinae*; *Ceratopogoninae*, tribes *Culicoidini* and *Stenoxenini*. A difficulty lies in the fact that little is known of the life cycles of the modern insects. The principle American work has been done on the New York species by Thomsen (1937).

A number of the pupal types among these fossil pupae are not allied to any described pupa, but are undoubtedly ceratopogonid, hence it has been necessary to assign new generic names, realizing that when more is known of the pupae of existing genera, these fossils may ultimately be correlated. I feel that this step is justified, for we need to have names to associate our findings, and Palmer (1957) has already started the precedent. We are trying to bridge a gap of 20 million years.

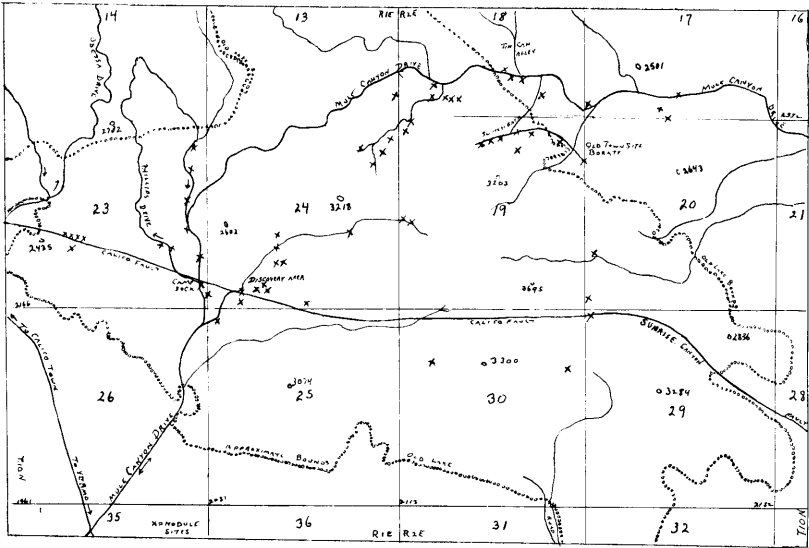
In the *Ceratopogonidae* the terminal segment of the pupa is so characteristic that I have, following Palmer's lead, given species names to each type, after first assigning species numbers for ready separation. Ten of these species are well distributed; eight others are more limited. Three pupal types are withheld because of doubts, and must be reported later.

Inasmuch as it seems that further exploration of all possible sites for these interesting nodules may result in giving stratigraphic or other valuable information, and that these pupae may be the keys for interpretation of relative age, etc., it is well to show how these ceratopogonid pupae line up in the quarter sections.

The Calico Mountains series were obtained from nodules collected in 8 sections, 14 quarter sections, extending the whole length and width of the ancient lake, lying along the Calico Fault and north of it (see Map). The total number of pupae isolated from each quarter section is followed in parenthesis by the number identified to species: In R.1.E., T.10.N., Section 23, SW  $\frac{1}{4}$ -8 (2); SE  $\frac{1}{4}$ -17 (7), NE  $\frac{1}{4}$ -10 (3); Section 24, SW  $\frac{1}{4}$ -149 (68), NE  $\frac{1}{4}$ -139 (67); Section 25, NW  $\frac{1}{4}$ -1. R.2.E., T.10.N., Section 17, SE  $\frac{1}{4}$ -1 (1), SW  $\frac{1}{4}$ -1 (1); Section 18, SW  $\frac{1}{4}$ -77 (36), SE  $\frac{1}{4}$ -36 (16); Section 19, NW  $\frac{1}{4}$ -53 (27), NE  $\frac{1}{4}$ -258 (112), undesignated  $\frac{1}{4}$ -54 (30); Section 20, SW  $\frac{1}{4}$ -1; Section 21, NW  $\frac{1}{4}$ -1; Section 29-0; Section 30-0.

The three identified Frazier Mountains specimens come from Mount Frazier. R.20.W., T.9.N., SW  $\frac{1}{4}$  Section 36; and from Mount Pinos, R.21.W., T.8.N., NE  $\frac{1}{4}$  Section 14 and SW  $\frac{1}{4}$  Section 24.

The nodules from which this series of pupae were extracted were collected on many expeditions by the following persons: Charles and



*Map. The Calico Mountains nodule sites.*

Helen Artman, Mrs. A. G. Browne, John and Marie Carr, John Clark, Judith Clark, Kenneth Frey, Russell, Bernice and Cherry Gamage, John Gibron, Sr., Jeanne Hotchkiss, George Kanakoff, Mrs. Ruth Kirkby, Elza Kops, Sam Lager, Jere Lipps, Richard B. Loomis, Delmer Mangum, W. Dwight Pierce, Mary Robertson, Mrs. Laura Rouse, Rostick Ryshkoff, Dara Shilo, E. R. and Jim Vicklund, Jeff and Tom Wagner, Sheryl Weber, Donald, Ruth, Bruce and Carol Weissman in the Calico Mountains, and the late Mrs. Vergyle Ritchey in the Frazier Mountains.

The type material is deposited in the Invertebrate Paleontology Collections of the Los Angeles County Museum of Natural History (LACMIP).

Measurements were made to the nearest thousandth of a millimeter with the aid of an ocular micrometer.

## DESCRIPTIONS OF PUPAE

## Subfamily Dasyheleinae

The caudal plate is more complex than in the next subfamily, there being apicolateral and apicomedian lobes, and at least a spine or process to define each. The genital plates do not exceed the anal orifice. See Figures 1 to 8.

Genus *Dasyhelea* Kieffer

Wirth (1952) has illustrated the caudal plate of 5 living species, and Palmer (1957: 2, 4) 2 fossil species, and I am adding 5 fossil types (Figs. 1, 2, 5, 7, 8) which seem to belong in the series.

*Dasyhelea australis antiqua* Palmer 1957

## Figure 4

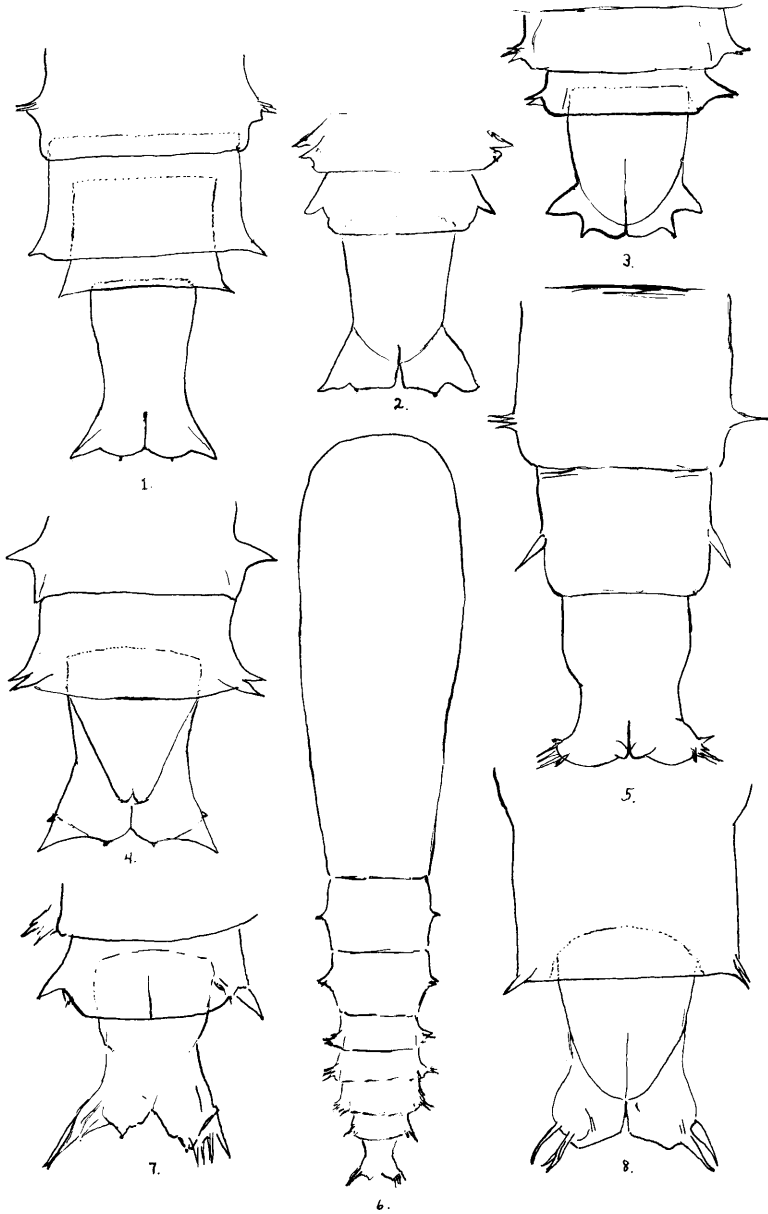
This pupal species is fully described and illustrated by Palmer (1957), and associated with adult female and male, and with a larval type. In view of the fact that we have found in the same quarter section (SW  $\frac{1}{4}$  Section 24), 6 kinds of *Dasyhelea* pupae, and 5 kinds of other pupae in the same family, I cannot corroborate the association of other stages with any of the pupae until the adults included within their pupal shells have been thoroughly studied.

I have assigned to this species the pupal type No. 9, of which there are at present 105 specimens, found at elevations 2400 to 3000 feet in 10 quarter sections of the Calico Mountains, as follows: R.1.E., T.10.N., Section 23, SW  $\frac{1}{4}$ -2; SE  $\frac{1}{4}$ -3, NE  $\frac{1}{4}$ -1; Section 24, SW  $\frac{1}{4}$  (type locality)-27, NE  $\frac{1}{4}$ -17; R.2.E., T.10.N., Section 17, SW  $\frac{1}{4}$ -1; Section 18, SW  $\frac{1}{4}$ -7, SE  $\frac{1}{4}$ -6, Section 19, NW  $\frac{1}{4}$ -5, NE  $\frac{1}{4}$ -27, unstates  $\frac{1}{4}$ -9; total 105.

The important features of this species are in the female caudal segment, which has the genital plates of triangular form, but with the apex a pair of rounded tips. The apicolateral processes are acute angled, directly only about  $10^\circ$  posteriorly, with tiny setigerous tubercles at center base; and each of the apicomedian lobes also has a tiny setigerous tubercle.

There has been some chance of confusing worn and partly eroded specimens of this species with *Dasyhelea judithae* (pupae No. 3) and the *Neopalpomyia* spp. (pupae No. 22 and 28).

There are 32 complete pupae, ranging in length from 2.18 to 3.94 mm., mean 3.27 mm. in normal specimens, and 4.59 to 4.71 mm. in two containing the extended adult.



Figures 1-8. Fossil pupae of Family Ceratopogonidae. Subfamily Dasyheleinae, extracted from Miocene nodules found in the Calico Mountains: *Figure 1: Dasyhelea judithae*, new species, LACMIP S 9124, last four segments of specimen 253.

The caudal segment of 96 specimens ranged in length from 0.269 to 0.426 mm., mean 0.321 mm., but most normally 0.3269 to 0.346 mm. In width of 94 specimens the range was 0.192 to 0.365 mm., mean 0.277 mm., most normally 0.269 to 0.307 mm.

***Dasyhelea browneae*, new species**

Figure 5

Based on 6 pupae of pupal type No. 13, all from the Calico Mountains, from 4 adjoining quarter sections at altitudes 2400-2900 feet: R.1.E., T.10.N., Section 24, SW  $\frac{1}{4}$ -1, NE  $\frac{1}{4}$ -3; R.2.E., T.10.N., Section 19, NW  $\frac{1}{4}$  (type locality)-1, NE  $\frac{1}{4}$ -1; total 6.

Holotype specimen 2450 registered as LACMIP Type S 9126, extracted from nodule 16966, collected by Mrs. A. C. Browne at Site 90, 2750 feet, in NW  $\frac{1}{4}$  Section 19, R.2.E., T.10.N.

Four pupae are complete and measure 3.59 to 4.46 mm., mean 4.02 mm., type 3.99 mm. The longest pupa (No. 134) contains an adult with abdomen extended.

The terminal segment measures in length 0.307 to 0.403 mm., mean 0.336 mm., type 0.346 mm.; and in width 0.269 to 0.426 mm., mean 0.339 mm.; type 0.307 mm.

This segment is different from all others known, in that the apicolateral areas have clusters of 5 or more spines, directly laterally; and the apex is almost truncate, with four rounded lobes. In general shape it belongs near *D. kanakoffi*, but in armature resembles *D. dara*. The genital plates are broadly rounded at apex. The two preceding segments have strong median spines.

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from nodule 298, collected by W. Dwight Pierce at Site 10 (LACMIP 317), 2700 feet altitude, NE  $\frac{1}{4}$  Section 19, R.2.E., T.10.N. *Figure 2: Dasyhelea kanakoffi*, new species, LACMIP S 9125, last three segments of specimen 159, from nodule 276A, collected by George Kanakoff at Site 3A (LACMIP 352), 2700 to 2750 feet, NE  $\frac{1}{4}$  Section 24, R.1.E., T.10.N. *Figure 3: Dasyhelea stenoceras* Palmer, last three segments of specimen 2703, from nodule 175335, collected by Laura Rouse at Site 115, in NE  $\frac{1}{4}$  Section 19, R.2.E., T.10.N. *Figure 4: Dasyhelea australis antiqua* Palmer, last three segments of specimen 2208, from nodule 3563, collected by Rostick Ryshkoff, at Site 15 (LACMIP 362), 2700 feet, SW  $\frac{1}{4}$  Section 24, R.1.E., T.10.N. *Figure 5: Dasyhelea browneae*, new species, LACMIP S 9126, last three segments of specimen 2450 from nodule 16996, collected by Mrs. A. C. Browne at Site 90, 2750 feet, NW  $\frac{1}{4}$  Section 19, R.2.E., T.10.N. *Figure 6: Dasyhelea dara* variant, entire pupa, specimen 2053, from nodule 142, collected by Jeanne Hotchkiss, at Site 4 (LACMIP 353) in NE  $\frac{1}{4}$  Section 23, R.1.E., T.10.N. *Figure 7: Dasyhelea dara* variant, last three segments of specimen 2053. *Figure 8: Dasyhelea dara*, new species, LACMIP S 9127; last two segments of paratype specimen 3421 from nodule 1101. Collected by Dara Shilo at Site 10 (LACMIP 357), altitude 2700 feet, in NE  $\frac{1}{4}$  Section 19, R.2.E., T.10.N.

**Dasyhelea judithae**, new species

## Figure 1

Based on 20 pupal specimens of pupal type No. 3, 19 from Calico Mountains and one from Mount Pinos in the Frazier Mountains, collected as follows: Calico Mountains, R.1.E., T.10.N., Section 24, SW  $\frac{1}{4}$ -3, NE  $\frac{1}{4}$ -5; R.2.E., T.10.N., Section 18, SW  $\frac{1}{4}$ -2; Section 19, NW  $\frac{1}{4}$ -3, NE  $\frac{1}{4}$  (type locality)-5; unstates  $\frac{1}{4}$ -1; Mount Pinos, R.21.W., T.8.N., Section 14, NE  $\frac{1}{4}$ -1; total 20. Named in honor of Judith Clark, one of the collectors.

Holotype pupa, specimen 253, registered as LACMIP Type S 9124, extracted from nodule 298, collected by W. Dwight Pierce at Site 10 (LACMIP 357), 2700 feet, in NE  $\frac{1}{4}$  Section 19, R.2.E., T.10.N.

Total length of pupa depends on whether the abdomen is distended or contracted. Five complete pupae measure 2.88 (type), 2.88, 2.98 (containing adult), 3.11 and 3.36 mm., mean 3.04 mm.

The terminal segment measures 0.267 to 0.365 mm., type 0.307 mm., mean 0.3083 mm. in length; and 0.211 to 0.346 mm., type 0.240 mm., mean 0.2625 mm. in width at apex.

The apicolateral spines of the terminal segment are directed laterally and do not extend apically beyond the bounds of the apico-median lobes.

The species is related to *Dasyhelea australis antiqua*, but the genital plates are apically broadly lobate, not triangular; the caudal segment is narrower, and the spiny armature of the abdomen is different. The seventh and eighth segments are armed with terminal spines; the sixth segment with a cluster of median lateral spines.

Specimen 86 is of special interest as it contains the adult with antennae not fully withdrawn from their sheaths, and the abdomen still extending the full length of the pupal abdomen.

**Dasyhelea dara**, new species

## Figures 6, 7, and 8

Based on 34 pupal specimens of pupal type No. 14, from the Calico Mountains, and one from Mount Pinos in the Frazier Mountains, and named in honor of Dara Shilo, one of the collectors. These were extracted from nodules collected at altitudes 2510 to 2900 feet as follows: Calico Mountains, R.1.E., T.10.N., Section 23, NE  $\frac{1}{4}$ -1; Section 24, SW  $\frac{1}{4}$ -6, NE  $\frac{1}{4}$ -7; R.2.E., T.10.N., Section 18, SW  $\frac{1}{4}$ -3; Section 19, NW  $\frac{1}{4}$ -4, NE  $\frac{1}{4}$  (type locality)-8, unstates  $\frac{1}{4}$ -1; Mount Pinos, R.21.W., T.8.N., Section 24, SW  $\frac{1}{4}$ -1; total 30.



The variants, Figures 6, 7, came from Section 23, NE  $\frac{1}{4}$ -1; Section 19, NE  $\frac{1}{4}$ -1, NW  $\frac{1}{4}$ -1; Section 18, SW  $\frac{1}{4}$ -1; total 4.

Holotype pupa, complete, specimen 1869, registered as LACMIP Type S 9136, extracted from nodule 244, collected by W. Dwight Pierce at Site 3A, altitude 2700 to 2750 feet, in NE  $\frac{1}{4}$  Section 24, R.1.E., T.10.N.

Paratype pupa (Fig. 8) specimen 3421, registered as LACMIP Paratype S 9127, extracted from nodule 1101, collected by Dara Shilo at Site 10, (LACMIP 357), altitude 2700 feet, in NE  $\frac{1}{4}$  Section 19, R.2.E., T.10.N.

Fifteen complete pupae measure 2.88 to 4.52 mm. in length, mean 3.339 mm. (holotype 3.65 mm.). The variants measure 3.07, 3.65 and 3.84 mm.

The caudal segment varies in length from 0.289 to 0.403 mm., mean 0.324 mm., holotype 0.307, illustrated paratype 0.403 mm.; in width 0.269 to 0.327 mm., mean 0.287 mm., holotype 0.269 mm., illustrated paratype (Fig. 8) 0.289 mm. In the variants (Figs. 6 and 7) this segment measures 0.307 to 0.384 mm. in length and 0.269 to 0.307 mm. in width.

In all but four variant specimens the caudal segment has the apico-lateral corners extended diagonally with two long spines, but in the variants there is asymmetry, and one lateral corner has two spines, while the opposite has four or more spines. The other abdominal segments have many spines.

### ***Dasyhelea kanakoffi*, new species**

#### Figure 2

Based on 70 pupal specimens (pupal type No. 5) all from the Calico Mountains, extracted from nodules collected as follows: R.1.E., T.10.N., Section 23, SE  $\frac{1}{4}$ -1; Section 24, SW  $\frac{1}{4}$ -6, NE  $\frac{1}{4}$  (type locality)-20; R.2.E., T.10.N., Section 18, SW  $\frac{1}{4}$ -10, SE  $\frac{1}{4}$ -3; Section 19, NW  $\frac{1}{4}$ -3, NE  $\frac{1}{4}$ -18, un stated  $\frac{1}{4}$ -9; total 70. The nodules were collected at altitudes 2510 to 2900 feet.

Holotype pupa, specimen 159, registered as LACMIP Type S 9125, extracted from nodule 276A, collected by George Kanakoff at Site 3A LACMIP 352), 2700 to 2750 feet, in NE  $\frac{1}{4}$  Section 24, R.1.E., T.10.N.

Nineteen pupae are complete and range in length from 2.40 to 4.61 mm., mean 3.3059 mm., type 3.264 mm.

The terminal segment ranges in length from 0.201 to 0.384 mm.,

mean 0.313 mm., type and paratypes 0.346 mm.; and in width 0.154 to 0.289, mean 0.244, type and paratypes 0.269 mm.

The caudal segment has the appearance of being terminally truncate, in that the apices of the apicolateral and apicomedian lobes are almost on a line. The apicomedian lobes have a tiny spine. This species stands between *australis* and *stenoceras* in the positions of the terminal lobes.

*Dasyhelea stenoceras* Palmer 1957

Figure 3

This species (pupal type No. 7) was described by Palmer (1957) from pupae only, found at sites 19057 (type) and 19063b, c, in SW  $\frac{1}{4}$ , Section 24, R.1.E., T.10.N., and at site 19066 which Palmer does not locate, but is in either NE  $\frac{1}{4}$  Section 24 or NE  $\frac{1}{4}$  Section 19, R.2.E., T.10.N.

From the Calico Mountains we have 28 pupae extracted from nodules found in R.1.E., T.10.N., Section 24, SW  $\frac{1}{4}$  (type locality) -2, NE  $\frac{1}{4}$ -3; R.2.E., T.10.N., Section 18, SW  $\frac{1}{4}$ -1, SE  $\frac{1}{4}$ -1; Section 19, NW  $\frac{1}{4}$ -4, NE  $\frac{1}{4}$ -16, un stated  $\frac{1}{4}$ -1. One specimen, full of spherical crystals, from Mount Frazier, Kern County, SW  $\frac{1}{4}$  Section 36, R.20.W., T.9.N., at 5500 feet altitude, with broken anal segment, still seems to belong to this species.

Eleven pupae are complete, measuring in length 2.30 to 3.84 mm., mean 2.77 mm.

The caudal segment is the distinguishing character with its apicolateral spines directed laterally and at right angles to the apicomedian spines which are terminal. This segment measures in length 0.21 to 0.307 mm., mean 0.255 mm. and in width at lateral tubercles 0.21 to 0.307 mm., mean 0.253 mm.

The respiratory trumpet was recovered on only one specimen.

Subfamily Ceratopogoninae

Tribe Culicoidini

Genus *Culicoides* Latreille

I am assigning 5 species of pupae to this genus, 22 species of which genus Wirth records as breeding in California waters. *C. variipennis* is found breeding in an alkaline pond at Borax Lake in Lake County, and at margin of Paso Creek carrying salt water from oil fields in Kern County.

***Culicoides carri*, new species**

Figures 15 and 16

Based on a single complete pupa (pupa type No. 12), specimen 4279, extracted from nodule 2670, and registered as LACMIP Type S 9122, collected by John Carr at Site 2C in mine cave at 2700 feet, in SW  $\frac{1}{4}$  Section 18, R.2.E., T.10.N.

Length of pupa 2.42 mm.

Caudal segment measures 0.211 mm. in length, and 0.192 mm. in width; provided with two long cerci-like appendages, extending almost straight, diverging about  $12^\circ$  beyond the anal tip. Genital sacs broad at base, extending beyond anal tip, but surpassed by the lateral appendages.

***Culicoides fossilis*, new species**

Figure 11

Based on a partial specimen (pupa type No. 19), No. 805, designated as LACMIP Type S 9116, extracted from nodule 4729 collected by John Carr at Site 25 (LACMIP 373), altitude 2725 feet, in NE  $\frac{1}{4}$  Section 19, R.2.E., T.10.N.

In this species the genital plates extend beyond the anus to the line connecting the apices of the apicolateral cerci-like appendages, which diverge from the longitudinal axis  $40^\circ$ .

The terminal segment is 0.192 mm. long, by 0.192 mm. wide at the top of the appendages.

***Culicoides laurae*, new species**

Figure 9

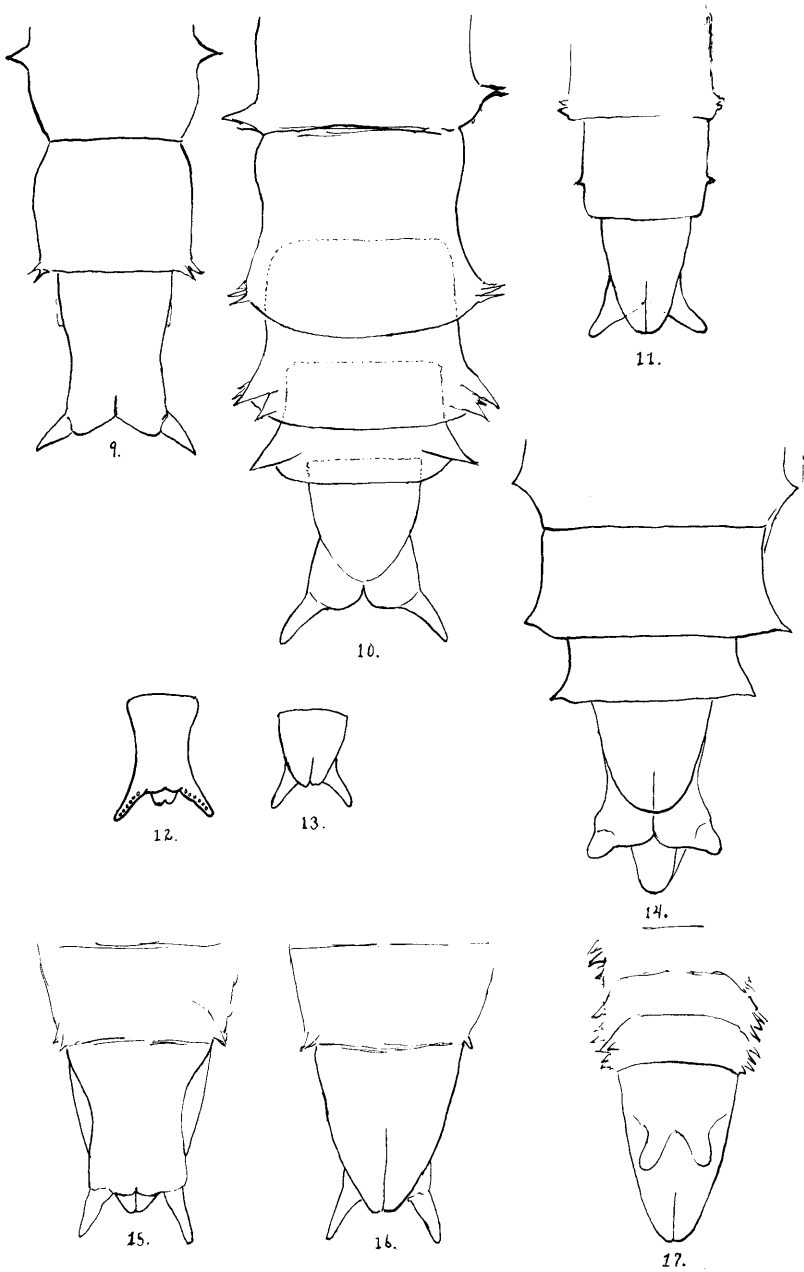
Based on a partial specimen (pupal type No. 29), No. 6831, recorded as LACMIP Type S 9114, extracted from nodule 20765, collected by Mrs. Laura Rouse in unspecified  $\frac{1}{4}$  Section of Section 19, R.2.E., T.10.N.

The caudal segment is characterized by postero-lateral cerci-like appendages directed downward and outward at an angle of  $12^\circ$ . The segment measures 0.307 mm. in length and 0.269 mm. in width at apex of the appendages.

*Culicoides megacanthus* Palmer

Figures 12 and 13

Palmer (1957) records this species (my pupal type No. 8) from the SW  $\frac{1}{4}$  Section 24 (LACMIP 372) at Sites 19057, 19063b and 19064b, at altitudes 2400 to 2700 feet, in R.1.E., T.10.N.



Figures 9-17. Fossil Pupae of Family Ceratopogonidae. Subfamily Ceratopogoninae, Tribe Culicoidini, extracted from Miocene nodules of Calico Mountains: Figure 9: *Culicoides laurae*, new species, LACMIP S 9114, last three segments of

I have one pupa from NE  $\frac{1}{4}$  Section 19.

Palmer's illustration shows that the genital sacs extend beyond the anal orifice, but are surpassed by the long postero-lateral processes, which extend outward at an angle of  $25^\circ$ .

**Culicoides miocenea**, new species

Figure 10

Based on 10 Calico Mountains pupae (type No. 6) collected as follows: R.1.E., T.10.N. Section 24, SW  $\frac{1}{4}$ -1, NE  $\frac{1}{4}$ -1; R.2.E., T.10.N., Section 19, NE  $\frac{1}{4}$  (type)-6, unstated  $\frac{1}{4}$ -1; Section 17, SE  $\frac{1}{4}$ -1; total 10. These were extracted from nodules collected at altitudes 2380 to 2900 feet.

The holotype specimen 2535, recorded as LACMIP Type S 9115, was extracted from nodule 16676, collected by George Kanakoff, at Site 17F (LACMIP 365) in NE  $\frac{1}{4}$  Section 19, R.2.E., T.10.N.

Three pupae are entire and measure 3.26 (type), 3.44 and 3.75 mm., mean 3.48 mm.

The terminal segment is characterized by rounded genital sacs reaching the anal orifice, but greatly exceeded by the postero-lateral lobes, extending at an angle of  $32^\circ$ , with long cerci-like appendages. The preceding segments are provided with sharp spiny processes.

**Neoculicoides**, new genus

Pupal genital sacs far exceeding anal cercal lobes.

*Type Species: Neoculicoides jeanneae*, n. sp.

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specimen 6831 from nodule 20765, collected by Laura Rouse in unspecified  $\frac{1}{4}$ , Section 19, R.2.E., T.10.N. *Figure 10: Culicoides miocenea*, new species, LACMIP S 9115, last five segments of specimen 2535 from nodule 16676, collected by George Kanakoff at Site 17F (LACMIP 365) in NE  $\frac{1}{4}$ , Section 19, R.2.E., T.10.N. *Figure 11: Culicoides fossilis*, new species, LACMIP S 9116, last three segments of specimen 805 from nodule 4729, collected by John Carr, at Site 25, altitude 2725, in NE  $\frac{1}{4}$ , Section 19, R.2.E., T.10.N. *Figure 12: Culicoides megacanthus* Palmer, drawn after Palmer (1957), dorsal view of last segment. Collected by Palmer, in SW  $\frac{1}{4}$ , Section 24, at Sites 19057, 19063b, 19064b, R.1.E., T.10.N. *Figure 13: Same*, ventral view of last segment. *Figure 14: Paraculicoides rouseae*, new species, LACMIP S 9121, last four segments of specimen 485 from nodule 28835, collected by Laura Rouse, at Site 17F (LACMIP 365), NE  $\frac{1}{4}$  Section 19, R.2.E., T.10.N. *Figure 15: Culicoides carri*, new species, LACMIP S 9122 dorsal view of last two segments of specimen 4279 from nodule 2670, collected by John Carr at Site 2C (LACMIP 351) in mine cave at 2700 feet, SW  $\frac{1}{4}$  Section 18, R.2.E., T.10.N. *Figure 16: Same*, ventral view of last two segments. *Figure 17: Neoculicoides jeanneae*, new species, LACMIP S 9123, last four segments of specimen 4560 from nodule 532, collected by Jeanne Hotchkiss at Site 10 (LACMIP 357) at 2700 feet in NE  $\frac{1}{4}$  Section 19, R.2.E., T.10.N.

**Neoculicoides jeanneae**, new species

## Figure 17

Pupal type No. 20 is based on pupal specimen 4560, recorded as LACMIP Type S 9123, extracted from nodule 532, collected by Jeanne Hotchkiss at Site 10 (LACMIP 357), NE  $\frac{1}{4}$  Section 19, R.2.E., T.10.N., altitude 2700 feet.

The total length of the pupa is 2.88 mm.

The apical segment is unusual in that the genital sacs are very long, narrowly rounded and far exceed the anal orifice and the two cercus-like lobes at middle. The postero-lateral processes are bluntly rounded and extend at  $52^\circ$  from anal base.

The sides of the preceding abdominal segments are armed with many sharp spines.

**Paraculicoides**, new genus

Pupal postero-lateral lobes blunt, directed outward, and exceeded by median dorsal lobe.

*Type species: Paraculicoides rouseae*, n. sp.

**Paraculicoides rouseae**, new species

## Figure 14

Pupal type No. 11 is based on specimen 4845, recorded as LACMIC Type S 9121, extracted from nodule 28835, collected by Mrs. Laura Rouse at Site 17F (LACMIP 365) in NE  $\frac{1}{4}$  Section 19, R.2.E., T.10.N.

The terminal segment measures 0.326 mm. in length and 0.192 mm. in width. The genital sacs are broadly rounded, barely over  $\frac{1}{2}$  as long as the segment, while the postero-lateral lobes are broad, blunt, directed outward at  $12^\circ$  from anal cleft, and greatly exceeded by the median dorsal lobe.

## Subfamily Ceratopogoninae

## Tribe Stenoxenini

Genus *Johannsenomyia* Malloch**Johannsenomyia hotchkissae**, new species

## Figure 18

Pupal species No. 1 is represented by 14 Calico Mountains pupae extracted from nodules collected as follows: R.1.E., T.10.N., Section 24, SW  $\frac{1}{4}$ -1, NE  $\frac{1}{4}$ -3; R.2.E., T.10.N., Section 18, SE  $\frac{1}{4}$ -1; Sec-

tion 19, NW  $\frac{1}{4}$ -2, NE  $\frac{1}{4}$  (type)-6, unstated  $\frac{1}{4}$ -1; total 14. Altitudes 2100 to 2800 feet, mostly 2700 feet.

Holotype specimen 467, registered as LACMIP Type S 9128, was extracted from nodule 437, collected by Jeanne Hotchkiss in NE  $\frac{1}{4}$  Section 19 at Site 10, the Rouse anticline, at 2700 feet altitude.

Three pupae are complete and measure 2.63, 2.78, and 2.89 mm. (type), mean 2.76 mm. in length.

The caudal segment measures 0.192 to 0.365 mm. in length, mean 0.2970 mm., type 0.289 mm.; and 0.153 to 0.230 mm. in width, mean 0.197 mm., type 0.192 mm. This segment is quite simple in outline, with long apicolateral processes directed posteriorly, neither incurved, nor outwardly curved; without apicomedian lobes. It closely resembles *Johannsenomyia sybleae* as figured by Wirth (1952: 154).

#### **Miopalpomyia**, new genus

Pupal postero-lateral lobes elongate directed posteriorly.

*Type species: Miopalpomyia shilo*, n. sp.

#### **Miopalpomyia shilo**, new species

Figure 20

Based on pupal specimen 783 (pupal type No. 4), registered as LACMIP Type S 9130, extracted from nodule 2826 collected by Dara Shilo at Site 2D (LACMIP 351), about 2700 feet in SW  $\frac{1}{4}$  Section 18, R.2.E., T.10.N.

Length of pupa 2.46 mm.

The terminal segment measures in length 0.269 mm., and in width at apices 0.230 mm. The postero-lateral processes are long, slender and diverging from the perpendicular  $20^\circ$ .

The preceding segments have very minute spines.

#### **Neopalpomyia**, new genus

Postero-lateral processes of pupal cauda directed sharply outward; apicomedian lobes evident.

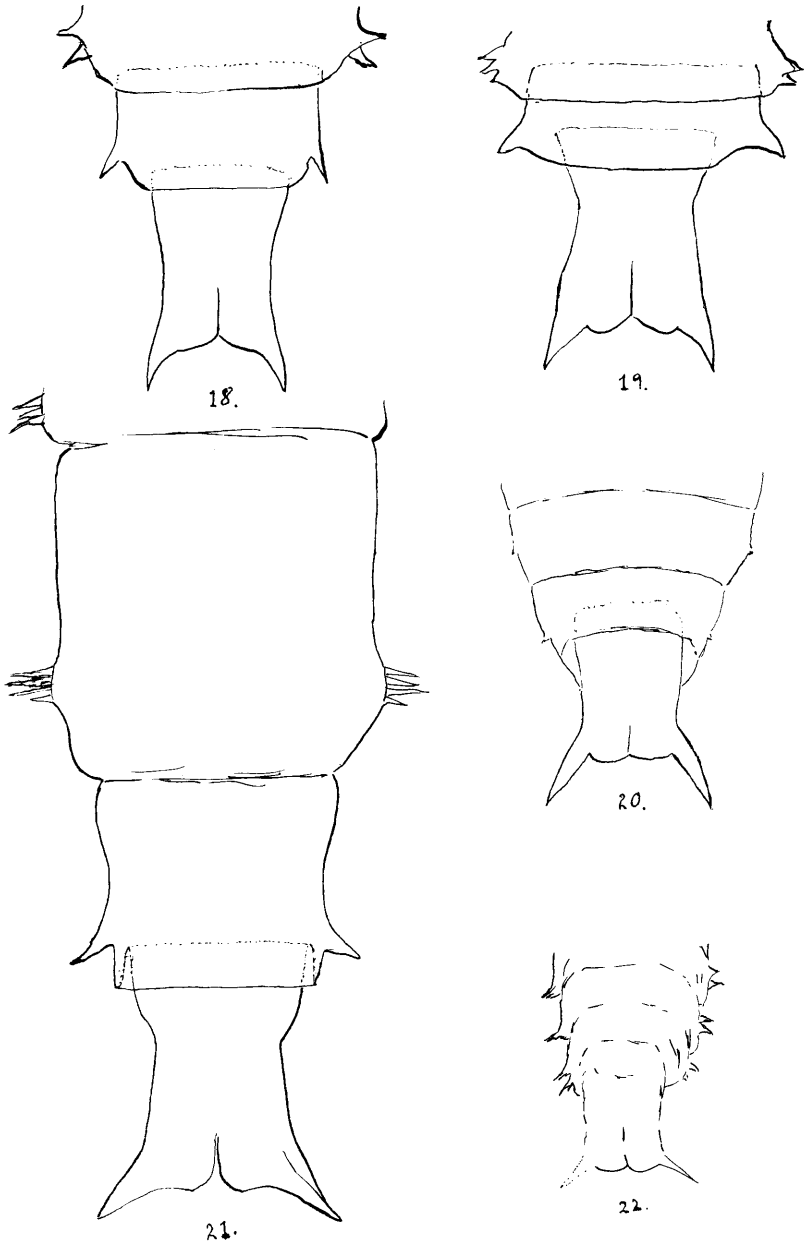
*Type species: Neopalpomyia freyi*, n. sp.

#### **Neopalpomyia freyi**, new species

Figure 21

Based on 20 specimens of pupal species No. 28, from R.1.E., T.10.N., Section 24, SW  $\frac{1}{4}$ -4; NE  $\frac{1}{4}$ -1; R.2.E., T.10.N., Section 19, NE  $\frac{1}{4}$ -9, undetermined  $\frac{1}{4}$ -2; Section 18, SW  $\frac{1}{4}$ -3; SE  $\frac{1}{4}$ -1.

Holotype specimen 4199, registered as LACMIP Type S 9131, ex-



Figures 18-22. Fossil pupae of family Ceratopogonidae. Subfamily Ceratopogoninae. Tribe Stenoxenini, extracted from Miocene nodules of the Calico Mountains: Figure 18: *Johannsenomyia hotchkissae*, new species, LACMIP S 9128, last three



tracted from nodule 10193 collected in SW  $\frac{1}{4}$  Section 24, R.1.E., T.10.N., Calico Mountains, California. Named for Kenneth Frey.

Eight specimens are complete and measure 3.26 to 4.26 mm., mean 3.71 mm., type 4.03 mm. as pupa; 4.80 to 4.807 mm. as pupae containing adults with extended abdomens.

The caudal segment measures 2.50 to 3.84 mm., mean 0.334 mm., type 0.326 mm., in length; 0.230 to 0.403 mm., mean 0.341 mm., type 0.346 mm., in width at apex of processes.

This segment is sharply incised at median apex, and has postero-lateral processes acute and directed outward at an angle of  $24^\circ$  from the anal base.

The bristles on the preceding segments are many, long and sharp.

#### ***Neopalpomyia multispinosa*, new species**

Figure 22

Pupal species No. 26 is based on specimen 144, registered as LACMIP Type S 9132, extracted from nodule 277A, collected by George Kanakoff at Site 4 (LACMIP 353) in NE  $\frac{1}{4}$  Section 24, R.1.E., T.10.N.

While the specimen is imperfect it differs from all others by the postero-lateral spines being about transverse, as they part from the anal terminus at  $13^\circ$ .

The preceding segments are armed with many sharp spines, the character upon which the new name is based.

#### ***Parapalpomyia*, new genus**

Pupal caudal segment with apicomedian lobes, and with long apicolateral pointed lobes.

*Type species: Parapalpomyia ryshkoffi*, n. sp.

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segments of specimen 467 from nodule 437, collected by Jeanne Hotchkiss at Site 10 (LACMIP 357), altitude 2700 feet, in NE  $\frac{1}{4}$  Section 19, R.2.E., T.10.N. *Figure 19: Parapalpomyia ryshkoffi*, new species, LACMIP S 9129, last three segments of specimen 330 from nodule 107, collected by Rostick Ryshkoff at Site 2 (LACMIP 351), 2650 to 2800 feet, in SW  $\frac{1}{4}$  Section 18, R.2.E., T.10.N. *Figure 20: Miopalpomyia shilo*, new species, LACMIP S 9130, last three segments of specimen 283 from nodule 2826, collected by Dara Shilo at Site 2D (LACMIP 351), about 2700 feet, in SW  $\frac{1}{4}$  Section 18, R.2.E., T.10.N. *Figure 21: Neopalpomyia freyi*, new species, LACMIP S 9131, last three segments of specimen 4199 from nodule 10193, collected by George Kanakoff at Site 15 (LACMIP 362), about 2400 feet, SW  $\frac{1}{4}$  Section 24, R.1.E., T.10.N. *Figure 22: Neopalpomyia multispinosa*, new species, LACMIP S 9132, last four segments of specimen 144 from nodule 277A, collected by George Kanakoff at Site 4 (LACMIP 353), NE  $\frac{1}{4}$  Section 24, R.1.E., T.10.N.

**Parapalpomyia ryshkoffi**, new species

## Figure 19

Pupal species No. 2 is based on 33 Calico Mountains specimens extracted from nodules collected in R.1.E., T.10.N., Section 24, NE  $\frac{1}{4}$ -5, SW  $\frac{1}{4}$ -8; R.2.E., T.10.N., Section 18, SW  $\frac{1}{4}$ -5, SE  $\frac{1}{4}$ -2; Section 19, NW  $\frac{1}{4}$ -3, NE  $\frac{1}{4}$ -9, undesignated  $\frac{1}{4}$ -1; total 33.

Holotype specimen 330, registered as LACMIP Type S 9129, was extracted from nodule 107, collected at Site 2 (LACMIP 351), 2650 to 2800 feet, in SW  $\frac{1}{4}$  Section 18, by Rostick Ryshkoff.

Ten complete pupae measure in length 2.21 to 3.769 mm., type 3.173 mm., mean 3.1324 mm.

The caudal segment ranges in length 0.209 to 0.403 mm., mean 0.333 mm., type 0.307 mm.; and width 0.192 to 0.307 mm., mean 0.254 mm., type 0.250 mm. This segment is simple with apico-lateral processes posteriorly produced, neither incurved, nor outwardly curved, with definite apicomedian lobes.

It is rather interesting that the type is from the same nodule as six specimens of pupal species No. 6, *Culicoides miocena*, described above, which is entirely different in character.

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