

FOSSIL ARTHROPODS OF CALIFORNIA. NO. 25. SILICIFIED
LEAFHOPPERS FROM CALIFORNIA MOUNTAINS NODULESW. DWIGHT PIERCE¹

It is with great pleasure that I present the studies of a series of silicified jassid (cicadellid) leafhoppers, Order Homoptera, all extracted by acids (formic and hydrochloric) from Miocene calcareous petroliciferous nodules collected in the Calico Mountains, San Bernardino County, California, by Allison R. Palmer, Mrs. Laura Rouse, Mr. and Mrs. Samuel Kirkby, Mrs. Dara Kuznetzoff (as Dara Shilo), Mr. and Mrs. John Gibron, Sr., and Dr. Donald Weissman.

The nodules were found at twelve sites on two sides of the mountain mass and probably represent quite a range in age, as there is over 300 feet difference in altitude, although the tilting of the strata reduces the value of present altitude. However, other evidences indicate sites Gibron 4 and U.S. 19057 to be the oldest. They are all Miocene.

For comparison of location and approximate altitude I have tabulated the material (Table 1). The collection sites are in SE and SW quarters of Section 23, and SW quarter of Section 24, R.1.E., T.10.N.; and in NE quarter Section 19, and SW quarter Section 18, R.2.E., T.10.N., a distance of $2\frac{1}{4}$ miles east and west, and about 1 mile, north and south.

The classification of the Jassidae is very confusing inasmuch as each authority has used a different system of group classification. The head shows tremendous differences, due to the movement of the epistomal suture, the frons, and the antennae and ocelli. The group has been called by various family names, but I have chosen to follow as nearly as possible the system of Evans (1946-1947).

Hitherto, the few fossil leafhoppers reported have been compressed by pressure of volcanic ash, or aquatic deposits. The fossils from the lake-bed nodules formed in volcanic areas are unique, in that they are three-dimensional, siliceous replicas of the insects, often still containing traces of the petroleum that was evolved by catalytic action from their tissues. As the silica is colloidal, the preservation of form is perfect, and in several specimens even the form of the brain and nervous system is clearly outlined.

The first specimen found was described and illustrated by Palmer

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TABLE I
SOURCES OF THE LEAF HOPPER MATERIAL.

Quarter, Section and Range	Site	Specimen	Nodule No.	Altitude	Collector of Nodule	Species
S.W.23.1	Gibron 4	H1704		2415 ±	Gibron	<i>Miochlorotettix gibroni</i> ♂ paratype
S.E.23.1	(G.1) LA 115	H1820 5743		2415 ±	Gibron	<i>Miochlorotettix gibroni</i> ♂ paratype
S.E.23.1	(G.1) 115	H1561		2415 ±	Gibron	♀
S.E.23.1	(G.1) 115	H1567		2415 ±	Gibron	<i>Miochlorotettix gibroni</i> ♂ paratype
S.E.23.1	(G.2) 116	H1431		2400	Gibron	
S.E.23.1	(G.3) 117	H1940		2415 ±	Gibron	<i>Miochlorotettix gibroni</i> ?
S.W.24.1	19057	5076		2420	Gibron	nymph
S.W.24.1	19057	(H20) 5278		2420	Gibron	<i>Miochlorotettix gibroni</i> allotype
S.W.24.1	19057	(H21) 5279		2420	Gibron	<i>Miochlorotettix gibroni</i>
S.W.24.1	19057	(H22) 5280		2420	Gibron	<i>Miochlorotettix gibroni</i>
S.W.24.1	19057	(H23) 5281		2420	Gibron	<i>Miochlorotettix gibroni</i>
S.W.24.1	19057	(H26) 5283		2420	Gibron	<i>Miochlorotettix gibroni</i> holotype
S.W.24.1	19057	(H60) 5296		2420	Gibron	<i>Miochlorotettix gibroni</i>
S.W.24.1	19057	(H70) 5299		2420	Gibron	<i>Miochlorotettix gibroni</i>
S.W.24.1	19057A	H785		2400	Gibron	
S.W.24.1	19057A	H899		2400	Gibron	<i>Miochlorotettix gibroni</i> ?
S.W.24.1	19057A	H1801		2400	Gibron	<i>Miochlorotettix gibroni</i> ?
S.W.24.1	19057B	H1354		2410	Gibron	
S.W.24.1	19063	(H1216a) 5745		2500+	Gibron	<i>Miomesamia juliae</i> holotype
S.W.24.1		H1216b		2500+	Gibron	<i>Miochlorotettix gibroni</i> ?
S.W.24.1	19064b	US NM 561985		2500	Palmer	<i>Euscelis palmeri</i>
S.W.24.1	LA 38	854	10263C	2700	R. Kirkby	fragment
N.E.19.2	12	1312	2201	2700	Shilo	<i>Protochlorotettix calico</i> ♀ holotype
N.E.19.2	17F	3723	28805	2700+	L. Rouse	<i>Phlepsius weissmanae</i> ♂ holotype
N.E.19.2	17	2142	11806	2700+	L. Rouse	<i>Protochlorotettix calico</i> impression
N.E.19.2	KX42b	5787	18799	2700+	S. Kirkby	<i>Miochlorotettix kirkbyi</i>
N.E.19.2	KX14	5788		2660	S. Kirkby	<i>Miochlorotettix kirkbyi</i>
S.W.18.2	42	2491	10528	2750	Weissman	nymph
4 quarter Sections	15 Sites	28 Specimens		2400-2750	7 collectors	6 species

(1957), but he did not give it a name, because of the absence of a male specimen. In paleontology one cannot wait until we find all diagnostic characters before we assign a name to a species, even though the generic position must later be changed, because we need a "handle" for it. I am, therefore, assigning a name to his specimen, naming it in his honor, and have reproduced his drawings so that the species can be readily compared to the others found in the nodules.

These are the first leafhopper fossils preserved by silica replications, and they are truly remarkable fossils. The clear transparent nature of some of them makes it very difficult to correctly interpret all characters.

Leafhoppers are not aquatic, although they may visit and breed upon aquatic plants growing out of the waters; hence, we might consider these insects as accidentally preserved, probably being drowned by the downfall of volcanic liquids or gases.

There are six distinct species in the series and by the figures it can be seen that they are readily separated by the face, the anterior outline of the head, the shape and proportions of frons, and clypeus. Two of the species, *gibroni* and *kirkbyi* are unusual in the arching of the prothorax due to a greatly enlarged scutellum, and both of these and *calico* show a complete median division of the sternal segment preceding the female genitalia. Nine of the specimens are assigned to one species, *gibroni*, although there is considerable variation in head measurements.

Specimens 5279 and 5787 are interesting in that the brain has been differently crystallized and hence is quite apparent in the clear head.

In Table 2 are listed the measurements for comparison; and these are to form part of the descriptive data.

Order HOMOPTERA Leach 1815
Family JASSIDAE (Cicadellidae)
Subfamily EUSCELINAE
Tribe EUSCELINI

Palmer (1957) described and figured a female leafhopper, which Dr. David A. Young considered to belong to the genus *Deltocephalus* s.s., based on size and general appearances.

However, DeLong (1926) states: "In regard to venation proper, the normal and apparently constant condition in the *Deltocephalus* wing is a series of three antepical cells, with a costal cell beyond the outer antepical cell." In those wings in which two cross veins inter-

vene between the first and second sectors there are two discal cells, three anteapical cells, and five apical cells.

Palmer's leaf hopper has only one cross vein and consequently two discal and two anteapical cells, plus the five apical cells. For this reason I feel that the fossil must belong to one of the genera in which its type of wing venation is known to exist, as: *Euscelis*, *Eutettix*, *Chlorotettix*, *Thamnotettix*, *Phlepsius*, and *Paraphlepsius*.

We have three other characters to assist in the elimination: (1) short, broad vertex, not excessively angulate; (2) wide face, with frons broad at base, narrowing to clypeus, which is one-half as wide as frons at base, and with clypeus wider at apex than base; (2) last sternal segment (7th) of female broadly roundly emarginate, exposing basal parts of valves and valvifers, and with pygofer at base no wider than the emargination.

All three of these characters are to be found in *Euscelis deceptus* Sanders, *E. parallelus* (Van Duzee), *E. striolus* (Fallen), and *Thamnotettix mellus* Sanders.

Inasmuch as Palmer describes his species as having head slightly convex in profile, it seems to fit better into *Euscelis* than *Thamnotettix*, and hence it is here tentatively placed in the genus *Euscelis*.

Genus *Euscelis* Brullé

Euscelis palmeri, new species

(Figures 6, 7, 19, and 20)

Holotype: USNM 561985, the specimen figured and described by Dr. Allison R. Palmer (1957), without name, but placed tentatively in *Deltocephalus*. It is with pleasure that I assign it the species name *palmeri*. I repeat his description, adding in parentheses points derived from his drawings.

Type locality: Site 19064b, U.S.G.S. Cenozoic locality, SW ¼ Sect. 24, R.1.E. T.10.N., Calico Mts., San Bernardino County, California.

Description: Female. Length about 3.2 mm. Crown slightly produced forward, sharply rounded anteriorly in dorsal aspect, slightly convex in profile; median length about three-fifths width between eyes. (Face with proportions of width to length as 23:18; posterior margin of eyes at about middle line of facial length; posterior margin of face a curve enclosing genae and clypeus. Frons a little more than twice as wide at apex as at base. Clypeus one-half wider at apex than at base. Lorae not completely defined. Antennae inserted between eyes and frons opposite middle of frons).

Forewing with discal cells undivided; cross vein dividing costal area originates from (near base of) anteapical area; proximal parts of claval veins not preserved; (basal cells, three; discal cells, two; costal cell, one; anteapical cells, two; apical cells, four).

Femur with two distal pairs of spines, and a single more proximal spine arranged on knee. Anterior spines in each pair seem more slender than posterior spines.

Seventh sternite with broad median indentation in its posterior margin that is flat at its anterior end except for a small centrally located notch. This segment has been pulled forward in fossil to expose first valvifers of ovipositor, and between these, smooth basal parts of first valves. Posterior to these, basal parts of pygofer overlap slender basal parts of third valves. Surfaces of third valves and pygofer granular. Pygofer also bears strong spines on its posterior half. Tips of third valves extend posteriorly beyond apex of pygofer. (Three dorsal segments are visible beyond the pygofer).

Miochlorotettix, new genus

Leafhoppers with typical deltocephaline form, but with prothorax strongly arched forward; and scutellum occupying the arch, as well as extending back between the wings to about the same distance as it extends forward.

At first sight it was thought this might be a deformity of the prothorax, but identical thorax and scutellum has been found in all specimens.

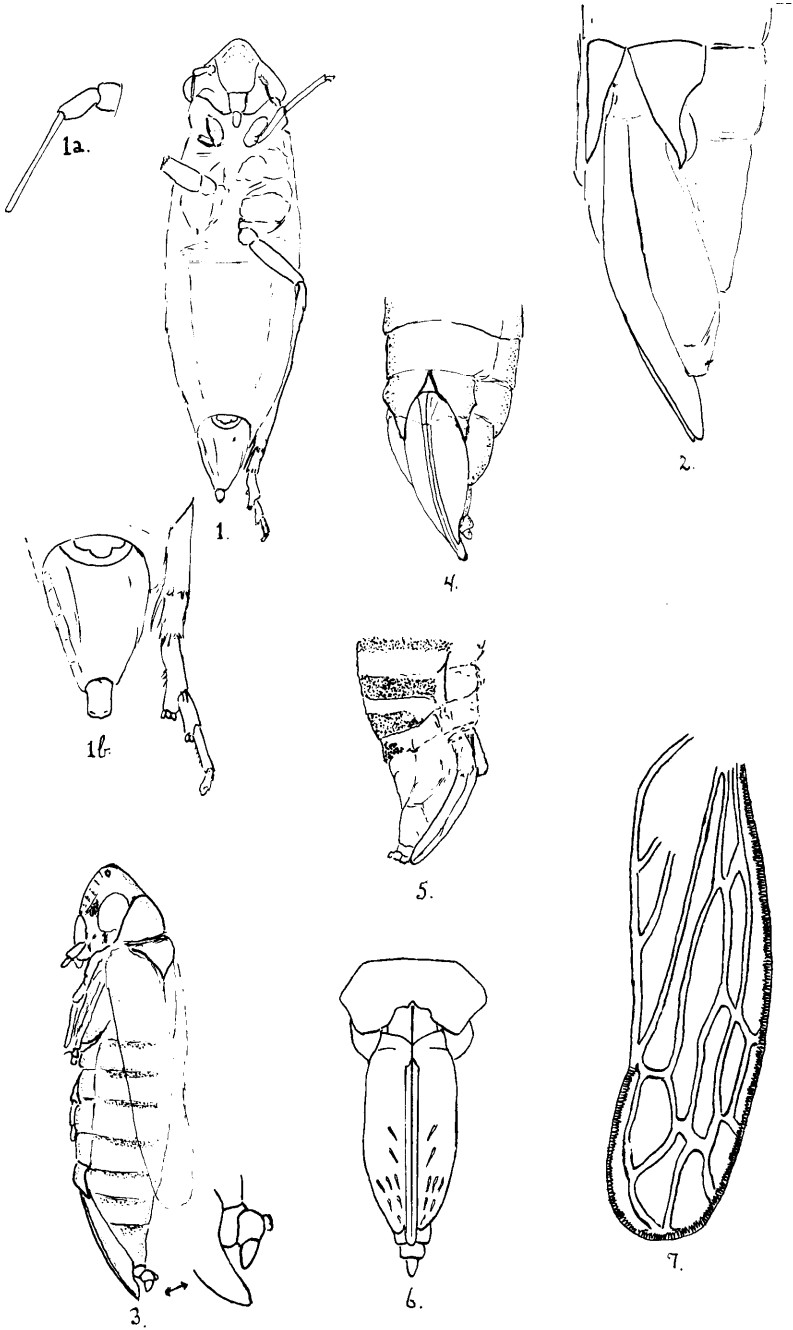
It is placed tentatively near *Chlorotettix*, because of the genitalia.

Miochlorotettix gibroni, new species

(Figures 1, 2, 15, 16, and 17)

Type locality: Crystallized fossil leafhoppers, extracted by hydrochloric acid from calcareous Miocene nodules from Calico Mountains, SW ¼ Section 24, R.1.E., T.10.N., San Bernardino Co., Calif., from site 19057 U.S.G.S. Cenozoic locality, collected and extracted by Mr. and Mrs. John Gibron, Sr., of Campbell, California.

Types: Holotype: ♂ specimen 5283 (Gibron H26); allotype ♀, 5278 (Gibron H20); paratypes 5279 (Gibron 21), with tip of abdomen broken, but probably male; 5296 (Gibron H60) head and thorax only; 5280 (H22); 5281 (H23); 5299 (H70), all from U.S. Geol. Site 19057; also, 5743 (H1820), H1561, H1567 from Gibron Site 1, near camping site on Mule Cañon Drive; H1431 from Gibron Site 2,



across the hill on Phillips Drive side; H1704 from Gibron Site 4 farther west. Other specimens, labeled with (?) are Gibron's H1940, H899, H1801, and H1216b. Types mounted in balsam, deposited in Los Angeles County Museum Collection; all other material in personal collection, John Gibron, Sr.

Description: Measurements of all specimens given in Table 2.

Male. Smaller than female. In the holotype the body is complete, with antennae; one anterior leg with femur and tibia; fragment of median leg; one entire posterior leg.

The face is $\frac{3}{4}$ as long as wide; frons wider than clypeus, which is more or less quadrate. Antennae with broad basal segment; second segment more than twice as long as wide; third joint elongate, slender.

The prothorax is strongly arched forward, and the concavity of the arch is occupied by the anterior half of the scutellum.

Gibron's specimen H1704 is a dry mounted male attached on a slide by gum tragacanth. It has the six legs mostly intact and has been studied by illumination, comparative measurements being made of the lengths of the various leg segments using spaces in ocular micrometer, 52 spaces=1 mm.

COMPARATIVE MEASUREMENTS OF THE LEGS

leg element	front legs	middle legs	hind legs
coxa	8	13	—
trochanter	11?	3	—
femur	30	25	30
tibia	15	20	62
tarsus (entire)	14	15	33
tarsus I	5	—	18
II	6	—	10
III	6	—	10

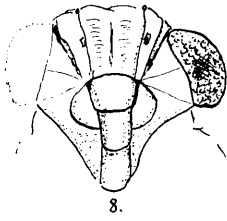
The legs are armed with many long spines. The tarsal joints are attached before the apex of the preceding joint, and each is terminated by two pulvilli.

Figure 1. Miochlorotettix gibroni, ventral view of ♂ 5283.

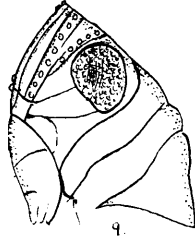
a. Same. Antenna, ♂ 5283.

b. Same. Caudal segments and hind tibio-tarsus, ♂ 5283.

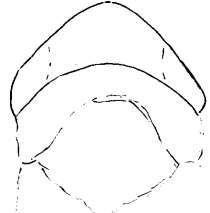
Figure 2. M. gibroni, caudal segments, ♀ 5279. *Figure 3. Protochlorotettix calico*, side view, ♀ 1312. *Figure 4. Same*, caudal segments, ♀ 1312. *Figure 5. Miochlorotettix kirkbyi*, caudal segments, ♀ 5787. *Figure 6. Euscelis palmeri*, caudal segments, after Palmer. *Figure 7. Same*, wing, after Palmer.



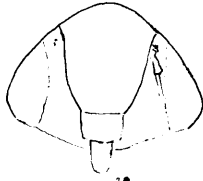
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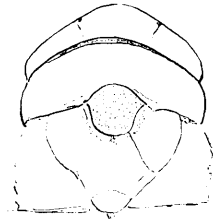
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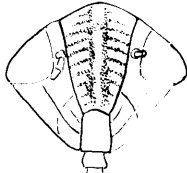
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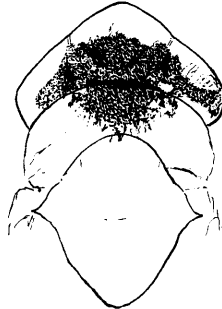
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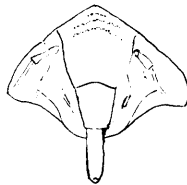
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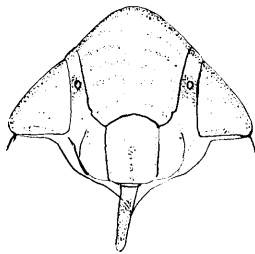
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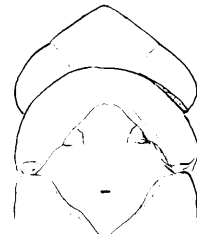
15.



19.



18.



17.



20.

Female. The allotype is larger than the holotype male but has the same shaped head, and the scutellum occupying the arch of prothorax. The specimen is broken in two parts and mounted in balsam.

This specimen is interesting in the preservation of the brain, which is not crystallized in the same manner as the rest of the body. This is a great white mass extending the width of the base of the head, with long arms reaching into the eyes dorsally with two large lobes separated by a lower median area, and from the lobes extend a pair of fine nerves to the anterior margin to indicate the position of ocelli. The under and posterior part of the brain occupies the facial portion.

The female genitalia also set this species aside among the Jassidae, in that the last ventral segment is completely divided at base into two lobes, broad at base, and acute at apex. The ovipositor extends beyond the pygofer.

The paratypes have the head, thorax, and scutellum of identical pattern as described above.

***Miochlorotettix kirkbyi*, new species**

(Figures 5, and 10-12)

Holotype: ♀ specimen 5787 collected by Samuel Kirkby in NW ¼ NE ¼ Section 19, R.2.E., T.10.N., Calico Mountains, and dissolved from nodule 18799, Site 42B, altitude close to 2700 feet.

This specimen is placed in the new genus *Miochlorotettix* because of the greatly enlarged scutellum displacing the prothorax forward; and also the complete division of the sternite preceding the female genitalia, with two separate sternal lobes as in *gibroni* and *calico*. However, it differs in the frontal curvature of the head being not as sharply angled as *gibroni*; side profile wider than *gibroni* or *calico*; face quite distinct from all four species included in this paper.

Length 3.68 mm., which is shorter than the ♀s of *gibroni* or *calico*.

Figure 8. Miomesamia juliae, face, 5795. *Figure 9.* Same, side view of head, prothorax and scutellum, 5795. *Figure 10. Miochlorotettix kirkbyi*, face, 5787. *Figure 11.* Same, side view of face, 5787. *Figure 12.* Same, dorsal view of head, prothorax and scutellum, 5787. *Figure 13. Phlepsius weissmanae*, face, 3723. *Figure 14.* Same, dorsal view of head, prothorax and scutellum, 3723. *Figure 15. Miochlorotettix gibroni*, face, ♂ 5283. *Figure 16.* Same, dorsal view of head, prothorax and scutellum showing brain, ♀ 5278. *Figure 17.* Same, dorsal view of head, prothorax and scutellum. *Figure 18. Protochlorotettix calico*, face, ♀ 1312. *Figure 19. Euscelis palmeri*, face, after Palmer. *Figure 20.* Same, head, prothorax and scutellum, after Palmer.

Genus **Protochlorotettix**, new genus

This genus is close to *Chlorotettix*, and has a normal triangular scutellum, but the last sternal segment is completely divided into two plates as in *Miochlorotettix*, which however, has the scutellum extending forward into the prothorax.

Protochlorotettix calico, new species

(Figures 3, 4 and 18)

Holotype: specimen 1312, balsam slide mount, crystallized female, acid extracted by W. D. Pierce from blue-gray nodule, No. 2201, found by Dara Shilo, May 11, 1956, on blue-gray mine dump (LAC-MIP 359) altitude about 2700 feet, on lot 13, from NE ¼ Section 19, R.2.W., T.10.N., Calico Mountains, San Bernardino County, California.

Description: Length 4.88 mm. This fine crystallized female still shows traces of color. The remarkable replacement of the tissues by the silica has preserved even the reticulate and granulate surface sculpture of head, legs and abdomen.

Its measurements are compared in Table 2 with the specimens of *M. gibroni*.

It differs from *Euscelis palmeri* by much more angulated projection of vertex; clypeus quadrate; seventh sternite posteriorly divided into two lobes; last dorsal segments surpassed by pygofer and valves; the last segment shorter. While having several characters similar to *Euscelis deceptus*, it differs from that species also in the more angulate head.

The head (Figures 3 and 18), is strongly arched at a 90° angle (measured from tip of front to outer corners of eyes), though apically rounded. Ocelli on parietals between eyes and frons on the anterior edge of the vertex. Antennae fossae ventral, obovate, on parietal strips between eyes and frons, about middle of eyes. Frons slowly narrowed to a distinct notch, then suddenly narrowed to width of clypeus; marked with six transverse bands as in *Euscelis ovatus* and *deceptus*. Clypeus oblong, almost the same width throughout as in *Euscelis deceptus*. Rostrum elongate, about as long as clypeus. Lorae not well defined, but probably terminate at the frontal notches. Genae apically acute.

The legs are not complete. Front coxae widely separated. Middle and hind coxae practically contiguous.

The abdomen (Figures 3 and 4), has pygofers and valves sur-

passing the last two dorsal segments. The last dorsal is a small palpi-form segment not twice as long as wide.

The seventh ventral segment is divided at base to form two acute lobes, exposing the first valves and valvifers of the base of the pygofer, and the narrow parallel lined third valves. These valves exceed the length of the pygofer.

While a little color and a very fine surface granulation is visible, there are no setae present on the pygofer.

Internally the alimentary canal is visible.

In addition to the type, specimen 2142, on nodule 11806, collected by Mrs. Laura Rouse in NE $\frac{1}{4}$ Section 19, is a surface impression from which good latex molds disclose the dorsal form of the male leafhopper with dimensions as given in Table 2.

TABLE 2
DIMENSIONS OF FOSSIL LEAF HOPPERS

Species	Specimen No.	Sex	Total Length mm.	Head Length Dorsal mm.	Head Width mm.	Face Length mm.	Frontal Angle °
<i>Phlepsius weissmanae</i> holotype	3723	♂	3.5	0.16	0.80	0.88	95°
<i>Miochlorotettix gibroni</i> holotype	5283	♂	3.76	0.29	0.86	0.72	90°
	5279	♂	3.60	0.25	0.98	0.88	92°
	5281	♂	4.44	0.28	0.88	0.84	90°
	5299	♂	4.68	—	—	0.92	—
allotype	5278	♀	4.96	0.38	1.00	0.73	91°
	5280	♀	4.80	0.40	0.88	0.88	—
	5296	—	—	0.19	1.05	0.88	90°
	5743	—	2.8†	0.14	0.98	0.80	92°
	H1704	♂	3.60	—	0.96	0.96	—
	1567	♂	3.36	0.21	0.88	0.88	—
	1801	♂	4.00	0.327	0.96	0.903	—
?	1216b	—	—	0.48	1.04	0.88	—
?	5787	♀	3.68	0.28	0.92	0.86	90°
<i>Miochlorotettix kirkbyi</i>	5788	♀	3.04	0.192	—	0.96	—
<i>Protochlorotettix calico</i> holotype	1312	♀	4.88	—	—	1.32	90°
impression	2142	♂	3.60	0.16	0.88	—	90°
<i>Miomesamia juliae</i>	5745	—	4.45	0.31	1.05	1.12	90°

Genus *Phlepsius* Fieber

Phlepsius weissmanae, new species

(Figures 13 and 14)

Holotype: Crystallized male extracted from Miocene nodule 28805. Specimen 3723, collected by Mrs. Laura Rouse, and extracted by Mrs. Ruth Weissman and writer. From Site 17F, Lot 333, NE $\frac{1}{4}$ Section 19, R.2.E., T.10.N., Calico Mountains, San Bernardino County, California. Named in honor of Mrs. Weissman in acknowledgment of her great help for several years in these studies.

Description: Size: 3.5 mm. Head length: 0.16 mm., width 0.80 mm., face length: 0.88 mm.

Color: although crystallized, the brown pattern of face markings and thoracic and abdominal sclerites makes this an unusual specimen.

Head anteriorly broadly rounded, not extending much beyond the eyes. From dorsal aspect the median length of head is less than half the distance between the eyes. Eyes minutely granulate.

Face elongate, about as long as wide. Frons broad at vertex; gradually narrowed to clypeus, almost twice as long as eyes, marked with ten transverse colored bars which are interrupted on median line but mutually connected in two longitudinal stripes; two and one half times as long as clypeus.

Antennae between eyes and frons at about middle of eyes; three basal joints of right antenna present.

Ocelli minute, on anterior margin at corner of eyes.

Mandibular and maxillary plates or genae diagonal from eyes to clypeus. Lorae outlined by curved line from tip of clypeus to frons, bisecting the diagonal mandibular and maxillary plates.

Labium divided into two segments.

Tribe *Platymetopiini*

A very unusual insect was extracted by John Gibron, Sr., which is unfortunately, not whole, as it lacks the posterior part of the abdomen; the legs, except their basal segments; and the right eye, which has been cleft off. Still, as it is so different from any of the other leaf-hopper material it should be discussed.

Classification in the Jassidae is very difficult, but species with large protuberant eyes are rare. The presence of the ocelli on the anterior margin, and the sharp marginal profile of the head place the specimen in Euscelinae, the tribe being *Platymetopiini*, according to J. W. Evans 1947, or *Mesamiini*, according to P. W. Oman 1934.

Genus **Miomesamia**, new genus

Face wide; eyes prominent, large, strongly faceted, and only slightly emarginate on lower side facing lorae. Dorsal outline very much as in *Ulopa reticulata*.

Profile sharp angulate, with ocelli on the anterior margin each terminating a ridge, the frontal suture, which passes the antennae and originates at the epistomal suture.

Frons quadrangular, wider at apex than base, medianly depressed, rests on epistomal suture, in front of which the beak is in three parts: postclypeus, preclypeus, and labium. At the sides of the clypeus are the somewhat swollen lorae and the genae. Antennae set at the sides of the frontal sutures, opposite the upper corner of the eyes. The parietals between frons and eyes wide and longitudinally ridged, and along the ridges are rows of round pits, probably originally setigerous.

Crown of head depressed.

Miomesamia juliae, new species

Type: specimen 5795 (Gibron #1216), extracted from nodule by hydrochloric acid, by John Gibron, Sr., collected at U.S. Geol. Serv. Site 19067, in SW $\frac{1}{4}$ Section 24, R.1. E., T.10.N., Calico Mountains, by Mr. Gibron, and named in honor of Julia Gibron.

Description: Length of specimen 3.2 mm. Probable total length about 4.45 mm. Length of head above 0.31 mm.; width of head 1.05 mm.; length of face 1.12 mm.

Before the final mounting of the specimen considerable petroleum was drawn out into the balsam.

AN UNIDENTIFIED LEAF HOPPER

A more fragmentary specimen (859 from nodule 10263), consisting of a crystallized thorax, one anterior and one posterior wing, from a nodule found by Mrs. Ruth Kirkby at Site 38 (LACMIP 386), in the southeast $\frac{1}{4}$ southwest $\frac{1}{4}$ Section 24, R.1.E., T.10.N., in the Cañon south of that in which *D. palmeri* was found. The fragment measures 6.0 mm., and is hence different from either of the preceding, but as it has no diagnostic characters, cannot even be assigned to a genus.

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