

THE HYMENOPTEROUS PARASITES OF THE CALIFORNIA RED SCALE.

By L. O. HOWARD.

In none of the numerous habitats of the now wide-spread *Aspidiotus aurantii* have true hymenopterous parasites been found except in California. Mr. D. W. Coquillett, in the course of several years' careful study of the insect at Los Angeles in his capacity as field agent of the Division of Entomology, has reared several parasites which he has sent on to Washington from time to time for study. All have been designated to him by their generic names, but none have heretofore been thoroughly studied for descriptive purposes. Sufficient material has now been reared by Mr. Coquillett to warrant the technical characterization of the species, and this paper has therefore been prepared at Prof. Riley's suggestion.

There are, in Mr. Coquillett's material, six distinct species which are undoubted parasites of the Red Scale. Mr. Coquillett also sent in, in

1387, a specimen of a handsome species of the Mymarid genus *Alaptus* which he had reared from orange leaves infested with the so-called Yellow Scale from San Gabriel. This he at first supposed to be a parasite of the scale insect, but as he afterwards reared a large series of the same species from the little eggs of a Psocid—*Oxycilus aurantiacus*—he concluded that his first specimen probably issued from some unnoticed Psocid egg among the scales on the leaves. He is, without much doubt, correct in his conclusion, and the species is mentioned here simply to warn other investigators against falling into the same error.

The true parasites are as follows:

- (1) *Aspidiotiphagus citrinus* Craw.
- (2) *Coccophagus aurantii* n. sp.
- (3) *Coccophagus lunulatus* n. sp.
- (4) *Aphelinus diaspidis* Howard.
- (5) *Signiphora californica* n. sp.
- (6) *Aphycus immaculatus* n. sp.

Owing to the occurrence throughout this article of the names "Red Scale," "Yellow Scale," "*Aspidiotus aurantii*, typical form," and "*Aspidiotus aurantii* var. *citrinus*," it will be necessary to explain that they all refer to the same species, which exists in California in two different forms. The typical *Aspidiotus aurantii*, or Red Scale, is the form described by Maskell from New Zealand, and which also occurs in Australia and in the Mediterranean countries. It was studied by Prof. Comstock in California, in 1880, and described and figured in his report for that year. The name "Yellow Scale" is in common use in California, and refers to a light brownish-yellow variety of the Red Scale which occurs principally in the San Gabriel Valley in California, but which is also found in all other orange-growing portions of the State. This variety differs not only in color, but the dorsal and ventral scales seem to be more firmly cemented together than with the typical Red Scale, and it occurs, moreover, only upon the leaves and fruit, never upon the bark, while the typical Red Scale occurs very abundantly upon the bark as well as upon the leaves and fruit. The typical Red Scale, moreover, seems to be oviparous, while the Yellow Scale is viviparous. The Yellow Scale is mentioned in some California publications as *Aspidiotus citrinus* Coquillett, and Mr. Craw is of the opinion that it is a distinct species and was imported independently from Japan into the San Gabriel Valley. The name *Aspidiotus citrinus* Coquillett was sent to Prof. Riley with a MS. description, but from his own careful study in California and correspondence with Mr. Coquillett, Prof. Riley concluded that the structural differences between the two forms are not constant, and that *citrinus* can only be considered as a variety.

(1) ASPIDIOTIPHAGUS CITRINUS (Craw).

Coccophagus citrinus Craw. Destructive Insects, etc., Sacramento, 1891.

Encarsia citrinus (Craw). R. & H., INSECT LIFE, Vol. IV, p. 168, 1891.

In 1887 Mr. Coquillett sent to Dr. Riley two specimens of a parasite reared from the so-called yellow variety of the Red Scale received from San Gabriel, Cal. In Dr. Riley's absence I wrote him that the insect was a new species of *Coccophagus* and gave him the manuscript name *C. aurantii*. This insect, or another one, subsequently made some stir in horticultural circles in California, since it was the first known parasite of the Red Scale, and Mr. Alexander Craw, the entomologist of the State Board of Horticulture, was commissioned to examine the orchards in which the parasite occurred and report. He did so, and we understand advised the discontinuance of spraying on account of the abundance of this species. A great deal of newspaper discussion as to the advisability of this course followed, and the State board, in its report for 1891, published a number of letters tending to show the abundance and importance of the parasite.

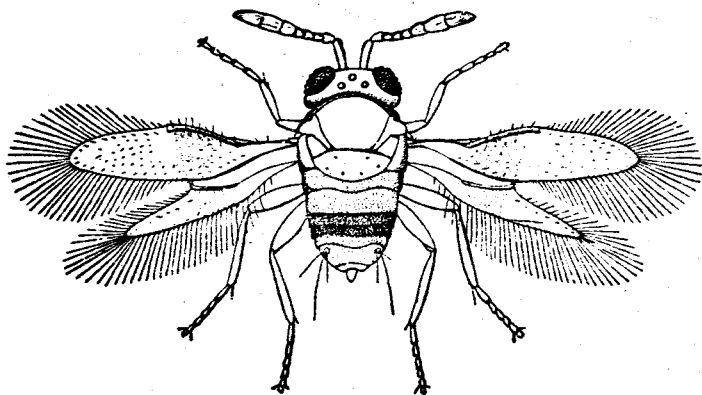


FIG. 6.—*Aspidiotiphagus citrinus* (Craw) greatly enlarged (original).

In 1891 Mr. Craw drew up a report upon the species, under the title "Internal Parasites; discovered in the San Gabriel Valley; Recommendations and Notes," which was published as Bulletin No. 57 of the State Board of Horticulture. In this bulletin he gave a technical description of *Coccophagus citrinus* Craw, accompanied by a figure and a preliminary statement concerning the discovery and work of the insect.

Later in the same year a bulletin was published and distributed by the State Board of Horticulture bearing the title "Destructive Insects, their natural enemies, remedies, and recommendations. By Alexander Craw," etc. On pp. 28 and 29 of the bulletin are given a figure and description of "*Coccophagus citrinus* Craw," both of which differ, in some respects, from the figure and description in Bulletin No. 57.

We suspect that these two descriptions refer to two distinct insects, since two species bearing a strong general resemblance to each other

have been sent us by Mr. Coquillett as reared from the so-called "Yellow Scale," the one having perfectly clear wings, as shown in Mr. Craw's earlier figure, and the other having the fore-wings with a fuscous band, as shown in his later figure. I shall not push this point, however. Mr. Craw may have described two distinct insects under one name. If so, we shall accept his second and presumably more careful figure and description as carrying the name. Mr. Craw's reference of the form to the genus *Coccophagus* was probably based upon our original determination as sent to Mr. Coquillett, but unfortunately for this reference the form sent us was the clear-winged one, and that which bears Mr. Craw's name has other generic affinities. Mr. Coquillett sent us specimens of the dusky-winged form bred January 18 and 24, and February 2, 1889, from San Gabriel scales and from these specimens, as well as from Mr. Craw's figure, we tentatively placed the species in Förster's genus *Encarsia* (INSECT LIFE, Vol. IV, p. 168). More prolonged and critical study, however, renders it evident that a new genus must be erected to contain the species.

Aspidiotiphagus gen. nov.

Female.—Antennæ 8-jointed; scape long, slender; pedicel a little longer than its apical width; funicle joints 1, 2, and 3 increasing in width, but each approximating pedicel in length; club long, distinctly 3-jointed, basal joint shortest, apical joints sub-equal, terminal joint pointed. Lateral ocelli equi-distant from each other and margin of compound eyes. Parapsides of mesoscutum widely separated, very narrow posteriorly, broadening out rapidly towards tegulæ; mesoscutellum like that of *Aphelinus*, its scapulæ longitudinally elongate and extending forward to lateral widening of the parapsides; metanotum very narrow. Abdomen short, broadly sessile and broadly rounded at tip. Spur of middle tibiæ very slender, as long as the short, first tarsal joint. Fore wings long, narrow; submarginal and marginal veins sub-equal in length; post-marginal lacking; stigmal very slight and parallel with costa, situated at half the wing length and exactly opposite to the termination of thickening of hinder margin of wing; this being also the widest point of the wing; cilia of wing surface rather sparse, a clear rounded space immediately below stigma, and a narrow clear line around margin; marginal vein bristly; marginal cilia very long, longer than wing width, those on costal margin just beyond stigma nearly as long as those on hind margin. Hind wings very narrow, with long marginal cilia and but one row of discal cilia on outer third; marginal vein ending abruptly and extending up apparently beyond costa.

Differs from *Coccophagus* in wings and from *Encarsia* in antennæ and wings.

ASPIDIOTIPHAGUS CITRINUS (Craw).

Female.—Length 0.58 mm; expanse 1.16 mm; greatest width of fore wing 0.09 mm. Antennæ light yellow-brown; eyes black, ocelli bright-red; head yellow; occiput dark brown; pronotum dark brown; mesonotum yellow; metanotum yellow-brown; abdomen brown; legs uniformly dusky yellow; wings with marginal vein dark fuscous, and a broad fuscous band extending directly across wing from marginal vein as a base. Spiracular hairs on pre-anal abdominal joint very long. Thorax somewhat wider than head or abdomen, these being sub-equal in width.

Redescribed from 14 ♀ specimens reared January 18 and 24, February 2, and March 13, 1889, by D. W. Coquillett from *Aspidiotus aurantii* Maskell, var. *citrinus*, from San Gabriel, Cal.

There are four specimens of this species in the collection of the Department of Agriculture, reared January 6, 1881, from *Diaspis bromeliæ* Kern. on *Ananassa sativa* in the greenhouses of the Department.

(2) COCCOPHAGUS AURANTII n. sp.

This is the original clear-winged form referred to in the preliminary remarks under the last species. We have but two specimens, and these were reared by Mr. Coquillett, May 9, 1887. It is the species to which

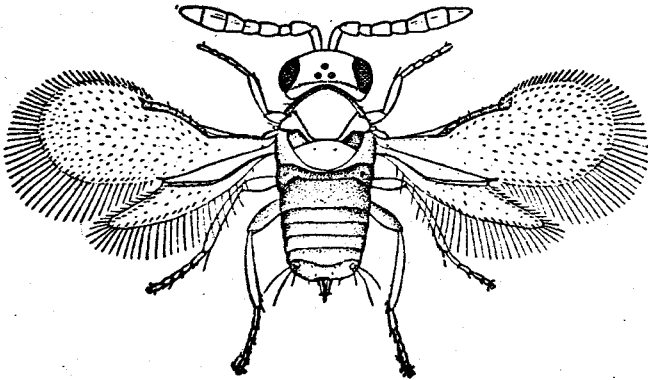


FIG. 7.—*Coccophagus aurantii* n. sp.; greatly enlarged (original).

we gave the above name in MS at the time of its first receipt. It differs from the typical *Coccophagus* principally in the long fringe to the hind wings; but it hardly seems necessary to erect a new genus for it.

COCCOPHAGUS AURANTII n. sp.

Female.—Length 0.7 mm.; expanse 1.16 mm.; greatest width of forewing 0.18 mm. Joint 1 of funicle shorter and narrower than pedicel and than joint 2, which is subequal to pedicel in length and width; joint 3 shorter than 2. General color light brownish yellow; occipital line, margin of pronotum, scapulæ, outer edge of the tanotum, abdomen, especially lateral margin, darker; antennæ and legs light fuscous; eyes black, ocelli red; wings hyaline, veins slightly dusky. Fore-wings with disc densely, finely, and uniformly ciliate, costal margin with very short marginal cilia beginning at stigma, growing gradually longer at tip of wing and on lower outer margin becoming half the width of wing; broadest portion of wing beyond stigma; hind wings with two rows of discal cilia and an incomplete third row on outer third; cilia of lower margin somewhat longer than greatest wing width.

Described from two female specimens reared May 9, 1887, by D. W. Coquillett from *Aspidiotus aurantii* var. *citrinus* from San Gabriel, Cal.

Specimens of this species occur in the collection of the Department of Agriculture, reared from the following species of Coccidæ: *Aspidiotus ancylus* Put. var. on Linden, District of Columbia; *Mytilaspis citricola* Pack. on Orange, Florida; and *Aspidiotus pini* Comst. on *Pinus rigida*, Ithaca, N. Y.

This form may be at once distinguished from the preceding by the fact that its fore-wings are twice as broad in comparison to their length, are perfectly clear, and have no very long cilia on their anterior margin. It is a somewhat larger species and lighter in color.

(3) *COCCOPHAGUS LUNULATUS* n. sp.

In November, 1892, Mr. Coquillett sent to the Division some orange leaves thickly covered with the Red Scale for use in the collections which were then being prepared for the Chicago Exposition. These leaves were carefully mounted, but as it would be some little time before they would be needed for the boxes, they were placed in a glass jar to ascertain whether they were parasitised. A week later a single para-

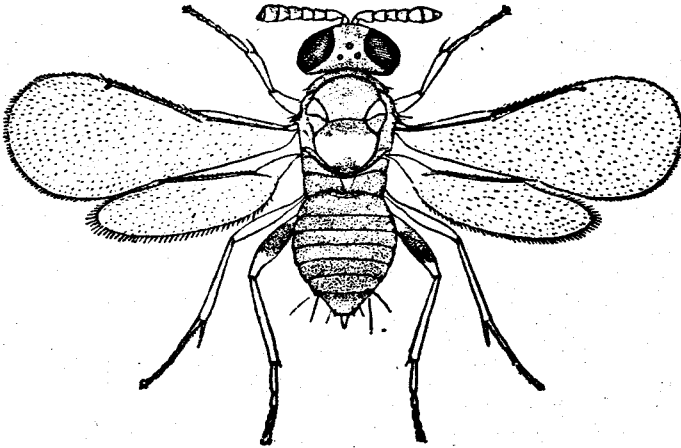


FIG. 8.—*Coccophagus lunulatus* n. sp.; greatly enlarged (original).

site issued which proved to be a typical *Coccophagus* (not an aberrant one like the preceding species), but belonging to an undescribed species. It is a very handsome form and is readily distinguished by its coloration no less than by its structural features from any of the other Red Scale parasites.

COCCOPHAGUS LUNULATUS n. sp.

Female.—Length, 0.93 mm.; expanse, 2 mm.; greatest width of fore-wings, 0.39 mm. Head rather coarsely punctulate, opaque; mesonotum very finely shagreened, somewhat glistening; mesoscutellum with apical bristles very long; abdomen smooth, shining. General color black; apical three-fifths of mesoscutellum bright orange, with an irregular black spot at tip and with the dividing line between the orange and black irregular; tegulae black; antenna with the scape black and the flagellum dark fuscous; front legs, including coxae, light orange yellow, considerably lighter than the mesoscutellum; middle and hind coxae and hind femora black, middle and hind trochanters, tibiae and tarsi and middle femora light orange yellow. Wings hyaline, veins dark brown, marginal cilia very short.

Described from one female reared December 5, 1892, from *Aspidiotus aurantii* received from D. W. Coquillett, Los Angeles, Cal.

(4) APHELINUS DIASPIDIS How.

APHELINUS DIASPIDIS How. Annual Report U. S. Department of Agriculture, 1880, p. 355.

This species was first reared from *Diaspis rosa*, received in 1880 from Fort Reed, Fla. Later, specimens were received, reared from the same species of scale, from Santa Barbara, Cal. Specimens were received from Mr. Coquillett in 1892, which were found upon leaves infested with *Aspidiotus aurantii* received from Santa Ana, Cal., in July and August. Some specimens were observed by Mr. Coquillett in the act of ovipositing in the scales.

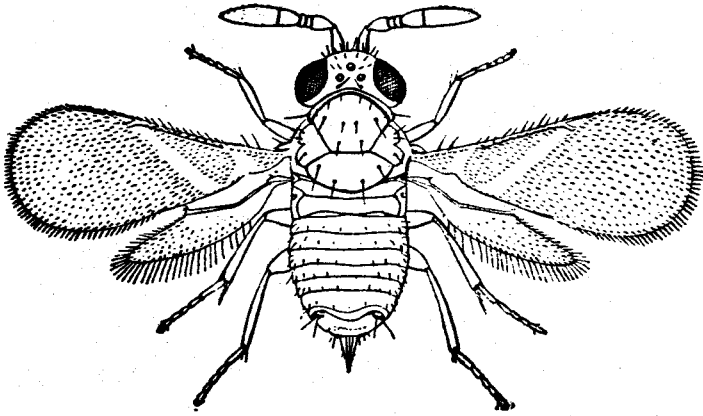


FIG. 9.—*Apelinus diaspidis* How.: greatly enlarged (original).

This species is larger than either of those previously described, and is bright yellow in color. It is probably the "golden Chalcid," referred to by Mr. Craw in his article in the *California Fruit Grower* of February 28, 1891.

(5) SIGNIPHORA OCCIDENTALIS n. sp.

In his work on Orange Insects published at Jacksonville, Fla., in 1880, Mr. W. H. Ashmead erected the genus *Signiphora* to contain a species which he called *S. flavopalliat*a and of which he had reared two specimens from *Aspidiotus citricola* Pack., the Purple Scale of the Orange. Since Mr. Ashmead's volume is now very rare, we reprint his generic characterization:

SIGNIPHORA Ashmead.

Form, robust, polished, or shining; head wider than thorax, ocelli 3, triangularly arranged; labial palpi 3-jointed; antennæ inserted in front between the eyes, rather close together, 3-jointed; first joint or scape long; second small and round; third large and fusiform; thorax broad, not quite as long as abdomen; legs setaceous, with five-jointed tarsi, first joint longest; hind tibia in place of the usual spine furnished with an anomalous five-lobed appendage, in this respect differing

from any known Chalcid. Abdomen somewhat sharply pointed and ending in a rather long ovipositor. Wings well rounded and strongly ciliated. Coxæ almost touching.

In the Annual Report of the U. S. Department of Agriculture for 1880 (p. 371), we called attention to this remarkable insect and stated that Mr. Ashmead was probably in error in locating the "anomalous five-lobed appendage" upon the hind legs instead of upon the middle legs, since it is probably homologous with the apical spur of the middle tibia so strongly developed in the Aphelininæ and Encyrtinæ.

Subsequent rearings of specimens from *Mytilaspis gloverii* and *Aspidiotus cydonia* from Florida, from an *Aleyrodes* on oak from California, by Mr. Coquillett, and from *Aspidiotus aurantii* by the same gentleman, as well as the deposit of one of Mr. Ashmead's types in the collection of the U. S. National Museum, have enabled us to make a careful

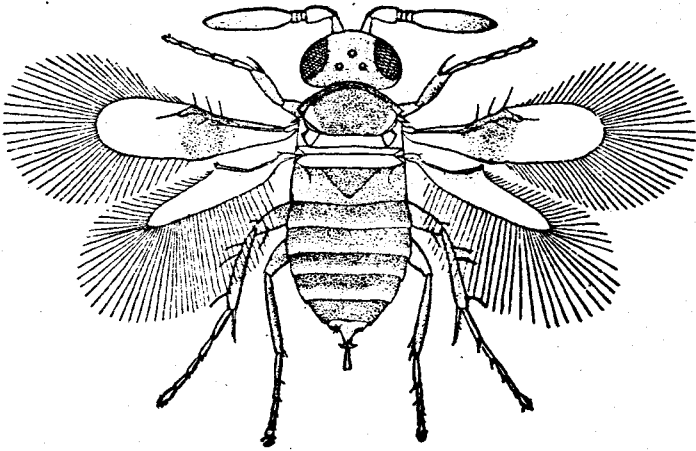


FIG. 10.—*Signiphora occidentalis* n. sp. greatly enlarged (original).

study of this peculiar genus. It differs so markedly from all other known Chalcididæ that it must be placed in a subfamily by itself, and we therefore propose for it the subfamily name *Signiphorinæ*. Several important points in the structure of the insect were not made out by Mr. Ashmead, and with more abundant material at our disposal we have drawn up a somewhat closer description of the genus and have characterized the subfamily, adding a description of the new species reared by Mr. Coquillett from the Red Scale.

SIGNIPHORINÆ, Subfam. nov.

Tarsi 5-jointed. Apical spur of middle tibia long and with several long spines on inner edge. Pronotum reaching nearly to tegulæ. Mesoscutum entire. Mesoscutellum represented by a narrow transverse band. Mesopleura short, sharply divided from metapleura. Metascutum with a differentiated triangular central sclerite, resembling the normal mesoscutellum. Antennæ at most 8 jointed. Ovipositor cleft of female abdomen extending back to 3d segment.

SIGNIPHORA Ashmead.

*Type, S. flavopalliat*a Ashm. Orange Insects, 1880, p. 30.

Body robust; ocelli 3, situated in triangle. Antennæ inserted at border of clypeus, 6-jointed; scape reaching nearly to top of head; pedicel large, nearly as long as scape; funicle joints 1, 2, and 3 very small; club very long, undivided. Face round; mandibles strong, bidentate; labial palpi rudimentary; maxillary palpi 3-jointed. Fore-wings rather broad and short; submarginal and marginal veins subequal in length; marginal thick; stigmal thinner and curved; marginal and stigmal veins with several long, stiff bristles; no discal cilia; marginal cilia very long and delicate, beginning on costal margin just beyond stigmal and extending around to a point opposite the stigmal. Hind-wings narrow and with very long and delicate cilia beginning beyond marginal vein and extending around nearly to hinder base of wing. Middle tibiæ with a number of stout bristles, apical spur as long as first tarsal joint and furnished on inner edge with five or six long bristles at regular intervals; front and hind legs unarmed. Abdomen broadly sessile, rounded at tip; ovipositor of female somewhat extruded, apical spiracles facing ventrally; male penis long, cleft at tip.

SIGNIPHORA OCCIDENTALIS n. sp.

Female.—Length, 0.53 mm.; expanse, 1.2 mm.; greatest width of fore-wing, 0.09 mm. Antennal scape robust, reaching to middle of eyes; pedicel large, stout, rather more than one-third as long as scape; funicle joints 1, 2, and 3 subequal in diameter, very small, together only a little over one-third length of pedicel and considerably less than the tip width of pedicel; increasing in length from 1 to 3; club nearly as long as scape and pedicel together, long oval when seen from side, twice as wide as pedicel, narrow with parallel sides when seen from above, scarcely wider than funicle joint 3. Marginal vein with 6 strong bristles, stigmal with one, submarginal with one. Middle femora with a strong spine near inner side of tip, tibiæ with three strong external spines, two near base and one near tip. Color (from balsam-mounted specimens only): Head, pronotum, metanotum and abdomen, dark brown, nearly black, eyes dark red; mesonotum bright lemon-yellow; all legs and antennæ fuscous; mouth parts light-brown, mandibles tipped with black; wing veins fuscous; fore-wings with an indefinite fuscous patch occupying entire disc except at base and apical fourth.

Male.—Resembles female, except that it is rather larger and has the entire mesoscutum brown, leaving the yellow band to include mesoscutellum and metascutum.

Described from two ♀, three ♂ specimens reared by D. W. Coquillett, from *Aspidiotus aurantii* var. *citrinus*, from San Gabriel, Cal., May 30, June 1 and 3, 1887.

(6) APHYCUS IMMACULATUS n. sp.

The sixth of the Red Scale parasites belongs to another subfamily, the Encyrtinæ. Mr. Coquillett reared two specimens of this form from typical specimens of *Aspidiotus aurantii* October 11, 1887, and unfortunately mounted both specimens in balsam. The species has not been reared since, and hence can not be properly studied from dry mounts. Enough of its characters, however, are brought out in the balsam mounts to separate it from all described species. It is possible that this is the adult of an interesting parasitic larva which Mr. Coquillett

has studied, and of which he writes that, as it increases in size, it causes the dorsal scale to separate from the ventral so that the adult escapes from beneath the scale instead of gnawing a hole through it.

APHYCUS IMMACULATUS n. sp.

Male.—Length, 0.55 mm.; expanse, 1.3 mm.; greatest width of fore-wing, 0.21 mm. Antennal scape slightly widened below, pedicel nearly half as long as scape, club as long as three preceding funicle joints together, funicle joints with hairs rather longer than length of each joint; mesoscutum with punctation longitudinal down

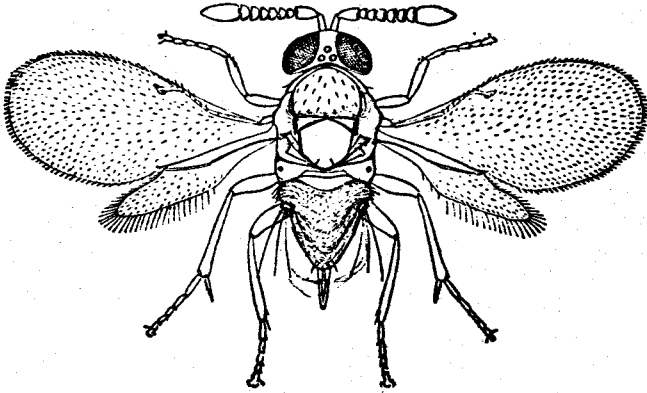


FIG. 11.—*Aphycus immaculatus* n. sp., greatly enlarged (original).

middle, transverse each side; metascutum with short longitudinal punctation; scapulae and visible portions of metascutum with lengthy transverse punctation. Hairs from third abdominal spiracles extending beyond tip of abdomen. Color uniform dark yellow brown, head light yellow, all legs dusky; antennae uniformly dusky yellow; wings hyaline.

Described from one balsam-mounted ♂ reared from typical *Aspidiotus aurantii*, by D. W. Coquillett, at Los Angeles, Cal., October 11, 1887.