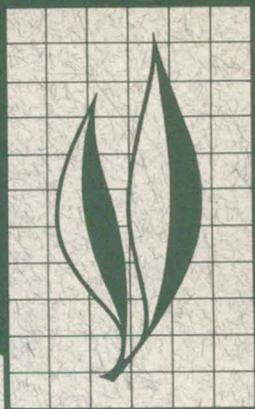


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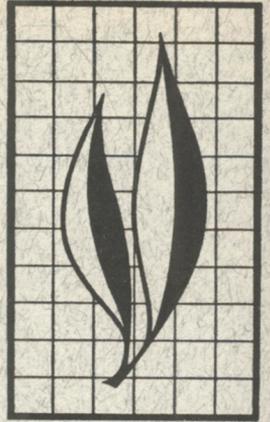
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G. L. Finney



I. The genus *Coccophagoides* (Hymenoptera: Aphelinidae) is revised herein and two new species are described. These are *Coccophagoides comperei* Doutt and *Coccophagoides utilis* Doutt. Both *C. utilis* and another new species, *Anthemus inconspicuus* Doutt (Hymenoptera: Encyrtidae), are primary parasites of *Parlatoria oleae* (Colvée). They were collected in Pakistan and have been imported to California to control this olive pest.

II. *Coccophagoides utilis* is arrhenotokous. The females develop as internal primary parasites of *Parlatoria oleae* whereas the males develop adelphoparasitically on the prepupal and pupal stages of their own species. A significant aspect of the life history of *C. utilis* is a mechanism of retarded development in certain female progeny which ensures that the males on emerging meet with females.

(Continued, inside back cover.)

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I. A Taxonomic Analysis of Parasitic Hymenoptera Reared from *Parlatoria oleae* (Colvée)^{1,2}

INTRODUCTION

A MAJOR effort to achieve biological control of the olive scale, *Parlatoria oleae* (Colvée), in California was undertaken by the California Agricultural Experiment Station in 1951. In that year Dr. A. M. Boyce began a search for this diaspine scale and its natural enemies throughout an extensive area of the world, including the region to which *Parlatoria* is supposedly indigenous, namely northern India and Pakistan. Between May and November of 1951 he sent to California 63 separate lots of host material from collections made in India, Pakistan, Afghanistan, Iran, Iraq, Syria, Egypt, Lebanon, Cyprus, Israel, Greece, and Spain.

All of these shipments arrived at the Division of Biological Control at Albany, California, and were processed in the quarantine laboratory by the author. The entomophagous species emerging from this imported host material were duly tested in accordance with the standard procedures in biological control work. Therefore, only those species that were successfully reared as primary parasites were released from the quarantine laboratory for insectary production and eventual field colonization and testing.

It is not unusual to find hyperparasitic species among the entomophagous organisms that emerge from such imported host material, and we suspected that species in the genera *Ablerus*,

Azotus, and *Thysanus* which appeared in some of the shipments have this habit. Nevertheless, we provided these insects with scale hosts to test their ability to develop as primary parasites. No progeny resulted, and we assumed on the basis of these negative results and on the basis of our knowledge of related species that these insects are hyperparasitic in habit.

The shipments in 1951 produced the sibling species of *Aphytis* that were recognized morphologically only as *A. maculicornis* (Masi). The initial finding of these biological entities in *Aphytis* and their subsequent propagation and performance in California have been previously reported (Hafez and Doutt, 1954; Doutt, 1954; Huffaker, Kennett, and Finney, 1962). The *Parlatoria* collected in Iran yielded another primary parasite, which is a species of *Aspidiotiphagus* closely resembling *A. citrinus* (Craw.). This aphelinid was easily reared in the insectary and was ultimately colonized in great numbers, but it disappointingly failed to suppress scale infestations in commercial olive plantings (Doutt, 1954).

The *Aphytis* are external parasites of the *Parlatoria*, whereas the *Aspidiotiphagus* develop within the host's body. Another internal parasite was noted in the collections made by Dr. Boyce in India and Pakistan, and dissections indicated that it was probably

¹ Submitted for publication September 11, 1964.

² This study was supported in part by a grant from the National Science Foundation (GB-1833).

a primary parasite and potentially of great importance. This parasite proved to be a species of *Coccophagoides*, but the first attempts to culture it in quarantine were unsuccessful, and Doutt (1954) reported that: "The reason for this failure has not been determined; however, the culture of related forms is often made difficult by a complicated life history which requires the male sex to develop as an obligatory hyperparasite."

Further testing of this *Coccophagoides* seemed particularly desirable. To obtain more parasites for this purpose, the explorers from the Department of Biological Control were asked to collect *Parlatoria* whenever the opportunity presented itself. In this connection Dr. Robert van den Bosch collected and shipped material from Iran, Iraq, and Lebanon in 1955 and 1956; and although this material contained the Persian *Aphytis*, which was proving itself to be an effective natural enemy of the scale in California, the desired internal aphelinids were absent, and there is today no indication that they occur in those particular countries. Finally, the first opportunity to repeat

the attempts to culture *Coccophagoides* occurred in 1957, when Dr. Paul DeBach sent to California a shipment of *Parlatoria oleae* on apple twigs collected on April 6, 1957, at Parachinar, Pakistan. This collection was remarkably productive. It produced 41 female and 14 male *Coccophagoides* in the quarantine laboratory at Albany between April 19, 1957, and June 24, 1957. In view of later findings on the life history of *Coccophagoides*, it is significant that from May 6 until June 24 of that year, only male *Coccophagoides* emerged from this shipment. This Parachinar collection was also especially important because it yielded 1 female and 7 males of a new species of *Anthemus*, and this single female was sufficient to establish a culture of this interesting parasite.

Both the *Coccophagoides* and the *Anthemus* appear to be new and undescribed species of parasites. Because of their importance to agriculture as natural enemies of *Parlatoria oleae* and because they are now established as beneficial elements in our California fauna, they are described, named and analyzed taxonomically as follows:

Family Aphelinidae (Hymenoptera: Chalcidoidea)

Genus *Coccophagoides* Girault

Coccophagoides Girault, 1915, p. 58.³

Type: *Coccophagus abnormicornis* Girault.

Diaspiniphagus Silvestri, 1927, pp. 35-36. Type: *Prospalta similis* Masi.

Girault's decision to set up the genus *Coccophagoides* has a rather interesting history. It apparently stems from the difficulty of being able to determine precisely the limits of certain genera in the family Aphelinidae. An illustration of this is Compere's comment (1931) that, "The genus *Coccophagus* is imperfectly defined, as it is a heterogeneous assemblage containing species that partially intergrade with other genera. The char-

acters that separate *Coccophagus* from *Prospaltella*, *Encarsia*, *Aneristus*, *Prococcophagus*, *Aspidiotiphagus*, and *Coccophagoides* are relative and cannot be defined." Girault (1915) had obviously encountered this difficulty, for he voiced his displeasure by synonymizing the genus *Prospaltella* with *Coccophagus*, because "the species of *Prospaltella* intergrade and it is impossible to distinguish the genera in the case of many species." However, he then did a rather curious thing, for he took three species of *Coccophagus* (namely, *abnormicornis*, *singularis*, and *regulus*), which he designated as "extreme *Prospaltella*

³ See Literature Cited for citations referred to in the text by author and date.

forms," and established a new genus for their reception, which he named *Coccophagoides*. Compere (1931) thought that Girault was being inconsistent in synonymizing one genus while erecting a new one for annectant species, but said that, "Regardless of this inconsistency, *abnormicornis*, *singularis*, and *regulus* seem to represent a group more unlike typical *Coccophagus* than is *Prospaltella* and as such are probably entitled to generic rank." The literature indicates that students of aphelinids subsequent to Girault have not accepted his synonymy of *Prospaltella* with *Coccophagus* but have recognized the validity of *Coccophagoides*.

In 1927 Silvestri overlooked the genus *Coccophagoides* and proposed a new genus, *Diaspiniphagus*, to hold *Prospaltella similis* (Masi) as genotype and a species from Japan that Silvestri proceeded to describe as *Diaspiniphagus kuwanae*. Mercet (1930) synonymized the genus *Diaspiniphagus* and recognized his species *Prospaltella ilicis* as a synonym of *P. similis* (Masi).

Girault did not illustrate *Coccophagoides*, and his description is very brief, consisting of the following single sentence: "The genus differs from *Coccophagus* in having a markedly tapering flagellum, the first funicle joint abruptly shortened and the marginal vein *distinctly* shorter than the submarginal." In spite of its brevity, Compere (1936) was apparently satisfied with this description and stated that, "Although the generic classification given by Girault is no longer applicable to all the species now assigned to *Coccophagoides*, the writer is unable to prepare a better description to define the genus and at the same time exclude certain species of related genera."

This description proved inadequate, however, in the case of the parasites reared from *Parlatoria oleae* collected in Pakistan and India. Doubt as to their correct affinities arose because the females showed a peculiar and distinctive development of certain abdominal

sternites into a very striking hypogynium at the basal part of the ovipositor. Although this structure is most conspicuous, it had not been described by Girault and it had not been mentioned or illustrated by any subsequent workers on species of *Coccophagoides*. Therefore, the only way that one could positively decide whether these *Parlatoria* parasites were congeneric with *Coccophagoides* was to resort to an examination of Girault's type specimens. These were located by Dr. Edgar Riek in Brisbane, Australia, and were brought by him to California in 1964 for the purpose of this analysis.

When the type specimens of the three Australian species placed in *Coccophagoides* by Girault were examined, it was found that each of them possessed the hypogynium, and it was then clear that the species imported from Pakistan and employed in the biological control of *Parlatoria oleae* is in the same genus. Therefore the genus *Coccophagoides* may be further characterized by the presence of a distinct hypogynium enclosing the ovipositor, by having the antennae with elongated radicle and scape inserted low on the face, and by having the foretibiae shorter than the foretarsi. The biological attributes that are characteristic of *Coccophagoides* appear to be the development of the immature females as primary internal parasites of diaspine scales, and the adelphoparasitic development of the hyperparasitic males.

After studying the aphelinid material in the professional reference collections of the biological control units of the University of California and after examining the type specimens from Australia, the following comments on the species seem appropriate.

Coccophagoides abnormicornis (Girault).

Coccophagus abnormicornis Girault, 1915, p. 53.

Coccophagoides abnormicornis (Girault), Girault, 1915, p. 58.

Locality: Queensland, Australia.

Host: Unknown.

This species, which is the generotype, was described from a single specimen reportedly caught in a forest at Gordonvale (Cairns), Queensland, on August 22, 1912. The type, located by Dr. Edgar Riek at the Queensland Museum, Brisbane, consists of the female abdomen, thorax, fragments of a leg, and a poorly mounted forewing, glued on a tag. According to the original description, Girault had mounted the head, a forewing, and a hindleg separately on a slide, but Dr. Riek was not able to find this in his search. The specimen is shrunken and distorted, as is common with dry series of *Coccophagoides*; furthermore, the type specimen has apparently faded considerably since the original description was made. However, this fragmented individual is especially valuable in this study, for it shows that the well-developed hypogynium is characteristic of the genus.

Male. Unknown.

***Coccophagoides aurithorax* Girault.**

Coccophagoides aurithorax Girault, 1939, pp. 18–19.

Locality: Western Australia.

Host: Unknown coccid.

This species has not been seen, but the distinguishing characters mentioned in the original description have been set forth in the key to the species below (page 226) and should serve to differentiate *Coccophagoides aurithorax* from the other members of the genus.

According to the original description, this species is based on two female specimens reared from "coccids" at Perth, Western Australia.

***Coccophagoides comperei* Doutt, new species.**

Coccophagoides regulus (misidentified), Compere, 1936, p. 293.

Locality: New South Wales, Australia.

Host: Unknown.

In 1936 Compere illustrated a species

of *Coccophagoides* which he thought was *C. regulus* Girault. He commented on it as follows:

"The species figured here as *Coccophagoides regulus* was reared from an unknown host taken in Sydney, New South Wales. The type specimen of *C. regulus* was collected at Murwillumbah, New South Wales. The Sydney specimens show considerable variation; although none of them is in exact agreement with Girault's description, nor with the type of *C. regulus* which the writer has studied, all are supposed to be specifically the same."

When one compares the illustration by Compere with the specimen designated as the true type of *Coccophagoides regulus*, it is immediately evident that they could never be considered as the same species; for they are not only distinctly different, but each is quite unlike any other member of the genus. The misidentification of the Sydney specimens arose because there are two slides in the Queensland Museum collection labeled "*Coccophagoides regulus*, Gir. Type." One of these bears the Hacker designated type number Hy/2940, which conforms to the number published in the original description, and it has a specially printed "type" label affixed to the slide. The second slide has several Hymenoptera on it, including the alleged type of *Ablerus beenleighi* Girault, and a specimen of *Coccophagoides* marked *regulus* with the word "type" written in long-hand after it. Neither slide has any locality, date, or collector data. The specimen on slide No. Hy/2940 corresponds to Girault's original description of *C. regulus*, whereas the specimen on the second slide closely resembles the Sydney series collected and illustrated by Compere. It is therefore apparent that Compere studied the second "type" slide, and was understandably misled by it. Dr. Riek (personal communication) has indicated that the types in the Girault collection are very difficult to find; therefore it is not surprising

that Compere did not locate the actual specimen from which Girault described *regulus*.

The series of specimens from Sydney are so clearly distinctive that they are herein described as a new species and are named for Mr. Harold Compere: *Coccophagoides comperei* Doult, new species.

Female. Eyes and ocelli red, vertex orange, face golden, thorax fundamentally yellow or golden, with brownish areas on pronotum, scutum, and scutellum. The brown pattern on the scutum is triangular, with its broad base at the anterior edge tapering to an apex at middle of posterior margin of scutum. There are two large brown areas on the scutellum; edges of most thoracic sclerites are dark brown, pleurae and axillae brown; abdomen brown; antenna with pallid radicle; scape with base pallid, followed by dark band in lower half of scape and dark apex; pedicel dark at base but pallid at apex; funicle and club segments uniformly dark brown. Forewings with smoky pattern below venation as indicated in figure 1B, venation light brown; posterior wings hyaline, legs pallid with brown bands on tibiae and femora.

Antennae as in figure 2E,⁴ longitudinal sensoria on club segments but lacking on funicle; small setae present on scape, pedicel, funicle segments, and first club segment; less conspicuous on second club segment and nearly lacking on terminal segment. Forewing and venation as illustrated in figure 1B. Abdomen with characteristic hypogynium, ovipositor only slightly exerted. Forefemur with forward projecting spine near apex on ventrolateral area; foretibia shorter than femur and shorter than combined tarsal segments; foretibial spur curved; the strigil well developed. Middle tibia with prominent apical spur, nearly as long as basitarsal segment. Middle femur with short, slightly curved spine near apex on ventral margin; middle tibia about equal

to length of femur, longer than combined tarsal segments; hind coxae large, hind tibia longer than hind femur.

Male. Unknown.

This species is most readily separated from other *Coccophagoides* by the distinctive pattern of the forewings, the banded scape and pedicel, and the more setaceous flagellum.

Collection data. The type specimen was collected by Harold Compere at Centennial Park, Sydney, New South Wales, on October 25, 1927. There are six paratypes. Three of these were collected along with the type specimen, and one has been fragmented and mounted on the slide with the type specimen, while the other two of this series are on separate slides. One paratype female was collected in a jar with oleander leaves by Harold Compere in Sydney on December 18, 1927, and is mounted on a slide with three *Prosopaltella*. One paratype was collected by S. E. Flanders at Sydney on May 9, 1931. These paratypes are in the collection of the Department of Biological Control, University of California, Riverside; the type specimen with the one paratype is in the collection of the California Insect Survey at Berkeley, California. One paratype on a slide with the type of *Ablerus beenleighi* Girault is without collection data. This slide has been returned to Brisbane, Australia.

Coccophagoides kuwanae (Silvestri).

Diaspiniphagus kuwanae Silvestri, 1927, pp. 39–41.

Coccophagoides kuwanae Compere, 1936, p. 294.

Localities: China, Japan, Formosa, Connecticut.

Hosts: *Diaspis pentagona* Targ., *Quadraspidiotus perniciosus* (Comstock).

This species was originally described as a parasite of *Diaspis pentagona*

⁴ Figures 1–6 appear on pp. 228–230.

Targ. in Japan. It has been reared from San Jose scale, *Quadraspidiotus perniciosus* (Comstock), collected in China, Formosa, and Japan. *Coccophagoides kuwanae* was first reported as a parasite of San Jose scale in North America by Rice (1937), and it has been collected by E. Dietrick from this scale at New London, Connecticut, where it is apparently an accidental introduction and establishment.

***Coccophagoides regulus* (Girault).**

Coccophagus regulus Girault, 1915, p. 54.

Coccophagoides regulus (Girault), Girault, 1915, p. 58.

Locality: New South Wales, Australia.

Host: Unknown.

This species is based on one female collected by A. P. Dodd by sweeping forest vegetation at Murrwillumbah (Tweed River), New South Wales, on May 4, 1914. I have examined the type specimen, No. Hy/2940, Queensland Museum, which is slide-mounted. This specimen is very distinct in having a very large ovipositor, which is over twice the length of the thorax; but the species is correctly placed in *Coccophagoides*. The antenna is illustrated in figure 2D. There is some confusion regarding *C. regulus* in the literature because the specimen so well illustrated and designated as that species by Compere (1936) on page 293 of his valuable work on Aphelinidae is not *C. regulus* but a new and hitherto undescribed species.

***Coccophagoides similis* (Masi)**

Prospalta similis Masi, 1908, p. 148.

Prospaltella similis Mercet, 1912, pp. 213-215.

Prospaltella ilicis Mercet, 1921, p. 304.

Diaspiniphagus similis Silvestri, 1927, p. 36.

Coccophagoides similis Mercet, 1930, p. 81.

Localities: Italy, Spain.

Hosts: *Diaspis ostreaeformis* Curt.,

Diaspidiotus viticola Leonardi, *Targionia vitis* Signoret, and *Quadraspidiotus perniciosus* (Comstock).

Flanders (1960) reports that this species is occasionally reared from the San Jose scale, *Quadraspidiotus perniciosus* (Comstock), in the United States. Its life history has been reported in detail by Zinna (1962). Although no specimens of *Coccophagoides similis* have been available for study, the species has been well illustrated, and the characters useful in distinguishing it from other *Coccophagoides* are set forth in the key on page 226.

***Coccophagoides singularis* (Girault)**

Coccophagus singularis Girault, 1915, p. 53.

Coccophagoides singularis (Girault), Girault, 1915, p. 58.

Locality: Queensland, Australia.

Host: Unknown.

This species is apparently very closely related to *Coccophagoides abnormicornis*. It was collected on March 31, 1914, in the same locality as *C. abnormicornis*; and according to Girault, it differs from *C. abnormicornis* only in having silvery-white legs and in having two spots on the scutellum somewhat larger in size than similar spots on *C. abnormicornis*. The wings and antennae of this species are reported to be very similar to those of the generotype, and have therefore been illustrated in figures 1A and 2A, respectively. It is quite possible that *C. singularis* is only a variant of *C. abnormicornis* instead of being a distinct and separate species, for the differences reported by Girault do not impress one as being particularly fundamental.

Male. Unknown.

***Coccophagoides utilis* Doutt, new species.**

Localities: India, Pakistan, California.

Host: *Parlatoria oleae* (Colvée).

Female. Vertex golden, ocelli deep red, compound eyes reddish black, frons

golden, lower face and genae brown, occiput dark brown; mouthparts, except mandibles, pale; prothorax brown, scutum yellow with dark brown areas on posterolateral borders, scutellar setae black, propodeum yellow; abdomen nearly black; mesopleura and prepectus brown; legs pale, except that hind coxae and anterior half of hind femora are dusky; wings hyaline except for smoky area across forewing from marginal vein to posterior border; venation dusky; antennae yellowish, but with dark-brown areas at articulations; ovipositor brown; thoracic sternites mostly yellow.

In living specimens face anteriorly quite convex; but in dead, dry specimens, the interocular area becomes sunken and head distorted. Antennal sockets low on face, near border of clypeus; maxillary palpi three-segmented, terminating in long spinelike process; labial palpi apparently of single segment. Antennae (fig. 2B) with somewhat elongated radicle and scape, first funicle segment short, its ventral dimension longer than dorsal; the articulations of the funicle segments appear to be located more dorsally than centrally; longitudinal sensoria on third, fourth, and fifth segments and club, but apparently lacking on first two funicle segments; club segment slender, tapering. Thorax with major setae arranged in pattern as shown in figure 3. Propodeal spiracles inconspicuous, abdomen broadly joined, phragma projecting into abdomen and extending to the fifth segment of the gaster. Abdominal sternites modified to form plowshare-shaped hypogynium enclosing ovipositor; this is very conspicuous in most dead specimens.

Male. Normally smaller and darker than female; body almost entirely dark brown to black, except for golden parapsides anterior of wing bases; a small golden area immediately posterior to scutellum on propodeum; suggestions of gold color on scutellum and intersclerotic areas: vertex gold, ocelli

deep red, eyes reddish black; face yellow with dark vertical ridge between antennal scrobes, occiput and genae dark brown; antennae light yellowish brown; wings hyaline, lacking smoky band beneath venation that is present in females, venation dusky; coxae of all legs blackish, trochanters of forelegs and middle legs pallid, hind trochanters darker; all femora dark except at apex; foretibiae and tarsi pale, middle and hind tibiae and tarsi progressively darker; abdomen black with purple highlights in reflected light. Viewed from front, head wider than high; antennae (fig. 2C) with longitudinal sensoria on all funicle segments but lacking on club; first funicle not markedly reduced as in female.

This species most closely resembles *Coccophagoides kuwanae* (Silvestri) but differs from the latter in the color of the body and legs and in lacking apical spines on the fourth and fifth funicle segments.

Collection data. Described from 37 females and 17 males reared from *Parlatoria oleae*. Type female: Madera, California, February 23, 1961, C. E. Kennett, collector. Paratype females: Thirteen females emerged in quarantine at Albany, California, May, 1957, from *Parlatoria oleae* on apple twigs collected by Paul DeBach at Parachinar, Pakistan, on April 6, 1957. Eighteen females reared in quarantine at Albany, California, May, 1957, as progeny of the Parachinar specimens. Three females reared from insectary stock, Albany, California, in March, 1962. Two females reared from *Parlatoria oleae* on olives, Madera, California, in February, 1961, C. E. Kennett, collector.

Allotype male: Madera, California, February 23, 1961, C. E. Kennett, collector. Paratype males: One specimen reared from *Parlatoria oleae* on olive, in February, 1961, Madera, California, C. E. Kennett, collector. Three males reared from the insectary stock, Albany, California, in March, 1962; 12

males reared in quarantine at Albany, California, May, 1957, as progeny of the Parachinar specimens.

Types and paratypes are deposited in the collection of the California Insect Survey, Berkeley, California.

Key to the species of *Coccophagoides* Girault

1. Ovipositor very long, twice length of the thorax *regulus* (Girault)
Ovipositor not so conspicuously long, never twice the length of the thorax . . . 2
2. Second funicle segment "square," one-half length of pedicel; first funicle segment distinctly wider than long and about one half length of the second funicle segment *aurithorax* Girault
Second funicle segment distinctly longer than wide and clearly longer than one-half length of the pedicel 3
3. Second funicle segment nearly three times the length of the first funicle segment, which is abruptly short and clearly wider than long; combined length of club segments I and II longer than total length of funicles I, II, and III. 4
Second funicle segment at most not more than two times the length of first funicle segment; combined funicle segments longer than first two club segments 5
4. Legs brownish or blackish with paler markings *abnormicornis* (Girault)
Legs silvery-white *singularis* (Girault)
5. First funicle segment at least three-fourths the length of funicle II 6
First funicle segment less than three-fourths the length of funicle II 7
6. Forewings with several clouded areas beneath venation; scape, and pedicel, with alternating dark and light areas *comperei* n. sp.
Forewings with single clouded area, scape and pedicel without such conspicuous color contrasts *similis* (Masi)
7. Club segments I and II each with a large, gross, preapical upper seta; body color dark chestnut, legs and antennae dark chestnut color
kuwanae (Silvestri)
Club segments lacking gross preapical upper setae; thorax yellowish or golden, forelegs and middle legs pale *utilis* n. sp.

Family Encyrtidae

Genus *Anthemus* Howard

Anthemus Howard, 1896, p. 643. Type: *Anthemus chionaspidis* Howard.

Hexalis Bakkendorf, 1939, p. 84. Type: *Hexalis funicularis* Bakkendorf.

According to Ferrière (1953), this single genus *Anthemus* constitutes the subfamily Antheminae of the palearctic Encyrtidae. Although the genus was originally placed in the Mymaridae (presumably because of the insect's small size, four-segmented tarsi, peculiar wings with reduced venation, and long marginal cilia), it does have much closer affinities with the Encyrtidae, and the present association with that family concept seems correct.

Anthemus inconspicuus Doutt, new species.

Localities: Pakistan and California.

Host: *Parlatoria oleae* (Colvée).

Female. (See figure 4.) Body color of slide-mounted specimens in gum dammar generally brown, except for scutum and scutellum, upper face, and vertex, which are yellow. Eyes red. Distal portion of scape, pedicel, and first funicle segment yellow, remainder of antenna dusky. Tarsi, tibiae, apex of femora,

and trochanters of all legs pale; coxae and basal portion of femora dusky. Forewings with clouded areas beneath venation, hindwings hyaline. In living specimens the body color is much darker, and the areas seen as brown in slide-mounted specimens are nearly black in dried specimens.

Antenna as in figure 5A. Radicle very long, two-thirds the length of the scape; pedicel as long as first two funicle segments combined; club appears two-segmented, but previous authors interpret the basal segment as being the fifth funicle; apical or club segment with large colorless curved spine on dorsal surface. Forewings typical of genus, with venation very difficult to trace at apex, but apparently with slight post-marginal vein (fig. 6). Phragma prominent, extending well into abdomen.

Male. In living specimens vertex golden yellow, eyes and ocelli red. Pronotum, scutum, axillae nearly black; scutellum yellowish brown. Base of abdomen brownish black, with apex becoming lighter. Wings hyaline except black at base. Scape black, pedicel yellowish brown, flagellar segments brownish. In general, body color tending to be darker than that of female. Wings like those of female, two lines of discal

setae on posterior wings; antennae as in figure 5B.

This species is most readily differentiated from other species of *Anthemus* by the antennal structure, particularly the club segment with its dorsal spine.

Collection data. Described from 10 females and 15 males, all reared from *Parlatoria oleae*. Type female, insectary culture, Albany, California, April 10, 1964. Paratypes: One female reared in quarantine as F₁ progeny of Pakistan specimens, May, 1957; two females recovered from field-collected hosts at Lindcove, California, July, 1958, C. E. Kennett and C. B. Huffaker, collectors: two females collected from insectary stock, Albany, California, March 7, 1962; five females collected from insectary stock, Albany, California, April 10, 1964.

Allotype male, collected from insectary culture, Albany, California, March 7, 1962. Paratypes: Six males collected from insectary culture, Albany, California, March 7, 1962; six males collected from insectary culture, Albany, California, April 10, 1964; three males recovered from field-collected hosts at Lindcove, California, July, 1958, C. E. Kennett and C. B. Huffaker, collectors.

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Dr. Edgar Riek, C.S.I.R.O., Canberra, Australia, made a special trip to Queensland to obtain the type speci-

mens of *Coccophagoides abnormicornis*, *C. singularis*, and *C. regulus* from the Girault collection and personally carried them to California for this study. Mrs. Heidi Garrett delineated figure 1B, and figures 3, 4, 5 and 6.

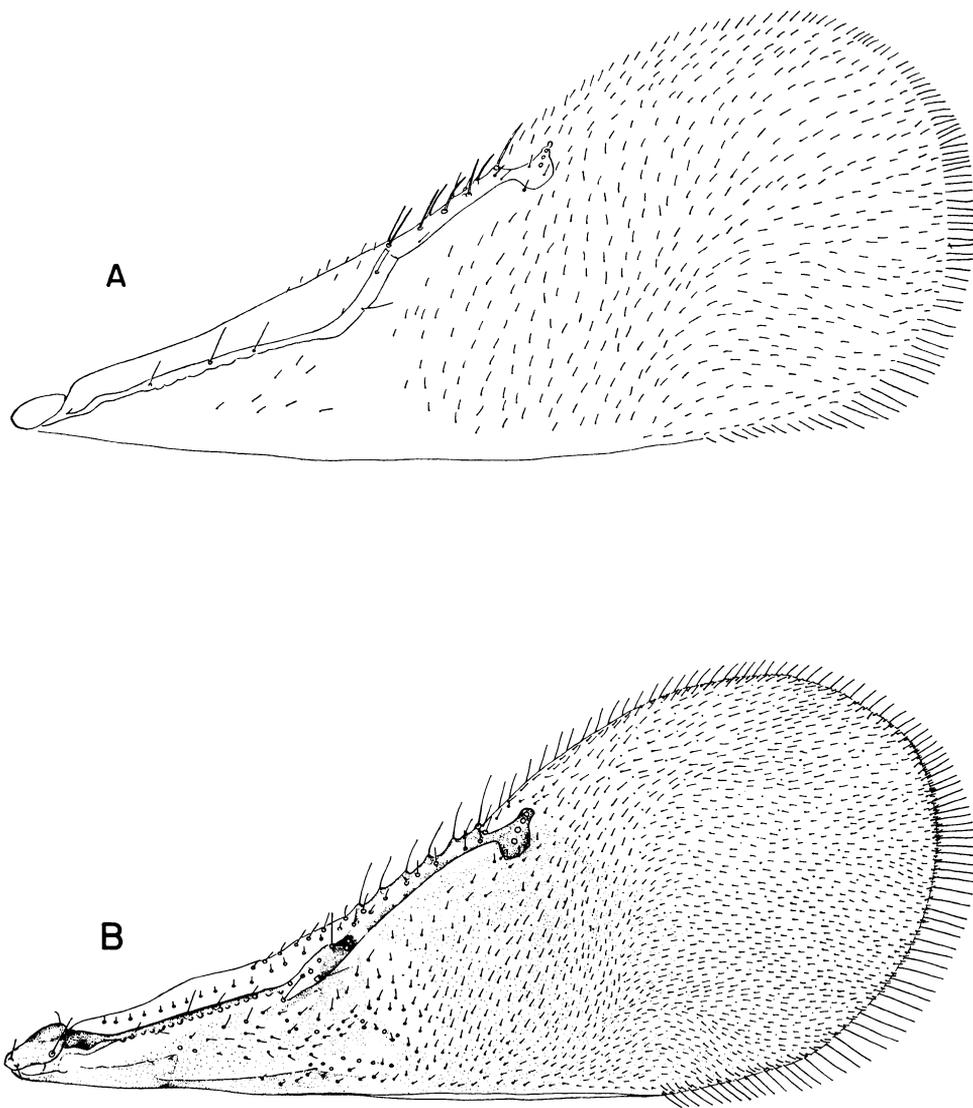


Fig. 1. A. Forewing of *Coccophagoides singularis* (Girault) ; B. Forewing of *Coccophagoides comperei* n. sp.

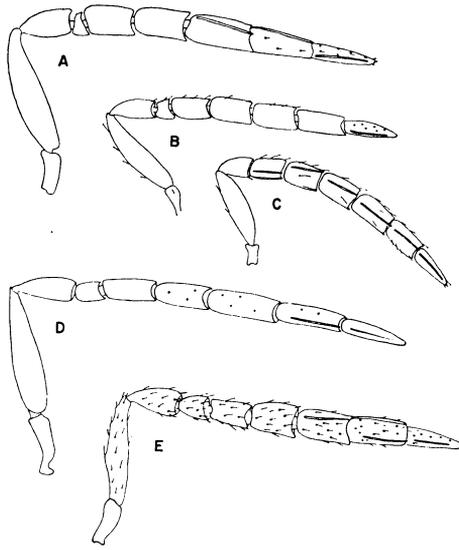


Fig. 2. Antennae of species of *Coccophagoides*: A. *Coccophagoides singularis*, female; B. *Coccophagoides utilis*, female; C. *Coccophagoides utilis*, male; D. *Coccophagoides regulus*, female; E. *Coccophagoides comperei*, female.

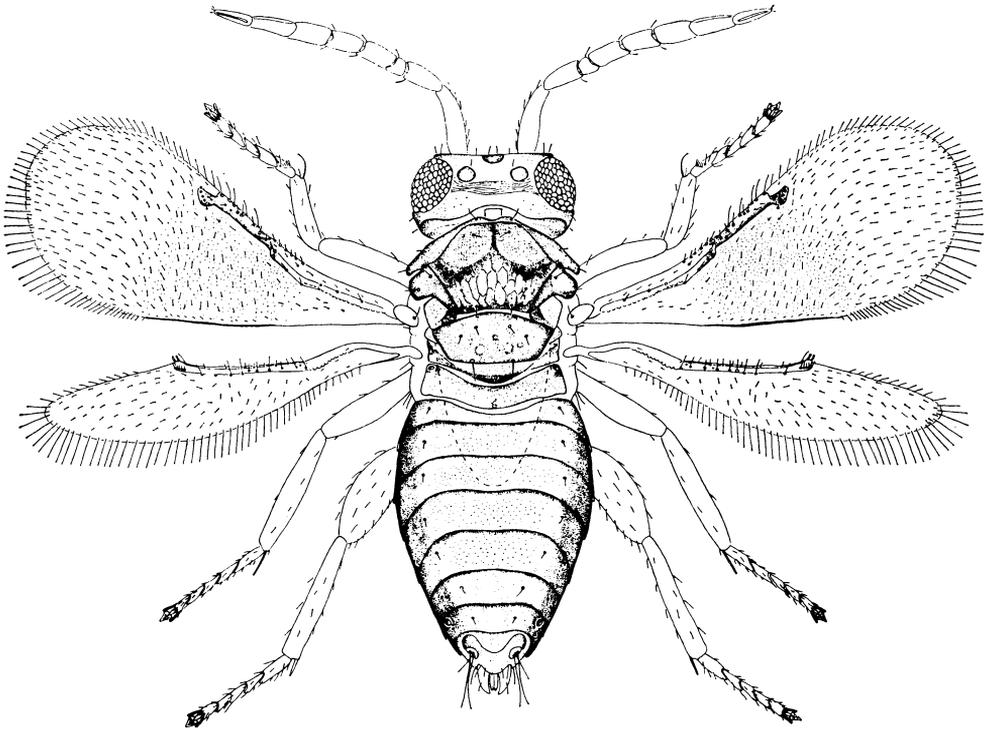


Fig. 3. Female adult, *Coccophagoides utilis*, n. sp.

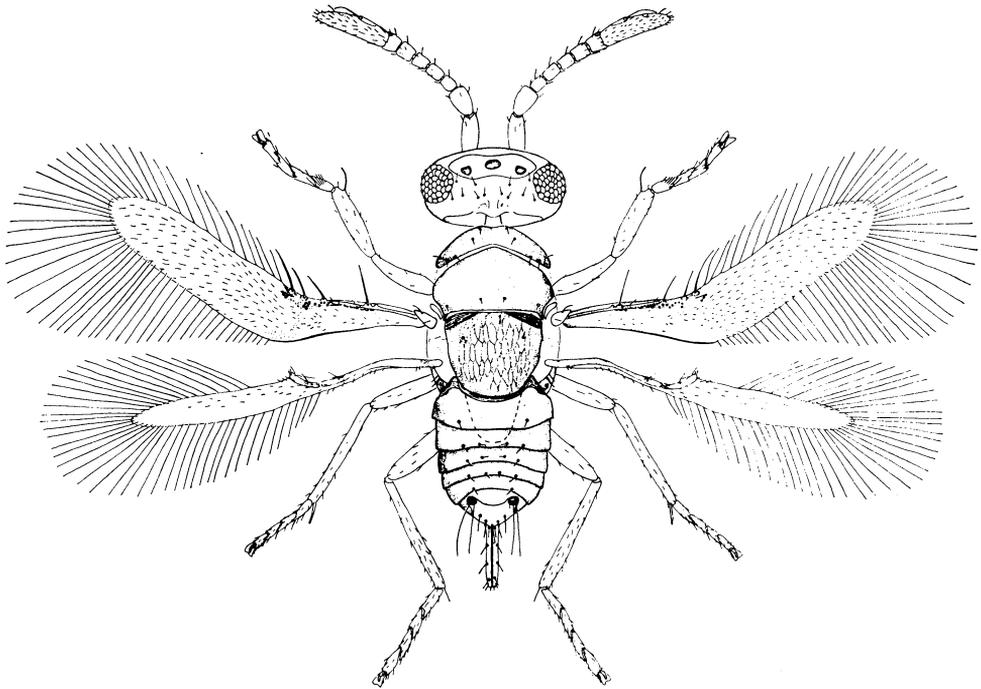


Fig. 4. Female adult, *Anthemus inconspicuus*, n. sp.

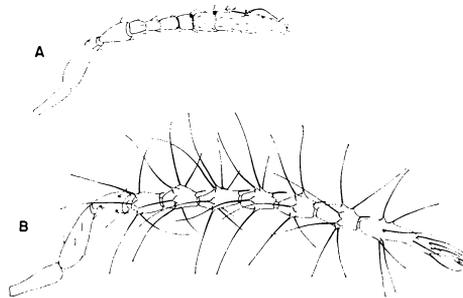


Fig. 5. Antennae of *Anthemus inconspicuus*:
A. Female antenna; B. Male antenna.

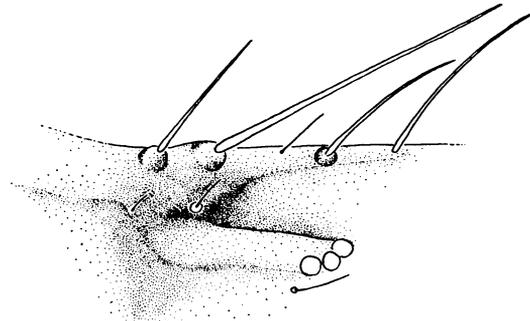


Fig. 6. Detail of forewing venation of female *Anthemus inconspicuus*.

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III. The olive scale, *Parlatoria oleae*, was first found in California in 1934 and has since become a major pest. Attempts to control this insect by biological means began with the introduction of the external parasite, *Aphytis maculicornis*, from Iran in 1952. Inconsistent control by *A. maculicornis* led to the introduction of two additional parasites from Pakistan in 1957. One of these, *Coccophagoides utilis*, became established in California.

Coccophagoides utilis is an internal parasite which attacks both scale generations which *P. oleae* produces each year. Adult female *C. utilis* which have been mated deposit female eggs only. Unmated females deposit male eggs only. Field results show *C. utilis* capable of destroying up to 50 per cent of each host generation. The two species of parasites working together have exhibited the ability to give excellent control of olive scale.

IV. The competitive population interactions between *Aphytis maculicornis* and *Coccophagoides utilis* were analyzed in order to determine their roles in controlling olive scale, *Parlatoria oleae*, in California olive groves. There is strong evidence that the two parasites working together give better control of olive scale than does *A. maculicornis* working alone. Conclusions are based on observations of parasite populations at selected groves over a period of five years.

K-values for various factors affecting olive scale mortality were developed in order to measure and assess the controlling effects of these two parasites on olive scale from generation to generation.

V. In 1961 the large-scale production of the aphelinid parasite *Coccophagoides utilis* was initiated. During the seasons of 1962 and 1963, over four million were made available for release against the olive scale, *Parlatoria oleae*, in colonization sites throughout California.

The factors involved in the production of *P. oleae* and *C. utilis* are briefly discussed and the methods and equipment used in the insectary are described and illustrated.

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