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PARASAISSETIA NIGRA (HEMIPTERA: COCCIDAE) AND ITS PARASITOIDS FROM THE GENUS *COCCOPHAGUS* (HYMENOPTERA: APHELINIDAE), WITH DESCRIPTION OF A NEW SPECIES FROM TAMAULIPAS, MÉXICO

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ABSTRACT

A list of parasitoids of the genus *Coccophagus* Westwood that parasitize the soft scale *Parasaissetia nigra* (Nietner), in the world, is given. Data on the biology of *P. nigra* in Mexico are presented. A key to species of *Coccophagus* associated to *P. nigra* in Mexico, including possible species of parasitoids, was prepared. A new species, *Coccophagus minor* Myartseva sp. nov., reared from *P. nigra* on mistletoe, *Phoradendron quadrangulare* (Kunth) Griseb., growing over leaves and shoots of huisache, *Acacia farnesiana* (L.) Willd., in Tamaulipas, Mexico, is described.

Key Words: *Phoradendron quadrangulare*, mistletoe, *Acacia farnesiana*; *Coccophagus*

RESUMEN

Se elaboró una lista de parasitoides del género *Coccophagus* Westwood que parasitan la escama blanda *Parasaissetia nigra* (Nietner) a nivel mundial. Se presentan datos de la biología de *P. nigra* en México. Se preparó una clave de especies de *Coccophagus* asociados a *P. nigra* en México, incluyendo posibles especies parasitoides de la plaga. Se describe la nueva especie *Coccophagus minor* Myartseva sp. nov., emergida de *P. nigra* en el muérdago *Phoradendron quadrangulare* (Kunth) Griseb. sobre hojas y ramitas de huizache *Acacia farnesiana* (L.) Willd. en Tamaulipas, México.

Palabras Clave: *Phoradendron quadrangulare*, muérdago, *Acacia farnesiana*, *Coccophagus*

Soft scales of the family Coccidae (Hemiptera: Coccoidea) are phytophagous insects that infest leaves, branches and fruits of various plants. Some species are pests of agricultural crops, for example, *Saissetia oleae* Olivier and *Coccus hesperidum* L. (Hayat 1997; Stauffer & Roaw 1997). On the other hand, they are host for parasitic wasps that belong predominantly to 9 genera of Chalcidoidea. Among these, species of 4 genera, including *Coccophagus* Westwood, are primary endoparasitoids and have economic importance for biocontrol of hemipteran pests (Hayat 1998).

Parasaissetia nigra (Nietner) belongs to the family Coccidae and has worldwide distribution (Noyes 2012a). It was described by Nietner in 1861 from Ceylon and has many synonyms and various combinations (Ben-Dov et al. 2013). Smith (1944) suggested that several strains of *P. nigra* may exist, each with different host preferences, or there may be several geographical races (De Lotto 1967). Hayat (1997) noted that the Afrotropical region is richer in *Coccophagus* species parasitizing *P. nigra* and also has more endemic species.

Parasaissetia nigra is polyphagous, feeding on host plants from 80 families (Ben-Dov 1993), especially on ornamental plants of tropical origin. Several agricultural crops are attacked, including avocado, citrus, coffee, cotton, guava, mango, pomegranate and other plants. Scales often infest heavily leaves, branches and fruits (Clausen 1978; Hamon & Williams 1984).

These scales produce copious, sticky honeydew on which sooty moulds develop, coating the plant. This restricts photosynthesis, weakening the plant and sometimes stunning new growth and causing defoliation (Smith 1944). *Parasaissetia nigra* is a moderate pest of ornamental plants, particularly in tropical countries. The scale is also a minor pest of citrus and of other agricultural crops and, at times, has been an important pest (Smith 1944).

In Mexico, this soft scale is widely distributed in the states of Baja California, Chihuahua, Colima, Guanajuato, Guerrero, Jalisco, Michoacan, Morelos, Nayarit, Nuevo Leon, Oaxaca, Puebla, Queretaro, Sinaloa and Sonora (Miller 1996). *Parasaissetia nigra* was newly recorded for the states of Tamaulipas and San Luis Potosi; in

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Tamaulipas it was collected in 2012, and according to our investigations, in San Luis Potosi it was found earlier (Myartseva 2006). Despite its wide distribution, polyphagy and economic importance as potential pest of agricultural crops, morphological and biological descriptions are lacking in the Mexican scientific literature. This article provides a morphological description of *P. nigra* and its parasitoids based in the literature and based on our own observations.

Materials and Methods

Infested leaves and twigs with soft scales of several plants were found and examined in the field using a magnifying pocket lens (10X), and later transferred to the laboratory to be examined under a Leica MZ6 microscope (140X). Collection and rearing of parasitoids were carried out following methodologies by Noyes (1982). Leaves and twigs were placed separately in glass containers until emergence of parasitoids. For further examination and identification reared adult parasitoids were mounted on microscope slides with Canada balsam. The species of soft scale was identified by Dr. I. A. Gavrilov-Zimin, specialist in scale insects from the Zoological Institute of the Academy of Sciences of Russia, Saint Petersburg. All materials are preserved in the Insects Museum of the Universidad Autonoma de Tamaulipas, Mexico. This insect collection has 195 specimens of *Coccophagus* on slides and numerous specimens in 75% alcohol.

Results and Discussion

Parasaissetia nigra (Nietner)

Adult female is elongate-oval, shiny, dark brown, 3-4 mm long. Body shape varies according to the substrate, specimens found on leaves are broad, only slightly convex but much more convex than those on stems or leaf-mid-ribs, which are elongate and less convex. Immature stages and young adult specimens of *P. nigra* are translucent-yellow and sometimes mottled (Hamon & Williams 1984).

In California and Florida, *P. nigra* has 1 complete generation per year outdoors (Gill 1988). Ben-Dov (1978) recorded up to 6 generations per year in greenhouses in Israel. In Tamaulipas, Mexico, from Oct 2012 to Jun 2013, we observed the development of at least 2 complete generations of *P. nigra* on mistletoe *Phoradendron* spp. (Santalales: Santalaceae) near Rio San Marcos in Ciudad Victoria. Upon hatching, the first instar nymphs (crawlers) move away from the female to other parts of the plant, where they fix themselves and start feeding.

It is interesting that in natural landscapes in Tamaulipas, scale colonies developed on mistletoes, hemiparasitic plants from the genus *Phoradendron*, but not on *Acacia farnesiana* (L.) Willd., *Guazuma ulmifolia* Lam., *Salix humboldtiana* Willd. and *Prosopis glandulosa* Torr., which have been reported as host plants of this species. In Mexico, *P. nigra* was recorded as pest of guava (Ben-Dov 1978). Moreover, parasitoids were obtained only from *P. nigra* on huisache *Acacia farnesiana* (L.) Willd. in the State of Tamaulipas.

Families of parasitoids of *Parasaissetia nigra*

Parasitoids from several families of Chalcidoidea have been reported as natural enemies of *P. nigra* in the world: Encyrtidae, Aphelinidae, Eulophidae, Eupelmidae and Pteromalidae. In Peru, the dominant parasitoid species in agroecosystems belong to 3 families: Encyrtidae, Aphelinidae and Pteromalidae (Núñez 2008). In many countries where it was once a pest, *P. nigra* is now successfully controlled by natural enemies originally introduced to control *Saissetia oleae* (Bartlett 1978). For example, the most effective control agent of *P. nigra* in California (USA), is an encyrtid *Metaphycus helvolus* (Compere), that was introduced with several other enemies to control *S. oleae*, which has been more effective against *P. nigra* (Ebeling 1959).

In Mexico, we reared from *P. nigra* parasitoids from 6 families: Encyrtidae, Aphelinidae, Eupelmidae, Eulophidae, Pteromalidae and Signiphoridae, but the encyrtid and aphelinid species were the most dominant. This is the first record of Signiphoridae as parasitoids of *P. nigra*. The main parasitoids in the family Aphelinidae are species of the genus *Coccophagus* Westwood.

Coccophagus spp.—parasitoids of *Parasaissetia nigra*

Species of the genus *Coccophagus* are mainly parasitoids of soft scales (Coccidae), but rarely parasitize armored scales (Diaspididae) and other Coccoidea. In the world, the genus *Coccophagus* consists of 257 species (Noyes 2012a), some of which are widely distributed. In the family Aphelinidae, *Coccophagus* is the second most speciose genus after *Encarsia* Foerster. *Coccophagus* is divided into 6 species-groups: *lycimnia*-group, *pseudococci*-group, *varius*-group, *malthusi*-group, *ochraceus*-group and *zebratus*-group (Hayat 1997).

Females of this genus have 8-segmented antenna; mandible with 1 or 2 teeth and a truncation; pronotum entire, medially sometimes narrow; mid lobe of mesoscutum with numerous short setae; axillae large, strongly projecting forwards, with at least 2 setae, rarely more to about as densely setose; Each side lobe with 4 or more setae, rarely less; scutellum large, usually convex, not overlapping propodeum, either with 3 pairs of setae or several additional setae to densely setose; propodeum either medially membranous or with

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a triangular median projection: fore wing large, broad, densely setose, with short marginal fringe; submarginal vein with 5 or more setae, stigma vein variable, either subsessile or with a neck and swollen stigma; linea calva absent; hind wing usually broad, with a broadly rounded apex; all tarsi 5-segmented; hind coxae sometimes large, as long as femora; tibiae often with thick setae (bristles) along dorsal (outer) margins; gaster with 7 terga; length of ovipositor and relative dimensions of last tergum highly variable; hypopygium extending to about two-thirds along gaster and with apex broadly rounded or truncate; color of body variable from whitish-yellow to brown black, partially or entirely; males similar to females except for genitalia and, in most species, antennae quite different from those of females.

Coccophagus females are diploid, developing from fertilized eggs, but are also produced from unfertilized eggs, whereas the males are invariably haploid, produced from unfertilized eggs; males are either primary ectoparasitoids, secondary ectoparasitoids or endoparasitoids of other primary hymenopterous parasitoids, including females of the same species (Hayat 1997). For example, females of *C. caridei* (Brèthes) are soft scale parasitoids, but males develop in the mealybug *Planococcus citri* (Risso) as hyperparasitoids of the encyrtid *Anagyrus pseudococci* (Girault) (Flanders et al. 1961).

Twenty-four species of *Coccophagus* have been recorded as parasitoids of *P. nigra*, and of these some species have a worldwide in distribution due to various introduction programs (Hayat 1997; Noyes 2012a). An analysis of the lists of species distributed in some large regions – South Africa, Oriental and Neotropical, and United States according to Noyes (2012a), showed that these regions have a similar number of *Coccophagus* species that parasitize *P. nigra*: In addition to the widespread parasitoid species some regions have 1-2 specific parasitoids from their local fauna: South Africa – 1 from a total of 12 species, the Oriental Region – 1 of 8 species, and the Neotropical Region – 2 of 13 species (Table 1). In the South Africa list, some species of *Coccophagus* were included by Hayat (1997): *C. bivittatus* Compere, *C. lutescens* Compere, *C. modestus* Silvestri, *C. nubes* Compere, *C. saintbeauvei* Compere and *C. varius* Silvestri.

In Tamaulipas, Mexico, we reared the following 5 *Coccophagus* species from *P. nigra*: *C. rusti* Compere (introduced into Mexico accidentally from California, where it was introduced for *Saissetia oleae*), *C. lycimnia* (Walker), *C. ochraceus* Howard, *C. minor* **sp. nov.** and *Coccophagus* sp. As Table 1 shows, 2 other species of *Coccophagus* (*C. pulvinariae* and *C. scutellaris*) are widely distributed in the world; in Mexico, they are parasitoids of other coccid species: *C. lycimnia* from *Philephedra lutea* (Cockerell), *Coccus hesperidum* L., *Pulvinaria* spp. and S*aissetia* spp. (Myartseva et al. 2012).

Below is presented a key to species of *Coccophagus* associated with *P. nigra* in Mexico, including *C. scutellaris* and *C. pulvinariae*, species present in Mexico as parasitoid, of other soft scales that probably also attack *P. nigra*. All these species are distributed in the Neotropical Region and USA (California).

TABLE 1. *COCCOPHAGUS* PARASITOIDS OF *PARASAISSETIA NIGRA* AND THEIR DISTRIBUTION IN THE WORLD (AFTER NOYES 2012A).

Species of *Coccophagus*	SA[1]	USA	Oriental	Neotropical	Mexico
C. basalis Compere	+	+		+	
C. bogoriensis (Koningberger)			+	+	
C. capensis Compere	+	+		+	
C. caridei (Brèthes)		+		+	
C. ceroplastae (Howard)	+	+	+	+	
C. cooperatus Sugonjaev & Ren			+		
C. cowperi Girault	+	+	+	+	
C. fallax Compere				+	
C. hawaiiensis Timberlake	+	+	+	+	
C. isipingoensis Compere	+				
C. lycimnia (Walker)	+	+	+	+	+
C. minor Myartseva sp. nov.					+
C. ochraceus Howard	+	+	+	+	+
C. pulvinariae Compere	+	+		+	+
C. rusti Compere	+	+		+	+
C. saissetiae Gahan				+	
C. scutellaris (Dalman)	+	+		+	+
C. sp.					+

[1]SA = South Africa, USA = United States of America.

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KEY TO SPECIES OF *COCCOPHAGUS* ASSOCIATED WITH *P. NIGRA* IN MEXICO

1a. Scutellum with 3 pairs of setae 2

1b. Scutellum with numerous scattered setae. Scutellum yellow, fore and mid femora yellow, hind femora black . . . . . *scutellaris* (Dalman)

2a. Fore wing distinctly or slightly infuscate 3

2b. Fore wing hyaline 4

3a. Scutellum yellow, at most the anterior margin narrowly blackish. Legs yellow, mid and hind coxae infuscate basally . . . . . *pulvinariae* Compere

3b. Scutellum dark brown. Propodeum light yellow. Hind coxae, trochanters and femora light yellow . . . . . *rusti* Compere

4a. Antennae with funicle segments ventrally connected 5

4b. Antennae with funicle segments centrally connected 6

5a. Body primarily yellow with black to dark brown pronotum medially, mesoscutum anteriorly, propodeum and band on apical half of gaster. Antennal scape longer than funicle, club shorter than funicle . . . . . .*ochraceus* Howard

5b. Body completely yellow. Antennal scape as long as funicle, club as long as funicle . . . . . *minor* Myartseva **sp. nov.**

6a. Antennal scape and pedicel infuscate. Hind tibia blackish . . . . . *lycimnia* (Walker)

6b. Antennal scape and pedicel light yellow. Hind tibia light yellow . . . . . *Coccophagus* sp.

COCCOPHAGUS MINOR MYARTSEVA, **SP. NOV.**
(Figs. 1-4)

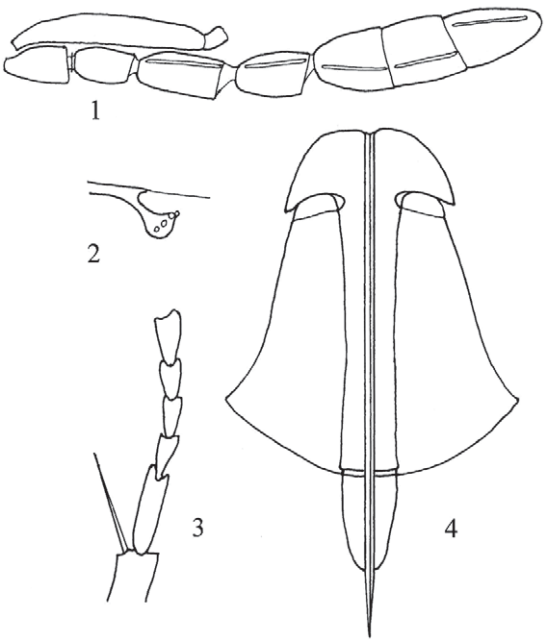
Type Material

HOLOTYPE female, MEXICO, Tamaulipas, Ciudad Victoria, Rio San Marcos, ex *Parasaissetia nigra* (Nietner) on *Phoradendron quadrangulare* (Kunth) Griseb., associated with *Acacia farnesiana* (L.) Willd., 18.IV.2013 (col. E. Ruiz-Cancino, N. Y. Martinez-Ruiz, B. Villarreal-Alanis, N. Rivera-Tovias). Paratype: same locality and host, 1♀, 18.IV.2013 (col. E. Ruiz-Cancino, N. Y. Martinez-Ruiz, B. Villarreal-Alanis, N. Rivera-Tovias). Both specimens mounted in slides. Holotype deposited at the Entomological Research Museum, University of California - Riverside, USA, paratype deposited in UAT Museum.

Description

Length of body – 0.7 mm. Coloration. Head light yellow, face whitish, second-sixth flagellar segments slightly infuscate; low border of cheeks, near mouth margin, black, eyes and ocelli reddish. Body light yellow, apex of third valvulae slightly infuscate. Fore wings hyaline. Legs whitish yellow.

Structure. Head not wider than thorax, about 1.3 times as wide as high. Frontovertex 0.5 times as wide as head width. Distance between posterior ocelli 1.8 times as long as distance from hind ocellus to eye margin. Eyes 0.8 times as long as



Figs. 1-4. *Coccophagus minor* **sp. nov**., female: 1 – antenna, 2 – stigmal vein, 3 – mid tarsus and mid tibial spur, 4 – ovipositor.

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TABLE 2. STRUCTURAL DIFFERENCES OF THREE *COCCOPHAGUS* SPECIES.

Structures	*C. lutescens* Compere	*C. perflavus* Girault	*C. minor* sp. nov.
Pedicel	1.5 times as long as wide and 1.5 times as long as F1	more than 1.5 times as long as wide and about equal to F1	1.9 times as long as wide and slightly longer than F1
F1	1.25 times as long as wide	slightly more than 2 times as long as wide	about 2 times as long as wide
F1-F2	F2 and F1 subequal in length	F2 1.3 times as long as F1	F2 1.5 times as long as F1
F2-F3	slightly longer than wide	about 2 times as long as wide	F2 twice, F3 1.7 times as long as wide
Mid tibial spur	slightly longer than basitarsus	as long as basitarsus	1.3 times as long as basitarsus
Ovipositor	at least slightly longer than mid tibia	distinctly shorter than mid tibia	as long as mid tibia
Length of body	0.6 mm	0.8 mm	0.7 mm

cheeks. Mandible with 1 tooth and a truncation. Antennae (Fig. 1) inserted below the level of lower margin of eyes, closer to mouth margin. Distance between toruli 0.6 times as long as distance from torulus to eye. Antennal radicle short, as wide as long. Scape about 6.4 times as long as wide. Pedicel 1.9 times as long as wide. First segment of funicle (F1) shorter than pedicel and about 2 times as long as wide. Second segment (F2) the longest and also 2 times as long as wide. Third segment (F3) as wide as second segment and 1.7 times as long as wide. Pedicel and funicle furnished with sparse, large setae. Club 1.3 times wider than funicle and as long as funicle. Second-sixth segments (F2-F6) of flagellum with 1 long sensilla each. Segments of funicle ventrally connected, longer ventrally than dorsally. Mid lobe of mesoscutum with sparse, large setae, 2 basal setae longer. Axilla large, with 2 long setae. Side lobe with 3 long setae. Scutellum about 0.8 times as long as mid lobe, with 3 pairs of long setae situated symmetrically. Fore wing uniformly setose, 2.7 times as long as maximum width of disc. Marginal vein slightly longer than submarginal vein. Stigmal vein (Fig. 2) short, with wide uncus. Marginal fringe about 0.2 times as long as wing width. Hind wing about 7 times as long as maximum width of wing, its marginal fringe about 0.8 times as long as wing width. All tarsi 5-segmented. Mid tibial spur (Fig. 3) longer than basitarsus of mid leg (25:20). Gastral tergites T2-T7 with 2, 2, 2, 4, 6 and 4 setae. Ovipositor (Fig. 4) slightly exserted, about as long as mid tibia. Third valvula about 0.3 times as long as second valvifer and about as long as basitarsus of mid leg.

Male unknown.

Remarks

Coccophagus minor **sp. nov.** belongs to the *ochraceus* species-group. The new species is close to *C. lutescens* Compere described from South Africa and to *C. perflavus* Girault described from United States. We compared *C. minor* with the original descriptions and redescriptions of both species (Girault 1916; Compere 1931; Annecke & Insley 1974; Hayat 1998). Both species are small in size, with the head and body pale yellow, without any dark markings. *Coccophagus minor* has slightly infuscate antenna and apex of third valvula, and black low border of cheeks near mouth margin. Structural differences are in Table 2.

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