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The Pistachio Fruit Hull Borer Moth *Arimania komaroffi* RAGONOT, 1888 (Lepidoptera, Pyralidae)

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Abstract

A short description of the genus *Arimania* AMSEL, 1954 is given including the first figures of the female genitalia and larva of its single species *Arimania komaroffi* RAGONOT, 1888. The biology of the species in Iran is discussed, where it is an important pest of cultivated pistachio trees and called the Pistachio Fruit Hull Borer Moth. Three hymenopterous parasitoid species were reared from larvae of this moth.

Zusammenfassung

Die Gattung *Arimania* AMSEL, 1954 wird kurz beschrieben sowie die weiblichen Genitalien und die Larve der einzigen Art *Arimania komaroffi* RAGONOT, 1888 erstmals abgebildet. Die Biologie der Art im Iran wird besprochen, wo sie ein wichtiger Schädling des kultivierten Pistazien-Baumes ist und die Pistazien-Fruchthüllen-Bohrer-Motte genannt wird. Drei parasitoide Hymenopteren-Arten wurden aus der Larve dieser Motte gezüchtet.

Introduction

The Pistachio Fruit Hull Borer Moth (PFHBM), *Arimania komaroffi* RAGONOT (Lepidoptera: Pyralidae) was first discovered in 1939 in Iran by BRANDT (AMSEL, 1954) and recorded from Mian-Kotal, Sine-Sefid, Tang-Ab near Firuzabad and Muk-Pass, all localities in the province of Fars and the specimens were collected at light and not bred. It was then collected from cultivated pistachio trees, *Pistacia vera* LINNAEUS, in Rafsanjan, southern part of Iran in 1972 by SAMET (1974, 1985). The present paper provides a more detailed description of the adults, the larvae, the biology and feeding habits including the first figures of the female genitalia and larvae, as there are only poor descriptions and data of the species in the literature record.

Redescription

Arimania AMSEL, 1954

Ark. Zool. (2) 6 (1953): 289

The original diagnosis of the genus is rather poor. According to AMSEL (1954), the genus *Arimania* is similar to "*Salebria* ZELLER, 1846" [= *Pempelia* HÜBNER, [1825]] and *Tephris* RAGONOT, 1891 in the structure of labial palpi and venation, but very distinct in the male genitalia. No other indication about the systematic position of the genus was available.

The genus is a member of the Phycitinae, tribe Phycitini, subtribe Phycitina as defined by ROESLER (1968) according to the structure of the male antennae. Typical for the subtribe is the knob at the base of the male antenna. This knob is formed by a sinus of the antennal flagella, and a bush of scales. Also characteristic for the Phycitina are the sclerotized structures in the cervix of the bursa (ductus bursae).

Male genitalia (Pl. 3, fig. 12): The valva is peculiarly shaped, strongly sclerotized and ending in an acute tip. Uncus is rounded, gnathos very small. Inner end of aedeagus very narrow, distal end broad.

Female genitalia (Pl. 3, fig. 13): Apparently undescribed so far, and typical for Phycitina. Ductus bursae broad, strongly sclerotized. Corpus bursae oval, with ductus seminalis originating in upper third of corpus, no signum.

Remark: The structure of the male genitalia is certainly unique; nor do the female genitalia indicate any clear relationship of the genus, and the generic separation of the single species of the genus, *A. komaroffi*, by AMSEL (1954) seems to be well justified. The male genitalia structures are most like those of the genus *Catastia* HÜBNER, [1825], but this similarity does not necessarily reflect a close phylogenetic relationship between the two genera.

Arimania komaroffi RAGONOT, 1888 (Plate 1, fig. 1-3)

Salebria komaroffi RAGONOT, 1888, Nouv. Genres Espèces Phycitidae Galleriidae: 18. Type-locality: Transcaucasie

= *Nephopteryx* [sic] *diplocapna* MEYRICK, 1937, Exot. Microlepid. 5: 67. Type-locality: Iraq: Rowanduz Gorge (2000 ft); Shaqlawa, Diana (2800 ft). Synonymized by AMSEL, 1949: 292.

= *Salebria komaroffi* var. *amanella* ZERNY, 1935, *in* OSTHELDER, 1935, Mitt. münch. ent. Ges. 24: 87. Type-locality: [Turkey: Maras] Yüksek Dagh

Remark: The name *amanella* ZERNY can potentially be used for a geographical subspecies which is differentiated by its smaller size (forewing length 8-9 mm, wingspan 15-19 mm) and the pure grey ground-colour of the forewings, which lack an admixture of yellow or brown scales (ZERNY, *in* OSTHELDER, 1935). This "subspecies" has been recorded, in addition to its type-locality, from Iraq (AMSEL, 1949). We had only specimens from Iran for study, but the features mentioned above do not seem to be very convincing for separating a geographical population. We found a high variability in the size, and also differences in colour which depends on the freshness of the specimens (cf. pl. 1, fig. 1 and 2). A final decision about the taxonomic status of var. *amanella* has to await further comparative studies.

Distribution: *A. komaroffi* is known from Armenia, Iraq, Iran and Turkey.

Larva: Larvae of *A. komaroffi* (Pl. 1, fig. 4, 5), vary in colour from pale greenish to pale pinkish, with brown head. They are remarkably active when disturbed. In the field, most young larvae (Pl. 1, fig. 5) are light green and very sensitive to any nearby movement. They react to any disturbance, jump up and spin around. During development, the larval ground colour changes to a light pink. Mature larvae mostly appear in light greenish pink with very pale-yellow stripes on the sides and the middle of the back, up to 18 mm in length (Pl. 1, fig. 4).

Biology: Little information is available on biology of PFHBM at pistachio orchards. Although, SAMET (1985) reported two generations for this insect, our recent research showed that *A. komaroffi* certainly produces 3 or 4 generations a year. Larvae mostly feed within the pistachio clusters, boring amongst the fruits in a white, silken spinning within which they remain concealed. On cultivated pistachio trees, larvae almost exclusively live in this way within the fruit clusters, but they may also construct a spinning among the foliage and bore into the leaf parenchyma. The larvae cause different

kinds of damage to the fruits during the seasonal growth, but the injury is almost always severe enough to destroy the entire fruit. They may attack several fruits in a cluster before they pupate. The first generation attacks newly formed pistachio fruits by boring into the fruits between late April and about mid May, usually feeding on the soft skin (Pl. 2, fig. 6). The damage caused by this generation are usually mixed with that caused by the pistachio fruit moth, *Recurvaria pistaciicola* DANILEVSKY, 1955 (Lepidoptera: Gelechiidae) (MEHRNEJAD, 2001). The larvae of the second generation of PFHBM feed on stem tissues of cluster as well as in the base of fruits, which results in the fruits becoming detached from the cluster stems, and their desiccation (Pl. 2, fig. 7). During the third and fourth generation, larvae always feed on the body of the fruits (hull) (Pl. 1, fig. 4, pl. 2, fig. 8 & 9), stopping the kernel development and causing the fruits to dry out. From late August, pistachio fruits gradually become mature, and pistachio hard skin (shell) eventually splits. At this stage, creation of any wound or crack on the surface of the fruit commonly leads to mould development on the kernel which will spoil the fruit. As the PFHBM usually bores into the fruit, it may also introduce fungal spores, such as those of *Aspergillus flavus* LINK.FR and *Aspergillus parasiticus* SPEARE, which spoil the nuts (MEHRNEJAD & PANAHI, 2006).

The larvae may feed on cultivated pistachio leaves (Pl. 1, fig. 5), *P. vera*, throughout the season, but the damage caused is insignificant. On wild pistachio trees, such as *Pistacia khinjuk* STOCKS, they feed exclusively on mainly one side of the leaf surface, on both epidermis and parenchyma (Pl. 2, fig. 11), in a spinning made by folding the edges together, attaching it by silken threads to other leaves, and hiding inside.

Fully developed larvae leave the feeding site and drop to the ground. They pupate within delicate greyish silken cocoons beneath the canopy, or in other shelters around the base of the trees. *A. komaroffi* overwinters as a pupa beneath the surface of the ground in obligatory diapause from early October. Adults emerge around late April. They usually lay eggs singly on newly formed fruits, but may also oviposit on small fruits damaged by the pistachio fruit moth, *R. pistaciicola* or other pistachio pests. In all other generations the eggs are usually laid on damaged fruits in the pistachio cluster, preferably in dense clusters of fruit. During the day, moths remain quiet, usually resting amongst dense pistachio fruit clusters or among foliage in the canopy. They become active at dusk.

Recent change in abundance: The population density of *A. komaroffi* in Iran remained low until the late 1990s, after which it has gradually increased (MEHRNEJAD, 2001) and extended its range. Now, this insect occurs almost in 70% of the pistachio plantation areas in Rafsanjan, the main pistachio production region of country, and causes damage in Sirjan, Zarand and Ardakan pistachio plantations as a patchy localized pest.

The status of the PFHBM has changed due to several reasons. There has been an increase in the use of chemical applications in the whole area. Chemical insecticides have been used in pistachio orchards during the last 60 years, but the use of synthetic pyrethroid pesticides became common only in last two decades and might have caused heavy damage to beneficial insects. A study on biocontrol agents of the pistachio pests clearly showed that natural enemies of key pests are very effective in the pistachio plantation areas throughout Iran. Several parasitoids and predatory mites and insects were found for all the major pistachio pests (MEHRNEJAD, 2002, 2003, 2010; MEHRNEJAD & JALALI, 2004; MEHRNEJAD & EMAMI, 2005; MEHRNEJAD & BASIRAT, 2009; MEHRNEJAD & UECKERMANN, 2002) including *A. komaroffi* (MEHRNEJAD, unpublished). Reduction of

rainfall and increasing average temperature through the last years may have also reduced the natural mortality of the overwintering pupae of *A. komaroffi*. The change in the kind of insecticide used in pistachio orchards may also be responsible for the decrease of effectivity in the control of this pest. In this respect, Phosalone was used against the common pistachio psyllid *Agonoscena pistaciae* BURCKHARDT & LAUTERER (Hemiptera: Psylloidea), over 20 years and was only stopped after 1991 when the pest target became resistant to it (MEHRNEJAD, 2001, 2002). This insecticide was also effective on *A. komaroffi*, and in its absence the population density of the PFHBM was probably able to increase.

Natural enemies: Our field survey showed that at least three parasitoids attack *A. komaroffi*. *Iconella myeloenta* (WILKINSON) (Braconidae: Hymenoptera), was found to be the most common solitary and primary parasitoid of PFHBM in Rafsanjan. It develops on *A. komaroffi* as a larval endoparasitoid, but its alternative host(s) in pistachio orchards remain unknown. It is estimated that about 35% of the PFHBM population on cultivated pistachio trees is parasitised by this species through July to September. The parasitoid *Habrobracon telengai* MULJARSKAYA (Hymenoptera: Braconidae) was found as a gregarious endoparasitoid on larvae of *A. komaroffi*. It is active throughout the growing season. These two braconid parasitoids were also reared from larvae of PFHBM that were collected from *P. khinjuk* in Sirjan's wild pistachio growing areas. *Elasmus nudus* NEES (Hymenoptera: Eulophidae) was found to be the second dominant parasitoid species on *A. komaroffi*. This is a gregarious ectoparasitoid, which attacks the fully developed larvae prior to pupation. However, it also attacks the braconid *I. myeloenta*, the primary parasitoid of PFHBM. A colony of this parasitoid was established in laboratory conditions in order to study its biological and behavioural parameters.

In addition to parasitoids, predators make pressure on the population of PFHBM. The green lacewing, *Chrysoperla lucasina* (LACROIX) is known to be a predator of the common pistachio psyllid, *A. pistaciae*, and also attacks eggs and young larvae of PFHBM (MEHRNEJAD, unpublished). Spiders are the most abundant arthropods on pistachio clusters damaged by PFHBM, but their importance, and that of predatory bugs and coccinellid beetles on populations of *A. komaroffi* needs to be investigated.

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Plate 1

Fig. 1. *Arimania komaroffi* male, worn specimen. Iran (Acc. 5), Syrjan, Host: Pistacia khinjuk, 15. vi. 2001, M. R. MEHRNEJAD.

Fig. 2. *Arimania komaroffi* male. Iran (Acc. 3), Rafsanjan, Host: Pistacia vera, 15. vii. 2008, M. R. MEHRNEJAD.

Fig. 3. *Arimania komaroffi* female. Iran (Acc. 3), Rafsanjan, Host: Pistacia vera, 15. vii. 2008, M. R. MEHRNEJAD.

Fig. 4. Pistachio fruits injured by the larva of *A. komaroffi* at 3rd & 4th generation (late summer). Larva in centre of picture

Fig. 5. Pistachio (*Pistacia vera*) leaf injured by larva of *A. komaroffi*

Plate 2

Fig. 6. Fruits injured by larva of *A. komaroffi* at 1st generation (late April)
Fig. 7. Fruits injured by larva of *A. komaroffi* at 2nd generation (late May - early June)
Figs 8 & 9. Fruits injured by larva of *A. komaroffi* at 3rd generation (July - August)
Fig. 10. The braconid parasitoid cocoon on feeding site of *A. komaroffi* larva
Fig. 11. Leaf of the wild pistachio tree (*Pistacia khinjuk*) injured by larva of *A. komaroffi*

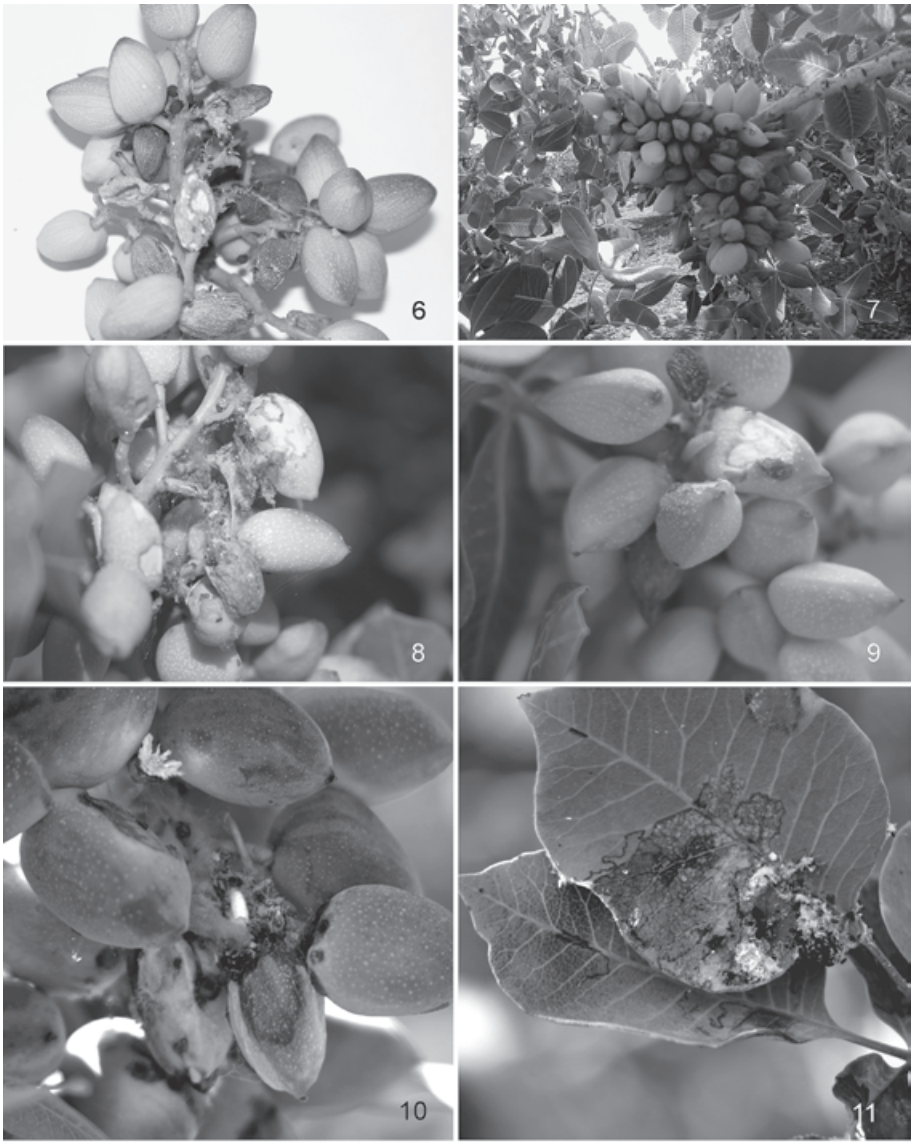
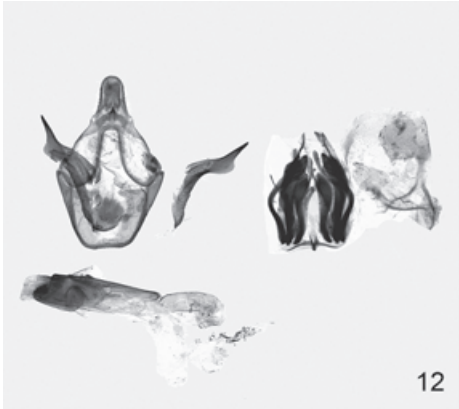


Plate 3

Fig. 12. *Arimania komaroffi*. Male genitalia.
Fig. 13. *Arimania komaroffi*. Female genitalia.



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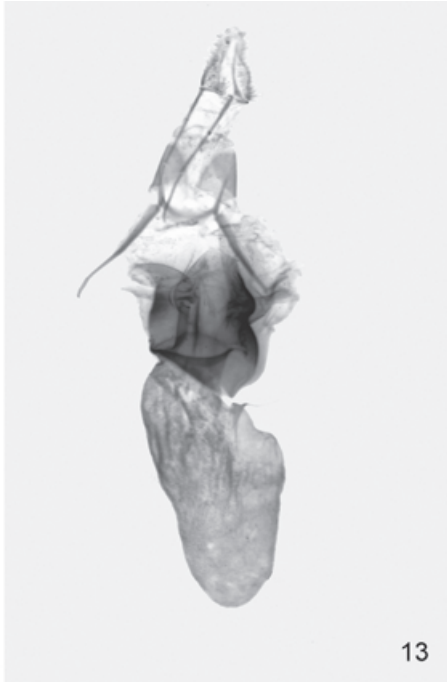

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