

# Ladybirds associated with pistachio trees in part of Kerman province, Iran (Coleoptera: Coccinellidae)

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The majority members of the family Coccinellidae are predators, so they have received considerable research attention because of their potential to act as biocontrol agents. The coccinellids complex of pistachio trees was monitored at both cultivated and wild pistachio plantations in Shahr-e Babak (Kerman, Iran) during 2009 - 2010. Sampling was carried out randomly in the cultivated pistachio plantations at elevations between 1590 - 1864 m and the wild pistachio growing areas at elevations between 2103-2364 m, using a white beating tray. Totally, 25 species belonging to 14 genera from six tribes and four subfamilies were collected. 21 and 15 species were identified on cultivated and wild pistachio plantations respectively, among which eight new species for Kerman province were recorded. *Chilocorus bipustulatus*, *Exochomus quadripustulatus*, *Parexochomus nigripennis*, *Hyperaspis polita*, *Hyperaspis* sp., *Menochilus sexmaculatus*, *Nephus* (*Nephus*) *quadrimaculatus*, *Nephus* (*Sidis*) *elbursi*, *Scymnus* (*Scymnus*) *flavicollis*, *Pharoscymnus setulosus*, were found in few experimental sites on planted pistachio trees only. In addition *Exochomus octosignatus*, *Clitostethus arcuatus*, *Parexochomus melanocephalus* and *Scymnus* (*Pullus*) *auritus* were only collected from wild pistachio trees.

**Key words:** Coccinellinae, ladybird fauna, pistachio trees, Shahr-e Babak, Iran

## INTRODUCTION

The family Coccinellidae, colloquially known as the ladybirds is a well-known, abundant, and diverse family with about 6000 species in worldwide (Vandenberg, 2002; Majka et al. 2010). The majority members of this family (about 90 %) are predator of herbivorous pests such as aphids, adelgids, psyllids, mealy bugs, and scale insects and the rest are phytophagous or mycophagous, and consequently the predatory coccinellids play a significant role in development of biological control strategies (Gurney and Hussey, 1970; Galecka, 1991; Obrycki and Kring, 1998). Generally, the brightly coloured species feed on aphids, while the darker coloured and smaller species feed on scale insects, mealybugs, whiteflies or spiders and mites (Ipetri, 1999), also these insects have a wide range of species from stenotopic to eurytopic. The dependence of any species on a given habitat is mainly determined by the occurrence of essential prey and physical conditions of the environment (Hodek, 1967). This family is characterized by a 3-3-3 tarsal formula (some are actually 4-4-4 but the third tarsus is hidden), an expanded pronotum partly to completely concealing the head dorsally at rest, a body that is convex dorsally and flat ventrally and first abdominal sternum that is entire with postcoxal lines (Majerus, 1994; Jones, 2002).

*Pistacia* Linnaeus is mainly a subtropical genus comprising some 10 species of dioecious trees and shrubs (Zohary, 1995). Three *Pistacia* species occur naturally in Iran, e. g. *Pistacia atlantica* Desf., *Pistacia kbinjuk* Stocks and *Pistacia vera* Linnaeus (Sheibani, 1995; Mehrnejad, 2006). The planted pistachio trees, *P. vera* is considered as a very important plant species with 420,000 ha of plantations over the country, and pistachio is considered as the major economic agricultural crops in Iran (Mehrnejad, 2010). The wild pistachio species including *P. atlantica* and *P. kbinjuk* are important in the development of pistachio varieties because they provide rootstocks resistant to biotic and abiotic stresses, and tolerant of drought and poor soil conditions. Due to these characteristics this crop and its wild relatives are suitable for planting in marginal lands (Padulosi et al. 1995).

Due to present of numerous pests on pistachio trees a rich diversity of beneficial insects as the natural enemies on this habitat are associated (Mehrnejad, 2010). Insect pests attack every part of plant throughout its growth period. However, the use of chemical pesticides for pistachio pest control was unsuccessful through the last six decades. Nevertheless, pistachio pests can be very effectively controlled by using agricultural applications, introduction and conservation of biocontrol agents (Mehrnejad, 2001). Amongst them the coccinellid fauna are concerned. In this regards, Mehrnejad and Jalali (2004) and Mehrnejad et al. (2011) showed that several ladybird species attack the common pistachio psylla, *Agonoscena pistaciae* Burckhardt and Lauterer, the pistachio key pest in Iran and neighboring countries (Mehrnejad et al, 2011). Indeed, the aim of present investigation is to improve our knowledge on the diversity of the coccinellid beetles on planted and wild pistachio trees in Shahr-e Babak, southern part of Iran.

#### MATERIAL AND METHODS

Sampling was carried out at both plane and mountainous areas in Shahr-e Babak city (30°07'N and 55°07'E) at 10 experimental sites all together in 2010-2011. The specimens were collected randomly from both cultivated pistachio plantation (*P. vera*) in plane areas at elevations between 1590 m and 1864 m and the wild pistachio *P. atlantica* sub sp. *P. mutica* (Fischer and C.A. Meyer) growing areas at elevations between 2103 m and 2364 m. Both sites were sampled at 15 day intervals from April to October using a white beating tray (Mills, 2005; Speight, 2005) measuring 60 × 50 cm. On each sampling occasion 30 trees were checked, one branch on each of the four aspects of the trees (120 branches per sample) was beaten at each experimental site. Samples were collected from patches of 500 trees at the center of the experimental sites; however, the trees were randomly chosen on each sampling occasion. Sampling was carried out at the same time of day throughout the survey, 8–10 a.m. in spring and summer, 9–11 a.m. in autumn. The tray was held beneath a branch and the limb was struck sharply three times with a 40 cm long rubber hose. Adults of the coccinellid beetles that fell onto the tray were counted and recorded.

The collected ladybirds were transferred into jars containing cyanide poison. The morphological characters of each species were carefully studied under stereomicroscope; also, the slides of body parts and male and female genitalia were prepared. The body parts and genitalia were drawn using a drawing tube and under a stereomicroscope. The beetles were identified to the species level with the help of available keys (Chapin, 1965 a, b), (Leeper, 1976), (Gordon, 1985), (Gordon and Hilburn, 1990), (Pope, 1988), (Fürsch, 1981, 1989), (Majerus and Kearns, 1989). The identifications were confirmed by Prof. H. Fürsch from Ruderting, Germany. Some of the collected specimens were labeled and deposited in the insect collection, Pistachio Research Institute of Rafsanjan, in addition voucher specimens of the identified ladybirds retained at the insect collection, Zoology Museum München, Germany.

## RESULTS

Totally, 25 species belonging to 14 genera from six tribes and four subfamilies were recorded. 21 and 15 species were collected on cultivated and wild pistachio plantations respectively, among which eight new species for Kerman province were identified.

### Subfamily Coccinellinae

#### Tribe Coccinellini Latreille, 1807

##### *Adalia bipunctata* (Linnaeus, 1758)

**Material examined:** 38 specimens were collected from cultivated and wild pistachio growing areas in May, June, July, August and October.

**Diagnosis:** Length 3.7 to 5.1 mm, width 2.8 to 3.9 mm. polymorphic as in Figures 1A-F. Male genitalia with parameres less than basal lobe; siphon spoon-shaped apically.

**Remark:** This species was extremely difficult to separate from *A. decempunctata*. The genitalia are similar in two species. In the rule, *A. bipunctata* has black mesosternal epimera.

On pistachio trees, three forms were dominant, e.g. commonest melanic form was *sexpustulata* (black with six red spots as in Fig. 1A), and the most frequent non-melanics was *typica* (red with two round black spots as in Fig. 1B), and with many black spots on a light red background was *revelierei* form (Fig. 1C).

##### *Adalia decempunctata* (Linnaeus, 1758)

**Material examined:** 21 specimens were found from cultivated and wild pistachio growing areas in May, June, July, August and September.

**Diagnosis:** Length 3.5 to 5 mm, width 2.6 to 3.5 mm. Body ground color with variable patterns as in Figures 1G-I. Mesosternal epimera with light color.

Remarks: The common form was light red background with ten black spots.

##### *Coccinella septempunctata* Linnaeus, 1758

**Material examined:** 215 specimens were collected from cultivated and wild pistachio trees in April, May, June, July, August, September and October.

**Diagnosis:** Length 5.3 to 7.6 mm, width 4 to 5.1 mm. Elytra red with 6 black spots in addition to scutellar spot as in Figure 2A. Prosternal keels diverging to the front. Male genitalia with club shape siphonal capsule.

##### *Coccinella undecimpunctata* Linnaeus, 1758

**Material examined:** 14 specimens were collected from both cultivated and wild pistachio trees in April, May, September and October.

**Diagnosis:** Length 3.5 to 5 mm, width 3.2 to 4 mm. Elytra red with 10 black spots in addition to scutellar spot as in Figure 2B. Prosternal keels parallel to the front.

##### *Hippodamia variegata* (Goeze, 1777)

**Material examined:** All together 219 samples were collected from cultivated and wild pistachio trees in April, May, June, September and October.

**Diagnosis:** Length 4.4 to 5 mm, width 3 to 3.25 mm. color and pattern of the elytra varied as in Figure 2C. Male genitalia with flat trapes, fovea at apex; siphon with membranous process at apex.

Remarks: In most collected samples of this species, elytra were red with 6 black spots in addition to scutellar spot.



FIGURE 1. A-I) Outline and colour pattern: A-F) *Adalia bipunctata*, G-I. *Adalia decempunctata*

***Menochilus sexmaculatus* (Fabricius, 1781)**

**Material examined:** 3 specimens were only found from cultivated pistachio plantations in July and October.

**Diagnosis:** Length 3.3 to 6.2 mm, width 3 to 5.3 mm. Elytra yellow or pinkish with six black maculate including: two zigzag lines and a posterior black spot, sutural line with a narrow to moderately broad black stripe as in Figure 2D. Prosternal process with a pair of subparallel carinae reaching up to the middle. Male genitalia with slender siphon and long setae at apex. Female genitalia with swept, elongated sperm duct.

***Oenopia conglobata* (Linnaeus, 1758)**

**Material examined:** 29 specimens were collected from cultivated and wild pistachio growing areas in April, May, June, July, August and September.

**Diagnosis:** Length 3.3 to 4 mm, width 2.4 to 3 mm. Male genitalia with triangular siphon at apex. Female genitalia with apically divided basal lobe.

Remarks: Coloration of elytra in this species was cream in plain areas and pink in mountainous areas with 8 black spots as in Figure 2E.

***Oenopia oncina* (Olivier, 1808)**

**Material examined:** 8 specimens were found from planted and wild pistachio trees in May and June.

**Diagnosis:** Length 3.3 to 4 mm, width 2.4 to 3 mm. Male genitalia with flat siphon and long setae at apex. Female genitalia with basal lobe not apically divided.

Remarks: Three forms of this species were collected but background of the elytra in most specimens was yellow with joining black spots as in Figure 2F.

**II. Subfamily Chiolorinae****Tribe Chilacorini Mulsant, 1846*****Chilocorus bipustulatus* (Linnaeus, 1758)**

**Material examined:** 4 specimens were only found from planted pistachio trees in June, August and April.

**Diagnosis:** Length 3 to 3.5 mm, width 2.7 to 3 mm. Color background light to dark brown with narrow, irregular band of 3 partially connected spots as in Figure 2G. First abdominal sternum with incomplete postcoxal line. Male genitalia with trapes longer than phallobase; siphon stout, twisted near apex. Female genitalia with large spermathecal capsule, without differentiation into nodulus and ramus.

***Exochomus octosignatus* (Gebler, 1830)**

**Material examined:** 6 specimens were only collected from wild pistachio trees in May and June.

**Diagnosis:** Length 3.5 to 4 mm, width 2.5 to 2.8 mm.

Male genitalia with parameres longer than basal lobe; trapes rather slender at apex; Female genitalia with cornu rather small, bent and rounded; accessory gland large; sperm duct shorter than usual; infundibulum longer than usual.

Remarks: This is the first record for presence of this species on pistachio trees and in Kerman province. Elytra in collected specimens were dark red with 8 black spots as in Figure 2G.

***Exochomus quadripustulatus* (Linnaeus, 1758)**

**Material examined:** 9 specimens were only found from cultivated pistachio plantations in June, July and August.

**Diagnosis:** Length 3.5 to 4.4 mm, width 3 to 3.5 mm.

Male genitalia with parameres longer than basal lobe. Female genitalia with long sperm duct, genital plate elongated.

Remarks: Collected samples were orange or reddish without spot as in Figure 2I.

***Exochomus undulatus* Weise, 1878**

**Material examined:** 7 specimens were found from planted and wild pistachio trees in April, May and June.

**Diagnosis:** Length 3 to 4.2 mm, width 2.4 to 3.6 mm. Elytra black with orange and checkered – shape maculation, spots sometimes joined as in Figure 3A. Male genitalia with parameres slightly shorter than basal lobe; siphon membranous at apex. Female genitalia with long sperm duct, genital plate elongated.

Remarks: This is the first record for presence of this species on pistachio trees and in Kerman province.

***Parexochomus melanocephalus* (Zoubkoff, 1833)**

**Material examined:** 2 specimens were only collected from wild pistachio trees in July.

**Diagnosis:** Length 2.2 to 2.7 mm, width 1.9 to 2.2 mm. dorsal surface black and covered with pubescence. Pronotum black with red lateral angle as in Figure 3B. Male genitalia with parameres longer than basal lobe; phallobase as long as trapeses; trapeses rather slender at apex.

***Parexochomus nigripennis* (Erichson, 1843)**

**Material examined:** 12 specimens were only collected from planted pistachio trees in July, September and October.

**Diagnosis:** Length 3.5 to 4 mm, width 3 to 3.2 mm. Elytra black and glabrous. Pronotum completely yellow as in Figure 3C. Male genitalia with parameres longer than basal lobe; phallobase as long as trapeses; trapeses rather flat at apex.

### III. Subfamily Scymninae

#### Tribe Scymnini Weise, 1846

***Clitostethus arcuatus* (Rossi, 1794)**

**Material examined:** This species was only collected from wild pistachio tree in May.

**Diagnosis:** Length 1.2 mm, width 0.9 mm. Elytra dark brown with arcuate yellow band on disc which partially enclosing dark discal spot. Lateral portion of pronotum yellow as in Figure 3D.

Abdomen with nearly completed postcoxal line recurved to near anterior margin of first abdomen sternum. Male genitalia with large basal lobe, parameres short with 2 elongate setae at apex; siphon curved toward inside of body and narrow at apex. Female genitalia without infundibulum; genital plate triangular and elongate.

Remarks: This is the first record for presence of this species on pistachio trees and in Kerman province.

***Nephus (Nephus) quadrimaculatus* (Herbst, 1783)**

**Material examined:** 1 specimen was only found from cultivated pistachio plantations in August.

**Diagnosis:** Length 1.7 mm, width 1.3 mm. Elytra black with 4 red spots, covered with bright pubescence as in Figure 3E. Abdomen with incompletely curved postcoxal line; distinctly curved forward, not parallel to hind margin of first sternum.



**FIGURE 2.** A-I) Outline and colour pattern: A) *Coccinella septempunctata*, B) *Coccinella undecimpunctata*, C) *Hippodamia variegata*, D) *Menochilus sexmaculatus*, E) *Oenopia conglobata*, F) *Oenopia oncina*, G) *Chilocorus bipustulatus*, H) *Exochomus octosignatus*, I) *Exochomus quadripustulatus*.



***Nephus (Sidis) elbursi* Fürsch, 1981**

**Material examined:** 2 specimens were only found from cultivated pistachio plantations in May.

**Diagnosis:** Length 1.5 mm, width 1.2 mm. Elytra dark brown with two successive dark red stains. Front edge of pronotum brighter as in Figure 3F. Postcoxal line on 1st abdominal sternum incomplete, nearly reaching lateral margin, curved forward parallel to lateral margin. Male genitalia with symmetrical basal lobe; spermathecal capsule of female divided into spindle-shaped nodulus and annulated cornu, accessory gland opening at middle of nodulus.

**Remarks:** This is the first record for presence of this species on pistachio trees and in Kerman province.

***Scymnus (Pullus) auritus* Weise, 1905**

**Material examined:** This species was only collected from wild pistachio tree in July.

**Diagnosis:** Length 1.8 mm, width 1.1 mm. The dorsal surface black except brown apex of elytra which covered with grayish pubescence as in Figure 3G. Postcoxal line of 1st abdominal sternum complete; recurved, extending to base of first sternum. Male genitalia with parameres longer than basal lobe; siphon curved near base, small process at apex.

**Remarks:** This is the first record for presence of this species on pistachio trees and in Kerman province.

***Scymnus (Pullus) subvillosus* (Goeze, 1777)**

**Material examined:** 2 specimens were collected from cultivated and wild pistachio growing areas in June.

**Diagnosis:** Length 2 mm, width 1.4 mm. Elytra dark brown with 4 reddish brown spots, pronotum reddish brown at apex. Dorsal surface with bright pubescence as in Figure 3H. Postcoxal line on 1st abdominal sternum complete, recurved, extending to base of first sternum. Male genitalia with parameres less than basal lobe.

***Scymnus (Pullus) syriacus* (Marsuel, 1868)**

**Material examined:** 185 specimens were found collected from planted and wild pistachio trees April, May, June, July, August, September and October.

**Diagnosis:** Length 1.7 to 2.3 mm, width 1.2 to 1.6 mm. Elytra light to dark brown with 1 cycle shape spot on middle with yellow surroundings. Dorsal surface with bright pubescence as in Figure 3I. Postcoxal line on 1st abdominal sternum complete, recurved, extending to base of first sternum. Male genitalia with parameres as long as basal lobe; siphon curved and with process at apex, with 1 membranous lobe near apical.

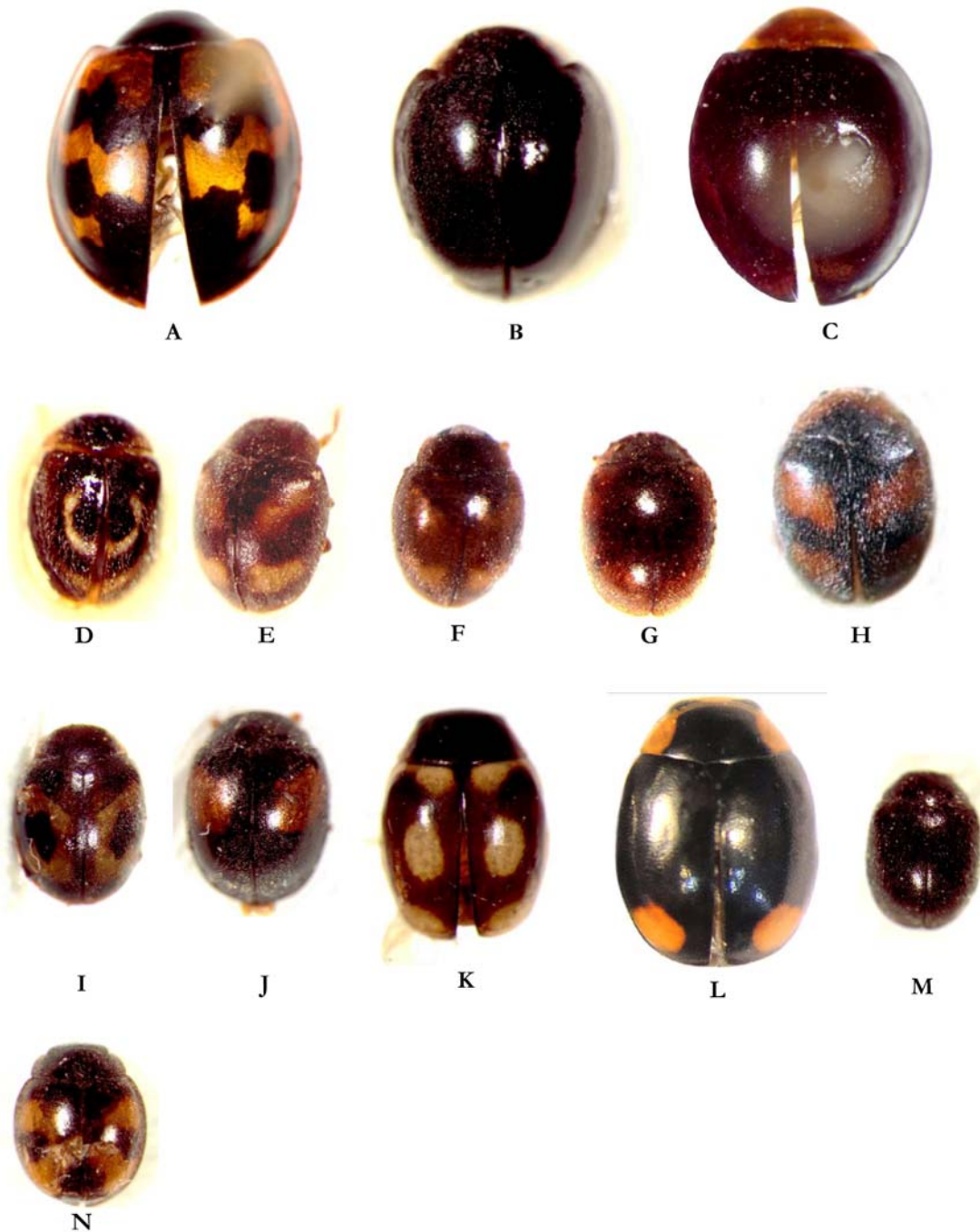
***Scymnus (Scymnus) flavicollis* Redtenbacher, 1843**

**Material examined:** This species was only found from cultivated pistachio plantations in August.

**Diagnosis:** Length 1.8 mm, width 1.4 mm. Dorsal surface black with bright pubescence. Elytra with 2 orange spots in the middle. Anterior margin and anterolateral angle of pronotum orange as in Figure 3J. Postcoxal line on 1st abdominal sternum incomplete, apical end recurved, extending to base of first sternum. Male genitalia with basal lobe longer than parameres, trapes longer than phallobase; siphon membranous at apex with 2 dome-shape lobes.

**Remarks:** This is the first record for presence of this species on pistachio trees and in Kerman province.





**FIGURE 3.** A-N) Outline and colour pattern: A) *Exochomus undulatus*, B) *Parexochomus melanocephalus*, C) *Parexochomus nigripennis*, D) *Clitosthetus arcuatus* E) *Nephus* (*Nephus*) *quadrimaculatus*, F) *Nephus* (*Sidis*) *elbursi*, G) *Scymnus* (*Pullus*) *auritus*, H) *Scymnus* (*Pullus*) *subvillosus*, I) *Scymnus* (*Pullus*) *syriacus*, J) *Scymnus* (*Scymnus*) *flavicollis*, K) *Hyperaspis polita*, L) *Hyperaspis* sp, M) *Stethorus pusillus*, N) *Pharoascymnus setulosus*.

**Tribe Hyperaspini Costa*****Hyperaspis polita* Weise, 1885**

**Material examined:** 3 specimens were only collected from cultivated pistachio plantations in September.

**Diagnosis:** Length 2.7 to 3 mm, width 1.9 to 2.1 mm. Dorsal surface glabrous. Elytra black with 1 spots on middle, 1 basal spot, 1 apical spot and 2 external spots. Pronotum black except yellowish anterior margin as in Figure 3K.

Male genitalia with short and flat phallobase; parameres apically as long as basal lobe, at lateral margin knob; siphon curved near base, flat at apex. Female genitalia with compound spermathecal capsule.

***Hyperaspis* sp**

**Material examined:** 28 specimens were only found from planted pistachio trees in September and October.

**Note:** This species is of uncertain status and the question species or subspecies is to be cleared later with material of its whole area and DNA analysis (Fig. 3L).

**Tribe Stethorini Dobzhansky, 1924*****Stethorus pusillus* (Herbst, 1797)**

**Material examined:** 26 specimens were collected from cultivated and wild pistachio growing areas trees in May, June, July, August, September and October.

**Diagnosis:** Length 1.35 to 1.57 mm, width 0.9 to 1.12 mm. Dorsal surface completely black with grayish pubescence as in Figure 3M. Female genitalia lacking spermathecal capsule and infundibulum; genital plate small, not triangular.

**Remarks:** This is the first record for presence of this species on pistachio trees and in Kerman province.

**V. Subfamily Sticholotidinae****Tribe Sticholotidini Weise, 1901*****Pharoscygnus setulosus* (Chevrolat, 1861)**

**Material examined:** 2 specimens were only found from cultivated pistachio plantations in months June and July.

**Diagnosis:** Length 1.76 mm, width 1.36 mm. Dorsal surface black with white setae. Spots on elytra yellow as in Figure 3N. Male genitalia symmetrical, parameres longer than basal lobe; siphon pointed at apex, chitinized near apex.

**Remarks:** This is the first record for presence of this species on pistachio trees and in Kerman province.

**DISCUSSION**

The certain types of vegetation are preferred by certain ladybird species, which sometimes exhibit seasonal preferences for certain strata of the habitat (Ipetri, 1999). Based on the results, 25 different species from 14 genera belonging to sub-families Coccinellinae, Chilocorinae, Scymninae and Sticholotidinae existed on pistachio trees. 15 coccinellid species were collected at the wild pistachio plantation and 21 coccinellid species were identified from planted pistachio trees. In this regard, Mehrnejad et al (2011) reported 17 coccinellid species, at the wild pistachio plantation and 11 species from planted pistachio trees during 2000 - 2001 in Rafsanjan. It was found that the coccinellid community structure in cultivated pistachio plantations and wild pistachio growing areas are different, which seems ladybird fauna were highly affected due to particular ecosystem parameters in

two experimental sites as well as altitude. Based on results *Chilocorus bipustulatus*, *Exochomus quadripustulatus*, *Parexochomus nigripennis*, *Hyperaspis polita*, *Hyperaspis sp*, *Menochilus sexmaculatus*, *Nephus (Nephus) quadrimaculatus*, *Nephus (Sidis) elbursi*, *Scymnus (Scymnus) flavicollis*, *Pharoscymnus setulosus*, were found at few experimental sites on planted pistachio trees only. In addition, *Exochomus octosignatus*, *Clitostethus arcuatus*, *Parexochomus melanocephalus* and *Scymnus (Pullus) auritus* were only collected from wild pistachio trees. Some ladybird species exhibited many morphological phenotypes, and this is most commonly observed in *A. bipunctata*. This species is known as a polymorphic species (Majerus et al. 1982; Hodek and Honek, 1996) with Afrotropical, Australian, Palaearctic, Nearctic and Neotropical distribution (Löbl and Smetana, 2007). In addition, a considerable variation in color and pattern of the elytra in *H. variegata* was reported (Dobzhansky, 1933). This species have been reported in Afrotropical, Palaearctic, Nearctic and oriental regions (Löbl and Smetana, 2007). The various ladybirds that were found on pistachio trees are useful predatory insects and their conservation is highly recommended. A valuable information on the host range and biological parameters of some ladybirds e.g. *A. bipunctata*, *C. septempunctata*, *C. undecimpunctata*, *P. nigripennis*, *H. variegata* and *O. conglobata*, was reported (Mehrnejad, 2010; Mehrnejad and Jalali, 2004; Mehrnejad et al., 2011). However, food regimes of other coccinellid species need to be investigated.

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