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NEW DATA ABOUT SNAIL-KILLING FLIES (DIPTERA, SCIOMYZIDAE) IN IRAN

S. Khaghaninia[1], F. Kazerani[2*] & Jean-Claude Vala[3]

[1]*Faculty of Agriculture, Department of Plant Protection, University of Tabriz, Tabriz, Iran, P. O. Box: 51664*
[2]*Research Institute of Forests and Rangelands, Agricultural Research Education and Extension Organization (AREEO), Tehran, I. R. Iran*
[3]*University of Orleans, UFR sciences Laboratoire Biologie LBLGC, UPRES EA 1207, BP 6759 — 45067 Orleans, France*
**Corresponding author*
E-mail: farzane.kazerani@gmail.com

New Data about Snail-Killing Flies (Diptera, Sciomyzidae) in Iran. Khaghaninia, S., Kazerani, F. — Based on material collected in East Azerbaijan Province during 2009–2012, 15 species belonging to 11 genera of the family Sciomyzidae are recorded. Two species, *Euthycera sticticaria* (Mayer, 1953) and *Tetanocera arrogans* Meigen, 1830, are recorded for the first time from Iran. Biology and distribution of all species are provided. Also a key to *Coremacera* Rondani, 1856 species in Middle East and central Asia is provided.
Key words: Diptera, Sciomyzidae, Iran, new records.

Introduction

Sciomyzidae (commonly called snail-killing flies or marsh flies) with about 550 declared species and 63 genera belonging to three subfamilies (Phaeomyiinae, Salticellinae and Sciomyzinae), is a moderately small family of acalyptrate flies (Steyskal, 1965; Barnes, 1980; Vala, Gbedjissi, 2011; Vala et al, 2012). Only Sciomyzinae (Sciomyzini and Tetanocerini) and Salticellinae occur in Iran (Tirgari, Massoud, 1979; Ayatollahi, 1971; Knutson et al., 1973; Yano, 1978; Vala, Leclercq, 1981; Rozkošný, 1987; Khaghaninia et al., 2016). Morphologically sciomyzids differ from the other closest families of flies by the following combination of characters: small to medium size (about 2–12 mm); body color varies from pale yellowish to brownish or greyish to shiny black; oral vibrissae absent; two orbital (sometimes one) setae usually present; postvertical setae diverging; wing hyaline, usually spotted or patterned; costa unbroken; subcosta complete; at least one tibia with preapical setae; abdomen moderately long and cylindrical (Fisher, Orth, 1983; Freidberg et al., 1991). Biologically, most larvae of sciomyzids are important parasitoids or predators of mollusks and some have potential of biological control agents agricultural pest snails or vector snails that cause diseases in human or domestic animal (schistosomes (bilharzia) and liver flukes) (Chock et al., 1961; Tirgari, 1977; Berg, Knutson, 1978; Ferrar, 1987; Gormally, 1988; Barker et al., 2004).

Before this study, Tirgari, Massoud (1979); Ayatollahi (1971); Knutson et al. (1973); Tirgari, Fathpoor (1974); Yano (1978); Tirgari, Massoud (1979); Tirgari, Massoud (1981); Vala, Leclercq (1981); Rozkošný (1987); Mortelamans et al. (2016); Khaghaninia et al. (2016) listed 20 species of Sciomyzidae from Iran that most of these species were collected in Guilan and Khozestan provinces. In this study, we add two species for the Iranian insect fauna.

Material and methods

Adult specimens were collected by standard sweep-netting in various habitats (forest, grassland and semi-aquatic areas) in East Azerbaijan province, located in northern west of Iran during 2009–2012. The samples were killed in a killing jar containing potassium cyanide and the voucher specimens were deposited at Insect Museum of Tabriz University (IMTU) as well Museum national d´histoire naturelle, Paris (France).

Subfamily Sciomyzinae
Tribe Sciomyzini
Ditaeniella grisescens (Meigen, 1830)

Material examined: Iran: East Azerbaijan Province, Gharadagh (forests habitat) [38°5´ N, 46°52´ E, 1770 m], 15.06.2009, 1 ♂, 2 ♀; Qurigol (lagoon habitat) [37°54´.975 N, 46°41´,120 E, 1943 m], 9.06.2010, 3 ♂, 4 ♀; Kandovan (moist grassland habitat) [37°46´ N, 46°16´ E, 2500 m], 15.07.2010, 1 ♂, 1 ♀ (Khaghaninia leg.).

Distribution. Widespread in North and South Europe, North Africa. Oriental Region; Middle East: Afghanistan, Turkey, Mongolia. Iran: Rozkošný (1987); Knutson et al. (1973).

Biology. Larvae are predators as well some terrestrial (Haplotrematidae, Helicidae, Polygyridae) as freshwater gastropods (Lymnaeidae, Physidae, Planorbidae), and also the hygrophilous Succineidae (Bratt et al., 1969). Firstly, Rozkošný (1967) described the larval and puparial stages. As *Pherbellia grisescens*, Bratt et al. (1969) described the entire life cycle and detailed all the immature stages. The puparium is formed inside the host snail, and overwinters there (Bratt et al., 1969).

Pherbellia cinerella (Fallén, 1820)

Material examined: Iran: East Azerbaijan Province, Ajabshir (grove habitat) [37°31´ N, 46°07´ E, 1660 m], 10.07.2009, 1 ♂, 2 ♀; Kandovan (moist grassland habitat) [37°46´ N, 46°16´ E, 2500 m], 15.07.2010, 5 ♂, 4 ♀; Maragheh (grove habitat) [37°25´ N, 46°25´ E, 1790 m], 5.06.2011, 2 ♂, 5 ♀ (Khaghaninia leg.).

Distribution. Palaearctic: From north Europe to souh Europe; North Africa, eastern Russia. Oriental region. Middle East: Armenia, Tadjikistan, and Afghanistan. Iran: Rozkošný, Elberg (1984); Seddighi Sadr, Mohammadzade namin (2016).

Biology. Rozkošný (1967) described the larval morphology, and Bratt et al. (1969) described the life cycle and made the description of all immature stages. The larvae are predators of terrestrial and aquatic gastropods (Bratt et al., 1969). Oviposition stimulus is a substrate moistened with fresh snail faeces or mucus of helicid-prey (*Cernuella virgata* Da Costa) (Coupland, 1996). The puparium is formed outside the shell prey, and in southern France adults are overwintering (Vala, 1989) but in Russia has been found that pupa are overwintering also (Gaponov, 2016). This species has a short developmental time and is multivoltine (Vala, 1989; Gaponov, 2016).

Tribe Tetanocerini
Coremacera amoena (Loew, 1853)

Material examined: Iran: East Azerbaijan Province, Gharadagh (forest habitat) [38°53´ N, 46°48´ E, 1859 m], 20.06.2010, 3 ♂, 2 ♀ (Khaghaninia leg.).

Distribution. South Europe, Middle-east: Turkey. Iran: Knutson (1973); Knutson et al. (1973).

Biology. Unknown.

Coremacera catenata (Loew, 1847)

Material examined: Iran: East Azerbaijan Province, Qaradagh (forest habitat) [38°51´ N, 46°52´ E, 1770 m], 14.06.2010, 2 ♂, 6 ♀; Horand (grassland habitat) [38°59´ N, 47°22´ E, 1370 m], 14.07.2010, 1 ♂, 1 ♀; Kandovan (moist grassland habitat) [37°44´ N, 46°19´ E, 3005 m], 6.06.2011, 3 ♂, 4 ♀; Qurigol (lagoon habitat) [37°54.975´ N, 46°41,120´ E, 1943 m], 9.07.2012, 2 ♂ (Khaghaninia leg.).

Distribution. Palaearctic: From German to Poland. South Europe: France, Italy; Balkan region; Transcaucasia and Middle East: Turkey, Syria, Iraq. Iran: Rozkošný (1987); Seddighi Sadr, Mohammadzade Namin (2016).

Biology. Only the morphological features of the egg and the first-instar larva have been described and figured by Vala (1989). So, other information on the life cycle, developmental stages, and the prey remains lacking. This species appears univoltine and in Russia pupa are overwintering (Gaponov, 2016).

Coremacera marginata (Fabricius, 1775)

Material examined: Iran: East Azerbaijan Province, Chichakli (grassland habitat) [38°39′ N, 46°31′ E, 2140 m], 5.08.2009, 1 ♀; Ajabshir (grove habitat) [37°31′ N, 46°07′ E, 1660 m], 10.07.2009, 1 ♀; Qaradagh (forest habitat) [38°51′ N, 46°52′ E, 1770 m], 14.06.2010, 2 ♂, 5 ♀; Horand (grassland habitat) [38°59′ N, 47°22′ E, 1370 m], 14.07.2010, 2 ♂, 2 ♀; Kandovan (moist grassland habitat) [37°45′ N, 46°18′ E, 2840 m], 20.05.2010, 3 ♂, 7 ♀, [37°46′ N, 46°16′ E, 2500 m], 15.07.2010, 2 ♂, 1 ♀, [37°44′ N, 46°19′ E, 3005 m], 6.06.2011, 6 ♂, 5 ♀; Isperekhan (dry grassland habitat) [37°46′ N, 46°24′ E, 2504 m], 10.08.2012, 1 ♂, 1 ♀; Qurigol (lagoon habitat) [37°54′ N 46°42′ E, 1920 m], 8.06.2012, 2 ♂, 1 ♀; Qurigol (lagoon habitat) [37°54.975′ N, 46°41,120′ E, 1943 m], 9.07.2012, 1 ♂, 2 ♀ (Khaghaninia leg.).

Distribution. Palaearctic: from Ireland to Spain, France, European parts of Russia and Georgia. Middle East: Turkey, Armenia, Azerbaidjan. Iran: Rozkošný (1987); Seddighi Sadr, Mohammadzade Namin (2016).

Biology. Based on Knutson (1973) laboratory studies; larvae are predator of a range of terrestrial snails (*Cochlicopa lubrica*, *C. minima*, *Discus rotundatus*, *Helicella itala, H. caperata, H. virgata, Eulota fruticum, Hygromia hispida* and *Oxychilus* spp), then became saprophagous on dead snail host. Knutson (1973) described all larval stages and stated that puparium is formed outside the host snail, and represents the overwintering stage. This species is strictly univoltine (Knutson, 1973; Gaponov, 2016).

Dichetophora obliterata (Fabricius, 1805)

Material examined: Iran: East Azerbaijan Province, Qaradagh (forest habitat) [38°51′ N, 46°52′ E, 1770 m], 14.06.2010, 1 ♂, 4 ♀; Horand (grassland habitat) [38°59′ N, 47°22′ E, 1370 m], 14.07.2010, 1 ♂ (Khaghaninia leg.).

Distribution. Widespread in Europe Scotland, England, Belgium, Holland, France, Austria, Germany, Switzerland, Spain, Italy, Czech Republic, Romania, Greece. North Africa: Morocco. Middle East: Turkey, Iraq. Iran: Rozkošný (1987).

Biology. Immature stages: Vala et al. (1987) described and figured in details all the immature stages, provided information on the biology, and the life cycle. Eggs were often laid (after a long pre-oviposition period up to 2 months) on the shells of living terrestrial snails (Vala et al., 1987). In the laboratory, the first-instar larvae fed as internal parasitoids on *Lauria cylindracea* and later instars fed on more large size *Helicella* and *Theba* spp (Vala et al., 1987). Overwintering occurs as the mature larva, then the puparium (Vala et al., 1987). Pupariation occurs either in the shell of the host snail or away from it (Vala et al., 1987). This species is univoltine (Vala et al., 1987).

Euthycera sticticaria (Mayer, 1953)

Material examined: Iran: East Azerbaijan Province, Kandovan (moist grassland habitat) [37°45′ N, 46°18′ E, 2840 m], 20.05.2010, 2 ♂, 2 ♀; Qaradagh (forest habitat) [38°51′ N, 46°52′ E, 1770 m], 14.06.2010, 2 ♀ (Khaghaninia leg.).

Distribution. Generally in Europe: Italy, Macedonia, Greece. First record for Iran.

Biology. Unknown.

Diagnostic characters: Antenna yellow, arista with white hairs (figs 1, *b, c*); wing pattern as in Figure 1, *a*; sternite 5 with 2 small lobe at the middle (figs 1, *d*, *e*), sternite 6 with 2 flat and asymmetrical projection at middle (fig. 1, *d*), surstylus as in fig. 1, *f*.

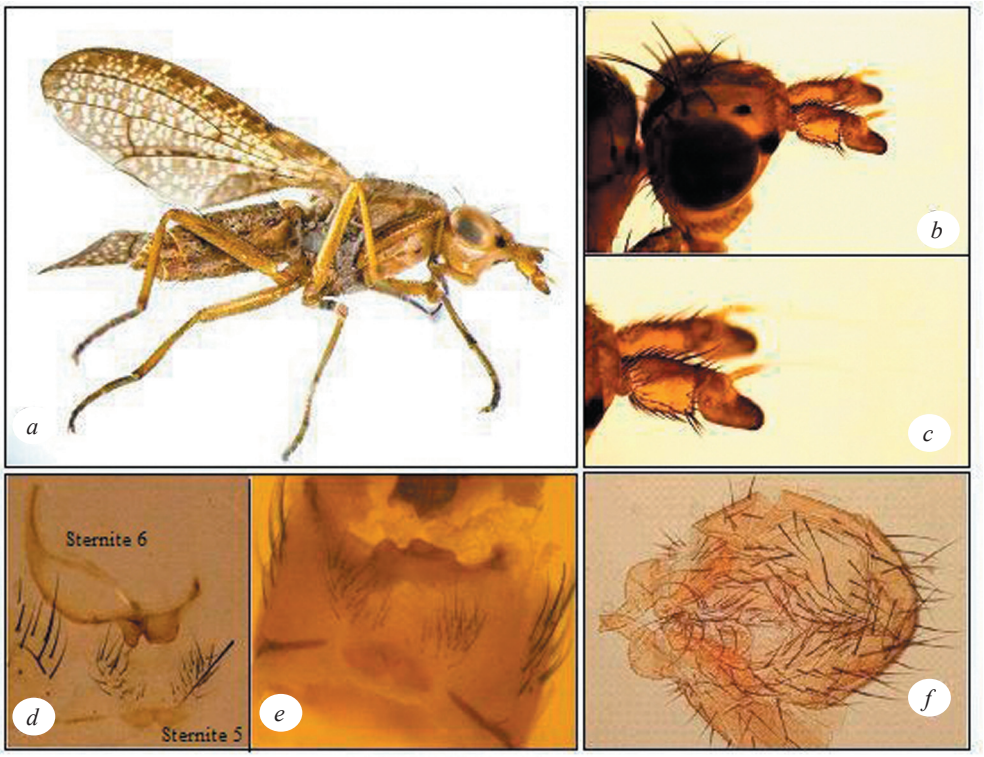

Fig. 1. *Euthycera sticticaria* (Mayer, 1953): *a* — female habitus (lateral view); *b* — head (lateral view, male); *c* — antennal (lateral view, male); *d* — sternites 5 and 6 in male, *e* — sternite 5 (ventral view of abdomen, male); *f* — Epandrium and surstylus (caudal view, male).

Hydromya dorsalis (Fabricius, 1775)

Material examined: Iran: East Azerbaijan Province, Kandovan (moist grassland habitat) [37°45′ N, 46°18′ E, 2840 m], 20.05.2010, 1 ♀; Qaradagh (forest habitat) [38°51′ N, 46°52′ E, 1770 m], 14.06.2010, 3 ♂, 4 ♀; Horand (grassland habitat) [38°59′ N, 47°22′ E, 1370 m], 14.07.2010, 1 ♂; Qurigol (lagoon habitat) [37°54.975′ N, 46°41,120′ E, 1943 m], 9.07.2012, 1 ♂, 3 ♀ (Khaghaninia leg.).

Distribution. Palaearctic: Europe: widely distributed from Scandinavia to Spain and the British Isles to Siberia. North Africa. Asia: Turkey, Afghanistan, Mongolia to Japan. Iran: Knutson, Berg (1963); Seddighi Sadr, Mohammadzade Namin (2016).

Biology. Larvae predate mainly the aquatic gastropods living on wet edge of various lentic freshwater habitats, predominantly Lymnaeidae species and also attack their egg masses with or without embryos or not (Knutson, Berg, 1963; Gaponov, 2016). Vaillant (1956) found larvae in many madicole microhabitat in France. All the immature stages have been described by Knutson, Berg (1963). The puparia are formed outside of the snail host, on wet edge of the larval habitat (Knutson, Berg, 1963). This species seems multivoltine (Gaponov, 2016).

Ilione turcestanica (Hendel, 1903)

Material examined: Iran: East Azerbaijan Province, Jolfa (grassland habitat) [38°53′ N, 45°47′ E, 738 m], 12.06.2009, 1 ♂, 1 ♀ (Khaghaninia leg.).

Distribution. East Europe: Serbia, Greek. Asia: Turkey, Kazakhstan, Armenia, Afghanistan, Pakistan. Iran: Knutson et al. (1973).

Biology. Unknown.

Pherbina coryleti (Scopoli, 1763)

Material examined: Iran: East Azerbaijan Province, Kandovan (moist grassland habitat) [37°45′ N, 46°18′ E, 2840 m], 20.05.2010, 3 ♂, 1 ♀; Jolfa (grassland habitat) [38°52′ N, 46°01′ E, 1350 m], 5.07.2010, 4 ♂, 6 ♀ (Khaghaninia leg.).

Distribution. Most of Eurasia. Iran: Yano (1987); Seddighi Sadr, Mohammadzade Namin (2016).

Biology. Knutson et al. (1975) studied the larval development of this species, and described all immature stages. The larvae are predators of various freshwater and terrestrial gastropods, also hygrophilous Succinids (Knutson et al., 1975). The species is univoltine and overwintering as a third-instar larva (Gaponov, 2016).

Psacadina verbekei Rozkošný, 1975

Material examined: Iran: East Azerbaijan Province, Shahyordi (grassland habitat) [37°40′ N, 46°30′ E, 2620 m], 13.06.2009, 4 ♂, 3 ♀ (Khaghaninia leg.).

Distribution. Most of Eurasia. Iran: Rozkošný (1987).

Biology. In laboratory, Knutson et al. (1975) studied and described all immature stages, and provided details on larval biology. The larvae are semi-aquatic predators, attacking principally freshwater snails such Lymnaeidae living on the wet edge of aquatic habitats and also their egg masses (Knutson et al., 1975; Gaponov, 2016). Pupariation takes place outside of the snails on the wet margin of aquatic habitats or soil, and represents the overwinter stage (Knutson et al., 1975). This species is multivoltine (Knutson et al., 1975; Barendregt, 2014).

Sepedon sphegea (Fabricius, 1775)

Material examined: Iran: East Azerbaijan Province, Jolfa (grassland habitat) [38°52′ N, 46°01′ E, 1350 m], 5.07.2010, 3 ♂ (Khaghaninia leg.).

Distribution. Widespread in Palearctic Region. Iran: Tirgari, Massoud (1978); Motamedi et al. (2006).

Biology. Neff, Berg (1966) described the complete life cycle and figured all the immature stages. That was one of the first sciomyzids known as predators of aquatic snails (Neff, Berg, 1966). Many snails species belonging to Lymnaeidae, Physidae and Planorbidae particularly some *Biomphalaria* spp. implicated as intermediate host of human schistosomiasis (Neff, Berg, 1966). In Iran, Tirgari (1977) used their larvae for his field experiments against Planrbidae. Also, Mc Donnell et al. (2005) collected third-instar larva feeding on *Radix gedrosiana* (Annandale, Prashad, 1919) from Iran (Shushtar). This species is multivoltine, and overwinters as adult (Neff, Berg, 1966, Gaponov, 2016).

Sepedon spinipes (Scopoli, 1763)

Material examined: Iran: East Azerbaijan Province, Qaradagh (forest habitat) [38°51′ N, 46°52′ E, 1770 m], 14.06.2010, 2 ♂ (Khaghaninia leg.).

Distribution. Widely distributed in the Palaearctic Region, North Africa, Mediterranean islands, Turkey, Siberia, Armenia. Iran: Knutson et al. (1973); Motamedi et al. (2006).

Biology. From laboratory rearing, Neff, Berg (1966) elucidated the life cycle and described all the immature stages. The larvae are typical aquatic predators of snails such *Helisoma*, *Physa*, and *Planorbis* whose tropical *Biomphalaria* spp. implicated as intermediate hosts of Schistosoma parasitizing human (Neff, Berg, 1966). The puparium, formed out of the water, is unusually glued on the ventral side to an

emerged substratum (Neff, Berg, 1966). This species is multivoltine and overwinters as an adult (Berg et al., 1982).

Tetanocera arrogans Meigen, 1830

Material examined: Iran: East Azerbaijan Province, Ahar (grassland habitat) [38°26′ N, 46°53′ E, 1530 m], 10.06.2011, 1 ♂, 2 ♀ (Khaghaninia leg.).

Distribution. North Europe: Denmark, Sweden, Finland, Norway. South Europe: Ireland, Spain, Greece. Asia: Turkey. **First record from Iran**.

Biology. Rozkošný (1967) described the puparium and the cephalopharyngeal skeleton of the third instar larva extracted from this single puparium. The complete larval developmental and the life cycle have been explained by Vala (1989). In nature, third instar larva had been found to living as parasitoide in *Succinea elegans*, and many eggs jointed by their extremities and laid along the veins of *Iris pseudacorus* leaves (Vala, 1989). In laboratory, larvae attacked also *Cepaea nemoralis* (Linnaeus, 1758) and *Hygromia hispida* (Linnaeus, 1758) (Vala, 1989). The puparium is formed outside of snail host and can be parasitized by *Mesoleptsus* spp. (Icheuneumonidae) (Vala, 1989). This species is multivoltine and overwinters as pupa (Vala, 1989).

Diagnostic characters: whitish pruinose patches forming occipital spots fused in basal half (fig. 2, *c*), anterior orbital setae close to vertical setae than to anterior margin of frons (fig. 2, *b*, *c*); antenna yellow, arista with long brown hairs (fig. 2, *b*); wing hyaline slightly darkened as in fig. 1, *a*; surstylus as in fig. 1, *d*.

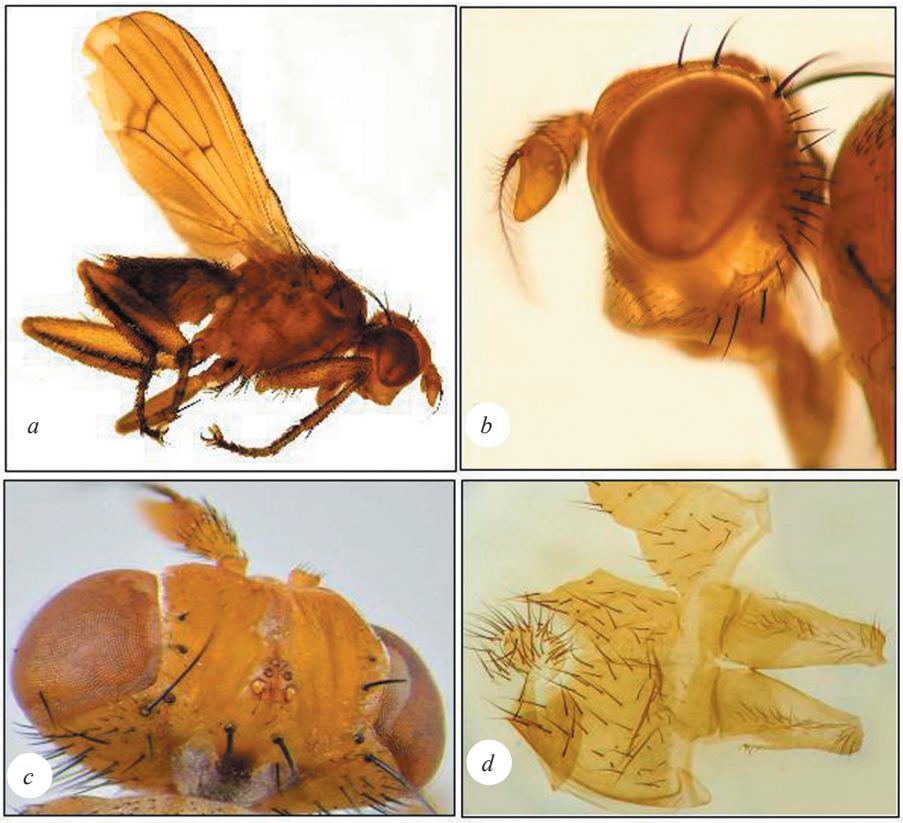

Fig. 2. *Tetanocera arrogans* Meigen, 1830: *a* — male habitus (lateral view), *b* — head (lateral view, male), *c* — head (upper view, male), *d* — epandrium and surstylus (caudal view, male).

Trypetoptera punctulata (Scopoli, 1763)

Material examined: Iran: East Azerbaijan Province, Shahyordi (grassland habitat) [37°40′ N, 46°30′ E, 2620 m], 13.06.2009, 3 ♂, 4 ♀; Ajabshir (grove habitat) [37°31′ N, 46°07′ E, 1660 m], 10.07.2009, 2 ♂, 5 ♀; Jolfa (grassland habitat) [38°52′ N, 46°01′ E, 1350 m], 5.07.2010, 4 ♂, 1 ♀; Qaradagh (forest habitat) [38°51′ N, 46°52′ E, 1770 m], 14.06.2010, 7 ♂, 6 ♀; Horand (grassland habitat) [38°59′ N, 47°22′ E, 1370 m], 14.07.2010, 6 ♂, 8 ♀; Kandovan (moist grassland habitat) [37°46′ N, 46°16′ E, 2500 m], 15.07.2010, 2 ♂, 3 ♀; Maragheh (grove habitat) [37°25′ N, 46°25′ E, 1790 m], 5.06.2011, 10 ♂, 12 ♀; Ahar (grassland habitat) [38°26′ N, 46°53′ E, 1530 m], 10.06.2011, 3 ♂, 2 ♀; Qurigol (lagoon habitat) [37°54.975′ N, 46°41,120′ E, 1943 m], 9.07.2012, 4 ♂, 5 ♀ (Khaghaninia leg.).

Distribution. Very widespread, North Europe: Denmark, Sweden, Norway, Scotland, Ireland, Finland to Siberia. South Europe: Italy, Spain, France. North Africa. Middle East: Turkey, Iran: Rozkošný (1987); Seddighi Sadr, Mohammadzade Namin (2016).

Biology. The complete life cycle has been realized in laboratory by Vala (1986) who described all the immature stages. If adult emerge from mid-April no matting is observed before August, due to a long pre-oviposition period, and flies are collected until early November (Vala, 1986). In laboratory, larvae attacked and fed the terrestrial gastropods *Candidula unifasciata* (Poiret, 1801), *Cornu aspersum* (Müller, 1774), *Lauria cylindracea* (Costa, 1778) and *Trochulus hispidus* (Linnaeus, 1758) (Vala, 1986, Gaponov, 2016). With the viviparous *L. cylindracea*, the first-instar larvae of *T. punctulata* fed firstly the young snails located in the pallial cavity of the mother host (Vala, 1986). Then, they fed the later before to leave the shell, and the second and third instar larvae attack larger snails (Vala, 1986). Puparia are mostly formed inside the host snail´s shell. The species is univoltine and overwintering as pupa (Vala, 1986; Gaponov, 2016).

Key to the *Coremacera* species occurring in Middle East and Central Asia (modified from Vala, Leclercq,1981) (Distribution follows Rozkošný, Elberg,1984); Leclercq, Schacht, 1986)

1. Face with a black round spot or black median strip below antenna. 2
— Face without black spots blow antenna. 4
2. Mainly black species; face with black median strip from base of antenna to the mouth edge (Cyprus, Greece, Turkey). ..... *C. obscuripennis* (Loew 1845)
— Mainly brown species; face with a black round spots blow antenna. 3
3. Wing: costal margin brown with several light spots; base of wing to anterior cross vein yellow, without reticulate patterns; mesonotum with a longitudinal median yellow dusting strips surrounding with 2 longitudinal grey strips (Central Europe and Iran, Azerbaijan, Armtnia, Turkey). ..... *C. catenata* (Loew, 1847)
— Wing: uniformly reticulated pattern with small spots; hind margin with narrow brownish band; mesonotum dark brown covered by grey dusting with black spots at the base of bristles (Uzbekistan). ..... *C. turkestanica* (Elberg, 1968)
4. Wing densely reticulate pattern, with a broad brown band from costal margin of wing to apex (Europe, Turkey, Iran). ..... *C. marginata* (Fabricius 1775)
— Wing with normal reticulate pattern, costal margin of wing with whitish or brownish spots. 5
5. Wing with transverse brown bands. 6
— Wing without transverse brown bands, with large light spots, apex of wing from R_{2+3} to M_{1+2} with a dark brown band (Eurasia, North and south Europe). ..... *C. fabricii* Rozkosny, 1981
7. Wings dark brown, apical half with 2 light transverse bands separated by a small brown transverse band; mesonotum brownish with grey and yellow dusting, many small black and brown spots arranged symmetrically; (Europe, Turkey). ..... *C. trivittata* (Loew, 1860)
— Wings light brown, apical half with 2 rows of light spots separated by larger brown transverse bands; mesonotum light brown with whitish dusting, finely brown punctuated and 2 longitudinal rows of brown spots along the dorsocentral bristles and some small brown spots laterally (south Europe, Turkey, Iran). ..... *C. amoena* (Loew, 1835)

Discussion

Despite a lot of species added recently, the list of Sciomyzidae present in Iran is still incomplete and requires further investigations. Note that most of the species listed in the country has been harvested in areas north and northeast of Iran (Knutson et al., 1973; Yano, 1978; Rozkošný, 1987; Mortelamans et al., 2016). The distribution of some Palaearctic species, such *Tetanocera arrogans* are extended to Iran in addition to Kazakhstan.

The malacophagous larvae of the sciomyzids offer a high economic significance. In Iran, Tirgari (1977) and Tirgari, Massoud (1981) released *Sepedon sphegea* in rice paddies, and noted a population reduction of the freshwater snail *Bulinus truncatus* (Audouin) implicate in the transmission of human schistosomiasis. Some authors, such Speight (2001, 2004), suggested the Sciomyzidae as bioindicators of habitats, biogeographical, and agricultural areas. In addition to the laboratory rearing and land experiments show the potential applications in agriculture and medical investigations of the sciomyzids as biological control agents against undesirable snails and slugs.

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