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Research Article

New records of dung flies (Diptera: Scathophagidae) from Iran, with an updated checklist

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Abstract: Among specimens collected from some parts of East Azerbaijan and West Azerbaijan provinces, Iran, during 2017-2019, nine species of the genera *Coniosternum* Becker, 1894; *Cordilura* Fallén, 1810; *Gimnomera* Rondani, 1866 and *Scathophaga* Meigen, 1803 were identified. Three species of *Gimnomera dorsata* (Zetterstedt, 1838), *Scathophaga inquinata* (Meigen, 1826), and *Scathophaga islandica* (Becker, 1894), are reported as new records of the Iranian insect fauna. A key to the studied species, along with their diagnostic characters, geographical distribution, supplementary figures, and an updated checklist of the Iranian Scathophagidae, are given.

Keywords: Scathophagidae, dung flies, new records, Iran

Introduction

The family Scathophagidae (dung flies), with 362 known species in 65 genera, is one of the small families of the superfamilies Muscoidea (Diptera: Calypterata) (Bernasconi and Šifner, 2021). It comprises two subfamilies of Scathophaginae and Delininae (Šifner and Bernasconi, 2021). Recent studies have reported 256 species in 44 genera from the Palaearctic region (Bernasconi and Šifner, 2021).

Adults have been mainly reported to occur in moist habitats such as forests, lowland to mountain meadows, littoral vegetation, marshes, and peat bogs (Šifner, 2008). They have a predacious behavior and tend to feed on insects and other small invertebrates, coprophagous, and saprophagous. The larvae have been reported to have broad feeding behavior i. e. majority of them are phytophagous and mine mostly in the leaves and stems of monocotyledonous plants and very rarely from dicotyledonous plants, while some can be predaceous or saprophagous, living in the soil, and stagnant and running waters and a few of them are scavenger or carnivorous (Šifner, 2008; Ozerov and Freidberg, 2010).

Adults, usually slender flies, have some distinctive characteristics as small to large (3-12 mm). Their color varies from a dull yellowish brown to lustrous black or yellow, in some species bicolourous. Their body and legs usually have many bristles and sometimes are densely covered by fine hairs. Occiput is usually characterized by some to many pale longhairs, arista bare to plumose; interfrontal bristles absent. Wing usually clear, sometimes distinctly marked or darkened at the tip or along the crossveins; anal vein long, usually reaching the wing margin. Meron without bristles along the hind margin, near the posterior spiracle (Oosterbroek, 2006).

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The Iranian fauna of Scathophagidae is far from fully discovered and needs more investigations. Totally ten species of this family have been reported from Iran, among which *Paramicroprosopa hoberlandti* (Šifner, 1981) and *Scathophaga jezeki* (Šifner, 1981) have been described from this country (Šifner, 1981; Kaghaninia and Gharajedaghi, 2014).

The objective of this study is to investigate the Scathophagidae in northwestern Iran.

Materials and Methods

Adult specimens were collected weekly using a standard sweeping net, and two Malaise traps from grassland and wetland habitats of East Azerbaijan and West Azerbaijan provinces, located in northwestern Iran from May to September 2017–2019 (Fig. 1). The collected specimens by sweeping net were killed in a potassium cyanide jar. The specimens were kept in 75% ethanol in glass vials. To prepare the male genitalia, the end of the abdomen was removed and boiled in 10% KOH solution for about 10 minutes. The specimens were deposited in the insect collection of Professor Hasan Maleki Milani, Tabriz, Iran (ICHMM). The photographs were taken using a Nikon SMZ 800N stereomicroscope equipped with a Nikon DS-Fi3 microscope camera. The species were identified according to valid keys such as Ball (2014), Khaghaninia and Gharajedaghi (2014), and Šifner (2018).

Results

In this study, nine species of the genera *Coniosternum* Becker, 1894, *Cordilura* Fallén, 1810, *Gimnomera* Rondani, 1866 and *Scathophaga* Meigen, 1803 from East Azerbaijan and West Azerbaijan provinces were collected and identified which among them, *Gimnomera dorsata* (Zetterstedt, 1838), *Scathophaga inquinata* (Meigen, 1826) and *Scathophaga islandica* (Becker, 1894) are newly reported from Iran. Species are listed in alphabetic order.

Figure 1 Northwestern regions of Iran where species have been collected. A. Kandovan (Arshad Chaman); B. Chichakli; C. Khoy (Safaeyeh); D. Arasbaran forest.

List of species
Subfamily Scathophaginae
Genus *Coniosternum* Becker, 1894
***Coniosternum jezeki* Šifner, 1981 (Fig. 2 A-C)**
Synonym: *Scathophaga jezeki*
Material examined: (36 ♀, 2♂): East Azerbaijan (Chichakli), 38°41' N, 46°31' E, 1788 m a.s.l., 17 July 2019; (47 ♀): West Azerbaijan (Khoy), 38°42' N, 45°12' E, 968 m a.s.l., 19 July 2019; (30 ♀, 1♂): West Azerbaijan (Khoy), 38°42' N, 45°12' E, 968 m a.s.l., 24 July 2019, leg: S. Khaghaninia and N. Abbaszadegan.
Distribution: Iran, United Arab Emirates (Šifner, 2009).

***Coniosternum kaszabi* Šifner, 1975 (Fig. 3 A-C)**
Synonym: *Scathophaga kaszabi*
Material examined: (39 ♀): East Azerbaijan (Chichakli), 38°41' N, 46°31' E, 1788 m a.s.l., 17 July 2019; (20 ♀, 3♂): West Azerbaijan (Khoy), 38°42' N, 45°12' E, 968 m a.s.l., 31 May 2019; (23 ♀, 3♂): West Azerbaijan (Khoy), 38°42' N, 45°12' E, 968 m a.s.l., 19 July 2019; (14 ♀, 2♂): West Azerbaijan (Khoy), 38°42' N, 45°12' E, 968 m a.s.l., 16 August 2019, leg: S. Khaghaninia and N. Abbaszadegan.
Distribution: Mongolia (Šifner, 2008) and Iran (Khaghaninia and Gharajedaghi, 2014).
Genus *Cordilura* Fallén, 1810

***Cordilura rufipes* (Meigen, 1826) (Fig. 4 A, B)**
Synonym: *Cordilura pubera* (Linnaeus, 1758)
Material examined: (2 ♀, 1♂): East Azerbaijan (Arasbaran Forests, Skolo), 38°51' N, 46°52' E, 1721 m a.s.l., 1 Juy 2018, leg: S. Khaghaninia.
Distribution: Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Ireland, Lithuania, Netherlands, Norway, Poland, Romania, Slovakia, Spain, Sweden, Switzerland, Russia: northern European regions, East Palaearctic (Ball, 2014) and Iran (Khaghaninia and Gharajedaghi, 2014).

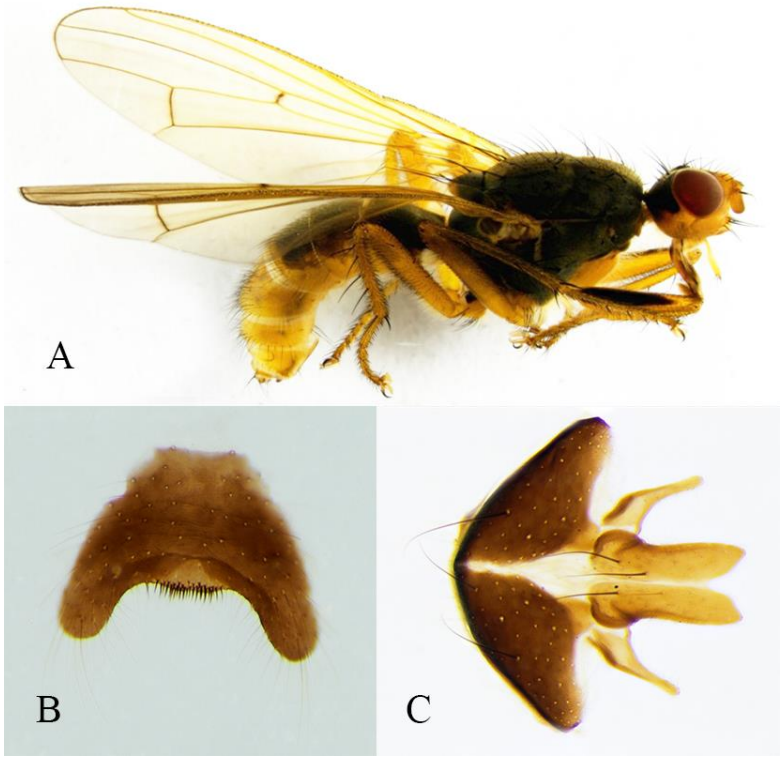

Figure 2 *Coniosternum jezeki* (male): A. Lateral view; B. 5th abdominal sternite. C. Epandrium, cercus, and surstylus (dorsal view).

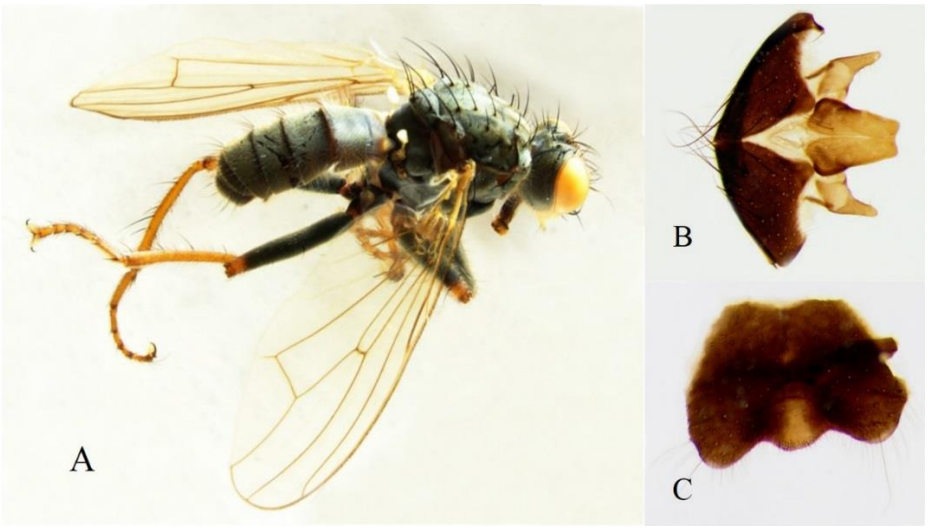

Figure 3 *Coniosternum kaszabi* (male): A. Lateral view; B. Epandrium, cercus, and surstylus (dorsal view); C. 5th abdominal sternite.

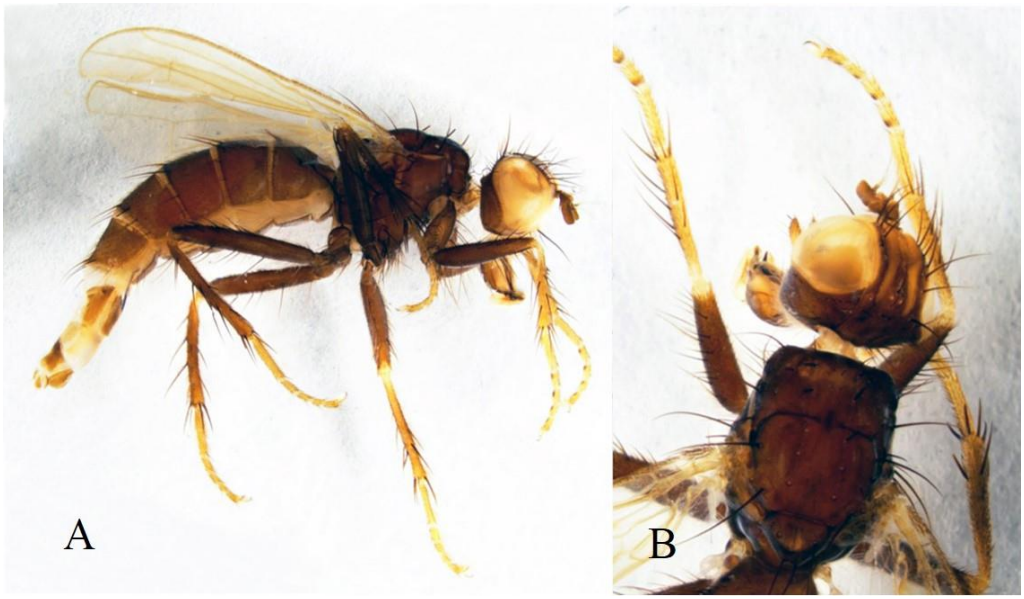

Figure 4 *Cordilura rufipes* (female): A. Lateral view; B. Dorsal view of thorax.

Genus *Gimnomera* Rondani, 1866

***Gimnomera dorsata* (Zetterstedt, 1838) (Fig. 5 A-E)**

Synonym: *Cordylura dorsata* Zetterstedt, 1838

Material examined: (2 ♀, 1♂): East Azerbaijan (Kandovan, Arshad Chaman), 37°45' N, 46°18' E, 2705 m a.s.l., 15 July 2019, leg: S. Khaghaninia.

Distribution: Austria, Finland, Germany, Italy, Norway, Russia, Switzerland (Šifner, 2008).

New record species for Iran.

Genus *Scathophaga* Meigen, 1803

***Scathophaga inquinata* (Meigen, 1826) (Fig. 6 A-D)**

Material examined: (1 ♀, 1♂): West Azerbaijan (Khoy, Safaeyeh), 38°48' N, 44°35' E, 1796 m a.s.l., Malaise trap, 10 July 2019, leg: N. Abbaszadegan.

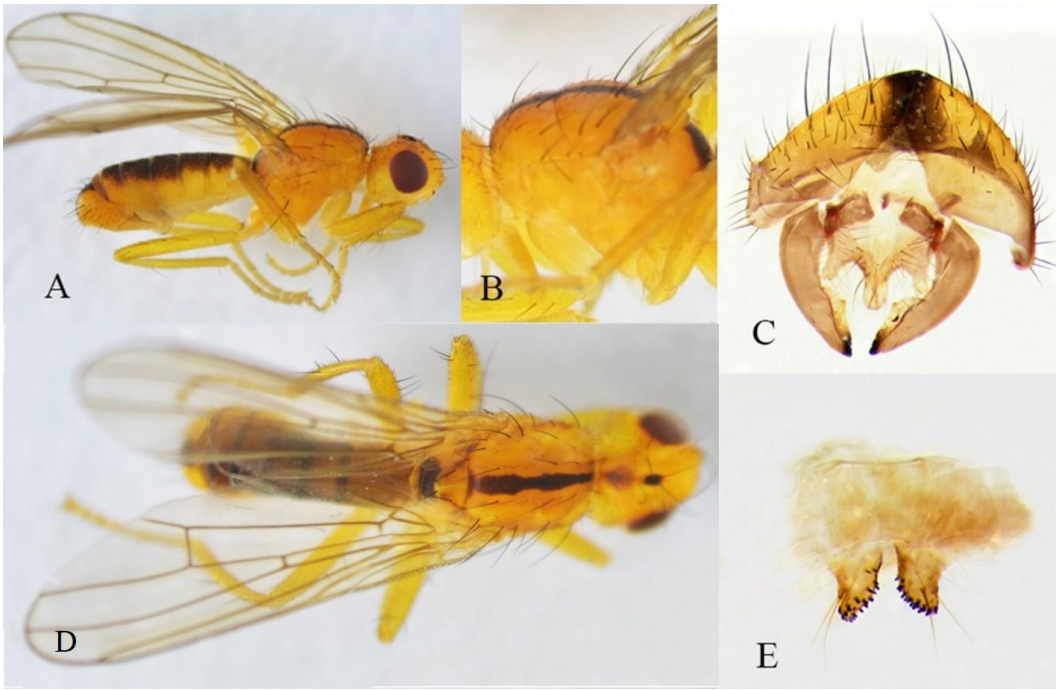

Figure 5 *Gimnomera dorsata* (male): A. Lateral view; B: Lateral view of thorax; C. Epandrium, cercus, and surstylus (dorsal view); D. Dorsal view; E. 5th abdominal sternite.

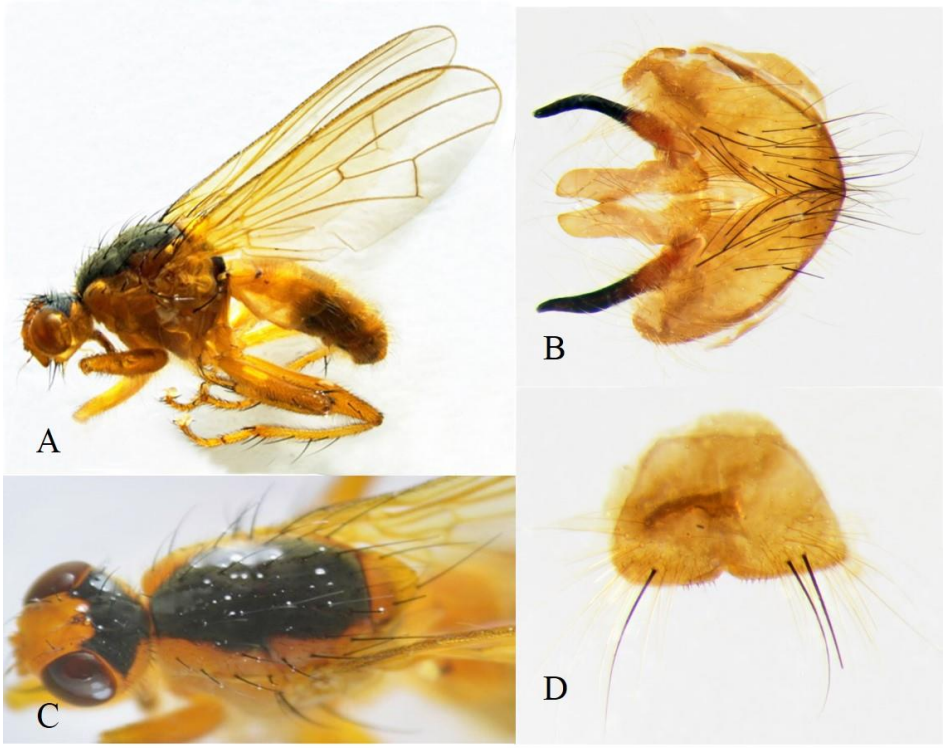

Figure 6 *Scathophaga inquinata* (male): A. Lateral view; B. Epandrium, cercus, and surstylus (dorsal view); C. Dorsal view of head and thorax; D. 5th abdominal sternite.

Distribution: Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, Great Britain, Hungary, Ireland, Italy, Latvia, Lithuania, Netherlands, Norway, Poland, Portugal, Romania, Russia, Slovakia, Slovenia, Spain, Sweden (Šifner, 2008). **New record species for Iran.**

******Scathophaga islandica* **(Becker, 1894) (Fig. 7 A, B)**
Synonym: *Scathophaga litorea* (Fallén, 1819)
Material examined: (2 ♀): East Azerbaijan (Kandovan, Arshad Chaman), 37°45' N, 46°18' E, 2705 m a.s.l., 15 July 2019, leg: S. Khaghanania.
Distribution: Belgium, Canada, Croatia, Denmark, Estonia, Finland, France, Germany, Great Britain, Iceland, Ireland, Norway, Netherlands, Poland, Portugal, Russia, Sweden, Nearctic region (Šifner, 2008, 2018). **New record species for Iran.**

Scathophaga lutaria **(Fabricius, 1794) (Fig. 8 A-E)**
Material examined: (71 ♀, 1♂): East Azerbaijan (Arasbaran Forests, Skolo), 38°51' N, 46°52' E, 1721 m a.s.l., 1 July 2018; (32 ♀, 2♂): East Azerbaijan (Chichakli), 38°41' N, 46°31' E, 1788 m a.s.l., Malaise trap, 17 July 2019; (10 ♀, 2♂): West Azerbaijan (Khoy, Safaeyeh), 38°48' N, 44°35' E, 1796 m a.s.l., Malaise trap, 20 May 2019; (21 ♀): West Azerbaijan (Khoy, Safaeyeh), 38°48' N, 44°35' E, 1796 m a.s.l., Malaise trap, 10 July 2019; leg: S. Khaghaninia and N. Abbaszadegan.
Distribution: Algeria, Andorra, Austria, Belgium, Bosnia-Hercegovina, Canada, Czech Republic, Denmark, Estonia, Faeroe Islands, Finland, France, Germany, Great Britain, Greenland, Hungary, Iceland, Ireland, Israel, Italy, Lebanon, Mexico, Netherlands, Norway, Poland, Russia, West Siberia, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Tunisia, Turkey, USA (Ball 2014, Šifner, 2008) and Iran (Khaghaninia and Gharajedaghi, 2014).

Scathophaga stercoraria **(Linnaeus, 1758) (Fig. 9 A-C)**
Synonym: *Musca stercoraria* (Linnaeus, 1758)
Material examined: (90 ♀, 3♂): East Azerbaijan (Arasbaran Forests, Skolo), 38°51' N, 46°52' E, 1721 m a.s.l., 1 July 2018; (88 ♀): East Azerbaijan (Arasbaran, Ainali forests), 38°53' N, 46°46' E, 1271 m a.s.l., 1 July 2018; (27 ♀): East Azerbaijan (Chichakli), 38°34' N, 46°30' E, 1907 m a.s.l., 17 July 2019; (48 ♀, 2♂): West Azerbaijan (Khoy), 38°42' N, 45°12' E, 968 m a.s.l., 31 May 2019; leg: S. Khaghaninia and N. Abbaszadegan.

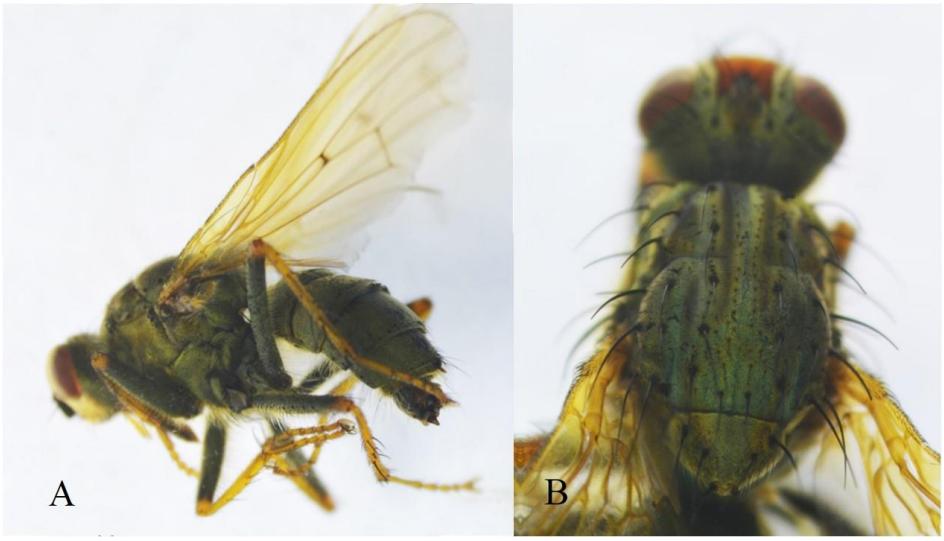

Figure 7 *Scathophaga islandica* (female): A. Lateral view; B. Dorsal view of head and thorax.

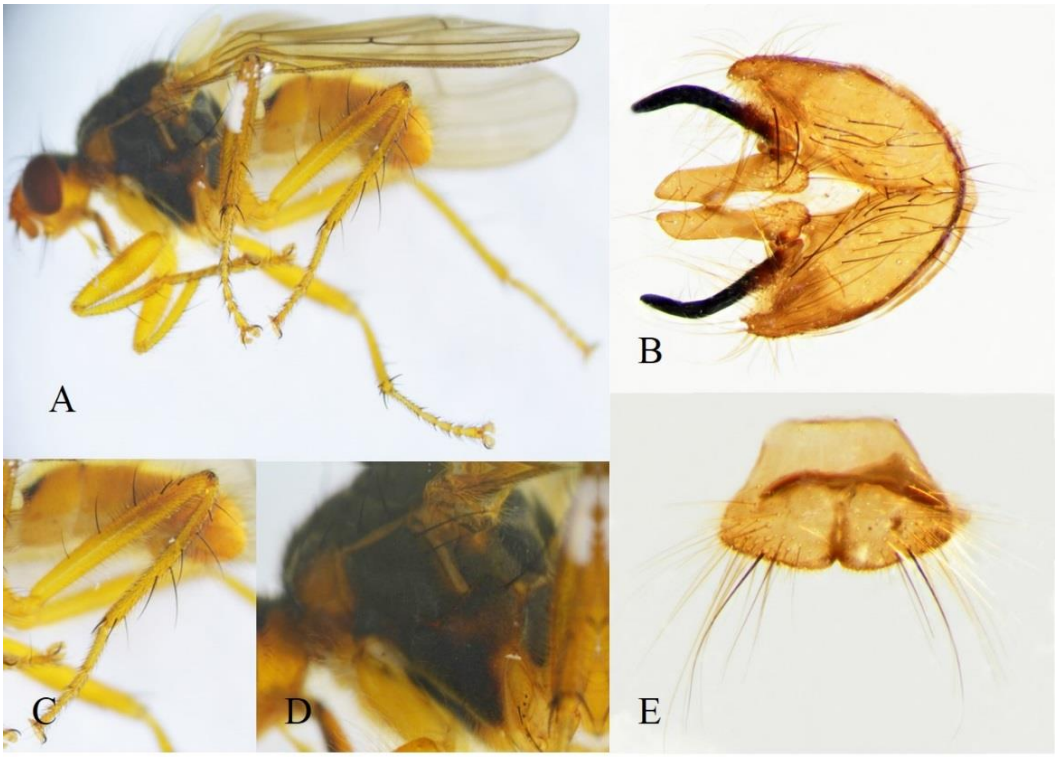

Figure 8 *Scathophaga lutaria* (male): A. Lateral view; B. Epandrium, cercus, and surstylus (dorsal view); C. Lateral view of hind leg; D. Lateral view of thorax; E. 5th abdominal sternite.

Figure 9 *Scathophaga stercoraria* (male): A. Lateral view of mid and hind tibias; B. Lateral view of thorax; C. Lateral view.

Distribution: Afghanistan, Andorra, Austria, Azores, Balearic Islands, Belgium, Bosnia-Hercegovina, Bulgaria, Canary Islands, China, Croatia, Czech Republic, Denmark, Egypt, Estonia, Faeroe Islands, France, Finland, Germany, Great Britain, Greece, Hungary, Iceland, Ireland, Italy, Japan, Lithuania, Madeira Islands, Mongolia, Norway, Netherlands, Poland, Portugal, Romania, Russia, Slovakia, Spain, Sweden, Switzerland, Tunisia, Turkey, Yugoslavia, Russia: European and eastern Palaearctic, North Africa, Asia: Kashmir, Nearctic: Canada, USA, Neotropical, Brazil, Afrotropical, South Africa (Ball 2014, Šifner, 2008) and Iran (Khaghaninia and Gharajedaghi, 2014).

***Scathophaga taeniopa* (Rondani, 1867) (Fig. 10 A-C)**

Material examined: (4 ♀, 2♂): East Azerbaijan (Chichakli), 38°41' N, 46°31' E, 1788 m a.s.l., 17 July 2019; (25 ♀, 1♂): West Azerbaijan (Khoy, Safaeyeh), 38°48' N, 44°35' E, 1796 m a.s.l., Malaise trap, 10 July 2019, leg: S. Khaghaninia and N. Abbaszadegan.

Distribution: Austria, Canada, China, Czech Republic, France, Germany, Italy, Poland, Russia, Slovakia, Switzerland (Ball 2014, Šifner, 2008) and Iran (Khaghaninia and Gharajedaghi, 2014).

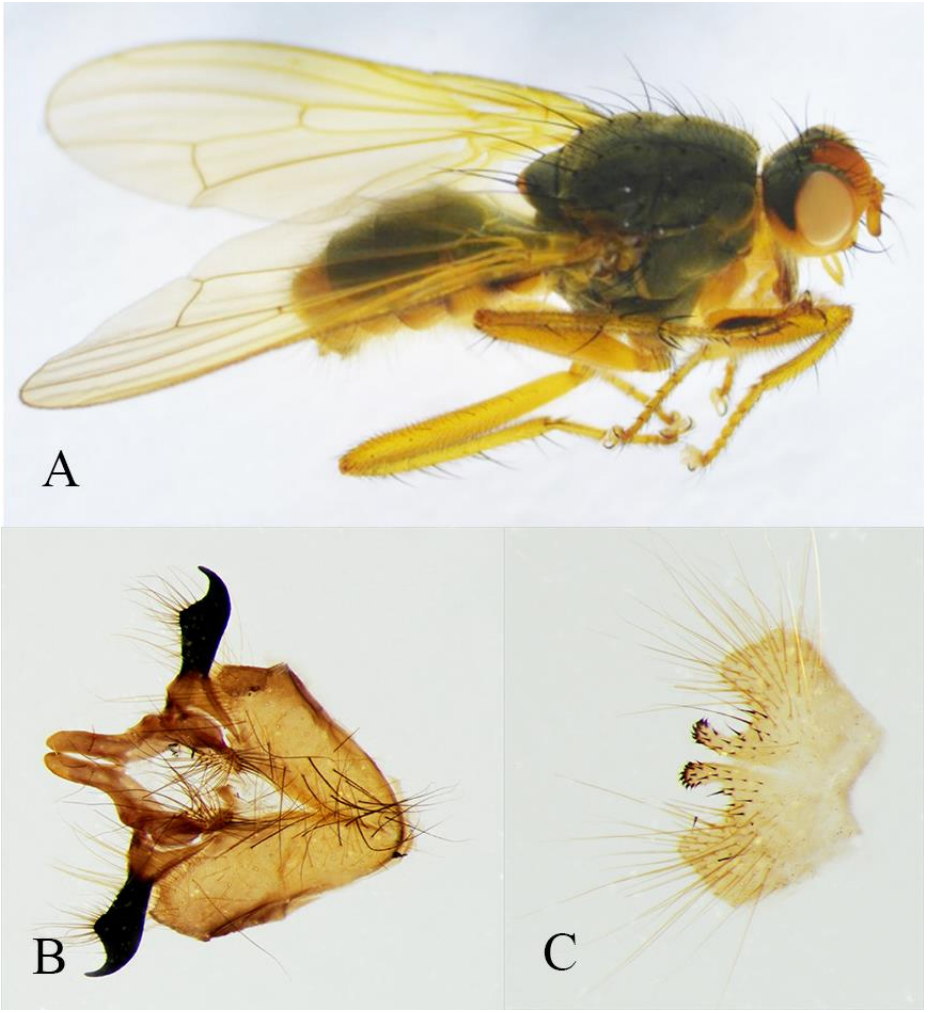

Figure 10 *Scathophaga taeniopa* (male): A. Lateral view; B. Epandrium, cercus, and surstylus (dorsal view); C. 5th abdominal sternite.

Key to the studied species of the family Scathophagidae (With some modification from Ball, 2014 and Šifner, 2013, 2018)

1- Black species with strong leg bristles. Thorax, abdomen, and at least the femora are black, although the tibia and tarsi are orange/yellow (Genus *Cordilura*)……..…….. 2
- Flies with the legs and at least parts of the sides of the thorax and abdomen with a grey, brownish, or yellow ground color…….…….…... 3
2- Scutellum with four strong bristles (Fig. 4B), At least the front and middle tibia yellow. Tarsi darkened beneath at the base of at least the last four joints (Fig. 4A). Vein R1 with numerous fine setulae above towards tip. Arista long haired……. *Cordilura rufipes*
- Without this combination ……. other species
3- Vein R_1 with a few small bristles on the upper side towards the end. Front margin of humeri with a fringe of short bristles (Genus *Gimnomera*) ……..…. 4
-Vein R_1 bare above at end. Humeri without a fringe of bristles in front ……. 5
4- 5th abdominal sternite, as in Fig. 5E, Abdomen without dens hairs, Body yellow (Fig. 5A), epandrium, cerci and surstyli as in Fig. 5C ……..…….. *Gimnomera dorsata*
- Without this combination……. other species
5- The whole body is covered with yellow to greyish hairs of different lengths, proepisternum and proepimeron haired, arista plumose or bare, first flagellomere brown to black, surstyli distinctly sclerotized, pointed apically or weakly forked, cerci short, always separated and haired, praegonite of males wide with varying number of bristles, postgonite of males always narrow and arched (Genus *Scathophaga*) …… 6
- The whole body is covered with grey to short black hairs, proepisternum grey haired in anterior part only, proepimeron bare, arista always bare and thickened in the first quarter to third, first flagellomere always black, surstyli short and narrowed apically without sclerotization, cerci prolonged, separated or partially jointed and covered with individual short bristles only, praegonite of males very short with one to three bristles, postgonite of males always wide and weakly pointed apically (Genus *Coniosternum*) ……. 10
6- Abdomen without dens hairs (Fig. 7A) ……..…….*Scathophaga islandica*
- Abdomen with long and dens yellow hairs .. 7
7- Pteropleuron hairy (Fig. 9B) …….……..……. *Scathophaga stercoraria*
- Pteropleoron bare ……..…. 8
8- Male hind femora without (BUT female with) anterodorsal bristles. Typically a smaller and rather pale-colored species. 5th abdominal sternite, as in Fig. 10C, Epandrium, cerci, and surstyli, as in Fig. 10B……..... *Scathophaga taeniopa*
- Hind femora of both sexes with distinct anterodorsal bristles towards the tip. 5th abdominal sternite, epandrium, cerci, and surstyli otherwise …… 9
9- Male abdomen is entirely yellow and yellow-haired (Fig. 6A). 5th sternite with a patch of tiny black spines on the hind margin, near median indentation (Fig. 6D). Epandrium, cerci, and surstyli as in Fig. 6B. Females are generally smaller and darker with dark humeri and scutellum and front femora immaculate ……...… *Scathophaga inquinata*
- Male abdomen with at least the hind margin of the first tergite darkened and some dark hairs mixed with the yellow ones towards the tip of the abdomen. 5th sternite with fine hair only near the median indentation (Fig. 8E). Epandrium, cerci, and surstyli as in Fig. 8B. Female larger and typically (but not invariably) with yellow humeri, a yellow scutellum, and often with a dark streak on the front femora…….. ……*Scathophaga lutaria*
10- Abdominal venter yellow, male 5th sternite as in Fig. 2B, Epandrium, cerci, and surstyli as in Fig. 2C ……..……... *Coniosternum jezeki*
- Abdominal venter greenish, male 5th sternite as in Fig. 3C, Epandrium, cerci, and surstyli, as in Fig. 3B ……..…. *Coniosternum kaszabi*

Discussion

The adults have been reported from various sheltered and moist habitats like forests, lowland to montane meadows, littoral vegetation, marshes, and peatbogs. Some

adults are predators of small insects, some rarely feed from the nectar of flowers, and some are saprophagous (Šifner, 2008). Moreover, the influence of climatic conditions, humidity, temperature, and altitude on changes in community structure and ecosystem processes, peak abundance, and diversity of insects have been researched in various studies (Blanckenhorn, 1997, 1998, Sundqvist *et al*. 2013). Chichakli region has a rich and unique ecosystem, fauna, and flora where the highest frequency of species from the viewpoint of number and diversity is obtained. According to the results, it can be assumed that diversity and the number of species of the Scathophagidae could be directly proportional to vegetation diversity, climate conditions, humidity, and temperature of the sampling region.

Before this study, 10 species of the family Scathophagidae had been recorded from Iran (Šifner 1981; Kaghaninia and Gharajedaghi 2014); with the results of this study, the number of species in Iran is increased to 13 species (Table 1). Most previous studies were conducted in East Azerbaijan parts of Iran (Kaghaninia and Gharajedaghi, 2014). Among 13 species *Cordilura rufipes*, *Gimnomera dorsata*, *Norellisoma spinimana*, *Parallelomma albipes Scathophaga inquinata*, *S. islandica*, *S. lutaria*, *S. stercoraria* and *S. taeniopa*, species are widely distributed in the Palearctic and *Coniosternum jezeki*, *C. kaszabi*, *Gimnomera Montana* and *Paramicroprosopa hoberlandti* species are have relatively restricted geographical ranges (Ball 2014; Ozerov and Krivosheina, 2013; Šifner, 2008, 2009, 2018). Since the species of this family can be used as biological control (Cotterell, 1920), additional studies are necessary to identify the fauna of this family in other parts of Iran.

Table 1 The updated list of the family Scathophagidae (Diptera: Muscoidea) of Iran.

No.	species	Distribution in Iran (Provinces)	References
1	*Coniosternum jezeki* Šifner, 1981	East Azerbaijan, Kerman, West Azerbaijan	Šifner (1981), Kaghaninia and Gharajedaghi (2014), and the current study
2	*Coniosternum kaszabi* Šifner, 1975	East Azerbaijan, West Azerbaijan	Kaghaninia and Gharajedaghi (2014) and the current study
3	*Cordilura rufipes* (Meigen, 1826)	East Azerbaijan	Kaghaninia and Gharajedaghi (2014) and the current study
4	*Gimnomera dorsata* (Zetterstedt, 1838)	East Azerbaijan	Current study
5	*Gimnomera montana* Ozerov and Krivosheina, 2013	East Azerbaijan	Kaghaninia and Gharajedaghi (2014)
6	*Norellisoma spinimanum* (Fallén, 1819)	East Azerbaijan	Kaghaninia and Gharajedaghi (2014)
7	*Parallelomma albipes* (Fallén, 1819)	East Azerbaijan	Kaghaninia and Gharajedaghi (2014),
8	*Paramicroprosopa hoberlandti* (Šifner, 1981)	Zanjan	Šifner (1981)
9	*Scathophaga inquinata* (Meigen, 1826)	West Azerbaijan	Current study
10	*Scathophaga islandica* (Becker, 1894)	East Azerbaijan	Current study
11	*Scathophaga lutaria* (Fabricius, 1794)	East Azerbaijan, West Azerbaijan	Kaghaninia and Gharajedaghi (2014) and the current study
12	*Scathophaga stercoraria* (Linnaeus, 1758)	East Azerbaijan, West Azerbaijan	Kaghaninia and Gharajedaghi (2014) and the current study
13	*Scathophaga taeniopa* (Rondani, 1867)	East Azerbaijan, West Azerbaijan	Kaghaninia and Gharajedaghi (2014) and the current study

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گزارش‌های جدید از فون مگس‌های سرگین (Diptera: Scathophagidae) از ایران، به‌همراه لیست به‌روز شده

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چکیده: از میان نمونه‌های جمع‌آوری شده از برخی مناطق استان‌های آذربایجان‌شرقی و آذربایجان غربی-ایران، طی سال‌های ۱۳۹۶ تا ۱۳۹۸، ۹ گونه از جنس‌های *Coniosternum* Becker, 1894، *Cordilura* Fallén, 1810، *Gimnomera* Rondani, 1866 و *Scathophaga* Meigen, 1803 شناسایی شدند. سه گونه *Gimnomera dorsata* (Zetterstedt, 1838)، *Scathophaga inquinata* (Meigen, 1826) و *Scathophaga islandica* (Becker, 1894) برای اولین بار از ایران گزارش می‌شوند. کلید شناسایی برای گونه‌های مورد مطالعه به‌همراه خصوصیات تشخیصی، پراکندگی جغرافیایی، تصاویر آن‌ها و لیست به‌روز شده خانواده Scatophagidae در ایران ارائه شده است.

واژگان کلیدی: Scathophagidae، مگس‌های سرگین، گزارش‌های جدید، ایران