



Received:
25 March, 2018

Accepted:
11 July, 2018

Published:
22 August, 2018

Subject Editor:
Ehsan Rakhshani

Contribution to the fauna and phenological knowledge of high mountains Opiinae (Hymenoptera, Braconidae) in Kerman province (Iran)

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ABSTRACT. The present study provides new data about the fauna and phenology of Opiinae (Hymenoptera: Braconidae) species captured in high mountain areas of Kerman province (South-Eastern Iran). Sampling was carried out from April 2014 to September 2015. In total, 19 species belonging to four genera have been listed of which *Opius* (*Cryptonastes*) *gracilis* Fischer, 1957, *Phaedorotoma gafsaensis* (Fischer, 1964) and *Phaedorotoma scaptomyzae* (Fischer, 1967) are recorded for the first time from Iran.

Key words: Braconidae, Opiinae, high mountains, parasitoids, Iran, new records.

Citation: Safahani, S., Madjdzadeh, S.M. & Peris-Felipo, F.J. (2018) Contribution to the fauna and phenological knowledge of high mountains Opiinae (Hymenoptera, Braconidae) in Kerman province (Iran). *Journal of Insect Biodiversity and Systematics*, 4(2), 73–83.

Introduction

Opiinae is one of the largest Braconidae subfamilies containing approximately 1,970 described species known in the world fauna (Yu et al., 2016). The species of Opiinae are an assemblage of small parasitic wasps, strictly koinobiont parasitoids of Cyclorrhaphous Diptera (Wharton et al., 1997), mainly of leaf miners and other larvae living in fruits. The hosts are known for only around 300 species, mostly within Agromyzidae, Anthomyiidae, Drosophilidae, Ephydriidae, Psilidae, Scatophagidae and Tephritidae (Fischer 1971a,b, 1972, 1977, 1987; Shaw & Huddleston, 1991).

Recently, several studies have been conducted on Opiinae from Iran and only 104 species have been recorded (Khajeh et al.,

2014; Gadallah et al., 2016; Ranjbar et al., 2016; Peris-Felipo et al., 2018). Despite this, no survey was focused on the Opiinae diversity of high mountains. The present work increases the knowledge of the diversity and phenology of this large group of parasitoid wasps in Iran.

Material and methods

Samples were carried out in high altitude mountains (1630–2870 m) within the range of eight localities located in Kerman province (Sirch, Kuhpayeh, Negar, Dashkar, Qal-eh-Askar, Bidkhan, Kuhbanan, Rabor) (Fig. 1). The vegetation of these regions includes the scattered bushes and shrubs mainly *Artemisia* L. along with some

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perennial and annual grasses. These localities belong to areas with semi-arid, from temperate to cool climatic area (Zohary, 1973). The information about altitude and weather conditions is recorded on Table 1 (Iran Meteorological Organization 2018).

Specimens were collected during 2014–2015 by sweep net and Malaise traps and were preserved directly in ethyl alcohol (75%) for subsequent studies. The specimens were then softened in the laboratory using the AXA method (van Achterberg, 2009), mounted on triangular

point cards and examined by Nikon™ SMZ800 stereomicroscope.

The collected specimens were determined with the keys of Tobias et al. (1986) and van Achterberg (1993). Classification and nomenclature for each species follow Yu et al. (2016). Material was identified with Leica S8APO stereoscopy and imaged by Keyence® VHX-2000 Digital Microscope and Adobe Photoshop® software. The specimens are deposited in the Insect Collection of the Zoological Museum of Shahid Bahonar University of Kerman, Kerman, Iran (ZMSBUK).

Table 1. Altitude, annual rainfall and range of temperatures of sampling locations in Kerman province.

| Location | Altitude (m) | Annual rainfall (mm) | Range of temperatures (C°) |
|--------------------|--------------|----------------------|----------------------------|
| Sirch | 1637 – 1760 | 120 | From -13 to 38 |
| Kuhpayeh | 1807 – 2057 | 130 | From -15 to 38 |
| Negar and Dashtkar | 2077 – 2126 | 160 | From -20 to 33 |
| Qal-eh-Askar | 2660 – 2677 | 200 | From -25 to 30 |
| Bidkhan | 2800 – 2900 | 230 | From -26 to 32 |
| Kuhbanan | 2100 – 2150 | 125 | From -22 to 36 |
| Rabor | 2400 – 2500 | 210 | From -25 to 35 |

Results

A total of 19 species belonging to four genera were captured. The identified material is provided bellow. New records are marked with an asterisk (*). In Kuhpayeh, specimens were collected on *Medicago sativa* and *Anethum graveolens*. In Negar and Dashtkar specimens were collected mainly from *Mentha pulegium*, *Beta vulgaris*, *Triticum aestivum* and *Medicago sativa*, among others. In Qal-eh-Askar, all specimens were captured on *Medicago sativa* while *Artemisia aucheri*

steppe is dominant in this locality. Finally, in Bidkhan samples were collected on *Medicago sativa*.

Subfamily Opiinae Leach, 1815

1. *Biosteres spinaciae* (Thomson, 1985)

Material examined: 1♀, Kerman, Ghanat sir, 29°44'39.33"N, 56°45'25.3"E, 2969 m, 05.x.2015, swept on *Medicago sativa* L. (S. Safahani leg.).

Distribution in Iran: Kermanshah (Ghahari & Fischer, 2012) and Kerman.

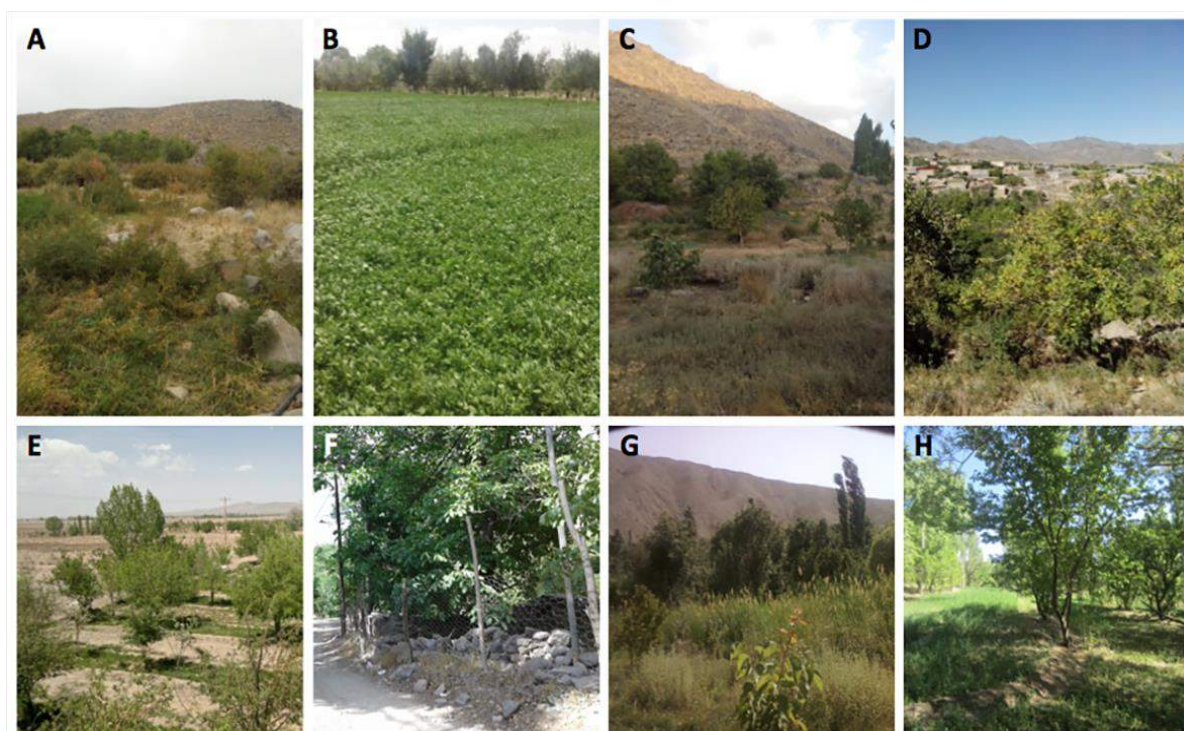


Figure 1. Habitats of Kerman province where the Opiinae specimens were collected: A. Kuhbanan. B. Kuhpayeh. C. Qal-eh-Askar. D. Rabor. E. Negar. F. Dashtkar, G. Sirch. H. Bidkhan.

2. *Indiopijs cretensis* Fischer, 1983

Material examined: 1♀, Kerman, Negar, 29°51'58.9"N, 56°47'21.7"E, 2097m, 26.ix.2014, swept on *Medicago sativa* L. (F. Abdolalizadeh leg.).

Distribution in Iran: Sistan & Baluchestan (Peris-Felipo et al., 2014) and Kerman.

3. *Opius (Agnopijs) novosimilis* Fischer, 1989

Material examined: 1♀, Kerman, Sirch, 30°12'036"N, 57°32'421"E, 1760m, 17.ix.2014, swept on *Medicago sativa* L. (M. Iranmanesh leg.).

Distribution in Iran: Hormozgan (Ameri et al., 2014) and Kerman.

4. *Opius (Agnopijs) rex* Fischer, 1958

Material examined: 1♀, Kerman, Rabor, Siyahbanooieh, 29°20'43.6"N, 56°55'45.5"E, 2461m, 11-25.iv.2015, Malaise trap, (S. Safahani leg.).

Distribution in Iran: Mazandaran (Ghahari et al., 2011a), Ardabil (Ghahari & Fischer, 2011) and Kerman.

5. *Opius (Agnopijs) similis* Szépligeti, 1898

Material examined: 1♀, Kerman, Negar, 29°51'57.9"N, 56°47'55.5"E, 2095m, 22.iv.2014, swept on *Mentha pulegium* L. (F. Abdolalizadeh leg.).

Distribution in Iran: Lorestan (Ghahari et al., 2012a), Golestan (Sakenin et al., 2012) and Kerman.

6. *Opius (Allophlebus) tabificus* Papp, 1979

Material examined: 6♀, Kerman, Kuhpayeh, Deh Lolo, 30°30'03.6"N, 57°16'01.4"E, 2013m, 12.viii.2014, swept on *Medicago sativa* L. (S. Kazemi leg.).

Distribution in Iran: Sistan & Baluchestan (Khajeh et al., 2014), Hormozgan (Ameri et al., 2014) and Kerman.

7. *Opius (Cryptonastes) gracilis* Fischer, 1957 (Fig. 2)

Material examined: 3♀, Kerman, Kuhpayeh, Deh Ghazi, 30°26'43.1"N, 57°18'54.7"E, 1984m, 21.xiii.2014, swept on *Medicago sativa* L. (S. Safahani leg.); 2♀, Kerman, Sirch, 30°11'585"N, 57°33'507"E, 1689m, 01.ix.2014, swept on *Rubus* sp., (M. Iranmanesh leg.); 2♀, Kerman, Kuhpayeh, Nehzat Abad, 30°25'38.9"N, 57°18'58.9"E, 2045m, 10.xiii.2015, swept on *Medicago sativa* L. (S. Safahani leg.); 1♀, Kerman, Negar, 29°38'42.4"N, 56°43'52.9"E, 2126m, swept on *Medicago sativa* L. (S. Safahani leg.); 4♀, Kerman, Kuhpayeh, Deh Saleh, 30°29'03.7"N, 57°19'39.1"E, 1807m, 22.ix.2014, swept on *Medicago sativa* L. (S. Kazemi leg.).

Diagnosis: Oral cavity not developed. Temples half long as eye. Face smooth. Mandibles basally broadened. In fore wing, vein r present. Vein 3-SR longer than 2-SR vein in fore wing. Mesoscutal pit rounded. Scutellum and propodeum smooth. Precoxal suture smooth. Metasoma reddish dark brown. First metasomal tergite about as long as its maximum width.

Distribution in Iran: Kerman (new record for Iran).

8. *Opius (Cryptonastes) pygmaeus* Fischer, 1962

Material examined: 2♀, Kerman, Bidkhan, 29°35'27.9"N, 56°30'44.2"E, 2861m, 02.vii.2014, swept on *Medicago sativa* L. (F. Abdolalizadeh leg.); 2♀, Kerman, Sirch, 30°11'58.5"N, 57°33'50.7"E, 1689m, 01.ix.2014, swept on *Rubus* sp., (M. Iranmanesh leg.).

Distribution in Iran: Fars (Lashkari Bod et al., 2010, 2011), Lorestan (Ghahari et al., 2012a) and Kerman.

9. *Opius (Hypocynodus) bouceki* Fischer, 1958

Material examined: 3♀, Kerman, Baft Dam, 29°14'32.4"N, 56°37'42.8"E, 2301m, 11-25.ix.2015, Malaise trap (S. Safahani leg.); 1♀, Kerman, Qal-eh-Askar, 29°30'31.5"N, 56°40'06.0"E, 2660m, 31.viii.2015, swept on *Medicago sativa* L. (S. Safahani leg.); 2♀, Kerman, Qal-eh-Askar, 2677m, 16-31.viii.2015, Malaise trap (S. Safahani leg.).

Distribution in Iran: Sistan & Baluchestan (Khajeh et al., 2014) and Kerman.



Figure 2. *Opius (Cryptonastes) gracilis* Fischer, 1957: habitus, lateral view (female).

10. *Opius (Hypocynodus) flavipes* Szepliget, 1898

Material examined: 1♀, Kerman, Bidkhan, 29°35'27.9" N, 56°30'44.2"E, 2861m, 02.vii.2014, swept on *Medicago sativa* L. (F. Abdolalizadeh leg.); 1♀, Kerman, Kuhbanan-Zarand Rd., 31°08'55.7"N, 56°31'13.8"E, 2412m, 22.viii.2015, swept on *Medicago sativa* L. (S. Safahani leg.); 1♀, Kerman, Negar, 29°38'42.4"N, 56°43'52.9"E, 2126m, 28.viii.2015, swept on *Medicago sativa* L. (S. Safahani leg.).

Distribution in Iran: Hormozgan (Ameri et al., 2014) and Kerman.

11. *Opius (Misophthora) seductus* Fischer, 1959

Material examined: 1♀, Kerman, Negar, 29°51'58.9"N, 56°47'21.7"E, 2097m, 26.ix.2014; swept on *Mentha pulegium* (F. Abdolalizadeh leg.); 1♀, Kerman, Qal-eh-Askar, 29°30'39.9"N, 56°39'52.1"E, 2677m, 16–31.viii.2015, Malaise trap (S. Safahani leg.).

Distribution in Iran: Isfahan (Ghahari et al., 2011b) and Kerman.

12. *Opius (Opiothorax) longicornis* Thomson, 1895

Material examined: 1♀, Kerman, Dashtkar, 29°53'28.7" N, 56°42'09.0"E, 2077m, 04.ix.2014, swept on *Medicago sativa* L. (F. Abdolalizadeh leg.); 1♀, Kerman, Kuhpayeh-Nehzat Abad, 30°25'38.9"N, 57°18'58.9"E, 2045m, 10.viii.2015, swept on *Anethum graveolens* L. (S. Safahani leg.).

Distribution in Iran: Guilan (Ghahari et al., 2012b) and Kerman.

13. *Opius (Opiothorax) opacus* Fischer, 1968

Material examined: 1♀, Kerman, Kuhbanan-Zarand Rd., 31°08'55.7"N, 56°31'13.8"E, 2412m, 22.viii.2015, swept on *Medicago sativa* L. (S. Safahani leg.).

Distribution in Iran: Sistan & Baluchestan (Khajeh et al., 2014) and Kerman.

14. *Opius (Opius) lugens* Haliday, 1837

Material examined: 1♀, Kerman, Sirch, 30°11'585"N, 57°33'507"E, 1689m, 01.ix.2014, swept on *Rubus* sp. (M. Iranmanesh leg.); 2♀, Kerman, Kuhpayeh-Vamegh Abad, 30°30'47.9"N, 57°16'21.2"E, 2057m, 11.viii.2015, swept on *Medicago sativa* L. (S. Safahani leg.); 1♀, Kerman, Negar-Gumane, 29°51'58.3"N, 56°48'41.2"E, 2106m, 28.viii.2015, swept on *Medicago sativa* L. (S. Safahani leg.).

Distribution in Iran: Kermanshah (Ghahari & Fischer, 2012) and Kerman.

15. *Opius (Opius) pallipes* Wesmael, 1835

Material examined: 3♀, Kerman, Bidkhan, 29°35'27.9"N, 56°30'44.2"E, 2861m, 02.vii.2014, swept on *Medicago sativa* L. (F. Abdolalizadeh leg.); 1♀, Kerman, Kuhpayeh-Deh Ghazi, 30°26'43.1"N, 57°18'54.7"E, 1984m, 21.viii.2014, swept on *Medicago sativa* L. (S. Safahani leg.); 2♀, Kerman, Sirch, 30°11'58.5"N, 57°33'50.7"E, 1689m, 01.ix.2014, swept on *Rubus* sp. (M. Iranmanesh leg.); 1♀, Kerman, Sirch, 30°11'58.5"N, 57°33'50.7"E, 1689m, 01.ix.2014, swept on *Medicago sativa* L. (M. Iranmanesh leg.); 7♀, Kerman, Kuhpayeh-Vamegh Abad, 30°30'47.9"N, 57°16'21.2"E, 2057m, 10.viii.2015, swept on *Medicago sativa* L. (S. Safahani leg.); 8♀, Kerman, Kuhpayeh-Vamegh Abad, 30°30'47.9"N, 57°16'21.2"E, 2057m, 11.viii.2015, swept on *Medicago sativa* L. (S. Safahani leg.); 3♀, Kerman, Kuhbanan-Fidkoiyeh, 31°27'24.9"N, 56°11'16.8"E, 2114m, 21.viii.2015, swept on *Medicago sativa* L. (S. Safahani leg.); 15♀, Kerman, Kuhbanan-Fidkoiyeh, 31°27'24.9"N, 56°11'16.8"E, 2114m, 22.viii.2015, swept on *Medicago sativa* L. (S. Safahani leg.); 3♀, Kerman, Sirch, 30°11'29.7"N, 57°34'37.8"E, 1637m, 16.vii.2014, swept on *Medicago sativa* L. (M. Iranmanesh leg.).

Distribution in Iran: Guilan (Ghahari et al., 2012b), Sistan & Baluchestan (Khajeh et al., 2014, reported as *Opius (Opius) exilis* Haliday, 1837) and Kerman.

16. *Phaedrotoma diversa* (Szépligeti, 1898)

Material examined: 1♀, Kerman, Sirch, 30°11'58.5"N, 57°33'50.7"E, 1689m, 01.ix.2014, swept on *Rubus* sp. (M. Iranmanesh leg.).

Distribution in Iran: Ardabil (Rastegar et al., 2012, reported as *Opius* (*Phaedrotoma diversa*), Guilan (Ghahari et al., 2012b, reported as *Opius* (*Phaedrotoma diversa*), Sistan & Baluchestan (Khajeh et al., 2014) and Kerman.

17. *Phaedrotoma exigua* (Wesmael, 1835)

Material examined: 1♀, Kerman, Negar, 29°38'42.4"N, 56°43'52.9"E, 2126m, 28.viii.2015, swept on *Medicago sativa* L. (S. Safahani leg.).

Distribution in Iran: Tehran (Fischer 1990), Lorestan (Ghahari et al., 2012a, *Opius* (*Phaedrotoma exiguus*), Sistan & Baluchestan (Khajeh et al., 2014) and Kerman.

18. **Phaedrotoma gafsensis* (Fischer, 1964) (Fig. 3)

Material examined: 1♀, Kerman, Kuhpayeh-Nehzat Abad, 30°25'38.9"N, 57°18'58.9"E, 2045m, 10.viii.2015, swept on *Medicago sativa* L. (S. Safahani leg.).

Diagnosis: Oral cavity developed. Vein 3-SR longer than 2-SR vein. Radial cell not reaching wing apex. Brachial cell on forewing posteriorly open. Mesoscutal pit absent. Precoxal suture smooth. Propodeum smooth. First metasomal tergite smooth. Second metasomal tergite sculptured. Legs dark brown. Hind femur 4.0 times as long as its maximum width. Antennae as long as body. Body black.

Distribution in Iran: Kerman (new record for Iran).

19. **Phaedrotoma scaptomyzae* (Fischer, 1967) (Fig. 4)

Material examined: 1♀, Kerman, Negar, Gumane, 29°51'58.3"N, 56°48'41.2"E, 2106m, 28.viii.2015, swept on *Medicago sativa* L. (S. Safahani leg.).

Diagnosis: Oral cavity developed. Vein 3-SR longer than 2-SR vein. Radial cell not reaching wing apex. Mesoscutal pit absent. Precoxal suture smooth. Propodeum smooth. Hind femur 4.5 times as long as its maximum width. First metasomal tergite rugose. Second metasomal tergite sculptured. Antenna longer than body. Body black.

Distribution in Iran: Kerman (new record for Iran).

Discussion

The phenological emergence of adult Opiinae species in the field of high mountains has been shown in Table 2. As it is possible to see there are "Spring" species which fly from April to May and "Summer" species which fly from July to September.

Before this study only eleven Opiinae species had been recorded from Kerman province (Ranjbar et al., 2016) however as result of this study the number of known species has increased to 19 species. Moreover, three species are recorded for the first time for Iran (*Opius* (*Cryptonastes*) *gracilis* Fischer 1957, *Phaedrotoma gafsensis* (Fischer, 1964) and *Phaedrotoma scaptomyzae* (Fischer, 1967)) increasing the number of known Opiinae to 107 species in Iran. Of 19 species reported in the present study, five species have been already reported from Kerman province (Ranjbar et al., 2016).

On the other hand, this is the first study carried out in high Iranian mountains. In Sirch county, specimens were collected on *Medicago sativa* and *Rubus* sp..

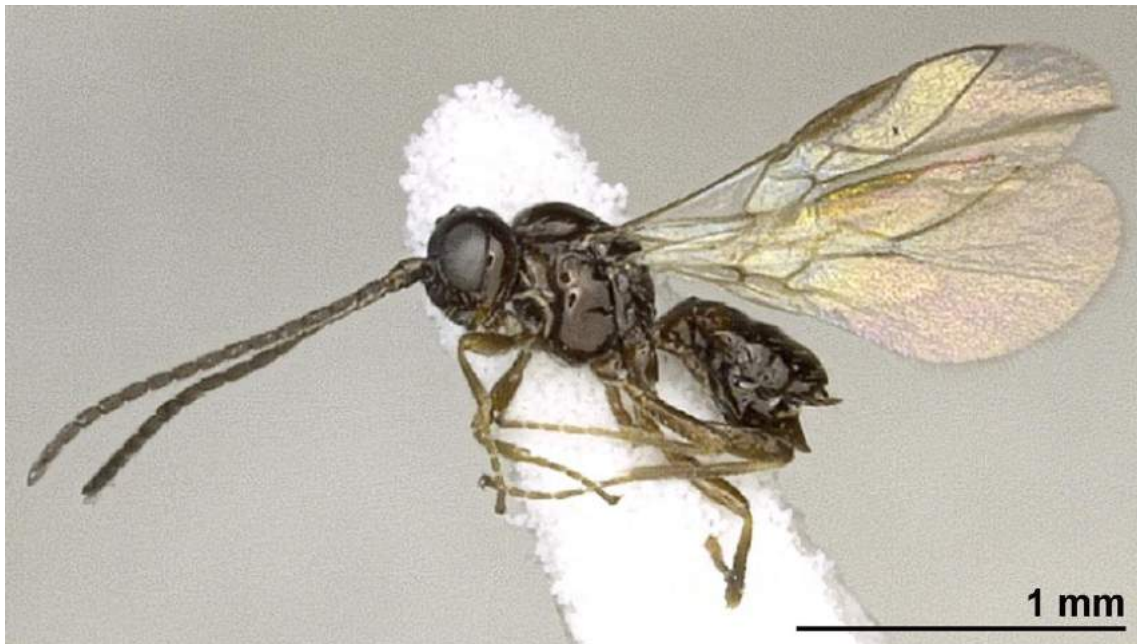


Figure 3. *Phaedrotoma gafsaensis* (Fischer, 1964): habitus, lateral view (female).



Figure 4. *Phaedrotoma scaptomyzae* (Fischer, 1967): habitus, lateral view (female).

Table 2. Phenological data of Opiinae species collected from high mountain localities in Kerman province.

| Species | Apr | May | Jun | Jul | Aug | Sep | Species | Apr | May | Jun | Jul | Aug | Sep |
|---------------------------------------|-----|-----|-----|-----|-----|-----|-------------------------------|-----|-----|-----|-----|-----|-----|
| <i>Biosteres spinaciae</i> | | | | | | | <i>Opius lugens</i> | | | | | | |
| <i>Indiopis cretensis</i> | | | | | | | <i>Opius pallipes</i> | | | | | | |
| <i>Opius (Agnopius) novosimilis</i> | | | | | | | <i>Opius pygmaeus</i> | | | | | | |
| <i>Opius (Agnopius) rex</i> | | | | | | | <i>Opius seductus</i> | | | | | | |
| <i>Opius (Cryptonastes) gracilis</i> | | | | | | | <i>Opius similis</i> | | | | | | |
| <i>Opius (Hypocynodus) bouceki</i> | | | | | | | <i>Opius tabificus</i> | | | | | | |
| <i>Opius (Hypocynodus) flavipes</i> | | | | | | | <i>Phaerotoma diversa</i> | | | | | | |
| <i>Opius (Opiothorax) longicornis</i> | | | | | | | <i>Phaerotoma exigua</i> | | | | | | |
| <i>Opius (Opiothorax) opacus</i> | | | | | | | <i>Phaerotoma gafsensis</i> | | | | | | |
| | | | | | | | <i>Phaerotoma scaptomyzae</i> | | | | | | |

In addition, the phenological analysis showed that Opiinae species could be found in high altitudes from April to September being the highest abundance and diversity on August and September when weather conditions are better. These results are similar that ones found by Jiménez-Peydró & Peris-Felipo (2011) or Falcó-Garí et al. (2014) in continental and Mediterranean forests, where the most abundant period was from May to August, coinciding with the greatest herbaceous diversity.

To conclude, it is necessary to mention that still some areas of the province have not investigated to date and more investigations are necessary to increase the knowledge of diversity and applicability of this group of parasitoids in Kerman Province.

Acknowledgments

This research was supported by Shahid Bahonar University of Kerman, Kerman, Iran, which is greatly appreciated.

Conflict of Interests

The authors assert that there is no conflict of interest regarding the publication of this paper.

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فون و فنولوژی زنبورهای زیرخانواده (Opiinae (Hymenoptera: Braconidae) در مناطق مرتفع استان کرمان، ایران

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تاریخ دریافت: ۵ فروردین ۱۳۹۷، تاریخ پذیرش: ۲۰ تیر ۱۳۹۷، تاریخ انتشار: ۳۱ مرداد ۱۳۹۷

چکیده: در مقاله حاضر اطلاعاتی در خصوص فون و فنولوژی گونه‌های زیرخانواده Opiinae (Hymenoptera: Braconidae) که از مناطق مرتفع در استان کرمان (جنوب شرقی ایران) جمع آوری شدند ارائه شده است. نمونه‌برداری از اردیبهشت ماه ۱۳۹۳ تا شهریور ماه ۱۳۹۴ انجام شد. ۱۹ گونه متعلق به چهار جنس جمع‌آوری و شناسایی گردید. از بین گونه‌های جمع‌آوری شده سه گونه *Opius (Cryptonastes)* Fischer 1957 *gracilis* و *Phaedrotoma gafsaensis* (Fischer 1964) و *Phaedrotoma scaptomyzae* (Fischer, 1967) برای اولین بار از ایران گزارش می‌شوند.

واژگان کلیدی: Opiinae, Braconidae. مناطق مرتفع، پارازیتوییدها، ایران، گزارش‌های جدید