

Study of three genera of the *Orthocentrus* genus-group (Hymenoptera: Ichneumonidae, Orthocentrinae) in northern Iran

Abbas Mohammadi-Khoramabadi¹ & ², Ali Asghar Talebi¹ & *

1- Department of Entomology, Faculty of Agriculture, Tarbiat Modares University, P.O.Box: 14115-336, Tehran, Iran, 2- Department of Plant Production, College of Agriculture and Natural Resources of Darab, Shiraz University, Darab, Iran.

*Corresponding author, E-mail: talebia@modares.ac.ir

Abstract

The subfamily Orthocentrinae comprises a diverse group of ichneumonid parasitoid wasps. The species of three genera of the *Orthocentrus* genus-group (Hymenoptera: Ichneumonidae, Orthocentrinae) was studied in northern Iran: *Batakamacrus* Kolarov, *Plectiscus* Gravenhorst and *Stenomacrus* Förster. A total of 847 specimens of these genera were collected from Alborz, Tehran, Qazvin, Gilan and Mazandaran provinces using Malaise traps during 2010-2011. Nine species including *Batakamacrus caudatus* (Holmgren, 1858), *Plectiscus agilis* (Holmgren, 1858), *P. minutus* (Holmgren, 1858), *Stenomacrus carbonariae* Roman, 1939, *S. curvicaudatus* (Brischke, 1871), *S. deletus* (Thomson, 1897), *S. exserens* (Thomson, 1898), *S. merula* (Gravenhorst, 1829) and *S. minutissimus* (Zetterstedt, 1838) are recorded for the first time from Iran. Their phenology, seasonal abundance, adult emergence period, distribution and altitudinal changes on two northern and southern slopes of the Alborz Mountains of Iran are provided. Our data showed that the Caspian Hyrcanian forests at the northern slope of the Alborz Mountains inhabit a more diverse and higher abundant community of *Orthocentrus* genus-group than the southern one.

Key words: Hyrcanian forests, distribution, parasitoid, taxonomy, new record.

مطالعه سه جنس از گروه جنس *Orthocentrus* (Hymenoptera: Ichneumonidae, Orthocentrinae) در شمال ایران

Orthocentrinae در شمال ایران

عباس محمدی خرم آبادی^۱ و^۲ و علی اصغر طالبی^۱ *

۱- گروه حشره‌شناسی، دانشکده کشاورزی، دانشگاه تربیت مدرس، صندوق پستی ۳۳۶-۱۴۱۱۵، تهران، ایران، ۲- گروه تولیدات گیاهی، دانشکده کشاورزی و منابع طبیعی داراب، دانشگاه شیراز، داراب، ایران.

* مسئول مکاتبات، پست الکترونیکی: talebia@modares.ac.ir

چکیده

زیرخانواده Orthocentrinae دربرگیرنده گروه متنوعی از زنبورهای پارازیتوئید ایکثنومونید می باشد. گونه‌های سه جنس از گروه جنس *Orthocentrus* (Hymenoptera: Ichneumonidae, Orthocentrinae) شامل *Batakamacrus* Kolarov، *Plectiscus* Gravenhorst و *Stenomacrus* Förster در شمال ایران مورد مطالعه قرار گرفت. در مجموع ۸۵۵ فرد از سه جنس مذکور از استان‌های البرز، تهران، قزوین، گیلان و مازندران با استفاده از تله مالیز در سال‌های ۱۳۸۸ و ۱۳۸۹ جمع‌آوری گردید. ۹ گونه شامل *Batakamacrus caudatus* (Holmgren, 1858)، *Plectiscus agilis* (Holmgren, 1858)، *P. minutus* (Holmgren, 1858)، *S. carbonariae* Roman, 1939، *S. curvicaudatus* (Brischke, 1871)، *S. merula* (Gravenhorst, 1829)، *S. exserens* (Thomson, 1898)، *S. deletus* (Thomson, 1897) و *S. minutissimus* (Zetterstedt, 1838) برای اولین بار از ایران گزارش می‌شوند. فنولوژی این گونه‌ها، فراوانی فصلی، دوره ظهور افراد بالغ، پراکنش و تغییرات ارتفاعی آن در دو شیب شمالی و جنوبی رشته‌کوه‌های البرز فراهم گردید. داده‌های این مطالعه نشان می‌دهند که جنگل هیرکانی واقع در شیب‌های شمالی رشته‌کوه‌های البرز از تنوع گونه‌ای بالاتر و فراوانی بیشتر گونه‌های گروه جنس *Orthocentrus* نسبت به شیب‌های جنوبی برخوردار است.

واژه‌های کلیدی: جنگل‌های هیرکانی، پراکنش، پارازیتوئید، تاکسونومی، گزارش جدید.

دریافت: ۹۶/۹/۵، پذیرش: ۹۶/۱۱/۲۳.

Introduction

The subfamily Orthocentrinae (Hymenoptera: Ichneumonidae) contains 446 described species classified into 31 genera, most of which have been described from the Holarctic region (Yu *et al.*, 2012). Where known, orthocentrines have been found to be larval koinobiont endoparasitoids of Keroplatidae, Mycetophilidae and Sciaridae (Insecta: Diptera) (Aubert, 1981; Wahl & Gauld, 1998; Humala *et al.*, 2017) and can thus be found in damp localities. Townes's Orthocentrinae (Townes, 1971) and Orthocentrini sensu Humala (Humala, 2007) are now known as the *Orthocentrus* genus-group, which includes seven genera (*Orthocentrus*, *Batakomacrus*, *Stenomacrus*, *Neurateles*, *Plectiscus*, *Picrostigeus* and *Chilocyrtus*) comprising a monophyletic distinctive group within this subfamily (Wahl & Gauld, 1998; Broad, 2010).

The genus *Batakomacrus* was described by Kolarov from Bulgaria and has been reported from Palaearctic and Neotropical regions (Kolarov, 1986; Broad, 2010; Humala, 2010). *Batakomacrus* is placed in a basal clade within the *Orthocentrus* genus-group with a unique and distinct shape of the metasoma (Broad, 2010). Eleven species of *Plectiscus* Gravenhorst, 1829 have been described from a wider distributional range in the Nearctic, Palaearctic and Ethiopian regions (Aubert, 1981; Kolarov, 1986; Jussila, 2007; Yu *et al.*, 2012). According to numbers of described species, *Stenomacrus* Förster is the most diverse taxon in the *Orthocentrus* genus-group, with about 73 described species which are mainly distributed in the Holarctic, with a small number described from the Neotropical region (Yu *et al.*, 2012). After Aubert's (1981) revision of the western Palaearctic species of the genus, there have been a few taxonomic changes (Kolarov, 1986; Horstmann, 1992, 2006; Horstmann & Yu, 1998; Broad, 2010). The vast majority of species of the *Orthocentrus* genus-group has been remained undescribed (Veijalainen *et al.*, 2013, 2014; Zwakhals & Diller, 2015) and the patterns of diversity of the genera are poorly reflected in the numbers of described species.

The central north of Iran which includes five Iran's provinces (Alborz, Tehran, Qazvin, Gilan and Mazandaran) provides diverse climatic conditions and water supplies for unique vegetation, natural biomes as well as agricultural areas. These regions located on the southern and northern slopes of the Alborz Mountains and include very suitable habitats for Orthocentrinae within Iran. As we know, 18 species of Orthocentrinae have been reported from Iran among them 11 species collected from northern part (Amirinasab, 2016; Bakhtiarynasab *et al.*, 2014; Barahoei *et al.*, 2012, 2014; Ghafouri Moghaddam *et al.*, 2016; Ghahari & Jussila 2010, 2016; ; Hooshyar *et al.*, 2012; Hooshyar & Vafaei-Shoushtari, 2013; Mohammadi-khoramabadi & Talebi, 2013; Mohammadi-Khoramabadi *et al.*, 2014, 2016; Mohebban *et al.*, 2016; Sarafi *et al.*, 2015)

This paper provides new distribution data for the species of three genera of the *Orthocentrus* genus-group (*Batakomacrus*, *Plectiscus* and *Stenomacrus*) which were

collected using Malaise traps during 2010-2011 in the central north of Iran. With this large scale sampling, phenology, abundance, habitat preference and altitudinal faunal changes of these genera on two slopes of the Alborz Mountains are provided.

Material and methods

Study sites

The present study was carried out in 16 localities (30 Malaise traps) in Alborz, Tehran, Gilan, Qazvin and Mazandaran provinces (35°40' N and 37°22' E) in the central north of Iran during 2010 and 2011 (Fig. 1). The Alborz Mountains separate the tropical Caspian Sea area (Gilan and Mazandaran provinces) from Alborz, Tehran and Qazvin provinces. Gilan and Mazandaran provinces, with an area of 14,042 km² and 23,842 km² respectively, extend along the Caspian Sea and in the northern slopes of the Alborz Mountains. Gilan and Mazandaran have a humid subtropical climate with heavy annual rainfall of about 1500 mm, moderate temperature, and high relative humidity leading to diverse vegetation. The relative humidity is about 80%, which decreases with altitude. The Alborz Mountains provide many unique types of vegetation at various altitudes in addition to the Caspian coast flora. The known natural biome of this region is the Caspian Hyrcanian mixed forests but coastal plains have been almost completely converted to urban sites and rice paddies. As the elevation increases, the flora gradually differentiates and diversifies from humid forests below 500 m a.s.l. to pure oriental Beech or mixed forests at middle altitude (500-1000 m a.s.l.). Shrub lands and steppe occur in the upper mountains and the highest elevations are covered with Alpine tundra and meadows (Marvie Mohajer, 2006; Siadati *et al.*, 2010). Alborz and Tehran provinces cover an area of 18,909 km² and located in the southern slopes of the Alborz Mountains with various vegetation and climates. This area receives an average annual rainfall of about 240 mm that usually starts from October. The southern part of these provinces has a semi-arid steppe climate and the northern one an alpine character. The climate in the mountain regions of northern Alborz and Tehran is cold and semi-humid and at higher elevations is cold with a long winter. These provinces are the most densely populated regions in Iran with many different valleys and rivers which makes them very heterogeneous with agricultural production as well as with rich pastures. Qazvin province, in the north-west of Iran and west of Alborz province, covers an area of 15,821 km². Similar to Alborz province, the climate of Qazvin province in the northern parts is cold and snowy in winter and temperate in summer. In the southern parts the climate is mild with comparatively cold winters and warm summers (IRIMO, 2017).

Collecting specimens

Material for the present study was collected using Malaise traps with 70 % ethanol as a killing and preservation agent. Sampling was carried out from March to November during

2010 and 2011 at four localities in Alborz, Gilan and Mazandaran provinces, at three localities in Qazvin province and at one locality in Tehran province. Two Malaise traps were placed in each locality. They were placed in different habitats such as forests, pastures or orchards. The geographical and main floristic characteristics of each locality are presented in Table 1. Sampling procedures were similar for all localities. The specimens were extracted from Malaise traps and sorted weekly in 2010 and at biweekly intervals in 2011. They were then preserved in 70% ethanol or card-mounted and labeled. Images were taken with an Olympus SZX9 stereomicroscope with a Sony 8.1 digital camera. Image stacking was done with Combine ZP software (Hadley, 2010) and additional photo editing with Adobe Photoshop software (Adobe Photoshop, 2012). The collected specimens were identified using Aubert (1981), Horstmann (1994), Broad (2010) and Jussila (2007)'s keys and interpretations. The following measurements and indices were used: forewing length: length of forewing from the edge of the tegula to the apex of the wing in mm; Lwfl index: length of first flagellomere divided by apical width in anterior view, O/HT index (ovipositor–hind tibia index): length of the ovipositor projecting beyond the apex of the hypopygium divided by the length of the hind tibia; Specimens are deposited in the insect museum of the Department of Entomology, Tarbait Modares University, Tehran, Iran (ITMU), and Natural History Museum, London, United Kingdom (BMNH).

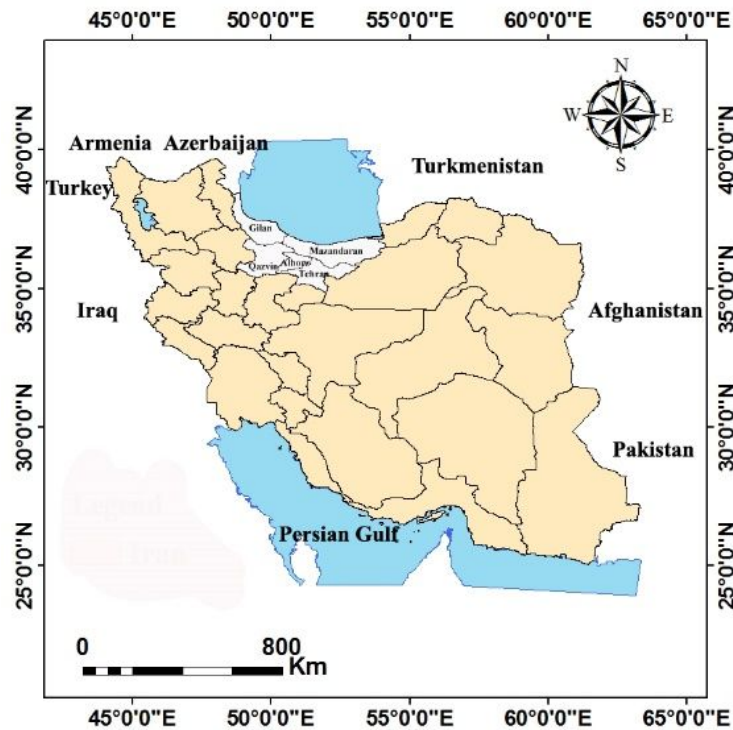


Fig. 1. Iran's provinces (Alborz, Tehran, Qazvin, Gilan and Mazandaran provinces) where sampling was carried out during 2010 and 2011.

Results

A total of 847 specimens including 36 female specimens of *Batakocomacrus* sp., 55 (16 males and 39 females) specimens of *Plectiscus* sp., and 756 (541 males and 216 females) specimens of *Stenomacrus* sp. were collected from northern Iran

during 2010-2011, representing 10 species in the north central Iran. Nine species are new records for the Iranian fauna.

Table 1- Geographical and floristic characteristics of sampling locations in Alborz, Tehran, Qazvin, Gilan and Mazandaran provinces during 2010 and 2011.

Locality	Geographical coordinates	Altitude (m)	Habitat
Shahryar, Tehran province	N= 35° 40 135 , E= 50° 56 944	1168	Rosaceous Orchard
Karaj, Alborz province	N= 35° 46 336 , E= 50° 56 79	1278	Rosaceous Orchard
Asara, Arangeh, Alborz province	N= 35° 55 120 , E= 51° 05 154	1891	Rosaceous Orchard
Asara, Sarziarat, Alborz province	N= 35° 55 173 , E= 51° 06 854	1980	Rosaceous Orchard
Asara, Shahrestanak, Alborz province	N= 35° 57 583 , E= 51° 22 329	2305	Rosaceous Orchard and pasture
Astaneh-e-Ashrafieh , Gilan province	N= 37° 22 61 , E= 49° 57 964	-1	Humid forest
Rudsar, Rahimabd, Ziaz, Gilan province	N= 36° 52 574 , E= 50° 13 290	537	Hazelnut
Rudsar, Rahimabad, Orkom, Gilan province	N= 36° 45 739 , E= 50° 18 198	1201	Deciduous forests and hazelnut
Rudsar, Rahimabad, Ghazichak, Gilan province	N= 36° 45 959 , E= 50° 19 587	1803	Hazelnut and pasture
Rudbar, Loshan, Gilan province	N= 36° 40 152 , E= 49° 25 629	291	Olive orchards
Qazvin, Zereshk Road, Qazvin province	N= 36° 21 717 , E= 50° 03 887	1541	Almond and walnut orchards
Qazvin, Zereshk, Qazvin province	N= 36° 25 398 , E= 50° 06 628	1926	Rosaceous Orchard
Nur, Jourband, Mazandaran province	N= 36° 26 288 , E= 52° 07 227	272	Citrus orchards
Nur, Chamestan, Tangevaz, Mazandaran province	N= 36° 21 917 , E= 52° 06 179	692	Deciduous forests
Nur, Chamestan, Jangal-e Vaz, Mazandaran province	N= 36° 18 857 , E= 52° 07 800	1353	Deciduous forests
Nur, Chamestan, Gaznasara, Mazandaran province	N= 36° 16 947 , E= 52° 10 975	2032	pasture

Genus *Batakocomacrus* Kolarov, 1986

(Fig. 2)

Diagnosis: *Batakocomacrus* can be identified by the combination of the following features: lower mandibular tooth present and visible when mandible closed; vein 3rs-m of forewing present (Fig. 2 B), hind wing with vein cu-a vertical and abscissa of vein 2Cu angulate (Fig.

2 C); malar space with narrowly impressed sulcus (Fig. 2 A); metasoma elongate, 3rd tergite longer than 2nd (Fig. 2 E), apical tergites blade-like and capable of extension, ovipositor at rest originating far anterior of metasomal apex, capable of being hinged outwards (Fig. 2 D); male genital parameres not projected beyond apex of metasomal tergites (Kolarov, 1986; Broad, 2010; Humala, 2010).

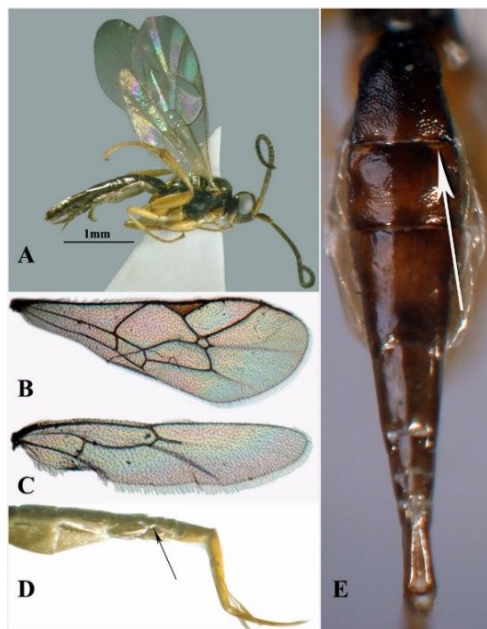


Fig. 2. *Batakamacrus caudatus*, female; A. General habitus, lateral view; B. Forewing; C. Hind wing; D. Metasoma, lateral view (arrow shows rectangle emargination of third tergite); E- Metasomal tergites, dorsal view (arrow shows 1stthyridium).

***Batakamacrus caudatus* (Holmgren, 1858)**

(Fig. 2 A–E)

Material examined: Material in IRAN, Gilan province: Rudsar, Rahimabd, Ziaz (N= 36°52' 574" E= 50°13' 290", 537 m a.s.l.) 9, 13.III- 05.IV.2010, 7, 05-12.IV.2010, 1, 12-19.IV.2010, 5, 19-26.IV.2010, 1, 03-10.V.2010, 4, 01-7.VI.2010, 1, 21-28.VI.2010, 2, 28.VI-05.VII.2010, 1, 12-19.VII.2010, 2, 19-26.VII.2010; Mazandaran province: Nur, Chamestan, Tangevaz (N= 36° 21' 917" E= 52° 06' 179", 692 m a.s.l.) 1, 13-30.IV.2011, 1, 11.X- 6.XI.2011, Leg. A. Mohammadi-Khoramabadi. Material in BMNH: IRAN, Gilan province: Rudsar, Rahimabd, Ziaz (N= 36° 52' 574" E= 50° 13' 290", 537 m a.s.l.) 1, 19-26.IV.2010, Leg. A. Mohammadi-Khoramabadi.

General distribution: Azerbaijan, Bulgaria, Croatia, Finland, Germany, Hungary, Lithuania, Macedonia, Norway, Poland, Portugal (Madeira), Russia, Sweden, Ukraine, UK (Kolarov, 1986; Broad, 2010; Humala, 2010) and Iran (new record).

Diagnosis: *Batakamacrus caudatus* can be identified by the combination of the following characters: Face black (Fig. 2A); 2nd metasomal tergite shiny with faint coriaceous sculpture, 1stthyridiae narrow, 2nd thyridiae faint (Fig. 2E); 3rd metasomal tergites onwards with a conspicuous rectangular posterior emargination (Fig. 2D); wings venation as in Fig. 2 B,C.

Remarks: Our collection data showed that all the specimens of *B. caudatus* were collected only on the northern slopes of the Alborz mountains of Iran at middle altitudes of about

Genus *Plectiscus* Gravenhorst, 1829

(Fig. 3)

Diagnosis: *Plectiscus* can be distinguished from other genera of *Orthocentrus* genus group by the following characters: epicnemial carina absent (Fig. 3 E); propodeum with pleural carina (Fig. 3 E); ovipositor short and straight (Fig. 3 A); mesoscutum usually uniformly hairy; metasomal tergite 2 usually strongly coriaceous/aciculate, rarely elongate (Fig. 3 C); forewing with rather long and vertical vein 2rs-m, usually with obviously shorter abscissa of M between it and vein 2m-cu (Fig. 3 B).

Key to the *Plectiscus* species known from Iran

- 1- First antennal flagellomere 3.0 x as long as wide (Fig. 3 A); first and second metasomal tergites strongly striate (Fig. 3 C) *P. agilis*
 - First antennal flagellomere about 4.3 x as long as its width (Fig. 3 E); only first metasomal tergite striate *P. minutus*

Plectiscus agilis (Holmgren, 1858)

(Figs 3 A–C)

Material examined: Material in IRAN, Gilan province: Rudsar, Rahimabd, Ziaz (N= 36° 52' 574" E= 50° 13' 290" , 537 m a.s.l.) 1 ♂, 01-07.VI.2010; Mazandaran province: Nur, Jourband (N= 36° 26' 288" E= 52° 06' 225" , 272 m a.s.l.) 1 ♂, 10-22.VI.2011, 1 ♀, 28.VII-16.VIII.2011, 3 ♂, 07-26.IX.2011, 2 ♀, 27.IX – 11.X.2011, 4 ♂, 2 ♀, 11.X- 06.XI.2011; Nur, Chamestan, Tangevaz (N= 36° 21' 917" E= 52° 6' 179" , 692 m a.s.l.) 1 ♂, 2 ♀, 28.VII-16.VIII.2011, 1 ♂, 2 ♀, 16.VIII–06.IX.2011, 8 ♂, 3 ♀, 07-26.IX.2011, 7 ♂, 4 ♀, 27.IX-11.X.2011, 6 ♂, 11.X – 06.XI.2011; Nur, Chamestan, Jangal-e Vaz (N= 36° 18' 857" E= 52° 07' 800" , 1353 m a.s.l.) 3 ♂, 1 ♀, 11-27.VII.2011, 1 ♀, 28.VII- 16.VIII.2011, Leg. A. Mohammadi-Khoramabadi. Material in BMNH: IRAN, Mazandaran province: Nur, Chamestan, Tangevaz (N= 36° 21' 917" E= 52° 6' 179" , 692 m a.s.l.) 1 ♀, 07-26.IX.2011, Leg. A. Mohammadi-Khoramabadi.

General distribution: Austria, Bulgaria, Finland, France, Germany, Latvia, Lithuania, The Netherlands, Poland, Russia, Sweden, United Kingdom (Yu *et al.*, 2012) and Iran (new record).

Diagnosis: Female (Fig. 3 A):Lwff1 index= 3, metasomal tergites 1 and 2 distinctly striate (Fig. 3 C), other metasomal tergites conspicuously laterally compressed (Fig. 3 A, C); anterior half of mesoscutum uniformly setose and posterior part with scattered setae; wing venation as in Fig. 3 B; fore wing 2.8 times and hind wing 3.2 times longer than maximum width.

Remarks: *Plectiscus agilis* was the most abundant species of the genus, comprising 95% of all *Plectiscus* collected specimens. Collection data showed that adults of *P. agilis* emerged from late spring and mostly summer to early autumn in northern Iran, when

temperature was at its highest in this region. 24% of specimens were collected in Jourband at an elevation of about 300 m, 67% in Tangevaz and Ziaz at an elevation of about 700 m and only 9% at an elevation of about 1400m. It may indicate that *P. agilis* prefers an altitude of about 700 m and can be distributed up to 1500 m in the north of Iran. Another interesting point was that this species is mainly distributed in Mazandaran province in the eastern extension of the Caspian Hyrcanian forest biome and was the dominant species of the *Orthocentrus* genus-group in this region (Table 2).

Plectiscus minutus (Holmgren, 1858)

(Fig. 3 D–E)

Material examined: IRAN, Gilan province: Rudsar, Rahimabad, Orkom (N= 36°45' 739 ; E= 50°18' 198 , 1201 m a.s.l.) 1 ♂, 24-31.V.2010, Leg. A. Mohammadi-Khoramabadi.

General distribution: Austria, Belgium, Bulgaria, Czech Republic; Slovakia, Finland, France, Germany, Hungary, Ireland, Lithuania, The Netherlands, Norway, Poland, Russia, Sweden, United Kingdom (Yu *et al.*, 2012) and Iran (new record).

Diagnosis: *Plectiscus minutus* females can be identified by the long and thin first flagellomere (Lwff1 index in our male specimen was 4.3) (Fig. 3 D, E), metasoma with first tergite finely striate and tergite 2 smooth.

Remarks: *Plectiscus minutus* were just sampled from the northern slopes of the Alborz Mountains in Gilan province.

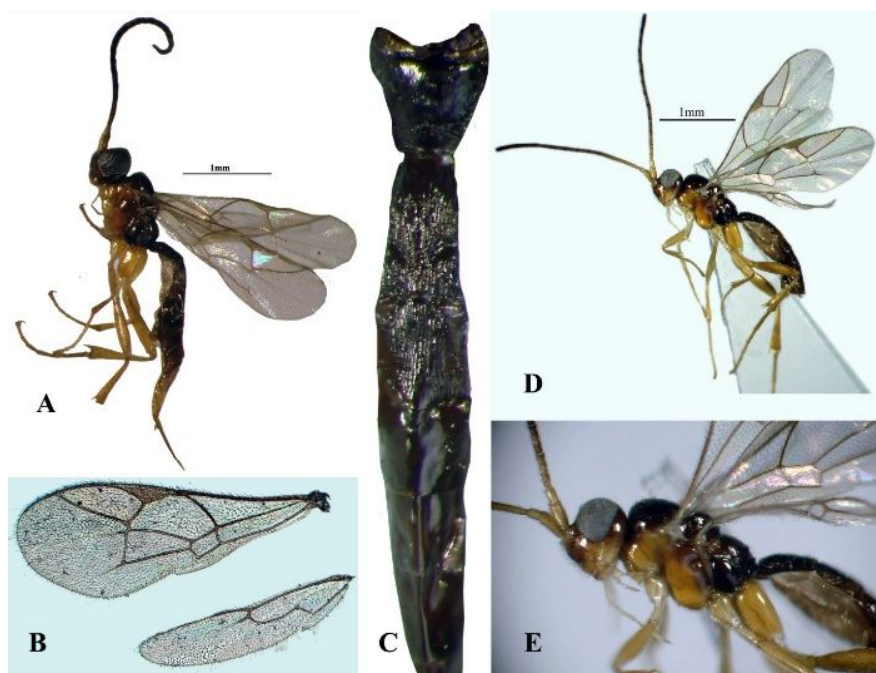


Fig. 3. *Plectiscus agilis*, female (A-C). A. General habitus, lateral view; B. Fore and hindwings; C. Metasoma, dorsal view; *Plectiscus minutus*, male (D-E). D. General habitus, lateral view; E. Head and thorax, lateral view.

Genus *Stenomacrus* Förster, 1869

(Figs 4–7)

Diagnosis: *Stenomacrus* can be identified by a combination of the following characters: mesopleuron with epicnemial carina present laterally (Fig. 6 A); lower mandibular tooth much smaller than upper one, or inner edge hardly visible in anterior or antero-ventral view (Fig. 6 D, E); propodeum usually with posterior transverse and median longitudinal carina; male hypopygium with an apical row of setae.

Key to *Stenomacrus* species known from Iran

- 1- Forewing with vein 3rs-m present (Fig. 5 B, C) 2
 - Forewing with vein 3rs-m absent (Figs. 4 C, 6 B, 7 A) 3
- 2- Forewing with vein Rs vein originating before the middle of a narrow stigma; areolet rather pentagonal (Fig. 5 B); leg III dark; Lwff1 index of female about 1.2 and of male about 2.0] *S. curvicaudatus*
 - Forewing with vein Rs originating near the middle of a broad stigma; areolet quadrate and large (Fig. 5 C); Lwff1 index of female = 2.0; propodeum with dorsal longitudinal carina; metasoma with first tergite coriaceous, dorsal carina absent and 2.0 x as long as apically wide; second tergite smooth *S. deletes*
- 3- Lwff1 index of female less than 2.0; forewing with vein Rs originating in anterior 1/3 of pterostigma (Fig. 7 A); propodeum with dorsal longitudinal carina; metasoma with first tergite longer than wide about 2.0 x as long as wide; forewing with abscissa of vein cu originating before the middle of 2cu (Fig. 7 A) *S. merula*
 - Lwff1 index of female more than 2.0; forewing with vein Rs originating in the middle of pterostigma (Figs. 4 C, 6 B, 7 C) 4
- 4- Propodeum smooth without dorsal longitudinal carina, first metasomal tergite smooth, shiny, without dorsal longitudinal carina (Fig. 7 E), Lwff1=3.0 *S. minutissimus*
 - Propodeum with dorsal longitudinal carina present 5
- 5- Propodeum and first tergite of metasoma strongly coriaceous (Fig. 6 C); first tergite of metasoma with dorsal longitudinal carina; second tergite transverse and coriaceous; ovipositor upcurved (Fig. 6 A) *S. exserens*
 - First tergite of metasoma smooth or finely sculptured 6
- 6- Lwff1 index of female about 2.0 and of male about 2.5; wing veins dark black (Fig. 4 A, C); male with lower face, gena and frontal orbits white-yellow; body length about 4.0 mm *S. carbonariae*
 - Lwff1 index about 3.0, body length about 2.0 mm *S. affinitor*
-

***Stenomacrus affinator* Aubert, 1981**

Material examined: IRAN: Gilan province: Rudsar, Rahimabad, Orkom (N= 36° 45' 739 E= 50° 18' 198 , 1201-1225 m a.s.l.) 2 , 07-14.VI.2010, Leg. A. Mohammadi-Khoramabadi.

General distribution: Bulgaria, France, Germany, Greece, Madeira, Turkey (Yu *et al.*, 2012) and Iran, Kerman (Bakhtiarynasab *et al.*, 2014).

Diagnosis: *Stenomacrus affinator* is a small species, about 2.5 mm, with a long first flagellomere (Lwff1 index about 3), forewing with Rs vein originating from the middle of pterostigma, propodeum with dorsal longitudinal carina present and first tergite with dorsal longitudinal carina and shiny.

Remarks: *Stenomacrus affinator* was sampled only on the northern slopes of the Alborz Mountains, Gilan province at an elevation of 1200 m, with deciduous forest and hazel plantations and moderate climate.

***Stenomacrus carbonariae* (Roman, 1939)**

(Fig. 4 A–C)

Material examined: IRAN: Gilan province: Rudsar, Rahimabd, Ziaz (N= 36° 52' 574 E= 50° 13' 290 , 537 m) 1 1 , 13.III.2010-05.IV.2010, 2 , 24- 31.V.2010, Rudsar, Rahimabad, Orkom (N= 36° 45' 739 E= 50° 18' 198 , 1201-1225 m a.s.l.) 1 , 13.III.2010-05.IV.2010, 3 11 , 26.IV.2010- 03.V.2010, 2 , 03-10.V.2010, 1 , 07-14.VI.2010, Rudsar, Rahimabad, Ghazichak (N= 36° 45' 959 E= 50° 19' 587 , 1787-1803 m a.s.l.) 7 10 , 26.IV.2010-03.V.2010, 6 12 , 03-10.V.2010, 2 , 10-17.V.2010, 3 , 17-24.V.2010, 1 , 24-31.V.2010, 1 , 01-07.VI.2010, 1 , 07-14.VI.2010, 1 , 01 -08.XI.2010, Leg. A. Mohammadi-Khoramabadi.

General distribution: Bulgaria, France, United Kingdom (Yu *et al.*, 2012) and Iran (new record).

Diagnosis: *Stenomacrus carbonariae* is a large species with 4.0 mm body length (Fig. 4 A); first flagellomere about 2.0 x as long as wide in the female and a bit longer in the male (Fig. 4 B); forewing veins dark black, vein Rs originating from the middle of the wide pterostigma and r-rs straight (Fig. 4 C); propodeum with dorsal longitudinal carinae; metasoma polished, first tergite with dorsal longitudinal carina and about 1.5 x as long as wide; tergites 2 and 3 near as long as wide. Males are similar to females but with a white face (Fig. 4 B).

Remarks: All the specimens of *S. carbonariae* were captured only from the northern slope of the Alborz Mountains, Gilan province. Collecting site data showed that 67% of all collected specimens were from Ghazichak at an altitude of 1800 m, followed by Orkom 27% and Ziaz 6%. The flight period was mainly from late March to June. The most abundant period of adult emergence for *S. carbonariae* was late April to May.

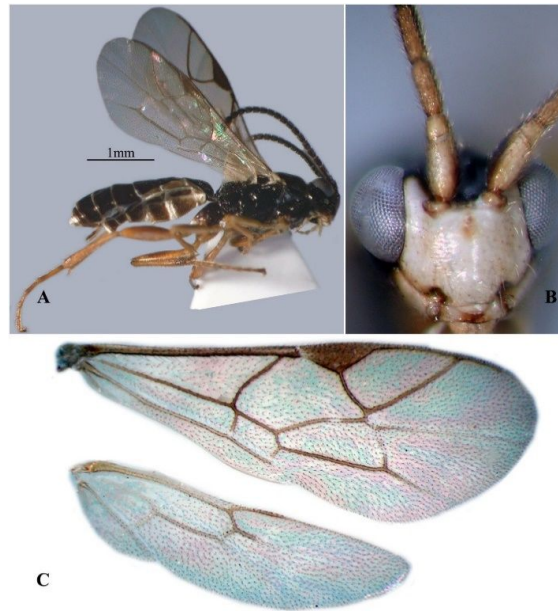


Fig. 4. *Stenomacrus carbonariae*; A. General habitus, lateral view, female; B. Head, frontal view, male; C. Fore and hind wing venation, female.

***Stenomacrus curvicaudatus* (Brischke, 1871)**

(Fig. 5 A–B)

Material examined: IRAN: Gilan province: Rudsar, Rahimabd, Ziaz (N= 36°52' 574" E= 50° 13' 290" , 537 m a.s.l.) 1 ♂, 24-31.V.2010, Rudsar, Rahimabad, Ghazichak (N= 36° 45' 959" E= 50° 19' 587" , 1787-1803 m a.s.l.) 2 ♀, 12-19.IV.2010, 2 ♂, 23 ♀, 10-17.V.2010, 4 ♂, 26 ♀, 17-24.V.2010, 8 ♂, 58 ♀, 24-31.V.2010, 3 ♂, 37 ♀, 01-07.VI.2010; Mazandaran province: Nur, Chamestan, Gaznasara (N= 36° 16' 968" E= 52° 10' 927") 2 ♀, 01-10.V.2011; Alborz province: Karaj, Asara, Shahrestanak (N= 35° 58' 271" E= 51° 21' 430" , 2235 m a.s.l.) 1 ♂, 15 ♀, 19-26.IV.2010, 4 ♀, 26.IV.2010-03.V.2010, 1 ♂, 2 ♀, 03-10.V.2010, 4 ♀, 10-17.V.2010, 2 ♂, 49 ♀, 24-31.V.2010, 2 ♂, 30 ♀, 01-07.VI.2010, 8 ♀, 07-14.VI.2010, 2 ♀, 16-23.VIII.2010, 1 ♀, 04-11.X.2010, Leg. A. Mohammadi-Khoramabadi.

General distribution: Bulgaria, Finland, France, Germany, Lithuania, Norway, Sweden, United Kingdom (Yu *et al.*, 2012) and Iran (new record).

Diagnosis: *Stenomacrus curvicaudatus* is characterized by the closed, pentagonal areolet of the forewing (vein 3rs-m present) (Fig. 5 B) and first antennal flagellomere a little longer than wide (Fig. 5 A).

Remarks: *Stenomacrus curvicaudatus* was the dominant species of the genus on the southern slopes of the Alborz Mountains and interestingly occurred only at an elevation of 2235 m in Shahrestanak, Alborz province, with a cool and alpine climate. It was the second most abundant species in Gilan province with 27% of all collected specimens. Although

S. curvicaudatus specimens were captured on the northern slopes of the Alborz Mountains from an elevation of 537 m in Ziaz, 94% of all collected specimens were from an altitude of 1800 m in Ghazichak. It may indicate that *S. curvicaudatus* prefers high altitudes with cool climate.

***Stenomacrus deletus* (Thomson, 1897)**

(Fig. 5 C)

Material examined: IRAN: Qazvin province: Qazvin, Zereshk (N= 36° 25 398 E= 50° 06 628 , 1926m a.s.l.) 1 , 11-25.V.2011, 1 , 28.VII.2011-16.VIII.2011, Leg. A. Mohammadi-Khoramabadi.

General distribution: Bulgaria, Finland, France, Israel, Lithuania, The Netherlands, Poland, Sweden, United Kingdom (Yu *et al.*, 2012) and Iran (new record).

Diagnosis: *Stenomacrus deletus* has a closed areolet like *S. curvicaudatus*, but in this species vein Rs originates from near the middle of a wide pterostigma and the areolet is large and quadrate (Fig. 5 C); Lwff1 index is about 2; first tergite of metasoma coriaceous, without dorsal longitudinal carinae and 2x as long as wide, second tergite smooth and longer than wide.

Remarks: *Stenomacrus deletus* was captured only on the southern slopes of the Alborz Mountains at high elevations with cold climate.

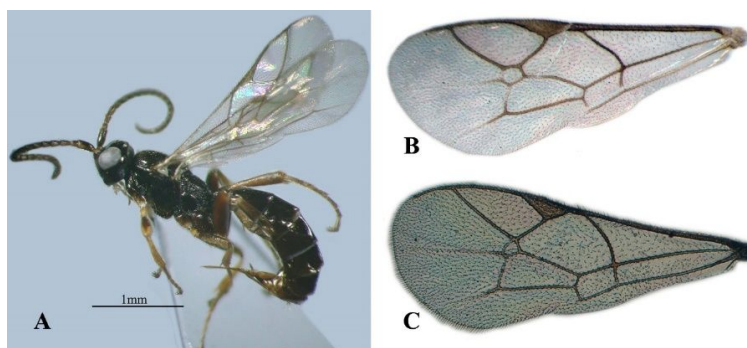


Fig. 5. *Stenomacrus curvicaudatus*, female (A-B); A. General habitus, lateral view; B. Forewing; C. *Stenomacrus deletus*, forewing, female.

***Stenomacrus exserens* (Thomson, 1898)**

(Fig. 6 A–E)

Material examined: IRAN: Gilan province: Astaneh-e-Ashrafieh (N= 37° 22 61 E= 49° 57 964 , 2 m a.s.l.) 1 , 03-10.V.2010, Rudsar, Rahimabd, Ziaz (N= 36° 52 574 E= 50° 13 290 , 537 m) 1 , 13.III- 05.IV.2010, 1 , 03-10.V.2010, 2 3 , 24-31.V.2010, Rudsar, Rahimabad, Orkom (N= 36° 45 739 E= 50° 18 198 , 1201-1225 m a.s.l.) 1 , 05-12.IV.2010, 1 , 24-31.V.2010, Rudsar, Rahimabad, Ghazichak (N= 36° 45 959 E= 50° 19 587 , 1787-1803 m a.s.l.) 3 , 12-19.IV.2010, 1 , 26.IV.2010-03.V.2010, 35 1 , 10-17.V.2010, 28 2 , 17-24.V.2010, 16 9 , 24-31.V.2010, 16 50 , 01-07.VI.2010, 5 29 , 07-14.VI.2010, 2 1 , 14-21.VI.2010, 2 1 , 05-12.VII.2010,

1, 12-19.VII.2010; Tehran province: Shahryar (N= 35° 40', E= 50° 56', 1168 m a.s.l.) 1, 19-26.IV.2010, 1, 10-17.V.2010, 1, 01-07.VI.2010, 1, 07-14.VI.2010; Alborz province: Karaj (N=35° 46', E= 50° 56', 1278 m a.s.l.) 1, 03-10.V.2010, 3, 10-17.V.2010, Karaj, Asara, Arangeh (N= 35° 55' 120", E= 51° 5' 154", 1891 m a.s.l.) 1, 07-14.VI.2010, 1, 28.VI.2010-05.VII.2010, Karaj, Asara, Shahrestanak (N= 35° 58' 271", E= 51° 21' 430", 2235 m) 1, 21-28.VI.2010; Mazandaran province: Nur, Chamestan, Tangevaz (N= 36° 21' 917", E= 52° 06' 179", 692 m a.s.l.) 1, 11-25.V.2011, 1, 26.V.-09.VI.2011, Leg. A. Mohammadi-Khoramabadi.

General distribution: Bulgaria, former Czech Republic: Slovakia, Denmark, Finland, France, Greece, Lithuania, Norway, Poland, Romania, Sweden, United Kingdom (Yu *et al.*, 2012) and Iran (new record).

Diagnosis: *Stenomacrus exserens* has strongly coriaceous propodeum and first metasomal tergite (Fig. 6C), thick antenna with Lwff1 index 2 and vein Rs of the forewing originating before the middle of the narrow pterostigma (Fig. 6 B) (Aubert, 1981). Female has a face with a wide yellow central patch (Fig. 6 E) but male's face is completely black (Fig. 6 D).

Remarks: *Stenomacrus exserens* was the dominant species of the genus in the northern slope of the Alborz Mountain, comprising 35% of all collected specimens in Gilan province, but was the least abundant species on southern slopes with just 7% of collected specimens in Tehran and Alborz provinces. Collection data showed that *S. exserens* occurred in all sampled altitudes and habitats but the most preferred site was Ghazichak at an altitude of 1800 m with cooler climate and lower humidity, mainly covered by shrub and steppe. All specimens were collected between April and July as follows: April 3%, May 47%, June 48% and July 2%, that indicated May and June was the most abundant period of adult emergence in the north of Iran.

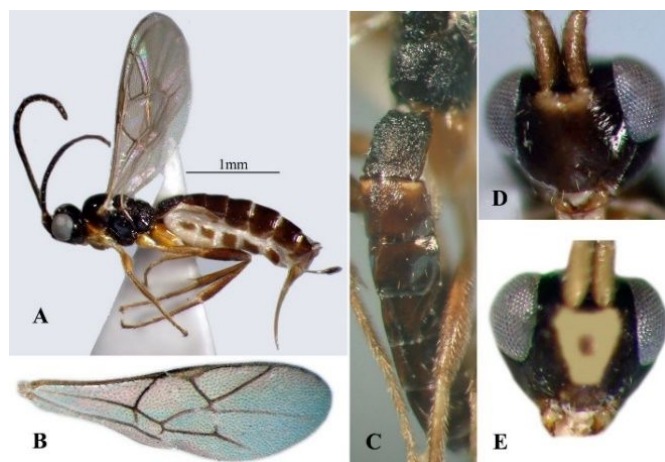


Fig. 6. *Stenomacrus exserens* (Thomson), female (A-C, E); A. General habitus, lateral view; B. Forewing; C. Propodeum and metasoma, dorsal view; D. Head, frontal view, male; E. Head, frontal view, female.

***Stenomacrus merula* (Gravenhorst, 1829)**

(Fig. 7 A)

Material examined: IRAN: Gilan province: Rudsar, Rahimabd, Ziaz (N= 36° 52' 574" E= 50° 13' 290" , 537 m) 3 , 05-12.IV.2010, 1 1 , 19-26.IV.2010, 1 , 03-10.V.2010, Rudsar, Rahimabd, Orkom (N= 36° 45' 739" E= 50° 18' 198" , 1201-1225 m a.s.l.) 2 1 , 01-07.VI.2010, 1 , 07-14.VI.2010, Rudsar, Rahimabad, Ghazichak (N= 36° 45' 959" E= 50° 19' 587" , 1787-1803 m a.s.l.) 4 , 05-12.IV.2010, 3 82 , 12-19.IV.2010, 8 8 , 19-26.IV.2010, 6 17 , 26.IV.2010-03.V.2010, 2 , 10-17.V.2010, 1 , 17-24.V.2010, 1 1 , 01-07.VI.2010, 1 1 , 07-14.VI.2010; Alborz province: Karaj, Asara, Arangeh (N= 35° 55' 120" E= 51° 5' 154" , 1891 m a.s.l.) 2 , 07-14.VI.2010, 2 , 14-21.VI.2010, 7 2 , 28.VI.2010-05.VII.2010, 2 , 02-09.VIII.2010, Karaj, Asara, Shahrestanak (N= 35° 58' 271" E= 51° 21' 430" , 2235 m a.s.l.) 1 , 10-17.V.2010, 2 , 24-31.V.2010, 1 , 28.VI.2010-05.VII.2010, 1 , 12-19.VII.2010, Leg. A. Mohammadi-Khoramabadi.

General distribution: Austria, Belarus, Belgium, Bulgaria, Canada, Denmark, Finland, France, Germany, Greece, Lithuania, Netherlands, Norway, Poland, Russia, Spain, Sweden, U.S.A., United Kingdom (Yu *et al.*, 2012) and Iran (new record).

Diagnosis: *Stenomacrus merula* can be distinguished by the combination of the following features: first flagellomere barely longer than wide, forewing vein Rs originating from before the middle of a narrow pterostigma (Fig. 7 A), and the propodeum with the dorsal longitudinal carinae.

Remarks: *Stenomacrus merula* was the third most abundant species in the north of Iran with 20% of all collected specimens. Similar to *S. curvicaudatus*, *S. merula* was sampled from 537 m in Ziaz, Gilan province upwards, but the main collecting site was Ghazichak, at an altitude of 1800m. In Alborz province, 75% of the specimens of *S. merula* were sampled from Arangeh, at 1891 m. It may show that the preferred altitudinal distribution of *S. merula* is about 1800-1900m on both slopes of the Alborz Mountains in the north of Iran. April was the most abundant period of adult emergence of *S. merula*, accounting for 81% of all specimens. It was followed by May 4%, June 13% and July 2%.

***Stenomacrus minutissimus* (Zetterstedt, 1838)**

(Fig. 7 B–E)

Material examined: Gilan province: Rudsar, Rahimabd, Ziaz (N= 36° 52' 574" E= 50° 13' 290" , 537 m) 2 , 24-31.V.2010; Alborz province: Karaj, Asara, Arangeh (N= 35° 55' 120" E= 51° 5' 154" , 1891 m a.s.l.) 1 , 28.VI-08.VII.2010, Leg. A. Mohammadi-Khoramabadi.

General distribution: Bulgaria, France, Norway (Yu *et al.*, 2012) and Iran (new record).

Diagnosis: *Stenomacrus minutissimus* can be identified by a slender first flagellomere, Lwff1 index= 3 (Fig. 7 B, D); forewing without vein 3rs-m, vein Rs originating from

before the middle of pterostigma (Fig. 7 C); propodeum smooth, shiny without dorsal longitudinal carina; first metasomal tergite shiny, without dorsal carinae and 1.5 x as long as wide, second tergite a bit wider than long and basally finely coriaceous (Fig. 7 E). The collected specimens have 20 flagellomeres, a white face with black body (Fig. 7 D). First metasomal tergite in our specimens was shiny without coriaceous sculpture which may differ with Aubert's (1981) description of the species.

Remarks: *Stenomacrus minutissimus* was sampled on both slopes of the Alborz Mountains in low numbers.

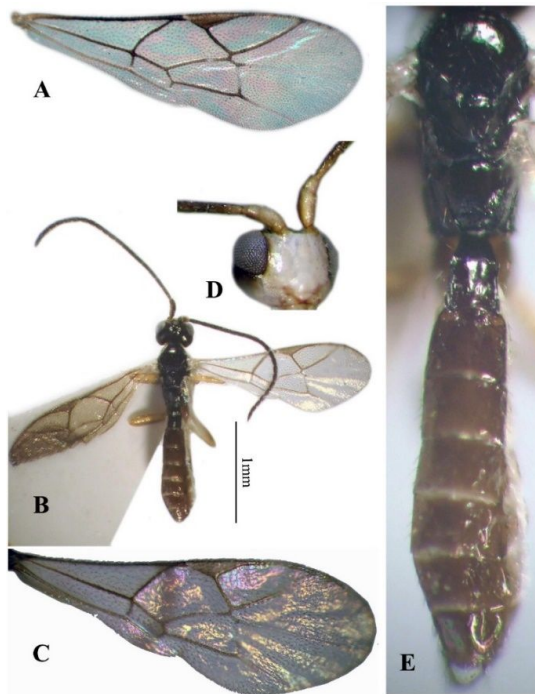


Fig. 7. A. *Stenomacrus merula* (Gravenhorst), female, Forewing; *S. minutissimus* (Zetterstedt), male (B-E); B. General habitus, dorsal view; C. Forewing; D. Head, frontal view; E. Mesosoma and metasoma, dorsal view.

Discussion

This study showed that a rich fauna of three genera of the *Orthocentrus* genus-group inhabit in the Alborz Mountains of Iran. Eight species, *Batakmacrus caudatus*, *Plectiscus agilis*, *P. minutus*, *Stenomacrus affinitor*, and *S. carbonaria* were found only on the northern slopes of the Alborz Mountains. Four species, namely *S. curvicaudatus*, *S. exserens*, *S. minutissimus* and *S. merula*, were sampled from both slopes. *Stenomacrus urvicaudatus* was the most abundant and common species in the north of Iran, followed by *S. exserens*, *S. merula*, *S. carbonaria*, *P. agilis* and *B. caudatus*. An altitude of 1800 m on the southern slopes of the Alborz Mountains and 2300 m on the northern slopes were the most abundant sampling sites. The most diverse site was Ziaz with eight species at an altitude of about 500m, followed by Orkom with seven, Ghazichak with 5, Shahrestanak and Astaneh-e-Ashrafieh with 4, Arangeh, Tangevaz and Zereshk road with two and finally Karaj, Shahryar and Jourband with one species.

Collection data showed that each genus has a somewhat distinct spatial and temporal occurrence in the north of Iran. *Batakomacrus caudatus* are distributed mainly in Gilan province which provides more humidity, precipitation and maybe more suitable vegetation compared to other parts of northern Iran. *Plectiscus* spp. occurs in Mazandaran province in high numbers, represented by 3 species. They may prefer the eastern extension of northern slope of the Alborz Mountains with lesser humidity. This region and province is located in the eastern extension of the Caspian Hyrcanian forests biome and future sampling in neighboring areas may reveal more species. Adults of *Plectiscus* emerge and fly in late spring and summer while *Stenomacrus* spp. had an adult emergence period during spring. *Stenomacrus* spp. showed higher diversity and numbers on the southern slopes of the Alborz Mountain in Gilan province which seemingly provides more suitable conditions for this group.

The study also provides a good collection of this group in Iran as well as details on spatial and temporal distribution of each species in two slopes of the Alborz Mountains, northern Iran (Table 2).

Acknowledgements

Thanks to the Department of Entomology, Tarbiat Modares University for providing financial support for this study. Our cordially thanks extend to Dr. Gavin Broad (Natural History Museum, London) for his useful comments on the early draft of this paper. We are also grateful to Dr. K. Horstmann (passed away on 30 July, 2013) and Dr. J. Kolarov for sending their valuable papers. Many thanks to Dr. Mohammad Khayrandish and Dr. Ahmad Nadimi for helping us in trapping and collecting specimens. We thank to three anonymous reviewers for valuable comments and recommendations on the earlier version of this paper.

References

- Adobe Photoshop CS6** (2012) Adobe Systems Incorporated, San Jose, United States of America.
- Amirinasab, N.** (2016) Fauna of Ichneumonidae (Hym., Ichneumonoidae) in Jiroft region, Kerman. MSc Thesis, University of Zabol, Zabol, Iran, p. 139.
- Aubert, J. F.** (1981) Révision des Ichneumonides *Stenomacrus* sensu lato. *Mitteilungen Munchener Entomologischen Gesellschaft* 71, 139–159.
- Barahoei, H., Rakhshani, E. & Riedel, M.** (2012). A checklist of Ichneumonidae (Hymenoptera: Ichneumonoidea) from Iran. *Iranian Journal of Animal Biosystematics* 8(2): 83–132.

-
- Barahoei, H., Fathabadi, K., Rakhshani, E. & Dozhanga, A.** (2014) Study on Ichneumonidae (Hymenoptera) in Khorasan-e-Razavi province, Eastern part of Iran. *First National e-conference on Agriculture and Sustainable Natural Resources, Tehran*, 1–7.
- Bakhtiarynasab, F., Khayrandis, M. & Mohammadiandi-Khoramabad, A.** (2014) Study of the fauna of the parasitic wasps group of Pimpliformes (Hymenoptera: Ichneumonidae) in some regions of Kerman province, Iran. *The second national conference on agriculture and sustainable development, opportunities and challenges ahead*, Islamic Azad University of Shiraz 1–8.
- Broad, G. R.** (2010) Status of *Batakamacrus* Kolarov (Hymenoptera: Ichneumonidae: Orthocentrinae), with new generic combinations and description of a new species. *Zootaxa* 51–68.
- Ghafouri Moghaddam, M., Mokhtari, A., Barahoei, H., Amirinasab, N. & Rakhshani, E.** (2016) A survey on the fauna of Ichneumonidae (Hymenoptera, Ichneumonoidea) associated with grasslands of Ardabil, and key to species of *Homotropus* Foerster, 1869 from Iran. *Journal of Insect Biodiversity and Systematics* 2, 103–120.
- Ghahari, H. & Jussila, R.** (2010) A contribution to the Ichneumon wasps (Hymenoptera: Ichneumonidae) from Golestan National Park and vicinity, Northeastern Iran. *Linzer biologische Beitrage* 42, 1379–1384.
- Ghahari, H. & Jussila, R.** (2016) Contribution to the knowledge of the fauna of Ichneumonidae (Hymenoptera: Ichneumonoidea) from Iran. *Beiträge zur Entomologie* 66, 119–124.
- Hadley, A.** (2010) CombineZP public domain image processing software. Available from: <http://www.hadleyweb.pwp.blueyonder.co.uk/CZP/News.htm> (accessed 13 March 2013).
- Hooshyar, H. & Vafaei-Shoushtari, R.** (2013) Faunistic study of Ichneumon wasps, (Hym. Ichneumonidae) from mazandaran province, Iran. *The Second International Conference on Agriculture and Natural Resources, Kermanshah, Iran*, 914–917.
- Hooshyar, H., Vafaei-Shoushtari, R. & Barimai-Varandi, H.** (2012) Faunistic study of Ichneumon wasps, (Hym., Ichneumonidae) from Mazandaran province, Iran. *20th Iranian Plant Protection Congress, Shiraz*, 224.
- Horstmann, K.** (1992) Revisionen einiger von Linnaeus, Gmelin, Fabricius, Gravenhorst und Förster beschriebener Arten der Ichneumonidae (Hymenoptera, Ichneumonidae). *Mitteilungen Münchener Entomologischen Gesellschaft* 82, 21–33.
- Horstmann, K.** (1994) Die europäischen Arten von *Picrostigeus* Förster (Hymenoptera, Ichneumonidae, Orthocentrinae). *Zeitschrift der Arbeitsgemeinschaft Österreichischer Entomologen* 46(3/4):111–120.
-

- Horstmann, K.** (2006) Revisionen von Schlupfwespen-Arten X (Hymenoptera: Ichneumonidae, Braconidae). *Mitteilungen Munchener Entomologischen Gesellschaft* 96, 5–16.
- Horstmann, K. & Yu, D. S.** (1998) Bemerkungen zur taxonomie und nomenklatur westpaläarktischer Ichneumonidae (Hymenoptera). *Zeitschrift der Arbeitsgemeinschaft Österreichischer Entomologen* 50, 77–84.
- Humala, A. E.** (2007) Subfamily Orthocentrinae (Microleptinae + Orthocentrinae sensu Townes). pp. 680–718. in Lehr, P.A. (Eds) *Key to the insects of Russian Far East. Vol. IV. Neuropteroidea, Mecoptera, Hymenoptera. Pt 5.* 1052 pp. Dal'nauka, Vladivostok.
- Humala, A. E.** (2010) Review of the genus *Batakomacrus* Kolarov, 1986 (Hymenoptera: Ichneumonidae, Orthocentrinae) with description of new species. *Proceedings of the Russian Entomological Society* 81, 29–38.
- Humala, A. E., Kruidhof, H. M. & Woelke, J. B.** (2017) New species of *Megastylus* (Hymenoptera: Ichneumonidae: Orthocentrinae) reared from larvae of Keroplastidae fungus gnats (Diptera) in a Dutch orchid greenhouse. *Journal of Natural History* 51, 83–95.
- IRIMO (2018) Islamic republic of Iran Meteorological Organization. Available from: <http://www.irimo.ir/far/eng> [accessed 10 January, 2018].
- Jussila, R.** (2007) Ichneumonological (Hym.) reports from Finland VI, with *Picrostigeus svecofennicus*, new species. *Ichneumonological (Hym.) reports from Finland* 3, 1–9.
- Kolarov, J.** (1986) A revision of the Orthocentrinae of Bulgaria (Hymenoptera, Ichneumonidae). *Annales Historico-Naturales Musei Nationalis Hungarici* 78, 255–264.
- Marvie Mohajer, M. R.** (2006) *Silviculture and forest tending*. 325 pp. Tehran University Press.
- Mohammadi-Khoramabadi, A., Hesami, S. & Shafiei, S.** (2016) A contribution to the knowledge of the fauna of Ichneumonidae in Rafsanjan county of Kerman province, Iran. *Entomofauna* 37, 453–468.
- Mohammadi-Khoramabadi, A. & Talebi, A. A.** (2013) A study of the genus *Orthocentrus* (Hymenoptera: Ichneumonidae, Orthocentrinae) in Gilan and Tehran provinces of Iran, with first records of seven species and one subspecies. *Applied Entomology and Phytopathology* 80, 29–39.
- Mohammadi-Khoramabadi, A., Ziaaddini, M. & Asadi, A.** (2014 of Conference) A faunal study on the parasitoid wasps of Pimpliformes (Hym.: Ichneumonidae) in Kerman province, Iran. *3rd Integrated Pest Management Conference (IPMC), Kerman, Iran*, 352–359.
- Mohebban, S., Barahoei, H., Takaloozadeh, H. M., Madjdzadeh, S. M. & Riedel, M.** (2016) A survey of the Ichneumonidae (Hymenoptera, Ichneumonoidea) of Kerman province, south-east Iran. *Journal of Insect Biodiversity and Systematics* 2, 419–437.

- Sarafi, T., Barahoei, H., Madjdzadeh, S. M. & Askari, M.** (2015) A contribution to the knowledge of the Ichneumonidae (Hym.: Ichneumonoidea) from Neyriz county of Fars province, Iran. *Journal of Crop Protection* 4, 643–654.
- Siadati, S., Moradi, H., Attar, F., Etemad, V., Hamzeh'ee, B. & Naqinezhad, A.** (2010) Botanical diversity of Hyrcanian forests; a case study of a transect in the Kheyroud protected lowland mountain forests in northern Iran. *Phytotaxa* 7, 1–18.
- Townes, H.** (1971) The genera of Ichneumonidae, part 4. *Memoirs of the American Entomological Institute* 17, 1–372.
- Veijalainen, A., Broad, G. R. & Saaksjarvi, I. E.** (2014) Twenty seven new species of *Orthocentrus* (Hymenoptera: Ichneumonidae; Orthocentrinae) with a key to the Neotropical species of the genus. *Zootaxa* 3768, 201–252.
- Veijalainen, A., Saaksjarvi, I. E., Erwin, T. L., Gomez, I. C. & Longino, J. T.** (2013) Subfamily composition of Ichneumonidae (Hymenoptera) from western Amazonia: insights into diversity of tropical parasitoid wasps. *Insect Conservation and Diversity* 6, 28–37.
- Wahl, D. B. & Gauld, I. D.** (1998) The cladistics and higher classification of the Pimpliformes (Hymenoptera: Ichneumonidae). *Systematic Entomology* 23, 265–298.
- Yu, D. S., Van Achterberg, K. & Horstmann, K.** (2012) World Ichneumonidae 2011. Taxonomy, Biology, Morphology and Distribution. Ottawa, Ontario, Canada, Available from: www.taxapad.com (Accessed 14.June.2017).
- Zwakhals, K. C. & Diller, E.** (2015) Eight new *Orthocentrus* species from South America. *Mitteilungen Munchener Entomologischen Gesellschaft* 105, 65–78.
-