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Study of the subfamily Xoridinae (Hymenoptera: Ichneumonidae) in Iran: a new record, identification key and geographical distribution

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ABSTRACT. Xoridinae is a rather small subfamily of Ichneumonidae (Hymenoptera: Ichneumonoidea) known as parasitoids of xylophagous insects with most species classified in the genus *Xorides* Latreille, 1809. During a survey on the diversity of Ichneumonidae in Darab damask rose plain (Fars province, Iran), two species of this subfamily were collected using Malaise traps in 2019, and identified, i.e. *Xorides corcyrensis* (Kriechbaumer, 1894) and *X. annulator* (Fabricius, 1804). The second species is newly recorded from Iran. Illustrated taxonomic notes on the newly recorded species as well as an updated checklist and a key to the known species of this subfamily in Iran are provided.

Key words: Distribution, parasitoid, taxonomy, new record, fauna

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Introduction

Xoridinae Shuckard, 1840 is a rather small subfamily of Ichneumonidae (Hymenoptera: Ichneumonoidea) with 225 described species in the world (Yu et al., 2016). Members of this subfamily are idiobiont ectoparasitoids of xylophagous insects, mainly on deeply concealed larvae, prepupae, pupae and even pharate adults of Coleoptera families of Buprestidae and Cerambycidae (Gima, 2013; Quicke, 2015). Taxonomically, this subfamily has been split into four genera, out of which 161 species are classified in the genus *Xorides* Latreille, 1809 (Yu et al., 2016).

In Iran, the first data on this subfamily has been documented by Sharifi & Javadi (1971). They introduced *Xorides corcyrensis persicator* Aubert, 1976 as a parasitoid of the Rosaceae branch borer, *Osphranteria coerulescens* Redtenbacher, 1850 (Col.: Cerambycidae) as the most dangerous xylophagous pest of Rosaceae fruit trees in Iran, from Shiraz province (Klopfstein & Baur, 2011). *Xorides corcyrensis* can affect its host populations, *O. coerulescens*, by a parasitism rate of 5-20% in different regions of Iran (Radjabi, 2011). Although, Iran consists of a rich fauna of xylophagous insects (Ghahari et al., 2015; Rastegar et al., 2013),

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the known Iranian species of Xoridinae was remained constant to this record (one species) for a long time (Barahoei et al., 2012). Four species of this subfamily were recently collected and reported from the Hyrcanian forests of Guilan and Mazandaran provinces and then the number of Iranian Xoridinae have been increased to five species (Mohammadi-Khoramabadi, 2015; Mohammadi-Khoramabadi & Varga, 2017).

The aim of this study is to present an overview on the taxonomy and distribution of the subfamily Xoridinae in Iran. A key to the known Iranian species and an updated checklist of this subfamily together with illustrated taxonomic note on *X. annulator* (Fabricius, 1804), a new record for Iran, are provided.

Material and methods

Xoridinae specimens were collected during a survey on the diversity of family Ichneumonidae in Darab damask rose plain (28°42'15" N, 54°54'14" E, 2641 m a.s.l.), Fars province, Iran by Malaise traps in 2019. They were then pinned and identified using keys provided by (Kasparyan, 1981). Identity of the specimens was confirmed by O. Varga comparing the voucher specimens deposited in Schmalhausen Institute of Zoology, NAS of Ukraine. Digital photographs of the pinned specimens were taken using a Canon EOS 600D on a SZ-ST Olympus stereomicroscope. Stacking of images was done by Adobe Photoshop. Terminology followed conceptions available on <http://portal.hymao.org/> (Yoder et al., 2010). The identified species are deposited in the insect collection of Darab College of Agriculture and Natural Resources, Shiraz University, Iran.

Results

From ten collected specimens of Xoridinae, two species have been identified, of which one species is recorded for the first time from Iran, marked with an asterisk (*). All known Iranian species of the subfamily are arranged in alphabetical order.

Xorides annulator (Fabricius, 1804)* (Figs. 1-2)

Material examined: Iran, Fars province, Darab county (28°42'15" N, 54°54'14" E, Elevation: 2641m a.s.l.), 2♂♂2♀♀, 24.V-9.VI.2019, 1♀, 10-24.VI.2019, leg. A. Mohammadi-Khoramabadi.

Distribution in Iran: Fars province (Current study).

Distribution: Austria, Bulgaria, Croatia, Czech republic, France, Hungary, Italy, Romania, Russia, Turkey, Ukraine (Kazmierczak, 1991; Kolarov, 2008; Varga, 2015; Yu et al., 2016) and Iran (Current study).

Diagnosis: Metasomal tergites 1-3 red (Fig. 1); fore wing with two transverse dark bands (Fig. 2). Kasparyan (1981) mentioned that metasomal tergites 2 and 3 of *X. annulator* are red but in the Iranian specimens metasomal tergite 1 is also red.

Xorides corcyrensis (Kriechbaumer, 1894)

Material examined: Iran, Fars province, Darab county (28°42'15" N, 54°54'14" E, Elevation: 2641m a.s.l.), 3♂♂, 24.V-9.VI.2019, 1♀1♂, 10-24.VI.2019, leg. A. Mohammadi-Khoramabadi.

Distribution in Iran: Fars (Sharifi & Javadi, 1971), Markazi, Qom, Tehran and Yazd provinces (Mohammadi-Khoramabadi, 2015; Radjabi, 2011).

Distribution: Bulgaria, Czech Republic, Greece, Iran, Italy, Russia, Slovakia (Yu et al., 2016).



Figures 1-2. *Xorides annulator* (Fabricius, 1804); 1. habitus from dorsal view, middle transverse impression on the first metasomal tergite arrowed (A), 2. wings.

***Xorides fuligator* (Thunberg, 1822)**

Distribution in Iran: Mazandaran and Guilan provinces (Mohammadi-Khoramabadi, 2015; Mohammadi-Khoramabadi & Varga, 2017).

Distribution: Austria, Belarus, Belgium, Bulgaria, Croatia, Czech Republic, Finland, France, Georgia, Germany, Hungary, Ireland, Italy, Netherlands, Norway, Poland, Romania, Russia, Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine, United Kingdom (Yu et al., 2016) and Iran (Mohammadi-Khoramabadi, 2015; Mohammadi-Khoramabadi & Varga, 2017).

Xorides gravenhorstii (Curtis, 1831)

Distribution in Iran: Mazandaran and Guilan provinces (Mohammadi-Khoramabadi, 2015; Mohammadi-Khoramabadi & Varga, 2017).

Distribution: Algeria, Austria, Azerbaijan, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, France, Georgia, Germany, Greece, Hungary, Ireland, Italy, Lithuania, Netherlands, Norway, Poland, Romania, Russia, Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine, United Kingdom (Yu et al., 2016) and Iran (Mohammadi-Khoramabadi, 2015; Mohammadi-Khoramabadi & Varga, 2017).

Xorides praecatorius (Fabricius, 1793)

Distribution in Iran: Guilan province (Mohammadi-Khoramabadi & Varga, 2017).

Distribution: Austria, Belarus, Belgium, Bulgaria, China, Croatia, Czech Republic, France, Germany, Greece, Hungary, Ireland, Italy, Macedonia, Malta, Moldova, Netherlands, Poland, Romania, Russia, Slovakia, Sweden, Switzerland, Turkey, Ukraine, United Kingdom (Yu et al., 2016) and Iran (Mohammadi-Khoramabadi & Varga, 2017).

Xorides rufipes (Gravenhorst, 1829)

Distribution in Iran: Guilan province (Mohammadi-Khoramabadi & Varga, 2017).

Distribution: Austria, Azerbaijan, Bosnia Hercegovina, Bulgaria, China, Croatia, Czech Republic, Finland, France, Georgia, Germany, Hungary, Italy, Poland, Romania, Russia, Spain, Sweden, Switzerland, Turkey, Ukraine, United Kingdom (Yu et al., 2016) and Iran (Mohammadi-Khoramabadi & Varga, 2017).

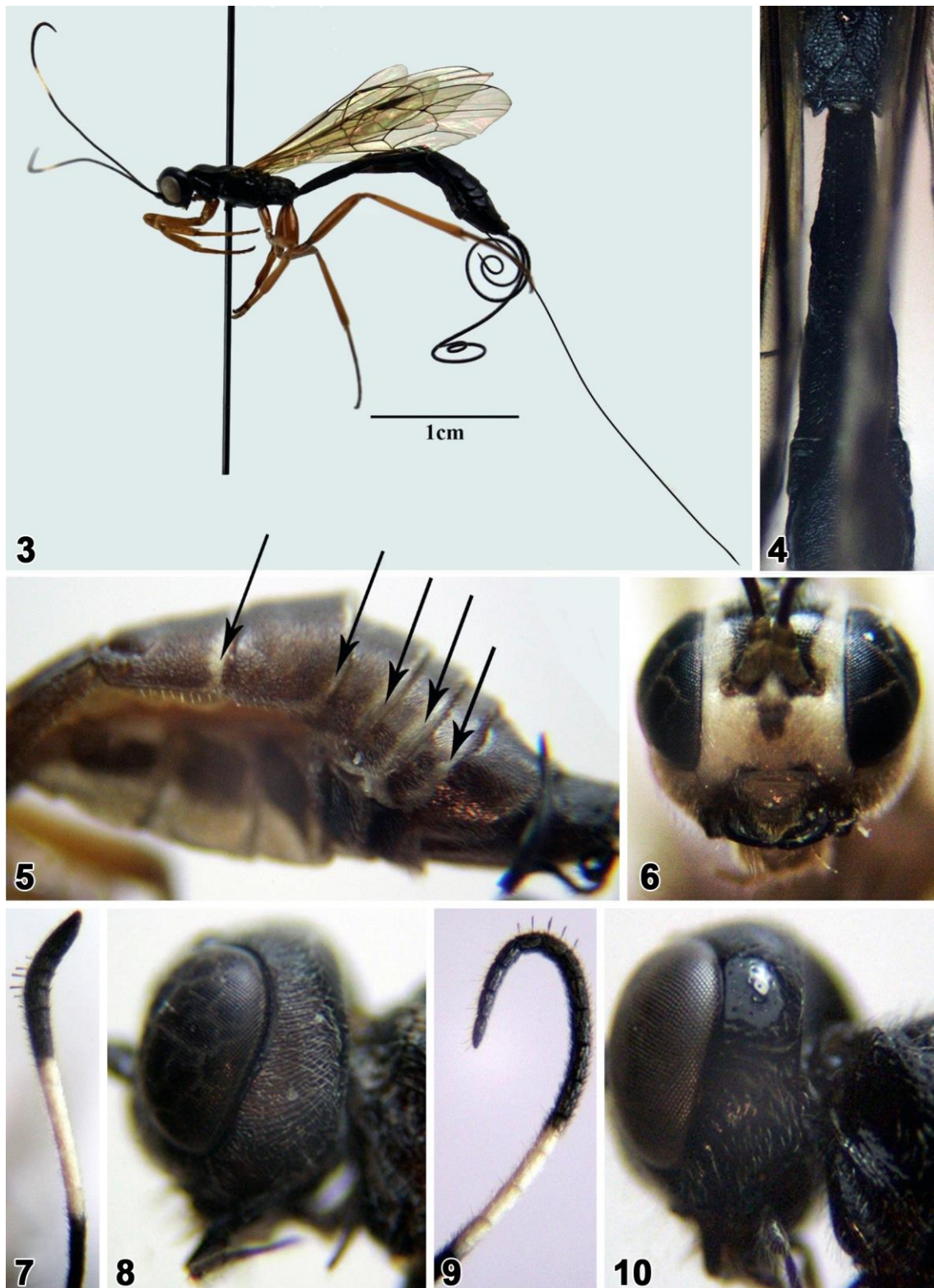
Updated Key to the Iranian species of Xoridinae (Mohammadi-Khoramabadi & Varga, 2017) (Modified from Kasparyan (1981))

1- Fore wing with vein 1cu-a basad of vein m+Rs (basal vein) (Fig. 2); hind wing with nervellus antefurcal (Fig. 2); mesosternum with posterior transverse carina complete; body in rough coarse sculpture; first metasomal tergite beyond the middle with a sharp reticulate-wrinkled transverse impression (Fig. 1, arrow A); hind trochantellus in lateral view about 2.5 × as long as hind trochanter; maxillary palp with 4th segment not shortened (Subgenus *Gonophonus*) **2**

-. Fore wing with vein 1cu-a distad of vein m+Rs (basal vein); hind wing with nervellus postfurcal; mesosternum with posterior transverse carina interrupted before mid coxa; body with less coarse sculpture; the first metasomal tergite without a sharp reticulate-wrinkled transverse impression or present only on lateral sides; maxillary palp with 4th segment shortened. **3**

2- Metasomal tergites 1-3 (or 2-3) red (Fig. 1); fore wing with two transverse dark bands (Fig. 2); [body length 15-20 mm]. *Xorides (Gonophonus) annulator* Fabricius, 1804

-. Metasoma completely black; fore wing without transverse dark bands; [antenna without a white ring; pterostigma black or brown with a white base].
..... *Xorides (Gonophonus) corcyrensis* (Kriechbaumer, 1894)



Figures 3-10. *Xorides* species; **3-4.** *Xorides rufipes* (Kriechbaumer 1882), **3.** female habitus, **4.** the first metasomal tergite, dorsal view; **5-6.** *Xorides praecatorius* (Fabricius 1793), **5.** metasoma, posterolateral spots arrowed, **6.** face; **7-8.** *Xorides gravenhorstii* (Curtis 1831), **7.** antenna, **8.** gena; **9-10.** *Xorides fuligator* (Thunberg 1822), **9.** antenna, **10.** gena.

3. Fore and mid trochantellus with an apical acute tooth; gena with punctures, not striated; body large and elongated (Fig. 3); ovipositor sheath longer than the body (Subgenus *Moerophora*); first tergite of metasoma long, strongly narrowed to the base, its apical margin about 2.4 × as wide as its basal edge, with longitudinal dorsal carinae distinct, reaching beyond the middle of tergite (Fig. 4); sclerotized part of first metasomal sternite extending beyond the middle; metasoma black; legs uniformly red; pterostigma black, white basally; antenna with flagellomeres 13–16 white (Fig. 3). *Xorides (Moerophora) rufipes* (Kriechbaumer 1882)
- . Fore and mid trochantellus without an apical acute tooth; gena striated at least at base (Subgenus *Xorides*). 4
4. Metasomal tergites 2–7 with posterolateral white spots (Fig. 5); legs mainly red; hind tibia with a white base; Face, eye orbits and gena white (Fig. 6); propluron with white stripes around epomia and at dorsal part; female with antennal flagellomeres 10, 11 and 12 white *Xorides (Xorides) praecatorius* (Fabricius 1793)
- . Metasoma uniformly colored, metasomal tergites without posterolateral white spots; hind tibia without white base. 5
5. Female with two preapical antennal flagellomeres transverse, flagellomeres 10–14 white (Fig. 7); gena distinctly striated from base to top (Fig. 8); [legs red, metasoma completely red]. *Xorides (Xorides) gravenhorstii* (Curtis 1831)
- . Female with all antennal flagellomeres longer than wide, flagellomeres 9–13 white (Fig. 9); gena punctate (Fig. 10); [all coxae black; hind coxa smooth and shiny; mesosoma black and metasoma red; hind femur entirely red]. ... *Xorides (Xorides) fuligator* (Thunberg 1822)

Discussion

This study increased the number of Iranian Xoridinae to six species, of which three species, (i.e. *X. corcyrensis*, *X. fuligator* and *X. gravenhorstii*) distributed in the Western Palaearctic ecoregion (Yu et al., 2016) but the three others (*X. annulator*, *X. praecatorius* and *X. rufipes*) have also some country records in the Eastern Palaearctic (Sheng & Lin, 2004; Sheng & Wen, 2008; Yu et al., 2016). The distribution map of the newly recorded species, *X. annulator*, extends to the southern border of the Western Palaearctic at 28°42' N, 54°54' E in Iran (Fig. 11). Species of this subfamily are usually found in collections with a low number of specimens (Mohammadi-Khoramabadi, 2015; Mohammadi-Khoramabadi & Varga, 2017; Riedel et al., 2018; Varga, 2015). Therefore, our knowledge of the fauna and distribution data of species of this subfamily is increasing and completing by detecting xoridine species even in some rather well-known European countries (Jones et al., 2018).

The occurrence records for the adults of Iranian species of the subfamily Xoridinae and available data on these species (Glavendekic & Kolarov, 1994; Kazmierczak, 1991; Sheng & Lin, 2004; Sheng & Wen, 2008) showed that *X. annulator*, *X. corcyrensis*, *X. rufipes* and *X. praecatorius* have one while *X. fuligator* and *X. gravenhorstii* have two periods of appearance which may reflect their annual generations per year (Table 1). The most prolonged adult appearance belongs to *X. corcyrensis* depending on the climatological conditions of its wide habitat in Iran. Adults of this univoltine species usually occur from early April in Yazd province, central Iran with hot and dry climate (Mohammadi-Khoramabadi, 2015) to late June in this study (Table 1). The adult flight season of the other univoltine species, *X. annulator*, lasted for about one month, from late May to late June (Table 1).

Table 1. The flight period of Iranian species of Xoridae (Hym.: Ichneumonidae).

Species	April (IV)	May (V)	June (VI)	July (VII)	Aug. (VIII)	Sept. (IX)	Oct. (X)
<i>X. annulator</i>			■	■			
<i>X. corcyrensis</i>	■	■	■	■			
<i>X. fuligator</i>			■	■		■	■
<i>X. gravenhorstii</i>			■	■	■	■	■
<i>X. praecatorius</i>		■			■		
<i>X. rufipes</i>		■					

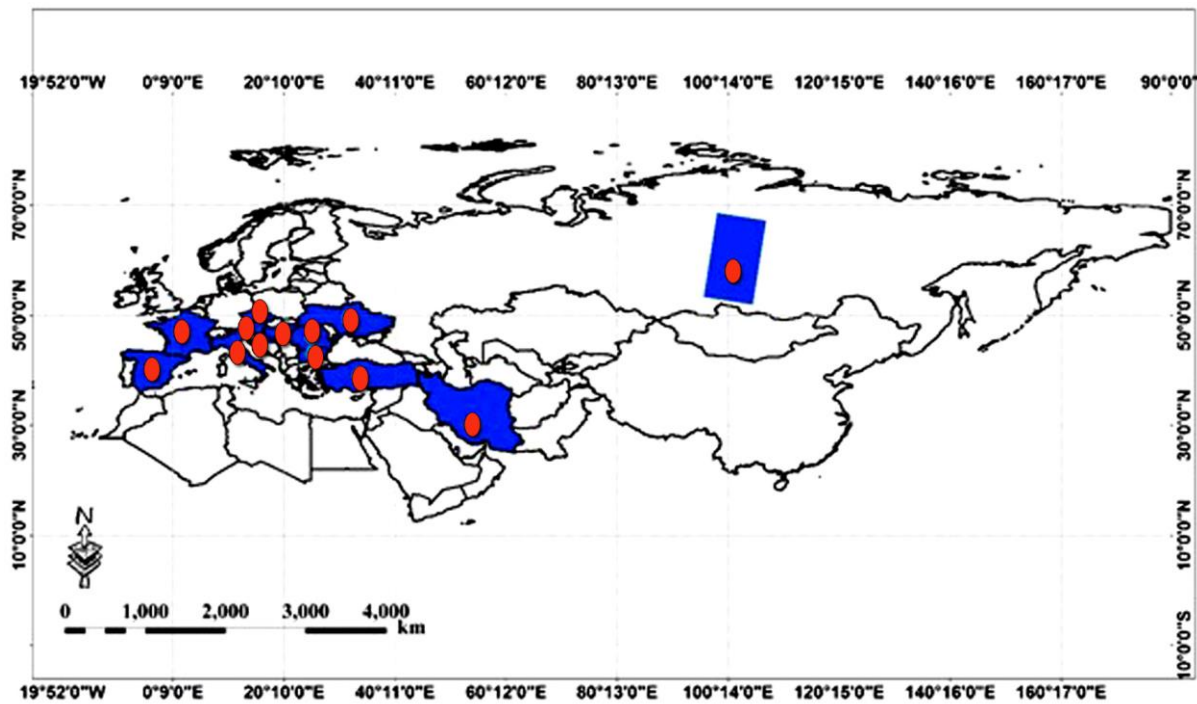


Figure 11. Distribution map of *Xorides annulator* (Fabricius, 1804) across Palearctic ecoregion, the blue rectangle shows the Russia-Irkutsk Olbast.

The flight period of this species established in Europe during July (Kazmierczak, 1991). *Xorides rufipes* adults fly during May (V) in Iran at the same time in Belarus, Eastern Europe (Tereshkin, 1989) while appear during June (VI) in China (Sheng & Lin, 2004). *Xorides praecatorius* has been captured during August in northern Iran but the study of Glavendekic & Kolarov (1994) showed that this species has a period of adult appearance in the former Yugoslavia from late April (IV) to early June (VI), that of Sedivy (2001) from March to April in Slovakia, and that of Tereshkin (1989) in early August (VIII) in Belarus. The examined specimen by Sheng & Wen (2008) was collected in China during July (VII). This species seems to be plurivoltine and future data will reveal the fact. *Xorides fuligator* and *X. gravenhorstii* have two distinct periods of adult flights in Iran, the first happened during June-July and the second in September (third month of summer) indicating two generations per year. The reported time of *X. fuligator* adult capturing in Belarus, Eastern Europe shows a similar trend in late May and early September (Tereshkin, 1989). The adult flying season of *Xorides gravenhorstii* prolonged more than one month from late June to late July in the first period as

well as September in the second one (Table 1). In eastern Europe, the first adult flight period of this species may start from early May (V) (Glavendekic & Kolarov, 1994) and prolong to early June (VI) in Ukraine (Varga, 2014).

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Conflict of Interests

The author declares that there is no conflict of interest regarding the publication of this paper.

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مطالعه زنبورهای زیرخانواده Xoridinae (Hymenoptera: Ichneumonidae) در ایران: یک گزارش جدید، کلید شناسایی و پراکنش جغرافیایی

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چکیده: Xoridinae یک زیرخانواده نسبتاً کوچک از خانواده Ichneumonidae (Hymenoptera: Ichneumonoidea) است که به عنوان زنبورهای پارازیتوئید حشرات چوبخوار شناخته شده‌اند و اغلب در جنس *Xorides* Latreille, 1809 طبقه‌بندی می‌شوند. طی بررسی تنوع زنبورهای خانواده Ichneumonidae در سال ۱۳۹۸ در دشت گل محمدی داراب (استان فارس، ایران) با استفاده از تله‌ی مالیز، دو گونه از این زیرخانواده به نام‌های *Xorides corcyrensis* (Kriechbaumer, 1894) و *X. annulator* (Fabricius, 1804) جمع‌آوری و شناسایی شد. گونه دوم یک گزارش جدید برای ایران محسوب می‌گردد. یادداشت تاکسونومیک روی ویژگی‌های ریخت‌شناسی افتراقی گزارش جدید به همراه فهرست و کلید شناسایی به‌روز رسانی شده گونه‌های شناخته شده این زیرخانواده در ایران ارائه شد.

واژگان کلیدی: پراکنش، پارازیتوئید، تاکسونومی، گزارش جدید، فون