Notes on Aquatic Beetles (Coleoptera: Dytiscidae, Hydrophilidae; Dryopidae; Haliplidae, Noteridae) from Semirom (Isfahan Province, Iran)

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Abstract
As one of the useful biological indicators for assessing water quality, aquatic beetles (Coleoptera) with two families, Dytiscidae and Hydrophilidae, have the highest species diversity and diversity in the world. This study is an attempt to identify the aquatic beetles of the Semirom region, Isfahan, Iran. Sampling was done from eight stations in Semirom area for year with the help of Sachuk. Samples taken in the laboratory were separated using tweezers and transferred to bottles containing 70% alcohol. The samples were first identified at the species level using valid identification keys and relevant sources and compared with samples recently collected and identified. The results showed that the collected samples belonged to five families, nine genera and ten species (*Agabus bipustulatus, Hydroglyphus geminus, Agabus sturmii, Peltodytes caesus, Noterus clavicornis, Ilybius fuliginosus, Laccobius bipunctatus, Dryops ernesti, Enochrus tentaceus, Coelostoma orbiculare*). Two species, named *Agabus bipustulatus* and *Hydroglyphus geminus*, were the most commonly preserved specimens.

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Introduction

The order Coleoptera of insects contains more species than any other order, accounting for 25% of all known life forms (Sharma et al., 2019) [19]. More than 30,000 species of aquatic insects that can live in freshwater have been identified, and some species live in brackish water (Abbasi et al., 2020) [1]. With more than 13,000 described species, aquatic beetles (Coleoptera) are one of the most common groups of aquatic insects worldwide (Short, 2017) [21]. Furthermore, aquatic beetles are one of the most common groups in benthic communities of streams and rivers of temperate regions (Spangler, 1982) [22] and they inhabit almost all aquatic ecosystems (Ribera and Foster, 1992) [15]. Due to their highly diverse morphological and ecological adaptations, aquatic beetles are among the most diverse animal order (Miserendino and Archangelsky, 2006) [12].

Aquatic beetles are considered one of the biological components of benthic animals due to their very different morphological and ecological adaptations. Many species prefer certain types of water bodies especially dytiscids and many hydrophiles which are commonly found in small shallow-water habitats and along the edges of rivers and marshes (Jack and Margaret, 1987) [11].

Dytiscidae (predatory leaf beetles) are one of the largest and most commonly encountered groups of aquatic beetles, with about 4000 species described and 5000 predicted (Jäch and Balke, 2008; Vafaei et al. 2008) [23]. Hydrophilidae are the second most common family, generally found in small habitats in shallow waters, accounting for most species in stagnant water, but also common in streams, rivers and springs.

Although there are several reports of Iranian aquatic beetles (e.g. Esfandiari et al., 2002; Ostovena and Niakan, 2004; Heydarnejad, 2010; Mousavi et al., 2016; Sahyeghi et al., 2015; Vonvondel et al., 2017; Saeidi and Vatandoost, 2018)

[5, 14, 9, 13, 20, 25, 16], there is little information on the fauna of Iran's aquatic beetles. Therefore, the main aim of the current study is to provide information on adult coleopteran species from selected sites in the Semirom county (the capital of the county is the city of Semirom). With an area of 5224 square kilometers, Semirom is located in the southwestern part of the province of Isfahan, Iran with an average altitude of 2400 meters above sea level.

Material and Methods

Study area

The study area comprised eight sites in the central Semirom:

1. **Semiram Waterfall**: It is located 4 kilometers east of Semirom with good environmental conditions and suitable weather have caused various plants to grow around the waterfall.
2. **Ab-Melkh waterfall**: The location of the falls is 60 km from Semirom town. The waterfall bed is covered with mud and vegetation.
3. **Khafar waterfall**: It is located 5 km from Khafar village and on the steep slopes of Dena in an area called Gash Mustan Valley. This beautiful and pleasant landscape is 80 kilometers southwest of Semiram. The height of this waterfall is about 30 meters, located on the eastern slope of Dena.
4. **Marbar River bank:** It is one of the biggest rivers in the south of Semirom. The length of the Marber River is about forty-eight kilometers. The height of its source is 1088 meters above sea level.
5. **Baba Zarang Kameh spring:** It is located 65 km south of Semiram. Around this spring, several small and big springs also flow. The stream bed is very sandy and has vegetation.
6. **Cheshme Naz Venk:** It is located at a distance of 35 kilometers west of Semirom. There is a town called Venk and a beautiful spring called Cheshme Naz lies on its northern slope. Due to the presence of brackish water in this spring, its surroundings are covered with various plants and it has created an incredibly green area that is unique in its kind.
   - **Bibi Sidan waterfall:** Bibi Sidan is the name of a village 30 kilometers from Semirom, where a beautiful river of the same name passes near it. This river, with its very clear and blue water, passing through high rocky gorges, along with very beautiful springs that join it along the way, creates very spectacular and eye-catching landscapes.
   - **Lake Park:** Semirom Lake Garden Park has an area of about 6 hectares and is located about 160 km from Isfahan city. In the outskirts of this park, there is an earthen embankment that was built with the aim of developing tourism, watershed management and strengthening underground water resources, which has brought vitality to this lake.

Sampling

Sampling was performed at eight designated locations in the Semirom district with the help of Sachuk. The geological information and the name of each location (site) are given in Table 1. Collected samples were cleared of debris with tweezers and transferred to vials of 70% ethyl alcohol. Adult aquatic coleoptera were identified primarily at the species level to species level following mainly Zaitsef, 1953 [26]; 1972 [27]; Jach and Balk, 2003 [10]; Foster and Friday, 2011 [6]; Franciscolo, 1979 [7]; Valladares and Ribera 1999 [24] and Angus 1992 [2]. Images of the samples were taken with a digital microscope (Model 1000x). All samples were deposited at the University's Zoological Museum.

Results

A total of 165 aquatic Coleoptera belonging to five families (Dytiscidae, Hydrophilidae, Dryopidae, Noteridae, Haliplidae), nine genera and ten species were collected. The most abundant family was Dytiscidae followed by Hydrophildae, Dryopidae, Noteridae and Haliplidae (Table 1 & Figure 1). Two species, named *Agabus bipustulatus* and *Hydroglyphus geminus*, were the most commonly preserved specimens.

Table 1: List of species collected and identified from nominated sites

Suborder	Family	Genus	Species	Locality
Adephaga	Dytiscidae	*Agabus*	*bipustulatus*	Semirom
Adephaga	Dytiscidae	*Agabus*	*bipustulatus*	Rod marbar
Adephaga	Dytiscidae	*Agabus*	*bipustulatus*	Khafr
Adephaga	Dytiscidae	*Agabus*	*bipustulatus*	Naz vanak
Adephaga	Dytiscidae	*Agabus*	*bipustulatus*	Daryache
Adephaga	Dytiscidae	*Agabus*	*sturmii*	Daryache
Adephaga	Dytiscidae	*Hydroglyphus*	*geminus*	Bebe seydan
Adephaga	Dytiscidae	*Hydroglyphus*	*geminus*	Baba zerang
Adephaga	Dytiscidae	*Hydroglyphus*	*geminus*	Khafr
Adephaga	Dytiscidae	*Hydroglyphus*	*geminus*	Ab malakh
Adephaga	Dytiscidae	*Ilybius*	*fuliginosus*	Ab malakh
Adephaga	Dytiscidae	*Ilybius*	*fuliginosus*	Naz vanak
Adephaga	Haliplidae	*Peltodytes*	*caesus*	Bebe seydan
Adephaga	Noteridae	*Noterus*	*clavicornis*	Rod marbar
Polyphaga	Hydrophilidae	*Laccobius*	*bipunctatus*	Ab malakh
Polyphaga	Hydrophilidae	*Laccobius*	*bipunctatus*	Baba zerang
Polyphaga	Hydrophilidae	*Laccobius*	*bipunctatus*	Khafr
Polyphaga	Hydrophilidae	*Enochrus*	*Testaceus*	Khafr
Polyphaga	Hydrophilidae	*Coelostoma*	*Orbiculare*	Ab malakh
Polyphaga	Dryopidae	*Dryops*	*ernesti*	Ab malakh

Agabus bipustulatus

Agabus sturmiis

Ilybius* cf *fuliginosus

Hydroglyphus geminus

Peltodytes caesus

Noterus clavicornis

Laccobius bipunctatus

Coelostoma orbiculare

Dryops ernesti

Enochrus tentaceus

Fig 1: Pictures of aquatic beetle species identified

Family Dytiscidae (Leach, 1815)
***Agabus bipustulatus* Linnaeus, 1767**
Material examined: Semirom 31° 24’ 41”N, 51° 36’ 24”E, 2021/03/04. Rode marbar 31° 08’ 47”N, 51° 22’ 19”E, 2021/03/04. Khafr 30° 59’ 44”N, 51° 26’ 32”E, 2021/03/04.Naze vanak 31° 29’ 16”N, 51° 17’ 20”E, 2021/03/04. Parke daryache 31° 24’ 33”N, 51° 34’ 18”E, 2021/03/12.

Description: Between 10-12 mm long, their body is convex, oval and shiny black, the tentacles, legs and mouthparts red with shields, both the dorsal and ventral surfaces black, the presternal appendage oval and pointed and tectiform, and tongue-shaped at the apex. The body oval, convex, black and slightly shiny, mouthparts red, the posterior margin of the ventral sternum usually reddish in color. Have a small triangular plate at the junction of the dorsal surface of the front of the chest and the wing cover. The eyes placed higher than the tentacles, the back surface black and slightly convex, two points on the head red. Body shield with a specific network throughout. The presternal appendage oval and pointed and tectiform and tongue-shaped at the top.

Agabus sturmiis* Gyllenhaal, *1808
Material examined: Parke daryache 31° 24’ 33”N, 51° 34’ 18”E, 2021/03/04

Description: Body length about 8.5-9.0 mm, the body shape oval and convex, the tentacles and legs yellow-red, the back surface of the chest orange-brown, pronotum black with orange border, and double reticulation under the microscope, the dorsal surface (elytra) with the sides of the pronotum orange-brown in color, with double reticulation, as the best feature seen under the microscope.

***Ilybius* cf *fuliginosus* Fabricius, 1792**
Material examined: Abe malakh 31° 09’ 01”N, 51° 21’ 32”E, 2021/03/04. Naze vanak 31° 29’ 16”N, 51° 17’ 20”E, 2021/03/04

Description: Size 10-11 mm, the shape of the body convex and reddish-brown in color with yellow sides reaching to the margin of the dorsal surface in front of the chest, and the color of the ventral surface brown. Have a shield at the junction of the dorsal surface of the chest and wing cover, the eyes placed higher than the tentacles, the lateral wings wide behind the chest, the front claws of the male long, the hind claws e long, narrow. Have a tip, the back paw with a ridge on the edge. In the female, an apex of a triangular-shaped tooth from a deep anal sternite, the middle of which in the form of a short spine.

Hydroglyphus geminus, Fabricius, 1792
Material examined: Material examined: Bebe seydan 31°11ʾ54ʺ N, 51°27ʾ33ʺE, 2021/05/16. Ab malakh 31° 09’ 01”N, 51° 21’ 32”E, 2021/03/04 . Khafr 30° 59’ 44”N, 51° 26’ 32”E, 2021/03/04. Baba zerang 31° 02’ 45”N, 51° 35’ 55”E, 2021/03/04

Description: About 2 mm in size, the shape of the body convex and elongated oval, the head dark brown, the back surface of Prothorax yellowish-brown with dark markings on the rear half, dorsal surface of prothorax with striae extending to the wing cover. Dorsal surface of prothorax with striae prothorax with dark markings on hind half, mostly yellowish brown with brown markings. A dark spot on the front part and two dark marks on the rear-middle half and with two parallel grooves and close to the middle line.

Family Haliplidae, Kirby 1837
***Peltodytes caesus*, Duftschmid,1805**
Material examined: Bebe seydan 31°11ʾ54ʺ N, 51°27ʾ33ʺE, 2021/05/16. 1♀.

Description: Size 3.5-4 mm, width 1.4 mm, its maximum width in the middle part of the body. Oval, slightly oblong, convex, bright, pale yellow, ventral surface black, the last joint of the lower jaw longer than the penultimate joint, wing with black spots, head with scattered spots

The dorsal surface of the chest slightly striped in the front part, with irregular black dots, these dots smaller in the middle part and sometimes form two rows. The front border slightly black, the wing cover near the shield is slightly compressed with irregular rows of dots that are larger at the end. These rows converge at the base and create only six rows. Next, the number of rows increased up to ten rows because secondary rows appear. The first points of each row well defined. and bigger than the next points. The ventral surface of the prethorax behind the front coxa almost triangular in shape, each of the plates of the hind coxa with a denticle (tooth-shaped protrusion) on its posterior margin and these plates covering a part of the sixth abdominal joint.

Family Noteridae, Thomson, 1860
***Noterus clavicornis,* De Geer, 1774**
Material examined: Rode marbar 31°08ʾ47ʺ N 51°22ʾ19ʺ E, 2021/04/23. 1♀.
Description*:* The front half of the ventral surface of the prethorax in both sexes convex in the middle and with a line in its middle part that starts from a small point in the front part of the ventral surface of the prethorax and continues to its end. In males, the tentacle joints very long and wide, 5-8. The wing cover punctures not placed in regular rows and these irregular points larger in the rear half. About 4 mm in size, the body shape convex, the back surface and rear margin of the head brownish, the wing cover darker. Parameres asymmetrical. The right paramere sharper and shorter than the left paramere and with hair.

Family Hydrophilidae, Latreille, 1802
***Laccobius bipunctatus*, Fabricius, 1775**
Material examined: Ab malakh 31° 09’ 01”N, 51° 21’ 32”E, 2021/03/04 . Khafr 30° 59’ 44”N, 51° 26’ 32”E, 2021/03/04. Baba zerang 31° 02’ 45”N, 51° 35’ 55”E, 2021/03/04.

Description*:* About 4-5 mm in size, the body shape convex, the dorsal surface dark brown or black and white with a broad lateral yellow stripe on the protonum and elytra, the posterior half of the elytra yellowish. Head and protonum without leather between slits. Dorsal surface with scattered black spots. Parameres subrectangular apically, about as wide as inner lobe at apex. The posterior half of the elytra yellowish. Head without pale spots before eyes. Antenna with seven antennae, the third antenna very small, spherical. Elytra often present with a pair of yellow spots on the primary third series of punctures**.**

***Enochrus tentaceus*, Fabricius, 1801**
Material examined: Khafr 30° 59’ 44”N, 51° 26’ 32”E**,** 2021/05/16

Description: Body length 5.5–6.8 mm, second seta of mandible distinctly darkened medially, pronotum at most obscurely darkened medially. Clypeus with posterior median black spot and relatively small or completely absent in male but larger in female and often reaching anterior margin of clypeal in females. Males with labrum usually reddish yellow or light yellowish brown, but females with labrum at least somewhat dark in color. Second segment of mandible distinctly dark in middle part, pronotum obscurely dark in middle part at most. Clypeus with a black posterior median spot and relatively small or completely absent in males, but larger in females and often reaches the anterior margin of the clypeal in females.

***Coelostoma orbiculare*, Fabricius, 1775**
Material examined: Abe malakh 31° 09’ 01”N, 51° 21’ 32”E, 2021/03/04.

Description: Body length 4-4.8 mm, broad, convex, dorsal surface black, sometimes the margin of the pronotum narrowly reddish brown, antennae (including nine antonomers), base of antennae in dorsal view obscured by developed lateral margin of head. Enlarges eyes. Tarsomere 1 longer than meso, and metatarsi longer than tarsomere 2. Abdominal ventrite 1 without median carina. Elytra fully impressed with sutural striae reaching from tip to middle. Convex body shape.

Family Dryopidae, Billberg, 1820
***Dryops ernesti*, Des Gozis, 1886**
Material examined: Abe malakh 31° 09’ 01”N, 51° 21’ 32”E, 2021/03/04. 1♀ 1♂.

Description: About 5 mm in size, the shape of the body convex, the body usually covered with very dense fine hairs, with a scutellum. Both sides with a longitudinal and complete groove. Convex in the middle and with a line in its middle part starting from a small point on the front part of the ventral surface of the pre-chest and continues to its end. In males, the tentacle joints very long and wide, 5-8. The wing cover punctures not placed in regular rows and these irregular points larger in the rear half.

Conclusions

In this study, we examined the aquatic coleopteran fauna in the Semirom region, Isfahan province of Iran. From eight stations investigated, five families, nine genera and 16 species were found and identified. Consistent with this study, the Dytiscidae and Hydrophilidae families were reported as the most abundant family in a study of aquatic coleoptera (Ostovan and Niakan, 2004; Sa′nchez-Ferna′ndez *et al*., 2006; Atamehr and Alaei, 2010; Darilmaz *et al*., 2013; Mousavai *et al*., 2016; Samin *et al*., 2016). Two species named *Agabus bipustulatus* and *Hydroglyphus geminus* were the most commonly preserved specimens. All confirmed species are reported for the first time from this region.

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Conflict of Interest

The authors have no conflicts of interest to declare.

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