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On the biosystematics of aquatic coleoptera in central shahrekord (Chaharmahal-va-bakhtiari province, Iran)

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Abstract
Aquatic Coleoptera has been used as biological assessment of water quality with two largest families i.e. Dytiscidae and Hydrophilidae in terms of species richness and species diversity. As due to the limited studies on these organisms in Chaharmahl va Bakhtiari province, this study aimed to investigate bio systematics aquatic Coleoptera in central region of the province, i.e. Shahrekord. Sampling was done seasonally for one year at six nominated stations with the help of Sachuk. Collected samples were removed from debris by forceps and then transferred into vials containing 70% ethyl alcohol. The aquatic Coleoptera were identified at species level with the help of keys, books and related references and finally confirmed by foreign experts. A total of 8 species belonging to 6 genera (all from one family) were identified. *Agabus bipustulatus* and *Scarodytes halensis* were the most abundant insects. Considering that the identification of the aquatic Coleoptera fauna of the province is carried out for the first time, it is suggested that identification of aquatic Coleoptera to be continued at other freshwater habitats.

Keywords: Insecta; aquatic coleoptera; shahrekord; dytiscidae; hydrophilidae

1. Introduction
Aquatic insects are a major group of arthropods which at least one stage of their life cycle occurs in water [1]. Aquatic Coleoptera, known as water beetles, are one of the most abundant aquatic insects with over 13,000 species described [2]. The order Coleoptera with 176 families, 29500 genera and 386500 species is composed of four suborders including Archostemata, Myxophaga, Adephaga and Polyphaga. The suborder Polyphaga includes more than 90% of the Coleoptera species [3]. Aquatic Coleoptera has been used as biological assessment of water quality with two largest families i.e. Dytiscidae and Hydrophilidae in terms of species richness and species diversity [2]. Since the preservation of biological diversity (or biodiversity) as a measure of the variety of all organisms is one of the main conservation goals for the sustainable use of resources and animal survival, the identification and evaluation of animal habitats are considered topics of research priority. In this respect, aquatic Coleopteras are of great importance as indicators of biodiversity in freshwater ecosystems [4].
There is few information about faun of aquatic insects of Iran. For instance, [5]. For first time studied the aquatic beetle fauna of Fars province and [6]. Studied aquatic Coleoptera of Zanjan and Hamedan provinces. The other most important publications on Iranian aquatic beetles are: [7, 8, 9, 10, 1]. Apart from a study conducted by [11]. On aquatic Coleopteran of Choghakhor dam (in the vicinity of Shahrekord), no other study has not been done in Chaharmahal and Bakhtiari province so far. Thus, this study was aimed to study aquatic coleopteran faunas of central part of the province, i.e. Shahrekord.

2. Materials and Methods
Chaharmahl and Bakhtiari, one of the 31 Provinces of Iran, lies in the southwestern part of the country and surrounded by the famous Zakros mountains. (Figure 1). Sampling was done seasonally for one year at six nominated stations in Shahrekord region with the help of Sachuk. Collected samples were removed from debris by forceps and then transferred into vials containing 70% ethyl alcohol. The aquatic Coleoptera were identified at species level with the help of keys, books, related references and authors [12, 13, 14]. And finally confirmed by foreign experts. Photographs of the specimen were taken using a digital microscope (Model 1000x). All samples were deposited in the Zoology Museum, Shahrekord University (ZMSU).

Fig 1: Location of Chaharmahl & Bakhtiari province within Iran

Fig 2: Location of 6 stations within Chaharmahl & Bakhtiari

Table 1: Geographic information for each station

	locality	Latitude	Longitude	Elevation
1	Sudejan River	3232˚17"	5021˚09"	2321 m
2	Marghmalek Spring	3228˚36"	5030˚12"	2595 m
3	Mayak Spring	3231˚53"	5068˚06"	2091 m
4	Asad abad Spring	3222˚34"	5035˚52"	2417 m
5	Pirbalout Spring	3224˚44"	5042˚29"	2218 m
6	Kakolak Spring	3242˚28"	5078˚64"	2150 m

3. Results

A total of 8 species belonging to 6 genera (all from one family) were identified. All except one species i.e. *Laccophilus hyalinus*, the rest were reported for the first time from the province.

Family Dytiscidae Leach, 1815
Genus *Agabus* Leach, 1817
Agabus bipustulatus Linnaeus, 1767
Fig.1

Material examined: Sudejan 32° 32' 17" N, 50° 21' 09" E, 2017/10/04. Marghmalek 32° 28' 36" N, 50° 30' 12" E, 2017/10/04. Pirbalout 32° 24' 44" N, 50° 42' 29" E, 2017/10/04. Asad Abad 32° 22' 34" N, 50° 35' 52" E, 2017/10/04. Mayak 32° 31' 53" N, 50° 68' 06" E, 2017/09/12. kakolak 32° 42' 28" N, 50° 78' 64" E, 2018/04/13

Description: Length 9.5-11.5 mm. Oval; black and slightly curved, antennae, mouth parts, two frontal spots and tarsi red, posterior margins of abdominal sternites reddish, whole abdomen brownish red, elytra black with a distinct double reticulation throughout, large spur of hind tibiae longer than 1st tarsal segment, hind femora with a series of setae near the ventral margin of the anteroapical angle, Male: Shining; fore claws different; inner claw short, narrow, and curved with a pointed denticle at the base; outer claw half as long as the inner, broadened in the middle, penis narrow and pointed at the tip, parameres symmetrical with hairy tips, prosternal process pointed, and tectiform with a high keel to the apex.

Fig 1: *Agabus bipustulatus* A (dorsal Surface ,B (dorsal Surface ,C (Abdominal Surface

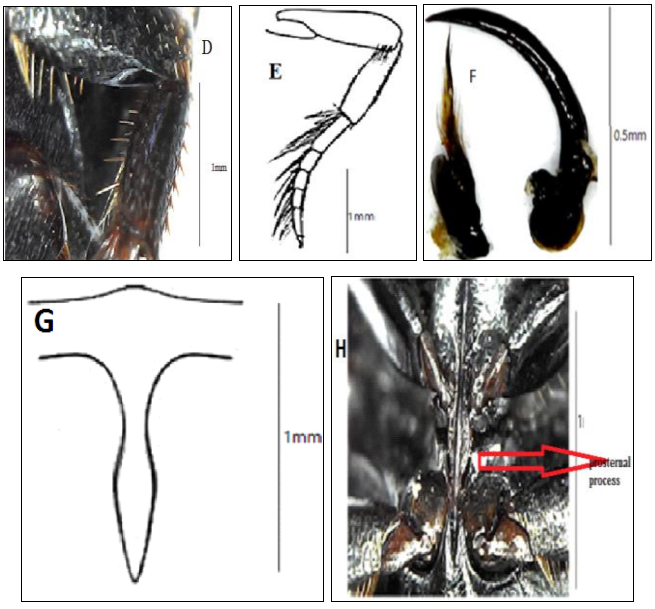

Fig 1: *Agabus bipustulatus* ,D (Hind Femora; E (Back leg; F (Penis and parameres; G (prosternal process; H (prosternal process

Family Dytiscidae Leach, 1815
Genus *Agabus* Leach, 1817
Agabus nebulosus Forster, 1771
Fig.2

Material examined: Marghmalek 32° 28’ 36” N, 50° 30’ 12” E, 2017/10/04. 1♂.

Description: Length 8-8.5 mm. Broadly oval, slightly convex, shining, brownish yellow to yellow dorsally with two black and dark spots in the middle of the dorsal surface of the pronotum, small and irregularly dotted on the elytra, especially in there are semi-backs where these spots are combined or separated in some, the slits are black, antenna and legs yellowish-red.

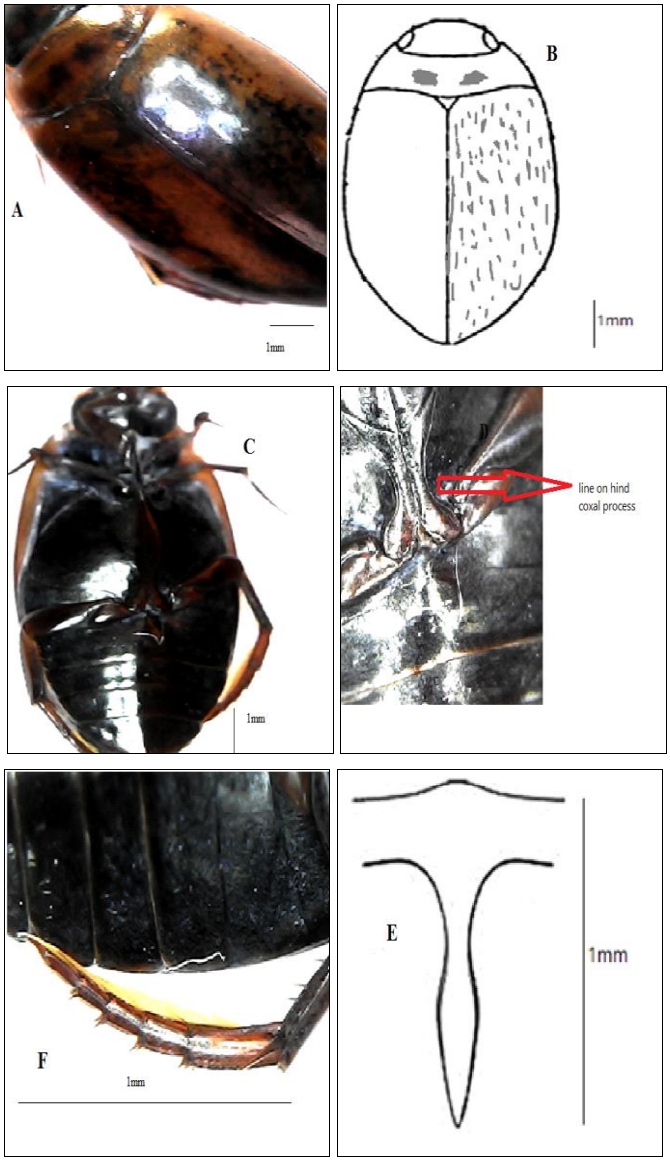

Fig 2: *Agabus nebulosus;* A (dorsal Surface ;B (dorsal Surface ;C (Abdominal Surface ;D (Hind coxal process; E (prosternal process; F (Back leg

Family Dytiscidae Leach, 1815
Genus *Agabus* Leach, 1817
Agabus biguttatus Olivier, 1795
Fig.3

Material examined: Marghmalek 32° 28’ 36” N, 50° 30’ 12” E, 2017/10/04 2♀ 3♂. Pirbalout 32° 24’ 44” N, 50° 42’ 29” E, 2017/10/04 3♀ 2♂.

Description: Length 8.5— 10mm. Broadly ovoid and strongly convex more shining anteriorly than posteriorly; dorsum with a fine network, its cells irregularly polygonal, loops smaller on sides of pronotum and elytra and near the apex. sides of pronotum rounded; lateral rim thin; posterior angles rounded, with a depression; row of dots near anterior margin broadly interrupted. Rows of dots on elytra distinct, more strongly marked posteriorly.

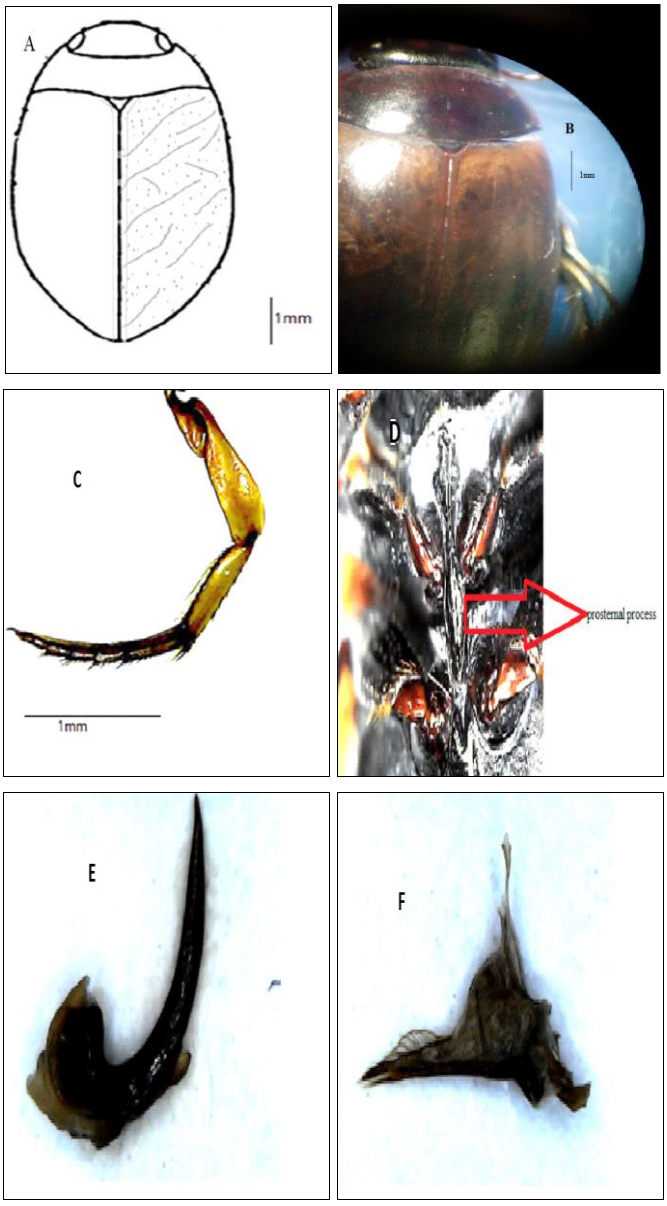

Fig 3: *Agabus biguttatus ;*A (dorsal Surface ;B (dorsal Surface ;C (Back leg ;D (prosternal process ;E(Penis; F (paramere

Family Dytiscidae Leach, 1815
Genus *Laccophilus* Leach, 1815
Laccophilus hyalinus De Geer, 1774
Fig.4

Material examined: Sudejan 32° 32’ 17” N, 50° 21’ 09” E, 2017/10/04 5♀ 8♂.

Description: Length 4.5—5 mm**.** broadly oval, coloration brown to greenish, antennae and palps uniformly reddish yellow, elytra brown with an indistinct pattern of yellowish ridges at the sides and a delicate double network, prothorax roof-shaped; its process is keeled, hind coxae with a stridulatory apparatus near middle of body which consists of an oblique row of short; impressed; slightly bracket-shaped

dashes, right paramere in form of an oblong scale; with broadly rounded apex and a small apical fascicle of hairs which stick together, left paramere smaller; its upper part triangular; also with a small fascicle of hairs, penis long with a small denticle at the apex of the dorsal surface.

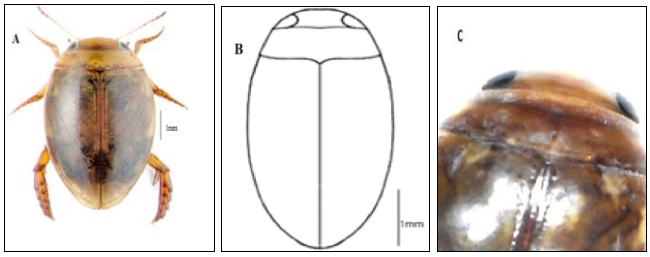

Fig 4: *Laccophilus hyalinus*; A & B (Dorsal Surface; C (Pronotum.

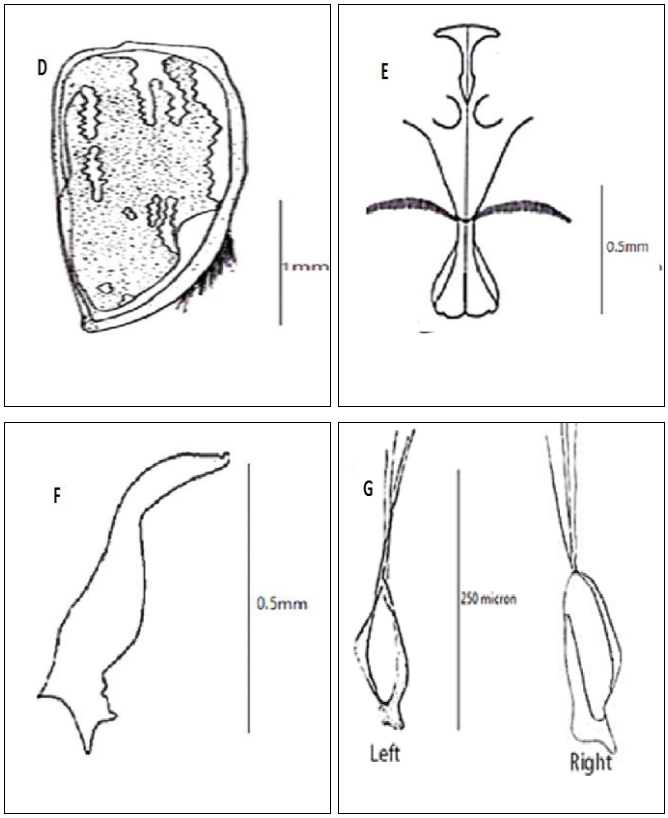

Fig 4: *Laccophilus hyalinus*; D (Elytra; E (metasternum and hind coxal process; F (penis; G (left and right parameres.

Family Dytiscidae Leach, 1815
Genus *Ilybius* Erichson, 1832
Ilybius fuliginosus Fabricius, 1792
Fig.5

Material examined: Sudejan 32° 32’ 17” **N**, 50° 21’ 09” **E,** 2017/10/04 2♀ 2♂.

Description: Oblong-oval, narrow, slightly pointed posteriorly; slightly convex, brown, with a bronze sheen; sides with a brownish yellow border which is usually divided by a brown line which begins at the apex. Network on the elytra distinct. Fore claws of male long and different; outer claw with a slight indentation before the middle; hind claws long, narrow and pointed, hind tarsi with a ridge at the outer margin. In the female, apical triangular indentation of anal sternite deep, its middle projecting in form of a short spine. Length 10—11.2 mm.

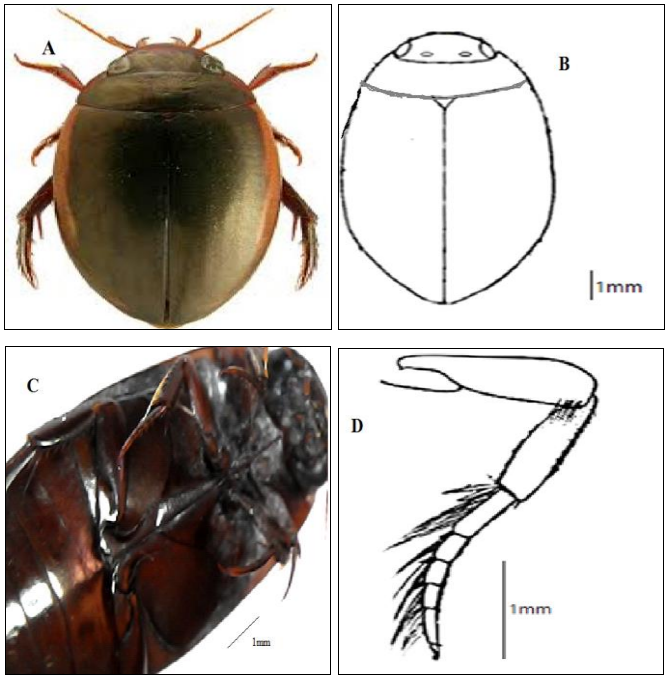

Fig 5: *Ilybius fuliginosus*; A & B (Dorsal Surface; C (Abdominal Surface; D (Back leg.

Family Dytiscidae Leach, 1815
Genus *Colymbetes* Clairville, 1806
Colymbetes fuscus Linnae, 1758
Fig.6

Material examined: Asad abad 32° 22’ 34”N, 50° 35’ 52”E, 2017/10/04 1♀ 1♂. Sudejan 32° 32’ 17” N, 50° 21’ 09” E, 2017/10/04 1♀ 2♂.

Description: Length 15-18 mm. body elongated and regularly oval, in the male 2nd abdominal sternite with a distinct stridulatory apparatus at the posterior margin; lateral to the middle; the apparatus consists of 23 short, dense, longitudinal dashes, anterior pro- and mesoclaw of male broadened at base and short, penis is narrow and strongly bent at base; apical region curved outwards, epipleura and underside of pronotum predominantly pale, elytra completely covered with undulate, weakly incised, thin dashes, gray or brown, but the ends of the elytra, the edges of it is yellow, ventral surface black, the legs reddish-brown, femora darker, metathoracic process usually flat between midcoxae, Parameres are large and symmetrical.

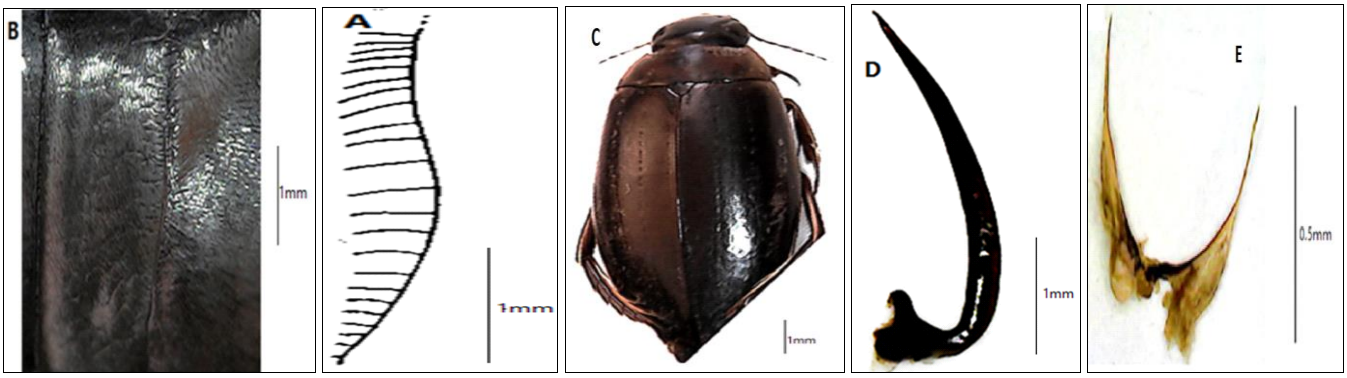

Fig 6: *Colymbetes fuscus*; A& B (Stridulatory apparatus; C (Dorsal Surface; D (Penis; E (Parameres

Family Dytiscidae Leach, 1815
Genus *Dytiscus* Linnaeus, 1758
Dytiscus persicus Wehneke, 1876
Fig.7

Material examined: Asad abad 32° 22' 34" N, 50° 35' 52" E, 2017/10/04 1♀ 3♂.

Description: Length 29-31 mm. clypeus groove presents with linear frons; pronotum expanded; yellow bar in front of the pronotum, tip of metacoxae sharp but its vertex convex. Color of the metasternum black and yellow; First (1st) abdominal sternum yellow; Second (2nd) abdominal sternum black and yellow. elytra with four grooves; portions of protonum and elytra yellow-red, in female, the groove on the elytra, penis often yellow with a bunch of hair at the apex. The grooved form of female apparently predominates as only one specimen had smooth elytra in a large series with grooved elytra.

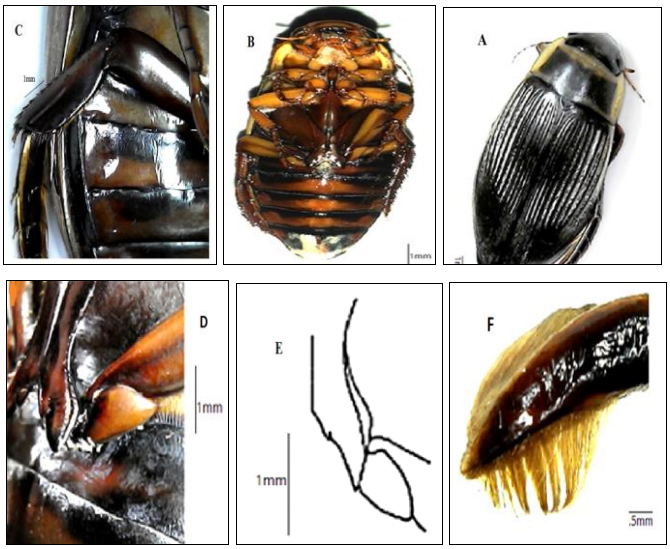

Fig 7: *Dytiscus persicus*; A (Dorsal Surface; B (Ventral Surface; C (Back Tibiae; D&E (Metacoxal process; F (Penis).

Family Dytiscidae Leach, 1815
Genus *Scarodytes* Gozis, 1914
Scarodytes halensis Fabricius, 1787
Fig.8

Material examined: Sudejan 32° 32' 17" N, 50° 21' 09" E, 2017/10/04, 4♀ 6♂ .kakolak 32° 42' 28" N, 50° 78' 64" E, 2018/04/13, 3♀ 7♂ .Mayak 32° 31' 53" N, 50° 68' 06" E, 2017/09/12 ,2.♂

Description: Length 3.8-5 mm. Oval and convex body shape, anterior is brighter than posterior, the back surface is thin, with irregular polygonal cells, pronotum with 2 large, irregular, black spots on the disc on each side of the midline which are sometimes fused; elytra clay-yellow; Venter black; epipleura, legs, and antennae reddish yellow rings. Small on the sides of the dorsal surface of the forearm and capillary and near the head in black or brownish-brown, reddish-brown, middle legs and oblique front, there are two spots on the head, Elytra without a denticle near the apex, Venter not shagreened, shining between the dots.

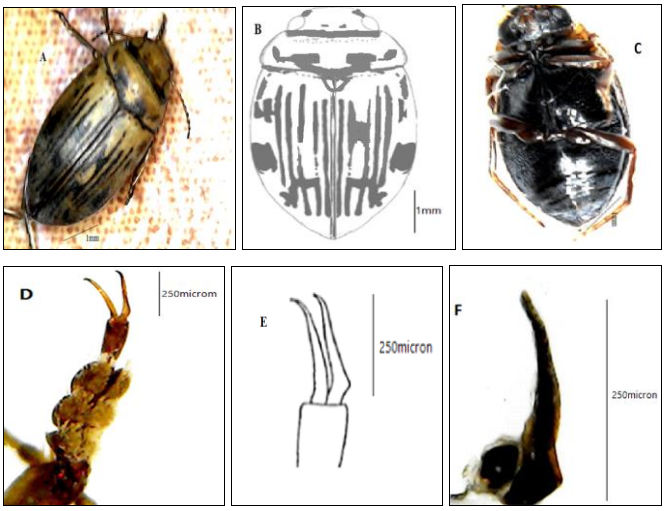

Fig 8: *Scarodytes halensis*; A & B (Dorsal Surface; C (Punctures of ventral surface; D& E (Fore tarsi; F (Penis.

4. Discussion

This study investigated aquatic coleopteran faunas of Shahrekord**,** Chaharmahl and Bakhtiari province, Iran. From six stations surveyed, 8 species, 6 genera and 1 family (Dytiscidae) were found and identified. In line with this research, the family Dytiscidae has been reported as the most abundant family in the study of aquatic Coleoptera by [15.16.17.7.18]. Also, this study showed that *Scarodytes halensis* and *Agabus bipustulatus* species were found in half of the stations where the samples were obtained. According to the results, Sudejan Bridge station is considered with the highest species richness. Of total number of specimens collected respectively *Laccophilus hyalinus*, *Agabus bipustulatus*, *Agabus biguttatus*, *Scarodytes halensis* were dominant species. This indicates that the abundance of these species was more than 5% of the total number of specimens. *Colymbetes fuscus* and *Ilybius fuliginosus* which contain 2 to 5% of all specimens, were semi-dominant species, but

Dytiscus persicus and *Agabus nebulosus* which their abundance was less than 2% of the total number of specimens, were rare species [17]. Except for *Laccophilus hyalinus*, the remaining samples are reported for the first time from Chaharmahal and Bakhtiari province.

5. Conclusions

The purpose of this research was to explore systematically the effect of environmental variables on the distribution of aquatic beetles in the Shahrekord region. Of the eight species identified in this study, seven are the province's first species. A total of 123 samples of predatory water beetles were gathered. We have reported eight species in six Dytiscidae genera. The remainder were first recorded from the province except for one species, i.e. Laccophilus hyalinus. In half of the stations where the samples were collected, *Scarodytes halensis* and *Agabus bipustulatus* species were discovered. Sudejan Bridge Station is regarded with the greatest species wealth according to the outcomes.

6. Acknowledgements

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