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Confirmed occurrence of *Hydroscapha granulum* in Iran, with notes on its biology (Coleoptera: Myxophaga: Hydroscaphidae)

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Abstract. During 2008 and 2009, a study of the hygropetric fauna was carried out in the provinces of Fars and Mazandaran in Iran. Fifteen hygropetric sites were sampled and the *Hydroscapha* specimens were recorded at twelve of them. All specimens collected were identified as *Hydroscapha granulum* (Motschulsky, 1855). Taxonomic and distributional features of this species, also some remarks regarding the ecological preferences are provided. Our study represents the first records of *Hydroscapha granulum* in Iran confirmed by the study of male genitalia.

Keywords. Myxophaga, Hydroscaphidae, *Hydroscapha granulum*, distribution, morphology, hygropetric habitats, bionomics, Iran, Palaearctic Region

Introduction

The family Hydroscaphidae belongs to the suborder Myxophaga whose representatives usually inhabit hygropetric habitats. Hydroscaphidae contains minute beetles that generally inhabit algal mats over which a thin water film flows (Vanin et al. 2005). The family comprises 3 genera: *Scaphydra* Reichardt, 1973 (3 species from southeastern Brazil), *Yara* Reichardt & Hinton, 1976 (2 species from Brazil and Panama), and *Hydroscapha* LeConte, 1874 with approximately 18 described species from Palaearctic, Afrotropical, Nearctic and Oriental Regions (Fikáček & Šípková 2009; Hall 2000; Hall & Short 2010; Jäch 1995; Löbl 1994, 2003; Maddison 2001; Vanin et al. 2005).

Hydroscaphidae generally resemble staphylinids having shortened elytra and an exposed abdomen, but are easily distinguished by the presence of distinct notopleural suture, and their aquatic way of life (Arnett 2000). Adults average 0.6–1.9 mm in length and are fusiform in body form. The elytra are truncate, leaving several tergites of the abdomen exposed. Antennae are 5- or 8-segmented, and tarsi 3-segmented. Body coloration ranges from tan to brown. Wings are fringed with long setae along margins and their venation is reduced (Hall 2000, Jäch 1995, Löbl 1994, Vanin et al. 2005).

Larvae are characterized by fusiform body shape, with the thorax broad and the abdomen strongly narrowing posteriad (Vanin et al. 2005). Similarly as in other Myxophaga, pupation of *Hydroscapha* occurs in the last larval exuvia based on the observations of the Nearctic *H. natans* LeConte, 1874 (Maddison 2001).

The biology of Hydroscaphidae is only poorly known so far, and is mostly based on the observations of Nearctic *Hydroscapha natans*. One large egg is laid at a time by the female on the mats of algae (Hall 2000, Leech & Chandler 1956). Hydroscaphids are considered exclusively algophagous in both adult and larval stages (Beutel 1998, Jäch 1995). They can tolerate a wide range of water temperatures, including both hot springs with temperatures up to 45°C, to icy snow-fed streams (e.g. specimens of *Hydroscapha natans* were collected not only in hot springs in Arizona but also in the cool water of the Amargosa River in Nevada) (Balke et al. 2004, Hall 2000, Leech & Chandler 1956, Vanin et al. 2005).

In a comprehensive revision of the Asian *Hydroscapha*, Löbl (1994) (re)described twelve Asian species and provided an identification key based on abdominal segments and aedeagal characters. During survey of the hygropetric habitats in north-east India by Fikáček & Šípková (2009), two new species of *Hydroscapha* were described and updated identification keys for males and females of Asian *Hydroscapha* were provided. This key was mainly based on the characters of the genitalia and abdominal sclerites, with antennal characters and body dimensions used in necessary cases.

Only two records of Hydroscaphidae were published from the Near East: (1) Reitter (1887) described *Hydroscapha sharpi* Reitter, 1887 from Lenkoran in southern Azerbaijan (the species is considered a synonym of *H. granulum* by d'Orchymont (1945) and Löbl (1994, 2003)). (2) Löbl (1994) mentioned a single female specimen tentatively identified as *Hydroscapha granulum* collected in the Khuzestan province in southwestern Iran. Within this contribution, we are showing *Hydroscapha* to be common in suitable habitats in Iran; the extensive material collected for this study also confirms the identification of the Iranian species by the examination of the male characters. Data on the biology is also provided for the Iranian specimens.

Material and methods

Samples were collected between July 2008 and December 2009 in different hygropetric habitats in Fars province (southern Iran) and at one locality in Mazandaran province (northern Iran). Collected specimens were killed in 70% ethanol solution. The whole abdomen was detached from the specimens, macerated in hot 10% KOH solution for nearly a minute, and then

dissected. Terminal abdominal tergites, sternites and genitalia were mounted in slides using the Hoyer's medium. In some specimens, the entire head was disjointed and mounted in order to examine the morphology of antennae. Identification of the specimens is based on antennal morphology (antennomeres 2 and 8), male sternites V–VII, and the shape of the aedeagus in lateral view, using the identification keys by Löbl (1994) and Fikáček & Šípková (2009). Male characters are sufficient for recognizing species according to Fikáček & Šípková (2009), thus only the genital segments of male specimens were used. Identification was confirmed by Martin Fikáček (National Museum, Prague, Czech Republic). Slide-mounted specimens and material are stored in collections of the senior author and collection of the Plant Protection Department, Jahrom Islamic Azad University.

Larvae and adult beetles were reared in simple plastic boxes (12×8×5cm) filled with algae in order to perform a preliminary biological study of *Hydroscapha granulum*.

Results

Hydroscapha granulum (Motschulsky, 1855)

(Figs. 1–19)

Redescription. Measurements: Length of fore body (i.e., the distance between the anterior margin of the head and the posterior margin of the elytra): 0.6–0.7 mm. Elytral length: 0.40–0.45 mm.

Colouration: Body uniformly dark brown (Fig. 18).

Antenna: Antennomere 2 long, 2.0 times longer than wide. Antennomere 8 ca 3.0 times longer than wide (Fig. 13).

Male: Sternite V (Fig. 14) with two tufts of setae at posterior margin; posterior margin slightly sinuate. Sternite VI without distinctly defined tufts of setae sublaterally. Postero-median portion of sternite VII (Fig. 12) slightly convex between lateral tufts of setae. Posterior margin of sternite VII without defined median projection, arrangement of postero-lateral setae irregular. Aedeagus (Fig. 10) straight in lateral view, subapically narrow, gradually narrowing apicad**.**

Female: Sternite VI simply rounded posteriorly. Tergite VI apically rounded.

Variation. Some superficial differences were observed in the shape of the male genitalia. In some cases, the aedeagus seems slightly wider in the apical portion (Fig. 11). Differences were also observed in the length of the elytra (Fig. 17) and in the chaetotaxy of the surface around the tufts of setae on male sternite V (Figs. 14–16).

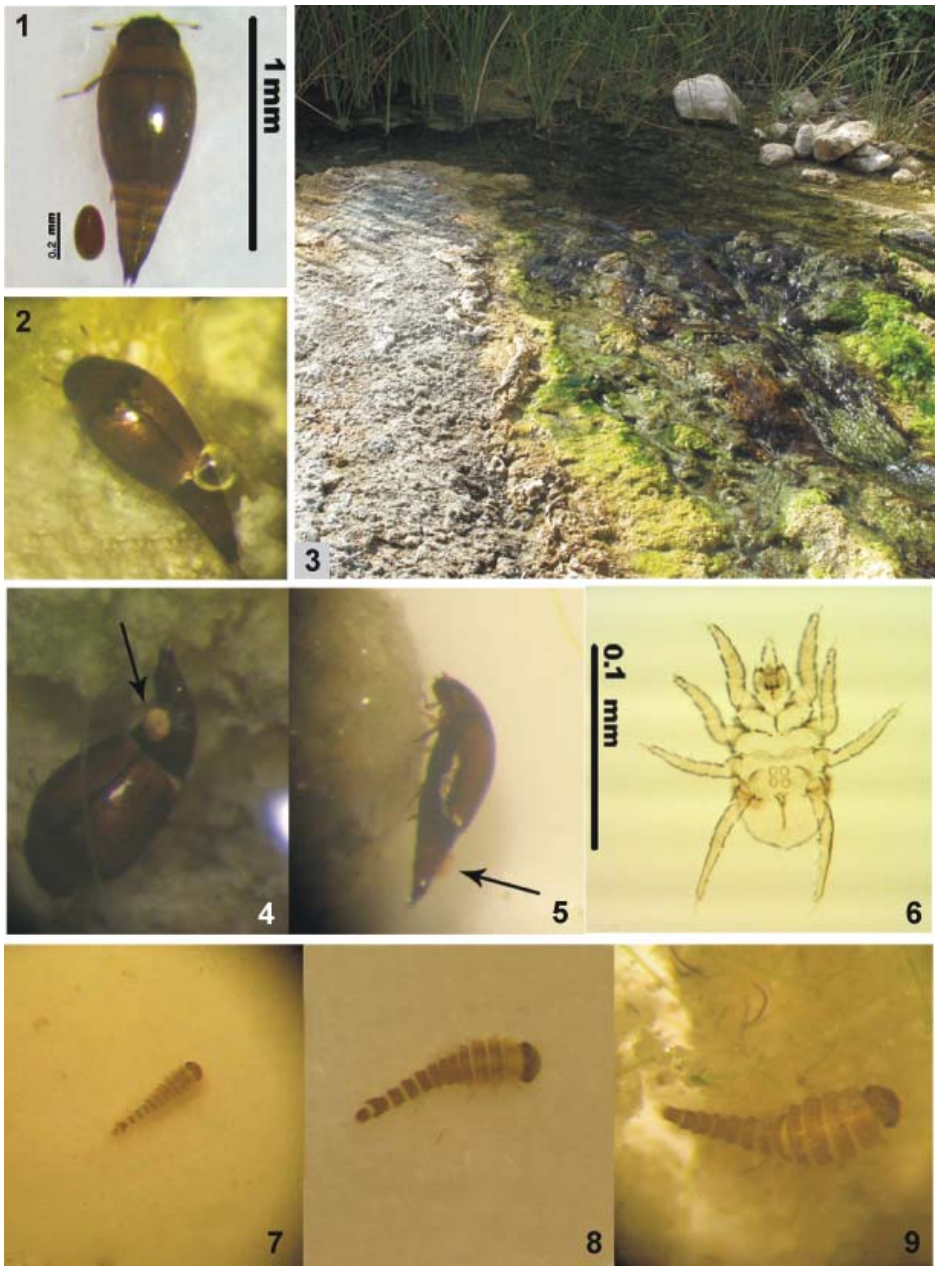
Distribution. Distribution of *Hydroscapha granulum* is still insufficiently known for two reasons: (1) the beetles are easy to overlook and are therefore rather rare in the collections; (2) the taxonomic status of *H. crotchi* Sharp, 1874 and *H. mauretanica* Peyerimhoff, 1922 remains unclear. *Hydroscapha crotchi* was considered as a synonym of *H. granulum* by d'Orchymont (1945) and Löbl (1994), but is considered as a separate species occurring in Spain and Corsica by Löbl (2003) and Audisio & Löbl (2004a). *Hydroscapha mauretanica* from Algeria was considered as a possible synonym of *H. granulum* by Löbl (1994) based on

Table 1. List of sampled localities in Iran. *Hydroscapha granulum* was not found on sites marked by an asterisk.

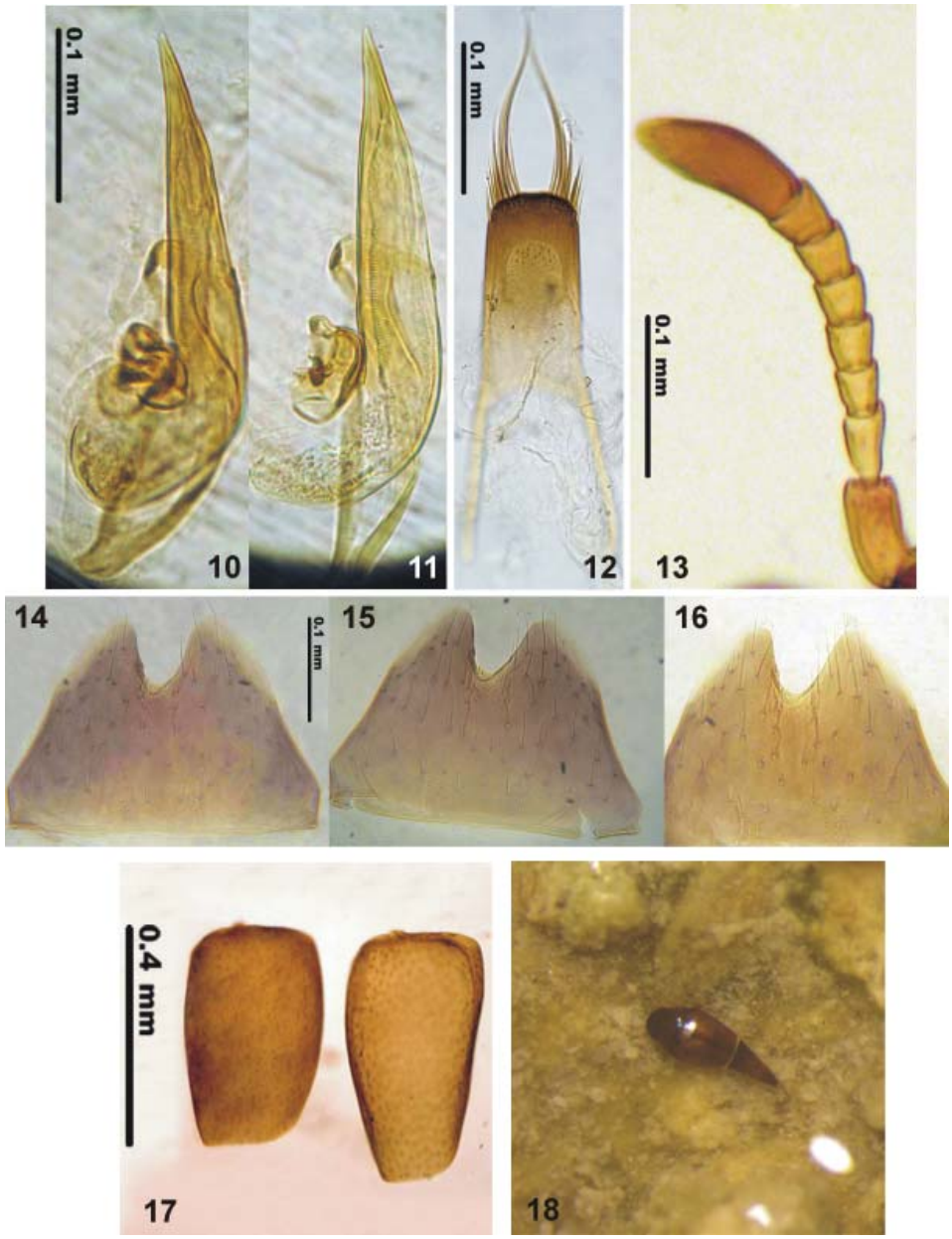
No	Sampling site	Coordinates	Habitat	Altitude	Collector	Collecting date
1	Mazandaran prov.: 10 km SE Abbasabad	36°38′95.9″N 51°12′22.5″E	small stream	149 m	A. Pütz & H. Naserzadeh	4.vi.2008
2	Fars prov.: Dehroud, 25 km S Firouzabad	28°36′48.0″N 52°34′25.1″E	river	883 m	Sh. & Gh. Falamarzi	14.viii.2009 30.–31.vii.2008
3	Fars prov.: Fathabad (1), 19 km SE Firouzabad	28°41′54.4″N 52°40′0.3″ E	river	1145 m	Sh. & Gh. Falamarzi	17.vii.2008
4	Fars prov.: Fathabad (2), 22 km SE Firouzabad	28°41′2.9″N 52°40′53.4″E	small stream	1140 m	Sh. Falamarzi	17.vii.2008
5*	Fars prov.: Joubkhale, 23 km NW Sepidan	30°29′3.18″N 51°52′43.22″E	river	1937 m	Sh. Falamarzi & M. Heidari	25.vii.2008
6	Fars prov.: Khavis, 32 km SE Firouzabad	28°34′12.6″N 52°39′39.2″E	small stream	1055 m	Sh. Falamarzi & M. Heidari	14.viii.2009, 19.vii.2008
7*	Fars prov.: Kherghe, 20 km W Firouzabad	28°53′56.19″N 52°22′39.97″E	small stream	1525 m	Sh. Falamarzi	25.vi.2008
8*	Fars prov.: Margoun, 24 km NW Sepidan	30°29′37.7″N, 51°53′28.52″E	waterfall	2140 m	Sh. Falamarzi	25.vii.2008
9	Fars prov.: Reykan (1), 11 km NW Qir	28°34′10.67″N 52°59′41.63″E	small stream	1052 m	Sh. Falamarzi	14.vii.2008, 27.viii.2008
10	Fars prov.: Reykan (2), 12 km NW Qir	28°34′51.32″N 52°58′17.5″E	spring	1130 m	Sh. Falamarzi	28.xii.2008
11	Fars prov.: Reykan (3), 11 km NW Qir	28°34′45.6″N 52°57.5′51.6″E	small stream	1107 m	M. Heidari & Sh. Falamarzi	22.vii.2008
12	Fars prov.: Shaldan (1), 10 km NW Qir	28°33′42.7″N 52°59′53.5″E	small stream	1067 m	Sh. Falamarzi	22.vii.2008, 6. and 17.vii.2009
13	Fars prov.: Shaldan (2), 10 km NW Qir	28°33′49.5″N 52°59′32.43″E	small stream	1077 m	Sh. Falamarzi	4.xii.2009
14	Fars prov.: Shaldan (3), 10 km NW Qir	28°34′1.28″N 52°59′51.08″E	small stream	1049 m	Sh. Falamarzi	12. and 15.xii.2008
15	Fars prov.: Tang kale, 17 km S Qir	28°21′35.48″N 52°55′20.3″E	small stream	775 m	Sh. Falamarzi & M. Heidari	27.vii.2008

the fact that it was diagnosed from the latter species only by the slightly different proportions of the elytra (this character is variable within *Hydroscapha* species as illustrated in Fig. 17). Below, we list only the records not concerning *H. crotchi* and *H. mauretanica*.

Europe: Spain (Jäch et al. 1999), France (d'Orchymont 1945, Richoux & Doledec 1987, Löbl 2003), Italy (Löbl 2003), Serbia (Löbl 1994), 'Yugoslavia' (Löbl 2003, Audisio & Löbl 2004b; may concern the Serbian record), Bulgaria (Hinton 1969, Joost 1979), Greece (d'Orchymont 1945, Löbl 2003).
Asia: Turkey (Anatolia: d'Orchymont 1945, Löbl 2003); Azerbaijan (Länkäran: Reitter 1887, Löbl 2003), Iran (Khuzestan, Andimeshk, 32°41′N, 48°15′E: Löbl 1994; Fars, Mazandaran: this paper).



Figs. 1–9. Iranian specimens of *Hydroscapha granulum* (Motschulsky, 1855) and their typical habitat. 1 – egg size in comparison to female beetle (locality no. 6); 2 – air bubble under elytra; 3 – typical habitat of the species (rocks covered by algae, locality no. 12); 4–6 – mites (possibly parasitic) infecting *Hydroscapha* adults at localities 6 and 12 (4, 5 – mites on abdominal tergites; 6 – microscopic slide of the mite, scale bar 0.1 mm); 7–9 – habitus of different larval instars.



Figs. 10–18. Morphology of Iranian *Hydroscapha granulum* (Motschulsky, 1855). 10–11 – aedeagus, lateral view; 12 – sternite VII; 13 – antenna; 14–16 – male, sternite V; 17 – different proportions of elytra in two specimens from the same stream (localities 12 and 13); 18 – *H. granulum* in natural habitat (locality 9).

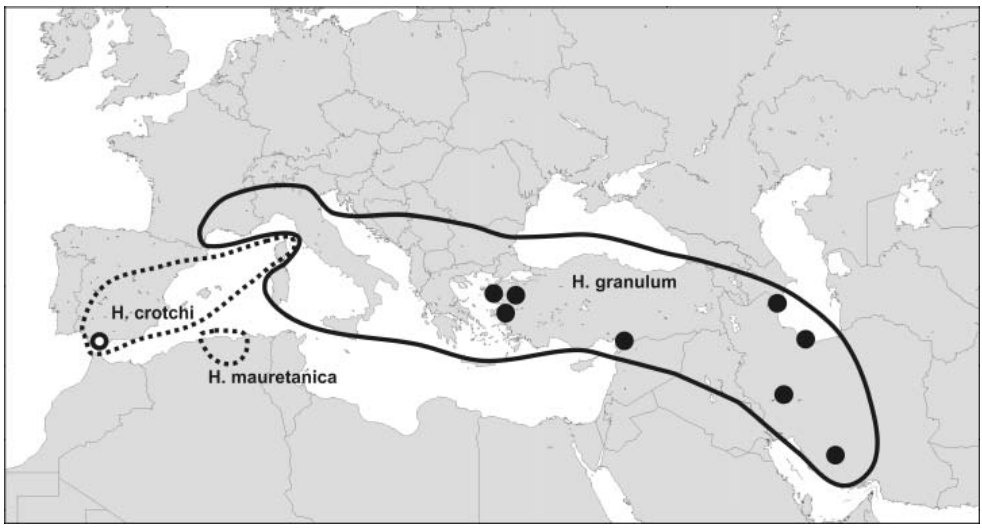


Fig. 19. Known distribution of West-Palaearctic *Hydroscapha* derived from the published data (see the text for details). Asian records are mapped by full circles, Spanish record of *H. granulum* (Motschulsky, 1855) by Jäch et al. (1999) by an empty circle. Species whose synonymy with *H. granulum* requires revision are mapped in dotted line.

Distribution of *Hydroscapha granulum* and the species which may be its synonyms are illustrated in Fig. 19.

The list of collecting sites in Iran is given in Table 1. Our study provides the first record of Hydroscaphidae in Fars and Mazandaran provinces. Several hydraenid species (*Hydraena* sp., *Ochthebius* sp., *Limnebius* sp.) were collected in the same microhabitats together with the *Hydroscapha* specimens. We also collected *Sphaerius* sp. (Myxophaga, Sphaeriusidae) at localities 2, 9 and 12. Some (possibly parasitic) mites (Figs. 4–6) were observed on exposed abdominal tergites of one *Hydroscapha* specimen at the locality of Shaldan (loc. 1) and between algal filaments in Khavis.

Notes on biology. The egg is large in proportion to the female's abdomen (length up to 0.2 mm; width about 0.12 mm; Fig. 1) and only one is developed and deposited at the time. Eggs are oval, smooth, dark brown and without sculpture on surface. We observed them attached to the algae few days after keeping beetles in rearing boxes, and dissected them also from the female body. At least three larval stages (Figs. 7–9) were observed in the examined alive larval specimens. All larval stages are elongate, dark grey and strictly aquatic. Presence of larvae together with adults was detected almost in all localities (no. 2, 3, 6, 9–14). Both adults and larvae can be found in large numbers in suitable streams, especially on the rocks covered by algae in the marginal shallows (Fig. 3) (see also Fikáček & Falamarzi (2010: Figs. 13–14) for photographs of localities of Shaldan and Reykan). An air bubble was observed under the elytra of the adults and extending behind the elytra (Fig. 2). Females were observed to attract the males by moving elytra up and down.

Table 2. Observed microhabitat preferences in the representatives of the genus *Hydroscapha*.

Habitat	Observed at sites	Previously referred by
Filamentous algae growing on rocks	2, 3, 9, 11, 12, 13, 15	Hall (2000), Fikáček & Šípková (2009)
Sandy borders and gravel banks of rivers and seepages	2, 3, 4	Jäch (1998) Vanin et al. (2005)
Moist mud	2, 10, 11	–
Under fallen leaves at side of waterfall on small river	13, 14	Fikáček & Šípková (2009)
In fast-flowing streams under stones almost 1 m below the surface	–	Vanin et al. (2005)
Pools and hot springs	–	Jäch (1995), Vanin et al. (2005), Hall (2000)

During our study, *Hydroscapha granulum* was found in four different types of microhabitats, which partly correspond with those mentioned by other authors for other *Hydroscapha* species. Observed habitat preferences and their comparison to data of previous authors are provided in Table 2.

Discussion

Altitude may determine the distribution of aquatic insects since this factor sets the gradient which influences several characteristics of the aquatic environment and therefore the associated fauna (Valladares et al. 1990). *Hydroscapha* species are known to occur in higher altitudes in the tropical areas (e.g., *Hydroscapha satoi* Löbl, 1994, *H. nepalensis* Löbl, 1994 and *H. monticola* Löbl, 1994 at altitudes between 1800–2800 m). *Hydroscapha granulum* was so far found exclusively in lowlands in Europe and Anatolia (Richoux & Doledec 1987, Löbl 1994). In contrast, the Iranian localities range between 149–1145 m a.s.l. (with the highest altitude at Fathabad River, loc. 3). We have sampled three similar microhabitats (blue algae on rocks) at higher altitudes at Khavis (1055 m), Khergheh (1525 m) and Margoun (2140 m), but *Hydroscapha* was only found at the first locality (1055 m). Similarly, in Dehroud (883 m) and Fathabad (1145 m), *Hydroscapha* was found together with *Ochthebius* sp. in gravel and moist mud at the edges of rivers. But in the Joubkhale river (1937 m), *Limnebius* sp. and *Ochthebius* sp. occurred without *Hydroscapha*. Absence of *Hydroscapha granulum* from higher altitudes suggests that this species may not be adapted to colder climate and may have more limited temperature ranges than North American *H. natans* which occurs in icy streams as well as in hot springs. Besides pollution being hypothesized as a key factor influencing the distribution of this species, temperature may also play an important role.

Further studies are needed for a better understanding of taxonomy as well as biogeography of the western Palaearctic *Hydroscapha* species.

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