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Endemic and sub-endemic water beetles of Mongolia and their distribution ranges

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The aim of this study was to compile a species list of endemic water beetles of Mongolia and determine their distribution patterns. A total of 1,179 individuals of endemic water beetles were collected from nine different sub-basins (123 sample points) throughout the country. Currently, 21 endemic and sub-endemic species have been recorded in Mongolia. Eight of these species were strictly endemic. The endemic and sub-endemic species were found only among four families: Dytiscidae (10 out 99 spp.), Gyrinidae (1 out 7 spp.), Helophoridae (5 out 16 spp.), and Hydraenidae (5 out 13 spp.). The rate of endemism was higher in Hydraenidae than other families (38.4%). Endemic beetle fauna was most similar between the Onon and Kherlen River Basins (80%). *Helophorus parajacutus* Angus, 1970 was common in five sub-basins, but *Agabus kaszabi* Guéorguiev, 1972, *Gyrinus sugunurensis* Nilsson, 2001 and *Ochthebius mongolicus* Janssens, 1967 were recorded from only one sub-basin. In terms of sub-endemic species, Mongolia was mostly similar to the fauna of Eastern Siberia, Russia (73.7%) than other neighboring regions. Due to Mongolia's vast territory and different natural zones, endemism was exceptionally low (12.4%), but these data provide baseline information of endemic and rare species for their further conservation.

Keywords: Coleoptera, endemism, sub-basin, water beetle

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Introduction

The geography of Mongolia is characterized by environmental and geographical transition zones of the northern edge of Central Asian Desert and the southern margin of Siberian taiga, which generate a distinctive combination of ecosystems and unique faunal patterns. Mongolia has a diverse insect fauna because of its various ecosystems and diverse habitats, including high mountains and boreal taiga forests in the north, the vast steppes and plain grasslands in the center, and the dry deserts and semi-deserts in the south. Therefore, aquatic insect fauna, particularly the endemic fauna of Mongolia is worth investigation. There is a considerable number of very interesting and important insects in Mongolia from a systematic point of view (Bayartogtokh *et al*., 2016).

In the country, the most endemic species are included in families of Coleoptera (481 endemic species) and Homoptera (Sternorrhyncha, Auchenorrhyncha) (208 endemic species) (Puntsagdulam *et al*., 2017). Many species of Tenebrionidae and Curculionidae beetles are endemic to Mongolia and central Asia (Tsendsuren, 1973; Medvedev, 1990). However, researchers have never focused on studies of endemism of aquatic insects in Mongolia.

Early works on species composition of water beetles in Mongolia have focused on not only the country, but also adjacent regions (Jakovlev, 1899; Zaitzev, 1910; 1972; Zimmermann, 1930; Feng, 1933; Brinck, 1943; Guignot, 1956). A significant contribution was made by Zoltan Kaszab, who worked in Mongolia (1963−1968) for six expeditions and collected a half of a million specimens (Kaszab, 1983). Various insect specimens in his collections were later identified by specialists from different countries. Almost all of these specimens are deposited in the Hungarian Natural History Museum in Budapest. Aquatic coleoptera specimens were identified and included in publications by Angus (1966; 1970a; 1970b; 1985), Guéorguiev (1965; 1968a; 1968b; 1969; 1972), Janssens

(1967; 1968; 1971), and Gentili (1973). Later, some papers were published by Brancucci (1982; 1983), Bellstedt (1985), Shaverdo and Fery (2001), Nilsson (2001), Nilsson and Fery (2006), and other researchers who focused on specific families of water beetles of Mongolia.

Recently, aquatic insect fauna of Mongolia was investigated extensively by the Selenge River Basin Project (SRP) in 2003−2006 and Mongolian Aquatic Insect Survey (MAIS) in 2008−2011 carried out in central, northern, western, and some eastern parts of Mongolia. As results, researchers described species new to science and many new records for the country (Enkhnasan, 2006; 2008; 2011; Shaverdo and Fery, 2006; Short and Kanda, 2006; Shaverdo *et al*., 2008; Short *et al*., 2010). About 30 of the beetle families have aquatic representatives, and in 25 of these families, at least 50% of the species are considered to be aquatic (Jäch and Balke, 2008). Currently 169 species belonging to seven families of aquatic beetles (Janssens, 1971; Short and Kanda, 2006; Short *et al*., 2010; Enkhnasan, 2011; Enkhnasan and Boldgiv, 2019) are recorded in Mongolia.

In this paper, we reviewed the species composition and distribution patterns of endemic and sub-endemic water beetles of Mongolia for the first time. We characterized endemic and sub-endemic species recorded from four families (Dytiscidae, Gyrinidae, Helophoridae, and Hydraenidae), which are the only families among seven water beetle families to contain endemic and sub-endemic species (other three families without endemics and sub-endemics being Haliplidae, Noteridae, and Hydrophilidae).

Materials and Methods

We considered an "*endemic species*" as a species with its known distribution only within Mongolia by scientific community, although not restricted by administrative borders, and "*sub-endemic*" as species occurring exclusively in Mongolia and nearby adjacent countries, following the characterization by Biondi *et al*. (2013).

Study area

There are three main river basins in Mongolia (Davaa and Jambaljav, 2014): the Arctic Ocean Basin (AOB), Pacific Ocean Basin (POB), and Central Asian Inland Basin (CAIB), which are divided into ten regional sub-basins. Three of these sub-basins are included in the Arctic Ocean Basin (Selenge river basin [SRB], Shishkhed river basin [ShRB], and Bulgan [BRB]), three sub-basins belong to Pacific Ocean Basin (Kherlen [KhRB], Onon [ORB], and Khalkhgol [KhGRB]), while four sub-basins are in the

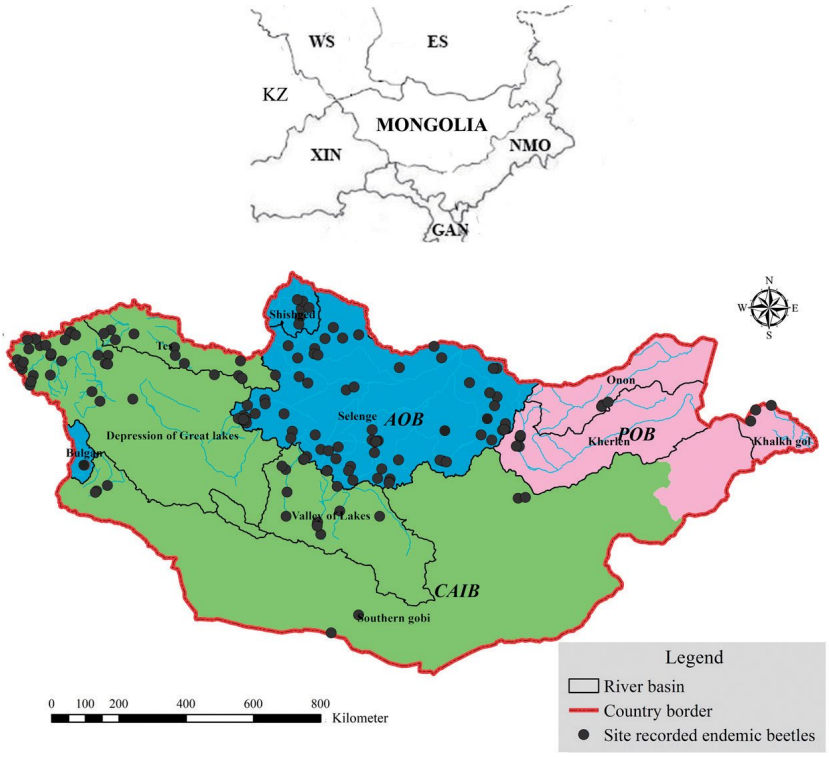

Fig. 1. Sampled points of endemic water beetles in Mongolia, divided into basins and sub-basins. The top figure shows the adjacent regions of China and Russia used in analyses. Abbreviations: KZ-Kazakhstan; WS-West Siberia; ES-East Siberia; NMO-Nei Mongol; Gan-Gansu; XIN-Xinjiang; AOB-Arctic Ocean basin; POB-Pacific Ocean Basin; CAIB-Central Asian Inland Basin.

Table 1. Species composition of water beetles in Mongolia.

Family	Total species number	Number (%) of endemic species	Number (%) of sub-endemic species	Number (%) of endemism
Dytiscidae	99	2 (2.0%)	8 (8.1%)	10 (10.1%)
Haliplidae	9	–	–	–
Gyrinidae	7	1 (14.2%)	–	1 (14.2%)
Noteridae	1	–	–	–
Hydrophilidae	24	–	–	–
Helophoridae	16	3 (18.7%)	2 (12.5%)	5 (31.2%)
Hydraenidae	13	2 (15.3%)	3 (23.0%)	5 (38.3%)
Total	169	8 (4.7%)	13 (7.7%)	21 (12.4%)

Table 2. Distribution of sub-endemic water beetles in Mongolia and adjacent territories.

Species name	Mongolia	Gansu	Xinjiang	Nei Mongol	East Siberia	West Siberia	Kazakhstan	Occurrence
Agabus angusi Nilsson, 1994	○				○			2
Agabus arcticus alpinus Motschulsky, 1860	○				○	○		3
Agabus c. coxalis Sharp, 1882	○				○	○	○	4
Agabus svenhedini Falkenström, 1932	○		○					2
Oreodytes shorti Shaverdo & Fery, 2006	○				○			2
Hydroporus kabakovi Fery & Petrov, 2006	○				○			2
Hydroporus crinitisternus Shaverdo and Fery, 2001	○						○	2
Zaitsevhydrus formaste Zaitzev, 1908	○	○	○		○	○		5
Octhebius perdurus Reitter, 1899	○						○	2
Octhebius subaeneus Janssens, 1967	○					○		2
Octhebius kuwerti Reitter, 1897	○			○	○			3
Helophorus khnzoriani Angus, 1970	○					○		2
Helophorus mongoliensis Angus, 1970	○						○	2
Total 13 species	13	1	2	1	7	5	4	

Central Asian Inland Basin (Tes [TRB], Depression of Great Lakes [DGLB], Valley of Lakes [VLRB], and Gobi basin [GRB]) (Fig. 1). Of these, Bulgan River Basin, however, was excluded from our analysis due to insufficient samples collected during faunal surveys. Administration and direction abbreviationsa: N-North; E-East; W-West, S-South; Aimag and soum are administrative units. Aimag is divided into soums; gol-river.

Data collection

The survey was carried out during 21–24 days of summer months (June and July) each year in 2003–2006 and 2008–2011. Sampled sites covered the main habitats of all water sub-basins in Mongolia, though the number of samples collected in each region differed because of their different area, habitat types, and remoteness. We collected 429 endemic and sub-endemic water beetle specimens from 72 sampling points during our surveys.

The material is deposited in the following collections: The Academy of Natural Sciences of Drexel University, Philadelphia, USA; Institute of Biology, Mongolian Academy of Sciences, Ulaanbaatar, Mongolia; and Vienna Natural History Museum, Austria.

Our data of the endemic and sub-endemic species of water beetles in Mongolia also included records obtained by a bibliographic screening of relevant publications (Guéorguiev, 1965; 1968a; 1968b; 1969; 1972; Angus, 1966; 1970a; 1985; Janssens, 1967; 1968; 1971; Gentili, 1973; Brancucci, 1982; 1983; Bellstedt, 1985; Nilsson, 2001; Shaverdo and Fery, 2006; Short and Kanda, 2006; Shaverdo *et al*., 2008; Short *et al*., 2010; Jäch and Skala, 2015; Löbl and Löbl, 2015; Przewoźny, 2017; Hájek and Fery, 2019; Nilsson and Hájek, 2019).

The complete list of endemic species, expressed as presence/absence in different basins and adjacent regions, is reported in Tables 2 and 3. Overall, a total of 1,179 beetle specimens and 123 sample sites were documented from Mongolia (Fig. 1). Images of the endemic species were taken with a Canon EOS 450D and Nikon D7100 cameras. The genitalia were examined with Motic BA410E and B series microscopes, as well as images of the genitalia were drawn and further processed with Adobe Photoshop CS 11.0.

Data analysis

Similarities among the selected sub-basins were calcu-

Table 3. Occurrence and collected number of individuals of endemic and sub-endemic species in Mongolia by aquatic sub-basins.

Species name	AOB						CAIB								POB					
	SRB		ShRB		BRB		GRB		DGLB		VLRB		TRB		KhGRB		KhRB		ORB	
	Rich	Abun	Rich	Abun	Rich	Abun	Rich	Abun	Rich	Abun	Rich	Abun	Rich	Abun	Rich	Abun	Rich	Abun	Rich	Abun
Endemic species	5	28	1	13	–	–	1	22	4	45	2	4	2	25	–	–	2	2	3	27
Agabus kaszabi Guéorguiev, 1972	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1
Gyrinus sugunurensis Nilsson, 2001	2	11	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Helophorus kaszabianus Angus, 1970	1	1	–	–	–	–	2	22	1	7	–	–	–	–	–	–	–	–	–	–
Helophorus parajacutus Angus, 1970	2	5	–	–	–	–	–	–	2	2	–	–	1	1	–	–	1	1	1	7
Helophorus shatrovskyi Angus, 1985	1	1	–	–	–	–	–	–	–	–	1	1	–	–	–	–	–	–	–	–
Ochthebius mongolensis Janssens, 1967	–	–	–	–	–	–	–	–	2	4	–	–	–	–	–	–	1	1	1	19
Ochthebius mongolicus Janssens, 1967	–	–	–	–	–	–	–	–	–	–	2	3	–	–	–	–	–	–	–	–
Oreodytes mongolicus Brinck, 1943	7	11	2	13	–	–	–	–	9	32	–	–	6	24	–	–	–	–	–	–
Sub-endemic species	8	617	3	14	1	1	3	12	7	200	4	7	4	153	1	2	1	1	2	8
Agabus angusi Nilsson, 1994	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	2
Agabus arcticus alpines Motschulsky, 1860	9	55	3	9	–	–	–	–	2	3	1	1	–	–	–	–	–	–	–	–
Agabus c. *coxalis* Sharp, 1882	8	56	1	4	–	–	1	1	5	23	–	–	–	–	1	2	–	–	1	6
Agabus svenhedini Falkenström, 1932	–	–	–	–	–	–	–	–	1	1	–	–	1	1	–	–	–	–	–	–
Helophorus khnzoriani Angus, 1970	–	–	–	–	–	–	–	–	–	–	1	1	–	–	–	–	–	–	–	–
Helophorus mongoliensis Angus, 1970	2	11	–	–	–	–	–	–	1	100	1	2	2	39	–	–	–	–	–	–
Hydroporus kabakovi Fery & Petrov, 2006	2	4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Hydroporus crinitisternus Shaverdo and Fery, 2001	–	–	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Ochthebius kuwerti Reitter, 1897	1	317	–	–	–	–	1	1	1	3	–	–	3	112	–	–	1	1	–	–
Ochthebius perdurus Reitter, 1899	–	–	–	–	–	–	–	–	1	48	–	–	1	1	–	–	–	–	–	–
Ochthebius subaeneus Janssens, 1967	1	1	–	–	–	–	–	–	–	–	1	3	–	–	–	–	–	–	–	–
Oreodytes shorti Shaverdo & Fery, 2006	3	146	–	–	–	–	1	10	–	–	–	–	–	–	–	–	–	–	–	–
Zaitsevhydrus f. *formaster* Zaitzev, 1908	4	27	1	1	–	–	–	–	11	22	–	–	–	–	–	–	–	–	–	–
Total	13	645	4	27	1	1	4	34	11	245	6	11	6	178	1	2	3	3	5	35

Abbreviations: Rich-Richness: Number of species represented in a sub-basins; Abun-Abundance: Number of individuals represented in a sub-basins; AOB-Arctic Ocean Basin; CAIB-Central Asian Inland Basin; POB-Pacific Ocean Basin; SRB-Selenge river basin; ShRB-Shishkhed river basin; GRB-Gobi river basin; GLDB-Great lakes depression basin; VLRB-Valley of lakes river basin; TRB-Tes river basin; KhRB-Kherlen river basin; KhGRB-Khalkh gol river basin; ORB-Onon river basin

lated based on the Euclidean distance, while the actual analyses of faunistic similarities between sub-basins and adjacent countries were done using the Bray-Curtis' quantitative formula (Bray and Curtis, 1957) and the simple average linkage for hierarchical clustering. The results are presented in a similarity dendrogram. Similarities between objects were determined using Biodiversity Pro v.2 software (McAleece *et al*., 1997).

Results

Species composition, species richness and abundance

We collected 8 endemic and 13 sub-endemic species of water beetles in Mongolia: Dytiscidae (*Agabus kaszabi* Guéorguiev 1972, *Oreodytes mongolicus* Brinck 1943 as endemics; *Agabus angusi* Nilsson 1994, *Agabus arcticus alpinus* Motschulsky 1860, *Agabus coxalis* Sharp 1882, *Agabus svenhedini* Falkenström 1932, *Oreodytes shorti* Shaverdo & Fery 2006, *Hydroporus crinitisternus* Shaverdo & Fery, 2001, *Hydroporus kabakovi* Fery & Petrov 2006, and *Zaitsevhydrus formaster* Zaitzev, 1908 as sub-endemics), Gyrinidae (*Gyrinus sugunurensis* Nilsson, 2001 as an endemic), Hydraenidae (*Ochthebius mongolensis* Janssens 1967, *Ochthebius mongolicus* Janssens 1967 as endemics; *Octhebius perdurus* Reitter 1899, *Octhebius subaeneus* Janssens 1967, and *Octhebius kuwerti* Reitter 1897 as sub-endemics), as well as Helophoridae (*Helophorus kaszabianus* Angus 1970, *Helophorus parajacutus* Angus 1970, and *Helophorus shatrovskyi* Angus 1985 as endemics; *Helophorus khnzoriani* Angus 1970, *Helophorus mongoliensis* Angus 1970 as sub-endemics).

Family Dytiscidae

Agabus kaszabi Guéorguiev, 1972

Diagnosis. Length 10.0 mm. Body largely oval, slightly dilated in the middle, strongly convex, black, and slightly brilliant with a little bronze. Head brown-black, area behind head reddish, as well as two spots on vertex; pronotum black-brown and sides of pronotum, antennae and palps brownish-red. Elytra black with rufescent margin; a simple cross-linking of small, rounded, and even mesh on their intersections, but not dots in their interiors; dorsum punctuated entirely with dots larger than the suture; pronoto-elytral angle very low; underside brown, with prothorax and its apophysis, epipleurs and paws reddish-brown; entirely with micro-reticula of small and very fine mesh; metasternal wings finished in a fairly wide triangle; metacoxal lines whole rather divergent in front; last abdominal sternite entirely with micro-reticulous mesh, strongly on the posterior part; metatibias equal in length, their outer surface on the lower side entire with row of spurs; first segment of the metatarsi almost equal to the long metatibial spur (Guéorguiev, 1972).

Remarks. *Agabus kaszabi* Guéorguiev, 1972:38 [Holotype ♀ (Hungarian Natural History Museum, Budapest): Mongolia, Khentii, 19.viii.1965, leg. Z. Kaszab].

Oreodytes mongolicus Brinck, 1943 (Fig. 2)

Diagnosis. Body length 4.0–4.5 mm. Oblong-oval, slightly convex. Dorsum yellow, with narrow black stripe on the vertex; a more or less distinct additional dark spot near the eyes; pronotum with two spots near the base that are either fused or more less reduced; the following areas on the elytra black: suture, six longitudinal lines which do not reach the base, two oblong spots, and sometimes also a more or less long dash at the lateral margin. Three inner lines contiguous at the posterior end; three outer lines also often contiguous at the end; venter black; epipleura yellow; legs and antennae reddish; last antennal segments black apically. Pronotum much narrower than elytra, with a transverse depression or flattened near the base; sides of pronotum slightly rounded; lateral ridge very weak; lateral dash short and shallow; posterior angles almost rectangular; their apex not blunt. Elytra of male slightly oblique, with weakly marked indentation; in the female, there is indentation before the sutural denticle,

Fig. 2. *Oreodytes mongolicus* Brinck, 1943. Photos by Enkhnasan. a. Dorsal habitus, male, b. Head and pronotum, c. Adeagus, laterial view.

which is slightly produced posteriorly. Dorsum markedly shagreened, slightly more shagreened in the female and also with more or less scattered dots, which are of slightly different size (Brinck, 1943).

Material examined. Zavkhan aimag: 2♂♂, 1♀, Tosontsengel soum, 16 km of river Delgerekh, N48.15785, E97.21437; Arkhangai aimag: 1♀, Khangai soum, River Khoid Ekhen, N47.75747, E99.35827; Övörkhangai aimag: 1♂, Bat-Ölzii soum, River Orkhon, N46.89303, E102.39457. Töv aimag: 1♂, 1♀, Erdene soum, River Tuul, Gorkhi-Terelj National Park, N48.09549, E107.84265; Bayan-Ölgii aimag: 2♀♀, Ulaan Hus soum, 14 km NE of Jalpak, River Khar Yamaat, N49.38138, E88.6839; 5♂♂, 2♀♀, Khovd gol near the soum centre, N49.0419, E89.41659; 2♂♂, 1♀, Nogoonnuur soum, River Baga Khatuu, N49.7734, E90.02274; 1♂, 2♀♀, Tributary of River Khovd, at Develyn aral, N50.01458, E91.6014; 2♂♂, 4♀♀, pond 20 km NW of Nogoonnuur, N49.71056, E89.98618; Uvs aimag: 1♀, Undurkhangai soum, river Baruun Turuun 20 NNE of soum center, N49.44592, E94.79595; 1♂, 2♀♀, Ömnögovi soum, unnamed (Bornuur) lake, 24 km NNE of soum center; 1♀, River Orlogo, 25 km N of soum center, N49.33993, E91.68145; 1♂, Khovd soum, spring Deed Nuuryn Bulag, 37 km E of soum center, N49.298, E91.28097; 1♀, Turgen soum, Tributary of River Khöndlön, N50.01458, E91.6014; 1♂, 1♀, River Turgen, N49.88653, E91.34708; 8♂♂, 4♀♀, Confluence of rivers Javart and Turgen, 33 km SW of soum center, N49.89234, E91.35239; 4♂♂, 2♀♀, Bökhmörön soum, river Tavan Salaa, N49.7038, E90.23026; 3♂♂, 4♀♀, Tarialan soum, River Kharkhiraa gol, 4 km W of soum center, N49.77959, E91.86026; Hövsgöl aimag: 3♂♂ 7♀♀, Renchinlhumbe soum, river Arsain gol, N51.25344, E99.66698; 2♂♂, 1♀, three connected ponds, 19 km N of soum center, N51.25344, E99.66698; 3♀♀, Arbulag soum, lake Davst (salty), 3 km N of soum center, N49.90643, E99.39368.

Published records. Guéorguiev, 1965:128- Bayankhongor, Övörkhangai; Guéorguiev, 1968:25- Töv; Guéorguiev, 1968a:287, 288- Zavkhan, Khovd; Guéorguiev, 1972:34- Khentii; Bellstedt, 1985:138- Ulaanbaatar; Shaverdo *et al*., 2008:51- Zavkhan, Hövsgöl, Arkhangai, Töv, Övörkhangai; Enkhnasan and Boldgiv, 2019:106- Bayan-Ölgii, Uvs, Hövsgöl.

Remarks. *Oreodytes mongolicus* Brinck, 1943:155- [Holotype ♂ (Private collection of P. Brinck): Mongolia, Kemtchik, 1914, leg. F. Jensen].

This species was collected from Central Asian Inland Basin and Arctic Ocean Basin in Mongolia. It was collected from many sampling points of these two basins. Specimens are kept at the Institute of Biology, MAS.

Family Hydraenidae

***Ochthebius mongolensis* Janssens, 1967 (Fig. 3)**

Diagnosis. Body length: 1.60−1.65 mm. Anterior border of the right labrum not indented; its extremities only curved in such a way that the edge is not convex in all its width. Punctuation of the clypeus is sparse. Uncomplicated intercooler space: the points separated by smooth intervals, except in the two foveoles, which are crumbled. The outer edge of pronotum is a very obtuse angle, their posterior notch barely visible. Disc occupied by a transverse double depression whose anterior part is more or less smooth and the posterior distressed like the auricles. Streaks of elytra, punctuated well, but coarse. Both sexes have a matte pitch black, without bronze reflection even on the head and the pronotum. Funicular antennae have a more yellowish hue. The male genital frame has a mobile lobe shaped cornet surrounded by a veil more held (Janssens, 1967).

Published records. Bellstedt, 1985:139- Khovd.

Remarks. *Ochthebius mongolensis* Janssens, 1967:56- [Holotype ♂ (Hungarian National Museum, Budapest): Mongolia, Töv, 1,340 m, 19.vii.1965, leg. Z. Kaszab].

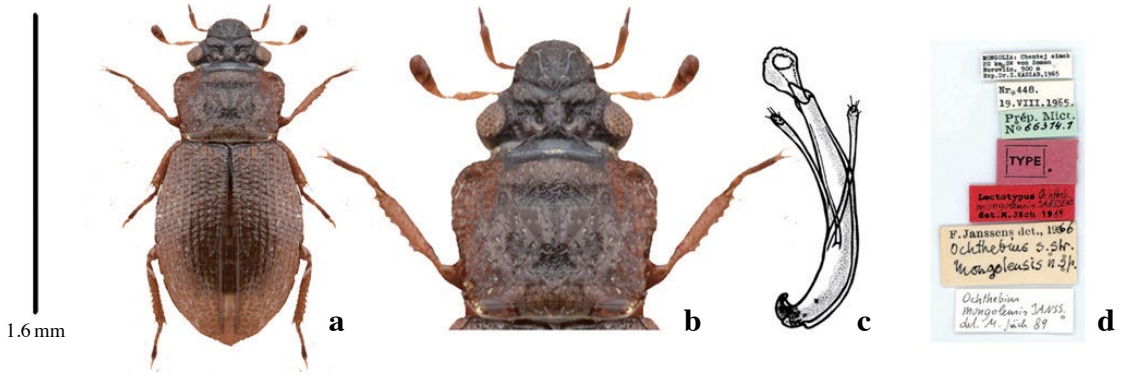

Fig. 3. *Ochthebius mongolensis* Janssens, 1967. Photos by Tamás Németh and Aranka Grabant. a. Dorsal habitus, male, b. Head and pronotum, c. Aedeagus, dorsal view, d. Labels for lectotype.

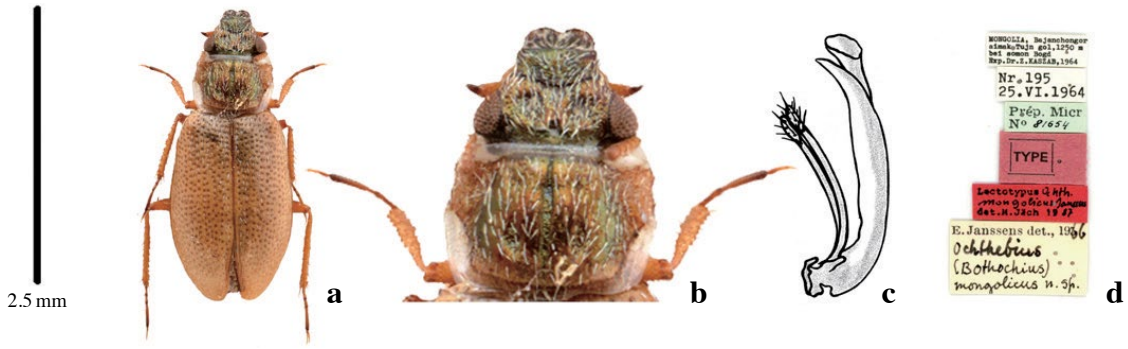

Fig. 4. *Ochthebius mongolicus* Janssens, 1967. Photos by Tamás Németh and Aranka Grabant. a. Dorsal habitus, male, b. Head and pronotum, c. Aedeagus, dorsal view, d. Labels for lectotype.

Fig. 5. *Helophorus kaszabianus* Angus, 1970. Photos by Robert Angus. a. Dorsal habitus, male, b. Head and pronotum, c. Aedeagus, dorsal view.

Khentii, 900 m. 19.viii.1965. 1♀; Type specimens are at the Hungarian National Museum and Museum of Natural History of the Humboldt University, Berlin.

Ochthebius mongolicus Janssens, 1967 (Fig. 4)

Diagnosis. Body length 2.5 mm. The anterior edge of the labrum swells in the middle. The anterior border of clypeus forming with its external sides a very marked angle. Foveoles of the inter-ocular space is very broad and almost confluent. Pronotum very depressed with respect to the disc; their denticulate outer sides forming a right angle forwards and extending towards the back in a long, non-denticulate re-entrant curve. The disc isolated from the depression of the auricles by a longitudinal furrow; the median groove of the disc, reaching the anterior and posterior edges, divides it into two shiny patches, each of which bears two foveus, the anterior of which is smaller but more accentuated than the posterior. Head and the pronotum are copper in color and bear a rather abundant pubescence, the elytra are yellow and their pubescence is much rarer. The punctuation, although clear, is rather irregular and streaks are very poorly defined. The male genital framework is easy to recognize that is pointed hook shape of the piece (Janssens, 1967).

Remarks. *Ochthebius mongolicus* Janssens, 1967:58-[Holotype ♂ (Hungarian National Museum, Budapest): Mongolia, Bayankhongor, 1,250 m, 25.vi.1964, leg. Z. Kaszab].

Family Helophoridae

Helophorus kaszabianus Angus, 1970 (Fig. 5)

Diagnosis. Length: 3.2−3.6 mm, breadth: 1.3−1.5 mm.

Head: shining pitchy with dark greenish reflections. Surface punctate or with weak rugose granulation. Stem of Y-groove shallow, ill defined, either narrow or distinctly expanded anteriorly. Maxillary palpi brown, apical segment asymmetrical, sometimes very short, occasionally darkened at the tip. Antennae nine-segmented, brown, the clubs darker. Pronotum: weakly arched, sometimes flattened across the internal intervals. Widest part at the base of the anterior third, distinctly narrowed posteriorly, the side either straight or weakly curved in the basal half, sometimes sinuate before the hind angles. Elytra: elongate, moderately striate, interstices flat. Ground color mid to dark, sutural Λ-mark and spot on interstice six

Fig. 6. *Helophorus parajacutus* Angus, 1970. Photos by Robert Angus. a. Dorsal habitus, male, b. Head and pronotum, c. Aedeagus.

Fig. 7. *Helophorus shatrovsky* Angus, 1985. Photos by Robert Angus. a. Dorsal habitus, male, b. Head and pronotum, c. Aedeagus.

evident on paler specimens. Legs: dark brown, long, tarsi with well-developed swimming hairs (Angus, 1970b).

Published records. Bellstedt, 1985: 140- Khovd.

Remarks. *Helophorus kaszabianus* Angus, 1970:275 Holotype ♂ (Hungarian Natural History Museum, Budapest): Mongolia, Bayan-Ölgii, 1,890 m, 29.vi.1968, leg. Z. Kaszab]. Collection No 1043.

Helophorus parajacutus Angus, 1970 (Fig. 6)

Diagnosis. Length: 2.8−3.6 mm, breadth: 1.3−1.6 mm.

Head: shining pitchy bronze with red and green reflections, rugosely granulate, granules flattened, merging into one another and with median punctures. Stem of Y-groove narrow linear, sometimes indistinct. Maxillary palpi yellowish brown, apical segment asymmetrical, occasionally pyriform and sometimes darkened at the tip. Antennae nine-segmented, yellowish brown, clubs a little darker. Pronotum: highly arched, widest slightly before middle, sides evenly curved to hind angles or occasionally straighter basally. Ground color shining pitchy brown or dull orange. Elytra: Uniform pale brown, with at most a trace of darkening in place of the sutural Λ mark. Moderately striate, the interstices flat. Flanks not visible from below. Legs: yellowish-brown, tibiae and tarsi with well-developed swimming hairs (Angus, 1970b).

Published records. Angus, 1970:279- Hövsgöl, Arkhangai, Khentii, Töv, Bayan-Ölgii; Bellstedt, 1985:140- Khovd.

Remarks. *Helophorus parajacutus* Angus, 1970:280 [Holotype ♂ (Hungarian Natural History Museum, Budapest): Mongolia, Töv, 22.vi.1968, leg. Z. Kaszab] collection No 1002.

Helophorus shatrovskyi Angus, 1985 (Fig. 7)

Diagnosis. Body length: 2.5−2.7 mm; breadth: 1.2−1.3 mm.

General form: robust, highly arched.

Head: shining dark green with bronze reflections, the surface granulates. Y-groove shining golden bronze stems linear, floor rugulose. Maxillary palpi yellowish brown, the apical segment symmetrical oval. Antennae 9-segmented, yellowish, the clubs a little darker. Pronotum: highly arched and domed, the inner edges of the internal intervals depressed towards the mid groove. Raised lateral margins distinct. Elytra: yellowish brown, strongly striate, the interstices convex, narrower than the striae. Widest point just behind the middle, the sides curved, the apex bluntly rounded. Flanks broadly visible from below. Legs: rather short, tarsal swimming hairs weak (Angus, 1985).

Published records. Angus, 1985:163- Töv.

Remarks. *Helophorus shatrovskyi* Angus, 1985:163

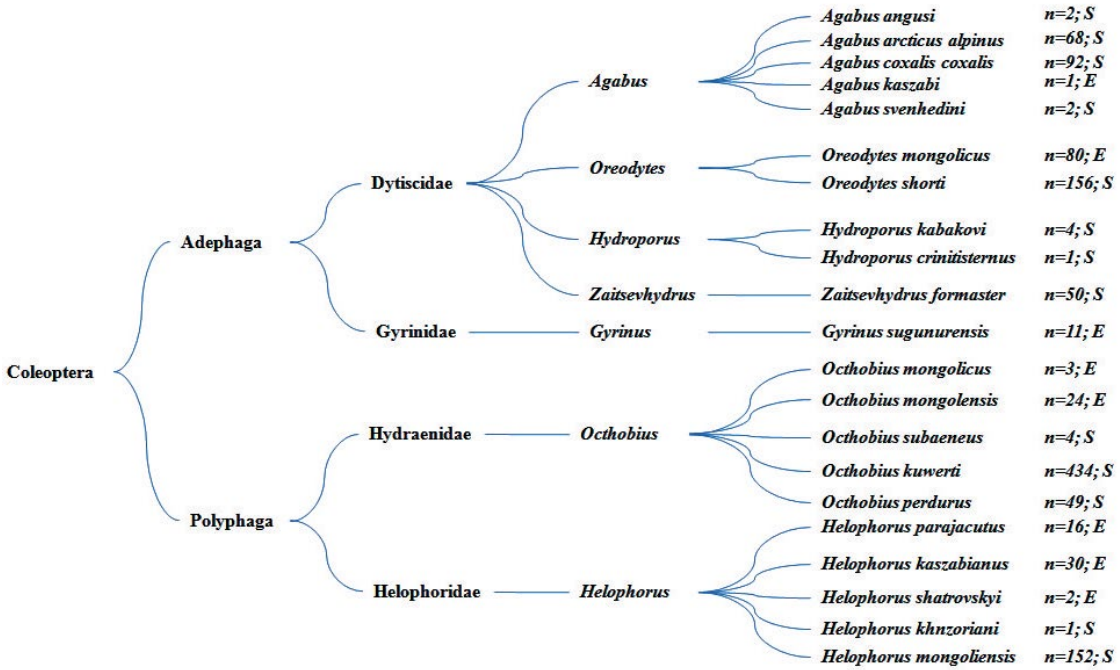

Fig. 8. Classification of endemic and sub-endemic water beetles in Mongolia. *n* is the total abundance in our samples; *E* endemic species; *S* sub-endemic species.

[Holotype ♂ (Department of Zoology, University of Halle): Mongolia, Bayankhongor, 23.vii.1982. leg. H.-J. Altner].

A list of 13 sub-endemic species is given in Table 2. In total, 21 species that are considered as endemic or sub-endemic water beetles belonging to seven genera in four families of total seven beetle families make up 12.4% of the all water beetle species recorded in Mongolia (Table 1). The majority of endemic and sub-endemic water beetles of Mongolia is represented by Dytiscidae (10 spp.), which comprises about 47.6% of the total endemic and sub-endemic species. Other three families, Gyrinidae (1 sp.), Hydraenidae (5 spp.) and Helophoridae (5 spp.), were represented by a relatively few species in Mongolia (Fig. 8). By comparing the number of total species recorded in Mongolia for each family, Hydraenidae has the highest endemism rate (Table 1).

At the level of genera, the most diverse genera are *Agabus* (5 spp.) belonging to Dytiscidae, *Helophorus* (5 spp.) belonging to Helophoridae, and *Ochthebius* (5 spp.) belonging to Hydraenidae. Several genera were represented by few species, namely, *Hydroporus* (1 spp.), *Oreodytes* (2 spp.), and *Zaitsevhydrus* (1 spp.) from Dytiscidae and *Gyrinus* (1 sp.) (Fig. 8).

Endemic and sub-endemic water beetles were recorded in different numbers (from 1 to 12) in the nine sub-basins included in this study. Each of these sub-basins had a peculiar composition of endemic beetles, but there were

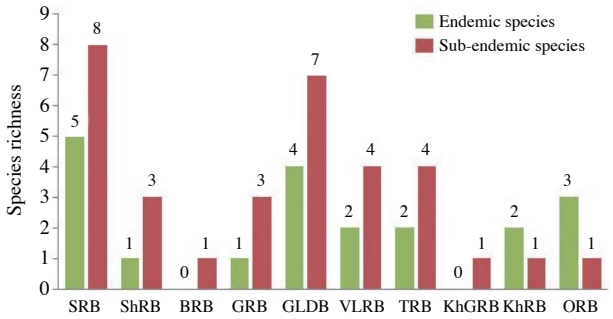

Fig. 9. Endemic and sub-endemic species richness in the nine sub-basins of Mongolia included in this study. SRB-Selenge River Basin; ShRB-Shishkhed River Basin; GRB-Gobi River Basin.

several species dominating in most of the sub-basins (Fig. 9). The highest number of endemic and sub-endemic beetles was found in SRB (13 species) followed by GLDB (11 species), VLRB and TRB (6 species). Four species were recorded for ShRB, ORB, and GRB, and 3 species for KhRB, while the lowest richness of endemic beetles (1 species) was found in KhGRB (Table 3).

For endemic species, *Helophorus parajacutus* was common to five sub-basins, while *Oreodytes mongolicus* inhabited four sub-basins, *Ochthebius mongolensis* and *Helophorus kaszabianus* were found from three, *Helophorus shatrovsky* was recorded for two sub-basins, which provide a variety of habitats, while *Agabus kaszabi*, *Gyrinus sugunurensis* and *Ochthebius mongolicus* were re-

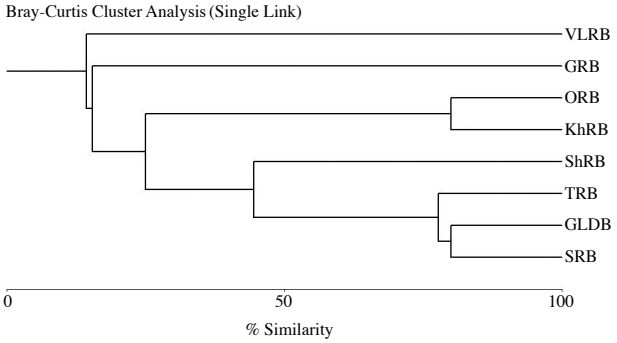

Fig. 10. Similarities of endemic beetle fauna among the sub-basins of Mongolia.

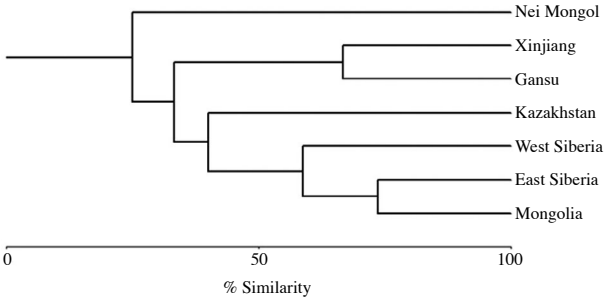

Fig. 11. A dendrogram of water beetle faunal similarity of Mongolia and adjacent territories.

corded from one sub-basin. From our analysis, the similarity of endemic species fauna was the highest between ORB and KhRB (80%) and between SRB and DGLB (76.9%), which are located close to each other. The endemic species fauna among other sub-basins was less similar to one another (Fig. 10).

Among the sub-endemic species, *Agabus coxalis* was the most common, occurring in six sub-basins, while *Ochthebius kuwerti* was common to five sub-basins, two other species (*Agabus arcticus alpinus* and *Helophorus mongoliensis*) were distributed in four, and *Zaitsevhydrus formaster* was found in three sub-basins. Several sub-endemic water beetles, such as *Agabus svenhedini, Ochthebius perdurus, Ochthebius subaeneus*, and *Oreodytes shorti*, were recorded from two sub-basins. From our data, it was apparent that three species (*Agabus angusi, Hydroporus kabakovi*, and *Helophorus khnzoriani*) had restricted ranges within Mongolia because of their distribution were confined to a single sub-basin (Table 3).

We considered regions bordering Mongolia in our characterization of sub-endemic distribution, including Xinjiang, Gansu and Nei Mongol of China, East Siberia and West Siberia of Russia, as well as Kazakhstan. The sub-endemic species were recorded from 1−5 of the above regions. *Zaitsevhydrus formaster* was distributed in five regions including Mongolia, *Agabus coxalis* was recorded from four regions, *A. arcticus alpinus* and *Ochthebius kuwerti* were found from three regions, while the most of sub-endemic species (*Agabus angusi, A. svenhedini, Oreodytes shorti, Hydroporus kabakovi, Ochthebius perdurus, O. subaeneus, Helophorus khnzoriani* and *H. mongoliensis*) were recorded only two regions including Mongolia (Table 2).

For our analysis concerned with sub-endemic water beetles, we identified a total of 13 species representing in six genera. Based on information of the distribution of sub-endemic species in Mongolia and adjacent regions, a presence or absence matrix for species in the six regions was constructed. We found that the faunistic similarity coefficient between Mongolia and adjacent regions ranged between 15.4−73.7% (Fig. 11).

The sub-endemic species fauna of Mongolia was the most similar with that of East Siberia, Russia (73.7%) and followed by West Siberia (58.8%). These results show that Mongolian endemic water beetle fauna was more similar with the neighboring regions in the north rather than in the south.

Discussion

To date, a total of 21 species of endemic water beetles (12.4% of total species composition) were found in Mongolia. Seven species were considered strictly endemic species to Mongolia: *Agabus kaszabi, Oreodytes mongolicus, Gyrinus sugunurensis, Helophorus kaszabianus, H. parajacutus, H. shatrovskyi, Ochthebius mongolensis*, and *O. mongolicus*. The most abundant endemic species was *Helophorus parajucutus* from five sub-basins out of nine, followed by *Oreodytes mongolicus* from four, *Ochthebius mongolensis* and *Helophorus kaszabianus* from three, *Helophorus shatrovsky* from two, and *Agabus kaszabi, Gyrinus sugunurensis* and *Ochthebius mongolicus* from one sub-basin.

Thirteen sub-endemic species were identified, occurring not only in Mongolia, but also in adjacent regions of the neighboring countries. The most abundant species in the sub-basins, *Ochthebius kuwerti* (42.8%) was found from five basins (GRB, GLDB, KhRB, SRB and TRB), followed by *Oreodytes shorti* (15.4% of total abundance) from GRB and SRB, and *Helophorus mongoliensis* (15.0% of total abundance) found from four sub-basins.

The degree of endemism of water beetles in SRB belonging to AOB was high (62.5% of endemic species) compared to other sub-basins. This pattern might be caused by the fact that surface water network is of a greater density in the north of the country. Also, SRB is the largest sub-basin (298,754 km^2) of AOB. Moreover, River Selenge flows north into the Russian Federation, eventu-

ally draining into Baikal Lake, of which it is the most substantial source of water and the headwater of the Yenisei-Angara River. Consequently, the fauna of sub-endemic species of Mongolia was most similar to that of East Siberia (73.7%) and West Siberia (58.8%).

In contrast, the rate of endemism of water beetles was lower in sub-basins ShRB, GRB, VLRB, KhGRB, KhRB, and ORB (with 1−6 species occurring). These sub-basins have relatively few rivers or other surface water resources and are located in the southern, central, and south-eastern parts of the country.

The second highest proportion of endemism (50.0% of total endemic species) was observed for DGLB, the largest sub-basins of CAIB. It includes 254,075 km^2 of salty and large sandy areas. Rivers and lakes of Western Mongolia collectively form what is known as the Great Lakes Depression, a self-contained watershed that drains into several large saltwater and freshwater lakes. Northern parts are dominated by arid steppes and southern by semi-deserts or deserts. Therefore, the distribution patterns of unique "native" water species seemed to be influenced by geographical conditions of Mongolia.

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