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We dedicate this article to our Mongolian friends

Occurrence and distribution of the Eurasian *Branchinecta orientalis* (Anostraca) in Central Asia (Northwest Mongolia, Uvs Nuur Basin) and in other holarctic areas

Wolfgang Horn and Markus Paul

With 4 figures and 2 tables

Schlagwörter: Branchinecta, Anostraca, Branchiopoda, Crustacea, Eurasien, Mongolei, Altai, Fundmeldung, Verbreitung, Habitat
Keywords: Branchinecta, Anostraca, Branchiopoda, Crustacea, Eurasia, Mongolia, Altai, find report, distribution, habitat

The Eurasian species *Branchinecta orientalis* Sars, 1901, distributed from Spain up to east Russia (Siberia), is a very scarce fairy shrimp. Details are given on a new geographic record and an account of further known records from Mongolia and the whole of Eurasia is presented. In addition ecological information on the habitat of this species is provided. Generally it lives in temporary ponds or lakes without fishes. The new record is from the endorheic Uvs Nuur Basin (northwest Mongolia). Because this area is very remote and difficult to access, it has remained rather poorly investigated in spite of its interesting features.

1 Introduction

"It is often true that the known ranges of many smaller, less charismatic animal species more accurately reflect the distribution of their (few) experts than that of the animals themselves..." (Dumont & al. 1995)

In summer of the years 1996 to 1999 Mongolian-German limnological expeditions explored the endorheic Uvs Nuur catchment area (Fig. 1). One aim was to study the inventory of aquatic organisms and the changes in aquatic communities as in relation to physical and chemical water parameters along a transect from the glacier covered Turgen/Kharkhiraa Mts., a range of the Mongolian Altai, to the salty flowless terminal lake Uvs Nuur.

During the examination of a brook – the glacier fed Turgen Gol (see Horn & al. 1999, Horn & Paul 2000) – we also made a short tour to an unnamed lake. In this alpine glacial lake some dead anostracan animals, later identified as *Branchinecta orientalis*, were found near the shore and caught by hand or with the help of a simple vessel. On this improvised detour it was not possible to

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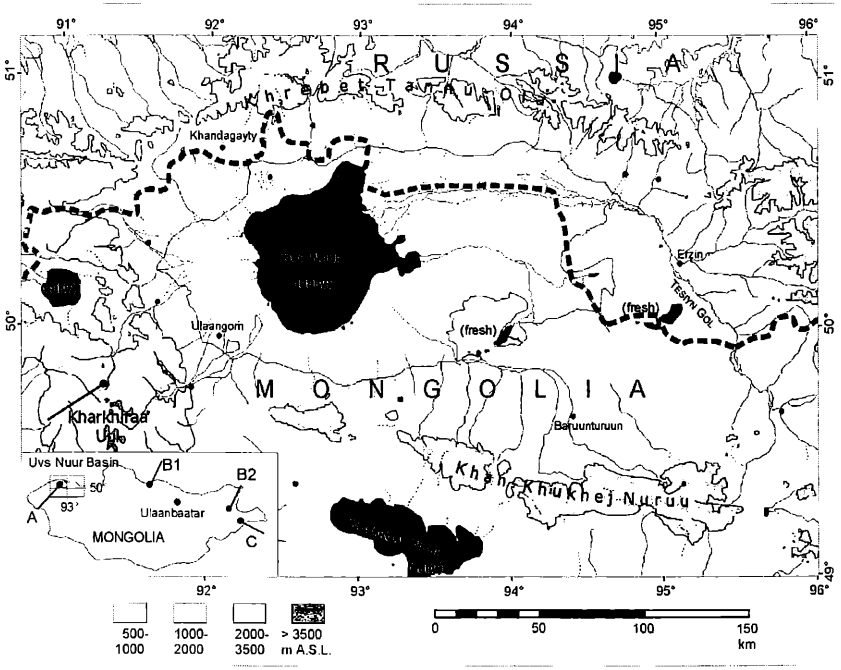
gather any further information or to catch more plankton organisms due to the lack of plankton nets. Two years later, a lake nearby – called Nogoon Nuur (49°49'03"N, 91°16'12"E; 2650 m a.s.l.) – was visited, but it did not contain any anostracans (see also Flößner 2001).



Localities of *Branchinecta orientalis*: A = this paper; B1 = Chairchan Nur, B2 = Cojbalsan (Brtek et al. 1984); C = Lake Chuntu-Nor (Sars 1901)

Fig. 1: Map of the area under investigation and outline of Mongolia. Bold broken line: state border; white stippled line: watershed Uvs Nuur basin; broken line: non-permanent river reaches; filled circles: settlements; arrows: waters with *Branchinecta orientalis*. Nuur = Lake, Gol = River, brook. Remark: Because of the various translations the names are different (the notation of the authors was chosen)

2 Zoogeographic situation of the area

The area under investigation is located in a closed endorheic basin. All surface water in that basin drains to the lake Uvs Nuur, which belongs to the great Mongolian endorheic drainage area. According to Dulmaa (1979) it is called Central Asian Basin, which is divided into two sub-parts: the Gobi Valley of Lakes and the Valley of the Great Lakes. The Uvs Nuur catchment belongs to the latter. Because of the area's long history of isolation the existence of en-

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demic species can be anticipated. According to present knowledge only the fishes are thought to have generated endemic species, e.g. genus *Oreoleuciscus* and species *Thymallus brevirostris*. After Bănărescu (1992) the area is zoogeographically attributed to the west Mongolian subregion of the Holarctic region. This division goes back on Berg (1912, see in Bănărescu 1992), who delimits a "western Mongolian" province of the High Asian ichthyologic subregion of the Holarctic (comprising the upper reach of the river Ob, the lakes Uvs Nuur, Khyargas Nuur etc.). The fish fauna is mainly characterized by the occurrence of the endemic cyprinid genus *Oreoleuciscus* (in the river Ob, except for its tributary, the Irtysh) and the endemic grayling *Thymallus brevirostris* (which is absent from the river Ob head waters). To the north this western Mongolian subregion is surrounded by the Siberian subregion and to the south by the High Asian subregion, which itself is a section of the Sino-Indian region.

The Uvs Nuur basin with its great distance (2500 km) to the Arctic and the Pacific Ocean respectively, to the Indian Ocean (3000 km) and to the Baltic Sea (4000 km), is one of the world's ocean farthest points (Lehmkuhl 1999). The climate is extremely continental, with large annual and daily differences of the temperature (for example Ulaangom (940 m a.s.l.): mean in January -32.5 °C, in July 19.5 °C; annual average -3.6 °C (monthly means 1943-1996); annual average precipitation 142 mm, around 75 % in summer). The inner parts of the basin are arid or semi-arid, as classified by the coefficient of aridity (= potential evaporation/precipitation). According to Köppen (1936, see in Hendl & al. 1978) it is a steppe climate (BS). In the mountains it is more humid with a precipitation of approximately 300 mm in an altitude of more than 2500 m; there the climate is of the Dw type (cold snowy forest with dry winters).

3 Location and habitat

The lake that contains the population of *Branchinecta orientalis* is situated in the Turgen/Kharkhiraa Mts. (4037 m), west-southwest of the lake Uvs Nuur (Fig. 1), not far from the "Dsagaan Degli" peak (3965 m), and does not seem to carry a name yet. Its position is 49°45'32"N, 91°19'07"E. According to the altitude meter the surface level was at 2780 m a.s.l. At the time of investigation (August 18th 1997, 1 p.m.) the water level was around 30 to 50 cm below the the outflow channel bed. But it seems, that the lake is a flow-through lake at times, suggested also by the measured conductivity of 87.4 µS/cm (reference temperature 25 °C). The water of the lake was a little bit alkaline with a pH of 8.25. Dimensions of the shallow oval shaped lake were estimated with a length of 200 m and a width of 100 m. The water was clear without any indication of pollution, although the catchment showed signs of occasional grazing by cattle. No emersed or submersed macrophytes were observed. The bottom near the

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shore was stony without a sediment cover. The lake is situated above the timberline.

Additional inhabitants of the lake were *Daphnia pulicaria* (confirmation Flößner) and other zooplankton as well as some corixids. This *Daphnia* is a species, which is typically found in alpine glacial lakes (Flößner 2000). It had been known hitherto from two sites in Mongolia only (Brtek & al. 1984, Flößner 2001). The population of these relatively large bodied and easily visible animals indicates together with the morphology and the altitude respectively the climate of the lake, that fishes – their main predators – are missing. This is a prerequisite for the occurrence of large Anostraca (e.g. Flößner 1972) and favourable for *Daphnia pulicaria* too (Flößner 2000). Amongst these zooplankton an ephippium of *Daphnia zschokkei* (Flößner det.) was found, a species usually occurring in cold and oligotrophic lakes, e.g. arctic and alpine waters, which apparently also prefers lakes without fishes. This species has yet been unknown for Mongolia, but another species that is similar to *D. zschokkei* exists in northern Mongolia (Flößner 2000). Other species caught were *Chydorus sphaericus* (Flößner det.), which is common in Mongolia, and *Acanthodiaptomus denticornis* (Flößner det.) of which there had been no record for this area before. *A. denticornis* is typical for permanent and temporary pools in alpine regions.

Sars (1901) had found *B. orientalis* in a zooplankton community, which is also typical for fish-free waters, with *Gammarus pulex*, *Daphnia magna*, and an unnamed diaptomid Copepod.

4 Species examination

The determination of the anostracan specimens as *Branchinecta orientalis* G. O. Sars, 1901, was the result of an intensive literature research and was based on the key and figures of Sars (1901), Smirnov (1940), Petkovski (1991) and Alonso (1996). It was confirmed by the late Dr. Denton Belk (San Antonio, Texas). The animals were then submitted to his collection. An adult ovigerous female, shape and size of the egg sack and the first abdominal segments as well as the furca are given among others in figure 2 (from Sars 1901). The female had been estimated to be around 15 mm long. There is also a picture of an adult male and male's head with the basal and apical parts of the antenna (Fig. 3, also from Sars 1901), but has been occasionally found in fresh/slight salty (0,8 mg/l) waters in lowland ranges of the basin also (Flößner, Horn & Paul, in preparation).

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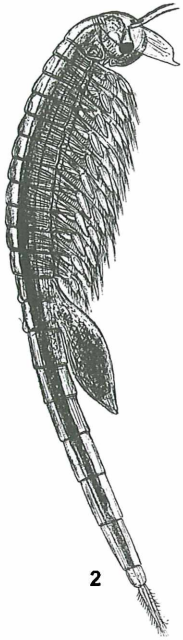

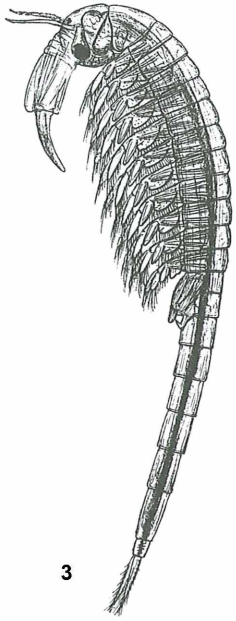

Fig. 2: Adult ovigerous female, viewed from the right side (from Sars 1901)
Fig. 3: Adult male, viewed from the left side (from Sars 1901)

5 Distribution pattern

Figure 4 gives an account of the distribution of *B. orientalis* in the European and Asian parts of the Holarctic region (for more details on the location of the investigated lake see figure 1). Because of the compilation of the records without the knowledge of the exact localities or geographic coordinates, some data are possibly double. This may be also true for the records of the following authors and areas: Spain/Alonso (1996), Austria/Löffler (1959), Eder & al. (1997), Yugoslavia/Petkovski (1991), Tibet and adjacent areas/Jiang (1981), Chiang & al. (1983).

Localities in Mongolia: Sars (1901) Lake Chuntu-Nor (near Lake Buir-Nor); Brtek et al. (1984) - water near town Cojbalsan [Choybalsan] (250 km west of Buir-Nor) and Chairchan Nur (between Bulgan and Möron, northern from the river Selenga).

Localities in Tibet and adjacent areas: Bond (1934) - Tibet (Gyantse), Indian Tibet (pond near village Chushol, 4336 m; Lake near Chushol 4491 m; Togarma Tso 5217 m). Other records from this region: Jiang (1981), Chiang & al. (1983) (both in Hammer 1986).

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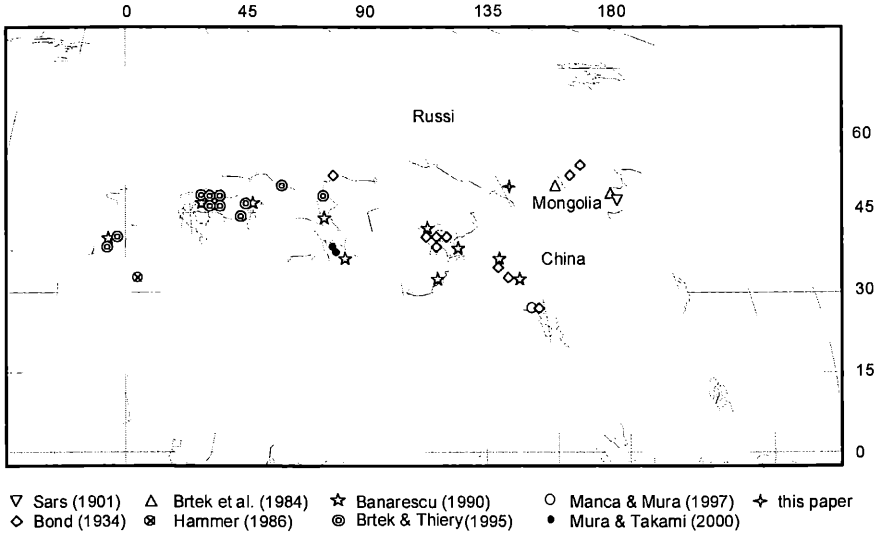

Fig. 4: Distribution map of *Branchinecta orientalis* according to the map of Bănărescu (1990), completed with the records from the plans of Bond (1934) and Brtek & Thiéry (1995), and the data of Sars (1901), Brtek & al. (1984), Manca & Mura (1997), Mura & Takami (2000), Hammer (1986; record Algeria only, no additional information), and this investigation

Further localities (Bond 1934): Charkov (Russia), Pamir (sec. Daday), "Russian Mongolia" (sec. Smirnov).

B. orientalis is restricted to the Paleaearctic area only, till now no localities in North America (Nearctic area) are known (Eder 2003).

Petkovski (1991) characterizes *B. orientalis* as a Mongolian steppe element, which occurs in waters from eastern Mongolia and the lower reaches of the river Selenga, through Tibet, Pamir, Afghanistan, Iran, south-Russian steppes, Wallachia, Pannonia to Spain. According to this author, temporary and extremely small, astatic, highly mineralized or saline pools are the favourite habitats of this species. In Central Asia it is also found in high-mountainous bitter and saline temporary waters. In the lowlands it lives in cool waters and appears early in spring or in late autumn, ending its life cycle when the water becomes too warm.

From steppe areas of the former USSR there are no exact records known from the accessible literature. Smirnov (1940) writes "in the steppe only", but does not provide any detailed geographic or environmental data. Löffler (1959, cit. in Hammer 1986) found the animals in Austrian alkaline saline lakes with maximum contents of 1046 mg/l Cl and 51 meq/l alkalinity. Hammer (1986)

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gives a record of *B. orientalis* in fresh and/or low salt waters (0 - 10 ‰) in Algeria, but there is no reference. Jiang (1981, cit. in Hammer 1986) notes the occurence of *B. orientalis* in fresh to saline lakes on the Xizang Plateau (Tibet) of China. Chiang & al. (1983, cit. in Hammer 1986) found this species on the Tibetan Plateau at altitudes of 4400 to 4900 m, in waters with a pH range of 6 to 11 and a temperature range of 9 to 19 °C.

The record with the highest altitude, locality Togarmo Tso (5217 m), is given by Bond (1934). This author describes altogether 4 places in the Tibet region in a altitude between 4336 m and 5217 m. The records of Manca & al. (1998) cover the same range of altitude (see Tab. 2). Akatova (1987) does not mention any own record, only the altitude 5217 m, which is the value given in Bond (1934).

In summary *B. orientalis* lives in waters of very different character with respect to altitude, climate and chemistry. It is commonly found in all types of lentic water bodies, which are low-predation environments, e.g. where the fishes are absent. This means, *B. orientalis* can exist in those waters, because they provide a habitat with a special milieu, where fishes cannot survive, may these waters be non permanent and/or have a high content of salt or may they freeze out completely in the cold season. All these harsh living conditions appear to pose no problem to this species of the Anostraca. Even though the animals are known as inhabitants of the steppe as well as alpine (not arctic!) areas, it remains a little bit surprising, how the habitats of one species can be so vastly different and can change so much with altitude.

6 Habitat comparison

In Europe *B. orientalis* is limited to steppe pools and only known from central Spain, Pannonian lowlands and steppe areas in Eastern Europe. In Asia there are records in the steppe as in the (steppic) alpine areas. Using the scarce data of the water chemistry their occurrence can be divided, into the habitats shown in table 1.

Comparing the habitats of Eurasia (Tab. 1), in present Europe *B. orientalis* seems to be confined to the saline non-permanent waters of lowland areas, while in Asia it is more common in alpine zones with fresh waters. However the proposed distribution pattern is based on a small pool of data only, so for future verification further informations are necessary.

Table 2 gives a summary of the chemistry of the waters with *B. orientalis* in the Mongolian Altai and in the Khumbu Valley (Nepalese Himalayas). The latter two lakes share an extremely low conductivity, characteristic for unpolluted snow/rain and glacier water. Also the nutrient content is very low (for more details see Manca & al. 1998, Tartari & al. 1998). In comparison to these

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lakes the conductivity of the water in the lake in the Turgen/Kharkhiraa Mts. is much higher, which is not so typical for glacier and snow fed waters. Its higher ionic content comes along with an alkaline pH, which is very characteristic for the lakes here (e.g. Nogoon Nuur: pH 8.4; 49 µS/cm).

Tab. 1: Habitats of *B. orientalis* in Eurasian waters with known major chemism (fresh, salty). [?] = no numerical data, [??] = neither numerical nor descriptive data of the water chemism

1 Europe	2 Asia
1.1 Lowland	2.1 Lowland
1.1.1 Fresh waters	2.1.1 Fresh waters
1.1.2 Salt waters: Petkovski (1991) [?], Löffler (1959), Eder & al. 1996	2.1.2 Salt waters: Sars (1901) [??]
1.2 Highland (alpine areas)	2.2 Highland (alpine areas)
1.2.1 Fresh waters	2.2.1 Fresh waters: Jiang (1981), Manca & Mura (1997), Manca & al. (1998), this paper
1.2.2 Salt waters	2.2.2 Salt waters: Jiang (1981), Petkovski (1991)

Tab. 2: Water chemism of lakes in Asia inhabiting *B. orientalis*. n.d. = not determined. References LCN30, LCN70: Manca & al. (1998), Tartari & al. (1998)

Lake		This paper	LCN30	LCN70
Altitude	[m]	2780	5111	4830
pH		8.25	6.2	7.4
Conductivity 20 °C	[µS/cm]	87 (25°C)	8	16
Total Phosphorus	[µg/l]	n.d.	2	3
Total Inorganic Nitrogen	[µg/l]	n.d.	129	33
Total Nitrogen	[µg/l]	n.d.	360	319
Total Organic Nitrogen	[µg/l]	n.d.	231	285

7 Conclusions

B. orientalis is a species, whose known geographic distribution in Eurasia, stretches out from East Mongolia, through Tibet, Pamir, Afghanistan, Iran, south Russia, Wallachia, Pannonia to Spain and even extends to Northern Africa (Algeria). Favourite habitats are small saline lowland and fresh or salty high alpine lakes or ponds. Common feature of these various types of water body is the absence of their predators (fishes). The evaluation of literature data supports the conclusion, that *B. orientalis* is a species which is a mixture of steppe and alpine elements, although there are some marked differences between their habitats in Europe and Asia.

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