TAXONOMICAL NOTES ON EURO-SIBERIAN FRESHWATER MOLLUSCS*: 2. REDESCRIPTION OF *PLANORBIS (GYRAULUS) STROEMI* WESTERLUND, 1881 (MOLLUSCA: GASTROPODA: PLANORBIDAE)

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This paper is dedicated to the memory of Dr. Alexander Kafanov, promiment Russian malacologist and zoogeographer, who died in April 2007.

Abstract Gyraulus stroemi *Westerlund, 1881 is a species distinct from* G. acronicus *(A. Férussac, 1807). It was, however, overlooked by the W-European malacologists for a long time. In this paper the shells as well as the anatomy have been studied thoroughly (including syntypes of* Planorbis stroemi*) and compared with morphological and anatomical features of* G. acronicus. *By means of scanning of museum collections and the literature, a distribution map was constructed which reveals that* G. stroemi *is a species that lives predominantly in the Artic and Subarctic.*

INTRODUCTION

When Westerlund (1885: 75-85) wrote his "*Fauna of the Palaearctic Region*" he recognised many *Gyraulus* spp. which live in the Arctic and Subarctic (the latter region is defined here as a territory between 60° N and the Arctic Circle of the continental region of Eurasia). These *Gyraulus* spp. were lumped together in the following period by many authors. Hubendick (1947: 449-454) only mentioned *G. albus* (O.F. Müller, 1774), *G. laevis* (Alder, 1838), and *G. acronicus* (A. Férussac, 1807) from Sweden, if we exclude the smaller ones *G. riparius* (Westerlund, 1865) and *G. crista* (Linnaeus, 1758). In addition, *Gyraulus rossmaessleri* (Auerswald, 1851) also lives in parts of N-Europe and Siberia (Vinarski *et al.* 2006), the species definition of which was pointed out by Meier-Brook (1964). These are the indigenous species accepted today for N-Europe (Killeen 1992, Kerney 1999, Meier-Brook 1983, Glöer 2002, Falkner *et al.* 2001, Glöer & Meier-Brook 2003, Anderson 2005, Bank 2007) by W-European authors.

In the recent Russian literature 12 additional species, which live in the arctic and subarctic region (regarding Prozorova & Starobogatov 1997) are recognised: *Gyraulus*‡ *stroemi* (Westerlund, 1881), *G. draparnaudi* (Sheppard, 1823), *G. thermochukchensis* (Prozorova & Starobogatov, 1997), *G. kamtschaticus* (Westerlund, 1897), *G. centrifugus* (Westerlund, 1897), *G. infraliratus* (Westerlund, 1876), *G. infirmus* (Mori, 1938), *G. borealis* (Lovén, 1875), *G. substroemi* (Starobogatov & Budnikova, 1976), *G. sibiricus* (Dunker, 1848), *G. chereshnevi* (Prozorova & Starobogatov, 1997), and *G. kussakini* (Prozorova & Starobogatov, 1997).

When Meier-Brook (1983) discussed the taxonomic status of many *Gyraulus* species, he did not take *Gyraulus stroemi* into consideration, and the CLECOM comission (Falkner *et al.* 2001), overlooked this species, too.

This paper is intended to redescribe *Gyraulus stroemi*, which is distinct from *G. acronicus* and other *Gyraulus* spp. known so far in W-Europe. In addition we provide a distribution map of *G. stroemi* based on all findings of the species known to us from the literature and the museum collections that are available to us.

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* The first part of the serial has been published in *Ruthenica* (Moscow), vol. 17(1-2) 55-63, 2007.

‡ In the Russian literature the genus name *Gyraulus* is mentioned as a subgenus of *Anisus*. The problem of subgrouping will not be discussed here, so we use only the genus name *Gyraulus* in this paper for the sake of uniformity.

Fig. 1 Syntype of *Planorbis stroemi* Westerlund, 1881.

MATERIAL AND METHODS

The syntypes of *Gyraulus stroemi* from the Natural History Museum in Göteborg were borrowed. In addition, we compared these species with materials from the collections of the authors and the Museum of Siberian Aquatic Molluscs, Omsk.

The snails of the authors' collections were preserved in 75% ethanol. The dissections and measurements of the genital organs and the shells were carried out using a Zeiss stereo microscope with an eyepiece micrometer; the photographs were made with a Leica R8 digital camera system.

RESULTS

The species *Planorbis stroemi* was described by Westerlund (1881: 63) from Scandinavia and Siberia (terra typica is very wide and includes Norway, Finland, and Siberia).

In the last century *Gyraulus stroemi* was mentioned by W-European authors as a form of *G. gredleri* (Gredler, 1859) (= *G. acronicus*, see Meier-Brook 1983: 45) by Geyer (1927: 148), Ehrmann (1933: 171), Schlesch (1942: 327), and Krausp (1934: 288). Only geologists like Menzel (1910: 258) accepted *G. stroemi* as a good species, characteristic of the arctic and subarctic climate. In Russian literature the first record of *G. stroemi* was that of Zhadin (1933: 191) as a variety of *G. gredleri*. Subsequently, Starobogatov & Streletzkaja (1967: 235) mentioned a planorbid species *Anisus (Gyraulus) filiaris* (Gredler, 1885) from Eastern Siberian waterbodies. The drawings of the shells of *A. filiaris*, which were depicted by the authors (Starobogatov & Streletzkaja 1967: 235, figs. 29-30) almost definitely illustrate *G. stroemi*. Nine

Planorbis (Gyraulus) *strömi* nov. sp.

Testa utrinque plana, medio impressiuscula, subtus paullo profundius, utrinque æqualiter dense et pulchre arcuatim transverse striata, nullo vestigio striarum spiralium, supra fusco-cornea, infra albido-virescens vel toto rufobrunnea; anfr. $4^1/_2$, forte regulariter accrescentes, primi sat convexi, ultimus latus sed aperturam versus regulariter arcuatus, parum dilatatus, depressus, utrinque subæqualiter convexiusculus, medio obsolete angulatus, antice vix brevissime descendens; apertura perobliqua, rotundato-ovalis, marginibus callo tenui junctis, exteriore rotundate protracto, interiore arcuato. Diam. $7^1/_2$—8, alt. 2 mm.

Norvegia (B. ESMARK), Fennia (ad Oulu et Nuottasaari Ostrobottniæ: MELA), Siberia.

Fig. 2 Faksimile of the original decription of *Planorbis (Gyraulus) stroemi* Westerlund, 1881.

years later Starobogatov & Budnikova (1976: 86) recorded *G. stroemi* under its proper name for the first time, indicating that it is not a synonym of *G. filiaris*, and since that time the species was accepted by other authors, too, e.g. Prozorova & Foster (1997: 155), Bogatov & Zatravkin (1990: 146) and Kruglov & Soldatenko (2000: 119). Thus *Gyraulus stroemi* is a well known species in Russia which is widely distributed and was overlooked by western European malacologists since its description by Westerlund in 1881. Meier-Brook (1964, 1983) did not consider this species, and Økland (1990: 220) as well as Kennard & Woodward (1926: 79) synonymised it with *G. acronicus*. But one of the depicted specimens (Økland 1990: 222, Fig. 6.71.B) is definitely *G. stroemi* with its type locality in Norway, thus this species could recently be found there and is still living in N-Europe.

ORIGINAL DESCRIPTION

The original lot (Fig. 1) contains two specimens, both with a diameter of 6.8 mm and a height of the last whorl of 1.5 mm.

Type locality The locus typicus is not given in

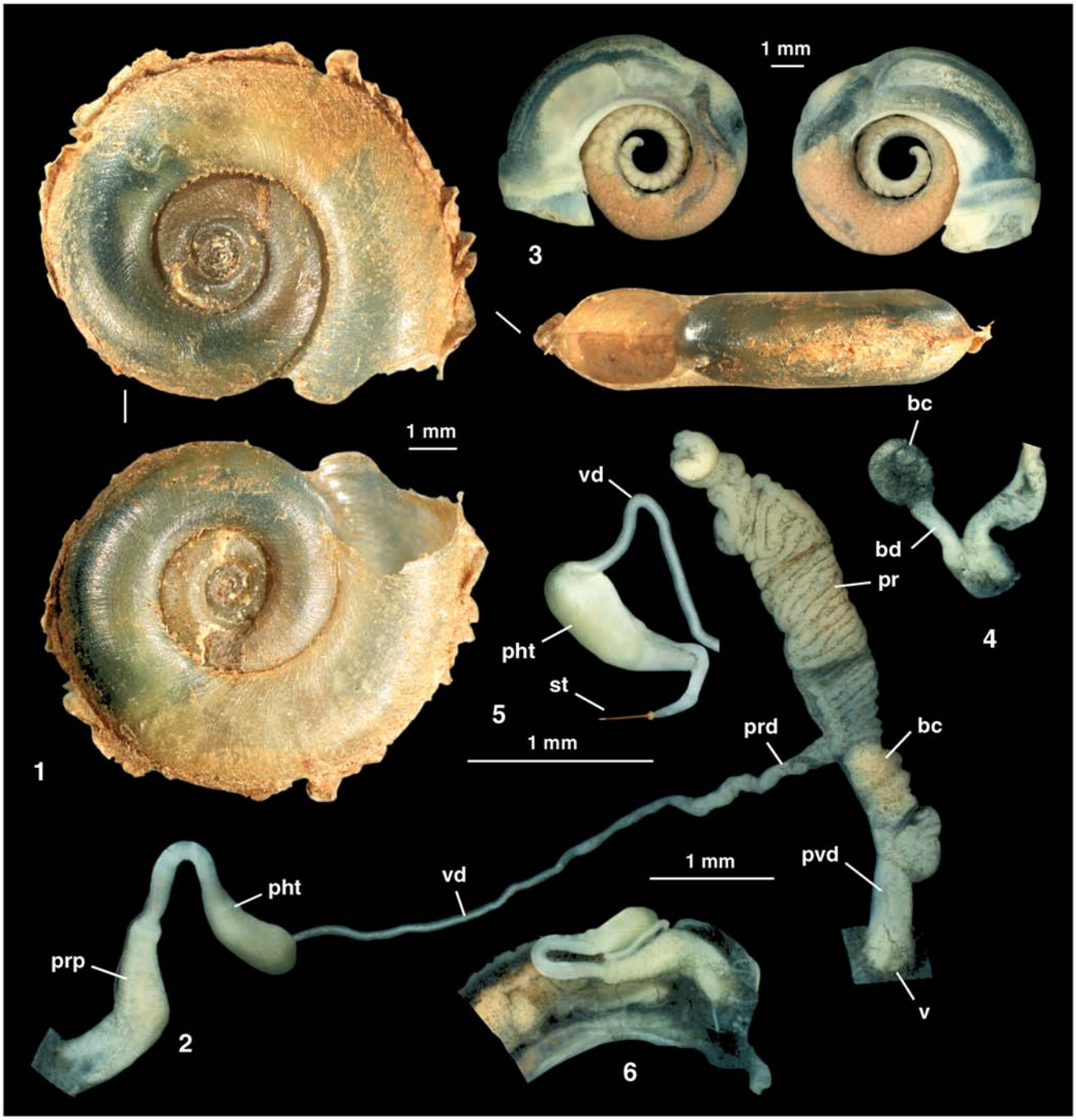

Fig. 3 *Gyraulus stroemi*, unnamed lake near Novoshumilovo village, Tomsk Region, Siberia (13.08.2006, leg M.V. Vinarski, A.V. Karimov). **1:** Shell, **2:** Copulatory organs, **3:** Mantle pigmentation, **4:** Bursa copulatrix, **5:** Stylet, **6:** Male copulatory organ *in situ*. – bc = bursa copulatrix, bd = bursa duct, pht = phallotheca, pr = prostata, prd = prostata duct, prp = praeputium, pvd = provaginal duct, st = stylet, vd = vas deferens, v = vagina.

the original description but Westerlund (1896: 120) mentioned for Norway the only sampling site in Norway "ad Eker (in Rökkebjergstjern)" (see Fig. 5, blue circle).

Characteristic shell features Periphery of the whorls is keeled, also in juveniles, the functional† upper margin of the aperture is not deflected neither is the last whorl, the surface is finely radially striped, and no spiral striae are visible.

† *Gyraulus* species are left coiled but the under side is the functional upper side of the snail. In the following description we refer to the functional sides.

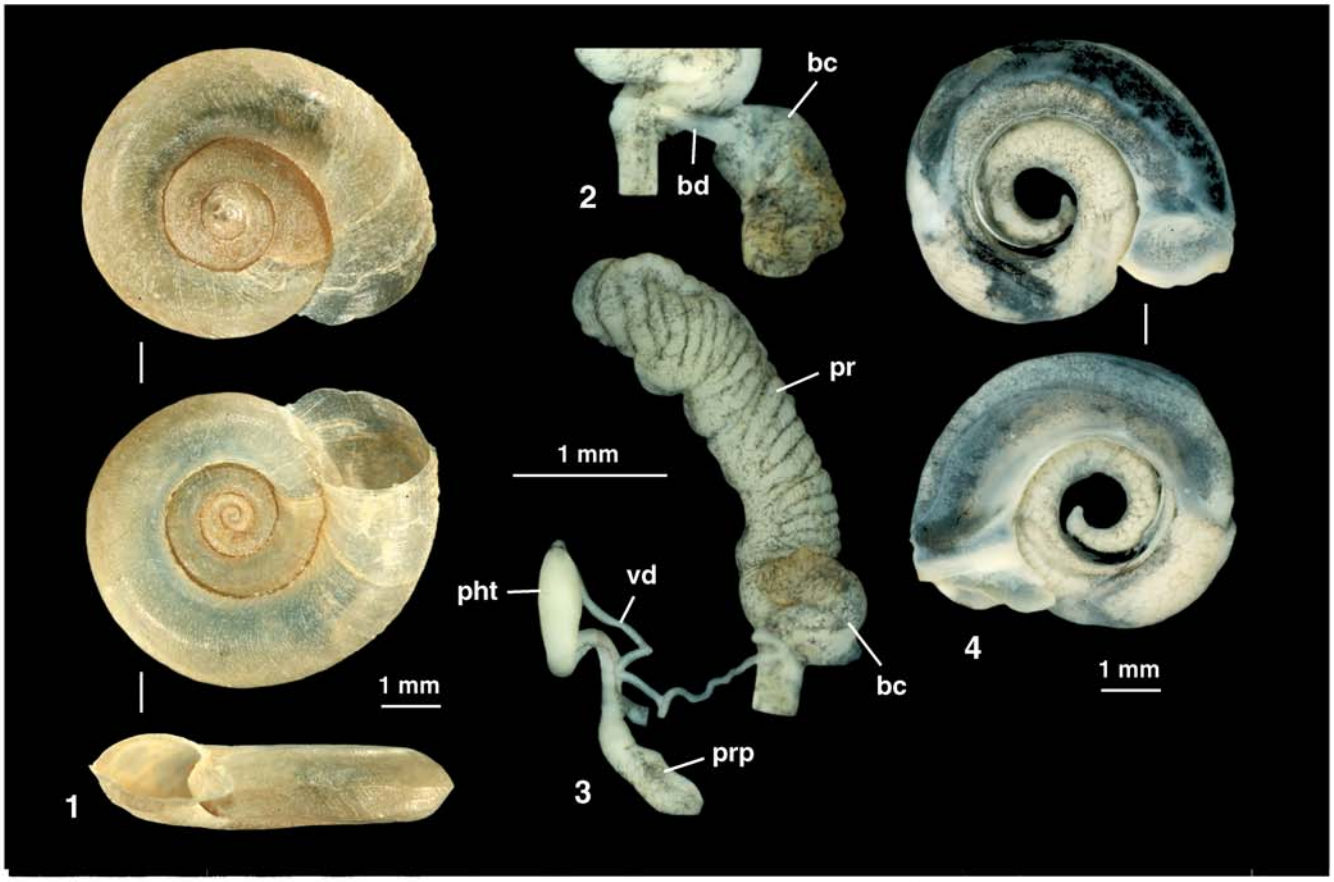

Fig. 4 *Gyraulus acronicus*, River Pang, Pangbourne Berkshire, England (11.07.2001 leg. I. Killeen). **1:** Shell, **2:** Bursa copulatrix, **3:** Copulatory organs, **4:** Mantle pigmentation. – bc = bursa copulatrix, bd = bursa duct, pht = phallotheca, pr = prostata, prp = praeputium, vd = vas deferens.

The whorls are regularly rounded on both sides, the first whorls are deep on the upper side, the under side is slightly umbilicated. The maximum diameter is 9.0 mm, and the height of the last whorl 1.5 mm.

Animal The animal is light grey, the mantle pigmentation shows small distinct patterns (Fig. 3.3).

Anatomy The ratio of penis sheat : preputium is ca. 1.0 to 1.3, the prostate gland bears 27-35 diverticula (Fig. 3.2), the male copulatory organ *in situ* is folded once (Fig. 3.6), the prostate duct is long, the stylet is ca. 0.25 mm long (Fig. 3.5) with a thickening at the proximal end, the bursa is spherical with a thick bursa duct (Fig. 3.4).

DIFFERENTIAL DIAGNOSIS

This species can be confused with *Gyraulus acronicus*, which lives sympatrically with *G. stroemi* in most parts of the subarctic region. The shell of *G. stroemi* is much larger (up to 9 mm vs. 7 mm), thicker (1.5 mm vs. 1.3 mm) with a keeled periphery, which is also present in the juveniles. In *G. acronicus* the whorls are rounded to angled. In *G. stroemi* fringes are very prominent and are there in specimens of all populations. In *G. acronicus* these fringes are less prominent and occur only in populations that live in waters with rich vegetation. The upper margin of the aperture is straight in *G. stroemi* and not deflected like in *G. acronicus*, and the last whorl is descended. *G. stroemi* never displays spiral striae like *G. acronicus*.

The mantle pigmentation is different (compare Fig. 3.3 and Fig. 4.4). The male copulatory organ in *G. stroemi* is only bent once, in contrast to *G. acronicus* in which it is doubly bent (Meier-Brook 1964: 237, Fig. 21). The bursa duct of *G. stroemi* is thicker than in *G. acronicus*.

G. acronicus has a wider distributional range, and *G. stroemi* is more common in the Arctic and Subarctic parts of Eurasia (see also zoogeographical considerations below).

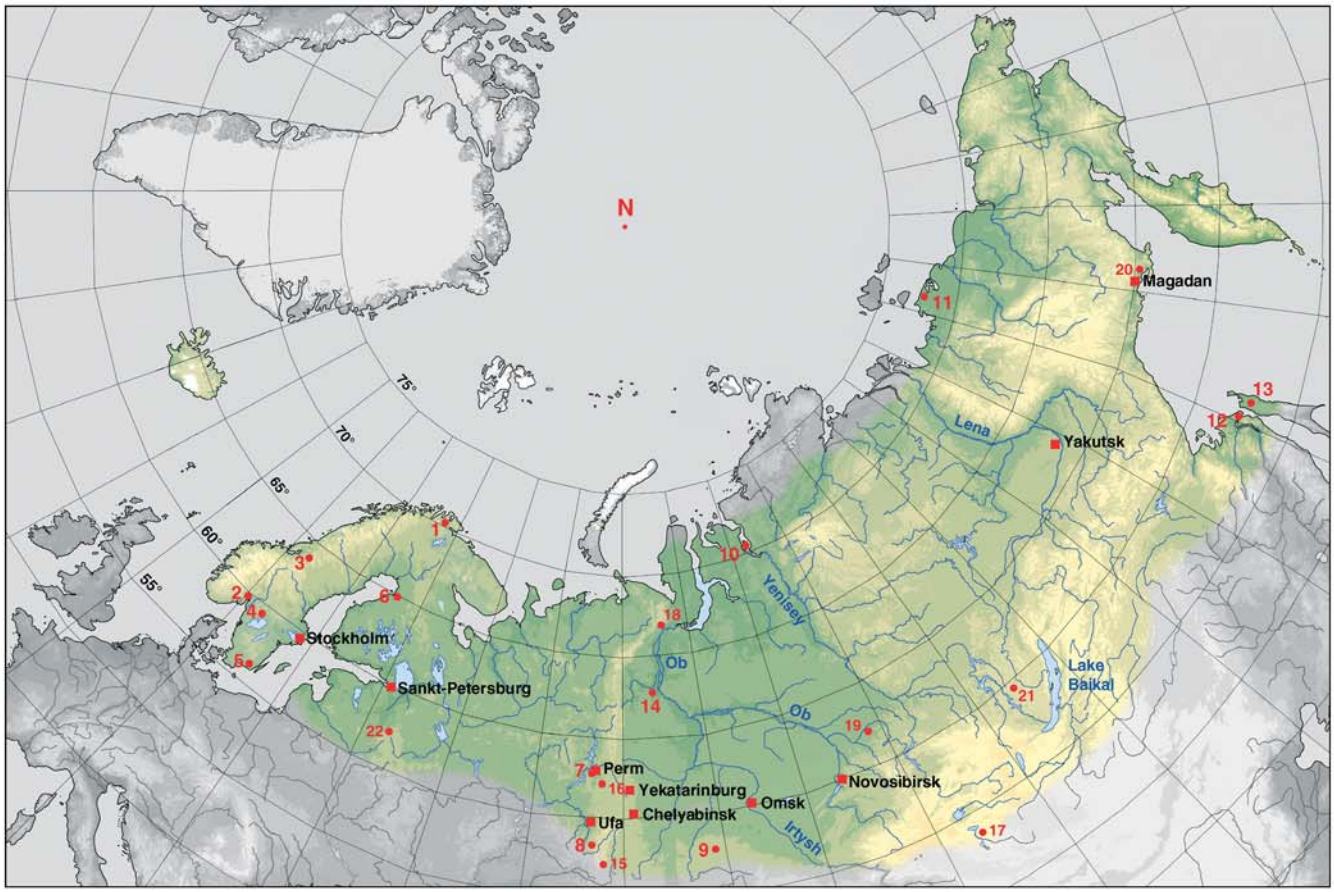

Fig. 5 The distribution of *Gyraulus stroemi* (Westerlund, 1881) in Eurasia. – **Norway: 1:** Östfinmarken (Johansen 1904), **2:** Borrevatn, Vestfold (Økland 1990), **Sweden: 3:** Kall, Jämtland, **4:** Karlstad, **5:** Ronneby, **Finland: 6:** Oulu (Westerlund 1884: 51), **Estonia:** Wagula-See near Werro, **Russia and Mongolia: 7:** Perm, **8:** Zlatoustovskaja, Orenburg, **9:** Kazakhstan, Akmola region, **10:** Jenissej (Johansen 1904), **11:** Jana-Gebiet, **12:** Nikolajewsk-na-Amure, **13:** Sakhalin, **14:** Beresowo town, **15:** Guberlinskaja, **16:** Kljuchi, **17:** Mongolia, Khovd Aimak, **18:** Tyumen Region, Vylposl channel in the Ob' River floodplain near Labytnangi, **19:** Tomsk Region, waterbodies of the Chulym River near Tegul'det Settl, **20:** Magadan, **21:** Bulga River, **22:** Seliger Lake. - **Type locality** (blue circle): Ekker in Rökkebjergstjern (Norway).

THE DISTRIBUTION OF *GYRAULUS STROEMI*

Between 1896 and 1898 Westerlund received 6 large parcels from Sankt-Petersburg (former Imperial Zoological Museum, now Zoological Institute of RAS, ZIN hereafter), which contained different continental molluscs for species determination. Göteborg samples of *Gyraulus stroemi* were sent to him in this period. For example, a lot collected near Guberlinskaja came in in 1896 and the one that was collected near Zlatoustowskaja in 1898 (12 of May), as could be read in the ZIN journal (M. Grebennikov, pers. comm.). These samples are still housed in the Natural History Museum Göteborg and could be studied by us.

The first clue as to sampling sites we obtained from Westerlund's collection: Norway (type locality), Amur near mouth of the Ussuri River (1855, leg. Maack. det. Westerlund), Dauria, Sivakov (leg. Czekanowski, det. Westerlund), Jana Region, Dolgolach (16.07.1885. leg. Baron Toll, det. Westerlund), Guberlinskaja ("Bashkiria, Orenburg Gouvernement", northern part of Guberlinskie Mountains, bank of the Shajratla River, leg. Nazarov, det. Westerlund), Zlatoustovskaja (small swamps in the floodplain of the Sylva River, leg. Czekanowski), Beresowo, Nikolajewsk, and 1 lot from Karlstad, Sweden.

In ZIN collection we found among others: Ronneby, Sweden (leg. et det. W.A. Lindholm), Norway (leg. Retowski, det. W.A. Lindholm), and Kall (Jemtland, Sweden, leg. Westerlund, det. Starobogatov (sic!)). The easternmost point where species were collected is the Sakhalin

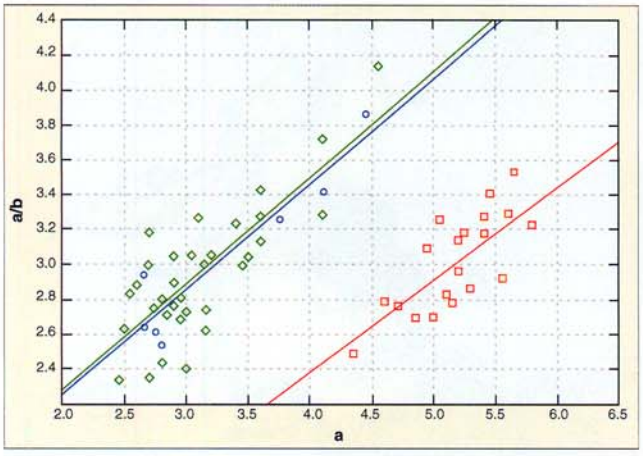

Fig. 6 Measurements of *G. acronicus* (blue: Bodensee, Germany, locus typicus; green: Kamyshlovka river near Omsk City, Siberia) and *G. stroemi* (red: Yarro-To Lake, Gydan Peninsula, Arctic Siberia). - a = diameter of the last whorl from aperture to periphery, b = height of the last whorl (see also Meier-Brook 1983: 4, Fig, 1 A and 46, Fig. 64). – The significance of the measurements were calculated by Student's test. For t-test q = a/b; q_{green} = 1.05 + 0.6a, t = 4.23, p = 0.0002; q_{red} = 0.26 + 0.53a, t = 3.413, p = 0.0029.

Island, it was collected in Mongolia as well (Tsalolikhin leg. 1978).

Other sampling sites could be located from citations in the literature and catalogues of some Russian museum collections: ZIN, Zoological Museum of the Institute of Plant and Animal Ecology (Yekaterinburg, see Khokhutkin & al. 2003), and Museum of Siberian Aquatic Molluscs, Omsk, and because *G. stroemi* is a common species in Siberia, we tried to find records that especially comprise the border of its distribution area. The records of *G. stroemi*, which are scattered among different Russian publications, ascertain us to believe that the species is distributed throughout the Asiatic part of Russia (Kruglov & Soldatenko 2000, Prozorova 2003) and some adjacent regions. Additionally it was recorded in the southern part of Russian Far Eastern (Primorye) (Bogatov & Zatravkin 1990 [1991]; Prozorova & Starobogatov 1997), Chukotka and adjacent areas (Starobogatov & Budnikova 1976), Northern Siberia from the Lower Ob's basin eastward to the Jana River basin (Dolgin 2001), Western Siberia (Karimov 2005), Yenisei drainage basin (Gundrizer 1984), Northern Kazakhstan (Vinarski *et al.* 2006a), Ilmeny State Reserve (Zatravkin 1980), Ural Region (Khokhutkin *et al.*, 2003). In the European part of Russia, the distribution of *G. stroemi* is limited to its northern and central parts, including Kama, Vychegda, Mezen' and Pechora drainage basins (Leshko 1998; Leshko *et al.* 2001), Seliger Lake (Zatravkin 1981), Vyatka drainage basin (Shikhova 2004), and Volzhsko-Kamsky Reserve (Lyubarskaja *et al.* 2005). Taking all mentioned sampling sites into account, we can state that *Gyraulus stroemi* prefers the arctic and subarctic region of Eurasia, though it might be found in regions down to 50° N southward (Mongolia, Northern Kazakhstan).

DISCUSSION

By comparing the shells as well as the anatomy of *G. stroemi* and *G. acronicus* it is apparent that most of the features that are suitable to distinguish *Gyraulus* species from each other do not appear to be very pronounced. This is not unusual within the genus *Gyraulus*, e.g. between *G. laevis* (Alder, 1838) and *G. parvus* (Say, 1817) "The most consistent character state in *G. parvus* is the strikingly changing width of the vas deferens." (Meier-Brook 1983: 38). To exacerbate the situation, *G. acronicus* is defined as a species with a large morphological plasticity: e.g. the periphery of the whorls can be rounded or angled, the last whorl may be deflected or not, the number of prostate diverticula lies in a range of 20-39, etc. But in case of doubt one stable feature is sufficient to distinguish two taxa as being good species, because this shows their genetic distinctness. This means there is no gene flow between the species if they live sympatrically, thus fits in with the biological species definition.

Meier-Brook (1983: 46, fig. 64) pointed out the differences in the shell shape between *Gyraulus acronicus* from W-Europe and *G. borealis* (Lovén, 1875) from the subarctic region of Russia. Meier-Brook (1983: 46) wrote: "It cannot be overlooked that *G. borealis* is persistently different in shell characters from the temperate European forms of *G. acronicus*". We borrowed materials of *G. borealis* from the Museum Stockholm and could study the anatomy, which has previously been done by Meier-Brook in 1977. We agree with him on the conclusion that these lots contained *G. acronicus*. The materials from the subarctic waterbodies that Meier-Brook used in his studies of 1983 (p. 46, fig. 64, regression lines 4–8) for measurements were possibly *Gyraulus stroemi*. Our measurements (Fig. 6) on samples of *G. stro-*

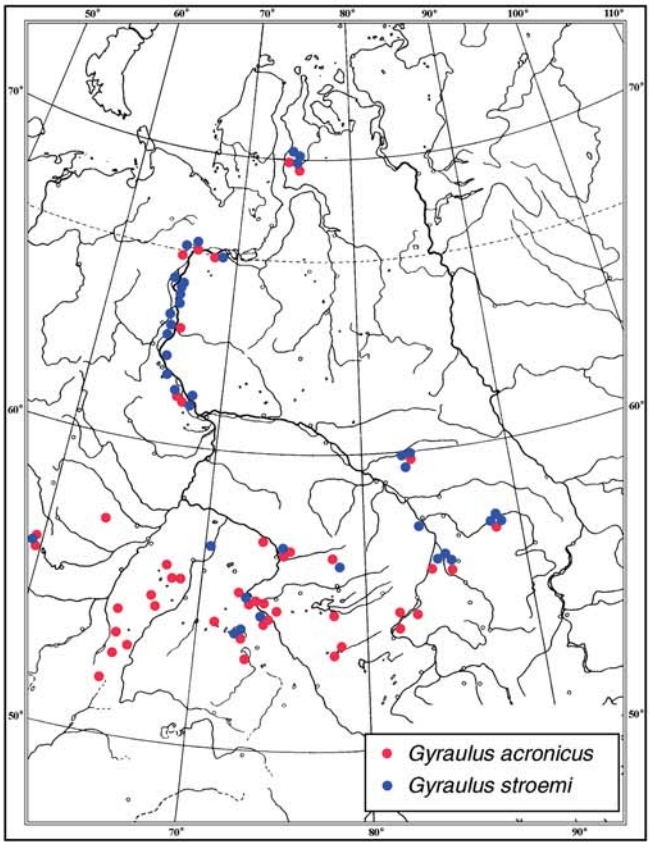

Fig. 7 The distribution of *G. acronicus* and *G. stroemi* in W-Siberia. The map is based on the electronic catalogue of the Museum of Siberian Aquatic Molluscs, Omsk.

emi led to results that are in good agreement with to those of Meier-Brook (1983: 46, Fig. 64).

From the zoogeographical point of view, the species under discussion have somewhat similar, but not wholly overlaping ranges. Likewise, *G. stroemi* seems to be absent in Central and Southern Europe, where *G. acronicus* dwells (i.e. in Ukraine, see Stadnichenko 1990; in European Russia, see Starobogatov *et al.* 2004). We cannot examine the Ložek's (1948) indication of *G. stroemi* in the former Czechoslovakia, however, there are some reasons to suppose that Ložek had an angled form of *G. acronicus* in his hands (L. Dvořák & M. Horsák, pers. communication). Quite to the contrary, in Beringia and easternmost parts of Asiatic Russia (Russian Far Eastern) *G. acronicus* is absent, whereas *G. stroemi* lives there (Bogatov & Zatravkin 1990; Prozorova & Foster 1997). Starobogatov *et al.* (2004) state that the eastern boundary of *G. acronicus* range lies in the Nizhnaja Tunguska River basin. Indeed, in July of 2003 numerous specimens of this species have been found by the junior author in the Nizhnaja Tunguska River and adjacent waterbodies, and, moreover, representatives of this species were found 40 km to the east, in waterbodies in the vicinity of Kirensk Town (situated within the Lena River basin). Presumably, it is the easternmost locality of *G. acronicus* known to the date.

Though in some parts of Eurasia the two species live sympatrically, *G. stroemi* seems to be more numerous and common in the North. Most findings of this species in Western Siberia were made in the northern part of the region, whereas *G. acronicus* is more common in the southern parts of Western Siberia (Fig. 7).

This zoogeographical consideration provides an additional, although indirect, evidence for accepting *G. stroemi* as being a good species distinct from *G. acronicus*. Following the Starobogatov & Streletzkaja (1967) we can suggest that *G. stroemi* is a member of a group of Palaearctic freshwater mollusks with a peculiar North European–Siberian type of distribution that covers Scandinavia (and sometimes Baltic countries and even alpine parts of Central Europe), the northern part of European Russia and Asiatic part of the Palaearctic. This is similar to another snail species, the prosobranch *Valvata sibirica* (Middendorff, 1851) which lives in Scandinavia and all Northern Russia eastward to Beringia, and also occurs in the Pleistocene deposits of Germany (Glöer 2002; Starobogatov *et al.* 2004).

ACKNOWLEDGEMENTS

We like to express our thanks to Maxim Grebennikov (Institute of Plant and Animal Ecology (RAS), Yekaterinburg), who helped us to identify cryptic sampling sites of *G. stroemi*, Ted von Proschwitz, Torsten Nordander (Natural History Museum Göteborg), and Karin Sindemark - Kronestedt (Museum of Natural History Stockholm) for lending us materials of Westerlund's collection. We acknowledge Dr A.M. Adam (Government of Tomsk Region), who provided to M.V. Vinarski an opportunity to collect snails in some remote sites of Tomsk Region, as well as David Walker (Hamburg) for looking over the English.

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