

MALAKOLOGISCHE ABHANDLUNGEN

Staatliches Museum für Tierkunde Dresden

Band 19

Ausgegeben: 15. Dezember 1999

Nr. 26

The water molluscs of the "Leopoldskroner Teich", a pond in the city of Salzburg, Austria (Gastropoda et Bivalvia)

With 1 figure and 3 tables

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Abstract. The aquatic molluscs of the Leopoldskroner Teich, a pond located in the city of Salzburg, as well as of five ditches nearby, were studied. Eighteen species of gastropods and seven species of bivalves were found. Nine of them were new to the "Leopoldskroner Teich". Twelve gastropods species and four bivalve species are cited in the Austrian "Red List". Aquatic macrophytes and physico-chemical parameters were recorded. Factors which explain molluscs distribution in water systems are discussed.

Kurzfassung. Die Wassermollusken des „Leopoldskroner Teiches“, ein Gewässer in der Stadt Salzburg, Österreich (Gastropoda et Bivalvia). – Die Wassermollusken des „Leopoldskroner Teiches“, ein Gewässer in der Stadt Salzburg und von fünf Wassergräben wurden untersucht. Achtzehn Schneckenarten und sieben Muschelarten wurden gefunden. Neun davon sind neu für den Leopoldskroner Teich. Zwölf Schnecken und vier Muscheln sind in der „Roten Liste“ von Österreich angeführt. Aquatische Makrophyten und physikalisch-chemische Parameter wurden aufgenommen. Faktoren über die Ausbreitung von Wassermollusken werden diskutiert.

Introduction

The "Leopoldskroner Teich" is a pond located in the city of Salzburg. Since the end of the last century it has attracted several malacologists (KASTNER 1892, KASTNER 1905, HOFFER & LÄMMERMAYR 1925, MAHLER 1944/45, MAHLER 1951, MAHLER 1952/53, KLEMM 1954, STÜBER 1967). After that time no further investigations were undertaken (PATZNER 1995). Recently some ditches in the west of the Leopoldskroner Teich were studied for gastropods (HANUS 1997).

The pond Leopoldskroner Teich is a remainder of a former swamp, which was enlarged in 1500, and then filled with water from the "Almkanal" (FREUDLSPERGER 1936). In the beginning of the 18th century the pond was set dry for a few years. In 1736, the Prince Archbishop of Salzburg LEOPOLD ANTON FREIHERR VON FIRMIAN began to construct the castle Schloss Leopoldskron, which nowadays is a national historic monument. In that period the lake was enlarged again and two islands were built. Since that time the pond is used by anglers. About 10 years ago a part of the sediment was removed. The north-western and western part of the pond is now private, while the rest of the lake is public.

The aim of the present study was to survey the molluscs of the Leopoldskroner Teich and its surrounding running waters, as a part of the mapping program of fresh-water molluscs in the country of Salzburg (PATZNER 1996) and to compare present findings with those from decades ago (see above).

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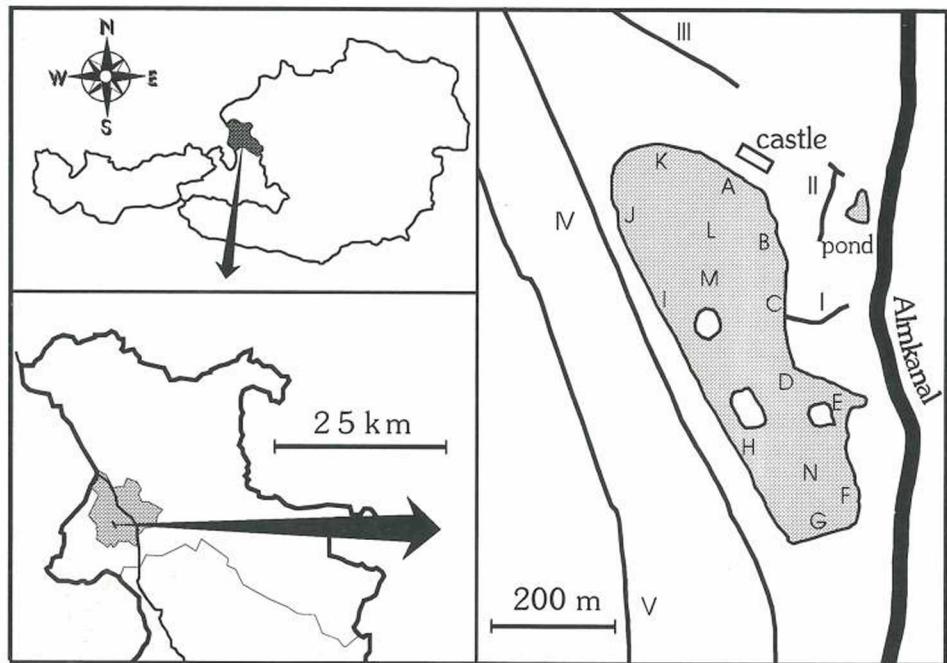


Fig. 1: Overview of the sampling places. A to K = Leopoldskroner Teich, sampled from the shore, L to M = Leopoldskroner Teich, sampled from the boat. I to V = ditches.

Study area and Methods

Fig. 1 shows the situation of the sampling places at the Leopoldskroner Teich and the other waters around it. The Leopoldskroner Teich has a maximum depth of 2 m and is partly surrounded by trees and bushes. The shore is lined with emerged vegetation and in certain areas with stones or wood. The bottom substrate consists of mud with a high organic content and occasionally of pebbles or stones. Fourteen stations were sampled from the shore, three from a boat (Fig. 1).

Furthermore 5 ditches and one small pond in the surrounding of the Leopoldskroner Teich were investigated for molluscs. Ditch I flows into the middle eastern part of the pond (Fig. 1). The shores consist of mud and some stones and are lined with trees and herbaceous vegetation. The substrate on the bottom is muddy with rests of wood and plants. Maximum depth is approximately 15 cm. Ditch II is located in the gardens of the castle (Fig. 1). The water is not flowing. Its other characteristics are similar to Ditch I. Ditch III is situated north from the pond (Fig. 1). Its shores are lined by herbaceous vegetation. The bottom consists of mud and some stones. Maximum depth is approximately 25 cm. Ditch IV is located in the north-west of the Leopoldskroner Teich (Fig. 1). Trees, bushes and herbaceous plants are next to the shores. The substrate is mud with rests of plants. The depth varies between 15 and 20 cm. Ditch V is situated south-east from the pond (Fig. 1). Its characteristics are similar to Ditch IV. Pond I is located in the gardens of the castle (Fig. 1). Trees, bushes and herbaceous plants surround it. Shores are lined by emerged vegetation. The substrate is very muddy, with rests of wood and plants.

Mollusc sampling: Sampling was made with a hand-net. In addition, vegetation, stones and wood were inspected visually for the presence of gastropods. The material collected (molluscs, vegetation and substratum) was sorted by using a series of sieves. The found molluscs were identified and counted as (a) living animals, (b) newly died and (c) died since a longer period. Their abundance was grouped in five classes: 0 = absent, 1 = rare, 2 = moderately frequent, 3 = frequent, 4 = very frequent. Determinations were made after GLÖER & MEIER-BROOK (1994). Samples of the molluscs are kept at the collection of the Institute of Zoology at the University of Salzburg (no. Fl-334 to Fl-344 and Fl-360 to Fl-367).

Table 1: Presence and abundance of freshwater molluscs and macrophytes in the different sampling places of the Leopoldskroner Teich. Classes of abundances for molluscs: - = absence, + = rare, ++ = moderately frequent, +++ = frequent, ++++ = abundant; n = new shells and r = old shells of dead individuals. The rest are living animals. Classes of abundances for macrophytes: - = absent, + = rare and isolated, ++ = rare and disperse, +++ = broaden, ++++ = abundant, +++++ = in mass.

Table 2: Presence and abundance of freshwater molluscs and macrophytes in the different sampling places of the ditches around the Leopoldskroner Teich. Classes of abundances: - = absence, + = rare, ++ = moderately frequent, +++ = frequent, ++++ = abundant; n = new shells and r = old shells of dead individuals. The rest are living animals.

species	sampling places				
	ditch I	ditch II	ditch III	ditch IV	ditch V
<i>V. contectus</i>	-	-	-	+++	-
<i>B. tentaculata</i>	+r	-	+n	++	-
<i>V. cristata</i>	+++r	+++	-	+++	-
<i>S. fuscus</i>	-	-	-	+++	-
<i>G. truncatula</i>	-	-	-	-	+++
<i>R. peregra</i>	+	-	-	-	-
<i>P. planorbis</i>	-	-	+++	-	-
<i>B. contortus</i>	+n	-	+++	+++	-
<i>P. corneus</i>	-	-	-	+++	-
<i>P. acuta</i>	-	-	-	-	++
<i>A. hypnorum</i>	-	-	-	++n	++
<i>M. lacustre</i>	-	-	-	++	-
<i>P. casertanum</i>	-	-	+++	+++	+++
<i>P. nitidum</i>	++	++	-	-	-
<i>P. subtruncat.</i>	-	-	-	+++	-

Macrophyte sampling: The quantity of the different species was defined as: 0 = absent, 1 = rare and isolated, 2 = rare and disperse, 3 = dispersed, 4 = frequent, 5 = in mass.

Water sampling: For the physico-chemical characteristics water samples were taken in the southern and northern extremes of the lake (Fig. 1). As the data differed only insignificantly the mean of the two values was taken. Temperature, pH, conductivity and oxygen content were measured directly in the field using portable instruments (WTW). Water samples were taken to the laboratory and total hardness, alkalinity, ammonium, nitrate, nitrite, chloride, phosphate and calcium contents were measured with test kits (Merck).

Results

Mollusca

A total of 12 species of gastropods and 6 species of bivalves (3 mussels and 3 pill clams) were found in the Leopoldskroner Teich (Tab. 1). The most frequent species were *Physella acuta* and *Radix auricularia*. *P. acuta* was found frequent or abundant in thirteen of the fourteen sampling areas, while *R. auricularia* was found frequent or moderately frequent in twelve of them.

In terms of species diversity and individuals abundance, the southern and south-eastern portions of the study area were found to be the richest. Few species were found in the north-western portion of the lake. Comparatively few shells were found in samples taken from the boat from the middle of the pond. Nearly all of them were empty shells. Most of the unionids *Unio pictorum*, *Anodonta cygnea* and *A. anatina* were found as newly died in the near of nests of the muskrats *Ondatra zibethica*.

In the four ditches (Ditch I to Ditch IV) in the vicinity of the Leopoldskroner Teich eleven gastropods and three bivalves were found (Tab. 2). No molluscs were found in the small pond (Pond I).

temperature (°C)	21.6
pH	8.7
oxygen content (mg/l)	12.6
BOD-5	4.4
conductivity (μS/cm)	292
total hardness (°dH)	7.0
alkalinity (mmol/l)	1.9
ammonium (mg/l)	0.01
nitrate (mg/l)	0.7
nitrite (mg/l)	<0.02
chloride (mg/l)	15
phosphate (mg/l)	0.5
calcium (mg/l)	<5

Table 3: Physico-chemical parameters in the water of the Leopoldskroner Teich.

Macrophytes

Five species of macrophytes were collected in the Leopoldskroner Teich. The distribution and abundance can be seen in Table 1. *Myriophyllum spicatum* was broadly extended throughout the whole pond. *Nymphaea alba* and *Phragmites australis* were very abundant in certain areas. *Iris pseudocorus* and *Isoetes lacustris* were occasionally found in some spots and are isolated or diffusely distributed. *N. alba* was abundant and widely distributed in the north-eastern part of the lake. At the south-eastern extreme of the lake *P. australis* was very abundant.

The only macrophyte species in the ditches was *P. australis*, present rarely and dispersed in Ditch III and Ditch IV. No macrophytes could be seen in Pond I.

Water analysis

Results of physico-chemical parameters measured in the Leopoldskroner Teich are shown in Table 3. Measurements were made on June 19th, 1997 at 11.00 a.m., the weather was sunny with some clouds.

Discussion

The presence of five gastropods and six bivalves found in Leopoldskroner Teich in the present study was already reported in the literature: *Valvata cristata* (HOFFER & LÄMMERMAYR 1925), *Radix auricularia* (MAHLER 1944/45), *Stagnicola corvus* and *S. fuscus* (MAHLER 1944/45, as *S. palustris*), *Gyraulus crista* (KASTNER 1892, KASTNER 1905), *Musculium lacustre* (KASTNER 1892, KASTNER 1905), *Pisidium casertanum* (MAHLER 1944/45), *Unio pictorum* (KASTNER 1892, KASTNER 1905, MAHLER 1944/45, MAHLER 1952/53), *Anodonta cygnea* (MAHLER 1944/45, MAHLER 1952/53), *A. anatina* (KASTNER 1892, KASTNER 1905, MAHLER 1944/45) and *Unio pictorum* (KASTNER 1892, KASTNER 1905, MAHLER 1944/45, MAHLER 1952/53). Three snails and one mussel were cited in the literature but not found in the pond at present: *Viviparus contectus* (KASTNER 1892, KASTNER 1905), *Planorbarius corneus* (MAHLER 1951), *Ancylus fluviatilis* (MAHLER 1944/45) and *Unio crassus* (KASTNER 1892, KASTNER 1905). However, *V. contectus* and *P. corneus* were found in high abundance in one of the ditches (Ditch IV). *A. fluviatilis* is usually found in running waters and was not expected in the pond. In the fifties *U. crassus* has been found in several places of the province of Salzburg but now is extinct since several years (REISCHÜTZ & SACKL 1991, PATZNER

1997a). The rest of the species found are new for the Leopoldskroner Teich: *Bithynia tentaculata*, *Acroloxus lacustris*, *Lymnaea stagnalis*, *Galba truncatula*, *Bathyomphalus contortus*, *Gyraulus parvus*, *Segmentina nitida*, *Physella acuta*, *Pisidium nitidum*). *G. parvus* is a species introduced from North America and recently reported in Austria for the first time (PATZNER 1997b). From *P. acuta* it is reported that it was spread from a garden shop not far from the Leopoldskroner Teich in the forties (MAHLER 1944/45).

Twelve gastropods species and four bivalve species found in this study are cited in the "Red List" of the Austrian endangered animals (FRANK & REISCHÜTZ 1994). They are in different categories of endangering. The gastropods *S. corvus*, *G. crista*, *S. nitida* and *A. hypnorum* as well as the bivalve *A. cygnea* are considered as seriously endangered for Salzburg.

There are different theories trying to explain the distribution of freshwater molluscs in a water system. Several authors have reported that macrophyte diversity was important in explaining the distribution of gastropods, since an increasing number of macrophyte species, i.e. increased habitat diversity, should be expected to increase the number of available microhabitats for gastropods and would thus lead to an increased number of gastropod species (e.g. BRÖNMARCK 1985a, COSTIL & CLEMENT 1996). For ÖKLAND (1983), among other authors, hardness of the water and aquatic vegetation are the determinative factors for the number of mollusc species and their abundance, respectively. In our study, areas with highest macrophyte diversity did not always show the highest number of gastropod species. An explanation is more likely to be found in the qualitative characteristic of the vegetation, since plant morphology and its fine structure may be more significant (CALOW 1973, COSTIL & CLEMENT 1996). COSTIL & CLEMENT (1996) showed that an environment with high trophic level, reflected in the presence of eutrophic plant communities, provides favourable conditions for the existence of many species of freshwater gastropods. BRÖNMARK (1985b) showed by enclosure experiments that predation, rather than competition, is the major structuring force of benthic gastropod communities. In permanent water bodies, predators can determinate distribution and abundance of snails (LODGE et al. 1987). In several areas of the Leopoldskroner Teich a rather high pressure of predators exists by different species of water birds and several species of fish. A special danger for the naiad mussels is given by the muskrats *Ondatra zibethica* (BRANDER 1955, NEVES & ODOM 1989, HOCHWALD 1990). Their occurrence is easily recognized by the empty shells which are accumulated in front of their nests (AKKERMANN 1972).

Acknowledgements

The work was supported by a scholarship from the European Union "Leonardo Da Vinci" to one of us (E.G.I.). We would further like to thank Mr. Walter DORFER, from the "Peter Pfenninger Schenkung", for the support with the boat and the "Salzburg Seminar" for the permission to collect in the private area. We also want to thank Rose SABLON (Brussels) for the determination of the *Stagnicola* species.

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(Received on January 11, 1999)

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Zeitschrift/Journal: [Malakologische Abhandlungen](#)

Jahr/Year: 1998-1999

Band/Volume: [19](#)

Autor(en)/Author(s): Patzner Robert A., Isarch Eva Garcia

Artikel/Article: [The water molluscs of the “Leopoldskroner Teich”, a pond in the city of Salzburg, Austria \(Gastropoda et Bivalvia\) 273-279](#)