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The aquatic malacofauna (Gastropoda et Bivalvia) in the Bluntau Valley in the Federal State of Salzburg (Austria)

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A b s t r a c t : The freshwater molluscs colonizing the brooks and lakes of the Bluntau Valley were subjected to a detailed malacological investigation. At 20 sample locations distributed in the whole valley respective waters were studied for their mollusc populations. In addition, important environmental parameters such as water temperature, pH value and total hardness were measured. In the studied biotopes a total of three gastropod species and 2 bivalve species could be collected. Highest population densities with partly more than 100 individuals per m² were determined for the Austrian spring snail *Bythinella austriaca* (FRAUENFELD, 1857), whereas other species occurred with low to intermediate frequency (<1-10 individuals per m²). Limited colonization of the valley by freshwater molluscs can be mainly traced back to the low temperatures and reduced nutrient levels distinguishing the running and stagnant waters. Respective habitats are preferentially occupied by small cold-stenothermic species with modest demand for food.

K e y w o r d s : Bluntau Valley, aquatic gastropods, bivalves, *Bythinella austriaca*, Federal State of Salzburg.

Introduction

In the past decades malacological mapping in the Federal State of Salzburg achieved great progress. As outlined in numerous studies (e.g., PATZNER 1995, STURM 1998, 1999, 2000, 2001, 2003, 2004, 2007, 2012, 2016, 2018), the number of aquatic mollusc species and population density continuously decline from the alpine foreland to the central-alpine regions. At higher altitudes only few pioneer species such as *Radix labiata* (ROSSMÄSSLER, 1835), *R. balthica* (LINNAEUS, 1758), *Pisidium casertanum* (POLI, 1791) and *P. subtruncatum* MALM, 1855 can be detected in valuable amounts (TURNER et al. 1998, GLÖER & MEIER-BROOK 2003, STURM 2007, 2012). This dramatic reduction of the aquatic malacofauna is largely owing to two main causes: (1) Water bodies of the alpine region are characterized by low temperatures, reduced contents of CaCO₃ being necessary for shell growth and extremely scarce supply with nutritive substances. (2) Due to the prevailing climatic situation numerous brooks and lakes undergo freezing in winter, so that the respective mollusc population has to evade to greater water depths. Many species, however, are not qualified for the colonization of deep-water habitats (GLÖER & MEIER-BROOK 2003, STURM 2007).

In the Northern Limestone Alps covering most parts of the southern Flachgau and the Tennengau stagnant and running waters commonly host intermediate numbers of mollusc species (PATZNER 1995, STURM 1998). In rare cases aquatic habitats are massively colonized by a given species with population density exceeding 100 individuals per m² (STURM 1998, 2000, 2016). Usually, population densities of gastropods and bivalves

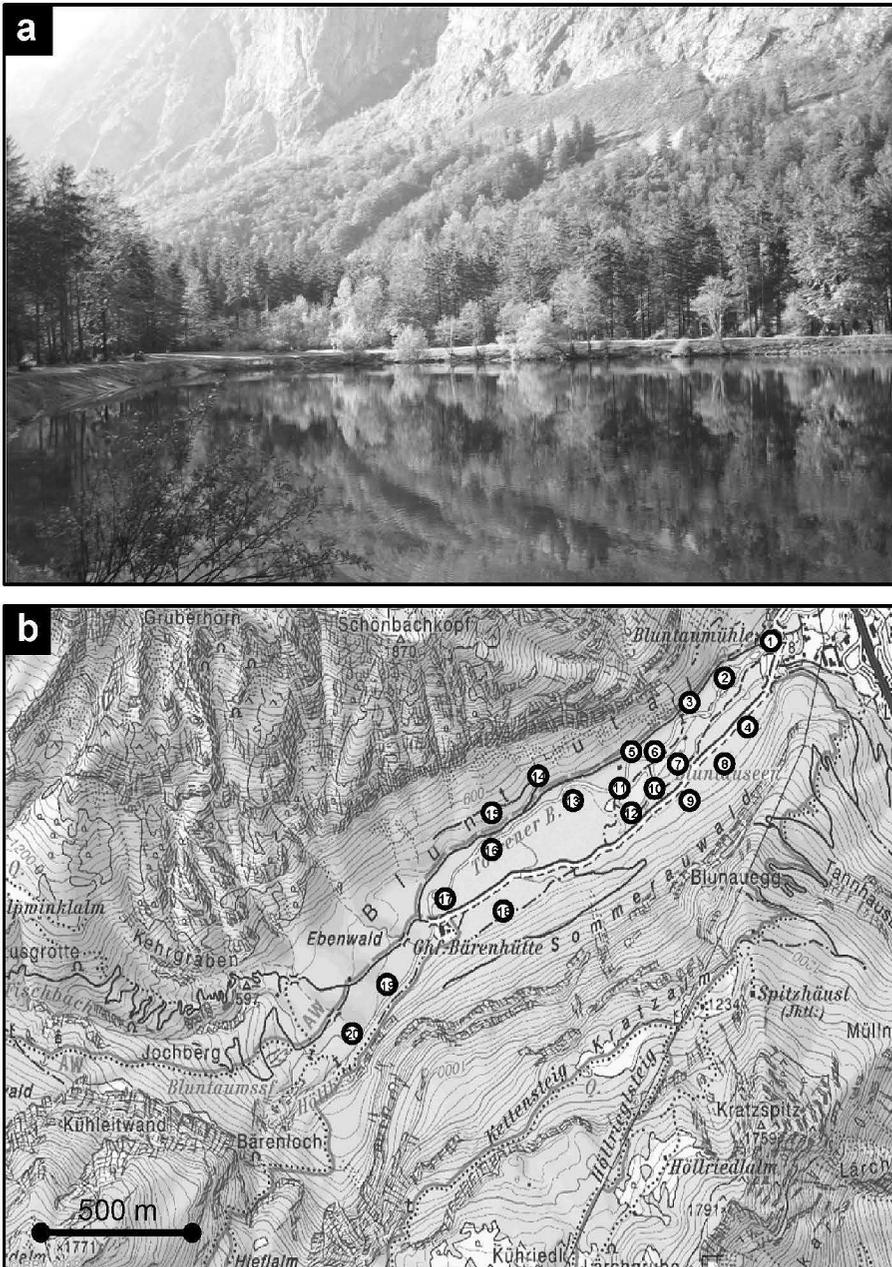


Fig. 1: (a) View into the Bluntau Valley with its larger lake positioned in the center; (b) Geographic map exhibiting the main water bodies of the Bluntau Valley as well as the 20 sampling locations defined for this study.

occurring at a certain sample location vary somewhere between 1 and 10 individuals per m². With regard to its geomorphology the southern Flachgau and adjacent Tennengau are characterized by the south-north-striking Salzach valley with its high number of lateral valleys, among which the Bluntau Valley near the village of Golling has superior significance (STURM 1998). Besides the Torren River the locality contains two lakes and numerous spring brooks running down from the northern and southern mountainsides (Fig. 1). From a malacological point of view the Bluntau Valley was studied in detail in the 1990s, whereby two major findings were made: (1) The Torren River and the lakes are characterized by low mollusc species diversities and related specific abundances. (2) In the spring brooks, on the other hand, partly massive occurrence of the Austrian spring snail *Bythinella austriaca* (FRAUENFELD, 1857) could be registered (STURM 1998).

In the present contribution the malacological colonization of the Bluntau Valley is subjected to a comprehensive re-evaluation. Changes of the population densities with respect to the studies of the 1990s are documented and, in the given case, also interpreted.

Materials and Methods

Malacological mapping

For a comprehensive malacological evaluation of the study site a total of 20 sample locations were selected which are homogeneously distributed over the whole valley (Fig. 1). In the case of the lakes and the Torren River only bank environments were systematically searched for aquatic gastropods and bivalves, whereas in the case of spring brooks also the riverbed was included into the collecting procedure. Investigation of the sediment, submerged rocks and riparian vegetation was carried out according to standardized strategy outlined in numerous previous studies (e.g., PATZNER 1994, STURM 1998, 2000, 2007). Thereby, a hand sieve with a mesh size of 0.5 mm served as standard tool for the effective sampling of the animals. Separation of the molluscs from the coarse substrate took place with the help of feather tweezers. Single species were already determined in the field and afterwards relocated to their natural habitats.

For a quantitative evaluation of single mollusc species occurring at a specific sampling site, a small area was demarcated with a frequency frame (0.5 x 0.5 m) and all gastropods and bivalves occurring within this frame were subjected to a counting procedure. Population density of single species was expressed by the definition of four distinct abundance categories: Category 1 corresponds to rare occurrence of an organism with less than 1 ind./m². Category 2 describes moderate occurrence with 1-10 ind./m², whereas category 3 is representative for frequent occurrence of mollusc species with 11-100 ind./m². Category 4, at last, corresponds to massive occurrence of an organism with more than 100 ind./m² (STURM 2007, 2012, 2018).

Measurement of environmental parameters

Besides comprehensive mollusc sampling also collection of chemical and physical parameters was conducted at the given locations. Concretely speaking, water temperature (°C), pH value of the water, electric conductivity (µS/cm) and total hardness (mg/L) were determined with the help of small portable gauges and test sticks (Fig. 2). Respective data acquisition took place immediately after mollusc sampling in order to reveal possible relationships between habitat colonization and physical and chemical characteristics of the related biotope.

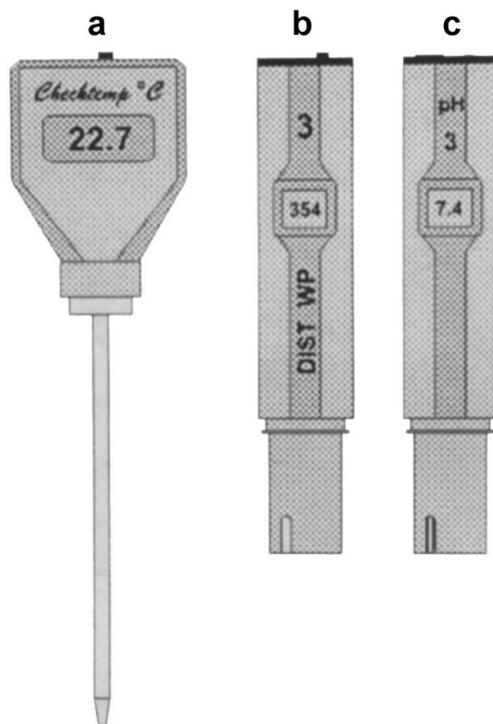


Fig. 2: Small portable gauges used for the in-situ measurement of physical and chemical water parameters: (a) portable thermometer, (b) analyzer of electric conductivity, (c) pH-meter. For the analysis of total hardness respective test sticks were used.

Results

Malacological mapping

The results of the malacological mapping campaign are summarized in Tab. 1. Concerning the Torren River forming the most important water body of the Bluntau Valley only rare to moderate occurrence of three gastropod species and two bivalve species can be reported. Thereby, highest population densities are obtained for *Radix labiata* on the one side and *Pisidium casertanum* on the other. In the lakes with their stony banks and minor contents of submerged vegetation only few individuals of pond snails and pill clams could be found at the respective sampling locations. In contrast to the extremely sparse colonization of the stagnant waters, the spring brooks are partly characterized by high to massive abundances of the Austrian spring snail *Bythinella austriaca*, whereas other mollusc species are distinguished by their complete absence. Smaller ponds or pools located near the hill sides can also contain pond snails and pill clams which colonize these micro-habitats with low to moderate population densities.

Measurement of environmental parameters

Results of the analysis of physical and chemical parameters are also listed in Tab. 1. Water temperature determined in the main river, lakes and spring brooks commonly ranges from 5.9 to 12.1°C indicating cold-stenothermic conditions in the related freshwater habitats. The pH value varies between 6.9 and 7.8 (neutral), whilst electric conductivity adopts values between 457 and 543 µS/cm. Total hardness is marked by measurements ranging from 250 to >300 mg/L, so that the concentration of Ca⁺⁺ and Mg⁺⁺ in the water can be evaluated as high.

Tab. 1: Results of freshwater mollusc mapping and measurement of environmental parameters. Abbreviations: *R. l.* = *Radix labiata*, *R. b.* = *R. balthica*, *B. a.* = *Bythinella austriaca*, *P. c.* = *Pisidium casertanum*, *P. s.* = *P. subtruncatum*, EC = electric conductivity, TH = total hardness.

Point #	Location	Freshwater molluscs					Water parameters			
		<i>R. l.</i>	<i>R. b.</i>	<i>B. a.</i>	<i>P. c.</i>	<i>P. s.</i>	T (°C)	pH	EC (µS/cm)	TH (mg/L)
1	Torren R.	1	-	-	2	1	7.9	7.4	485	250-300
2	Torren R.	1	1	-	1	-	7.7	7.4	534	>300
3	Torren R.	2	-	1	2	-	7.6	7.5	513	250-300
4	spring br.	-	-	3	-	-	6.6	7.1	483	250-300
5	Torren R.	1	-	-	-	-	7.3	6.9	478	250-300
6	lake	2	2	-	2	1	9.5	7.8	465	250-300
7	lake	1	1	-	1	1	10.2	7.6	457	250-300
8	pool	2	1	1	2	-	12.1	7.7	496	250-300
9	spring br.	-	-	4	-	-	6.5	7.2	534	250-300
10	lake	1	-	-	-	-	9.4	7.6	479	250-300
11	lake	1	1	-	2	2	9.6	7.5	491	250-300
12	lake	2	-	-	-	-	9.8	7.5	494	250-300
13	Torren R.	1	-	-	-	-	7.3	7.2	515	>300
14	spring br.	-	-	2	-	-	6.5	6.9	543	>300
15	spring br.	-	-	3	-	-	6.6	7.1	532	>300
16	Torren R.	-	-	-	1	-	6.9	7.4	514	>300
17	Torren R.	-	1	-	-	-	6.7	7.3	523	>300
18	spring br.	-	-	2	-	-	5.9	6.8	543	>300
19	Torren R.	-	-	2	1	-	6.3	7.2	512	>300
20	Torren R.	-	-	3	-	-	6.4	7.4	524	>300

Discussion

As outlined in numerous previous studies (e.g., TURNER et al. 1998, STURM 2000, 2004, 2007, 2012), aquatic habitats characterized by extreme environmental conditions are colonized by a very limited number of freshwater molluscs. These gastropods and bivalves are often termed 'pioneer species', because they are responsible for a continuous dispersal of the malaco-fauna to untypical biotopes which are avoided by the organisms under normal circumstances (GLÖER 2002, STURM 2003, 2004). The alpine region may be regarded as excellent example concerning the colonization strategy of aquatic molluscs (TURNER et al. 1998, STURM 2007, 2012, 2013): Whilst waters belonging to the montane altitude level (600-1400 m) are colonized by both generalists and specialists, brooks and lakes of the subalpine altitude level (1400-2200 m) are exclusively reserved for those species which are able to occupy ecological niches.

The Bluntau Valley may be attributed to the Northern Limestone Alps and thus can be partly evaluated as location showing extreme environmental conditions. This circumstance is chiefly expressed by the low temperatures of the running and stagnant waters which represent preferential habitats for cold-stenothermic species (BOETERS 1973, 1981, GLÖER & MEIER-BROOK 2003, STURM 1998, 2005). One of these molluscs showing a preference for cold waters is the Austrian spring snail *Bythinella austriaca* which was evaluated ecologically in previous studies (STURM 2005, 2016, 2018). According to the results of these investigation the gastropod mainly occupies small brooks with low depth, reduced current velocity and low to intermediate contents of organic substances. Thereby, its extremely reduced demand for algal food is among other expressed by its very limited size (2.5-3.5 mm; GLÖER & MEIER-BROOK 2003, STURM 2018).

The waters of the Bluntau Valley are generally marked by their low contents of nutritive substances. Lake and river beds are preferably formed by mineral components with highly variable grain size. These conditions, however, are only accepted by five mollusc species at present which are all known to lay low claims on their environment and hence can be partly specified as typical 'pioneers' (GLÖER 2002, STURM 2003, 2004). Although pond snails and pill clams exhibit highest population densities in small stagnant waters with high stock of submerged vegetation, they can be also collected from stony habitats with reduced entry of vegetable mass, so that the Bluntau Valley represents a valuable location for their further distribution. As a specificity some species seem to develop nanism in response to the partly extreme environmental conditions, but this has to be confirmed or disproved by future studies.

Zusammenfassung

Die aquatische Malakofauna (Gastropoda et Bivalvia) im Bluntautal im Bundesland Salzburg (Österreich). Die Süßwassermollusken, welche die Bäche und Seen des Bluntautales besiedeln, wurden einer detaillierten malakologischen Untersuchung unterzogen. An insgesamt 20 über das gesamte Tal verstreuten Probenorten wurden die entsprechenden Gewässer in Bezug auf ihre Weichtierpopulation geprüft. Zusätzlich wurden noch wichtige Umweltparameter wie Wassertemperatur, pH-Wert, elektrische Leitfähigkeit und Gesamthärte gemessen. In den untersuchten Biotopen konnten insgesamt drei Gastropodenarten und zwei Muschelspezies vorgefunden werden. Die höchste Populationsdichte mit teilweise mehr als 100 Individuen pro m² wurde für die österreichische Quellschnecke *Bythinella austriaca* (FRAUENFELD, 1857) festgehalten, wohingegen andere Arten

lediglich mit niedriger bis mittlerer Häufigkeit auftraten (<1-10 Individuen pro m²). Die eingeschränkte Besiedlung des Tales durch Süßwassermollusken kann hauptsächlich auf die niedrigen Temperaturen und reduzierten Niveaus an Nährstoffen, welche die Fließ- und Stillgewässer auszeichnen, zurückgeführt werden. Entsprechende Habitate werden bevorzugt durch kleine kaltstenotheime Arten mit moderatem Nahrungsanspruch besetzt.

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