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Malacological mapping in Austria: distribution of the Austrian spring snail *Bythinella austriaca* (v. FRAUENFELD, 1857) in the federal state of Salzburg

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A b s t r a c t : The distribution of the spring snail *Bythinella austriaca* (v. FRAUENFELD, 1857) was studied in detail by the faunistic analysis of 257 sample points spread all over the northern half of the country of Salzburg. As a main result of this malacological mapping campaign the gastropod preferentially occurs in the northern limestone alps of the Tennengau and Pinzgau. In the northern regions of the country and the city of Salzburg only minor occurrence of the aquatic snail can be observed. Towards the central alps *Bythinella* is characterized by its complete disappearance. From an ecological point of view the organism mainly prefers habitats situated in spring brooks and small ponds, but can be also collected from small rivers, moors, and lakes.

K e y w o r d s : Malacological mapping, spring snail, ecology, habitat, Salzburg.

Introduction

According to several previous studies (BOETERS 1973, 1981, GLÖER & MEIER-BROOK 2003, STURM 2005, 2016) the Austrian spring snail *Bythinella austriaca* (v. FRAUENFELD, 1857) is characterized by its rather limited geographical distribution. So far, this species could be only detected in eastern Bavaria including the city of Munich (GLÖER & MEIER-BROOK 2003), in the northern counties of Salzburg (PATZNER 1995, STURM 1998, 2016) as well as in scattered waters of Upper Austria (STURM 1998, 2001, AESCHT & BISENBERGER 2011). This isolated occurrence is not restricted to the Austrian spring snail, but can be also observed for the remaining Central European species of the genus *Bythinella* (BOETERS 1973, 1981, GLÖER & MEIER-BROOK 2003), so that taxonomic classification of this gastropod could be simply carried out according to geographical criteria in the past.

For the federal state of Salzburg, collection and mapping of the Austrian spring snail looks back on a long tradition, which started with the end of the 19th century (KASTNER 1892) and reached its highlights in the middle and at the end of the 20th century (see review in PATZNER 1995, STURM 1998, 2000, 2001). Systematic mapping campaigns came to the result that *Bythinella* has the ability to colonize different aquatic habitats ranging from small running waters, ponds and lakes to moors and largely isolated water bodies in pasture areas (STURM 1998, 2000, 2001, 2016). Depending on the ecological frame conditions the spring snail can reach population densities of more than 100 animals per square meter, which commonly corresponds to a plenty occurrence.

The present study describes the current distribution of *B. austriaca* in the federal state of Salzburg. For this purpose a total of 257 sample points spread all over the northern part of the country has been analyzed for the occurrence of this gastropod. Another question pursued by the work deals with the colonization of different habitats and its statistical evaluation.

Material and Methods

Faunistic mapping of the Austrian spring snail took place from May to October 2016. During the field investigations special attention was paid to the possible occurrence of the gastropod in brooks and rivers of inner-alpine valleys and in water bodies of the montane height level (600-1400 msm). Geographical coordinates of single sample points were determined with the help of a global positioning system (GPS) and were afterwards signed into a respective distribution map. From the 257 sample points mentioned above, 235 locations came from the previously published literature (see reviews of PATZNER 1995, STURM 2016), whereas the remaining 22 locations were added after field work. The geographical positions of the sample points are summarized in Fig. 1.

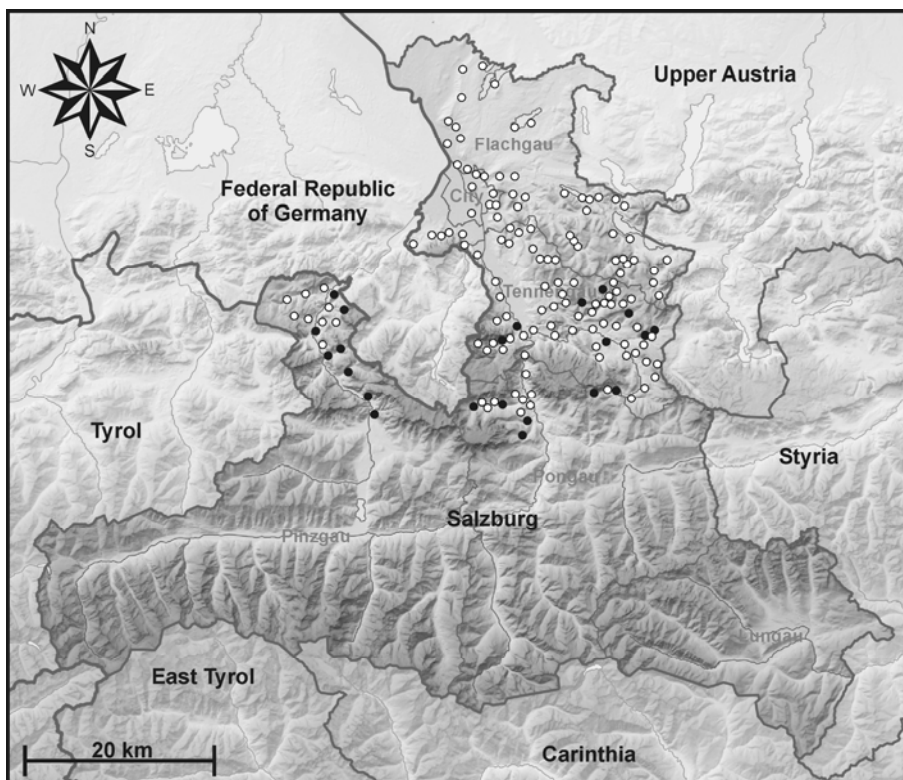


Fig. 1: Geographical map of the federal state of Salzburg including all sample points with registered occurrence of the Austrian spring snail *B. austriaca*. Open circles mark sample locations published in literature, whereas filled circles represent sample points of own field investigations.

Occurrence of the Austrian spring snail was quantified by using four categories of abundance: Category 1 corresponds to a population density of less than 1 individual per square meter, whilst category 2 indicates a population density of 1-10 individuals per square meter. Category 3 can be compared with a population density of 11-100 individuals per square meter, whereas category 4 finally corresponds to more than 100 animals per square meter (PATZNER 1994, STURM 1998, 2000, 2003, 2004, 2007, 2013). Local population densities were determined by using a reference frame with an area of 0.25 m² and extrapolating the counting results to 1 m².

The sample locations were not only investigated for their colonization by *Bythinella austriaca*, but also for their ecological nature. Thereby, five different types of habitats were distinguished: 1) spring brooks, 2) other running waters, 3) ponds, 4) lakes, and 5) small water bodies situated in alpine moors. The ecological information was combined with respective data published for the other 235 sample points and was finally subjected to descriptive statistics.

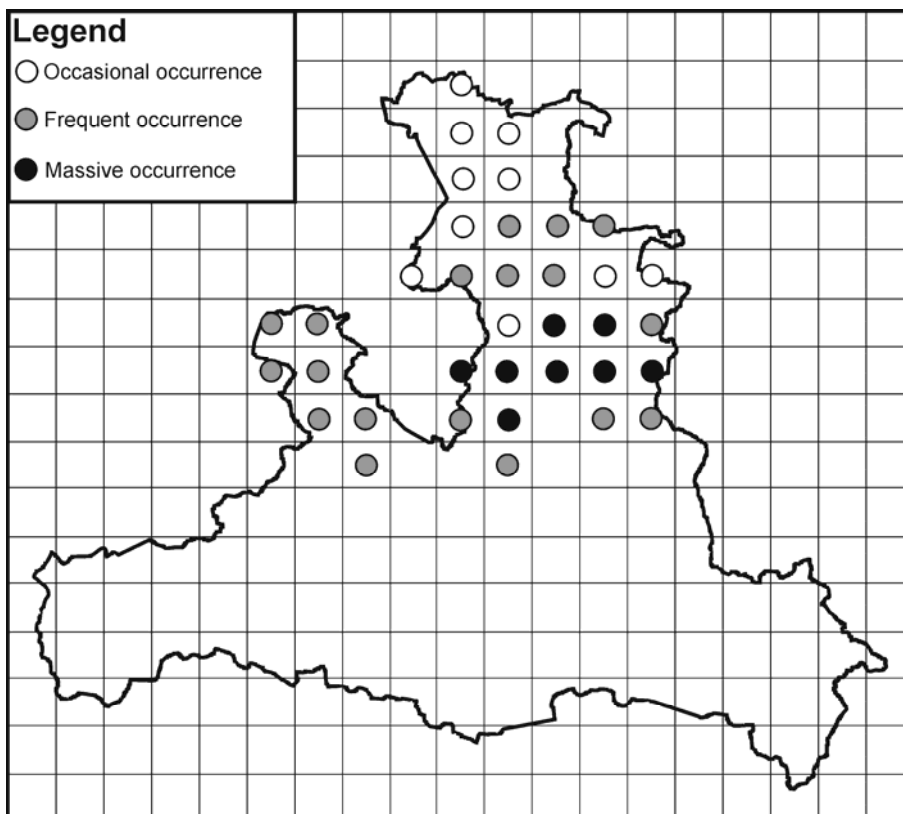


Fig. 2: Distribution map of *B. austriaca* for the federal state of Salzburg. The results presented here are based upon local abundances of the gastropod published in literature and detected during own faunistic mapping campaigns.

Results

Based upon the results of previous and current field studies a distribution map of the Austrian spring snail was constructed for the federal state of Salzburg (Fig. 2). The map clearly indicates a spatial restriction of the gastropod to the northern half of the country. This means that the species could not be documented for the central-alpine area hitherto. A more detailed analysis of the distribution map shows that the local frequency of the spring snail significantly increases from north to south. In some valleys of the northern limestone Alps and in higher pasture areas (800-1200 msm) the species is partly characterized by plenty occurrence (> 100 individuals per m^2). In the northernmost part of Salzburg *Bythinella* is marked by its sporadic presence, which is mostly limited to small spring brooks and running waters supplying the lakes of the alpine foreland. In general, aquatic habitats situated in the Tennengau as well as the northern Pongau and Pinzgau bear higher abundances of the spring snail, whereas the Flachgau and the city of Salzburg only offer very restricted living environments for the species.

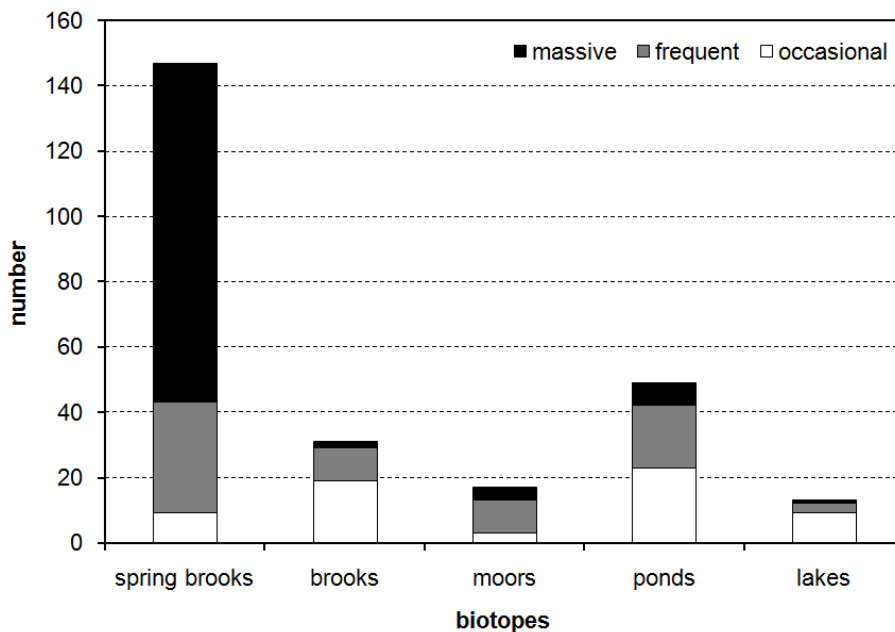


Fig. 3: Main biotopes colonized by the Austrian spring snail and their statistical evaluations. As can be clearly recognized from the graph, highest probabilities of occurrence and related population densities could be determined for spring brooks, followed by ponds, larger brooks, moors, and intermediately sized lakes.

Results of the statistical habitat analysis are summarized in Fig. 3. According to the results presented in the column diagram small spring brooks flowing down along the tributary valleys of the Salzach clearly represent preferential biotopes for the colonization by *B. austriaca*. For the majority of these running waters frequent occurrence of the spring snail could be registered during the field investigations. The

habitat type with second highest importance is represented by small ponds situated in pasture areas, which are frequently supplied with spring and rain water. Further habitats marked by the occurrence of *Bythinella* include larger brooks, moors with respective aquatic structures, and intermediately sized lakes. Within all these biotopes the gastropod can be rarely found in higher numbers. Typical population densities amount to several animals per m² (Fig. 3).

Discussion and Conclusions

The present contribution can be understood as another small progress with regard to the colonization strategies and ecological specificities exhibited by the Austrian spring snail. Comprehensive study of published reports concerning the occurrence of *Bythinella* as well as individual field investigations came to the result that in the federal state of Salzburg this gastropod is mainly found in the northern limestone Alps. Highest population densities could be reported for spring brooks and ponds. In the northern areas of the country and in the city of Salzburg itself *Bythinella* is mainly characterized by rare occurrence. Statistical analysis of colonized biotopes resulted in a preference of the snail for small running waters with low temperature. This cold-stenothermic behaviour, however, was also reported in numerous earlier publications and seems to be an ecological particularity of *Bythinella* (TURNER et al. 1998, GLÖER 2002, GLÖER & MEIER-BROOK 2003, STURM 2005, 2016).

Besides the above mentioned "standard habitat" the spring snail also occupies small biotopes that are periodically supplied with fresh water and do not reach water temperatures above 15°C. These specific areas include small ponds, brooks, and lakes. The occurrence of *Bythinella* in small water bodies of moors seems to be surprising at first sight, but was also reported in previously published papers (PATZNER 1994, 1995, STURM 1998, 2005, 2016). Here, it has to be strictly underlined that the moor areas have to be supplied with "hard" water containing high concentrations of Ca²⁺ and Mg²⁺ ions. As a side effect the water also bears a certain buffering capacity, which leads to the avoidance of low pH values being a significant limiting factor for the distribution of the spring snail (GLÖER & MEIER-BROOK 2003, STURM 2005, 2016).

The probably most interesting result obtained from the studies of this contribution is represented by the circumstance that the spring snail does not seem to have any distribution, which extends beyond the northern limestone Alps. According to several findings outlined hitherto the gastropod can be neither recorded in the grass mountains of the so-called greywacke zone nor detected in the central Alps following in the south (STURM 2004, 2005, 2012). In this specific case, however, it has to be assumed that 1) the regional geology and 2) the inner-alpine climate take influence on the water chemistry, which may not be tolerated by the spring snail. Future investigations should lead to a far-reaching confirmation of this hypothesis.

Zusammenfassung

Malakologische Kartierung in Österreich: Verbreitung der österreichischen Quellschnecke *Bythinella austriaca* (v. FRAUENFELD, 1857) im Bundesland Salzburg. – Die Verbreitung der Quellschnecke *Bythinella austriaca* (v. FRAUENFELD, 1857) wurde im Detail mithilfe der

faunistischen Analyse von 257 Probenpunkten, welche über die nördliche Hälfte des Bundeslandes Salzburg verstreut sind, studiert. Als ein Hauptresultat dieser malakologischen Kartierungskampagne kann das bevorzugte Auftreten der Schnecke in den nördlichen Kalkalpen des Tennengaus und Pinzgaus bewertet werden. In den nördlichen Regionen des Bundeslandes und in der Stadt Salzburg selbst ist lediglich eine reduzierte Verbreitung des aquatischen Weichtiers zu beobachten. In Richtung Zentralalpen ist das vollständige Fehlen von *Bythinella* in entsprechenden Habitaten feststellbar. Aus ökologischer Sicht bevorzugt der Organismus vor allem in Quellbächen und kleinen Tümpeln befindliche Habitate, kann aber auch in kleinen Flüssen, Mooren und Seen aufgesammelt werden.

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