FOLIA MALACOLOGICA
Vol. 17(2): 53–62
ISSN 1506-7629
The Association of Polish Malacologists
& Faculty of Biology, Adam Mickiewicz University
Poznań 2009
doi:10.2478/v10125-009-0009-9

MACROGASTRA BADIA (C. PFEIFFER, 1828) (GASTROPODA: PULMONATA: CLAUSILIIDAE) IN ZIELENIEC (BYSTRZYCKIE MTS, CENTRAL SUDETES) – ECOLOGY, CONSERVATION STATUS AND LIFE HISTORY – PRELIMINARY DATA

TOMASZ K. MALTZ, BEATA M. POKRYSZKO

Museum of Natural History, Wrocław University, Sienkiewicza 21, 50-335 Wrocław, Poland
(e-mail: tomaltz@biol.uni.wroc.pl, bepok@biol.uni.wroc.pl)

ABSTRACT: Information on the distribution on the Alpine *M. badia* in Poland dates from the 1960s and was not verified subsequently. A new locality was discovered in 2003 (Bystrzyckie Mts, Zieleniec near Duszniki-Zdrój); it forms a part of a group of isolated, Polish and Czech localities on the border of the species' distribution range. In the discussed part of the range the species is threatened by habitat destruction and climatic changes. It is legally protected in Poland but preserving its populations requires habitat protection. The preferred habitat is herb-rich beech forest, and cool and humid climate is crucial for the species' survival. The composition of the accompanying malacofauna varies among the sites which is probably associated with their origin. *M. badia* is oviparous; in May and June it produces batches of 1–3 eggs. The eggs are partly calcified, 1.39–1.61 in major and 1.32–1.45 mm in minor diameter. The incubation period is 16–19 days; the hatching is asynchronous; the juveniles reach adult size in 7–8 months. Some data on shell variation are provided; the number of apertural folds varies more widely than formerly believed.

KEY WORDS: Clausiliidae, endangered species, *Macrogastra badia*, life history, ecology

INTRODUCTION

Macrogastra badia (C. Pfeiffer, 1828), one of the most rare species in the malacofauna of Poland, is – next to *Cochlodina costata* and *Charpentieria ornata* – one of three native clausiliids representing the Alpine (East Alpine) zoogeographical element (LOŽEK 1955, 1956, 1964, WIKTOR 1964, 2004a, b, KLEMM 1969, KERNEY et al. 1983, RIEDEL 1988, HLAVÁČ & HORSÁK 2002). Its main distribution range includes the southern part of Eastern Alps (LOŽEK 1955, 1956, 1964, WIKTOR 1964, KERNEY et al. 1983, RIEDEL 1988, HLAVÁČ & HORSÁK 2002), in the west reaching the Brenner Pass and the Bavarian Allgäu region; in the south it comprises Styria, northern Carinthia, the Alpine part of north-eastern Italy (KLEMM 1969), and - across the Styrian Alps – northern Slovenia (BOLE & SLAPNIK 1997). In the Czech Republic *M. badia* was recorded from Šumava [Bohemian Forest] (also on the German side), Orlické hory and Králický Sněžnik (LOŽEK 1955, 1956, 1964, BRABENEC 1973, HLAVÁČ & HORSÁK 2002). In Poland it was first found by WIKTOR (1964) in a few localities in the Stołowe, Orlickie and Bystrzyckie Mts and in the environs of Gniewoszów near Bystrzyca Kłodzka. Both the Czech and the Polish localities form a group of the north-easternmost, isolated and relic occurrences of the snail (WIKTOR 1964, 2004a, b, RIEDEL 1988) (Fig. 1).

M. badia is a forest-dweller (LOŽEK 1964, WIKTOR 1964, 2004a, b, KERNEY et al. 1983, RIEDEL 1988, HLAVÁČ & HORSÁK 2002, MALTZ & SULIKOWSKA-DROZD 2008), inhabiting deciduous and mixed forests at higher altitudes (above 700 m a.s.l.), where it stays on logs, in litter, under bark and stones, and sometimes on shaded, moss-covered rocks.

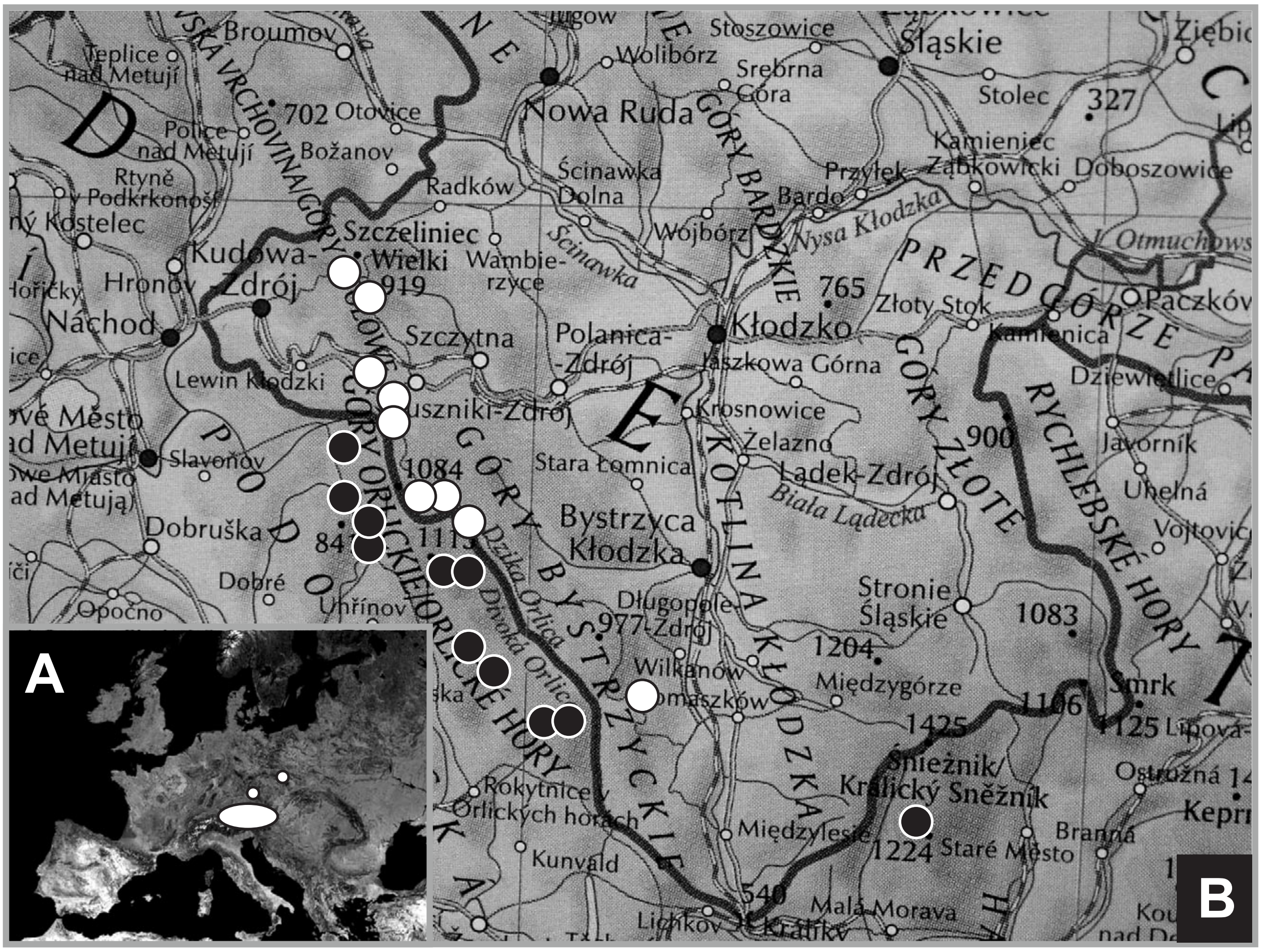

Fig. 1. Distribution of *Macrogastra badia*: A – in Europe, B – in the Stołowe, Orlickie & Bystrzyckie Mts: [○] – sites reported by WIKTOR (1964), [●] – Czech localities (according to BRABENEC 1973)

In Poland the species is legally protected (ROZPORZĄDZENIE MINISTRA ŚRODOWISKA 2004), it is red-listed (WIKTOR & RIEDEL 2002) and included in the Red Data Book (WIKTOR 2004b) as critically endangered (CR) because of its few and small populations threatened by random events and habitat destruction (POKRYSZKO & MALTZ 2007). In the Czech Republic it is regarded as endangered (JUŘIČKOVÁ et al. 2001) because of the small number of localities and similar risk factors.

The lack of information on the biology of the species, and the fact that the faunistic data are insufficient to provide a basis for an efficient protection strategy, constitute a serious problem. Finding its prosperous population encouraged us to undertake a more detaled study (field and laboratory observations), in hope that the results might contribute to designing an adequate protection strategy.

STUDY AREA

In 2003 we discovered a new, previously unknown locality of *M. badia*. It is situated in Zieleniec near Duszniki-Zdrój (Bystrzyckie Mts, Central Sudetes) (Fig. 2A). It is a forest fragment ca. 0.9 ha in area, on the eastern slope of the border mountain range, at an altitude of 900–920 m a.s.l., very close to the village, ca. 200 m from the road crossing its centre (50°20’21”N, 16°22’52”E, UTM: WR 97).

Floristically, it is a herb-rich beech forest (*Aceri-Fagetum*) – a plant community characteristic of the Alps and found above 850 m a.s.l. (ŚWIERKOSZ 2003). The dominant tree is beech, sycamore maple and spruce being less abundant; rowan forms an admixture, the herb layer is rich, especially in tall montane perennials of the class *Betulo-Adenostyletea* (Fig. 2B–D). Numerous rotting logs (deciduous) and the natural vertical and horizontal structure of the tree stand indicate its spontaneous development since at least 80 years (ŚWIERKOSZ 2003).

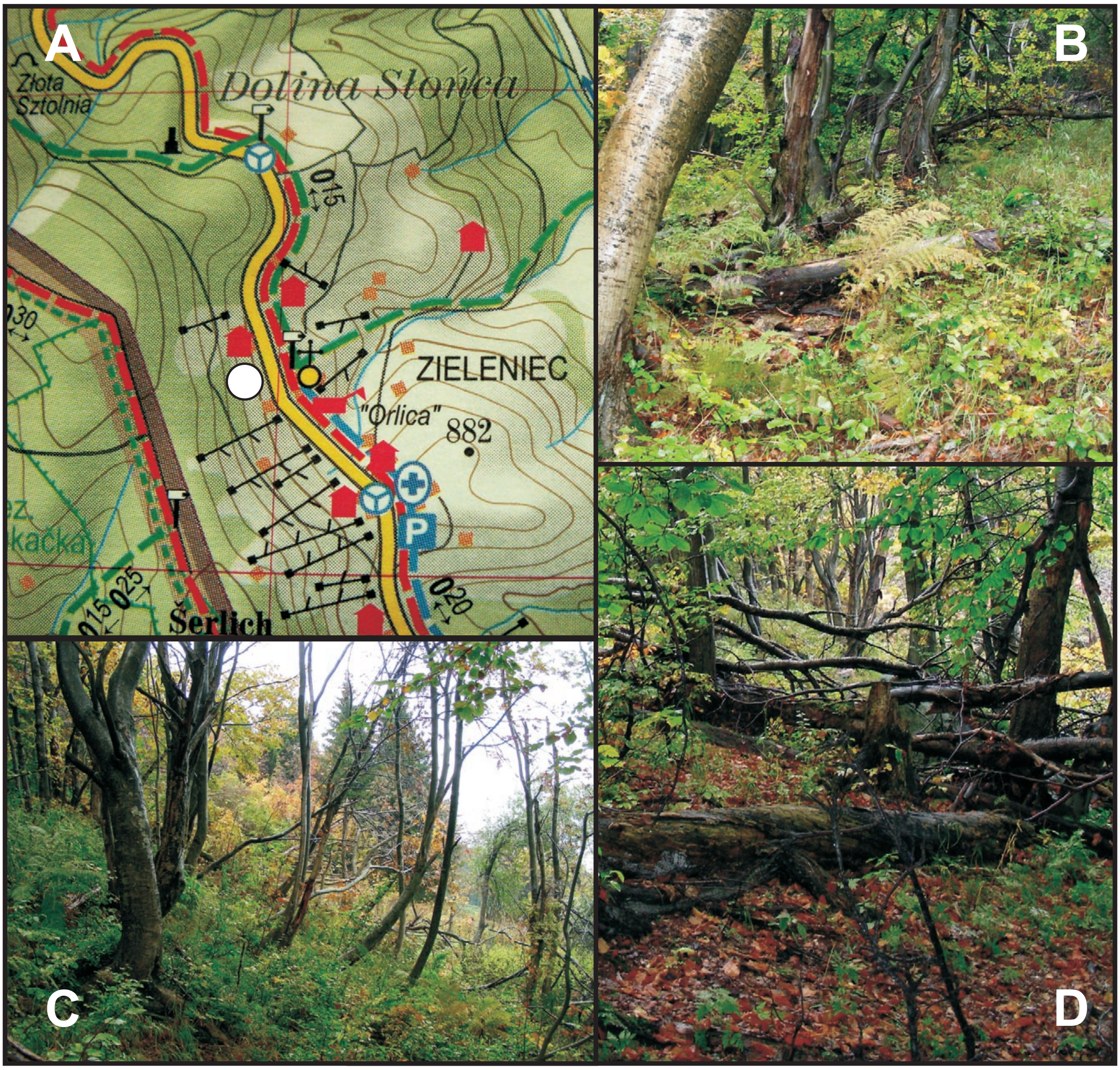

Fig. 2. Site of *Macrogastra badia* in Zieleniec (A) and its habitat (B-D) (Photo B. M. Pokryszko)

The substratum is micaschist with intercalations of amphibolites, quartzites and crystalline limestones, on which acid brown soils and podzols develop (Stupnicka 1989).

Pluviothermically, the region of Zieleniec is included in class VI d (cool and very humid climate) (Schmuck 1959, after Walczak 1968). The vegetation period is ca. 170 days (days with temperature >5°C), the number of days with temperature >10°C is ca. 110, and there is no climatic summer (days with temperature >15°C). Winter lasts more than 18 weeks, the annual precipitation sum is 1,000–1,200 mm, the snowfall period is ca. 190–200 days (Kosiba 1955, after Walczak 1968).

METHODS

Gastropods were sampled on two occasions: in June and October 2007. On each occasion collecting involved visual search during at least 2 hrs, considering all possible microhabitats, and taking a litter sample of 10–15 l volume. The samples were then processed as described in Cameron & Pokryszko (2005). Live clausiliids, helicids and slugs were identified in the site and released, the remaining material was identified in the laboratory and deposited in the collection of the Natural History Museum, Wrocław

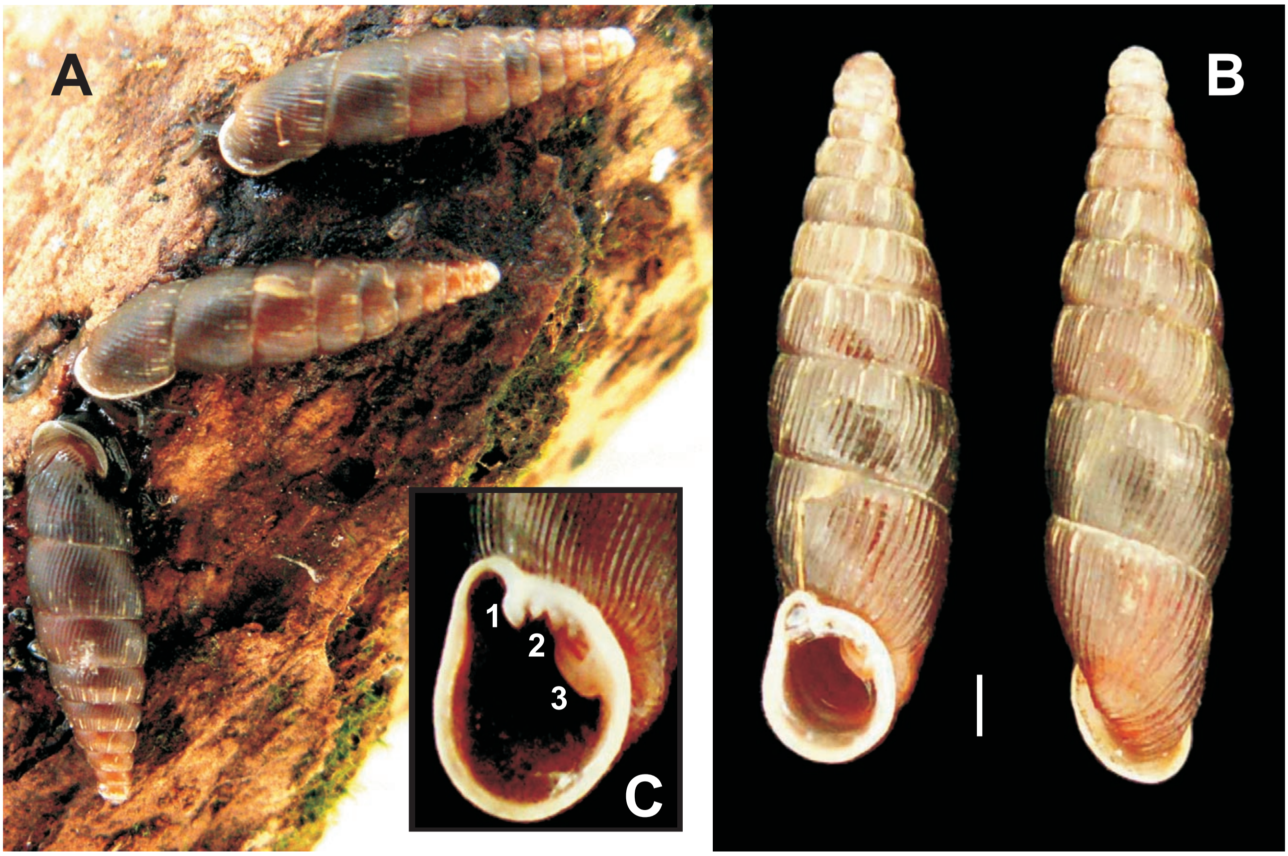

Fig. 3. *Macrogastra badia*. A – active adults, B – shell shown from two sides, C – aperture with parietal lamella (1), folds (2) and lower lamella (3). Scale bar 1 mm (Photo T. K. Maltz)

University. The nomenclature and systematic arrangement follow Kerney et al. (1983) and Wiktor (2004a), ecological and geographical groupings were adopted after Riedel (1988). The species composition in the locality was compared with species lists from sites with *M. badia* available in the literature (Hlaváč & Horsák 2002, Hlaváč 2003), using the Nei index (I_N) to estimate the similarity (Pokryszko & Cameron 2005).

In October 2007, 39 individuals of *M. badia* were brought to the laboratory: 22 adults and 17 juveniles (8 with shells of 6–6.9 whorls, 5 with shells of 7–7.9 whorls and 4 with shells of 8 whorls). The snails were kept in perspex boxes of 6 × 12 × 15 cm, lined with tissue paper, with tussocks of moss and pieces of dead timber from the locality. Adults were placed in groups of 4–5 in separate boxes, juveniles – in groups corresponding to the number of whorls. The boxes were controlled every two days, the tissue paper was exchanged every week. Dolomite tables were provided as the source of calcium. The snails were fed lettuce, Peking cabbage, carrot and champignons (food exchanged every 2–3 days). High humidity was maintained in the boxes through sprinkling the tissue paper, moss and timber with water every 2–3 days. From the beginning of the culture till June 2008 the temperature was 16–17°C, in July and August ca. 20–22°C, and since September – again ca. 17°C. The boxes were kept in natural lighting regime.

In July 2008, shells of 39 adults from the laboratory culture were measured; the measurements included shell height and width (H, W) and aperture height and width (h, w); whorls were counted (N), as well as the folds between the superior and inferior apertural lamellae (Fig. 3). Height/width ratios of the shell (H/W) and aperture (h/w) were calculated. Measurements were taken with calibrated eye-piece to the nearest 0.01 mm. Major and minor diameter of eggs (a, b) were measured to the nearest 0.01 mm, and a/b ratio was calculated. Growth rate of juveniles brought from the field and those obtained in the laboratory was monitored.

RESULTS

The species composition of the snail community in the locality in Zieleniec is shown in Table 1. The accompanying fauna is composed of 25 species, including 3 clausiliids and 6 slugs. Ecologically, the community includes three groups: forest-dwellers (majority), euryoecious species and hygrophiles (Fig. 4). Zoogeographically it is composed of European (14 species), Holarctic (6) and Palaearctic (2) species, and one species of each of the remaining categories (Fig. 5). The mean similarity I_N with the Šumava malacocoenoses is 0.52 (0.41–0.68), and that between the Czech and Polish sites – 0.44.

The shells from Zieleniec are spindle-shaped and rather tumid (H/W: 3.56–4.18; mean 3.82), purple--brown, shiny, with rectangular apertures of slightly rounded bottom corners (h/w: 1.08-1.39; mean 1.25) (Table 2). The number of whorls is ca. 10 (N: 9.25–10.5; mean 9.87). The arrangement of folds in the aperture varies widely (Figs 6, 7). The set of three folds is typical (nearly 40% of the shells), shells with 2.5 (two complete and one rudimentary fold) or 2 folds are rather frequent (12.75% and 10.2%, respectively). One specimen in the series has 4 folds; in some instances the folds are connected.

Egg laying in the laboratory was observed from 16 May till 20 June 2008. A total of 19 eggs were produced, in 8 batches (1–3 eggs, mean 2.38) (Table 3). The eggs of *M. badia* are resilient, partly calcified and spherical, sometimes slightly elongated (a/b: 1.00–1.13; mean 1.08) (Fig. 8). Calcium carbonate in the egg envelopes does not form distinct, separate crystals but a more continuous layer. The incubation period ranged from 16 to 19 days (mean 17.2). Hatching was asynchronous and lasted 1–2 days. The hatching success ranged from 0 to 100 (mean 53%). Only three of the snails hatched in the laboratory reached ultimate size (16% of obtained eggs (19) and 30% of juveniles (10)).

Reaching ultimate size by snails brought from the field in October 2007 depended on their size upon collection: individuals with shells of 8 whorls completed their growth at the begining of January 2008 (in ca. 2.5 months), those of 7 whorls – at the end of February (ca. 4 months), those of 6 whorls – at the end of March (ca. 5 months). The growth of individuals hatched in the laboratory to adult size took 7–8 months (2 snails hatched at half of May 2008 finished their growth at half of December, the snail hatched at the beginning of June 2008 – at the end of January 2009).

The temperature had a significant effect on the condition of the snails (at high, constant humidity and food availability). Below 17°C both adults and

Table 1. Malacocoenosis from the site in Zieleniec

Species	Ecological components	Zoogeographic composition
Carychium minimum	hygrophile	Euro-Siberian
Cochlicopa lubrica	euryoecious	Holarctic
Columella edentula	euryoecious	Holarctic
Vertigo pusilla	euryoecious	European
Vertigo substriata	woodland	N and E European
Acanthinula aculeata	woodland	W Palaearctic
Punctum pygmaeum	euryoecious	Holarctic
Discus rotundatus	euryoecious	W and C European
Arion subfuscus	euryoecious	European
Arion silvaticus	woodland	C and NW European
Vitrina pellucida	euryoecious	Holarctic
Eucobresia diaphana	hygrophile	C European
Vitrea diaphana	hygrophile	Carpathian-Alpine
Nesovitrea hammonis	euryoecious	Palaearctic
Oxychilus cellarius	woodland	W European
Limax cinereoniger	woodland	S and W European
Lehmannia marginata	woodland	European
Deroceras leave	hygrophile	Holarctic
Deroceras praecox	woodland	W Carpathian-Sudetes
Euconulus fulvus	euryoecious	Holarctic
Cochlodina laminata	woodland	European
Macrogastra badia	woodland	E Alpine
Alinda biplicata	woodland	C European
Perforatella incarnata	woodland	C and SE European
Trichia hispida	euryoecious	European
Arianta arbustorum	woodland	C and NW European

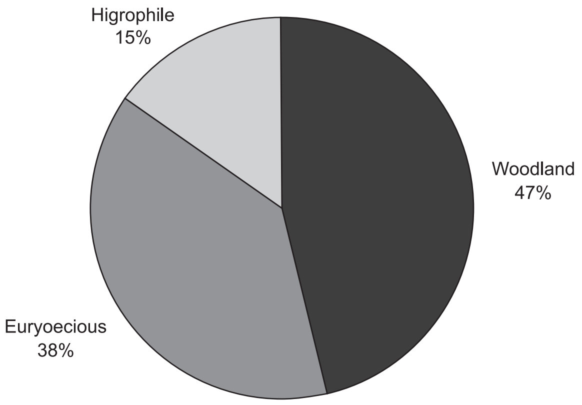

Fig. 4. Ecological composition of the Zieleniec malacocoenosis

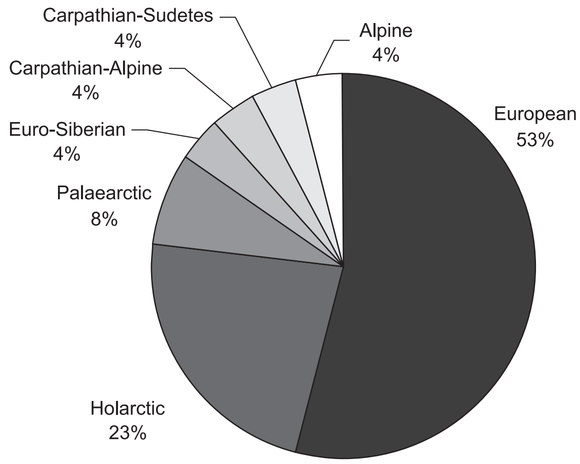

Fig. 5. Zoogeographical composition of the Zieleniec malacocoenosis

Fig. 6. *Macrogastra badia*. Variation in the number of apertural folds. Semi-diagrammatic

Table 2. *Macrogastra badia*. Shell parameters of specimens from the site in Zieleniec (n=39)

	H	W	h	w
Range (mm)	10.8–13.12	2.92–3.28	2.5–2.93	2.07–2.36
Mean	11.88	3.11	2.74	2.18
± SD	0.496	0.08	0.105	0.067
	N	folds	H/W	h/w
Range	9.25–10.5	0.5–4	3.56–4.18	1.08–1.39
Mean	9.87	2.67	3.82	1.25
± SD	0.332	0.719	0.159	0.058

Table 3. *Macrogastra badia*. Egg characters, egg number per batch and incubation period

	Range	Mean	± SD
Egg characters (n = 16)			
Major diameter (a) [mm]	1.39–1.61	1.51	0.089
Minor diameter (b) [mm]	1.32–1.45	1.39	0.039
a/b	1.00–1.13	1.08	0.044
Egg number per batch			
(n = 8)	1–3	2.38	0.744
Incubation period [days]			
(n = 10)	16–19	17.2	0.919

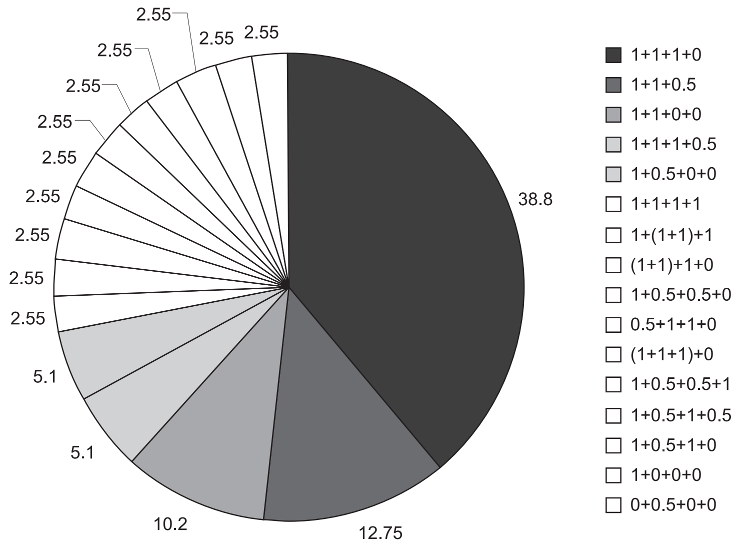

Fig. 7. *Macrogastra badia*. Proportion of various types of fold arrangement

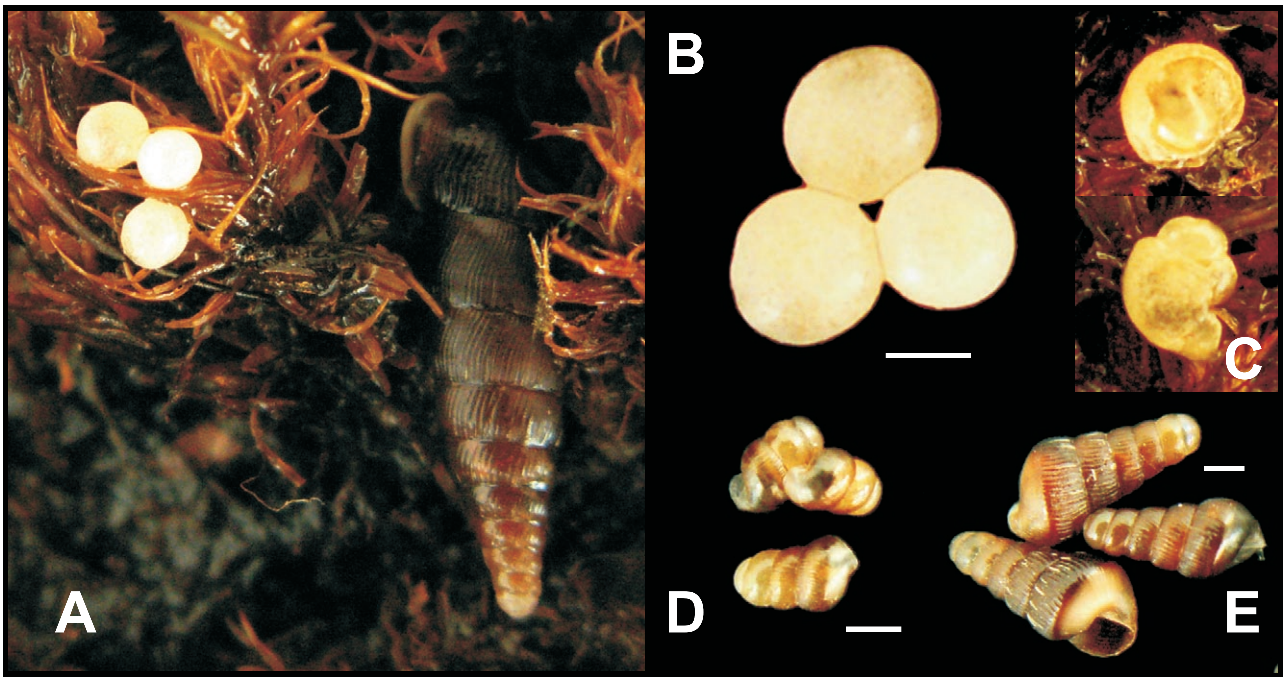

Fig. 8. *Macrogastra badia*: A – egg size versus adult size, B – eggs, C – hatching, D – three-week-old juveniles, E – five-month-old juveniles. Scale bar 1 mm (Photo T. K. MALTZ)

juveniles showed a considerable activity. At higher temperatures they remained hidden (moss, pieces of timber), immobile, retracted deep into their shells. Sometimes single active specimens could be seen early in the morning. When the temperature exceeded 20°C (July–August 2008), the snails showed no activity and soon most of them (70%) died.

DISCUSSION

The newly discovered locality of *M. badia* in Zieleniec, and the earlier Polish and Czech records (LOŽEK 1955, 1956, 1964, WIKTOR 1964, BRABENEC 1973, HLAVÁČ & HORSÁK 2002, HLAVÁČ 2003), form a group of localities which are remote and isolated from the main range of the species; they are located at an altitude of 700 to more than 900 m a.s.l. They are mainly natural deciduous and mixed forests with a considerable proportion of beech and sycamore maple, with rotting logs and a rich herb layer (WIKTOR 1964, 2004b, HLAVÁČ & HORSÁK 2002 and references cited therein). The occurrence of the species seems to be closely associated with the plant community of a composition similar to that in Zieleniec, identified by ŚWIERKOSZ (2003) as *Aceri-Fagetum* and characteristic of the Alps. Such places, located at considerable altitudes (800–900 m a.s.l.), provide adequate conditions: a) lower vegetation-season temperature compared to lower-situated areas, b) considerable humidity ensured by the dense canopy, rotting timber and frequent precipitation, and c) logs and large amounts of litter providing the snails with shelter during the winter. Recently described localities in Šumava (HLAVÁČ & HORSÁK 2002, HLAVÁČ 2003) are located at lower altitudes (720–750 m a.s.l.), but they are close to streams, on northern slopes with frequent thermal inversion. In such conditions *M. badia* can live also in partly open habitats (Debrník stream valley on the Czech-German border), where abundant herbs and stones compensate for the absence of trees and dead timber.

Natural deciduous and mixed forests with conditions favourable for *M. badia* are at present preserved only as small and scattered fragments. Their gastropod faunas vary widely in their composition and it is practically impossible to point to a characteristic malacocoenosis. The literature information is scanty and pertains only to recently described localities (HLAVÁČ & HORSÁK 2002 and literature cited therein, HLAVÁČ 2003). Because of the character of the habitat it is not suprising that forest-dwelling species form a majority. *Semilimax semilimax*, *S. kotulai*, *Malacolimax tenellus*, *Clausilia cruciata* and *Macrogastra ventricosa* (HLAVÁČ & HORSÁK 2002) are regarded as characteristic of the group of localities in Šumava. None of these species has been found in Zieleniec though all live in the Polish part of Central Sudetes (WIKTOR 1964, POKRYSZKO & MALTZ 2007, POKRYSZKO et al. 2008). Forest-dwelling species occurring both in Zieleniec and in Šumava include *Acanthinula aculeata*, *Arion silvaticus*, *Limax cinereoniger*, *Lehmannia marginata*, *Cochlodina laminata*, *Perforatella incarnata* and *Arianta arbustorum* – all common and widely distributed. The accompanying hygrophiles, recorded from Zieleniec but not from Šumava, are *Carychium minimum*, *Vitrea diaphana* and *Deroceras laeve.* Also the I_N values show the small similarity between the malacocoenoses. It can be supposed that *M. badia* is not a part of any definite malacocoenosis and its occurrence is determined solely by the environmental factors. The accompanying malacofauna may represent either an original malacocoenosis which survived in an unchanged habitat (sites in nature reserves in Šumava; HLAVÁČ & HORSÁK 2002), or result from a random colonisation of naturally regenerating human-transformed habitats from adjacent areas (overgrowing montane meadows in Zieleniec) (ŚWIERKOSZ 2003). A similar situation has been observed in the case of fauna accompanying another Alpine clausiliid, *Charpentieria ornata*, in Poland and the Czech republic (MALTZ 2009).

The shell measurements of specimens from Zieleniec do not depart from those reported by LOŽEK (1964), WIKTOR (1964) or HLAVÁČ & HORSÁK (2002) (Table 4). The only essential difference is the number of apertural folds (0.5–4; according to LOŽEK 1956, 1954 it is 1–2, according to KERNEY et al. 1983 – 1–3), and the number of 2–3 folds can be regarded as typical of the discussed population. The arrangement and appearance of apertural lamellae conform to the literature descriptions (LOŽEK 1956, 1964, WIKTOR 1964, 2004a i b, KERNEY et al. 1983).

Published literature contains no information on the life history of *M. badia.* Our laboratory observations show that it is oviparous, like nine other native clausiliids (MALTZ & SULIKOWSKA-DROZD 2008). Its eggs are partly calcified, but – contrary to the situation observed in the other studied native clausiliids – calcium carbonate in the egg envelopes, instead of distinct crystals, forms a more continuous layer. The egg size is similar to those observed for *Cochlodina orthostoma*, *Charpentieria ornata*, *Macrogastra latestriata*, *Clausilia dubia* or *C. pumila* – species of similar shell size (MALTZ & SULIKOWSKA-DROZD 2008). However, the eggs of *M. badia* are more spherical, compared to the eggs of these species, and their form is probably determined by the more compact carbonate layer. The number of eggs per batch is similar to such numbers in *Ch. ornata*, *M. latestriata* or *Clausilia parvula*

Table 4. *Macrogastra badia*. Shell parameters according to various authors

Parameter source	H (mm)	W (mm)	h (mm)	w (mm)	N	Folds
Ložek 1956	12.0–14.0	3.0–3.3	–	–	–	1–2
Ložek 1964	11.5–14.0	3.0–3.3	2.6–2.9	2.1–2.4	10	1–2
Klemm 1964 – N pop.	12.0–13.7	3.02–3.36	–	–	–	–
Klemm 1964 – S pop.	13.02–14.11	3.2–3.53	–	–	–	–
Wiktor 1964	11.0–13.0	3.0–3.5	–	–	–	–
Kerney et al. 1983	12.0–14.0	3.0–3.2	–	–	–	1–3
Wiktor 2004	11.0–14.0	3.0–3.3	–	–	–	–
Hlaváč & Horsák 2002	11.0–13.5	3.0–3.5	–	–	–	–
this study	10.8–13.12	2.92–3.28	2.5–2.93	2.07–2.36	9.25–10.5	0.5–4

(usually 2–3 eggs), and the incubation duration is close to that observed in *Cochlodina laminata*, *Ch. ornata*, *Macrogastra ventricosa* or *M. tumida*. The batches are deposited in tussocks of dense moss or pieces of rotting timber; like other clausiliids observed in the laboratory, *M. badia* shows egg-protecting behaviour (Maltz & Sulikowska-Drozd 2008). The egg-laying period in the labortory includes May and the first half of June; no batches were observed in subsequent months; the other clausiids, when kept at room temperature, lay eggs throughout the year. Probably for the other species room temperature is close to optimum, allowing for a whole-year reproduction. It has been shown that clausiliid reproduction is mainly determined by humidity and temperature (Maltz & Sulikowska-Drozd 2008). These factors are also essential for *M. badia*, but the species prefers lower temperatures (see above – preferred habitats), while higher temperatures act as a limiting factor and are even lethal. The age structure of the sample collected in October indicates that also in the field the reproduction takes place in the spring/early summer. The hatching is asynchronous despite the low number of eggs per batch, a phenomenon observed only in the case of many-egg batches in the other clausiliids (Maltz & Sulikowska-Drozd 2008). The time required to reach adult size in the laboratory is 7–8 months and is close to such time in *Laciniaria plicata*, *Alinda biplicata* or *Balea stabilis* – much larger clausiliids, while species of a shell size similar to *M. badia* (e.g. *M. latestriata* or *M. tumida*) take only 3.5–4.5 months to complete their growth (Maltz & Sulikowska-Drozd 2008). Our field and laboratory observations suggest that in the wild *M. badia* reproduces in May and June, and the juveniles reach 6–8 whorls before wintering, to complete their growth in the summer/autumn next year. They start reproducing in the third year of life. A similar situation has been observed for *Vestia gulo* in a locality in the Pieniny Mts (ca. 425 m. a.s.l.) (Drozd 2007), though the species has been found to grow much slowler in higher-situated localities (ca. 700 m. a.s.l., the Gorce Mts.). Low temperature is for this species the limiting factor which extends the growth period, whereas for *M. badia* it is crucial for survival and reproduction. The biology of the species requires further, more detailed observations both in the field and in the laboratory.

The analysis of literature data on the distribution of *M. badia* (especially altitudinal) in Poland and the Czech Republic, and the data from field and laboratory observations on its biology indicate that the snail is cold-loving and its isolated localities in the Kłodzko region and Šumava are remains of an erstwhile, wider distriution range. According to Ložek (1955) the northward extension of the distribution from the Alps could take place during the cooler Pleistocene phases, when montane habitats retreating from higher altitudes came to occupy increasingly larger areas of uplands and lowlands. According to Wiktor (1964) *M. badia* spread northward during the second or third interglacial. There is no Pleistocene subfossil record which could confirm such hypotheses (Ložek 1955, 1963). It seems more likely that the species arrived during an early post-glacial period, with the northward expansion of cold-loving trees (including plant communitis resembling herb-rich beech forests) which occupied lower-situated areas. During the climatic optimum, with the expansion of thermophilous trees (Stworzewicz 1989), the cold-loving formations started to retreat from the lowlands and were preserved only at higher altitudes (i.a. in the Sudetes or Šumava). Considering the preferences of *M. badia* it seems unlikely that it spread northward during the warm Atlantic period, as suggested by Brabenec (1973). It was probably then that the present territory of Poland was reached by such Alpine clausiliids as *Cochlodina costata* and *Charpentieria ornata*; at least the latter species is known to be a thermophile (Maltz 2009).

M. badia is endangered in all its relic localities, both in Poland and in the Czech Republic (Juřičková et al. 2001, Wiktor & Riedel 2002, Wiktor 2004b). The reasons should be sought in the specific ecological requirements of the species (natural forests at higher altitudes), the structure of this part of its range (few, isolated and scattered populations as a result of disappearance of such forests), climatic changes and anthropogenic destruction or structural changes in forests, and in recent years also with the development of tourism and winter-sports centres (Zieleniec). Legal protection of *M. badia* since 2004 has not and will not solve the problem. Habitat protection is the only way of preserving the species in Poland. Its localities should become nature reserves (postulated by WIKTOR 2004b), ecologically valuable areas, or be included in the Special Division of State Forests, which would prevent the habitats from being managed (postulated by ŚWIERKOSZ, 2003). It seems likely that felling of a part of spruce plantations near Zieleniec and Duszniki, with a subsequent natural expansion of herb-rich beech forest, would greatly contribute to improvement of the condition of the population of *M. badia*.

ACKNOWLEDGEMENTS

We are grateful to Prof. dr hab. ANDRZEJ WIKTOR for his help when preparing this publication.

REFERENCES

BOLE J., SLAPNIK R. 1997. Zoogeographische Analyse der Landschnecken des alpinen Gebietes Sloweniens (Gastropoda: Pulmonata). Malac. Abh. 18 (26): 271–276.

BRABENEC J. 1973. Ein Beitrag zur Verbreitung der Alpenclausiliide *Iphigena badia crispulata* (Westerlund). Arch. Moll. 103: 93–96.

CAMERON R. A. D., POKRYSZKO B. M. 2005. Estimating the species richness and composition of land mollusc communities: problems, consequences and practical advice. J. Conch. 38: 529–547.

DROZD A. 2007. Life cycle of *Vestia gulo* (E. A. Bielz, 1859) (Pulmonata: Clausiliidae). Folia Malac. 15: 123-124.

HLAVÁČ Č. J. 2003. Měkkýši přírodní rezervace Městišaské rokle na Šumavě (Česká republika) – II. Revizní malakocenologický výzkum. Silva Gabreta 9: 105–112.

HLAVÁČ Č. J., HORSÁK M. 2002. Rozšíření plaů *Macrogastra badia* a *Laciniaria plicata* (Gastropoda: Pulmonata: Clausiliidae) na Šumavé. Silva Gabreta 8: 191–204.

JUŘIČKOVÁ L., HORSÁK M., BERAN L. 2001. Check-list of the molluscs (Mollusca) of the Czech Republic. Acta Soc. Zool. Bohem. 65: 25–40.

KERNEY M. P., CAMERON R. A. D., JUNGBLUTH J. H. 1983. Die Landschnecken Nord- und Mitteleuropas. Verlag Paul Parey, Hamburg–Berlin.

KLEMM W. 1969. Der Rassenkreis *Iphigena* (*Macrogastra*) *badia* (C. Pfeiffer, 1828). Arch. Moll. 99: 133–155.

LOŽEK V. 1955. Měkkýši československého kvartéru. ČAV, Praha.

LOŽEK V. 1956. Klíč československých měkkýšů. SAV, Bratislava.

LOŽEK V. 1964. Quartärmollusken der Tschechoslowakei. ČSAV, Praha.

MALTZ T. K. 2009. *Charpentieria* (*Itala*) *ornata* (Rossmässler, 1836) (Gastropoda: Pulmonata: Clausiliidae) on the northern fringes of its range – a nationally endangered species surviving due to human activites. J. Conch. 39: 627-642.

MALTZ T. K., SULIKOWSKA-DROZD A. 2008. Life cycles of clausiliids of Poland – knowns and unknowns. Ann. Zool. 58: 857–880.

POKRYSZKO B. M., CAMERON R. A. D. 2005. Geographical variation in the composition and richness of forest snail faunas in northern Europe. Records of the Western Australian Museum, Supplement, 68: 115–132.

POKRYSZKO B. M., MALTZ T. K. 2007. Rare and endangered terrestrial gastropods of Lower Silesia (SW. Poland) – current status and perspectives. Acta Univ. Latv. 723: 7–20.

POKRYSZKO B. M., MALTZ T. K., WIKTOR A. 2008. Mięczaki. In: WITKOWSKI A., POKRYSZKO B. M., CIĘŻKOWSKI W. (eds), Przyroda Parku Narodowego Gór Stołowych. Wydawnictwo PNGS, Kudowa-Zdrój, pp. 210–220.

RIEDEL A. 1988. Ślimaki lądowe Gastropoda terrestria. Katalog Fauny Polski 46. PWN, Warszawa.

ROZPORZĄDZENIE MINISTRA ŚRODOWISKA z dnia 28 września 2004. Dziennik Ustaw Nr 220: pozycja 2237.

STUPNICKA E. 1989. Geologia regionalna Polski. Wydawnictwo Geologiczne, Warszawa.

STWORZEWICZ E. 1989. Ślimaki Gastropoda. In: KOWALSKI K. (ed.). Historia i ewolucja lądowej fauny Polski, pp. 43–67. Folia Quaternaria 59–60: 1–265.

ŚWIERKOSZ K. 2003. Godny ochrony fragment buczyny ziołoroślowej *Aceri-Fagetum* J. Bartach & M. Bartach 1940 w Zieleńcu (Góry Bystrzyckie, Sudety Środkowe). Przyr. Sud. Zach. 6: 67–72.

WALCZAK W. 1968. Sudety. PWN, Warszawa.

WIKTOR A. 1964. Mięczaki Ziemi Kłodzkiej i gór przyległych. Studium faunistyczno-zoogeograficzne. Prace Komisji Biologicznej, PTPN, 29: 1–132.

WIKTOR A. 2004a. Ślimaki lądowe Polski. Mantis, Olsztyn.

WIKTOR A. 2004b. Świdrzyk kasztanowaty *Macrogastra badia* (C. Pfeiffer, 1828). In: GŁOWACIŃSKI Z., NOWACKI J. (eds), Polska czerwona księga zwierząt. Bezkręgowce. Institute of Nature Conservation of the Polish Academy of Sciences in Cracow & The August Cieszkowski Agricultural University of Poznań, Kraków, pp. 330–331.

WIKTOR A., RIEDEL A. 2002. Ślimaki lądowe Gastropoda Terrestria. In: GŁOWACIŃSKI Z. (ed.), Czerwona lista zwierząt ginących i zagrożonych w Polsce. Institute of Nature Conservation of the Polish Academy of Sciences, Kraków, pp. 29–33.

Received: April 1st, 2009
Accepted: May 27th, 2009