FOLIA MALACOLOGICA
Vol. 8(3): 233–237
ISSN 1506-7629
The Association of Polish Malacologists
& Faculty of Biology, Adam Mickiewicz University
Poznań 2000

TENTACLE REGENERATION IN *PLANORBARIUS CORNEUS* (LINNAEUS, 1758) AND *CEPAEA HORTENSIS* (O. F. MÜLLER, 1774) (GASTROPODA: PULMONATA)

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ABSTRACT: Tentacle regeneration in *Planorbarius corneus* (L.) and *Cepaea hortensis* (O. F. Müll.) is found to depend on the extent of injury and the season; the regeneration time is longer in the stylommatophoran *Cepaea* than in the basommatophoran *Planorbarius*.

KEY WORDS: *Planorbarius corneus, Cepaea hortensis*, tentacle, regeneration

INTRODUCTION

Anomalies are rather rarely observed in gastropods. They mostly involve the shell, however they may also be found in soft body parts as malformations of reproductive organs (POLUSZYŃSKI 1910, 1911, FELIKSIAK 1950), mantle (SIMROTH 1905, BOETTGER 1956) and terminal section of foot (WIKTOROWA 1962, JACKIEWICZ et al. 1998).

Fairly much attention was paid to abnormal tentacle structure. The anomalies observed by various authors were: a single tentacle in the head centre (WÄCHTLER 1929, CHETAIL 1958, MALICKY 1964, JACKIEWICZ 1969), two tentacles arising from a single base (TECHOW 1910, HOFMANN 1912), partly fused tentacles situated in the head centre (RÖMER 1903) or bifurcated tentacles (JACKIEWICZ 1969, JACKIEWICZ et al. 1998). Tentacle anomalies were experimentally induced by amputation (TECHOW 1910, CARRIE'RE, after HOFMANN 1912). Variation of abnormally developed tentacles in gastropods, both in nature and in experimental conditions (TECHOW 1910, HOFMANN 1912) is noteworthy.

The aim of this study was to observe the regeneration of amputated tentacles in two pulmonate species: a freshwater basommatophoran *Planorbarius corneus* (Linnaeus, 1758) and a terrestrial stylommatophoran *Cepaea hortensis* (O. F. Müller, 1774). An attempt was made at identifying factors affecting the way and rate of regeneration, and tracing the dependence between the regeneration and possible anomalies.

MATERIAL AND METHODS

One hundred individuals of *Planorbarius corneus* (L.) were collected in a pond at Dębina near Poznań (Poland). Forty specimens of *Cepaea hortensis* (O. F. Müll.) were found at the citadel in Poznań. Only adult specimens were selected for the experiments. They were kept in the same conditions of temperature, illumination and food. The tentacles were amputated completely or at half length in the spring (June) and autumn (October). The number of individuals in each experimental series is given in Tables 1–4. The regeneration began about five days after the amputation. The process was carefully observed under a stereomicroscope. Each specimen was controlled 2–3 times per week.

Table 1. Regeneration of half amputated tentacles in *Planorbarius corneus*

Time of regeneration (days)	Number of specimens						
	Tentacle amputation date			Total	Tentacle amputation date		Total
	5 June	30 June	30 June		15 October	25 October	
15	–	–	–	–	2	–	2
16	1	–	–	1	–	5	5
19	–	6	–	6	–	–	–
20	–	–	1	1	2	3	5
21	5	–	–	5	–	–	–
23	3	–	–	3	–	–	–
24	–	2	1	3	1	–	1
25	–	–	1	1	–	–	–
26	–	–	7	7	–	–	–
27	–	–	–	–	4	–	4
30	–	–	–	–	–	1	1
no regeneration	1	2	–	3	1	1	2
Total	10	10	10	30	10	10	20

Table 2. Regeneration of completely amputated tentacles in *Planorbarius corneus*

Time of regeneration (days)	Number of specimens						
	Tentacle amputation date		Total	Tentacle amputation date			Total
	5 June	30 June		11 October	8 November	11 November	
14	5	–	5	–	–	–	–
15	2	–	2	–	3	1	4
17	1	–	1	1	–	–	1
19	–	6	6	–	–	–	–
20	–	–	–	1	1	–	2
22	–	–	–	1	2	3	6
23	2	–	2	–	–	–	–
24	–	–	–	1	–	–	1
30	–	–	–	1	1	4	6
33	–	–	–	–	–	2	2
36	–	3	3	–	–	–	–
37	–	–	–	2	–	–	2
41	–	–	–	3	2	–	5
no regeneration	–	1	1	–	1	–	1
Total	10	10	20	10	10	10	30

RESULTS AND DISCUSSION

Regeneration of a half-amputated tentacle in *P. corneus* lasted 16–26 days in the spring and 15–30 days in the autumn (Table 1). Regeneration of tentacles which were completely amputated was completed in 14–36 days in the spring and in 15–41 days in the autumn (Table 2). In both the spring and the autumn series the regeneration time varied individually within a considerable range. The regenerated half-amputated tentacles were only slightly different from the normal ones (Figs 1, 2); the regenerated wholly amputated tentacles were always thinner, shorter and less pigmented than the normal ones, and sometimes almost translucent (Fig. 3). In seven specimens no regeneration took place.

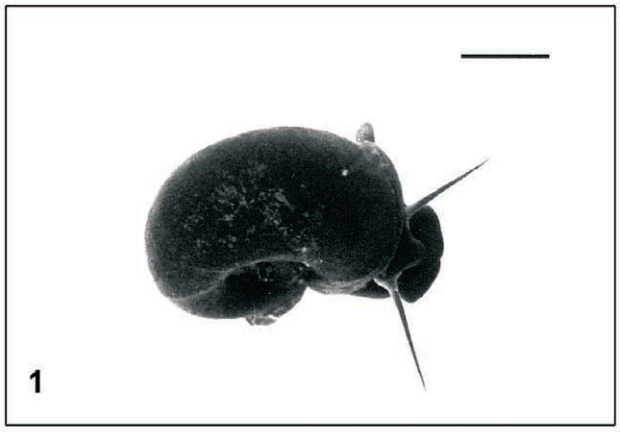
The regeneration time was somewhat longer in the autumn. At that time of year, some individuals of *P. corneus* laid egg masses on the aquarium wall. The energy expenditure implied by the egg-laying may be responsible for the slower regeneration.

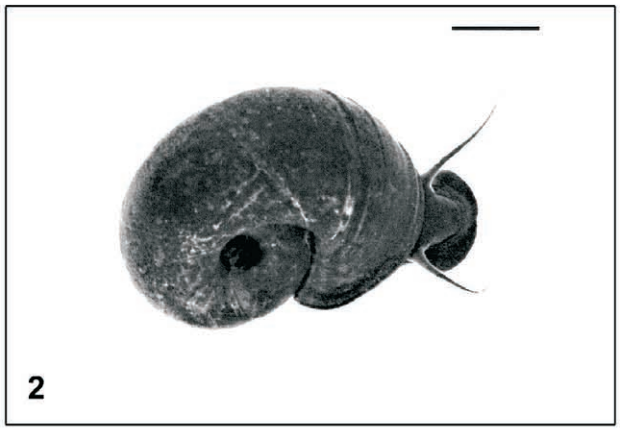
Regeneration in *C. hortenis* in the spring lasted 110–130 days, irrespective from the degree of amputation. Only two individuals showed no sign of regeneration (Tables 3, 4). In the autumn, the regeneration time was 79–82 days; seven specimens did not regenerate their tentacles (Tables 3, 4). The individual variation in the regeneration time in both the spring and autumn series was slight. The regenerated tentacles amputated at half length and those amputated completely were never as long as the normal ones (Figs 4–11). The eye and tentacle retractor muscle regenerated in almost all the individuals of *C. hortensis* that regenerated the amputated tentacle.

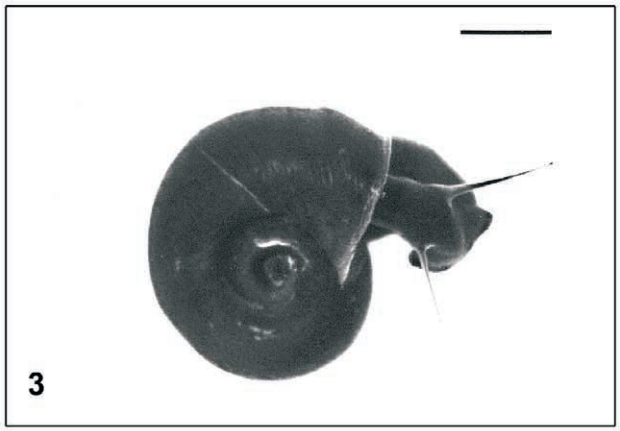
The slower regeneration rate in the spring may be explained by the spring reproductive season of *C. hortensis* requiring energy expenditure.

The longer regeneration time in *C. hortensis* compared to *P. corneus* undoubtedly results from the more complicated tentacle structure in stylommatophoran gastropods (FISCHER et al. 1968).

Though no individual of *C.hortensis* or *P. corneus* regenerated the amputated tentacle completely, i. e. to a degree identical with a normal tentacle, there were no abnormally regenerated tentacles, contrary to what was reported for some other species (TECHOW 1910, CARRIE'RE in HOFMANN 1912). It is likely that abnormal tentacles result from autogenic disorders rather than mechanical damage.







Figs 1–3. Tentacle regeneration in *Planorbarius corneus*: 1 – specimen with normally developed tentacles, 2 – specimen with right tentacle regenerated after amputation at half length, 3 – specimen with right tentacle regenerated after complete amputation

ACKNOWLEDGEMENT

The author is grateful to M. DRYTKIEWICZ, M. Sc., and B. JAKUBOWSKA, M. Sc., for their help in snail rearing.

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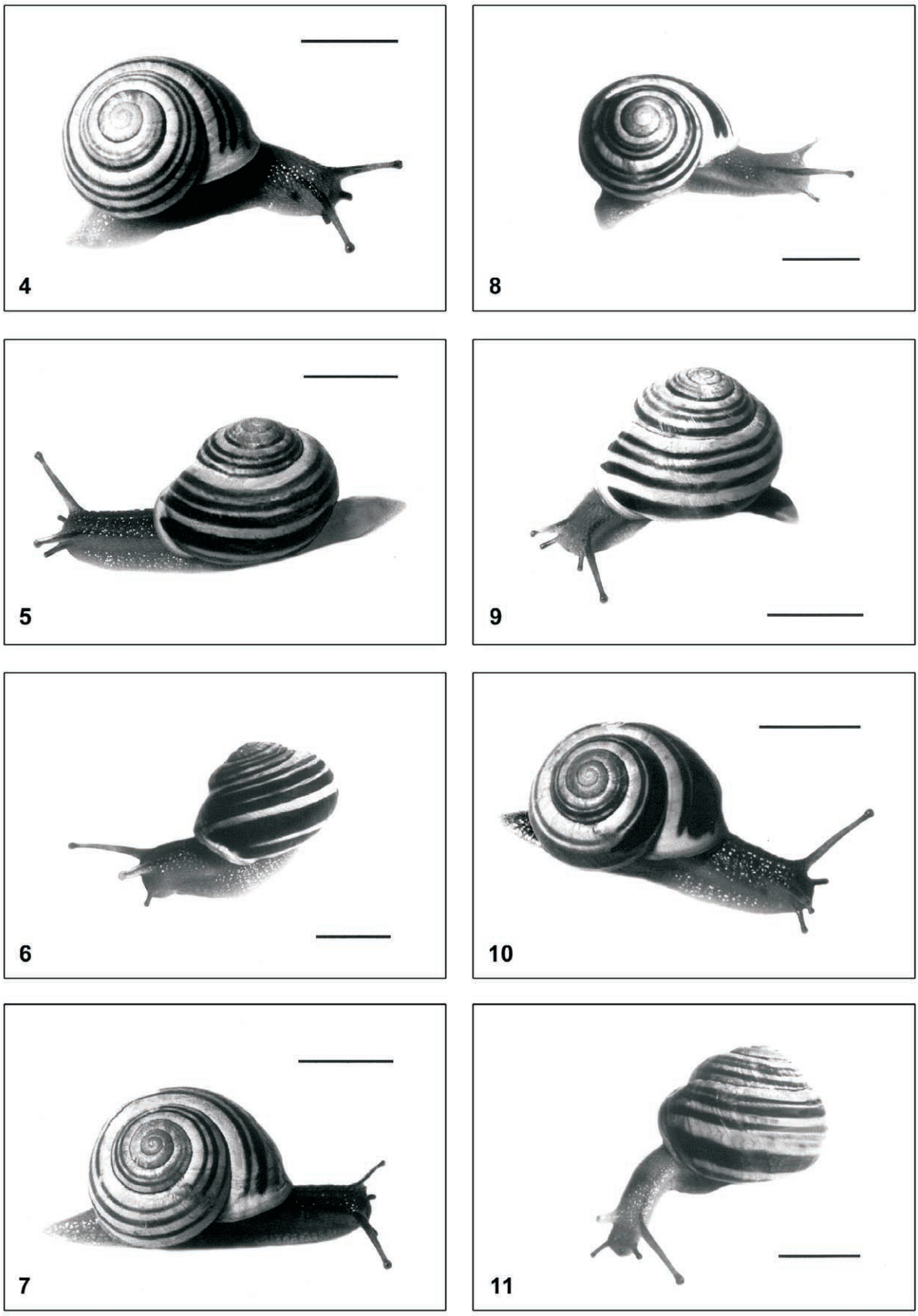

Figs 4–11. Tentacle regeneration in *Cepaea hortensis*: 4 – specimen with normally developed tentacles, 5–7 – specimens with left tentacle regenerated after amputation at half length, 8–11 – specimens with tentacles regenerated after complete amputation

Table 3. Regeneration of half amputated tentacles in *Cepaea hortensis*

Time of regeneration (days)	Number of specimens		
	Tentacle amputation date		Total
	15 June	15 October	
79	–	1	1
80	–	3	3
81	–	–	–
82	–	2	2
110	–	–	–
120	2	–	2
122	1	–	1
125	2	–	2
127	1	–	1
129	1	–	1
130	1	–	1
no regeneration	2	4	6
Total	10	10	20

Table 4. Regeneration of completely amputated tentacles in *Cepaea hortensis*

Time of regeneration (days)	Number of specimens		
	Tentacle amputation date		Total
	15 June	15 October	
79	–	–	–
80	–	1	1
81	–	2	2
82	–	4	4
110	1	–	1
120	–	–	–
122	–	–	–
125	4	–	4
127	2	–	2
129	2	–	2
130	1	–	1
no regeneration	–	3	3
Total	10	10	20

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received: May 15th, 2000
accepted: August 25th, 2000