EKOLOGIJA. 2005. Nr. 3. P. 28–33

Characteristic of lifespan and reproduction period of *Succinea putris* (L.) (Gastropoda: Styllomatophora)

Ingrida Ðatkauskienë

Department of Biology,
Vytautas Magnus University,
K. Donelaièio 58, LT-44248 Kaunas,
Lithuania,
E-mail: bbinci@vaidila.vdu.lt

The purpose of this study was to observe the lifespan, period of reproduction, characteristics of clutches and eggs, duration of embryo development of *Succinea putris* (L.) reared under laboratory and natural conditions in Lithuania. The lifespan of *S. putris* under laboratory conditions varies from 13 to 17 months. The period of mating continues from March to September–October in the field, whereas under laboratory conditions it is life-long. The average number of eggs in the clutch is 48 ± 12.11 in natural biotopes and 12.7 ± 6.77 under laboratory conditions. The development of embryos from eggs to juveniles lasts 10–20 days in the first and 30 days in the second laboratory snail generation. The development of juveniles to sexual maturity lasts 10 months under laboratory conditions. The study has shown that laboratory conditions exert an influence on the reproduction, development and growth of *S. putris*.

Key words: *Succinea*, Gastropoda, reproduction, development

INTRODUCTION

Succineidae are distributed almost everywhere in the world (Kerney, Cameron, 1979). The taxonomy and ecology of different species of Succineidae has been mostly studied in the United States, Hawaii, New Mexico (Patterson, 1971; Hubricht, 1972; Solem, 1976; Hubricht, 1985; Hoagland, Davis, 1987; Wu, 1993; Rundell, Cowie, 2003). Data on the ecology and life history of the Succineidae in Europe are scarce. Rigby (1964) reported some data on the histology, functional morphology and some aspects of life history of *Succinea putris* (Linnaeus, 1758).

Four species of the family Succineidae are found in Europe and in Lithuania. These are *S. putris*, *Succinella oblonga* (Draparnaud, 1801), *Oxyloma sarsii* (Esmark, 1886), *Oxyloma elegans* (Risso, 1826) (Kerney, Cameron, 1979; Šivickis, 1960; Gurskas, 1997).

S. putris is one of the most abundant species in Lithuania. Despite its wide distribution and importance as an intermediate host of *Leucochloridium* spp., there are no published studies on its biology. The literature has yielded only data on *S. putris* distribution and morphology (Ðivickis, 1967; Gurskas, 1987). Information on the life history of Lithuanian terrestrial pulmonates is scarce (Èinikaitë, 1998).

In this study, a short survey on the life history of *S. putris* reared in the laboratory is presented. The influence of laboratory conditions on its growth, reproduction and lifespan are also reported. In addition to this laboratory study, a number of general observations on the life history of *S. putris* are described from a field study.

MATERIALS AND METHODS

Specimens of *S. putris* (42 adults) were collected from one population near Domeikava village (biotope: *Alnus glutinosa – Coryllus avellanus – Arctium tomentosum – Aegopodium podagraria*) in Kaunas district, Lithuania in 2003–2004. The snails were kept in laboratory in transparent boxes (14 × 12 × 6 cm) containing soil from natural habitats. In deep autumn and winter, the soil was supplemented with a small amount of calcium carbonate. Pieces of barks, leaves of plants were put in the boxes to shelter the snails and their eggs. The snails were kept under a natural day/night light cycle at 20 °C and humidity of 80%. The deviation from natural conditions did not allow the snails to hibernate, and they were active in all the seasons. The snails were fed with lettuce, carrots and cucumbers. During the warm season the molluscs were additionally fed with plants from natural habitats: *Urtica dioica, Arctium tomentosum, Aegopodium podagraria*. The snails were examined 2–3 times per week.

S. putris was identified considering their shell, jaw morphology and the anatomy of the reproductive tract. Part of individuals (n = 22) was used for anatomical analysis and others (n = 20) for breeding in the laboratory. Snails (adults) (n = 20), collected in the field, were designated as native individuals. The

generation of snails (their parents were native snails from the field) (n = 30) hatched and grown in the laboratory was designated as F1. The generation of laboratory snails (n = 25) hatched from the eggs of F1 was designated as F2.

In total, 75 individuals of *S. putris* were surveyed under laboratory conditions.

Eggs and hatched juveniles were examined using a MÁÑ-9 stereoscopic binocular microscope. The size of the eggs and juveniles was evaluated using a stage micrometer**.** Adult individuals were measured with calipers (shell length × width, mm).

Fragmentary observations (mating of snails, egg-laying sites, the number of eggs per clutch, hibernation, snail size measurements) were made in the same natural population during a period from spring to autumn (from 1996 to date).

Descriptive statistics have the format: mean ± SD (sample size; Minimum, Maximum). The reliability of data was evaluated by using Student's t test. Statistically significant difference was accepted at $p < 0.05$.

RESULTS AND DISCUSSION

Lifespan

The lifespan of *S. putris* under laboratory conditions varied from 13 to 17 months. The lifespan of most snails of F1 generation (n = 20) reared under laboratory conditions was 13 months (Fig. 1). The lifespan of some individuals reached 15 (n = 8) and 17 months (n = 2). In the latter case, snail individuals did not reproduce during the last two months of their life.

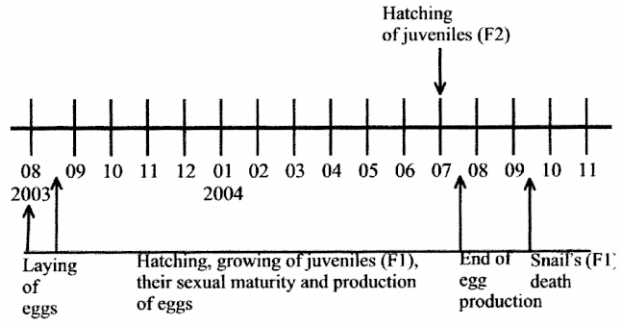

Fig. 1. Lifespan of *S. putris* under laboratory conditions

The lifespan of *S. putris* in the field was not determined exactly. Peake (1978) reported that a major constraint to studies of life history of terrestrial molluscs had been imposed by the procedures of obtaining the data; for example, measuring a sample of a population at regular intervals throughout the year. In the present study, on the basis of snails (eggs, juveniles and adults) found at various stages and various times in a natural population, it has been estimated that the lifespan of *S. putris* in the field can vary from 15 to 20 months. These variations were probably predetermined mainly by the long period of egg production, which consequently led to the hatching of juveniles and sexual maturity to start at various times and by the Lithuanian climatic conditions.

This study revealed that the juveniles that hatched at the end of March or beginning of April reached sexual maturity at the end of August and beginning of September; they hibernated, reproduced in the second spring or beginning of summer and died thereafter. In this case the lifespan of *S. putris* was about 15 months (Fig. 2.).

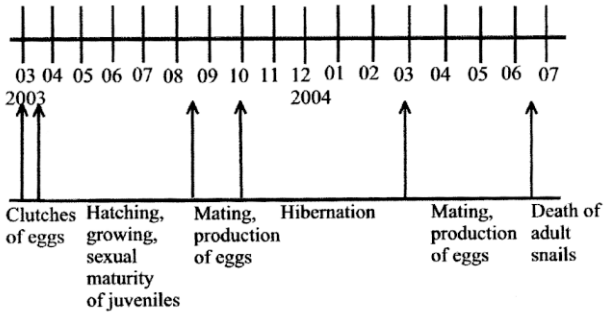

Fig. 2. Plausible scheme of the 15-month lifespan of *S. putris* in the field

This scheme of life history is supported by findings such as copulation of snails in March and clutches of eggs with full-developed embryos at the beginning of April. In addition, some adult individuals collected in the field in March–April reproduced in the laboratory and started to die in June.

On the basis of some observations it is possible to suppose that the lifespan of some molluscs could be as long as 20 months. According to this scheme, the juveniles that hatched at the beginning of September hibernated and reached sexual maturity in the summer of the next year. They can reproduce, hibernate for the second time and reproduce once again. In this case, the lifespan of the molluscs can reach up to 20 months (Fig. 3).

This scheme of life history is supported by intensive mating (3 pairs in 1 m^2) of *Succinea* in natural biotopes in August. Clutches of eggs were laid and

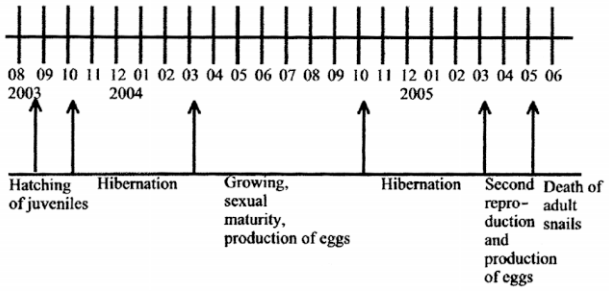

Fig. 3. Plausible scheme of the 20-month lifespan of *S. putris* in the field

juveniles hatched at the end of August and at the beginning of September. Juveniles (4–5 mm) and adults were found after hibernation. Another confirmation that the lifespan could be longer than 15 months comes from the finding that two laboratory individuals survived for 17 months. The generalization of Boycott (1934) on the life cycles of terrestrial molluscs that "all are normally annuals with a life of 9–15 months" was misleading (Mordan, 1978). As the literature on succineids is scarce, comparison with other stylommatophorans is necessary. Frömming (1954) states that the lifespan of *Oxychilus allarius* (Miller) is about two years and that *O. draparnaudi* (Beck) reaches maturity in 18–19 months. Rigby (1964) noted that "occasionally specimens of 18.5 mm are found during the early summer and these seem to be specimens who have survived two winters".

The lifespan of *S. putris* under laboratory conditions was shorter than that of wild molluscs and varied from 13 to 17 months. The shorter lifespan could be explained by the impact of laboratory conditions (stress, small territory, etc.). Umiñski (1975) demonstrated that life cycle length within a species might vary considerably over quite short distances, presumably in response to climatic changes. A second explanation of the shorter lifespan in the laboratory is consistent with the fact that snails lived without hibernation and permanently reproduced. These observations are in good agreement with reports of Rigby (1964) who proposed the average length of life of *S. putris* to be 15 months.

In agreement to these reports, the present observations favour a cycle length greater than 13 months for the *S. putris* under laboratory conditions and greater than 15 months in the field. Nevertheless, to obtain more precise details further investigations are required.

Variations of life length are possible as land molluscs show a plasticity of their life cycles. Marked changes in fecundity, growth rate, and onset of maturation are known to occur within a species in response to often quite local environmental differences (Umiñsky, 1975, Mordan, 1978).

Mating

Under laboratory conditions most intensive mating of *S. putris* was observed from March to May. Because the laboratory snails were kept without hibernation, in them mating and egg production were observed from January to February.

Intensive mating (3 couples of snail in 1 m^2) of *S. putris* was observed in the same natural population (3 couples × 1 m^2) at the end of March when the temperature was about +10 °C, and at the beginning of August. A lower number of mating pairs (approximately 1 couple in 1 m^2) was observed in September–October. These observations showed that the mating period in the field populations lasted from March–April to September–October. The mating of *S. putris* depends on climatic conditions: if March and April are cold (average temperature about +3 °C), the mating can start only in May. This is in good agreement with the observations of Rigby (1964) who reported that the breeding season of *S. putris* starts on May and lasts until the end of October. During this period, snails can be observed associated in pairs in the field as well as in captivity. In addition to Rigby (1964), observations of the present study showed that the breeding season of *S. putris* in the field could also start early (in March–April). Moreover, the reproduction period of *S. putris* under laboratory conditions was prolonged. These results disagree with Rigby (1964) that the reproductive activity of *S. putris* declines after about five days under laboratory conditions, in spite of the fact that the animals may remain alive for several weeks.

Eggs

After mating, snails laid eggs during 2–6 days under laboratory conditions. The eggs commonly were laid under leaves, pieces of bark or on the surface of soil, but not in cavities in the soil as it happens in other mollusc species. If no shelter was present eggs were found fixed on walls of the boxes. Clutches of eggs in natural biotopes were found in similar places: under stones, leaves and barks.

The eggs in the clutches were round, transparent, lacking any calcium inclusions, conglutinated and enveloped with a jelly-like substance.

The average size of the eggs of *S. putris* under laboratory conditions and in natural biotopes was 1.25 ± 0.04 mm in diameter (n = 20; Min = 1.11 mm; Max = 1.3 mm).

The average number of eggs per clutch in the natural biotopes was 48 ± 10.9 mm (n = 28; Min = 25 mm; Max = 65 mm) and in the laboratory 12.7 ± 6.51 mm (n = 14; Min = 6 mm; Max = 25 mm).

The number of eggs in the first clutches of laboratory snails was significantly different ($p < 0.001$) from that of snails found in natural biotopes. There might be several possible explanations of this difference. First of all, laboratory conditions (temperature, humidity, size territory, etc.) exert a significant influence on the development, sexual maturation and egg production, even if laboratory conditions are similar to natural ones. Baur and Baur (1992) reported that characteristics of several life cycles of *Balea perversa* were a function of population density. For example, at a high density sexual maturity required more time and was reached with a smaller body size, while the number of eggs in the clutch decreased. Secondly, the lower number of eggs in the clutches may be related to the diet of *S. putris*. Several studies on other pulmonates reported a positive re-

lation between the nutritional value of the food and the number of produced eggs (Smith, Carefoot, 1967; Wolda, Kreulen, 1973; Jordaens et al., 1998). Thirdly, the differences in clutch size can be explained by variations of body size between laboratory and field snails (Wolda & Kreulen, 1973; Oosterhoff, 1977; Jordaens, 1998). Indeed, the growth of laboratory snails was slower and the size of their body was smaller.

Because of transparency of the eggs, it was possible to determine the size of the embryos and thus to judge when the eggs had been laid. Under laboratory conditions, the size of embryos in freshly laid eggs was 0.2 ± 0.005 mm (n = 35; Min = 0.18 mm; Max = 0.22 mm). Eight to ten days later they reached 0.5 ± 0.033 mm (n = 30; Min = 0.38 mm; Max = 0.52 mm) and 1 ± 0.013 mm (n = 36; Min = 0.95 mm; Max = 1.2 mm) just before hatching.

As the clutches were laid with intervals of 1–2 days, the development of embryos and hatching of juveniles proceeded at different periods. First clutches of *S. putris* (snails that had been collected in the field and produced clutches in the laboratory) contained more eggs (40–50) than later produced clutches (10–20). These results are based on the fragmentary observations without reliable statistical calculations. To confirm them, further detailed studies are needed. Nevertheless, this observation agrees well witch Kosinska (1980) and Jordaens (1998) results which showed that the clutch size of some snail species (*Arion* and *Deroceras*) decreased witch an increase of clutch number.

Growth of juveniles

Juveniles (F1) hatched 10–20 days after eggs had been laid under laboratory conditions. Such a different duration of development of eggs depends on various conditions: temperature, humidity, and parasites. Freshly hatched juveniles of *S. putris* were white and transparent; their growth was irregular.

To follow the growth of juveniles in the laboratory, F1 individuals were measured during their life (one time per month). The average size of freshly hatched juveniles was 1.2 × 1 mm (length × width). The majority of juveniles (n = 15) reached 4.5 × 2.8 mm in size after 5 months. Nine months after hatching the majority of juveniles (n = 17) were 7 × 4 mm in size; single individuals (n = 3) reached 11 × 5 mm in size. After 12 months the snails (n = 17) were 9.8 × 5 mm and single individuals (n = 3) were 13 × 5 mm. Under laboratory conditions the snails hatched and reached 12 mm in size, matured sexually and laid the first clutch of eggs 10 months after they had been hatched (without hibernation). No external signs of sexual maturation were noticed. Therefore, the mean shell diameter of individuals reared in the laboratory was recorded at the time of first clutch production and used as the indicator of sexual maturity. This criterion was based on observations of Farnesi et al. (1984) and Barientos (1998) data, which showed a strong correlation between gonad maturation and body size in stylommatophores.

The growth of snails in the natural biotopes was more rapid: the snails usually reached sexual maturity before the tenth month. The size of adult molluscs from natural populations and molluscs collected from the same population but reared in laboratory was also significantly different (t test: $p < 0.001$). The average size of wild and laboratory snails measured in July 2004 was 11.30 ± 3.03 mm (n = 33; Min = 5.5 mm; Max = 17.90 mm) × 5.2 ± 1.01 mm (n = 33; Min = 2.9 mm; Max = 7.5 mm) (length × width) mm and 9 ± 2.61 mm (n = 13; Min = 3.2 mm; Max = 13.50 mm) × 5 ± 1.22 mm (n = 13; Min = 1.9 mm; Max = 5.9 mm), respectively.

The development of embryos to juveniles lasted 10–20 days in the first generation (F1) and 30 days in the second generation (F2). In contrast to these results, Rigby (1964) found that development of *S. putris* "in the laboratory takes about twelve days, then all the young snails emerge from gelatinous mass within a few hours of each other". Such discrepancy, first of all, can be related with differences in laboratory conditions in these studies. Secondly, the longer development could be also related to unnatural diet. Variations of development duration were observed also by Jordaens (1998), who has shown that differences in the hatching time of *Arion circumsriptus* from the same clutch can be very large (14 days).

Hibernation

Hibernation of *S. putris* was examined only in the field. In spring (March 2004; snow-broth; day temperatures 5–6 °C above zero, night temperatures 0–1 °C below zero) 5 investigation plots (1 m^2) in natural habitats of *S. putris* were surveyed. Most of hibernated individuals consisted of juveniles having a size from 5 to 8 mm (n = 32). Only a small part (n = 9) of hibernated individuals consisted of adults. Many (30) empty shells (15–20 mm) were found in the same biotopes. Before this hibernation (at the beginning of September 2003), a large abundance (about 10 individuals / m^2) of adult molluscs and their copulation were observed in the same biotopes. Empty shells found in the natural biotopes show that part of adult snails died during the winter. No eggs were found during the hibernation.

The aperture of shells of hibernated snails was covered with a thin, transparent epiphragm. *S. putris* hibernated under mosses, leaves, in upper layers of soil.

At rather low temperatures (+5 °C) when snow lingered in places and soil was still frozen, juveniles of *S. putris* after hibernation started to be ac-

tive more rapidly than adults. Under these conditions juveniles started actively crawling, meanwhile apertures of adults were still covered with the epiphagm.

On the basis of field observations after winter it possible to suggest that *S. putris* hibernates predominantly in the stage of juveniles and rarely as adults. These notes are in good agreement with observations of Rigby (1964). To confirm these notes, further studies are needed.

The results of the present study have shown that:

• the lifespan of *Succinea putris* under laboratory conditions varies from 13 to 17 months. The presumptive lifespan in the field can vary from 15 to 20 months;

• it is mostly juveniles that hibernate and more rarely adult snails (according to the results of one population examined in the field);

• the mating period under laboratory conditions (without hibernation) is elongated and continues till the death of snails. The mating of *S. putris* in the natural biotopes starts in March and continues to September–October;

• the average number of eggs in the clutch in natural biotopes is 48 ± 12.11 and 12.7 ± 6.77 under laboratory conditions;

• the development of embryos to juveniles under laboratory conditions lasts 10–20 days in F1 generation and 30 days in F2 generation;

• the development of juveniles to sexual maturity lasts approximately 10 months under laboratory conditions and less than 10 months in natural populations;

• Laboratory conditions exert an influence on the reproduction, development and growth of *S. putris*.

Received 29 April 2005

References

1. Barrientos Z. Life history of the terrestrial snail Ovachlamys fulgens (Stylommatophora: Helicarionidae) under laboratory conditions. *Rev. Boil. Trop.* 1998. Vol. 46. N 2 San Jos: P. 1–15.
2. Baur A., Baur B. Responses in growth, reproduction and lifespan to reduced competition pressure in the land snail Balea perversa. *Oikos.* 1992. Vol. 63. P. 298–304.
3. Bidart L., Fernandez M., Osorio M., Reynaldo E. Datos reproductyvos de Polymita muscarum muscarum Lea (Mollusca: Pulmonata: Fruticicolidae). *Reporte de investigación del Instituto de Ecológica y Sistemctica.* Academia de Ciencias de Cuba. 1992. Vol. 8. P. 1–8.
4. Boycott A. E. The habitats of land Mollusca in Britain. *J. Ecol*. 1934. Vol. 22. P. 1–38.
5. Èinikaitë I. Kai kuriø sausumos moliuskø rûðiø dauginimosi ir vystymosi ypatumai. *Ekologija*. 1998. Nr. 4. P. 23–26.
6. Dundee D. Notes on habitats and anatomy of the introduced land snails, Rumina and Lamellaxis (Subulinidae). *Nautilus.* 1986. Vol. 100. P. 32–37.
7. Gurskas A. *Lietuvos sausumos sraigës*. Aplinkos apsaugos ministerija, T. Ivanausko zoologijos muziejus. Kaunas, 1997. P. 116.
8. Frömming E. Biologie der mitteleuropäischen Landgastropoden. Berlin, 1954. S. 404.
9. Hoagland K. E., Davis G. M. The succineid snail fauna of Chittenango Falls. *Proc. Acad. Nat. Sci. Phil.* New York: Taxonomic Status with comparison to other relevant fauna, 1987. Vol. 139. P. 465–526.
10. Hubricht L. Endangered land snails of the Eastern United States. *Sterkiana.* 1972. Vol. 45. P. 33–34.
11. Hubricht L. The distribution of the native land mollusks of the eastern United States. *Zoology*. 1985. Vol. 24. P. 191.
12. Jordaens K., Backeljau T., Dongen S. V., Verhagen R. Preliminary observations on the breeding biology of *Arion fasciatus* and *A. silvaticus* (Gastropoda: Pulmonata: Arionidae). *Malak. Abh. Mus. Thierkd.* Dresden, 1998. Bd. 19. N 9. P. 77–88.
13. Kerney M. P., Cameron R. A. D. *A Field Guide to the Land Snails of Britain and North-West Europe*. Collins, London. 1979. P. 288.
14. Mordan P. B. The life cycle of *Aegopinella nitidula* (Draparnaud) (Pulmonata: Zonitidae) at monks wood. *J. Conch*. 1978. Vol. 29. P. 247–252.
15. Patterson C. M. Taxonomic studies of the land snail family Succineidae. *Malac. Rev*. 1971. N 4. P. 131–202.
16. Peak J. Distribution and ecology of the Stylommatophora. p. 429–526. In: V. Fretter, J. Peake (eds.). Pulmonates. Vol. 2. A Systematics, Evolution and Ecology. London: Academic Press, 1978.
17. Rigby J. E. *Succinea putris*: a terrestrial opisthobranch mollusk. *Proc. Zool. Soc. Lond*. 1965. Vol. 144. P. 445–486.
18. Rundell R. J., Cowie H. R. Growth and reproduction in Hawaiian succineid land snails. *J. Moll. Stud*. 2003. Vol. 69. P. 288–289.
19. Solem A. Status of *Succinea ovalis chittenangoensis* Pilsbry, 1908. *Nautilus.* 1976. Vol. 90. N 3. P. 107–114.
20. Šivickis P. Lietuvos moliuskai ir jø apibûdinimas. Vilnius, 1960. P. 351.
21. Umiñsky T. Life cycles in some Vitrinidae (Mollusca, Gastropoda) from Poland. *Annls zool. Warsz*. 1975. Vol. 33. P. 17–33.
22. Wu S. K. Notes on the succineid land snails of New Mexico. *Malac. Rev*. 1993. Vol. 26. P. 91–94.

Ingrida Ðatkauskienë

***Succinea putris* (L.) (GASTROPODA: STYLLOMATOPHORA) GYVENIMO TRUKMËS IR DAUGINIMOSI CHARAKTERISTIKA**

S a n t r a u k a

Straipsnyje apþvelgiama vienos daþniausiø Succineidae ðeimos rûðies *Succinea putris* (L.) gyvenimo trukmës, daugini-

mosi periodø, kiauðiniø ir dëèiø charakteristika, embrionø vystymosi trukmë laboratorinëmis ir gamtinëmis sàlygomis.

Nustatyta, kad *Succinea putris* (L.) gyvenimo trukmë laboratorinëmis sàlygomis kinta nuo 13 iki 17 mënesiø. Gamtiniø moliuskø dauginimosi periodas tæsiasi nuo kovo iki rugsëjo–spalio mën. Laboratorijoje moliuskai dauginasi pastoviai iki þuvimo. Lauko sàlygomis dëtyje nustatyta vidutiniðkai 48 (± 12,11) kiauðiniø ir laboratorinëmis sàlygomis – 12,7 (± 6,77). Pirmos laboratoriniø sraigiø generacijos vystymosi trukmë 10–20 dienø, antros generacijos – 30 dienø. Jaunikliø lytinio subrendimo trukmë laboratorinëmis sàlygomis – 10 mënesiø. Nustatyta, kad laboratorinës sàlygos turi átakos *Succinea putris* (L.) dauginimuisi, vystymuisi ir augimui.

Raktaþodþiai: *Succinea*, Gastropoda, dauginimasis, vystymasis