

Life history of the land snail *Habroconus semenlini* (Stylommatophora: Euconulidae) under laboratory conditions

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Abstract: *Habroconus semenlini* is a micro-terrestrial gastropod native to South America. There are no previous studies on its biology. We studied its pattern of growth, fertility and lifespan under laboratory conditions. For this purpose, 80 snails were either grouped or kept isolated (40 animals in each condition) during their lifetime. Growth is indeterminate and the species is capable of self-fertilization with high reproductive success. Grouped snails had lower fecundity than the animals that were kept in isolation. This species has a short lifespan and only one reproductive period, which characterizes the occurrence of semelparity. Rev. Biol. Trop. 57 (4): 1217-1222. Epub 2009 December 01.

Key words: Growth, land snail, longevity, reproduction, self-fertilization.

Land snails are ecologically and economically important. Many species spread seeds and spores, which can become adhered to their mucus or be eliminated in their feces. In nature they recycle nutrients, especially calcium, and function as bioindicators, since they are sensitive to pollution (Simone 1999). Despite the relevance of the molluscan group, there are few studies on the physiology and biology (Almeida & Bessa 2001, Thomé *et al.* 2006, Meireles *et al.* 2008, Silva *et al.* 2008).

Habroconus semenlini (Moricand, 1846) is a land snail native to South America, with wide distribution in Brazil, Paraguay, Argentina and Uruguay (Simone 2006). They live in woods and forest areas, under rocks and in leaf litter (Veitenheimer-Mendes & Aguiar-Nunes 2001, Veitenheimer-Mendes & Postal 2003), and their life cycle has not yet been studied.

The goal of this study was to investigate the life history of *H. semenlini* its self-fertilization,

fecundity, growth and lifespan under laboratory conditions.

MATERIAL AND METHODS

A group of 50 adult individuals of *H. semenlini*, were collected in the field— Morro do Imperador (21°45'13"-21°46'13" S, 43°21'19"-43°22'15" W)— Juiz de Fora, State of Minas Gerais, Brazil, during summer (January 2008). These animals were reared in the Laboratory of Mollusk Biology, Museum of Malacology "Professor Maury Pinto de Oliveira" at the Federal University of Juiz de Fora. Some specimens were sent to the mollusk collection at the National Museum of Federal University of Rio de Janeiro, State of Rio de Janeiro, Brazil (register MNRJ 12855).

The life cycle of *H. semenlini* was studied from February to July 2008, using recently

hatched animals only. This study was carried out at a temperature of $20^{\circ}\text{C} \pm 2$, relative humidity of $85\% \pm 2$, during natural photoperiod, under laboratory conditions.

Four groups of animals (10 snails each) were kept in larger plastic terrariums (8cm diameter x 6cm deep) during their lifespan (Grouped). The substrate (mulch) was sterilized at 120°C for one hour and then humidified once a day during culture. Animals were fed commercial ration for broilers (SOMA INDÚSTRIA E COMÉRCIO DE ALIMENTOS LTDA[®]), enriched with calcium carbonate at 3:1 (Bessa & Araújo 1995).

Shell diameter measurements were made, with the aid of a caliper (0.05mm precision), to each organism the first day of the study and every 15 days, so growth rates could be studied. The time range to the first reproduction was identified by the presence of hatched animals in the terrariums; throughout the experiment, terrariums were examined for daily hatched animals. In this case, all animals were counted and their day of hatch was scored.

In order to test self-fertilization, 40 recently hatched snails were kept individually isolated in small plastic terrariums (6 diameter x 4cm deep) during their lifespan (Isolated). This group was fed and observed, and reproduction was controlled as previously

described, following Bessa & Araújo (1995). Mortality control was also considered daily through direct observation of Grouped and Isolated animals.

RESULTS

The average growth of Grouped and Isolated *H. semenlini* during their life cycle is shown in Fig. 1. There is a continuous growth after reproduction and for this species can be considered indeterminate.

From the first reproduction event the average size of Grouped and Isolated snails was different (Mann-Whitney=3.62, $p=0.0003$), whereas no significant difference was measured in the first and last days of life (Mann-Whitney=0.16; $p=0.87$ and Mann-Whitney=0.53, $p=0.60$, respectively) (Table 1).

We observed that *H. semenlini* has a capacity of self-fertilization, evidenced by the fact that hatched snails appeared in isolation conditions ($40 \text{ days} \pm 9$). For this species only one reproductive period was observed during their life cycle. Isolated snails have produced a total of 1 332 hatched animals (33.3 hatched animals/snail). For animals kept in groups, reproduction was verified in $32 \text{ days} \pm 3$, which was not significantly different in isolation conditions (Mann-Whitney=1.96, $p=0.08$). During

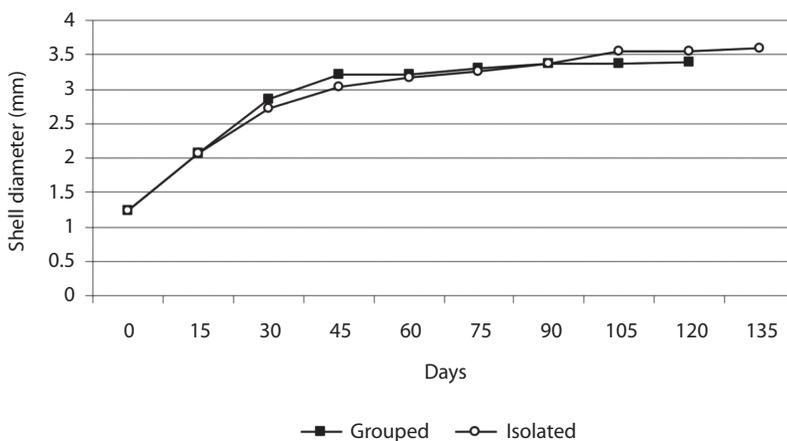


Fig. 1. Average growth of specimens of *Habroconus semenlini* maintained in Grouped and Isolated conditions during their life cycle.

TABLE 1
Size of Grouped and Isolated snails in the first day of life, in the first reproduction event and last day of life (shell diameter (mm) ± SD)

Land Snails	Shell Diameter (Mean ¹ ± std. error of mean)		
	First day of life	First reproduction event	Last day of life
Grouped	1.24a ± 0.23	2.85a ± 0.22	3.4a ± 1.14
Isolated	1.23a ± 0.18	3.00b ± 0.26	3.6a ± 0.16

¹ Treatments with different letters are different at p<0.05.

the life cycle of Grouped animals a total of 1 280 hatched animals (32.0 hatched animals/snail) appeared in all terrariums. However, the total number of hatched animals produced by Grouped snails was significantly lower than that produced by Isolated individuals (Mann-Whitney=9.59, p=0.0001). Table 2 shows the fecundity of *H. semenlini*.

The test of simple linear regression showed significant correlation between shell diameter and number of hatched animals produced (Simple Linear Regression=8, p=0.0009; Fig. 2).

Isolated individuals lived longer than Grouped individuals (Fig. 3). Lifespan was 111.75 days ±6 for Isolated and 77.30 days ± 41.50 for Grouped, but with no statistical difference (Mann-Whitney=0.28, p=0.78).

DISCUSSION

The pattern of indeterminate growth observed in this species has been reported for other tropical land snail species, such as *Leptinaria unilamellata* (d' Orbigny, 1835) and *Bulimulus tenuissimus* (d' Orbigny, 1835) (Almeida & Bessa 2001, Silva *et al.* 2008).

Indeterminate growth is apparently optimal when productivity increases with shell size. Thus, growth after the initiation of egg-laying does not reduce reproductive success, since it is compensated by an increase in body size (Heller 2001).

For this species, there was a high correlation between body size and fecundity. Body weight, shell length and egg production are all correlated in land snails *Subulina octona* (Brugüière, 1789) (D'Ávila & Bessa 2005) and *B. tenuissimus* (Silva *et al.* 2008), which suggests that *H. semenlini* gain reproductive success by breeding when they have reached a larger size.

A relationship between body size and egg production is often assumed. Since eggs are energetically costly, larger individuals should have the capacity to produce more eggs (Ghiselin 1969). Body size can be an important factor in sex allocation since it is an important indicator of resources available and therefore of energy available for gamete production (Norton & Bronson 2006).

Habroconus semenlini was able to reproduce through self-fertilization. This is

TABLE 2
Number of hatched eggs produced by specimens of *Habroconus semenlini* grouped and isolated during their life cycle

Land snails	Productivity				
	Minimum	Maximum	Mode	Mean ¹ ± std. (error of mean)	Coefficient of Variation (%)
Grouped	2	57	5	20.98a ± 13.65	65
Isolate	1	12	3	2.44b ± 0.68	28

¹ Treatment with different letters are different at p<0.05.

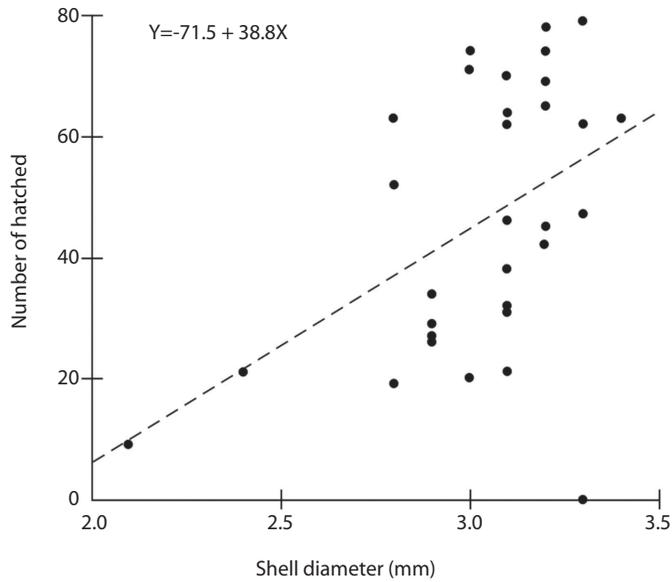


Fig. 2. Correlation between number of hatched and shell diameter (mm) of *Habroconus semenlini* isolated during the life cycle.

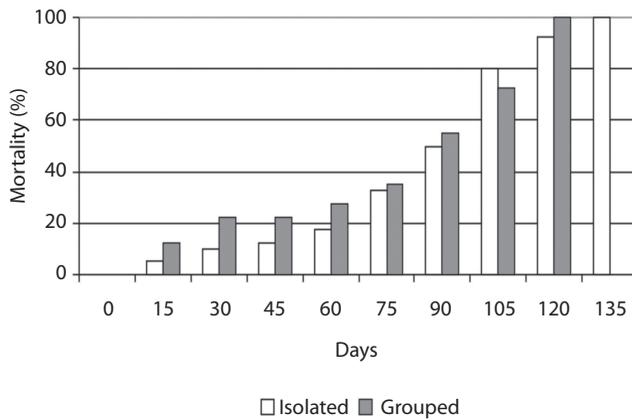


Fig. 3. Comparison of mortality rates in *Habroconus semenlini*, Grouped and Isolated during the life cycle.

an important characteristic for snails, which inhabit forest areas that have been destroyed. Thus, the ability to self-fertilize can ensure survival of the species in cases of environmental disturbances (Heller 2001).

Unlike what has been observed for other terrestrial gastropods (Almeida & Bessa 2001,

Meireles *et al.* 2008, Silva *et al.* 2008), *H. semenlini* displayed higher fecundity when kept in isolation. It has been reported that the frequency of self-fertilization can vary widely (Heller 1993, 2001). In *B. tenuissimus* there is a clear preference for cross-fertilization, and self-fertilization happens after a long period

of isolation (Silva *et al.* 2008). For *S. octona* reproductive success was the same in both reproductive processes (Bessa & Araújo 1995). For slug *Deroceras agrestis* (Linnaeus, 1758) reproduction by cross-fertilization can be four times more successful than reproduction by self-fertilization (Foltz *et al.* 1982).

The frequency of self-fertilization may vary within a single genus, as reported for species of *Arion* (Férussac, 1819) some of which reproduce only by cross-fertilization, while others only by self-fertilization, and others use both processes (Heller 2001). Age may influence self-fertilization frequency, as seen for the land snail *Partula taeniata* (Mörch, 1876), whose rates of self-fertilization are reported to decrease their life cycle (Murray & Clark 1966, 1976). Self-fertilization is a costly process in terms of energy, due to the need to develop two reproductive apparatus. Thus, this process would be beneficial when reproductive success is higher than energy costs. The greater reproductive success of *H. semenlini* through self-fertilization was compensated by an increase in the number of the hatched animals produced.

In *H. semenlini*, egg-laying was not observed, but the presence of hatched specimens in all terrariums was observed. This fact indicates that this species is viviparous or ovoviviparous. However, in order to establish the strategy adopted by this species, histological studies of the reproductive tract are required (Heller 2001).

The life cycle of *H. semenlini* was short. Johnson & Black (1991) suggest that small-sized land snails of tropical regions tend to be short-lived. Moreover, this species only has one reproductive period during their life cycle, which characterizes semelparity in this species. Land snails have two reproductive strategies, namely semelparity and iteroparity. In semelparity, animals only have one reproductive period during their life cycle, after which death occurs, as seen in this study with *H. semenlini*. In iteroparity, instead, animals have more than one reproductive period during their life cycle (Heller 2001). Semelparity has been reported for others land snails, such

as *Xeropicta vestalis* (Pfeiffer, 1841) (Heller & Volokita 1981), *Monacha cartusiana* (Müller, 1774) (Staikou & Lazaridou-Dimitriadou 1990), *Helicela itala* (Linnaeus, 1758) (Lazaridou-Dimitriadou & Sgardelis 1995) and species of the genus *Arion* (South 1992). Semelparity and iteroparity were related to environmental conditions. Thus, semelparity would be favored in unstable environments, giving the animals a short life cycle, with maximum reproductive effort, as observed in this study for *H. semenlini*. It is believed that the life cycle characteristics seen in *H. semenlini* are related to habitat type and morphological characteristics of the species. Specimens of *H. semenlini* have been found in border areas (unpublished data) that make them susceptible to environmental variations throughout the day, such as light, temperature and humidity, common in these areas (Murcia 1995). Environmental variations and small body size cause water stress in these animals and facilitate desiccation. Thus, environmental and morphological conditions may have favored semelparity in this species.

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RESUMEN

Habroconus semenlini es un gastrópodo micro-terrestre nativo de América del Sur. Actualmente se carece de estudios sobre su biología. Este estudio tuvo como objetivo verificar el patrón de crecimiento, la fecundidad y la esperanza de vida de esta especie en condiciones de laboratorio. Con este fin, 80 caracoles fueron mantenidos aislados o agrupados (40 animales en cada condición) durante su ciclo de vida. La especie tiene crecimiento indeterminado y es capaz de auto-fertilización con alto grado de éxito reproductivo. Los caracoles agrupados tuvieron menor fecundidad que los que se mantuvieron en aislamiento. Esta especie tiene una vida útil corta, y sólo un período reproductivo, lo que caracteriza la semelparidad.

Key words: Crecimiento, caracoles de tierra, longevidad, reproducción, fecundación libre.

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