

# Daily Activity Pattern of *Heleobia parchappii* (Gastropoda: Hydrobiidae) under Laboratory Conditions

Néstor J. Cazzaniga and Sandra M. Fiori

Departamento de Biología, Bioquímica y Farmacia, Universidad Nacional del Sur  
San Juan 670, (8000) Bahía Blanca, Argentina

## ABSTRACT

Crawling, floating and burrowing abilities of the Argentine freshwater mudsnail, *Heleobia parchappii* (d'Orbigny 1835), were experimentally analyzed. Floating showed a cyclic circadian pattern, young snails using floatation more frequently than adults; males and females did not show a differential use of a floating escape strategy. Though males of freshwater prosobranchs are expected to be more active than females as an adaptive outcome of reproductive fitness, crawling velocity of *Heleobia parchappii* did not differ significantly between sexes, but males were effectively more active than females on an activity-time allocation basis.

## INTRODUCTION

*Heleobia parchappii* (d'Orbigny 1835) is one of the most widespread freshwater mudsnails in Argentina (Gaillard and Castellanos 1976, Castellanos and Landoni 1995), but the knowledge on its biology still is rather fragmentary (Martín 1995). The species has an annual life cycle with direct development to a benthic juvenile. Snails occur on different substrata, such as submersed vegetation, pebbles, and mud (Cazzaniga 1982, Darrigrán 1995). Like other hydrobiids (Newell 1962), *Heleobia parchappii* allots time to floating, crawling, and burrowing, both in the field and laboratory conditions.

Personal observations on field populations of *Heleobia parchappii* in southern Buenos Aires Province (Argentina) revealed that drift of youngest mudsnails occurs after recruitment peaks. This phenomenon was detected in agricultural drainage channels in which smaller snails colonize areas of higher and higher salinity downstream, where conditions are quite unsuitable to stable population settlement (Cazzaniga 1982, unpublished data).

Floating is a common mechanism of passive dispersal in freshwater snails (Hubendick 1950, Lassen 1978). It is usually interpreted as a means for colonization of new habitats (Anderson 1971) and/or as an escape response to local crowding conditions (Levinton 1979), juvenile stages being more susceptible to washout by current (Schneider and Frost 1986).

On the other hand, the crawling pattern should differ between males and females of gonocoric freshwater gastropods. Reproductive fitness of males is closely linked to the number of matings, which depends on the encounter frequency, this in turn being a function of the locomotion rate and/or velocity. In females, instead, once enough sperm has been obtained, additional matings may increase variability but not the number of offspring; female reproductive fitness is thus less related to the number of matings than in males (Ribi and Arter 1986). One would therefore expect males to move more actively than females.

In the present study we investigated some possible age- and sex-related differences in floating ability and sex-related differences in crawling velocity and in the time allocated to each of these activities under laboratory conditions, aiming to test the following hypotheses. 1) Young snails float significantly more than adults, either male or female; 2) adult males crawl faster than females; and 3) the amount of time spent in these phases differs from male to female snails.

## MATERIAL AND METHODS

Mudsnail samples were gathered from submersed vegetation of the Napostá Grande stream, in Bahía Blanca city (38° 44' S – 62° 00' W), Province of Buenos Aires, Argentina. They were kept in aquaria with non-aerated stream water in order not to disturb the floatation pattern.

*Floating.* 1,200 adult snails were placed in 12 aquaria (20 x 10 x 10 cm each), and the number of floating individuals was recorded every two hours during a 36-hour period to establish if there was a floatation rhythm. The experiment was run under constant  $24 \pm 1^\circ\text{C}$ , controlled temperature, with diffuse natural lightning. The results were analyzed by a Spearman's rank autocorrelogram. Another set of 1,098 randomly collected live snails was maintained in a 40-liter aquarium (base area:  $1,080\text{ cm}^2$ ) to analyze possible sex differences in their floating ability. All floating animals were picked out at 1800 h on each of four consecutive days and then measured and sexed by dissection; at the end of sampling, all the remaining snails in the aquarium were similarly measured and sexed. The proportion of floating animals, discriminated as males, females and sexually undifferentiated, was analyzed by a percentage comparison index for large samples ( $> 30$ ) (Bailey 1959), which is the normal distribution probability significance.

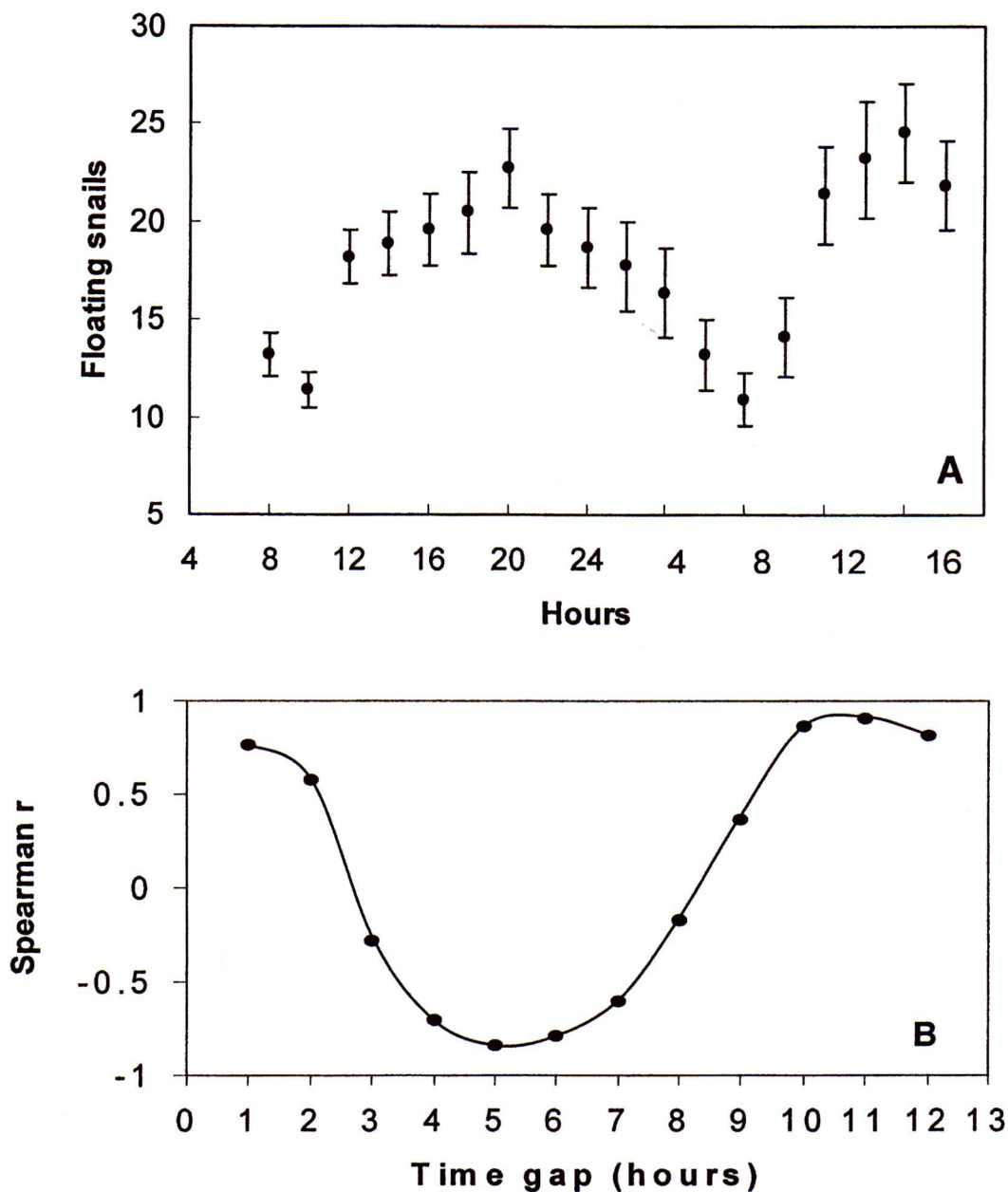


Figure 1. Daily floatation rhythm of *Heleobia parchappii* under laboratory conditions. A: Number of floating snails (each value averages 12 aquaria with 100 snails each; bars are standard errors). B: Spearman's rank autocorrelogram of the above.

*Crawling.* Two experiments were performed, in May (mid autumn) and August (mid winter), using 60 adult snails (23 males and 37 females) randomly selected from the largest shell-length cohort available at the time (Cazzaniga 1982); snails in the first experiment were 2.17 to 4.03 mm long, while those in the second one were 3.90 to 7.50 mm long. The trail traveled during three minutes by each snail on the bottom of a 15 cm diameter glass dish was drawn on acetate paper, amplified by laser photocopying, and measured with a curvimeter. Mean velocity and mean shell size of both sexes in each experiment were compared by t test.

*Individual time allocation.* Ten adult males and 14 adult females were isolated in individual plastic cells bearing stream sediment at the bottom and filled with stream water. Hourly observations were made during a 24-hour period recording whether each snail was crawling, floating or burrowing in the sediment. A total of 576 observations, discriminated by sex, type of activity and timetable (0700-1800 h or 1900-0600 h) was obtained. The resulting comparative frequencies were used as estimators of the time each sex allotted to the different activities.

## RESULTS

*Floating.* This activity was periodic (Fig. 1) with a maximum near sunset and a minimum shortly after sunrise. The autocorrelogram supported the existence of a cyclic pattern of floatation, with a range of values from -0.85 to 0.98; this was the basis to select 1800 h as the sampling time for the next four-day experiment, during which 22.04% of the snails in the aquarium were sampled as they floated.

The proportions of animals picked out while floating (male, female and undifferentiated) showed that males and females did not differ in their floatation abilities, but a greater proportion of young snails (undifferentiated) floated than adults (Table 1).

*Crawling.* There were no significant differences between the trail patterns followed by most individuals, the trails being quite rectilinear and centrifugal from the starting point. Table 2 displays the velocity of snails in the experiment 2 (mid-winter), when larger snails were used; it was significantly lower than in the experiment 1 (mid-autumn) ( $t = 2.946$ ,  $DF = 58$ ,  $p > 0.01$ ). A positive correlation of no or only slight significance was found between size and speed within the size range used in each experiment ( $r = 0.312$  and  $r = 0.370$ , respectively). In no case was the difference between sexes significant.

Table 1. Number of individuals of *Heleobia parchappii* picked out while floating and those remaining on the aquarium bottom at the end of the experiment.

	Floating	At bottom	Total
Males	106	372	478
Females	113	434	547
Undifferentiated	23	50	73
Total	242	856	1098

Percentage comparison	% Floating	d
Males	22.18	0.5913 $p > 0.10$
Females	20.66	
Sexed	21.37	0.0196 $p < 0.05$
Undifferentiated	31.51	

Table 2. Comparisons of mean velocity (cm min<sup>-1</sup>) and shell length (mm) of *Heleobia parchappii* in two crawling experiments.

	Males	Females	t	General
Experiment 1 (mid autumn)				
N	14	16		30
Velocity	2.02 ± 0.55	2.09 ± 0.53	-0.263 p> 0.60	2.06 ± 0.54
Length	3.20 ± 0.57	3.29 ± 0.48	-0.367 p> 0.60	3.25 ± 0.52
Experiment 2 (mid winter)				
N	9	21		30
Velocity	1.36 ± 0.23	1.60 ± 0.47	-0.942 p> 0.10	1.53 ± 0.43
Length	5.60 ± 0.84	6.39 ± 1.00	-2.033 p> 0.10	6.15 ± 1.01

*Individual time allocation.* Throughout the day, the main activity of adult *Heleobia parchappii* was crawling in both sexes all round the day (Fig. 2). Burrowing and floating were proportionally second and third, respectively. Males crawled significantly more than females, but the differences in the other activities were not statistically significant throughout the whole data analysis (Table 3).

There was a significant departure in results when day and night observations were analyzed separately (Fig. 2). There were no significant differences between sexes in either activity during light hours (0700 to 1800 h); instead, males showed a significantly higher level of crawling activity during the night, when females were observed more frequently burrowing in the sediment. The fact of being buried does not mean they were inactive, since we observed locomotion in subsuperficially burrowed snails, and they moved their snouts and exhibited radula eversion.

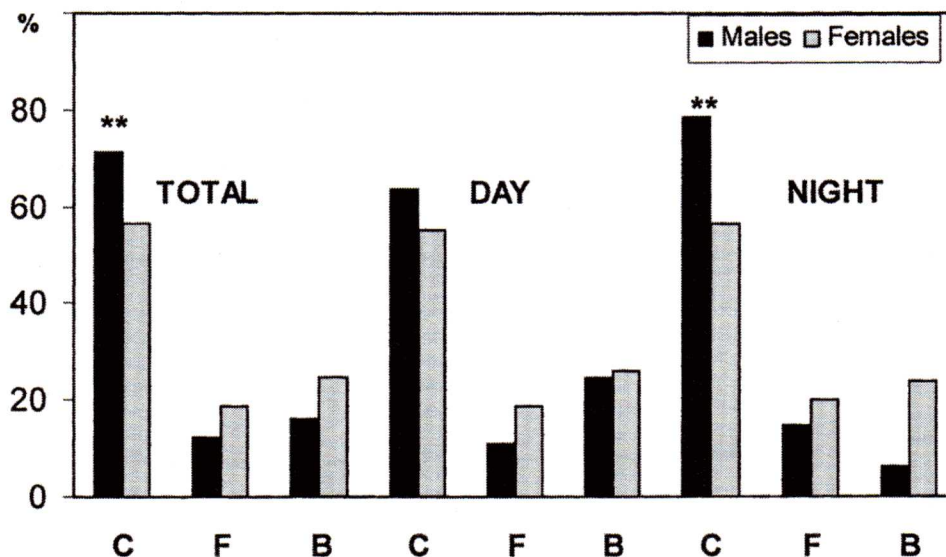


Figure 2. Percentage activity data of the behavior of individually isolated *Heleobia parchappii* under laboratory conditions (hourly records). On the left, all data; on the right, the data split into periods (Day: 0700-1800 h; Night: 1900-0600 h). C: crawling; F: floating; B: burrowing in the sediment. Two asterisks indicate highly significant differences between bars (p< 0.01).

Table 3. Frequencies of three activities of 14 male and 23 female, adult *Heleobia parchappii* during a 24-hour period (hourly observations). A: all data; B: 0700-1800 h; C: 1900-0600 h.

A: TOTAL	Males		Females		D	
Crawling	170	70.83 %	186	55.36 %	3.0015	p < 0.01
Floating	31	12.92 %	65	19.34 %	-0.7904	p > 0.05
Burrowing	39	16.25 %	85	25.30 %	-1.1384	p > 0.10
Total	240	100.00 %	336	100.00 %		

B: DAY	Males		Females		D	
Crawling	76	63.33 %	92	54.76 %	1.4544	p > 0.10
Floating	13	10.83 %	31	18.45 %	-0.6410	p > 0.10
Burrowing	31	25.83 %	45	26.79 %	0.1803	p > 0.10
Total	120	99.99 %	168	100.00 %		

C: NIGHT	Males		Females		D	
Crawling	94	78.33 %	94	55.95 %	3.9328	p < 0.001
Floating	18	15.00 %	34	20.24 %	-1.1398	p > 0.10
Burrowing	8	6.67 %	40	23.81 %	3.8470	p < 0.001
Total	120	100.00 %	168	100.00 %		

## DISCUSSION

A circadian rhythm of floating activity has been described for the estuarine mudsnail *Hydrobia ulvae*, the causes of this rhythmic pattern being assigned to several factors such as tidal cycles, planktotrophic activity, positive phototropism (Newell 1962) or salinity variations (Newell 1964). Endogenous factors also affect the rhythmic pattern, though the exact nature and extent of such influence is not yet fully understood. Little and Nix (1976) and Levinton (1979), on the other hand, presented some cases in which there was no evidence of a tidally based rhythm in the behavior of *Hydrobia* spp.

*Heleobia parchappii*, which shows a daily cycle of floatation, is an exclusively freshwater species; it is therefore free from direct influence of tidal forces. Our experiments were conducted under controlled temperature and diffuse light conditions, so there is no evidence that the behavior was directly influenced by any known external factor showing a cyclic pattern. The peak of activity occurring just before sunset is one of the most common patterns for invertebrate drifters (Brittain and Eikeland 1988), and in the present case the floating rhythm is perhaps best explained by endogenous mechanisms (Margalef 1980).

High population densities affect the movement rate of hydrobiids, which leads to an increase in floatation behavior as an escape response from overcrowded conditions (Levinton 1979). Juvenile snails are more likely to drift and, as expected, the smallest *Heleobia parchappii* snails floated more than adults in our experiment, even under conditions that could not be described as overcrowded (about one snail cm<sup>-2</sup>).

Crawling velocity of *Heleobia parchappii* is near the known value for *Hydrobia ulvae* (2 cm min<sup>-1</sup>; Anderson 1971, Newell 1962) and *Hydrobia ventrosa* (1.83 cm min<sup>-1</sup>; Levinton 1979). Ribí and Arter (1986) stated that males of freshwater prosobranch *Viviparus ater* moved greater distances on a daily basis than females did, but there was no indication as to whether this was due to greater velocity, a longer time spent in locomotion, or both factors. Our results

show that males of *Heleobia parchappii* are more active than females, though the crawling velocity was not different between sexes. This result points to the conclusion that the observed differences only reside in the activity-time allocation.

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