Individual growth of *Heleobia piscium* in natural populations (Gastropoda: Cochliopidae) from the multiple use natural Reserve Isla Martin Garcia, Buenos Aires, Argentina

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(With 6 figures)

Abstract

The present work analyses the individual growth of *Heleobia piscium* in natural conditions in coastal drainage channels of the Multiple Use Natural Reserve Isla Martín García, Buenos Aires, Argentina. Isla Martín García is located in the Upper Río de la Plata, to the south of the mouth of the Uruguay river (34° 11' 25" S and 58° 15' 38" W). Monthly collections were made from July 2005 to July 2006 in the eastern part of the island (Arena Beach). The population of *H. piscium* showed a complex and dynamic structure of sizes during a long period of the annual cycle. Two cohorts could be detected. The Bertalanffy growth equation was: $L_t = 6\ (1\text{-}e^{-1.85\ (t+0.38)})$ and $L_t = 3.9\ (1\text{-}e^{-0.19\ (t+4.84)})$ for cohorts 1 and 2, respectively. The pattern of population growth displayed a staggered model, where the greatest growth is observed during the summer. The reproductive period occurred during six months, from the beginning of summer to middle of fall. Based on only one reproductive effort, this pattern is not similar to that of other cogeneric species already studied.

Keywords: Heleobia piscium, individual growth, Isla Martín García.

Crescimento individual de *Heleobia piscium* em populações naturais (Gastropoda: Cochliopidae) da Reserva Natural de usos múltiplos Ilha Martín García, Buenos Aires, Argentina

Resumo

O presente trabalho analisa o crescimento individual de *Heleobia piscium* em condições naturais em poças costeiras da Reserva Natural de Usos Múltiplos Ilha Martín García, Buenos Aires, Argentina. A Ilha Martín García está localizada no Rio da Prata superior, ao sul da desembocadura do rio Uruguai (34° 11' 25" S e 58°15' 38" W). Amostras mensais foram analisadas entre os meses de julho de 2005 e julho de 2006, no setor este da ilha (Praia de Arena). A população de *Heleobia piscium* se caracterizou por uma complexa e dinâmica estrutura de talhas ao longo de grande parte do ciclo anual. Duas cohortes puderam ser detectadas. A equação de von Bertalanffy para a cohorte 1 foi: $L_t = 6\ (1\text{-}e^{-1.85\ (t+0.38)})$. Para a cohorte 2: $L^t = 3.9\ (1\text{-}e^{-0.19\ (t+4.84)})$. O padrão de desenvolvimento da população mostra um modelo escalonado, estendendo-se o período de maior crescimento durante toda a estação do verão. A temporada reprodutiva se manifestou durante seis meses, desde o princípio do verão até meados do outono. Este padrão baseado em um único esforço reprodutivo não se assemelha ao de outras espécies congenéricas já estudadas.

Palavras-chave: Heleobia piscium, crescimento individual, Ilha Martín García.

1. Introduction

Species of the genus *Heleobia* Stimpson, 1865 belong to the Cochliopidae and are distributed throughout the Neotropical region and in the Nearctic region along the Atlantic coast of the United States of America (Gaillard and Castellanos, 1976; Giusti and Pezzoli, 1984)

The participation of the Cochliopidae as intermediate hosts for digeneans causing dermatitis in humans illustrates the most relevant aspect of this family.

In Argentina, *Heleobia piscium* (d'Orbigny, 1835) and *H. parchappii* (d'Orbigny, 1835) have been confirmed as hosts for cercariae of different species of digeneans (Ostrowsky de Nuñez, 1975).

Gaillard (1973) reported *Heleobia piscium* from Río de la Plata where different ecological forms were found according to the anthropogenic impact which affected the environment they occupy. The maximum forms develop only with optimal environmental conditions, such as those occurring far from urban centres. Although Gaillard and Castellanos (1976) consider *H. piscium* as a freshwater species, Darrigran (1995) also considers it euryhaline enough to occur in zones of the Río de la Plata river with changes in the salinity of the water between 0.5 and 25‰.

To date, only Cazzaniga (1982) and De Francesco and Isla (2004) have carried out studies on population aspects of Cochliopidae from Argentina. The first author reports on the size structures of austral populations and the latter analyse the reproductive period and the growth range of *Heleobia parchappii* in saline environments of the Mar Chiquita coastal lagoon (Buenos Aires, Argentina). To date, there are no studies regarding the population dynamics and growth patterns of *H. piscium* from the Argentinean littoral of the Río de la Plata. The aim of the present study is to analyse the basic aspects of its life cycle, focusing on time variations in age structure and the individual growth of this gastropod in natural conditions in coastal drainage channels of the Multiple Use Natural Reserve Isla Martín García, where the species attain its largest size.

Isla Martín García is located in the Upper Río de la Plata, to the south of the mouth of the Uruguay river (34° 11' 25" S and 58° 15' 38" W) (Figure 1). It constitutes an outcrop of the Brazilian massif of Precambrian crystalline basement rocks, upon which there are sediments of the Holocene and Pleistocene (Quaternary) (Ravizza, 1984).

2. Materials and Methods

Monthly collections were made from July, 2005 to July, 2006 in the eastern part of the island (Arena Beach, Multiple Use Reserve Isla Martín García). This coastal part is delimited by the Canal del Infierno, which is characterized by a remarkable exposure to the strong winds from the southeast.

Samples of *Heleobia piscium* (n = 1237) were taken by hand (captures per unit effort: CPUE, that is specimens/60 min/person) in the coastal drainage channels formed by tidal erosion. Specimens were attached to the bottom pebbles and associated with bivalve *Limnoperna fortunei* (Dunker, 1875), hydrobiid *Potamolithus* Pilsbry, 1896 and representatives of the Ancylidae. Voucher specimens were deposited in the Collection of the Museo de La Plata (n° 12436).

In the laboratory, specimens were submitted to anaesthesia with Menthol crystals for 24 hours, before being fixed with Bouin's solution. The snails were measured using a stereoscopic microscope with micrometric ocular. Total body length was selected as a parameter to determine the monthly-size frequency histograms. These histograms were constructed with size intervals of 5 mm. each.

Individual growth was analysed using the Bertalanffy growth equation: $L_t = L\infty\ (1-e^{-k\ (t-to)})$. The

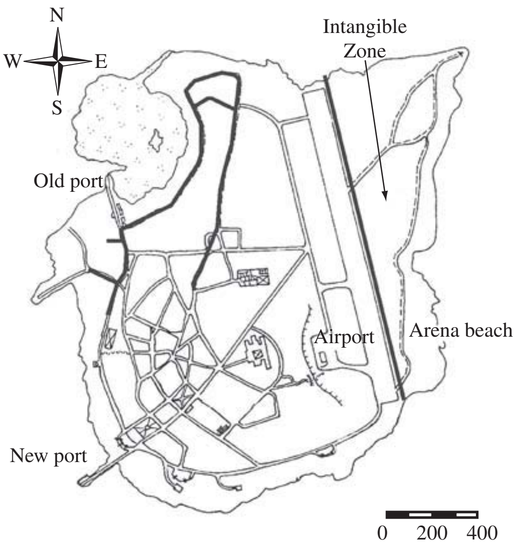

Figure 1. Isla Martín García Map with sampling station: "Arena Beach".

parameter L∞ (maximum body length that individuals of a cohort can reach) was estimated for each case using the Walford method. The time t was calculated considering 30 days per month, in the following manner: t = 1/360.[(m-1)30+d]. The parameter k (individual growth constant) was determined by linear regression between ln (1-Lt/L∞) = –k.t + k.t_0, equation of the form y = b.x + a, corresponding the k value to ordinate to origin, b. The parameter t_0 (hypothetical time in which the length of the individuals is zero) was deduced from k/a.

The cohorts (groups of individuals theoretically born at the same time) observed from the information obtained through the frequencies of sizes, were analysed as a function of the growth curve and the pattern of annual variation of the age structure of the population was defined. For each cohort, a test of goodness of fit using the Chi^2 test was done between the theoretical values and those observed.

The presence of egg capsules attached to the shells of the snails was used as indirect evidence of reproductive activity.

The environmental physico-chemical parameters such as water temperature, percentage of dissolved oxygen, pH and conductivity, were measured using a digital multimeter during most of the samplings.

3. Results

The population of *Heleobia piscium* was characterized by a complex and dynamic size structure throughout a large part of the annual cycle (Figure 2). Two cohorts could be detected (Figure 3). Cohort 1 (winter cohort) was observed in all the surveyed months. Cohort 2 (summer-fall cohort) appeared at the beginning of March 2006.

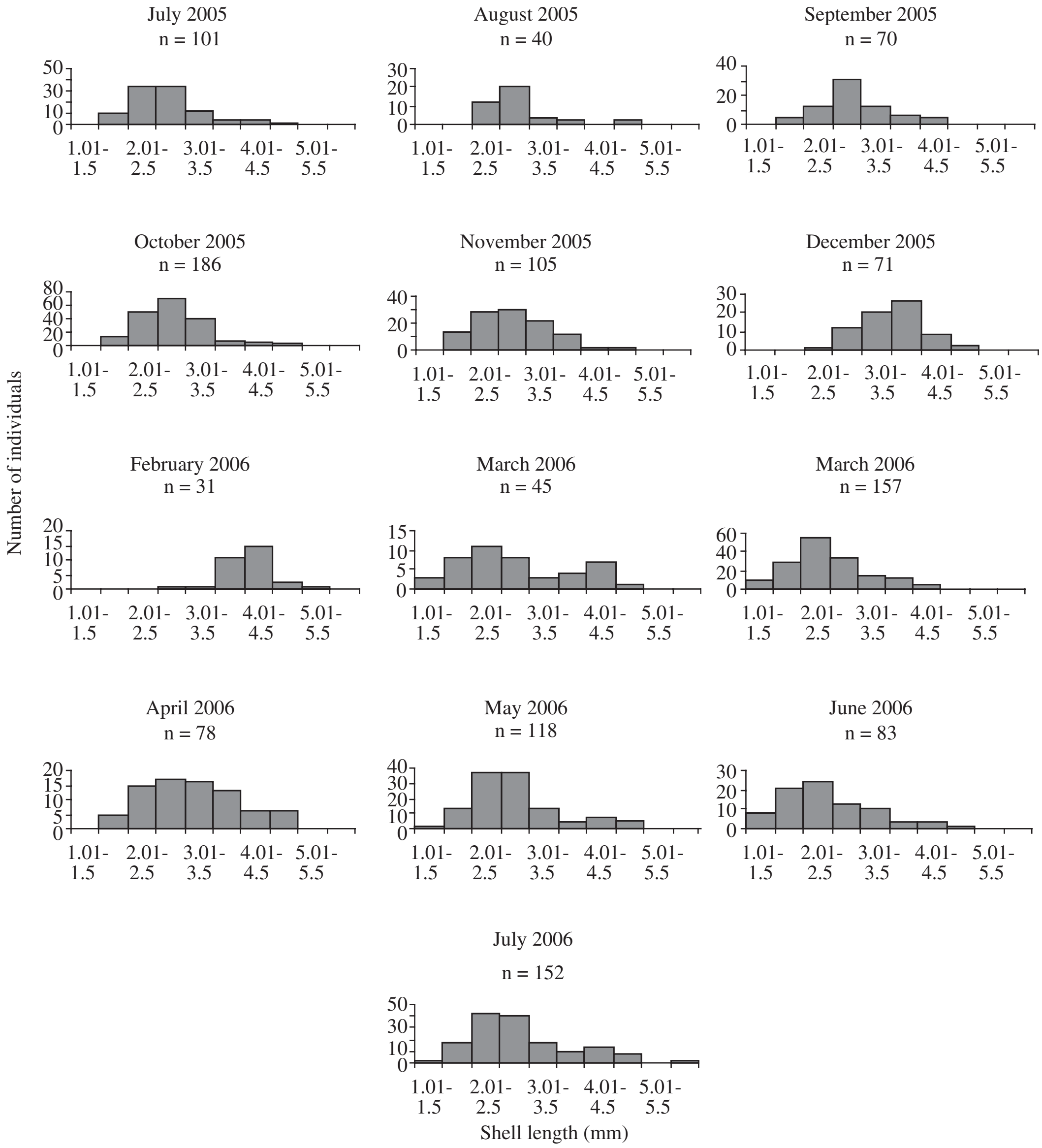

Figure 2. Size-frequency distributions of *Heleobia piscium* in "Arena Beach", Isla Martín García.

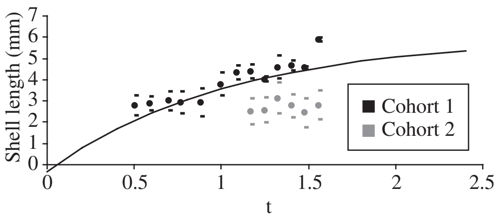

Figure 3. Theoretical growth curve of *Heleobia piscium*; black circles: growth values of cohort 1, greyish circles: growth values of cohort 2; solid line: Bertalanffy´s growth curve.

In March 2006, the population structure of *H. piscium* showed a bimodal size distribution because of the appearance of cohort 2.

The reproductive activity was evident with the presence of egg capsules attached to the shells of some specimens; this period extended from December 2005 to the end of May 2006.

Cohort 1 showed mean size values of 2.75 ± 0.47 mm to 5.89 ± 0.09 mm. The von Bertalanffy equation for this cohort was: $L_t = 6\ (1 - e^{-1.85(t+0.38)})$, where $L_\infty = 6$ (Figure 4a), and k = 1.85 (Figure 4b) $Chi^2 = 2.66$ for $P < 0.05$.

Cohort 2 occurred only from the beginning of March 2006 to the end of the sampling period, showing mean

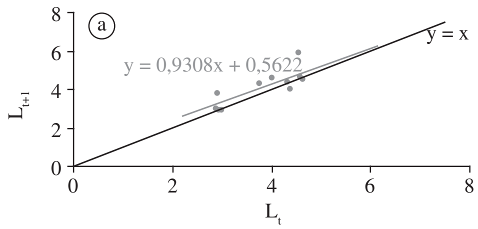

Figure 4a. L∞ calculated from Walford Method (Cohort 1).

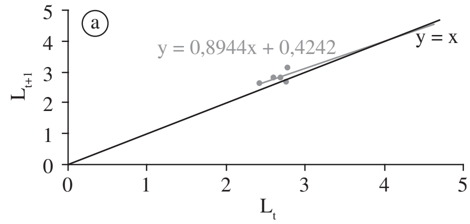

Figure 5a. L∞ calculated from Walford Method (Cohort 2).

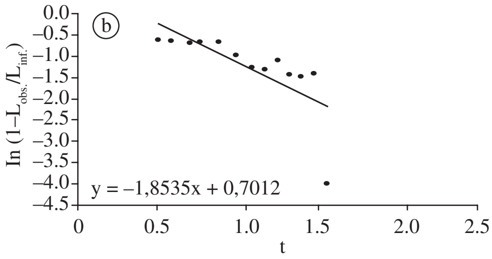

Figure 4b. Value of k calculated to Cohort 1.

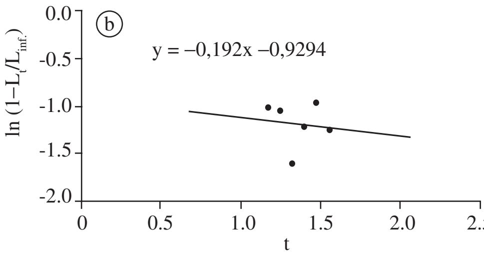

Figure 5b. Value of k calculated to Cohort 2.

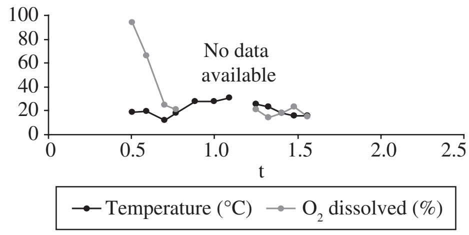

Figure 6. Annual distribution of temperature and oxygen dissolved in "Arena Beach", Isla Martín García.

size values of 2.43 ± 0.68 mm. to 3.12 ± 0.73. The von Bertalanffy equation for this cohort was: Lt = 3.9 (1-$e^{-0.19\,(t+4.84)}$), where L∞ = 3.9 (Figure 5a) and k = 0.19 (Figure 5b). $Chi^2 = 0.12$ for $P < 0.05$.

From December 2005 to March 2006 the highest growth of cohort 1 was observed with mean values of 3.77 ± 0.54 mm and 4.38 ± 0.32 mm., respectively. In fact, it is in this period where the highest values of water temperature were recorded (28 and 30.5 °C); variation in water temperature ranged between 11.9 °C and the values mentioned above (Figure 6). The pH was slightly alkaline during all the sampling period, ranging between 6.7 and 7.8. The percentage of dissolved oxygen was very variable throughout the year (Figure 6). The conductivity was low (2.3 to 178 $\mu S.cm^{-1}$).

4. Discussion

The great variability of the n values (number of individuals per sampling) reflected in the histograms could be caused by the strong winds from the South occurring in certain months (data provided by Subprefectura Naval Argentina, Isla Martín García). These winds produced a "washed" line on the coastal drainage channels which would explain, in part, the low number of specimens collected during August 2005 and February to March 2006.

The pattern of growth population shows a staggered model, with a period of greatest growth extending throughout the entire summer season. This is corroborated by the high growth rate of cohort 1 (k = 1.85).

The reproductive period took place during six months, from the beginning of summer to the middle of fall, when the egg capsules attached to the surface of the shell of some specimens were observed. This is consistent with the presence of a larger number of individuals of smaller sizes in March, the majority of which belonged to the new cohort. This pattern based on a unique reproductive effort is not similar to that of other cogeneric species already studied; Cazzaniga (1981) studied the *Heleobia parchappii* in freshwater environments of the south of the province of Buenos Aires and he reported two spawning peaks in the species' reproductive cycle. Cazzaniga (1982) pointed out that *H. parchappii* experienced a marked fluctuation in density, an unstable size structure and a high abundance of young snails in mesohaline environments in austral populations from Buenos Aires (Argentina).

De Francesco and Isla (2004) also describe two main spawning peaks for *H. parchappii*, one at the beginning of spring and another one during fall, in saline canals of Mar Chiquita coastal lagoon. According to these authors, the similarity observed in life cycles under different saline conditions invites some speculation about the relative importance of this factor in conditioning the reproductive activity of these snails. The authors have found that the size structure remains relatively stable and that the cohorts can be followed monthly during the year. Thus, it appears that salinity does not have a marked influence on the reproductive activity of *H. parchappii* but does affect population structure. From these works, we can infer that snails from the saline canal attain smaller sizes than those found in freshwater environments from Buenos Aires Province.

Unlike Gaillard and Castellanos (1976), Darrigran (1995) states that *H. piscium* is an euryhaline species, which inhabits the fluvial-inner zone (corresponding to Isla Martín García) (salinity < 0.5‰) and the fluvial-intermediate zone (0.5-25‰) of the Río de la Plata.

Although conductivity could not be measured in all studies, it exhibited a great variability throughout the year with values ranging from 0.002 to 0.18‰, not exceeding the limit percentage of the fluvial-inner zone. Conductivity is not the only parameter subjected to variations, even daily variations; this is due to the fact that the coastal drainage channels, which are subjected to the mild action of the tides and occasional strong southern winds, are also subordinated to variations in the water volume of the drainage channels. This affects not only the conductivity but also several physico-chemical parameters such as pH, percentage of dissolved oxygen, water temperature (Figure 6).

De Francesco (2002) proposed that *Heleobia conexa* (Gaillard, 1974) presents a reproductive pattern similar to that of *H. parchappii,* which is mostly influenced by water temperature. According to our observations, the water temperature is the parameter that best fits the growth pattern of *H. piscium*. Likewise, we cannot affirm that it has a marked effect on the reproductive cycle and on the species growth, as conductivity does on other species of *Heleobia*.

No data is available for the comparison among different populations of *Heleobia piscium* in different types of habitat. This is why this study on the annual cycle of natural populations of *H. piscium* represents a precedent for further investigations related to species biology.

5. Conclusions

The reproductive effort of *Heleobia piscium* in natural populations is characterized by having only one long spawning period; the reproductive season takes place from summer to the middle of fall. It is in the summer when population growth shows the highest peaks and the mean size values fit best the theoretical growth curve.

Renovation of the age structure of the *Heleobia piscium* population is in accordance with the highest levels of water temperature observed from December to March; this variable appears to be an important factor of mortality, particularly for the largest classes (see Figure 2). Therefore, temperature could be a regulating factor for growth and reproductive activity.

It is not the purpose of this report to explain why *Heleobia piscium* displays only one spawning peak and *H. parchappii* and *H. conexa* presents two, since factors probably affecting the spawning activity of these snails are of a diverse nature.

Although variations in saline conditions affect the age structure in *Heleobia parchappii* populations, it appears that these variations do not have a marked influence on its reproductive activity. In *H. piscium*, this environmental variable does not seem to regulate the reproductive capacity either, since conductivity values were always remarkably low, below the limit percentage of the fluvial-inner zone.

It is worth mentioning that as *Heleobia piscium* is a poorly studied species with growing sanitary interest, knowledge of it and the analysis of its basic aspects in the dynamics of natural populations become more relevant as a function of future strategies of control.

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