Primary Research Paper

Factors affecting the distribution and abundance of the commensal *Temnocephala iheringi* (Platyhelminthes: Temnocephalidae) among the southernmost populations of the apple snail *Pomacea canaliculata* (Mollusca: Ampullariidae)

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Abstract

*Temnocephala iheringi* is the most common temnocephalan inhabiting the mantle cavity of the apple snail *Pomacea canaliculata*, a freshwater neotropical gastropod that has become a serious rice pest in Southeastern Asia. *T. iheringi* has been recorded from Mato Grosso (Brazil) to water bodies associated with the Río de la Plata river (Argentina). During an extensive survey in the southern limit of the native area of *P. canaliculata* the presence of *T. iheringi* eggs was recorded in several apple snail populations, extending the known distribution of the commensal more than 400 km southwards. The aim of this study was to understand the factors affecting the distribution and abundance of *T. iheringi* among populations of *P. canaliculata*. Only 23% of the apple snail populations inhabiting streams harboured temnocephalans while the occurrence among lentic ones was 71%. *T. iheringi* was found mostly in populations of apple snails living in non-alkaline sites and where snails attaining sizes larger than 4 cm were very common. The prevalence of the temnocephalans in lentic populations was higher than 90%. The number of eggs on the shell (not including the umbilicus) ranged between 0 and 470 and was different among populations of *P. canaliculata*. The prevalence and number of eggs were lower in the lotic populations, except for a stream population immediately downstream of a lake with commensals. There was no difference between males and females of *P. canaliculata* neither in the prevalence nor in the number of eggs on the shell. The southernmost population of the world of *P. canaliculata* harbours commensals that tolerate cold winter water temperatures (4–5 °C) as well as its host. On the other hand, *T. iheringi* was found only in sites with bicarbonate concentrations lower than 6.6 meq l\(^{-1}\), suggesting that the tolerance of the commensal is very much lower than that of the apple snail (up to 9.95 meq l\(^{-1}\)). The number of worms inside each snail or the life history variation of *P. canaliculata* could explain the influence of the size of the snails on the occurrence of *T. iheringi*. In the big-sized snails, where the number of commensals is higher, the probability of survival of at least one worm is also higher, specially during the hibernation period, when crawling and feeding are null and snails remain buried. On the other hand, *P. canaliculata* snails from lentic populations are generally bigger and mostly iteroparous, while those inhabiting streams are smaller and semelparous. In these populations the snails have access to mate only with snails of their same cohort, while in iteroparous populations they can copulate with individuals of other cohorts, allowing the inter-generation transmission of worms and the long term persistence of the population of commensals.
Introduction

Pomacea canaliculata (Lamarck, 1822), the southernmost apple snail of the world, is a freshwater prosobranch gastropod with a basically tropical and subtropical natural distribution, including the Amazonas and the Plata basins (Cowie, 2002). In the last two decades it has invaded most Southeast Asian countries, becoming a serious rice pest (Wada, 1997). During an extensive survey in the southern limit of its native area (Martín et al., 2001), we observed that many populations of P. canaliculata harboured temnocephalan worms.

The Temnocephalidae are commensal turbellarians from New Guinea, New Zealand, Australia, Madagascar, Central and South America. Nineteen species of Temnocephala have been reported in the Neotropical region, mostly associated with crustaceans as hosts, and ten of these have been found in Argentina. Only three species (Temnocephala iheringi Haswell, 1893, Temnocephala rochensis Ponce de León, 1979 and Temnocephala haswelli Ponce de León, 1989) are associated with freshwater snails belonging to the family Ampullariidae and only T. iheringi has been reported from Argentina, mostly on Pomacea canaliculata. These species live in a closer relationship with their host than most other Temnocephala spp., because they occupy the mantle cavity of the snails which they leave only to lay the egg capsules on the shell (Damborenea & Cannon, 2001).

Although many aspects of the biology of temnocephalans have been studied, the knowledge of their interactions with their hosts is still fragmentary (Jones & Lester, 1993; Jennings, 1997). Most studies have focused on the intrapopulation level and almost nothing is known about the factors regulating the distribution and abundance of these commensal worms at higher levels (i.e. among the populations of their hosts). The aim of this study was to understand the factors affecting the distribution of Temnocephala iheringi in the southernmost populations of P. canaliculata, where this commensal worm has not been recorded previously.

Study area

The sampling region extended from 36° S to 39° S in southern Buenos Aires province. This range covers the southern limit of the distribution area of Pomacea canaliculata and includes the southern part of the Pampas and the only two mountainous areas in the province (Ventania and Tandilia mountains (Fig. 1)). The climate of the region is temperate, with a marked humidity gradient from the NE (mean annual rainfall 900 mm) to the SW (600 mm). The whole region lies within the 14 and 16 °C annual mean isotherms. Rivers and streams have scant and very variable water flow, with a pluvial hydrological regime (Grondona, 1975).

Materials and methods

The sampling scheme included all the main drainage basins and many isolated streams and lakes. Seventy-six sites were visited in February and March 1998 (late summer) (Martín et al., 2001). Two people searched for living apple snails among the submerged vegetation, under stones, or buried in the substrate; all snails larger than 2 cm were collected.

At every site the specific richness of snails and aquatic macrophytes (submerged, floating or emergent) were recorded. Other 16 environmental variables were recorded. Conductivity (mS cm⁻¹) and pH were determined in situ with a multimeter (Horiba U-10). Total and volatile suspended matter (g l⁻¹) were determined according to American Public Health Association (1981) methods. The concentrations (meq l⁻¹) of Na⁺, Ca²⁺, Mg²⁺, K⁺ and SO₄²⁻ were measured with an inducted plasma emission spectrometer (Shimadzu ICPS 1000-III), and Cl⁻, CO₃²⁻ and HCO₃⁻ were measured by titration. Surface water velocity (m s⁻¹) was measured at different points within each site. The dominant substrate was characterised on an arbitrary scale: 1 (sapropel, mud), 2 (sand) and 3 (pebbles, boulders, limestone). The trophic resource availability was coded as 1 (low), 2 (medium) and 3 (high), through a visual estimation of the abundance of macrophytes, microphytes, riparian vegetation and their debris.

The collected snails were killed by immersion in 70 °C water and stored at −20 °C. Forty snails from each site were selected for further analysis (except for the sites LA, TA, AC and QG, where the numbers were 12, 30, 8 and 22, respectively).