Seasonal dynamics of larvae and adults of two *Enochrus* (Coleoptera: Hydrophilidae) species in urban temporary and permanent water bodies in Buenos Aires

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Introduction

Several groups of aquatic organisms colonize temporary pools, in spite of the physical constraint that the loss of water represents. These organisms, which take advantage of the rich resources and the relative absence of predators (e.g. fishes), have developed physiological and behavioral mechanisms to survive dry periods. Among aquatic coleopterans, two species of the genus *Enochrus* (Hydrophilidae), *Enochrus variegatus* (Steinheil) and *Enochrus vulgaris* (Steinheil), are commonly present in temporary and permanent water bodies of temperate Argentina. We aim to describe the seasonal dynamics of these species and their reproductive strategies in temporary and permanent water bodies in a green area of Buenos Aires city.

Methods

Field studies were carried out in a Golf Club located within the urban area of Buenos Aires City, in temperate Argentina. This recreational area contains permanent ponds and temporary pools with different size and permanence. Two permanent ponds (sheltering fish populations that potentially prey on aquatic insects) and two temporary pools were selected based on preliminary studies. Permanent ponds (pond A and pond B) differed in the presence of floating and submerged aquatic vegetation, and both attained stable levels of water. Both temporary pools (pool C and pool D) showed fluctuations in the water level, and dried out repeatedly through the study period. Samples were collected from both type of habitats weekly throughout one year, and water surface area was recorded each time.

In the laboratory, *Enochrus* spp. adult and larval specimens were identified to species level. Chi square tests for independent proportions were performed to compare the proportions of sampling dates with adults and larvae for each species between: a) seasons (habitat types pooled), b) permanence categories (seasons pooled), c) permanent ponds, d) three categories of temperature ranges (< 15° C, 15–20º C, and > 20° C, according to the average temperature of the seven previous days).

Data of development time were obtained in laboratory to estimate the duration of each larval instar. The presence of different larval instars of each species in the field were compared to the expected larval instar according to the time elapsed since flooding and the development time observed for each species in the laboratory.

Results

Flooded area in temporary pools was larger in the winter and spring than during the summer and fall seasons (Fig. 1).

Adults of *E. vulgaris* were collected in both types of habitats, except during the driest period (summer), when they were recorded only in the permanent water. Immature stages of this species were collected only in permanent pools in summer, and no individuals were recorded in winter (Fig. 1A). Neither differences between seasons nor between types of habitats were detected in the proportions of presence of adults or larvae of this species (Table 1). Adults were detected in both permanent ponds, although mainly in the vegetated one ($X^2 = 3.9$; df = 1; N = 102; $p < 0.05$), and larvae exclusively in the same pond ($X^2 = 6.38$; df = 1; N = 102; $p < 0.05$). With regard to temperature, adults of *E. vulgaris* were collected in similar proportions at different temperatures. Although larvae were recorded in higher proportions of dates at increasing temperatures (Fig. 2A), no statistical differences were detected.

Adults of *E. variegatus* were collected both in temporary and permanent habitats during most of the year, with the exception of the driest period, when they were recorded only in the permanent ponds (Fig. 1B). This species was present in higher proportions in the winter-spring period than in the summer-fall period ($X^2 = 9.08$; df = 1; N = 51; $p < 0.005$). Immature stages were observed almost exclusively in temporary habitats (with the exception of one larva during the spring season) (Table 1). Larvae were collected only during the winter and spring seasons (Fig. 1B), when proportions showed significantly higher values than during the summer-fall period ($X^2 = 20.43$; df = 1; N = 51; $p < 0.001$). Adults were collected more frequently in the vegetated pond, although statistical results were only marginally significant ($X^2 = 3.46$; df = 1; N = 102; $p = 0.06$). The single larva of this species collected in permanent water was also found in this pond. Adults were observed at the whole temperature range recorded during the study period (Fig. 2B), although proportions decreased with increasing temperatures ($X^2 = 9.38$; df = 2; N = 51; $p < 0.01$). Larvae of *E. variegatus* were captured only at temperatures below 20° C (Fig. 3B), and a significant decrease was observed at higher temperatures ($X^2 = 10.92$; df = 2; N = 51; $p < 0.005$)

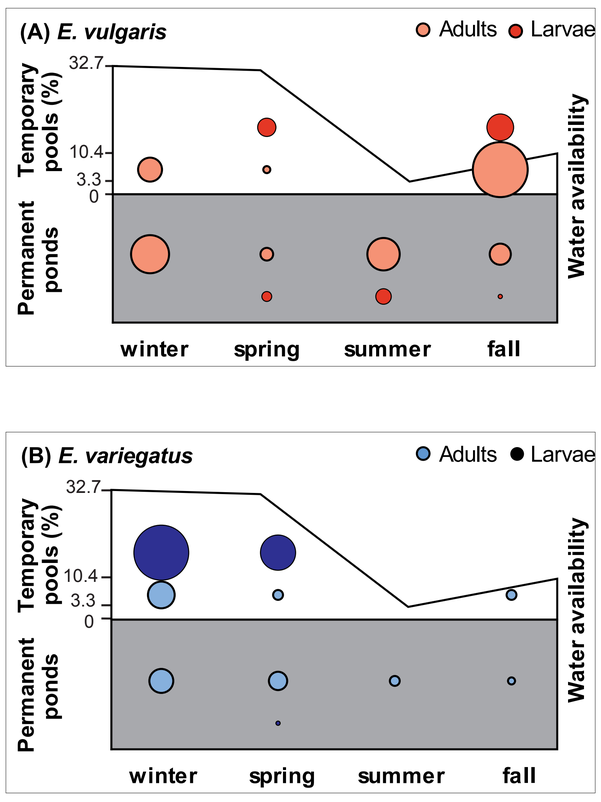

Fig. 1: Water availability (seasonal average flooded area (m2) in temporary pools) and relative abundance by season and type of habitat, of adults and larvae of *Enochrus*.
(A) *E. vulgaris*; (B) *E. variegatus*

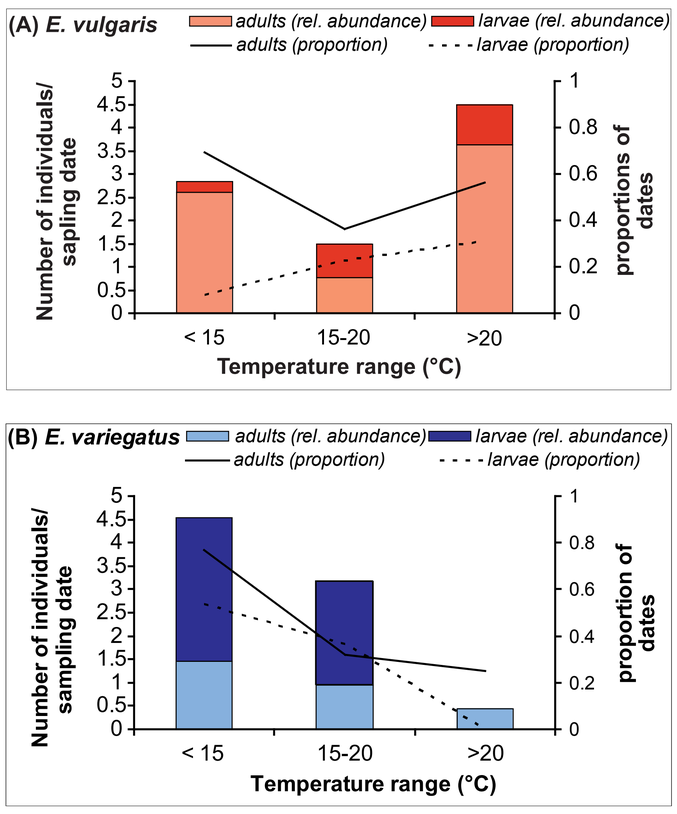

Fig. 2: Relative abundance and proportion of dates with presence of adults and larvae of Enochrus at different temperature ranges, representative of winter, spring-fall, and summer seasons:
(A) *E. vulgaris*, (B) *E. variegatus*

	Species	*Enochrus vulgaris*		*Enochrus variegatus*	
	Stage	adults	larvae	adults	larvae
Habitat permanence	permanent (prop.)	0.45	0.12	0.27	0.02
	temporary (prop.)	0.31	0.17	0.31	0.43
	X^2 of differences	1.62	0.5	0.16	22.92
	p (df = 1)	ns	ns	ns	<0.001
Season	Winter (prop.)	0.77	0.00	0.77	0.68
	Spring (prop.)	0.23	0.38	0.46	0.54
	Summer (prop.)	0.55	0.27	0.09	0.00
	Fall (prop.)	0.50	0.21	0.29	0.00
	X^2 of differences	7.61	5.98	12.58	20.62
	p (df = 3)	ns	ns	<0.01	<0.001

Table 1: Comparison of proportions of dates when the presence of *Enochrus* was recorded according to habitat permanence and season.
ns: no significant differences

Development times observed in laboratory indicates that *E. vulgaris* hatched from the egg case on day 6 and reached the second and third larval instar on days 13 and 16 respectively. Specimens moulted to pupa from day 26 on. *E. variegatus* emerged from the egg case on day 3, reaching the second and third instar on days 9 and 13 respectively. The pupal stage started on day 21.

Regarding larval dynamics in temporary pools, first instar larvae were observed in the first week after flooding, and also several weeks after. They were also observed in consecutive weeks and simultaneously with third instar larvae. The presence of the two first larval stages of *E. variegatus* and *E. vulgaris* was observed on dates immediately before the pools dried out completely. In two opportunities (October and April), second instar larvae of *E. vulgaris* were captured after the pool had dried out on the previous date. In October the time elapsed since the previous rainfall event was two days, whereas in April six days respectively (Fig. 3A). Similar observations were made for *E. variegatus* in pool D in three different opportunities. Second instar larvae were collected on dates immediately after flooding in July, October and November. And the time elapsed since the previous rainfall event was seven, two and eight days respectively (Fig. 3B).

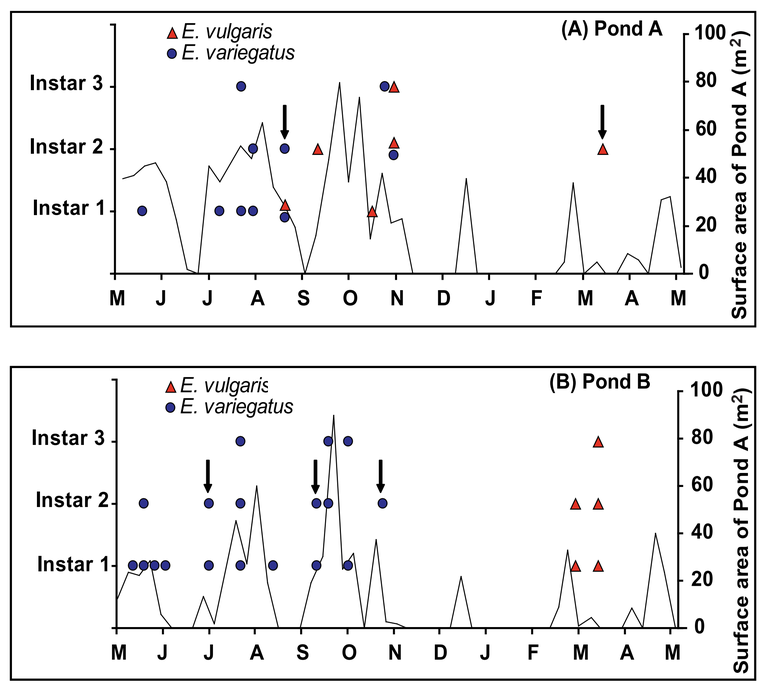

Fig. 3: Presence of three larval instars of *E. vulgaris* and *E. variegatus* in two temporary pools: (A) Pool C, (B) Pool D. Arrows indicate dates when second instar larvae were captured after the pool had dried out during the previous sampling.

Discussion

Results show that the reproductive seasons of *E. variegatus* and *E. vulgaris* differed through the study period, with a short overlapping period in spring. *E. variegatus* reproduced at lower temperatures (especially during the winter season), while *E. vulgaris* was associated with higher temperatures (especially during the summer season). Among permanent habitats, those containing vegetation seem to represent more favorable environments. The association of *Enochrus* with vegetation could be related to the availability of refuges to hide from predators, taking into account the presence of fishes in both ponds studied.

The predominant presence of larvae in temporary pools indicates that these are favorable habitats for both species despite the unpredictable permanence of water. Our results suggest that *E. variegatus* prefers temporary waters for reproduction. In contrast, the presence of *E. vulgaris* larvae was only slightly higher in temporary pools than in ponds. This might indicate a more opportunistic strategy of this species regarding the selection of breeding sites, especially taking into account that the reproductive season of *E. vulgaris* was coincident with the drought period during the study period.

The presence of first instar larvae in temporary pools over several consecutive weeks, and their coexistence with third instar larvae indicate that populations are not synchronized in oviposition time and development of immature stages. The observation of second instar larvae few days after the filling of the pools is an unexpected result, especially since laboratory data showed a longer development time (nine days for *E. variegatus* and 13 days for *E. vulgaris* to reach the second larval instar). These results suggest the possibility that those larvae survived the drought by burrowing into the substrate and did not hatch from egg-cases laid after flooding.