

## SPATIAL AND SEASONAL TRENDS OF A NATURAL POPULATION OF *BIOMPHALARIA OCCIDENTALIS* IN NORTHEASTERN ARGENTINA

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*This study aims to analyze the age structure of a population of *Biomphalaria occidentalis* on a pond of Riachuelo river basin, which is one of the three most important Middle Paraná river affluents in Corrientes province.*

*Samples were drawn from three stations, where spatial and temporal numerical variations of the snail, as well as its relation with different environmental parameters, mainly temperature, rainfall, pH and conductivity, were analyzed.*

*Snail abundance is given in number of individuals/hour. The differences between the three sampling stations, estimated by nonparametric tests, was nonsignificant.*

*A relative scale to the greatest shell diameter was employed to build the age pyramids. Temporal fluctuations of snail abundance correlated negatively with the highest monthly accumulated temperatures ( $P < 0.05$ ). Although different floristic compositions were observed at the three stations, no significant numerical variations were detected in *B. occidentalis* spatial distribution. Reproductive activity took place between March-April and November with overlapping cohort system. During summer (December-February) mortality increased along with temperature and reproductive activity was not evident.*

Key words: Planorbidae – *Biomphalaria occidentalis* – ecology

So far no endemic focus of schistosomiasis *mansoni* has been detected in Argentina. Nevertheless, its southward expansion in Brazil (Paraense & Corrêa, 1987) makes it advisable to investigate the Argentine species of *Biomphalaria* as potential intermediate hosts of *Schistosoma mansoni*.

Since there is good evidence for an adjustment between vector snail species and *S. mansoni* strains (Paraense & Corrêa, 1963a, b), the arising of a new strain through parasite-vector coevolution could result in its adaptation to a new host. This process might favor the expansion of *S. mansoni* to Argentina conditioned, of course, by ecological factors influencing the existence and survival of poten-

tial intermediate hosts (*Biomphalaria* spp.) and free stages (miracidia and cercariae) of the parasite.

Adaptation to a new host is evident in *Biomphalaria tenagophila*, which formerly proved retractory to *S. mansoni* (Lutz, 1918, under the name *Planorbis confusus*), and is now an important vector in the Brazilian states of Rio de Janeiro (Deane et al., 1953, as *Australorbis* sp.; Andrade & Martins, 1956, as *Australorbis immunis*, *A. bahiensis* and *A. tenagophilus*) and São Paulo (Corrêa et al., 1962, as *A. tenagophilus*).

On the other hand, one must consider the presence of native trematodes with redia stage which could compete with *S. mansoni* for the same intermediate hosts and prey upon its sporocysts. Paraense (1987) made a good review of this aspect.

The above considerations point to the need of further ecological investigation on Argen-

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tine biomphalarias, mainly in the Rio de La Plata basin biotopes, because that basin seems to be the more favorable site for the establishment of schistosomiasis.

Though *Biomphalaria occidentalis* Paraense, 1981, has proved insusceptible to infection with some strains of *S. mansoni* (Paraense & Corrêa, 1982; Coimbra & Engel, 1982), its recent finding in northeastern Argentina (Rumi & Tassara, 1985) has prompted the authors to study its population dynamics, focusing upon the main events of the annual cycle, temporal and spatial numerical changes, age structure and reproductive trends of a *B. occidentalis* population from Paiva pond.

Paiva pond, "paraje" Pampín (27° 30'S, 58° 45'W), is a lentic biotope which belongs to the basin of the Riachuelo river, one of the main Middle Paraná river affluents in Corrientes province. A profile of the littoral zone of the pond and surrounding environment is shown in Fig. 1. Large ponds enclosed in wetlands located in the lower areas and disrupted by floods are peculiar to that basin (Bonetto et al., 1978a, b).

The pond is egg-shaped, with an area of 70 ha and a maximum depth of about 3 m, varying with rainfall incidence. A compact macrophytia cover more than 70% of its area.

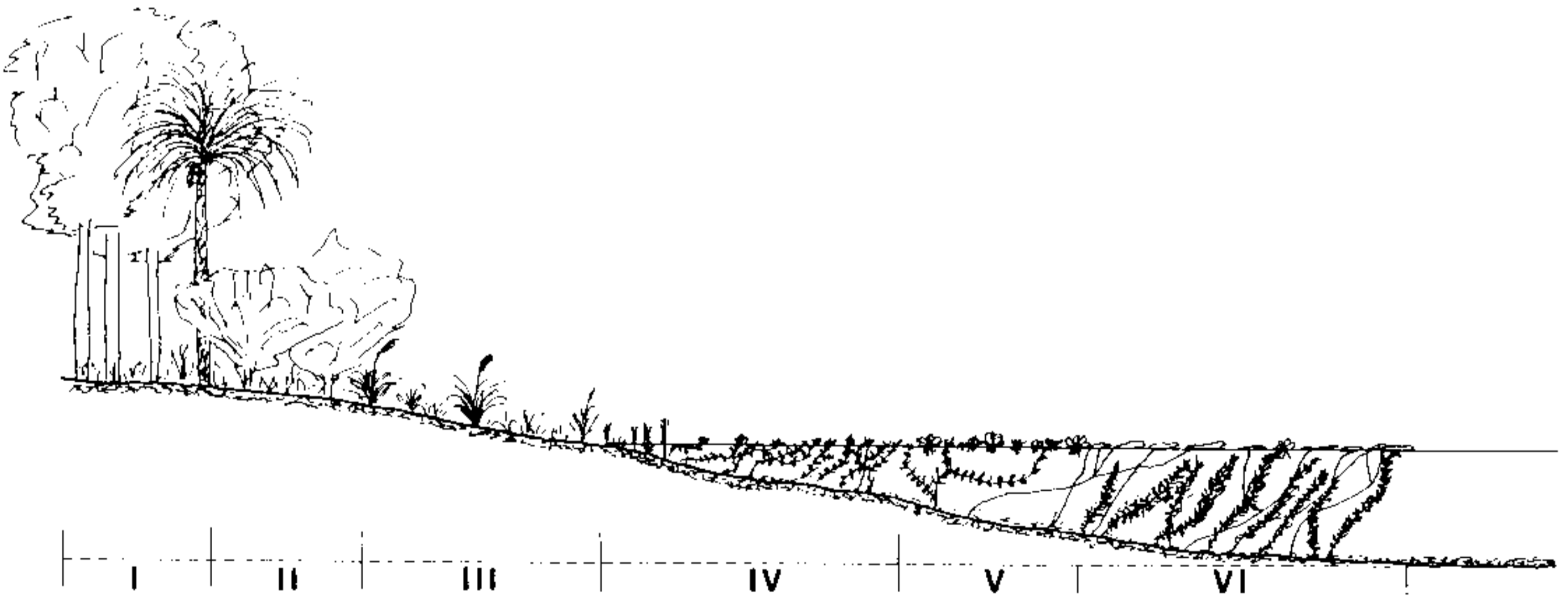


Fig. 1: Paiva pond, cross section and vegetation levels. I: arboreal level, with dominance of timbó (*Enterolobium contortisiliquum*) and lapacho (*Tabebuia heptaphylla*); ibirá-pitá (*Peltophorum dubium*) and pindó (*Cocos romanzoffiana*). II: shrub level, with dominance of young trees of timbó, lapacho, tala (*Celtis spinosa*) and guayaba (*Psidium guajava*). III: grass level, with codominance of *Cyperus surinamensis*, *Hymenachne amplexicaulis* and *Polygonum punctatum*. IV: rooted level, with *Eleocharis minima*, *Scirpus cubensis*, *Ludwigia peploides* and *Hydrocotyle ranunculoides*. V: free-floating level, with *Salvinia herzogii*, *S. minima*, *Ricciocarpus natans*, *Azolla caroliniana*, *Pistia stratiotes*, *Eichhornia azurea* and Lemnaceae (*Spirodela* sp., *Lemna* sp., *Wolffia* sp. and *Wolffiella* sp.). VI: submerged, rooted, floating-leaved level, with *Cabomba australis*, *Potamogeton* cf. *illinoensis*, *Hydrocleys nymphoides*, *Nymphaea* sp., and the rootless *Utricularia oligosperma*.

## MATERIALS AND METHODS

Sixteen nonperiodic samples were taken from shallow littoral areas at three stations, from April 1986 to July 1988. Snails were collected during one hour, between 9:00 AM and 1:00 PM, with a perforated bowl-shaped dipper. In all, 2098 specimens were collected. They were distributed into an age scale according to the greatest shell diameter, as shown in Table I. Snails' eggs were collected from leaves of macrophytes.

The graphic normalization method was applied to cohort identification (Fig. 4), and product-moment correlations were estimated.

Rainfall and maximum air temperature were daily recorded and monthly accumulated. Water temperature and conductivity were also recorded, the latter expressed in  $\mu\text{S}/\text{cm}$  units. Measurements of dissolved  $\text{O}_2$  by Winkler method and of pH with colorimetric pH meter were made in water taken by a peristaltic pump.

From July 1986 to August 1987 *B. occidentalis* abundance was estimated at three sampling stations, designated E1, E2 and E3 (to be described under "Results"). Samples of aquatic plants were taken at random from 250-cm<sup>2</sup> quadrats laid out at those stations. Dry weight of aquatic plants, expressed in g/m<sup>2</sup>, was determined after their exposure to

60 °C for 72 h. The significance of the differences in *B. occidentalis* abundance, between the three sampling stations and throughout the year, was estimated by the Kruskal-Wallis and the Friedman tests (Siegel, 1956), respectively.

RESULTS

*B. occidentalis* was mainly distributed between levels III and IV (Fig. 1), at a depth of 5-50 cm. Level V was covered with free-floating plants, which frequently spread to level IV. Free water occupied a small area; its variations were due to incorporation of plants from level VI, where floating-leaved macrophytes, mainly *Hydrocleis nymphaeoides*, predominated. Water showed a relatively low and variable conductivity; pH was rather acid to neutral, dissolved oxygen was usually under 5 mg/l with a highly variable (0 to 107) percent saturation; water temperature ranged from 11 °C in winter (July 1986) to 33.1 °C in late summer (March 1987). pH, dissolved oxygen and its percent saturation showed a decreasing trend during summer. Conductivity and rainfall were significantly and negatively correlated ( $r = -0.62$ ;  $P < 0.05$ , 12 *d.f.*). The vegetation biomass ranged from 104 to 779 g/m<sup>2</sup>. Fig. 2 shows annual parameter fluctuations.

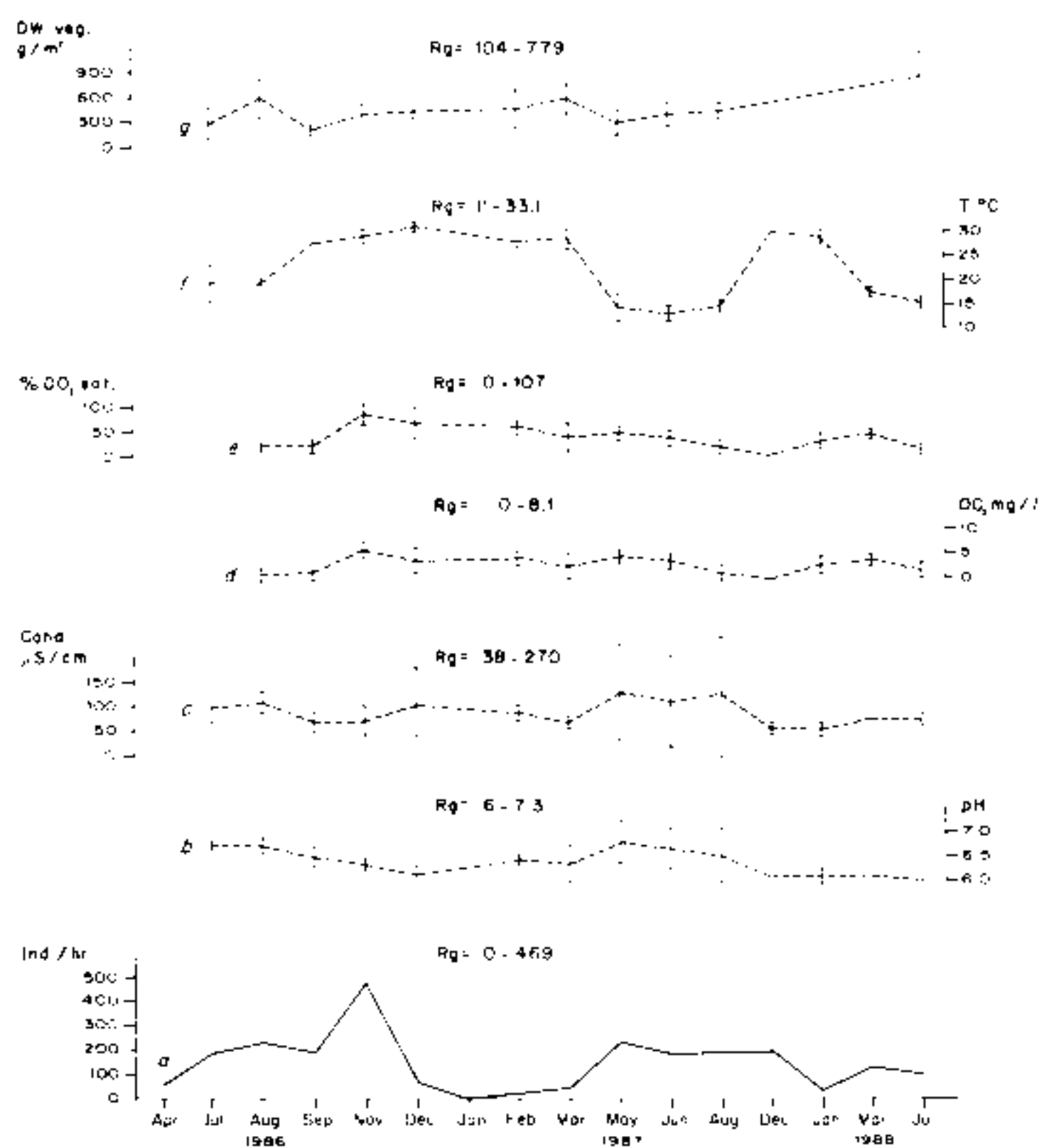


Fig. 2: annual fluctuation of parameters. Rg = range, a = *B. occidentalis* abundance, b = pH curve, c = conductivity, d = dissolved oxygen tension, e = dissolved oxygen percent saturation, f = water temperature, g = vegetation dry weight.

Environmental parameters did not markedly influence the observed numerical trends of the snail population, correlations being usually nonsignificant ( $P > 0.05$ ). A positive and linear correlation was observed between pH and snail abundance ( $r = 0.40$ ;  $P > 0.05$ , 13 *d.f.*); this relation was also positive, but logarithmic, when conductivity was taken into account ( $r = 0.36$ , 13 *d.f.*). Negative correlations were observed between snail abundance and plant biomass, rainfall and water temperature ( $r = -0.33$ , 13 *d.f.*;  $r = -0.33$ , 15 *d.f.*;  $r = -0.38$ , 13 *d.f.*, respectively). Monthly accumulated maximum temperatures were negatively correlated with snail abundance ( $r = -0.52$ ;  $P < 0.05$ , 15 *d.f.*) (Fig. 3).

Reproductive activity seems to begin by March-April, when the first stages of development are detected, and stops in summer months (Fig. 3). This activity keeps on nearly continuously, November being the month when most eggs (69%) were collected. Different cohorts overlapped between March and November. Almost nine months are required for each cohort to reach maximum size (16-18 mm). Only during the summer were a few maximum-sized specimens collected, when the most frequent age classes ranged from 3 to 8 (4 to 16 mm). Empty shells were mainly found during the warmer periods, from November to March, when temperature frequently reached the maximum records of about 30 °C. Table I shows the age structure data.

*B. occidentalis* showed a tendency to gather into clusters along the littoral section of the pond, a disposition that was attributed to the spatial distribution of aquatic plants with which snails associate. Three sampling points (E1, E2 and E3), differing in floristic composition, were chosen in order to test the above assumption. *Ludwigia peploides* was dominant at E1; at those points where it was not found, levels I and III were narrow and hardly distinguished. Patches of *Canna glauca* ("achira") were observed in E2, where only level V occurred. All levels occurred at E3. Level IV was often speckled with "embalsados" (rafts of pondweed like small floating islands).

The three sampling points showed no significant differences in snail abundance, which conversely changed significantly along the year (see results of Kruskal-Wallis and Friedman tests in Table II).

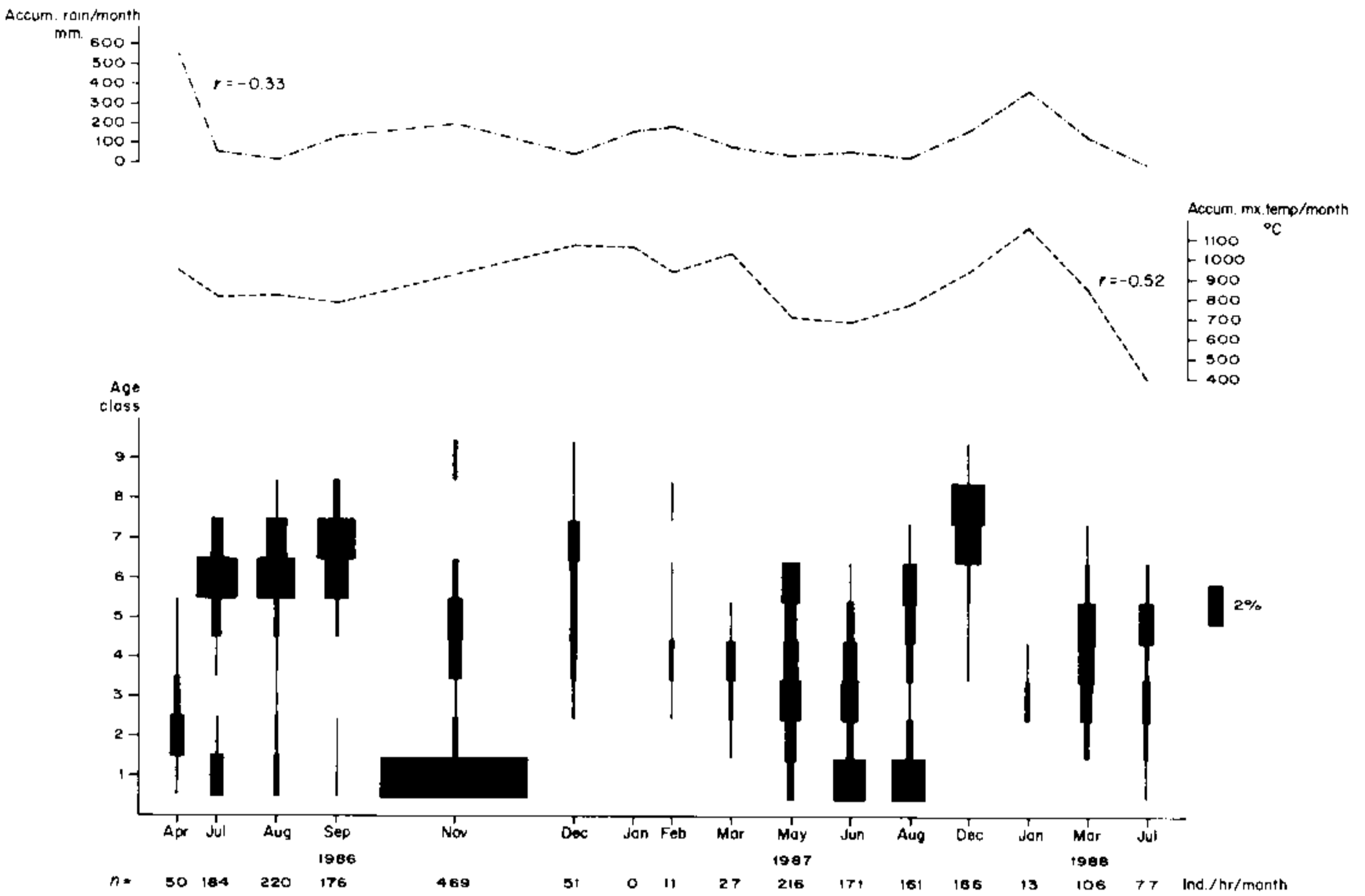


Fig. 3: age structure of *B. occidentalis*, monthly accumulated rainfall and monthly highest accumulated temperatures.  $r$  = correlation coefficient between parameter and no. individuals/hour.

TABLE I

Numbers of *Biomphalaria occidentalis* collected in Paiva pond, per age class and size, from April 1986 to July 1988

| Age class         | Diam mm | 1986 |     |     |     |     | 1987 |     |     |     |     | 1988 |     |     |     |     |     |
|-------------------|---------|------|-----|-----|-----|-----|------|-----|-----|-----|-----|------|-----|-----|-----|-----|-----|
|                   |         | Apr  | Jul | Aug | Sep | Nov | Dec  | Jan | Feb | Mar | May | Jun  | Aug | Dec | Jan | Mar | Jul |
| 9                 | > 16-18 | -    | -   | -   | -   | 9   | 2    | -   | -   | -   | -   | -    | -   | 3   | -   | -   | -   |
| 8                 | > 14-16 | -    | -   | 1   | 9   | -   | 4    | -   | 2   | -   | -   | -    | -   | 88  | -   | -   | -   |
| 7                 | > 12-14 | -    | 26  | 90  | 109 | -   | 18   | -   | -   | -   | -   | -    | 4   | 68  | -   | 1   | -   |
| 6                 | > 10-12 | -    | 104 | 104 | 52  | 14  | 7    | -   | 2   | -   | 47  | 1    | 26  | 3   | -   | 6   | 3   |
| 5                 | > 8-10  | 1    | 19  | 8   | 4   | 28  | 8    | -   | 2   | 2   | 31  | 15   | 20  | 2   | -   | 38  | 31  |
| 4                 | > 6-8   | 2    | 1   | 2   | -   | 24  | 7    | -   | 3   | 15  | 37  | 24   | 11  | 2   | 2   | 33  | 16  |
| 3                 | > 4-6   | 15   | -   | 2   | -   | 6   | 5    | -   | 2   | 9   | 56  | 40   | 3   | -   | 11  | 25  | 19  |
| 2                 | > 2-4   | 31   | 4   | 4   | 1   | 11  | -    | -   | -   | 1   | 27  | 13   | 13  | -   | -   | 3   | 6   |
| 1                 | Up to 2 | 1    | 30  | 9   | 1   | 377 | -    | -   | -   | -   | 18  | 78   | 84  | -   | -   | -   | 2   |
| Individuals/month |         | 50   | 184 | 220 | 176 | 469 | 51   | -   | 11  | 27  | 216 | 171  | 161 | 166 | 13  | 106 | 77  |

DISCUSSION

The present study describes a lenitic environment (Paiva pond) favorable to the maintenance of a population of *B. occidentalis* in northeastern Argentina. It is based on observations made over about two years (April 1986 to July 1988).

Most of the investigated abiotic parameters lie within the tolerance limits of other species of *Biomphalaria*. Particularly as concerns the influence of the highest accumulated temperatures and reproductive patterns upon the snail numerical changes, our observations agree with those of Michelson (1961) and Sturrock & Sturrock (1972), who showed that in *Biom-*

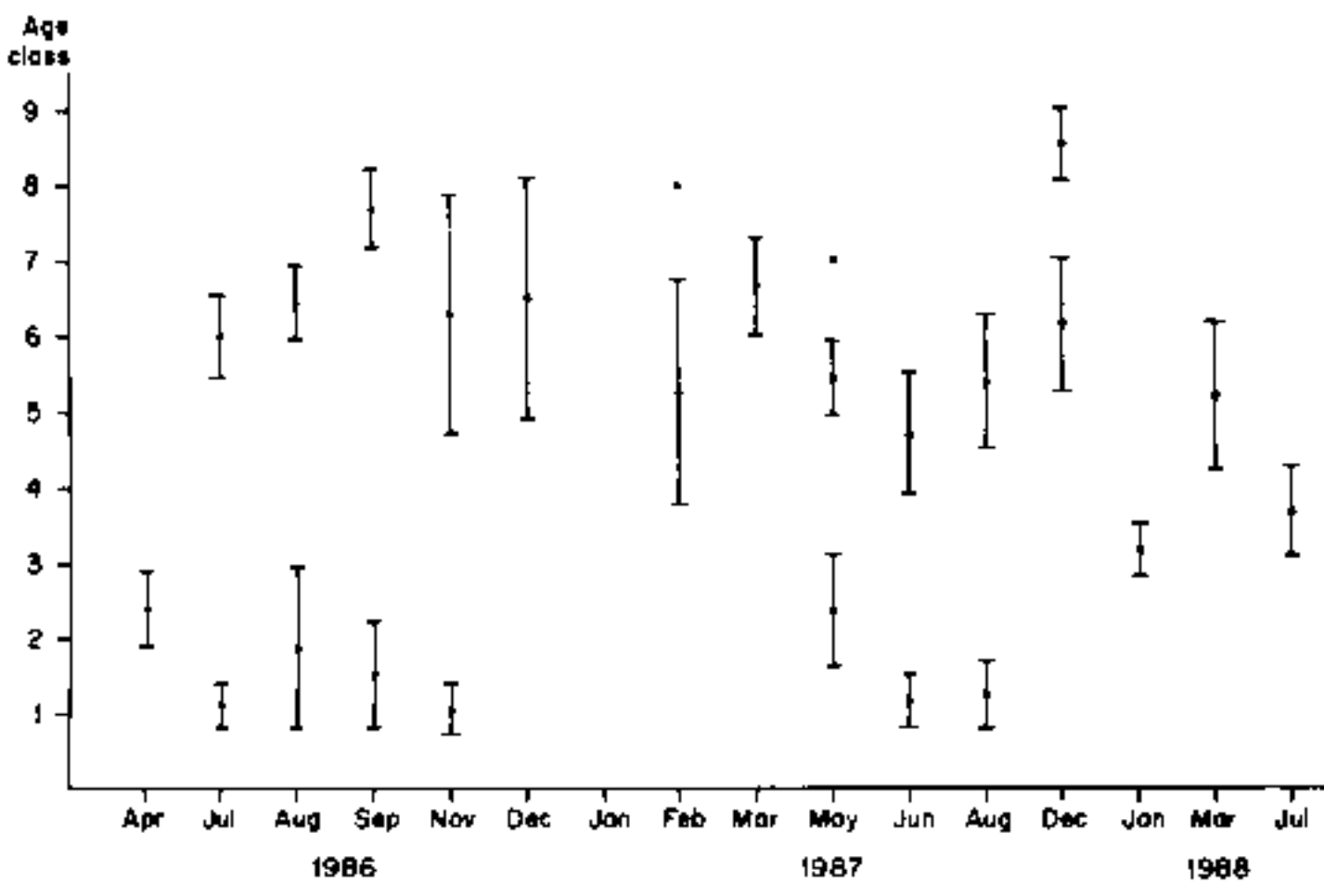


Fig. 4: mean  $\pm$  SD per ages and relative to cohort sizes along time. No snails found in Jan. 1987.

TABLE II

Numbers of *Biomphalaria occidentalis* per m<sup>2</sup>, collected from three stations in Paiva pond from July 1986 to August 1987

| Date                 | n | Sampling station |     |     |
|----------------------|---|------------------|-----|-----|
|                      |   | E1               | E2  | E3  |
| 7-28-86              | 4 | 68               | 306 | —   |
| 8-27-86              | 6 | 81               | 44  | —   |
| 9-29-86              | 5 | 143              | 0   | —   |
| 11-25-86             | 5 | 600              | 100 | 594 |
| 12-10-86             | 5 | 4                | 0   | 54  |
| 1-27-87 <sup>a</sup> | 3 | 0                | 0   | 0   |
| 2-24-87              | 3 | 8                | 36  | 0   |
| 3-31-87              | 3 | 60               | 24  | 24  |
| 5-26-87              | 4 | 60               | 16  | 44  |
| 7-23-87              | 6 | 250              | 8   | 84  |
| 8-24-87              | 6 | 867              | 28  | 210 |

a: samples not considered (snails absent).

Kruskal-Wallis test:  $H = 2.67$  (2 d.f.;  $\alpha = 7$ ), non-significant ( $P > 0.05$ ).

Friedman test:  $\chi^2 = 14.89$  (7 d.f.), good difference for same level of significance.

*phalaria glabrata* kept at 30 °C egg production is greatly reduced. Moreover, this negative effect upon population numerical trends is much stronger as regards prereproductive and postreproductive stages (Fig. 2). As temperature rises the water level of the pond lowers, so contributing to reinforce the mentioned effects.

The low correlation between snail abundance and rainfall might be due to the fact that rains are not so seasonally marked as in tropical areas.

The overlapping cohort pattern is somewhat similar to that observed by Appleton (1977) in *B. pfeifferi* and by Rumi (unpub-

lished) in *B. peregrina*, the latter exhibiting a continuous reproductive activity and an increased mortality at a late adult stage under experimental conditions, due probably to the physiological wear from reproductive effort.

As mentioned above, nonsignificant differences were observed among sampling sites with regard to abundance of snails, which indicates that their gregarious tendency results from their association with clusters of aquatic vegetation, as recorded by several authors (e.g. Pimentel & White, 1959, for *B. glabrata*).

The knowledge of the reproductive pattern and annual cycle events, as well as the influence of abiotic factors upon numerical spatial and temporal population changes, is required in order to know the reproductive value of each stage of development affecting them. In the case of intermediate hosts of parasites, such knowledge is essential in considering the application of control measures.

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