# TADPOLE DISTRIBUTION IN RELATION TO VEGETAL HETEROGENEITY IN TEMPORARY PONDS

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## ABSTRACT

The distribution in ponds of five species of anuran larvae has been studied in relation to the aquatic vegetation. According to the vegetal species composition, ponds have been classified in five zones. The innermost zone in which little or no vegetation grows was poorly frequented by tadpoles, which were mainly distributed throughout the other more vegetated zones. Some preferences for a specific zone have been found for several species.

## INTRODUCTION

Anurans commonly breed in temporary ponds and their larvae are considered to be adapted to the exploitation of the high productivity of this type of habitat (Wassersug 1975). Another adaptation observed is the flexibility of the breeding period of anurans in order to allocate the larval period when the ponds present adequate conditions for larval development (Díaz Paniagua 1985b, in press). Likewise, the larval stage also presents a flexibility according to the duration and the size individuals may reach, depending on the habitat conditions. Thus, tadpoles present a wide variability of sizes at metamorphosis although upper and lower limits are maintained inherent to each species (Wilbur & Collins 1973).

In this study I have studied the distribution of tadpoles in ponds in relation to the vegetation. This problem has been frequently studied for other aquatic animals, such as invertebrates and fishes (e.g. Rosine 1955, Dvorak & Best 1982, Corre *et al* 1982, Werner *et al* 1983, Keast 1984, Gregg & Rose 1985). For tadpoles, however, most of the studies concerning their distribution in ponds mainly consider physical or chemical charateristics (Noland & Ultsch 1981, Odendaal & Bull 1980, 1983, Odendaal *et al* 1982). Recently, Löschenkohl (1985), when studying niche dimensions of tadpoles, has analyzed the influence of vegetation, pointing out that vegetation may produce a shift in the microhabitat of some larval species.

## METHODS

During the anuran breeding season 1984-85, tadpole populations were sampled in 16 temporary ponds in the Biological Reserve of Doñana, a locality in south west Spain. Climate characteristics during the study period has been described in previous papers (see Díaz-Paniagua 1985b). Samples were taken monthly by sweeping with a fine meshed-net at different times of day, but always in daylight. They were located at different places along a transect from shore to the centre by each pond. Each sample consisted in sweeping three times each about 1.5m long. The larvae captured were identified, measured (body length without tail) and then released. Information was also recorded about depth and composition of the vegetal species with relative references to their abundance in each sample place.

The temporary ponds were all of freshwater and on sandy soil (detailed description in Díaz Paniagua 1983). Regarding the distribution of vegetation, five different zones were distinguished according to increasing depth. 1) Grass zone: These areas were mainly characterized by the presence of most of the species growing in the surrounding meadows. The most abundant ones were *Cynodon dactylon, Panicum repens* and *Chaetopogon fasciculatus*. 2) *Illecebrum verticilatum* or *Hypericum elodes* area: This area was characterized by the presence of one or both of these plants, presenting a peculiar thick appearance on the surface. 3) Emergent plant zone: *Eleocharis multicaulis,* very abundant in certain ponds was the most common species in this area, followed by *Eleocharis pallustris, Juncus heterophyllus, Holoschoenus vulgaris* and *Juncus spp.* 4) Submergent plants zone: A dense cover of *Myriophyllum alterniflorum, Ranunculus baudotii, Elatine alsinastrum, Callitriche spp., Potamogeton trichioides*, and/or *Zannichellia peltata* chacterized this area. 5) Innermost zone: where scarce or no vegetation was found (Fig. 1).

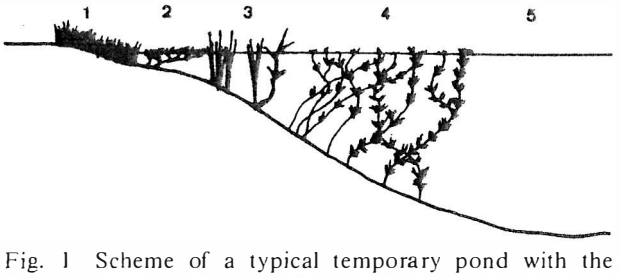


Fig. 1 Scheme of a typical temporary pond with the vegetation zones considered in this study.

Not all the zones referred to were present in all the ponds sampled. Number 1 was commonly followed by number 3, or, sometimes, in small zones, by zone 4.

The innermost zone was found only in the largest and deepest ponds, not occurring in the small and shallow ones.

These five zones were not fully defined in the ponds, where overlaps were wide and common. Therefore, a relative approximation was made according to the most abundant plant species to assign the sample places to one of the areas.

Data are presented as monthly histograms of each species, except for *Rana perezi* which occupied the ponds later than the others, thus only its total distribution is presented. Comparisons among them have been made by means of $X^2$-test and different degrees of freedom resulted because of the scarcity or absence of tadpoles in some vegetation zones, compelling a grouping of the data.

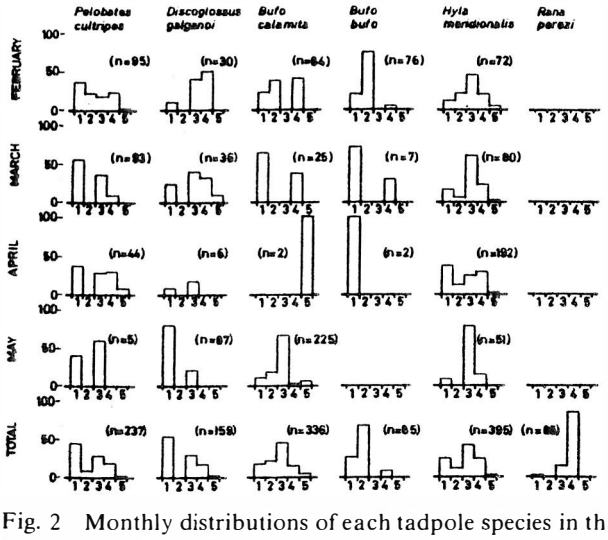


Fig. 2 Monthly distributions of each tadpole species in the five vegetation zones considered.

## RESULTS

The distribution of tadpoles of the five species according to the five vegetation zones in ponds is represented in Fig. 2. The main result common to all the species was the scarce or nonutilization of the innermost zone. Very low occurrences of *Pelobates cultripes, Discoglossus galganoi* (after Capula *et al*, 1985), *Bufo calamita* and *Hyla meridionalis* tadpoles have been observed there and none in the cases of *Bufo bufo* and *Rana perezi*. On the other hand, most of anuran larvae were distributed throughout the other vegetation zones, where their typical vegetation gave characteristic heterogeneity.

Considering each species individually, there did not seem to be a particular preference for the use of one of the four zones, as suggested by the differences between the distributions during each month considered (Fig. 2). However, in certain cases there was a major utilization of a specific zone. This was the case with *Hyla meridionalis* tadpoles, which were mainly associated with emergent plants, and *Bufo bufo* tadpoles appearing mostly in the first two zones. *Bufo calamita* and *Discoglossus galganoi* appeared in very different zones, having a large variation during the whole larval period. For *Pelobates cultripes*, a similar utilization of the different zones was observed, with a slight preference for the shore zones in the earliest months.

*Rana perezi* tadpoles showed a clear preference for the use of the submergent plants where approximately 80 per cent of the larval population was found.

Significant differences were found in comparing the total distributions of the species, except for the pair *Pelobates cultripes-Discoglossus galganoi* (Table 1), in which a main use of the first zone occurred.

| | *D. galganoi* | *B. calamita* | *B. bufo* | *H. meridionalis* | *R. perezi* |
|---|---|---|---|---|---|
| *P. cultripes* | 3.51 (d.f. = 3) | 65.42** (d.f. = 4) | 25.39** (d.f. = 4) | 30.66** (d.f. = 2) | 85.67** |
| *D. galganoi* | | 80.47** (d.f. = 3) | 34.33** (d.f. = 2) | 47.65** (d.f. = 3) | 113.70** (d.f. = 2) |
| *B. calamita* | | | 8.18* (d.f. = 2) | 29.20** (d.f. = 4) | 141.60** (d.f. = 2) |
| *B. bufo* | | | | 13.69** (d.f. = 2) | 103.79** (d.f. = 2) |
| *H. meridionalis* | | | | | 90.71** (d.f. = 2) |

*: $p<0.05$
**: $p<0.001$

TABLE 1: $X^2$-test comparisons among the total distributions of the species throughout the vegetation zones (d.f. = degrees of freedom).

## DISCUSSION

It is evident from the results that tadpoles mainly inhabited the vegetated zones of ponds while rarely visiting the innermost zones. The main difference between these two types of microhabitats concern the spatial heterogeneity provided by aquatic plants. Living in this more heterogeneous zone may provide some advantages to anuran larvae. The effect of predation has been considered an important factor regulating larval amphibian populations (Morin 1983) and it must be reduced in these zones because of the greater probability of escaping from predators (see e.g. Crowder & Cooper 1982, Werner *et al*, 1983). On the other hand, the phytophagous diet of these larval species (Díaz-Paniagua 1985) also suggest that in these zones they may largely find their optimal food.

I have not considered the influence of larval size in the distribution according to the zones in ponds, but it is probably important. There must be different requirements among tadpoles of different sizes, although in this case all the species showed a great use of all the vegetation zones.

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