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HABITAT AND PREY SELECTION IN THE LAKE FROG, *RANA LEVANTINA* IN NORTHERN CYPRUS

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INTRODUCTION

Three species of amphibian are native to Cyprus (Demetropoulos & Lambert, 1986; Bowles, 1989; Böhme & Wiedl, 1994), a toad, a tree-frog and a lake frog. As is commonly the case with island fauna which are part of widely-distributed species complexes, species determination has been controversial. Boehme & Wiedl's review regards the toad as *Bufo viridis*, not distinct enough from mainland populations to be regarded as a sub-species, though smaller and showing a greater range of colour patterns; the tree-frog is *Hyla savignyi*, now regarded as a distinct species, rather than a sub-species of *Hyla arborea.* Schneider and Sinsch (1992) and Schneider *et al* (1992) concluded on bioacoustical grounds that the widely distributed lake frogs previously all referred to *Rana ridibunda* should be sub-divided into three separate species, *R. ridibunda, R. balcanica* and *R. levantina.* Later allozyme analysis (Sinsch & Eblenkamp, 1994) supported this conclusion. On bioacoustic and morphological evidence, the Cyprus lake frog is *R. levantina* though there are doubts over the validity of the name (Böhme & Wiedl, 1994): this species is also found in Israel, the Nile delta and western Turkey.

As distinct from taxonomic investigation, very little work has been reported on the habits and ecology of *R. levantina*, especially from the northern part of the divided island of Cyprus. The observations reported here were made during July and August, the middle of the dry season. It rarely rains at this time of the year and skies are generally clear, resulting in day-time temperatures that often exceed 40°C. In Northern Cyprus, there are no running streams at this time and the only water-bodies are man-made reservoirs and ponds.

LAKE FROG DISTRIBUTION

Lake frogs were abundant in all four reservoirs we visited, distributed throughout Northern Cyprus (Fig. 1). We concentrated our efforts on a small reservoir near our base at Alagadi beach on the north coast, 10 km east of Girne (Kyrenia). Preliminary observations showed that the frogs emerged from the water to forage on the banks between 18.00-19.00h each evening allowing counts of distribution to be made.

Four distinct habitats occurred at the water's edge: open mud, reeds, rocks and floating weeds. A perimeter walk established the relative abundances of these habitats and the numbers of frogs found (Table 1). Though open mud was the commonest perimeter habitat type, frogs chose mainly the other three habitats, especially weeds.

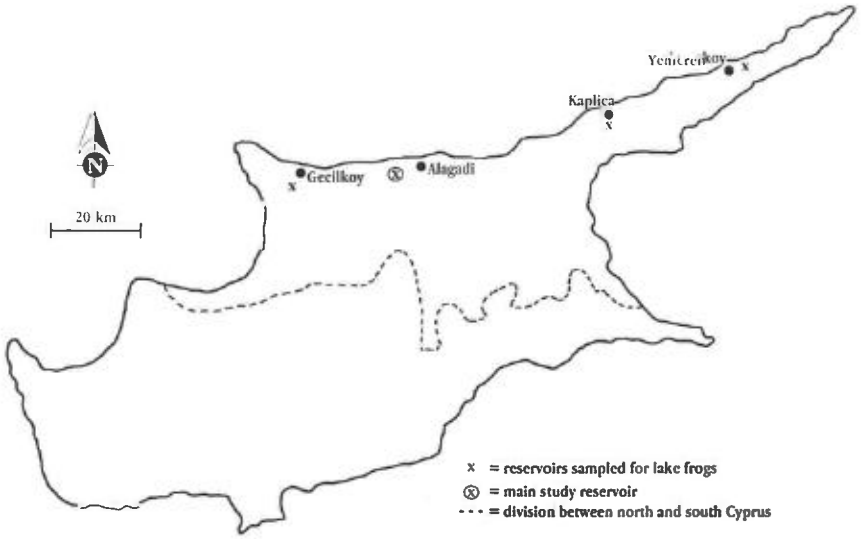

Figure 1. Sketch map of Northern Cyprus, showing reservoirs sampled for Lake Frogs, and base at Alagadi

The frogs could easily be allocated to two size classes: small, 2-3 cm body length; and large 3-9 cm. To check whether small and large frogs favoured the same habitats, two 10 metre lengths of each habitat type were checked for large and small frogs on five different occasions. Results are shown in Table 2. They confirm the overall habitat preference shown in Table 1 but additionally show a strong size-related preference: large frogs were absent from the weeds where small frogs were extremely abundant. However, large frogs predominated amongst the rocks, especially considering the overall distribution of about three small frogs to each large frog in the sample counted overall. X^2 calculations confirmed the statistical significance of these preferences.

EXPERIMENTAL POND

To allow more frequent observations of frog behaviour, an artificial pond was established at our base at Alagadi. An area of 1.5m² was dug to 0.5m deep and lined with polythene sheet. Once filled with water, the pond was divided into four quadrats and these were then set up to simulate the four habitats found at the reservoir perimeter (open, rocks, weeds and reeds) using vegetation and rocks brought from the reservoir. A sample of six large and eight small frogs was captured at the reservoir by hand-netting and released into the pond. After a day's acclimatisation, the distribution of the frogs in the pond was noted at different times around the clock over a period of three weeks. Results are shown in Table 3 using a habitat preference index corrected for the numbers of large and small frogs.

Although there were small differences around the clock, the distributions of the large and small frogs remained remarkably consistent, but showed some differences from the findings at the reservoir. As at the reservoir, neither large nor small frogs were found commonly in the open habitat; as at the reservoir large frogs were found among rocks more commonly than small frogs, and small frogs more commonly among weeds than large frogs. The main difference from the reservoir was that in the pond, both large and small frogs were most commonly found amongst reeds.

PREY SELECTION

Frogs were captured from the different habitat types around the reservoir perimeter, immediately after the twilight foraging period (18.00-19.00h). Frogs were then cooled and killed by freezing. Body sizes were measured and stomachs removed and preserved in formalin. Contents were later counted, measured and identified to Class or Order. Numbers and distribution of prey types related to foraging habitat are shown in Table 4. The commonest prey type was ants, followed by beetles and flies. In terms of prey items caught per frog, rocks were the most productive habitat and weeds conspicuously the poorest: amongst weeds, though numbers are small, spiders were the commonest prey, though representing only 7% of prey items taken by the whole sample.

Table 5 shows the size distribution of prey items, heavily skewed towards prey less than 3.0 mm long, mainly ants and small beetles. There is probably a tendency for larger frogs to capture larger prey: the largest prey item recorded was a 55 mm locust taken by a 69 mm long frog. However, our sample only included 5 frogs over 31 mm and there was no evidence that larger frogs ceased to capture small prey.

DISCUSSION

The main factors likely to influence the spatial distribution of lake-frogs such as *R. levantina* are predation, desiccation and food availability. During summer time in North Cyprus there is rarely any rainfall and the land is baked dry by the very hot sun. Lake frogs consequently spend much of the day in the water at reservoir perimeters, emerging to forage late in the day.

Frogs were not evenly distributed round the perimeter of the reservoir we studied. Though open mud was the commonest habitat, frogs were rarely found there: instead, they congregated in areas of rocks and vegetation. This pattern of distribution was essentially repeated in our experimental pond and was shown not to be the twilight hours. A somewhat similar result was found by Hovingh (1993) in a study of the Spotted Pond Frog *Rana pretiosa*. Rocks and vegetation are likely to provide better protection from predation and desiccation than an open mud bank, and may also be richer in food resources.

It was particularly interesting that large and small frogs preferred different habitats. This could be for several possible reasons. Cannibalism by large frogs on smaller conspecifics is not unknown: we saw no evidence of this, but our stomach contents sample for larger frogs was quite small. The weedy areas may offer better escape opportunities for small frogs and may be difficult for larger individuals to move through. The stomach contents sample was particularly interesting: if it relates well to prey availability, it suggests that the weedy area is poor in prey, and that the smaller frogs may use it mainly as a refuge, emerging into the reeds and rocky areas to forage.

This study is obviously limited by having been carried out only in the dry season: it would be of considerable interest to examine the life of these frogs at wetter and cooler times of the year. It is obvious that nowadays reservoirs are of vital importance for the maintenance of amphibian populations in Northern Cyprus. This study suggests that a varied perimeter, especially including rocks and vegetation, is essential if amphibians are to survive there.

Table 1
Distribution of habitats and frogs round the edge of a small reservoir in Northern Cyprus

Habitat type	Total length of habitat (m)	Frog density (number per metre)
open	571	0.03
reeds	185	0.5
rocks	77	0.4
weeds	22	3.2

Table 2
Mean numbers of large and small frogs observed in the different reservoir perimeter habitats (per 10 m length)

Habitat type	Large frogs	Small frogs
open	0.1	1.2
reeds	0.4	5.9
rocks	5.6	2.7
weeds	0	13.9

Table 3
Habitat preferences[4] at different times of day in the experimental pond

	Large frogs				Small frogs			
Time of day	open	reeds	rocks	weeds	open	reeds	rocks	weeds
Early morning[1]	0.9	3.8	1.7	0.8	0.3	3.8	0.2	2.7
Full day[2]	0.1	4.3	1.6	0.7	0.1	4.1	0.2	1.9
Night[3]	0.1	3.4	0.5	1.2	0.2	3.4	0.3	2.4

1: Early morning = 0.500-09.00h, sampled 23 times

2: Full day = 11.00-17.00h, sampled 34 times

3: Night = 19.00-02.00h, sampled 18 times

4: The habitat preference index shown in the table was calculated by totalling all sightings, then dividing by the number of times sampled and the number of large or small frogs in the pond (x10).

Table 4

Numbers and distribution of prey items related to reservoir perimeter habitat

Prey		Habitat type			
type	total	open	reeds	rocks	weeds
flies	13	4	3	6	-
beetles	24	3	5	16	-
ants	30	6	10	10	2
locusts	1	-	-	1	-
spiders	6	1	2	-	3
unidentified	1	-	1	-	-
Total	75	14	23	33	5
mean per frog[1]	2.1	2.8	3.8	4.1	1.0

1: 28 frogs in total were captured, 8 from rocks, 6 from reeds and 5 each from open and weeds.

Table 5

Size distribution of all prey items recorded (%)

0.6 - 3.0 mm	3.1 - 5.0 mm	5.1 - 7.0 mm	>7.1 mm
78	13	4	5

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