Short Notes

Summer habitat population estimate and body size variation in a high altitude population of *Rana temporaria*

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Population size and structure of the common frog, *Rana temporaria,* have been intensively studied by many authors during the last three decades (e.g. Cooke, 1975; Grossenbacher, 1980; Pascual and Montori, 1981; Hintermann, 1984; Loman, 1984; Ryser, 1986; Elmberg, 1990; Kneitz, 1998). Most of these papers deal with low- or mid-altitude populations in Central Europe, which are generally located in at least partly forested habitats, whereas few studies have been carried out on the ecology of *Rana temporaria* in alpine environments (e.g., Balcells, 1975; Elmberg and Lundberg, 1991; Ryser, 1996).

In the Alps and Pyrenees the species reaches altitudes as high as 2630 m (Alps: Grossenbacher, 1997) and at least 2700 m (Pyrenees, Ibones de la Facha near Circo de Piedrafita: pers. obs.; Esteban, 1997). Records of almost 3000 m (Balcells, 1975) or 2950 m (Esteban, 1997) probably refer to Beck (1943) who reported *R. temporaria* at 2965 m (Pic de Cambalès). However, ponds and marshes around this mountain are only found at lower altitudes, and the occurrence of a *R. temporaria* population at a mountain summit is not probable; the 2965 m altitude information is thus rather doubtful (Grossenbacher, pers. comm.).

From 6 to 29 July 1998 we studied *R. temporaria* specimens inhabiting the Ibón de las Ranas, a medium-sized glacial pond (water surface ca. 170 × 60 m; maximum depth 5 m), which is located at ca. 2200 m altitude in the Circo de Piedrafita, western Pyrenees, Aragón, Spain (42°49′N, 0°17′W). The pond is in an area without forest cover; the only

higher vegetation are some *Rhododendron ferrugineum* shrubs at the edges. Many large *R. temporaria* tadpoles were present in the pond, indicating that reproduction had taken place several weeks ago. Frogs were easily observed during day and night at the pond edges, generally jumping into the water when disturbed, and at a distance of mostly less than 2 m from the water. The aim of the present paper is to estimate the number of common frogs which were present in and near the pond in July 1998, and to describe variation in body size and mass among the observed specimens.

Frogs were captured on 15 July, 20 July and 25 July during the day by systematically searching the pond edges. Of each specimen, we measured snout-vent length (SVL) to the nearest mm using a ruler. All specimens of more than 50 mm SVL (and also some smaller specimens of 43-50 mm SVL) could be reliably sexed and were considered as adults. Adult specimens were marked by toe-clipping (wounds treated with antiseptic), most with individual marking codes. Recaptures after 10 days showed that the wounds were largely healed at that state; no infections were observed. The large amount of juvenile specimens (size class: SVL 15-26 mm) around the pond made their separate consideration necessary. One first sample was measured and marked (no individual codes) on 15 July; a larger sample was marked on 21 July (no measurements recorded), with recapture taking place on 25 July. During the study period nearly no precipitation was recorded, resulting in a very dry state of the pond surroundings. No migration of frogs was observed during regularly performed night searches; the studied part of the population can thus approximately be considered as closed for the study period, allowing the use of simple population estimates.

Using the weighted mean calculation of Seber (1973), the total number of adult frogs inhabiting the Ibón de las Ranas in the study period was estimated as 770 (table 1). Of these, by far the largest part were males. Only 40 out of the 581 captured adults (recaptures not considered) were females. The total number of juvenile specimens living in the surroundings of the pond was estimated as 5493 on 25 July (the higher estimate on 21 July is much less reliable since it was based on a rather low number of recaptures). According to the charts of Robson and Regier (1964), an accuracy of ± 10% is matched by the calculation of the total adult numbers 25 July (with $P < 0.05$). The same is true for the estimate of the numbers of males and juveniles on 25 July, whereas the accuracy of the

Table 1. Estimate of summer habitat population size of adult and juvenile *Rana temporaria* at the Ibón de las Ranas. (1) Simple Petersen estimate (Petersen, 1896); (2) Weighted mean estimate (Seber, 1973), ± standard error (see Begon, 1979). Due to low recapture rate on 21.7, no weighted mean estimate was calculated for juveniles.

	Total adults		Males		Females		Juveniles	
	20 July	25 July	20 July	25 July	20 July	25 July	21 July	25 July
marked in population (a)	348	492	327	456	21	36	216	1597
captured (b)	246	272	229	257	17	15	1415	908
marked in captured sample (c)	102	183	100	174	2	9	34	264
(1) Population ab/c	839	731	748	674	179	60	8989	5493
(2) Population *6* ab/*6* c	770 ± 46		701 ± 43		82 ± 27		–	

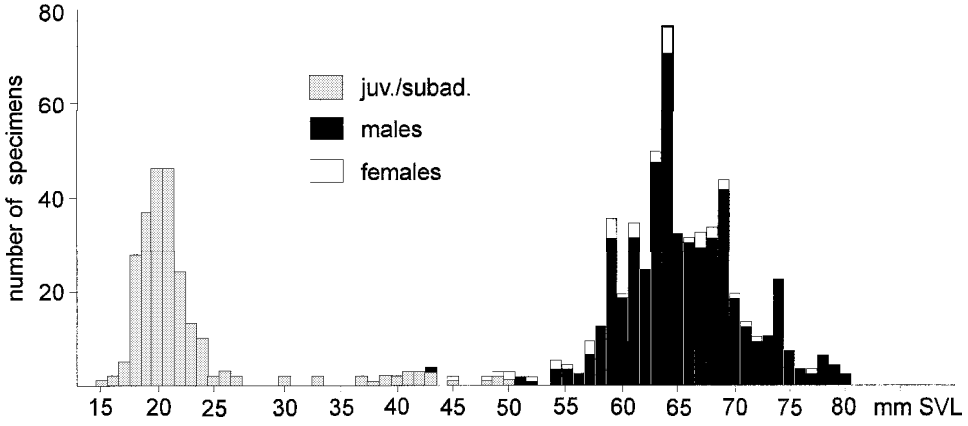

Figure 1. Size distribution (SVL) of 828 *Rana temporaria* specimens captured in July 1998 at the Ibón de las Ranas (recaptures not considered).

estimate for female numbers, due to the low sample size and recapture rate, is below the ± 50% level required for a preliminary survey (Robson and Regier, 1964).

Distribution of size classes (fig. 1) shows that the studied sample consisted mainly of a juveniles (almost certainly specimens metamorphosed in 1997) and adult males. Almost no subadults were found. Mean SVL (± standard deviation, minimum and maximum in parentheses) was 67 ± 6 mm (45-84 mm; n = 541) for males, 62 ± 7 mm (48-78 mm; n = 40) for females.

The female proportion in the studied sample (6.8%) was extremely low. The observed smaller size of the captured females (as compared to males) is not the typical pattern found in *Rana temporaria* (generally, females were found to be larger than males: e.g., Galán, 1989; Sperling et al., 1996; Ryser, 1996; Kneitz, 1998). Therefore, we assume that our sample is not representative for the total female population of the Circo de Piedrafita. Combes (1967), in another Pyrenean population (2030 m altitude), observed a 1 : 1 sex ratio in the breeding season, but during summer the male proportion increased to 83-94%; in mid-September, the population reached the 1 : 1 balance again. Almost certainly, a high percentage of the females breeding in the Ibón de las Ranas, especially the larger ones, were not present (or not active) around the pond in July.

According to the available data, *R. temporaria* lowland populations perform spring and partly autumn migrations to their breeding ponds, and are generally found in terrestrial summer habitats (e.g. Loman, 1978; Strijbosch, 1980; Verrell and Halliday, 1985; Hintermann, 1984; Ryser, 1986; Kneitz, 1998). Large-scale semi-aquatic summer activity, as observed in the Ibón de las Ranas population, appears to be a feature found mainly in alpine environments (Combes, 1967; Nöllert and Nöllert, 1992; Serra-Cobo et al., 1998). Such habits, at lower altitudes, are typical for water frog species of the subgenus *Pelophylax* (sensu Dubois, 1992), represented in Spain by *Rana perezi*. Water frogs may be relevant

competitors at lower altitudes, and thus constitute one factor explaining this altitudinal difference in *R. temporaria* summer habitat use. More probably, however, the lack of suited humid and shaded terrestrial environments, such as forest leaf litter, leads many *R. temporaria* specimens to stay close to the water bodies at high altitudes, especially during the dry summer periods.

Cooke (1975) calculated minimum population sizes of *R. temporaria* in Britain by egg mass count and an assumption of an 1 : 1 sex ratio. Of 574 recorded populations, 87 had (minimum) sizes of 100-999, and only three were calculated to consist of 1000 or more individuals. Applying a minimum estimate to the adult breeding population at the Ibón de las Ranas (700 males, sex ratio 3 : 1) gives a number of approximately 1000 specimens; the real numbers are probably much higher (at least 1400 when a sex ratio of 1 : 1 is assumed). Certainly, the population can therefore be characterized as relatively large. Pascual and Montori (1981) estimated the main population of the Catalonian Montseny massif as 820-1333 individuals, other estimates and records of large populations are 1916 (Grossenbacher, 1980), 312-2525 (Hintermann, 1984), and 821-1100 (Ryser, 1986).

Many of the known large lowland and mid-altitude colonies of *R. temporaria* breed in non-natural aquatic sites. So, the main breeding site of the Montseny population is a small dam (Pascual and Montori, 1981), Grossenbacher's (1980) population lived in an abandoned gravel pit, Ryser's (1986) study was done at a garden pond, and at least one of Hintermann's (1984) two ponds was also artificial. The large populations studied by Kneitz (1998) all lived in artificial ponds, too. According to our observations in the Circo de Piedrafita area and other parts of the Pyrenees, montane *R. temporaria* populations appear often to be rather large, and they mostly occur in natural ponds and lakes. Similarly, in the Alps, Grossenbacher (pers. comm.) regularly observed about 2000 egg masses in a montane lake at 1850 m. These large natural population sizes may be an important difference to many areas of lower altitude. In lowlands, *R. temporaria* probably inhabited originally swamp areas and stagnant tributaries of forest brooks and streams which in most cases can only harbour a metapopulation network of rather small subpopulations.

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