

The Cambalès fairy tale: elevational limits of *Rana temporaria* (Amphibia: Ranidae) and other European amphibians revisited

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Abstract. The highest altitude recorded for an amphibian in Europe (west of the Caucasus) is 2965 m. It refers to the "lacs de Cambalès" according to an old reference. However, these lakes are all situated below 2600 m, while the altitude corresponds exactly to that of the summit of the Pic de Cambalès. We undertook an almost complete survey of ponds in a 2.5 km radius from the Cambalès peak, and complemented these data by fieldwork in a larger portion of the Central Pyrenees. Based on our observations in a total of 325 lakes and ponds we conclude that no water bodies above 2800 m exist in the Cambalès area, and that no water bodies above 2600 m are populated by *Rana temporaria*. The highest amphibian record was that of a single *R. temporaria* specimen at 2569 m, while the highest reproducing population was found at 2516 m. Highest records of other amphibians were 2516 m (*Alytes obstetricans*), 2160 m (*Bufo bufo*), 2259 m (*Euproctus asper*), and 2142 m (*Salamandra salamandra*). The presence of ice-free water bodies during a sufficient amount of time for larval development is probably the limiting factor for elevational distribution of Pyrenean amphibians, and the adequate conditions are usually not met above 2500 m in this massif. In contrast, in the Alps, ponds at higher altitudes are often protected by much higher surrounding peaks, which leads to higher elevational occurrence of amphibians. The Italian Laghi di Tre Becchi (up to 2742 m) are therefore the highest locality of a reproducing anuran population in Europe west of the Caucasus.

Key words: Amphibia, altitudinal distribution, Pyrenees, Spain, France, *Rana temporaria*

Introduction

The common frog (*Rana temporaria*) is one of the European amphibians of largest altitudinal tolerance. It occurs near sea level as well as in alpine environments at high elevations in the Alps and Pyrenees (Grossenbacher 1997b), where it often forms large populations in glacial lakes (Vences et al. 1999). Its climatic plasticity is also evident from the fact that, as only amphibian species, it reaches the North Cape (Grossenbacher 1997b).

Rana temporaria is one of the most important amphibian model organisms in different fields of biology. An impressive number of old publications dealing with this species are listed by Grossenbacher et al. (1988); the database of the National Library of Medicine of the USA lists 4200 entries (as of July 2002). Despite this large number of publications, some basic natural history data on *R. temporaria* are still lacking (Dubois 1982a). Among these is its altitudinal limit in montane areas. Assessment of the ecological limits of this frog is an important prerequisite for comparative studies on its adaptive

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plasticity in morphological and natural history traits (e.g., Balcells 1975, Brand & Grossenbacher 1979, Miaud et al. 1999, Merilä et al. 2000, Vences et al. 2002).

The highest altitude for the species is based on Beck (1943) who reported the species from the "lac de Cambalès (2965 m) où elle a été capturée par M. de Bonnal." Consequently, the elevational limit of *Rana temporaria* is given as 2950 m (Barbadillo et al. 1999, Esteban 1997), 2965 m (García-Paris 1985), 2800 m (Martinez-Rica 1979) or 3000 m (Nöllert & Nöllert 1992). According to available maps, the "Lacs de Cambalès" are located north of the "Pic de Cambalès" (Pico de Cambalès), a mountain peak at the Spanish-French border in the Central Pyrenees.

During long-term studies on *Rana temporaria* in the Circo de Piedrafita area, west of the Cambalès peak, we also surveyed this massif and its surroundings. As we noted that no habitats suited for the species were present on the Cambalès summit, we decided to carry out more systematic fieldwork in this area. In the present paper we (a) provide detailed data for a region 2.5 km around the Cambalès peak, demonstrating that no breeding populations of the common frog occur above 2516 m in this area and (b) report on the altitudinal distribution of the species in a larger sample of ponds from the Central Pyrenees. We thereby provide basic data to understand the factors that constrain the occurrence of this frog species at higher elevations.

Methods and Study Area

Field work was carried out between 1998 and 2001 in an area encompassing a circular radius of 2.5 km around the Pic de Cambalès summit (Fig. 1). In this area, M. Vences, M. Puente and D. R. Vieites tried to localize all ponds potentially suited for *Rana temporaria* using topographic maps (Anonymous 1996, 2000). All these ponds were surveyed at least once in July 2001 when generally adults and tadpoles are easily recorded (Vences et al. 1999). Most localities between 2000 and 2300 m altitude were also surveyed in May and/or June 2001. Coordinates and altitudes of ponds were assessed both from maps and aerial photographs and from GPS readings *in situ*. A large number of additional ponds not included in the maps were also encountered and are included in the survey.

To gather data on the altitudinal distribution of *Rana temporaria* in a more representative portion of the Pyrenees, A. Palanca surveyed lakes and ponds in the central part of the Parc National des Pyrénées in France during July 2001, within an area of ca. 450 square km and located between 0°12'E and 0°30'W, and between 42°43'N and 42°45'N in the west and between 42°50'N and 42°52'N in the east. The study area included the lakes of Barraude, Troumouse, Espécières, Montferrat, Estom y Oulettes de Estom, Arratille, La Claou, roughly located north and northwest of Cambalès; and Batcrabère, Arrémoulit, Ayous, Peyreget, Pombie, roughly located east of Cambalès. A complete list of the water bodies surveyed is available by the authors on request.

For each pond, we recorded the presence or absence of *Rana temporaria*, and assessed reproduction of the species (by presence of reproducing adults, spawn or tadpoles). We also recorded a large number of additional environmental parameters, which will be subjected to analysis in forthcoming works.

Statistical analysis was carried out with SPSS for windows, version 10. Logistic regression curves were drawn using the Statgraphics Plus 2.1 software package.

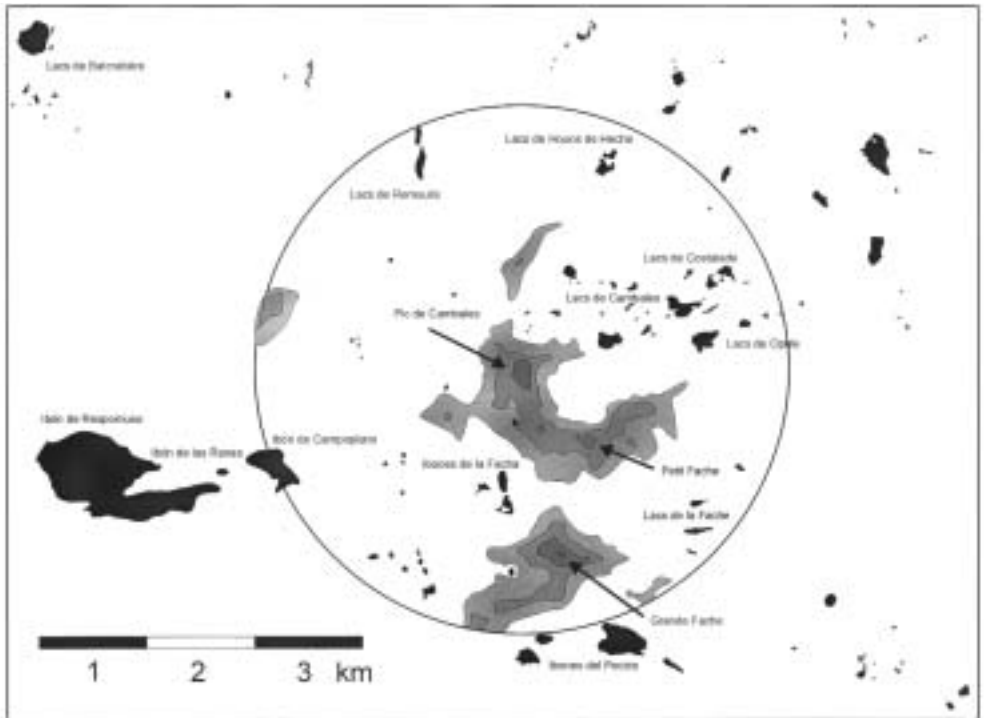


Fig. 1. Map of the study area around the Cambalès peak. The circle marks the area in a radius of 2.5 km around the Pic de Cambalès that was intensively surveyed. Black marks water bodies. Altitudinal levels (given only within the circle): light grey marks altitudes above 2700 m, dark grey above 2800 m, darkest grey above 2900 m.



Fig. 2. High-altitude localities in the Cambalès region. Left: View from the descent from the Col de Cambalès towards the lacs de Cambalès; the arrow points to the highest Cambalès lake (ID 130 in the appendix; 2578 m) on 21 July 2001 which was largely covered by ice and not populated by *Rana temporaria*. Right: upper Ibón de la Facha, (2516 m), highest site with ascertained reproduction of *R. temporaria* and *A. obstetricans*; 23 July 2001.

Results

Our survey yielded data on a total of 137 ponds and lakes in a radius of 2.5 km of the Cambalès peak. The majority of these (83) were located in the Circo de Piedrafita, in an area encompassing the Campoplano plain and the Respomuso lake. 20 sites were in the area of the Lacs de Cambalès, Lacs de Opale and Lacs de Costalade. Six sites were in the area of the Lacs de la Fache, east of the Col de la Fache, 12 sites were in the area of the Ibones de la Facha and the western slopes of the Campoplano peak, 10 sites on the northern slopes of the Grande Fache and Llenacantal peaks, and six sites in the Lac de Remoulis area. The only larger water bodies not surveyed by us were the Lacs de Houns de Heche and the limital Lacs de Bernat Barrau and Ibones de Pezico.

The highest record of *R. temporaria* in this area was one specimen captured above the Ibones de la Facha at 42°48'59"N, 0°14'49"W, at 2569 m (specimen found in a terrestrial habitat; locality therefore not included in appendix). The highest reproducing population was the one from the upper Ibón de la Facha at 2516 m (erroneously given as 2700 m by Venes et al. 1999). At this site (see appendix for coordinates) we also observed calling

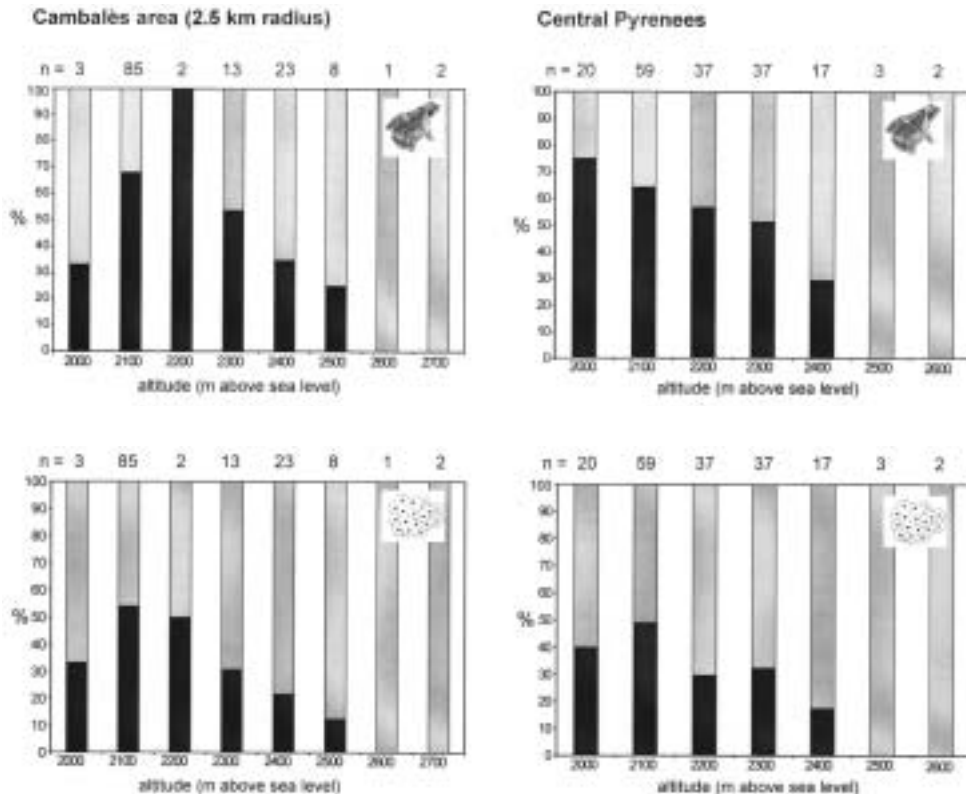


Fig. 3. Presence and ascertained reproduction of *Rana temporaria* in ponds in the survey area within a 2.5 km radius around the Cambalès peak (left graphs) and in a wider area of the Central Pyrenees excluding the Cambalès region (right graphs). Black bars mark the percentage of ponds and lakes in which *Rana temporaria* was recorded (upper graphs) or in which reproduction of the species was ascertained (lower graphs) at different altitudinal levels. Numbers above bars mark the total number of studied pond at the respective elevational level.

Table 1. Coefficients and their standard errors from logistic regression analyses of presence and ascertained reproduction of *Rana temporaria* in ponds within a 2.5 km radius around the Cambalès peak and in a wider area of the Central Pyrenees excluding the Cambalès region (for the logistic regression formula: presence = $\exp(\eta) / (1 + \exp(\eta))$, with $\eta = \text{constant} + a \cdot \text{altitude} - b \cdot \text{altitude}^2$).

	Cambalès area presence	Cambalès area reproduction	Central Pyrenees presence	Central Pyrenees reproduction
Constant	-117.55 ± 76.92	-74.59 ± 80.58	-33.60 ± 52.35	-33.79 ± 53.33
a	0.1066 ± 0.0671	0.0691 ± 0.0704	0.0351 ± 0.0463	0.0329 ± 0.0473
b	-0.000024 ± 0.000015	-0.000016 ± 0.000015	-0.000009 ± 0.000010	-0.000008 ± 0.000011

specimens in 2001 and large (probably overwintering) tadpoles of *Alytes obstetricans* in 1998 and 2000.

The Lacs de Cambalès are located in a valley northeast of the Cambalès peak. This complex includes a number of lakes and ponds as high as 2590 m which, however, on 21 July 2001 were still almost completely covered by ice. Despite intensive searches, no amphibians were found in this area above 2400 m, while ponds and lakes below this limit often were populated by *Rana temporaria*. Reproduction could be ascertained mostly in smaller ponds, and only limited numbers of frogs were seen along the shore of the large lakes, which harboured important numbers of fishes (*Salmo trutta fario* and *Phoxinus phoxinus*). The elevation of the Cambalès summit itself is 2968 m according to topographic maps and 2964 m according to our own GPS readings; the way to the summit was largely covered by snow at the end of July 2001. In 2000, we climbed the peak (GPS reading: 42°49'25"N, 0°14'36"W) and ascertained that no water bodies were present on the summit or at altitudes above 2800 m in the area.

Considering all 137 ponds within the 2.5 km radius around the Cambalès peak, the highest incidence (100%) of *Rana temporaria* was found at an altitudinal level between 2300 and 2400 m, while more than 30% of the ponds were populated at all levels between 2400 and 2500 m. Only two out of eight sites above 2500 m were populated, and the three sites above 2600 m were not populated (Fig. 3). A similar situation was found regarding reproductive activity, which was recorded in only one pond above 2500 m (upper Ibón de la Facha). The predictive values of a logistic regression analysis reached zero at altitude values between 2700 and 2800 m, both for presence and reproduction of *R. temporaria* (Fig. 3, Table 1).

Beside the Cambalès surroundings we surveyed a total of 188 ponds in the Central Pyrenees. As a general trend (Fig. 3), the lowest proportion of ponds with presence of *R. temporaria* or with ascertained reproduction corresponded to those between 2400 and 2500 m, while no frogs were observed above 2500 m. The highest record both of presence and reproduction was at the Lacs d'Estom at 2492 m (42°47'00"N, 0°05'02"W). The predictive values of a logistic regression analysis reached zero at altitude values between 2800 and 2900 m, both for presence and reproduction of *R. temporaria* (Fig. 3, Table 1).

The highest records of reproducing amphibian populations in the area surveyed were *R. temporaria* and *A. obstetricans* in the Ibones de la Facha, above 2500 m. Other maximum elevations of amphibians were as follows: *Euproctus asper*, 2259 m (Circo de Piedrafita;

42°49'03"N, 0°16'43"W); *Salamandra salamandra*, 2142 m (Circo de Piedrafita; 42°48'52"N, 0°16'55"W); *Bufo bufo*, 2160 m (Circo de Piedrafita; 42°48'58"N, 0°16'05"W).

During our surveys, we also made observations on the reproductive period of *R. temporaria* at different elevations. In 2001, egg deposition at 2100-2200 m altitude took place between late May and mid-June, while between 2400 and 2500 m fresh clutches were found in July. At the upper Ibón de la Facha we observed diurnal calling activity and very recent clutches on 23 July 2001. No older clutches or tadpoles were seen, indicating that reproduction had just started. In contrast, in the warmer years 1998 and 2000, we found relatively small tadpoles at this site in mid-July. In one other high-altitude pond (42°48'32"N, 0°15'29"W; 2491 m) we recorded, in July 2001, a large number of dead tadpoles in late developmental stages (partly with developed forelimbs) at places where the thick ice cover was melting. Nearby, fresh clutches were found, indicating that the dead tadpoles were remains from the previous year and died by freezing before completion of metamorphosis. No juvenile frogs were found at any site above 2450 m while they were common between 2100-2300 m.

Discussion

In the present paper we give results from the most complete amphibian survey so far carried out at high altitudes in the central Pyrenees. We failed to find *Rana temporaria* or any other amphibian at elevations higher than 2600 m, and did not observe any reproducing amphibian population above 2500 m. There is overwhelming evidence that the highest record of a frog species in Europe west of the Caucasus, 2965 m at the Cambalès lake according to Beck (1943), is actually based on a mistake: (a) no lake exists at this altitude in at least a 2.5 km radius around the Pic de Cambalès; (b) the altitude corresponds perfectly to the summit of the Cambalès peak but not to the lake system denominated "Lacs de Cambalès" on recent maps; (c) despite intensive surveys, no amphibians were found above 2600 m in the region. This also implies that the record at 2700 m in the "Puerto de Piedrafita" by Esteban (1997) does not refer to a breeding population.

The data of Beck (1943) were based largely on personal communications. At the end of his paper he acknowledged "M. le comte de Bonnal, de Montgaillard, qui a bien voulu me faire profiter de ses remarquables notes de chasse et de sa connaissance approfondie de notre région". Thus, the occurrence of *Rana temporaria* at 2965 m at "lac de Cambalès", based on a record of M. de Bonnal, most probably originated because in the field notes of that observer the altitude of the Pic de Cambalès was erroneously given as altitude for the lac(s) de Cambalès. A similar rationale applies to the highest record of the newt *Euproctus asper*, which is given as "Pic de Cambalès (2965 m)" in Beck (1943). We confirm the view of Clergue-Gazeau (1999) and Martínez-Rica (1997) that this record is a confusion with the Cambalès lakes, which are at much lower altitudes.

Besides defining the altitudinal limit of *Rana temporaria* in the Pyrenees, our data also bear relevance for other amphibians. So, the highest record of the midwife toad (*Alytes obstetricans*) was up to now 2400 m (Grossenbacher 1997a, Barbadiño et al. 1999) and is based on the finding by Angelier & Angelier (1964) of a reproducing population in the Gourg de Rabas, a small lake above the Aumar plateau in the Massif de Néouvielle. The population still exists (K. Grossenbacher, 13 July 2000), but is endangered by introduced trout (*Salmo trutta fario*). On the same excursion in July 2000, K.

Grossenbacher found few young larvae and an egg clutch of *Alytes obstetricans* in a small pond above the Gourg de Rabas at 2490 m altitude.

The reproducing population of *A. obstetricans* above 2500 m in the Ibones de la Facha therefore is the highest current record for the whole genus *Alytes* (see Barbadiño et al. 1999). Other amphibians present in the Circo de Piedrafita apparently do not occur above 2300 m in this region; this is true for *Bufo bufo*, *Salamandra salamandra* and *Euproctus asper*. *Bufo bufo* has been reported to occur up to 2600 m in the Pyrenees (Barbadiño et al. 1999) and is reliably known from 2650 m in the Moroccan Atlas (Dubois 1982b), but in the area surveyed by us we never observed the species at elevations higher than 2160 m. This agrees with the data of Martínez-Rica (1979) who reported the maximum Pyrenean altitude of this toad to be at about 2000 m. The presence of *S. salamandra* at 2100 m has already been reported by Beck (1943) for the French Pyrenees (Pic de la Cardinquère; observation of Bonnal), and the species is known to occur up to 2500 m on the Spanish Central massif (Barbadiño et al. 1999). Although some Pyrenean populations of *S. salamandra* may bear fully developed young, in the Circo de Piedrafita area the bearing of aquatic larvae is widespread according to our observations. The maximum altitude records of *Euproctus asper*, apart from erroneous 2965 m on the Pic de Cambalès by Beck (1943), are 2650 m without a precise locality (Martínez-Rica 1979) and up to 2550 in the Ruisseau de Marcadau (Beck 1943); further records at the 2500 m level

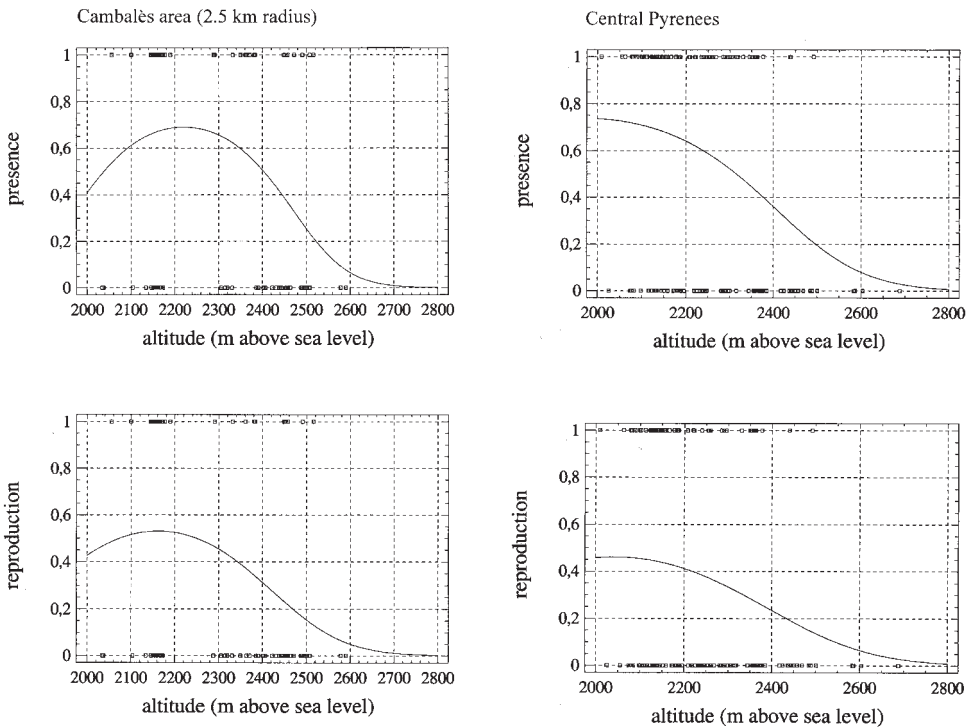


Fig. 4. Logistic regression curves of presence and ascertained reproduction of *Rana temporaria* in ponds within a 2.5 km radius around the Cambalès peak (left graphs) and in a wider area of the Central Pyrenees excluding the Cambalès region (right graphs).

are the "lac supérieur d'Estibère" (Clergue - Gazeau & Bonnet 1976) and the Llanos de Millaris, Ordesa (Clergue - Gazeau 1999). This suggests a possible altitudinal limit for this species similar to that of *Rana temporaria* in the Pyrenees. A species not recorded in the area surveyed herein was *Triturus helveticus*, although we have observed it in the Ibón de los Asnos, in the Tena valley at 2060 m (D. R. Vieites and S. Nieto-Román, 14 August 1999). This newt has been reported up to 2400 m in the Gourg de Rabas (Angelier & Angelier 1964, Clergue - Gazeau 1981).

Although our results refer to a relatively small stretch of only the Pyrenees, the altitudinal distribution of amphibians is unlikely to differ in other parts of the massif. The Pyrenees extend from east to west, and longitudinal influences on the climatic conditions are therefore not to be expected. Altitudes of 3000 m and above are found in the central parts of the massif only. The western portion of the Pyrenees is more strongly influenced by mediterranean climatic conditions; nevertheless, on the highest peak in the region, the Mont Canigou (2784 m), *Rana temporaria* has only been found below 2300 m (Dubois 1983). Lizards provide an example of lower tetrapods that are able to populate much higher sites in the Cambalès region: *Lacerta bonnali* has been found on the summit of the Grande Fache mountain above 3000 m, where it probably benefits from the fact that the snow layer on the steep peak disappears soon in spring (Vences et al. 1998).

Our observations in 2001 (D. R. Vieites & M. Vences, unpublished) demonstrated that larval development of *R. temporaria* in the Resposuso area (around 2200 m altitude) takes a minimum of about eight weeks from egg deposition to metamorphosis. Lakes above 2500 m were largely or completely covered by ice at the end of July 2001, and all lakes above 2700 m were covered by ice in July of 2000, which was a relatively warm summer. We never observed overwintering *R. temporaria* larvae but found evidence for massive tadpole deaths by freezing before the end of metamorphosis at altitudes around 2500 m. We therefore assume that, in the central Pyrenees, water bodies at elevations above 2600 m do not offer conditions that would allow for successful reproduction of *R. temporaria*. Although it can not be excluded that single individual amphibians may climb to higher altitudes during August or September of warm years, we are convinced that no stable amphibian populations can establish at these sites under the currently prevailing conditions.

If we compare the altitudinal distribution of *Rana temporaria* in the Pyrenees with the situation in the Alps, then the Alps seem to offer more favourable conditions at higher elevations. The highest alpine lakes or ponds with a good success of reproduction (thousands of big larvae near metamorphosis) were observed in the Laghi di Tre Becchi (2720-2745 m) near the Col du Nivoulet in the Parco Naturale di Gran Paradiso, Piedmont, Italy (K. Grossebacher, 18 August 2000). Three sites above 2600 m with reproducing populations of *Rana temporaria* are known in the Western Alps: south of Col de la Bonnette, France, 2640 m (K. Grossebacher, 11 July 1987 and 17 August 2000), Murtel below Piz Corvatsch, Engadine, Grisons, Switzerland, 2630 m (Brand & Grossebacher 1979, Grossebacher 1988) and a pond on Alpe Lona, Val de Moiry, Valais, Switzerland, 2603 m (Arlettaz 1993). A possible explanation for this difference between Alps and Pyrenees could be that the sites in Gran Paradiso, Valais and the Grisons are situated near mountains with much higher altitudes (above 4000 m) than the Pyrenean ones and thus are better protected. Since the altitudinal differences between the peaks and the potential reproduction sites are relatively small in the Pyrenees, these sites are

more exposed to the very rough and heterothermic climate. This explanation, however, cannot be invoked for the pond on Col de la Bonnette in the Alps, which is not far from the highest crest.

It also is instructive that, if the Cambalès records for *Rana temporaria* and *Euproctus asper* are corrected, the live-bearing species *Salamandra lanzai* is the amphibian that reaches the highest altitudes in Europe west of the Caucasus (2800 m: surroundings of Lago delle Forciolline, Massif of Monviso, western Italian Alps [A n d r e o n e 1999]). It can therefore be concluded that the factor limiting elevational occurrence of non live-bearing amphibians in the Pyrenees, and probably in the whole of Europe, is the presence of ice-free water bodies during a sufficient amount of time for larval development.

Appendix. Lakes and ponds surveyed in the area within a 2.5 km radius of the Cambalès peak summit, their coordinates, altitude, and presence and reproduction of *Rana temporaria*. Sites are ordered by presence and reproduction of *R. temporaria*, and by altitude. ID is the identification number of the pond in the GIS database of the authors. The locality of highest altitude (Ibón de la Facha 1, 2516 m) is marked in bold-italics; the altitude of this locality has previously been wrongly given as 2700 m (V e n c e s et al. 1999).

ID	Name	Altitude	Latitude	Longitude	presence	reproduction
Area Lacs de Cambalès / Opale / Costalade						
141	Lac d'Opale 2	2306 m	42°49'46"N	0°13'02"W	NO	NO
270	Lac de Costalade 1	2320 m	42°50'11"N	0°12'58"W	NO	NO
140	Lac d'Opale 1	2331 m	42°49'43"N	0°13'10"W	NO	NO
136		2386 m	42°49'49"N	0°13'39"W	NO	NO
135	Lac de Cambalès 2	2402 m	42°49'47"N	0°13'44"W	NO	NO
134		2407 m	42°49'50"N	0°13'48"W	NO	NO
189	Lac de Cambalès 4	2431 m	42°49'51"N	0°13'51"W	NO	NO
188	Lac de Cambalès 3	2452 m	42°49'58"N	0°13'58"W	NO	NO
187		2463 m	42°49'54"N	0°14'04"W	NO	NO
183		2488 m	42°49'53"N	0°14'10"W	NO	NO
186	Lac de Cambalès 5	2491 m	42°49'58"N	0°14'14"W	NO	NO
184		2495 m	42°49'54"N	0°14'12"W	NO	NO
185		2495 m	42°49'54"N	0°14'16"W	NO	NO
130	Lac de Cambalès 6	2578 m	42°49'49"N	0°14'18"W	NO	NO
131		2590 m	42°49'51"N	0°14'16"W	NO	NO
132		2590 m	42°49'51"N	0°14'12"W	NO	NO
269		2350 m	42°50'02"N	0°12'60"W	YES	NO
138	Lac de Cambalès 1	2364 m	42°49'50"N	0°13'29"W	YES	NO
139		2371 m	42°49'56"N	0°13'32"W	YES	NO
137		2361 m	42°49'49"N	0°13'31"W	YES	YES
Area Lacs de la Fache						
197	Lac de la Fache 1	2315 m	42°48'39"N	0°13'26"W	NO	NO
198	Lac de la Fache 2	2422 m	42°48'34"N	0°13'20"W	NO	NO
196		2439 m	42°48'45"N	0°13'29"W	NO	NO
194		2443 m	42°48'47"N	0°13'24"W	NO	NO
195		2288 m	42°48'57"N	0°13'03"W	YES	NO
193		2448 m	42°48'49"N	0°13'26"W	YES	YES

Appendix (continued)

ID	Name	Altitude	Latitude	Longitude	presence	reproduction
Area Ibones de la Facha / western slopes of Campoplano peak						
142		2391 m	42°49'53"N	0°14'59"W	NO	NO
148		2403 m	42°49'03"N	0°15'26"W	NO	NO
147		2453 m	42°49'01"N	0°15'18"W	NO	NO
146		2502 m	42°48'54"N	0°15'01"W	NO	NO
144	Ibón de la Facha 2	2507 m	42°48'48"N	0°14'37"W	NO	NO
145	Ibón de la Facha 3	2508 m	42°48'55"N	0°14'39"W	NO	NO
m1		2775 m	42°49'09"N	0°14'38"W	NO	NO
m2		2790 m	42°49'12"N	0°14'40"W	NO	NO
151		2332 m	42°48'54"N	0°15'35"W	YES	YES
150		2381 m	42°48'59"N	0°15'28"W	YES	YES
149		2383 m	42°48'59"N	0°15'26"W	YES	YES
143	<i>Ibón de la Facha 1</i>	2516 m	42°48'53"N	0°14'42"W	YES	YES
Area northern slopes of Grande Fache / Llenacantal						
m3		2670 m	42°48'25"N	0°14'39"W	NO	NO
158		2458 m	42°48'22"N	0°15'08"W	YES	NO
156		2472 m	42°48'31"N	0°15'14"W	YES	NO
153		2490 m	42°48'29"N	0°15'17"W	YES	NO
154		2507 m	42°48'32"N	0°15'23"W	YES	NO
152		2291 m	42°48'44"N	0°15'24"W	YES	YES
157		2449 m	42°48'27"N	0°15'10"W	YES	YES
159		2452 m	42°48'31"N	0°15'11"W	YES	YES
160		2457 m	42°48'33"N	0°15'12"W	YES	YES
155		2491 m	42°48'32"N	0°15'29"W	YES	YES
Area Lacs de Remoulis						
180		2034 m	42°50'23"N	0°15'14"W	NO	NO
179	Lac de Remoulis	2037 m	42°49'57"N	0°15'16"W	NO	NO
178		2104 m	42°49'03"N	0°15'19"W	NO	NO
133		2455 m	42°49'43"N	0°14'41"W	NO	NO
181		2055 m	42°50'11"N	0°15'18"W	YES	YES
182		2100 m	42°50'02"N	0°15'26"W	YES	YES
Area Circo de Piedrafita (Campoplano - Resposuso)						
60		2134 m	42°48'58"N	0°16'01"W	NO	NO
61		2146 m	42°48'58"N	0°16'02"W	NO	NO
74		2151 m	42°48'56"N	0°16'07"W	NO	NO
31		2152 m	42°49'01"N	0°16'02"W	NO	NO
34		2152 m	42°49'01"N	0°16'08"W	NO	NO
38		2152 m	42°49'01"N	0°16'09"W	NO	NO
52		2152 m	42°48'59"N	0°16'07"W	NO	NO
93		2152 m	42°49'05"N	0°15'56"W	NO	NO
33		2153 m	42°49'01"N	0°16'06"W	NO	NO
59		2155 m	42°48'58"N	0°16'01"W	NO	NO
117		2155 m	42°49'02"N	0°16'08"W	NO	NO
95		2156 m	42°49'05"N	0°15'58"W	NO	NO
48		2157 m	42°48'59"N	0°16'09"W	NO	NO

Appendix (continued)

ID	Name	Altitude	Latitude	Longitude	presence	reproduction
101		2157 m	42°49'03"N	0°16'02"W	NO	NO
29		2159 m	42°49'03"N	0°15'59"W	NO	NO
66		2161 m	42°48'59"N	0°16'05"W	NO	NO
68		2161 m	42°48'58"N	0°16'05"W	NO	NO
67		2162 m	42°48'59"N	0°16'05"W	NO	NO
115		2165 m	42°49'02"N	0°16'07"W	NO	NO
58		2166 m	42°48'59"N	0°16'01"W	NO	NO
110		2167 m	42°49'02"N	0°16'03"W	NO	NO
111		2169 m	42°49'02"N	0°16'03"W	NO	NO
109		2170 m	42°49'03"N	0°16'03"W	NO	NO
107		2173 m	42°49'03"N	0°16'02"W	NO	NO
108		2173 m	42°40'03"N	0°16'02"W	NO	NO
114		2173 m	42°49'02"N	0°16'08"W	NO	NO
72		2152 m	42°48'58"N	0°16'05"W	YES	NO
118		2153 m	42°49'02"N	0°16'08"W	YES	NO
73		2155 m	42°48'58"N	0°16'07"W	YES	NO
62		2156 m	42°48'57"N	0°16'03"W	YES	NO
50		2158 m	42°48'59"N	0°16'08"W	YES	NO
49		2159 m	42°48'59"N	0°16'09"W	YES	NO
56		2159 m	42°48'59"N	0°16'03"W	YES	NO
30		2160 m	42°49'04"N	0°15'59"W	YES	NO
103		2160 m	42°49'04"N	0°16'03"W	YES	NO
70		2161 m	42°48'58"N	0°16'06"W	YES	NO
28		2162 m	42°49'04"N	0°16'00"W	YES	NO
57		2168 m	42°48'60"N	0°16'02"W	YES	NO
42		2144 m	42°49'02"N	0°16'11"W	YES	YES
36		2146 m	42°49'01"N	0°16'09"W	YES	YES
44		2148 m	42°49'00"N	0°16'08"W	YES	YES
41		2149 m	42°49'02"N	0°16'11"W	YES	YES
46		2150 m	42°48'59"N	0°16'09"W	YES	YES
94		2150 m	42°49'05"N	0°15'57"W	YES	YES
37		2152 m	42°49'00"N	0°16'09"W	YES	YES
40		2152 m	42°49'02"N	0°16'10"W	YES	YES
71		2152 m	42°48'58"N	0°16'05"W	YES	YES
32		2153 m	42°49'00"N	0°16'06"W	YES	YES
39		2153 m	42°49'01"N	0°16'10"W	YES	YES
43	Ibón de Campoplano	2154 m	42°49'01"N	0°16'12"W	YES	YES
102		2155 m	42°49'03"N	0°16'03"W	YES	YES
121		2155 m	42°49'02"N	0°16'10"W	YES	YES
63		2157 m	42°48'58"N	0°16'03"W	YES	YES
75		2157 m	42°48'58"N	0°16'08"W	YES	YES
100		2157 m	42°49'03"N	0°16'02"W	YES	YES
64		2158 m	42°48'58"N	0°16'04"W	YES	YES
123		2158 m	42°49'02"N	0°16'01"W	YES	YES
124		2158 m	42°49'02"N	0°16'01"W	YES	YES
47		2159 m	42°48'59"N	0°16'09"W	YES	YES
76		2159 m	42°48'56"N	0°16'09"W	YES	YES

Appendix (continued)

ID	Name	Altitude	Latitude	Longitude	presence	reproduction
104		2159 m	42°49'03"N	0°16'03"W	YES	YES
122		2159 m	42°49'02"N	0°16'01"W	YES	YES
51		2160 m	42°48'60"N	0°16'07"W	YES	YES
53		2160 m	42°48'59"N	0°16'06"W	YES	YES
65		2160 m	42°48'58"N	0°16'05"W	YES	YES
97		2160 m	42°49'04"N	0°16'01"W	YES	YES
98		2161 m	42°49'04"N	0°16'01"W	YES	YES
99		2161 m	42°49'04"N	0°16'02"W	YES	YES
125		2161 m	42°49'03"N	0°16'00"W	YES	YES
69		2162 m	42°48'58"N	0°16'06"W	YES	YES
113		2162 m	42°49'02"N	0°16'05"W	YES	YES
35		2164 m	42°49'01"N	0°16'07"W	YES	YES
55		2164 m	42°48'59"N	0°16'04"W	YES	YES
96		2164 m	42°49'04"N	0°15'59"W	YES	YES
126		2164 m	42°49'02"N	0°16'02"W	YES	YES
120		2165 m	42°49'02"N	0°16'09"W	YES	YES
116		2166 m	42°49'02"N	0°16'08"W	YES	YES
45		2170 m	42°48'59"N	0°16'08"W	YES	YES
105		2171 m	42°49'03"N	0°16'03"W	YES	YES
119		2172 m	42°49'02"N	0°16'09"W	YES	YES
106		2173 m	42°49'03"N	0°16'02"W	YES	YES
112		2177 m	42°49'02"N	0°16'05"W	YES	YES
92		2189 m	42°49'04"N	0°15'47"W	YES	YES

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