

Distribution of the common frog *Rana temporaria* L. in subarctic Norway

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The distribution of the common frog, *Rana temporaria*, in northernmost Norway was recorded by means of information given by people living in the different local communities. The records are given in a detailed map. Occurrences on islands and peninsulas were especially emphasized. The survey shows that *R. temporaria* is present on most of the biggest islands and on some small ones. The species is lacking on some medium-sized islands and peninsulas and on most small islands. Documentation on intentional introductions by humans was obtained in a few cases, and explains the somewhat "random" distributional pattern, especially on the archipelago of Helgeland in the southern part of North Norway. Other factors explaining the distribution in subarctic Norway are discussed.

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Introduction

In Norway, the common frog, *Rana temporaria* L., is the only amphibian north of the Arctic Circle (66° 33' N) (Dolmen 1978, 1993a). The moor frog *Rana arvalis* Nilsson is a far more southern species in Norway (Dolmen 1978, Strand 1993), even if it is found in most parts of Sweden (Elmberg 1984, Ahlén et al. 1992), up to 68° N in Finland (Terhivuo 1981) and to the northwestern coast of Russia (Bannikov et al. 1977).

There are a number of examples of declining amphibian populations from various geographic regions, and some species are regarded as threatened (e. g. Skei 1993). In Norway, a project has been started to monitor the distribution and population status of reptiles and amphibians (Dolmen 1993b). This paper deals with the most common species.

Even if *R. temporaria* is a common species in northern Norway, a complete mapping of its distribution has never been done. As this part of Norway is characterized by many small and big islands as well as peninsulas and long fjords, there are many barriers for dispersal. The common frog can stand brackish water well [up to 0.5 % salinity (Terhivuo 1981)], but not oceanic water.

Although common in northern Norway, the species is apparently lacking on many islands and some peninsulas (Soot-Ryen 1948). At least on islands, its presence has probably been dependent on human introductions (anthropochorous dispersal), even if other modes of dispersal theoretically could be possible, e. g. on "rafts". The size of the island and presence of suitable habitats may also influence the survival chances.

This survey gives a detailed mapping of the common frog in northern Norway. The occurrence on islands and peninsulas is specifically emphasized.

Material and methods

R. temporaria is easily recognized both as eggs, tadpoles and adults. It can hardly be confused with other species except the moor frog *R. arvalis*, which may be present in the northeasternmost parts of Norway (Semb-Johansson 1992), and along the border between Sweden and Norway [see distribution in northern Sweden mapped by Elmberg (1984)]. As the common frog is well known, this mapping could be adequately based on information from people living in the different local communities. About one hundred persons from all over northern Norway, especially in coastal districts, was interviewed by phone, through personal contact, or by correspondence. A questionnaire about the distribution of the frog was also directed to readers of local newspapers (Nilssen 1979). The authors themselves also made many observations. The data from all these sources were compared and evaluated for reliability. For each island to be denoted a "frog island", at least two independent observations were required. In this way, we obtained information about presence/absence of frogs on all large and medium sized islands, and many small islands, in the counties of Nordland, Troms and Finnmark. The distribution on the mainland and the peninsulas was not thoroughly mapped, but the records received made it possible to get a general impression of the distribution.

Results

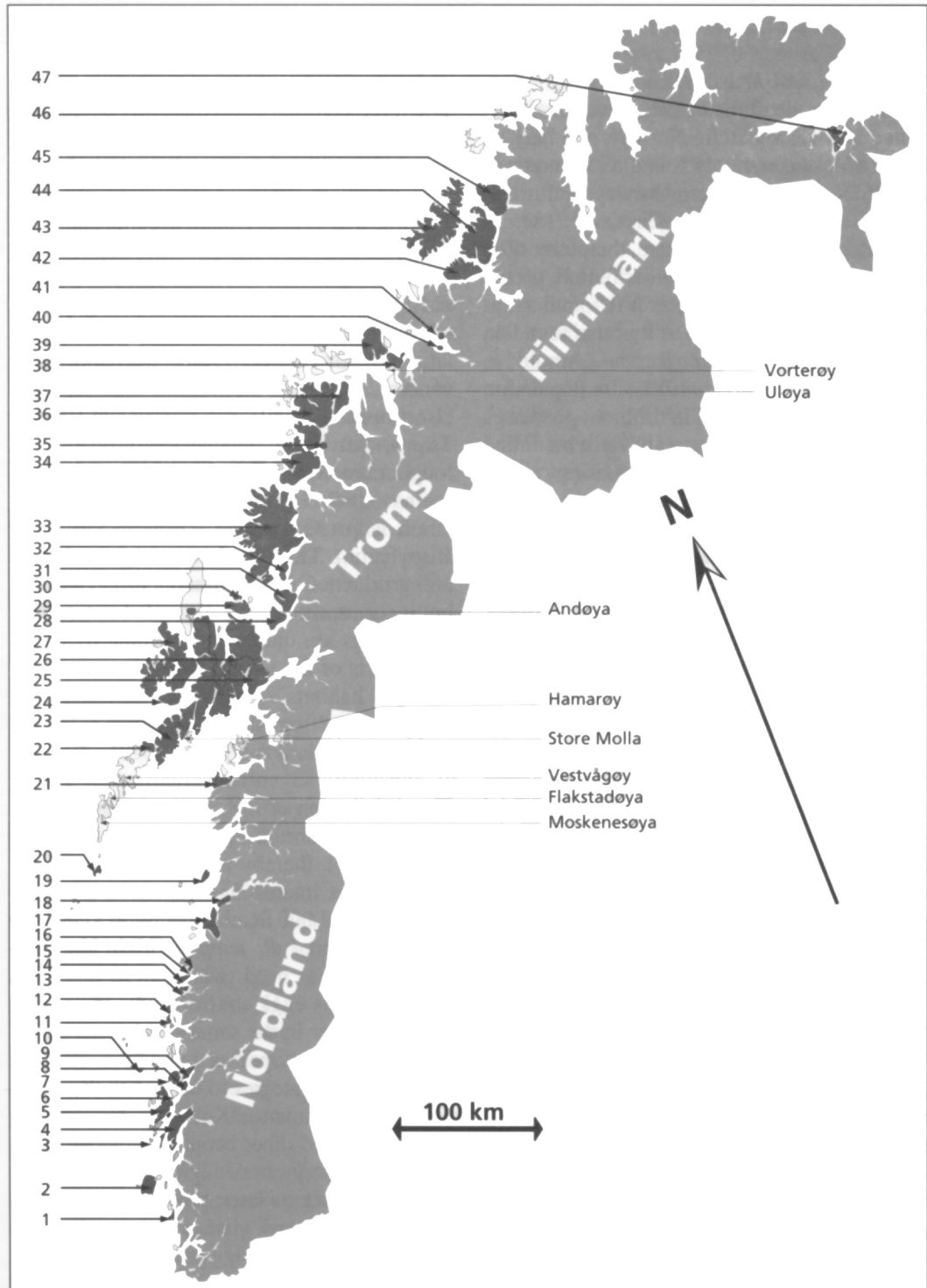
Figure 1 shows a map of the known distribution of *R. temporaria* in northern Norway. The distribution on the mainland and on the peninsulas is not thoroughly mapped, and the map only gives here a general picture of the occurrence provided that there are suitable habitats. We have not tried to suggest anything about the population density, which undoubtedly varies from place to place as a consequence of available habitats and climatic constraints. The frog is probably scarce on the peninsulas in Finnmark and may be lacking locally. Many islands, however, had populations of the common frog.

On some islands, our informants could give details about the origin of the frog. Thus, humans have evidently introduced the common frog on many islands in the last few decades. Table 1 gives details of such introductions.

Figure 1

The distribution of R. temporaria in northern Norway (shaded areas). The distribution on the mainland and on the peninsulas (light shading) is not thoroughly mapped, but the species seems to be present everywhere provided that there are suitable habitats. Each island with positive records of frogs (dark shading) has been numbered:

1: Torget; 2: Vega; 3: Brasøy; 4: Alsten; 5: Dønna; 6: Løkta; 7: Tomma; 8: Hugla; 9: Handnesøya; 10: Lovunden; 11: Selsøya; 12: Røddøya; 13: Åmøya; 14: Meløya; 15: Mesøya; 16: Teksmøna; 17: Sandhornøy; 18: Straumøya; 19: Landegode; 20: Værøy; 21: Engeløya; 22: Gimsøya; 23: Austvågøy; 24: Hadseløy; 25: Tjeldøy; 26: Hinnøy; 27: Langøya; 28: Rolla; 29: Grytøya; 30: Bjarkøya; 31: Andørja; 32: Dyrøya; 33: Senja; 34: Kvaløya; 35: Tromsøya; 36: Ringvassøy; 37: Reinøy; 38: Kågen; 39: Arnøy; 40: Skorpa; 41: Spildra; 42: Stjernøy; 43: Sørøy; 44: Seiland; 45: Kvaløya; 46: Måsøya; 47: Skogerøya.



Discussion

Rana temporaria is well adapted to a northern, subarctic climate. The species is distributed all over subarctic Norway, and may be more or less commonly found as far north as 70° 45' N, and in southern Norway at altitudes up to 1200 m above sea level (Semb-Johansson 1992). The climate, therefore, does not seem to restrict the distribution of the common frog in Norway, as it is found as far north as one can get, and as it is also found on the Kola Peninsula in Russia (Arnold & Burton 1978; Terhivuo 1981). Its population status has been mapped in different provinces of Finland by Terhivuo (1981), who found that the abundance was decreasing northwards, and that the species was rather scarce in the northernmost parts. Ecophysiological adaptations to a northern climate have been reported by Koskela & Pasanen (1975), Beattie (1987), and Beattie et al. (1991), explaining the success of this northernmost amphibian in such a climate.

The present study shows that *R. temporaria* occurs on a majority of the largest islands and most peninsulas in northern Norway, but seems to be lacking on some medium-sized islands and on most small islands (Figure 1). Some of these islands are rich in suitable frog habitats (e. g. Vestvågøya). The peninsula of Hamarøy seems also to be lacking frogs even if there are many suitable habitats. Some islands may be too small (especially those in Nordland) to support a population of frogs, but surprisingly small islands, such as Brasøy, Rødøy and Lovunden, evidently support a high density of frogs. Lack of habitats restricts the distribution in some areas, as is the case on the island of Magerøya and the peninsula of Nordkynnhalvøya, which both consist of rocky, treeless areas without much wetlands. Acidification may in other countries adversely affect the survival of *R. temporaria* embryos (Beattie et al. 1992), but this pos-

sible impact has not been investigated in northern Norway.

The three outermost large islands of Lofoten (Vestvågøy, Flakstadøya and Moskenesøya) are now lacking frog populations, but there are uncertain indications that at least Vestvågøy previously harboured this species. The presence of frogs on the outer island Værøy (Figure 1) is caused by a recent introduction (Table 1). Several decades ago, there were also frogs on Store Molla, but this population is now extinct (Andy Sortland, pers. comm.). Previous occurrences were reported also from the islands of Vorterøy and Uløy in Troms, but these populations probably no longer exist. Most of the big island of Andøya seems to be lacking frogs, but one local population is present in the southern part (near Risøyhamn). This population originated from an introduction made around 1940 (Table 1), but it seems not to have expanded noticeably. Thus, frogs are unknown to people living on other parts of the island, which has plenty of suitable habitats. Andøya is therefore not mapped as a "frog island" in Figure 1, but the local population is marked.

The distribution of the common frog reaches the 10° isotherm for the warmest summer month (July), thereby approaching the arctic climate. One interesting suggestion given by Ruud (1949) and Semb-Johansson (1992) is that tadpoles of *R. temporaria* in the northernmost areas need two years to reach the adult stage, as eggs and subadults have been found together in the same pond in spring. If this is true, the species may have evolved reproductive strategies to cope with the short, subarctic summers. Koskela & Pasanen (1975) detected other ecophysiological adaptations to a northern or high altitude climate: Oviposition occurs later; production of spawn decreases; size and glycogen content of the eggs increase, and egg number decreases. Beattie (1987) found that the lower lethal

Table 1. Recent introductions of *R. temporaria* to islands in northern Norway. No. see map in Figure 1.

No. Island	Location	Size (km ²)	Year	Source
3	Brasøy	65°55'N;12°12'E	1969	Marit Storholm
10	Lovunden	66°22'N;12°18'E	1950's	Hans Petter Meland
12	Rødøya	66°41'N;13°05'E	1900 ¹	Per Høivaag
20	Værøy	67°40'N;12°40'E	1980	Bergeton Solås
30	Bjarkøya	69°00'N;16°30'E	1978	Harald Westnes
-	Andøya	69°00'N;15°40'E	1940 ²	Fritz Rikardsen
-	Vanna	70°10'N;19°45'E	1974 ³	Ida Mathiassen

¹Still present in 1930.

²Now present only near Risøyhamn, not spread to the whole island.

³Not successful.

temperature limit for normal development was lower in upland northern ponds compared with lowland ponds in northern England, and minimum pond temperature is a significant factor in the survival of *R. temporaria* embryos (Beattie et al. 1992).

R. temporaria hibernates in dormancy submerged in shallow ponds or in the soil (Semb-Johansson 1992). Even if it can stand some frost, the duration of the winter may be a critical factor for survival.

The distribution of the frog on the many islands in northern Norway seems somewhat "random" and evidently reflects introductions by humans. This could be documented in a few cases (Table 1). In most cases the introductions were successful, even on small islands. As a "popular" animal and easy to transfer (as eggs or tadpoles), there have probably been many intentional introductions that never have been registered. It should be noticed, however, that introductions of reptiles and amphibians to new areas are now forbidden according to Norwegian laws ("Viltloven") (Dolmen 1993b).

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Sammendrag

Utbredelsen av vanlig frosk *Rana temporaria* L. i Nord-Norge

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Utbredelsen av vanlig frosk *Rana temporaria* i Nord-Norge ble undersøkt ved intervjuer og korrespondanse med lokalbefolkningen i ulike distrikter. Det ble lagt særlig vekt på å undersøke forekomstene på de tallrike øyene, og det viser seg at frosk finnes på de fleste større og på noen mindre øyer. Utbredelsen er plottet på kart. Menneskers utsetting av frosk forklarer i stor grad artens nåværende forekomster på øyer.

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