Provisional atlas and population status of the Finnish amphibian and reptile species with reference to their ranges in northern Europe

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Up-to-date provisional dot maps of the amphibian and reptile species of Finland have been drawn. The records, totalling 11831, are located in the 10 × 10 km squares of the uniform grid (27°E) system and the species recorded comprise the great crested newt *(Triturus cristatus)*, smooth newt *(T. vulgaris)*, common toad *(Bufo bufo)*, common frog *(Rana temporaria)*, moor frog *(R. arvalis)*, marsh frog *(R. ridibunda)*, common lizard *(Lacerta vivipara)*, slow-worm *(Anguis fragilis)*, grass snake *(Natrix natrix)*, smooth snake *(Coronella austriaca)*, and adder *(Vipera berus)*.

The data indicate the disappearance of the marsh frog from the Finnish herpetofauna in the 1960s, and the slow-worm was no longer found in the mainland of Åland despite having been recorded there about fifty to sixty years ago. The adder and the smooth newt were reported from further north than earlier and the great crested newt was collected both in the Åland archipelago, southwestern Finland, and near the southeastern border of Finland. Old, probably dubious records of the grass snake and the slow-worm near or north of the Arctic Circle, inland records of the smooth snake and records of the great crested newt from the southern and southwestern coastal area of the Finnish mainland could not be verified and they should be excluded from the herpetological literature referring to the up-to-date ranges of the species in northern Europe. Moreover, a great number of supplementary records of the moor frog were received from different parts of Finland.

Maps indicating the provisional abundances of eight Finnish amphibian and reptile species were prepared on the basis of 2677 reports with estimations of the state of local populations in the 1960s and '70s. Many local populations, especially those of the adder and the common toad, were reported as having been declining during the past ten to twenty years. Possible reasons for the trend are discussed. Data concerning the amphibians and reptiles killed by traffic in southern Finland are presented.

The northern European ranges of the Finnish amphibian and reptile species are reviewed in relation to the geographical, historical and climatic factors of that area.

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1. Introduction

Over the past ten years the adoption of grid systems in recording the locations of biological finds has much facilitated the surveying of many European vertebrate and invertebrate species. This can be regarded as the beginning of a series of repeated surveys to monitor possible future range changes of the species. In the field of herpetology, the provisional atlases of the species in the British Isles, the Federal Republic of Germany and Norway have been prepared by Arnold (1973), Müller (1976) and Dolmen (1978a), respectively.

In Finland, Terhivuo & Koli (1977) made an attempt to summarize the herpetological records up to 1976 and to prepare preliminary dot maps for the species. To supplement these maps and to gain additional data about possible trends in today's amphibian and reptile populations in different parts of Finland, a reprint of that article was sent to all those who contributed to the survey in 1974—76. The present paper summarizes the records compiled up to the end of 1979 and the maps presented include about 28 % more dots (= 10 × 10 km squares) for the species than those published in 1977.

The northernmost parts of the ranges of the amphibian and reptile species in Finland have been outlined by Mela (1882), Mela & Kivirikko (1909), Kivirikko (1940), Kaisila (1949), Koli (1962, 1977) and Lagerwerf (1975), but there was no detailed information on the provisional state of the populations. The reports with estimations of the abundances of local populations are therefore summarized according to the biological provinces of Finland. The number of these reports is sufficient to provide data for the estimation of the overall population status of most species within the biological provinces in which they can be regarded as permanent species. Unfortunately, no quantitative census method could be adopted in the survey and that is why the reports, though based on actual observations in the field, may also indicate observers' subjective views on the state of the populations, at least to some extent.

The present paper is mainly aimed at summarizing the data concerning the amphibians and reptiles of Finland, but, since the ranges of these species have rather recently been worked out in Norway, Sweden and the USSR, a supplementary review of the ranges in Fennoscandia and the northwestern parts of the USSR is also presented and discussed in relation to the geographical, historical and climatic factors of northern Europe.

2. Material and methods

2.1. Provisional dot maps

Most of the records acquired are unpublished and were received in 1974—79 as a result of the enquiries carried out by the Zoological Museum of the University of Helsinki. Many nature magazines, newspapers, scientific and educational organizations and some radio and TV programmes have facilitated the study by transmitting the enquiries to people interested in Finnish herpetofauna. The Finnish Forest Research Institute contributed to the study with several hundreds of records made during the third national forest inventory in 1961—63. The Bureau of Natural Resources has provided the author with a great number of unpublished records, and the officers of The Finnish Frontier Guards reported many locations for the species close to or at the frontier zone of Finland. Moreover, additional data were gathered from the files and museum specimens preserved in the Zoological Museums of Helsinki, Turku, Oulu, Kuopio and Forssa. The published articles considered for the maps total about one hundred and most of them were taken from Luonnon Tutkija (= Luonnon Ystävä), Archivum Societatis Zoologicae Botanicae Fennicae 'Vanamo', Annales Zoologici Fennici, Memoranda Societatis pro Fauna et Flora Fennica, Lounais-Hämeen Luonto and Molekyyli, as well as from Kivirikko (1940). At the end of 1979, the total number of records was 11831 and more than 1000 persons had contributed to the study with their unpublished records up to that time.

The records regarded as correct are located in the 10 × 10 km squares of the uniform grid (27°E) system (see Heikinheimo & Raatikainen 1971). Fig. 1 shows the

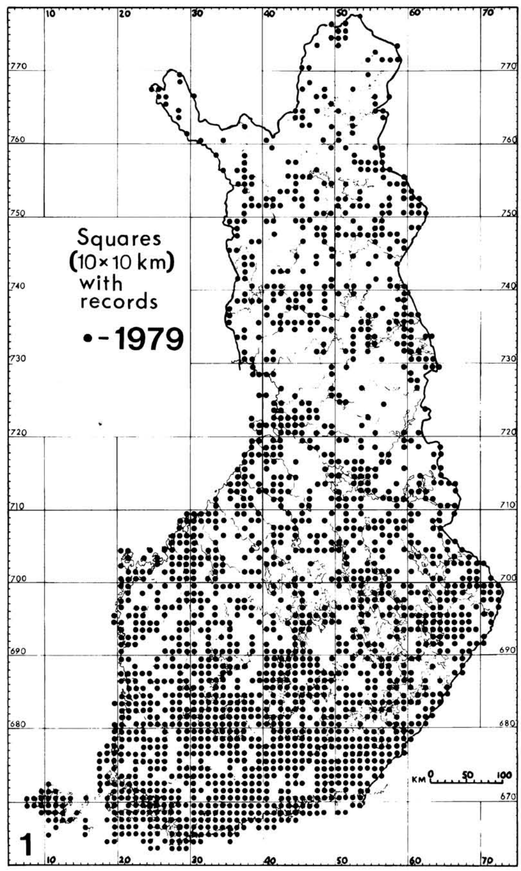


Fig. 1. The spatial distribution of the 10 × 10 km squares of the uniform grid (27°E) system with one or more records of the amphibian or reptile species in Finland up to the end of 1979. The number of dots (n = 1900) equals 49.6 % of all the 10 × 10 km squares with dry land in the 1:400,000 map of Finland.

spatial distribution of all the 10 × 10 km squares with one or more records of any amphibian or reptile species in Finland up to the end of 1979. The number of squares totals 1900, which is 49.6 % of all the squares with at least a small piece of land (e.g. island) in the map of Finland drawn to the scale of 1: 400,000. Since the records were not systematically collected, most, viz. 59.2 %, of the squares refer to the southernmost third (from 663 N to 700 N, see the grid in Fig. 1) of Finland where most of the contributors live. The corresponding figures for the central (700 N — 740 N) and northern (740 N — 777 N) parts of Finland are 28.3 % and 12.5 %, respectively.

Fig. 2 indicates the number of species recorded in different parts of Finland up to the end of 1979, but nowadays only 9 species can be found in the mainland of Åland, and no more than 8 species in the southern coastal parts of the Finnish mainland. The number of the species gradually decreases towards the north and, at the same latitude, there are no great differences in the numbers of species between eastern and western parts of Finland.

Table 1 indicates both the numbers of the records and those of the 10 × 10 km squares for the species. Records of the adder, common frog and common lizard total 61.6 %

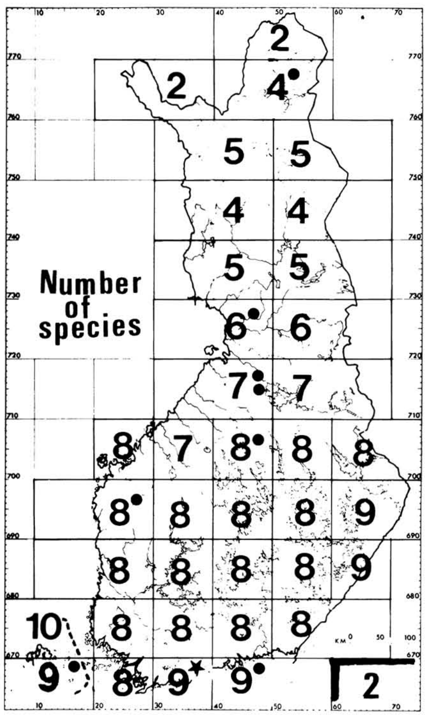


Fig. 2. The number of amphibian and reptile species in different parts of Finland based on the records received up to the end of 1979. Solid circles indicate the numbers of those species recorded prior to 1960 only. Today, due to the disappearance of the marsh frog in the 1960s, only 8 species are present on the southern coast of the Finnish mainland (solid star), and in the Åland archipelago (west of the broken line) 9 species can be found. See also the text.

Table 1. Number of records and 10 × 10 km squares for the amphibian and reptile species of Finland up to the end of 1979.

	Records		10 × 10 squares with records		
			Total to 1979	Prior to 1960 only	
	n	%		n	%
Triturus cristatus	27	0.2	15	6	40.0
T. vulgaris	606	5.1	340	35	10.3
Bufo bufo	1527	12.9	860	191	22.2
Rana temporaria	2308	19.5	1091	54	5.0
R. arvalis	451	3.8	254	16	6.3
R. ridibunda	12	0.1	3	2	66.7
Lacerta vivipara	1943	16.4	968	37	3.8
Anguis fragilis	1076	9.1	500	100	20.0
Natrix natrix	827	7.0	408	64	15.7
Coronella austriaca	15	0.1	11	8	72.7
Vipera berus	3039	25.7	1346	221	16.4
Total	11,831	100	5796	734	12.7

of all the records obtained. These species are distributed further northwards than the others. The common toad, slow-worm, grass snake, smooth newt and moor frog, mostly confined to southern and central parts of Finland, total 37.9 % of the records and the great crested newt, smooth snake and marsh frog, with very limited ranges in Finland, share the remaining 0.5 %.

Figures 3, 5, 8, 11, 14, 17, 19, 22, 26, 29 and 31 show the 10 × 10 km squares with records for the amphibian and reptile species of Finland. Some old records considered to be dubious or inexact are not indicated in the dopt maps, but instead are discussed in detail in connection with the species in question. In order to re-check faunistically noteworthy new records, especially those referring to the great crested newt and the smooth snake as well as to northern records of the grass snake and common toad, the observers were contacted once more in order to obtain as detailed data as possible. Moreover, some small locations indicated in the records but not found in official maps are located to the nearest village or other place given in the report. The total number of these records does not exceed 0.5 % of all the records.

The records suggesting the absence of a species in an area are rather few, and, considering the square size adopted it is no wonder that some opposing records referring to the occurrence of the species in the same square were received. Before making any trial to assess possible absence or presence of any species in an area one has to know whether an amphibian or reptile species has been recorded in that area. That is why the dots of Fig. 1 have been indicated with stippling on the maps of the species, too.

2.2. Provisional population status of the species

Since no up-to-date data concerning the provisional population status of the amphibian and reptile species in Finland have been published, the observers were asked to estimate the state of local populations. The 2677 reports received refer to the 1970s, but in many of them the observation period also extends in to the 1960s. All the data concerning the populations up to 1959 were excluded in this connection.

The contributors were asked to indicate separately for each species the most appropriate of the following descriptions for the present state of the population: 1 = the species is very scarce in the area, 2 = it is scarce, 3 = rather scarce, 4 = rather abundant, 5 = abundant, 6 = very abundant and "unknown" was reported when the observer had no view on the status of the species in the area.

The 100 × 100 km squares of the uniform grid (27°E) system within the geographical area of Finland were grouped according to the biological provinces (see Heikinheimo & Raatikainen 1971), with some slight exceptions, viz. the northern half of the province Satakunta (St) was combined with the province of Etelä-Pohjanmaa (EP) and its southern half with Varsinais-Suomi (V) and Laatokan Karjala (LK) was included in Pohjois-Karjala (PK). In other parts of the country the 100 × 100 km squares of the grid fitted rather well to the provinces.

The provisional means of the records for each species were counted on the basis of the abundance categories indicated above, assuming that the number of reports was ≥ 5 in the province. If the mean was ≥ 4.8, most populations of the species are regarded to be abundant, if 4.7—3.8 they are rather abundant, rather scarce if 3.7—2.8, and if ≤ 2.7 they are scarce or very scarce on average. The provisional overall abundances of the species are indicated in Figs. 6, 9, 12, 15, 20, 24, 27 and 32.

It is worth emphasizing that the abundances may only give an indication of the overall state of the populations in the provinces and no doubt great annual changes may take place in local populations. No interspecific comparisons should be made between the abundances in the various provinces, since the data from which the abundances are counted are relative and not absolute. Moreover, not only the abundance but also the relative frequency, viz. the number of the dots of the species in relation to that of the records of all the species, should be concomitantly considered when the status of the species in the province is assessed.

The reports received also include information on 440 locations where the amphibian and/or reptile populations were observed during three or more successive years. In these the observation period extends in to the 1970s. These data, mostly referring to southern parts of Finland, are summarized in Table 2 to indicate possible trends among the amphibian and reptile populations during the past ten years.

3. Results

3.1. Provisional distribution and status of the species in Finland

The great crested newt (Triturus cristatus) (Figs. 3—4).

Fig. 3 shows the two separate ranges of the great crested newt in Finland. Recently, in 1977 and in 1979, it was sampled in Värtsilä, Patsola (690:68) and in Åland in two locations near Mariehamn (667:10 and 668:10), respectively. In Åland the species is also recorded from some small islands in the archipelago.

In the herpetological collection of the Zoological Museum of the University of Helsinki there are two samples of the great crested newt labelled "Helsingfors (= Helsinki), ded. Lundahl". This may be material used for morphological studies or demonstrations in Helsinki but most probably it does not originate from there. Neither Kivirikko (1940) nor Kaisila (1949) mention this sample, and they have undoubtedly considered the locality incorrect. Since there are no later records of the species in the southern or southwestern coastal area of the Finnish mainland and considering the great number of records of the amphibian and reptile species made in the area, I conclude that, nowadays at least, the species is no longer present there. I chose to exclude the former record from Fig. 3.

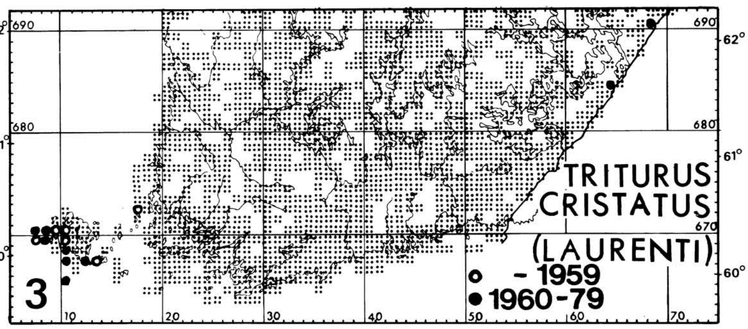


Fig. 3. The squares (10 × 10 km) with records of the great crested newt, *Triturus cristatus* (Laurenti), in Finland up to the end of 1979. The 10 × 10 km squares of Fig. 1 indicating the records of all the amphibian and reptile species up to the end of 1979 are finely dotted.

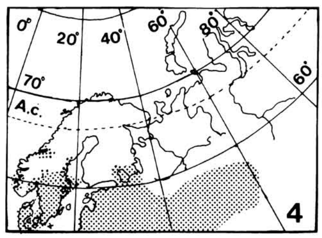


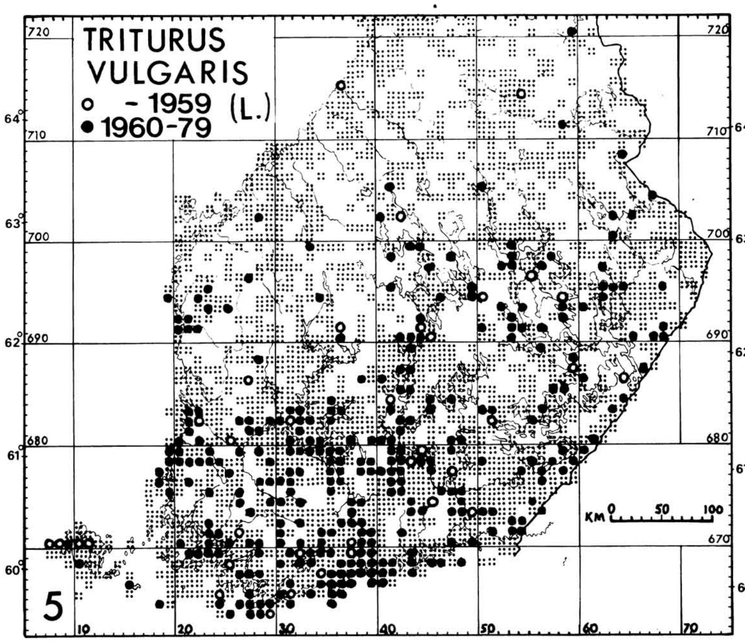
Fig. 4. The northern European distribution of the great crested newt. *T. cristatus*, according to the papers by Gislén & Kauri (1959), Bannikov et al. (1977), Andrén & Nilson (1978), Dolmen (1978a, b, 1980) and Fig. 3. A.c. = The Arctic Circle.

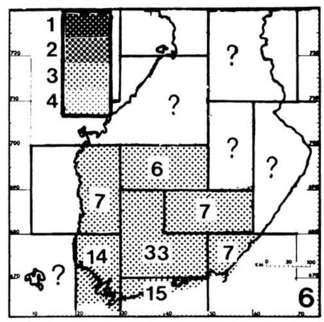
Hardly anything is known about the population status of the great crested newt in Finland. It may share the same pool with the smooth newt, and in Åland, in one case at least, it was reported to be superior in numbers to the latter species present in the same pool (Keskinen 1979). In Åland the great crested newt is nowadays protected by a local statute.

In Norway the great crested newt is recorded from southeastern, southwestern and western areas and the northernmost records refer to the area near Trondheim, at about 64°N (Dolmen 1978a, 1980) (Fig. 4). In Sweden its range continues up to about 61°N but on the east coast it extends to about 63°N (Gislén & Kauri 1959). The very northern population of the species in Stensele (about 65°N/17°E), Sweden, is reported to have been eradicated (Dolmen 1978b). In northwestern parts of the USSR it is distributed to about 63°N near the lakes of Ladoga and Onega (Bannikov et al. 1977). In other parts of the USSR it is not found north of 60°N. No doubt, the populations near the southeastern border of Finland belong to the Russian population of the species.

The smooth newt (Triturus vulgaris) (Figs. 5—7).

Most records of this species refer to the southern and southwestern parts of the Finnish mainland (Fig. 5). The northernmost find was made in Suomussalmi (720:59). The species is recorded from some islands of the outer archipelago as well as from the remote island of Tytärsaari (about 59°50′N/27°10′E) in the Gulf of Finland. More records can be expected from Åland, at least. It is noteworthy that the majority of the inland records, especially those in the central and northern parts of the range, refer to the vicinity of big lakes and rivers. Moreover, the marginal populations of the species in the north are very separate from each other. This is





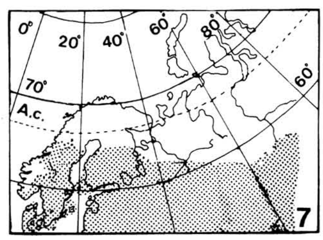


Fig. 5. The squares (10 × 10 km) with records of the smooth newt, *Triturus vulgaris* (L.), in Finland up to the end of 1979. The finely dotted areas correspond to the dots of Fig. 1.

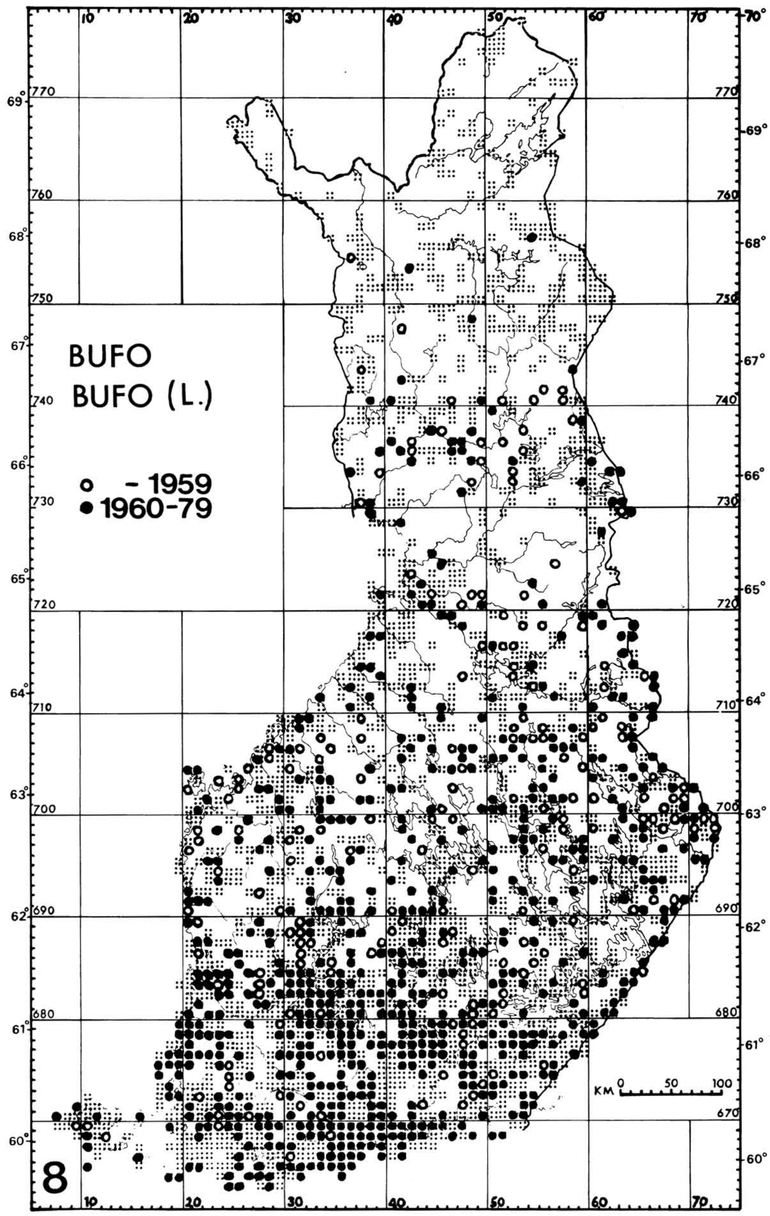
Fig. 6. The provisional population status of *T. vulgaris* in Finland in the 1960s and '70s. The different intensities of the stippling indicate the overall abundances as follows, 1) the populations are abundant or very abundant on average, 2) they are rather abundant, 3) they are rather scarce and 4) they are scarce or very scarce. The figures within the biological provinces indicate the number of the reports and if this is n $\leq$ 4 no abundance was counted for the province. For further information see the text.

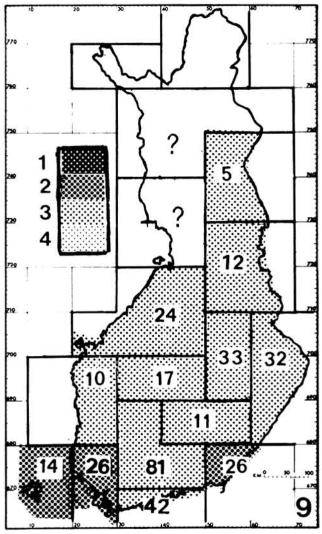
Fig. 7. The northern European distribution of the smooth newt, *T. vulgaris*, as suggested by Gislén & Kauri (1959), Bannikov et al. (1977), Andrén & Nilson (1978), Dolmen (1978a, b, 1980, 1981) and Fig. 4. A. c. = The Arctic Circle.

discussed in detail in a later connection.

In the southern and southwestern biological provinces of the Finnish mainland the smooth newt populations seem to be rather scarce on average, but there are no data from other parts of the mainland and the Åland archipelago (Fig. 6).

In Sweden (Gislén & Kauri 1959, Dolmen 1981) and in Norway (Dolmen 1978a and 1980) the smooth newt is distributed up to about 65°N and 66°N, respectively, but in the latter country it is absent from the southwestern coastal area north of about 59°N. The population of the species in Stensele (about 65°N/17°E), Sweden, has been eradicated by fish stocking in the 1960s (Dolmen 1978b), but another population has recently been found rather close to the old one (Dolmen 1981). In southwestern parts of the USSR it is recorded up to about 65°N, but near the Ural mountain region its range does not exceed north of about 60°N (Bannikov et al. 1977) (Fig. 7).





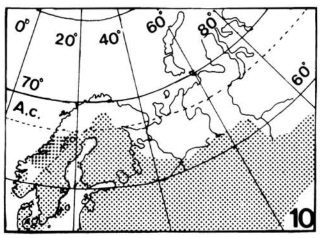


Fig. 8. The squares (10 × 10 km) with records of the common toad, *Bufo bufo* (L.), in Finland up to the end of 1979. The finely dotted areas correspond to the dots of Fig. 1.

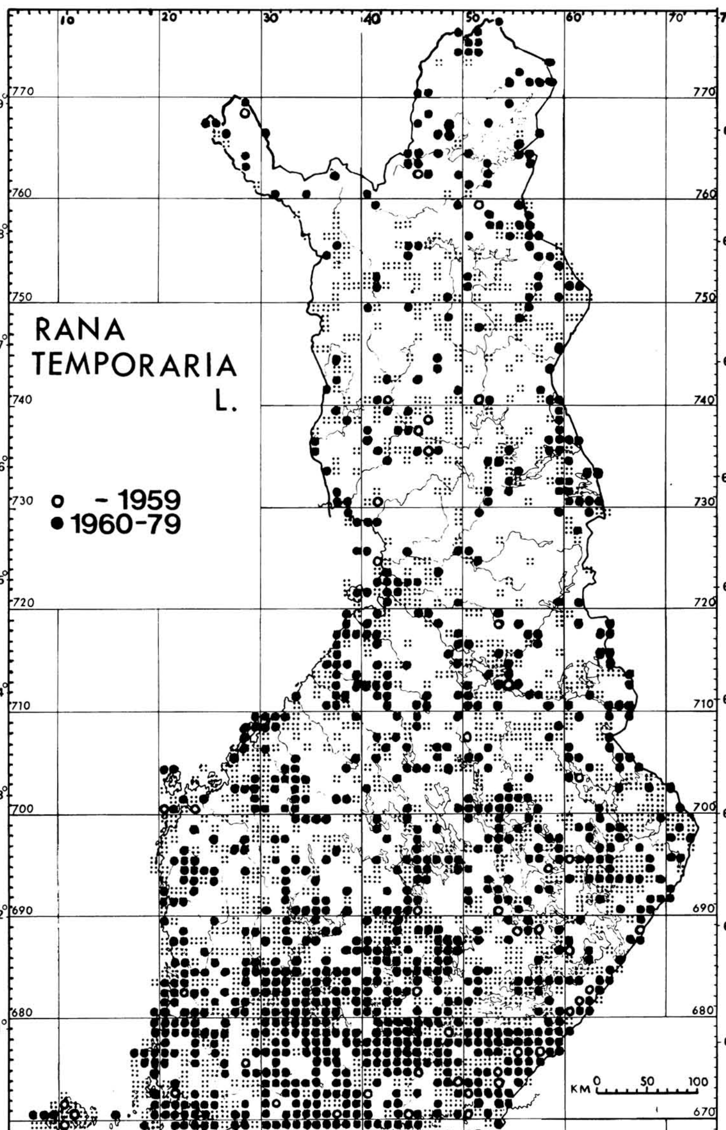
Fig. 9. The provisional population status of *B. bufo* in Finland in the 1960s and '70s. For further information see the legend to Fig. 6 and the text.

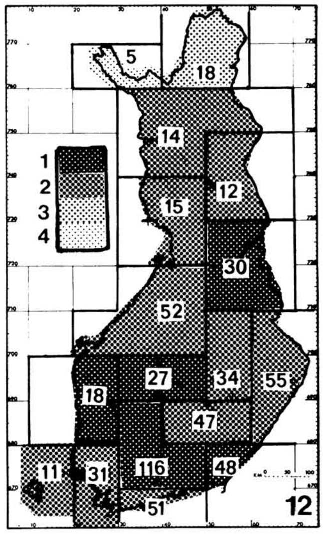
Fig. 10. The northern European distribution of the common toad, *B. bufo*, as indicated in the papers by Gislén & Kauri (1959), Bannikov et al. (1977), Andrén & Nilson (1978), Dolmen (1978a) and Fig. 8. A.c. = The Arctic Circle.

The common toad (Bufo bufo) (Figs. 8—10).

In Finland the common toad is distributed up to 68°N, the three northernmost localities being Saariselkä, Luirojärvi (756:54), Muonio (754:36) and Kittilä, Lintula (753:42) (Fig. 8). High up in the north it is mostly found in bogs. There are also many records referring to islands of the outer archipelago in Åland and to those lying close to the southern and southwestern Finnish mainland coast. Kivirikko (1940) considered the species to be common up to Tornio (about 66°N). Figs. 8 and 9 indicate that it is rather frequently found up to the Arctic Circle (66°30′N) but the most abundant populations seem to occur in southeastern and southwestern Finland, including the Åland archipelago. In other parts of the country they are reported to be rather scarce on average.

In Finland the range of the common toad seems to extend further northwards than in Sweden, where it is recorded up to about





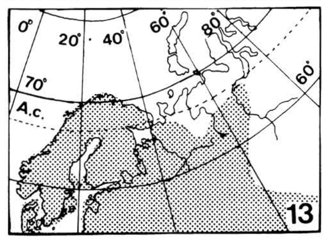


Fig. 11. The squares (10 × 10 km) with records of the common frog, *Rana temporaria* L., in Finland up to the end of 1979. The finely dotted areas correspond to the dots in Fig. 1.

Fig. 12. The provisional population status of *R. temporaria* in Finland in the 1960s and '70s. For further information see the legend to Fig. 6 and the text.

Fig. 13. The northern European distribution of the common frog, *R. temporaria*, as indicated in the papers by Gislén & Kauri (1959), Bannikov et al. (1977), Andrén & Nilson (1978), Dolmen (1978a) and in Fig. 11. A.c. = The Arctic Circle.

66°30′N (Gislén & Kauri 1959) or in the USSR where it is not found north of 67°N (Bannikov et al. 1977). In Norway it is distributed up to about 65°30′N and most of the records refer to the coastal areas of the southern and central parts of the country (Dolmen 1978a) (Fig. 10).

The common frog (Rana temporaria) (Figs. 11—13).

According to Kivirikko (1940) the species was common all over Finland, and nowadays it is still reported from all parts of Finland (Fig. 11). In northernmost Finland the high relative frequency, viz. the number of the 10 × 10 km squares with records of the species compared to the number of the 10 × 10 km squares with records of all the species, is due to the fact that the common frog and the common lizard are the only amphibian and reptile species recorded there. On the other hand, in the area between about 65°30′N and 68°N the corresponding frequency is low. This is to a great extent due to the large number of records of the adder causing many of the finely dotted squares there. In central and southern Finland the common frog is rather frequently recorded and in Åland it is undoubtedly more often present than indicated in Fig. 11. It stands brackish water well, and, since it has been captured in January in Kirkkonummi, Räfsö (665:36) in a fishing net, it seems to be able to pass the winter in water with a salinity of about 0.5 % (Bergman unpubl.). In Lapland it can even be found up in the regio subalpina on fells (Koli 1977).

In most biological provinces of Finland the populations of the species are reported to be abundant or rather abundant on average. In southern parts of Lapland they still seem to be rather abundant but in the northernmost provinces they are rather scarce or scarce (Fig. 12).

In Fennoscandia the common frog extends its range up to the coastal areas of the Arctic Sea (Gislén & Kauri 1959, Andrén & Nilson 1978, Dolmen 1978a), and in the northwesternmost parts of the USSR it is recorded up to the same latitudes but in the other parts of the country it is probably not distributed so far north (Bannikov et al. 1977) (Fig. 13).

The moor frog (Rana arvalis) (Figs. 14—16).

Since the papers by Kaisila (1947) and Terhivuo & Koli (1977) were published, the number of records of the species in Finland has much increased and they now refer to 254 squares. As shown in Fig. 14, the dots are still clustered in some areas and additional records, especially from central and northern parts of Finland, can be expected.

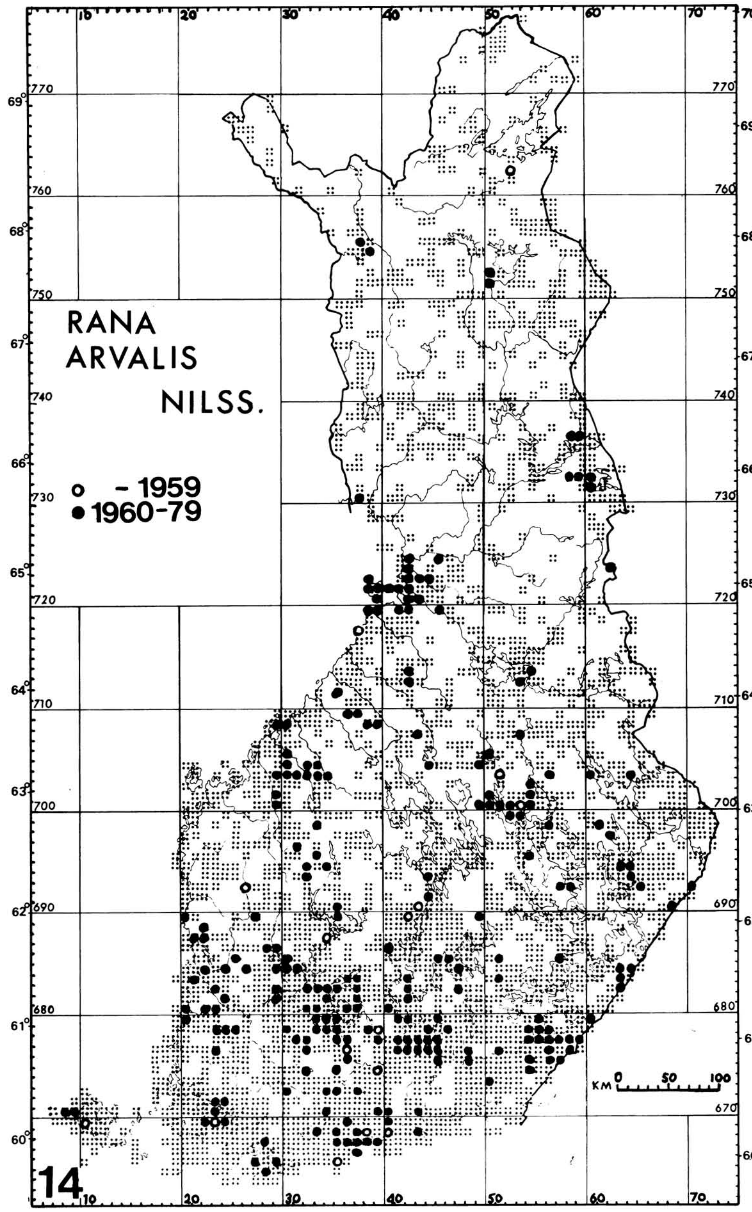
The moor frog seems to be present in most of the biological provinces of Finland, and, it may be distributed throughout the whole country. In Finland the northernmost record of the species is from Ivalo (762:52) (Kaisila 1955). Up in the north, the species is mostly found in bogs and never up on the fells. There are also records from some larger Finnish islands both in the Gulf of Finland and the Bothnian Bay but the species seems to avoid smaller ones.

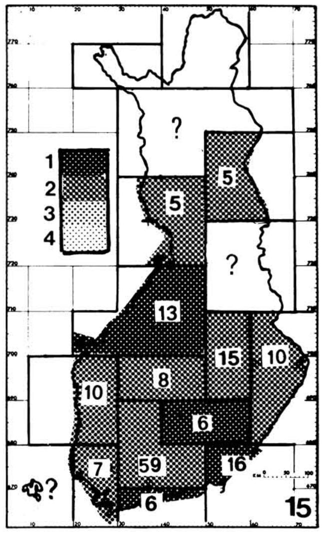
Many dots in Fig. 14 refer to locations where the moor frog was recorded during the breeding season when the presence of the species can be recognized by the call of the males. Undoubtedly, after the spawning season the moor frog can be easily mistaken for the common frog if it is not inspected carefully enough.

Fig. 15 shows that in most provinces the moor frog populations are estimated to be abundant or rather abundant on average. Most of the estimations are also based on the numbers of males calling for females during breeding season. Since the estimated number of the populations is still rather low and the locations are not evenly distributed but are clustered together, Fig. 15 may be a too approximate estimate of the overall state of the populations within the provinces. In any case, the moor frog can by no means be considered a scarce or uncommon species in southern and central parts of Finland.

In Finland the species has a strong preference for habitats close to water and it is more site tenacious than the common frog (Haapanen 1970). Both species are often recorded at the same spawning sites, and in many such cases the moor frog has been superior in numbers to the common frog. In Sweden this is also true in many locations with populations of both species (Elmberg 1978).

In Sweden the moor frog is recorded from all parts of the country (Elmberg 1978), but in Norway its range is restricted to the southeastern coastal region (Dolmen 1978a). In northwestern parts of the USSR there are northern records from the coastal area of the Barents Sea (Bannikov et al. 1977) (Fig. 16).





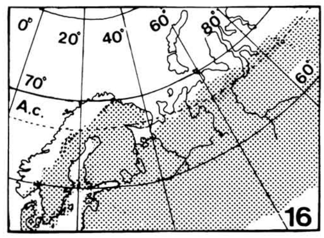


Fig. 14. The squares (10 × 10 km) with records of the moor frog, *Rana arvalis* Nilss., up to the end of 1979. The finely dotted areas correspond to the dots in Fig. 1.

Fig. 15. The provisional population status of *R. arvalis* in Finland in the 1960s and '70s. For further information see the legend to Fig. 6 and the text.

Fig. 16. The northern European distribution of the moor frog, *R. arvalis*, according to the papers by Gislén & Kauri (1959), Stugren (1966), Bannikov et al. (1977), Andrén & Nilson (1978), Dolmen (1978a), Elmberg (1978) and Fig. 14. A.c. = The Arctic Circle.

The marsh frog (Rana ridibunda) (Figs. 17—18).

The marsh frog, which is probably an introduced species in Finland (Suomalainen 1941), was recorded in two separate localities, viz. Helsinki (667:38 and 667:39) and Porvoo (669: 42). In both sites the habitats lie rather close to the mouth of a river where there are shallow bays of brackish water with dense vegetation. At least in Helsinki, the species was abundant and bred well at the end of the 1930s (Kivirikko 1940, Suomalainen 1941). At the end of the 1940s and in the 1950s it was still present in both places. The last record of the species refers to one individual captured in Helsinki Vanhankaupunginlahti on July 15, 1960 (Zoological Museum of the University of Oulu). Despite the frequent excursions to the habitats of the species by Finnish naturalists no later records have been made. Accordingly, it is concluded that it no

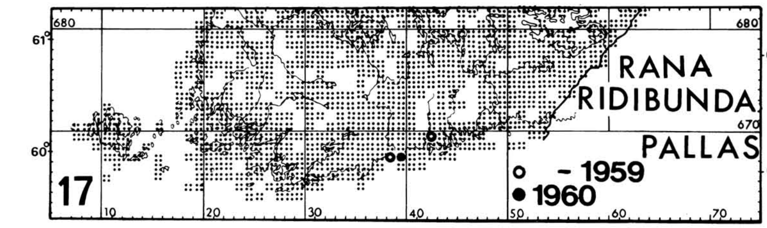


Fig. 17. The squares (10 × 10 km) with records of the marsh frog, *Rana ridibunda* Pallas, in Finland. The species died out in the 1960s. The finely dotted areas correspond to the dots in Fig. 1.

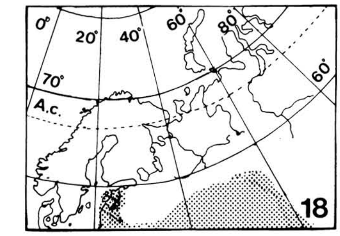


Fig. 18. The northern European distribution of *R. ridibunda* according to Bannikov et al. (1977) and Ebendal (1978). A.c. = The Arctic Circle.

longer belongs to the Finnish herpetofauna.

At the end of the 1930s, many marsh frog individuals were shot by local people in Helsinki (Suomalainen 1941), and at the beginning of 1940s the temperature variations were occasionally very extreme, causing a great decline in the amphibian and reptile population of southern Finland, at least (Olsoni 1943, Haartman 1950, Klingstedt 1950). However, at the beginning of the 1950s there were still marsh frog specimens to be found in both places. The final extermination seems to be due to the increasing amount of sewage and other pollutants carried by the river Vantaa in Helsinki and the river Porvoonjoki in Porvoo to the habitats of the species. In Helsinki the invertebrate bottom fauna had drastically diminished in the 1960s (Laakso 1965) and the same trend was observed in the avifauna, too (Eriksson 1966).

The marsh frog is absent from Scandinavia (Ebendal 1978). The records of the species nearest to Finland refer to Estonia, including the islands of Saaremaa and Hiiumaa (Kauri 1946, Bannikov et al. 1977, Ebendal 1978) (Fig. 18).

The common lizard (Lacerta vivipara) (Figs. 19—21).

As shown in Fig. 19, the common lizard occurs throughout Finland. It is found on some remote islands of the outer archipelago in the Gulf of Finland and the Gulf of Bothnia as well as on the slopes of the fells in Lapland.

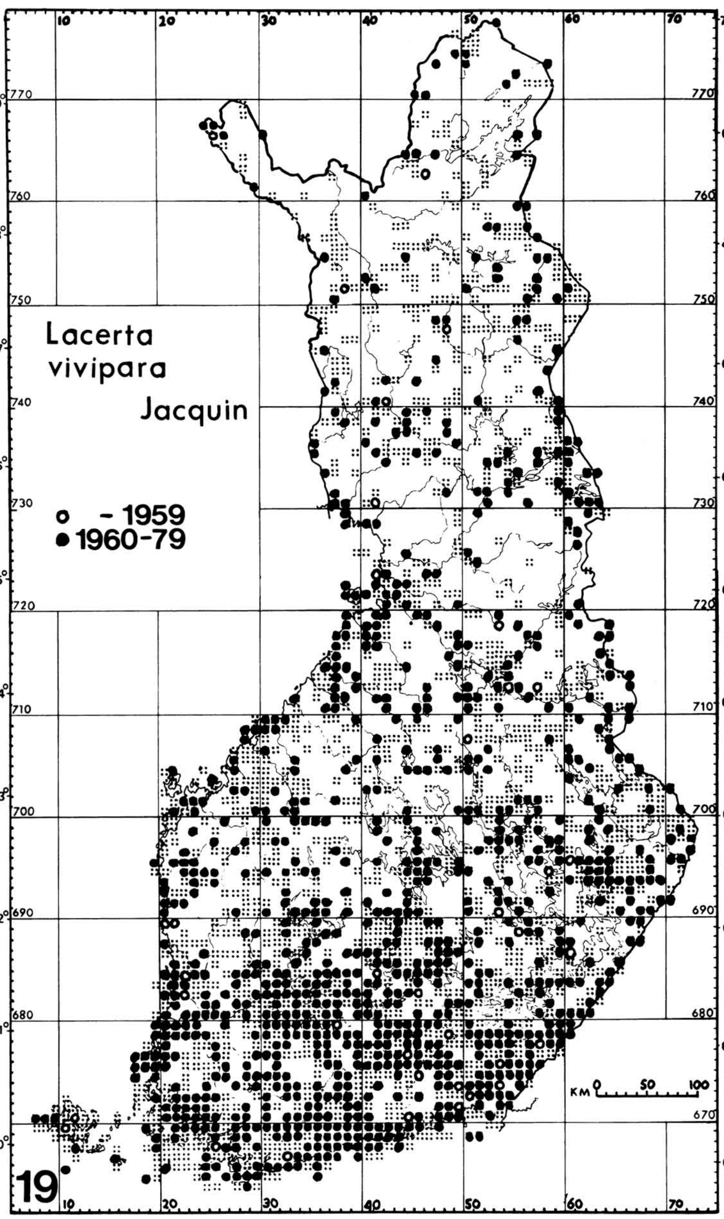
In central and northern parts of Finnish Lapland the populations seem to be scarce or very scarce, but the reports also indicate that there can be great local variation in this respect. In other parts of the country the populations are estimated to be rather abundant (Fig. 20) on average.

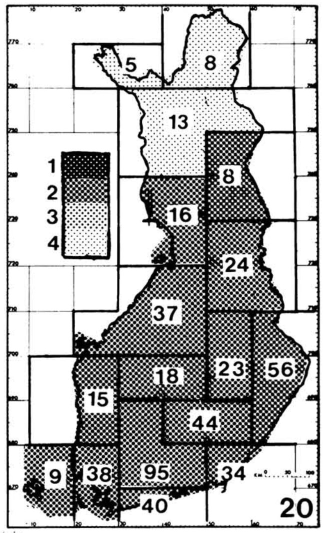
In Scandinavia and in northwestern parts of the USSR the species is distributed up to the coastal areas of the Arctic Sea but east of about 50°E it is absent from the most arctic parts of the USSR (Gislén & Kauri 1959, Bannikov et al. 1977, Dolmen 1978a) (Fig. 21).

The slow-worm (Anguis fragilis) (Figs. 22—25).

In Finland the slow-worm is distributed up to about 63°30′N and the northernmost records refer to Purmo (705:29), Kaustinen (705:33), Rautavaara (704:56) and Lieksa, Hämeenjärvi (704:65) (Ekman 1924, Koli 1977 and Fig. 22). North of about 63°N, it can be regarded as an occasional species. Ekman (1924) does not mention any record north of 64°N, but Hecht (1928) indicates two uncertain finds from Aavasaksa and Kemijoki in Finnish Lapland and he also writes: "Als ständiger, wenn auch noch seltener Gast ist sie bei Uleåborg (= Oulu) und Kajaani sicher belegt". Neither Kivirikko (1940) nor Kaisila (1949) mention these records and Gislén & Kauri (1959) ignored the records of Hecht (1928) referring to Swedish Lapland. The Finnish records of the latter author are not indicated in Fig. 22.

At the beginning of this century, the slow-worm was recorded only a few times from Åland (Ekman 1924). One of these records was made in Geta (about 671:10) (K. Linkola), another in Sund (about 670:11) (J. = I? Välikangas) and in the third only "some specimens in Ahvenanmaa (= Åland) (G. Gottberg)" is indicated. Despite very extensive excursions in Åland in 1920—27 and 1930—32 no records of the slow-worm were made (Palmgren unpubl.). Since no latter records of the species in that area have been reported, one must conclude that the species has disappeared from the area during the past fifty to sixty years.





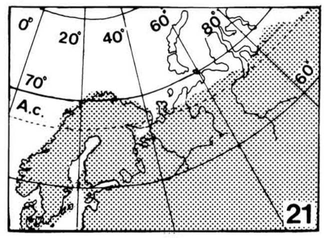


Fig. 19. The squares (10 × 10 km) with records of the common lizard, *Lacerta vivipara* Jacquin, in Finland up to the end of 1979. The finely dotted areas correspond to the dots of Fig. 1.

Fig. 20. The provisional population status of *L. vivipara* in Finland in the 1960s and '70s. For further information see the legend to Fig. 6 and the text.

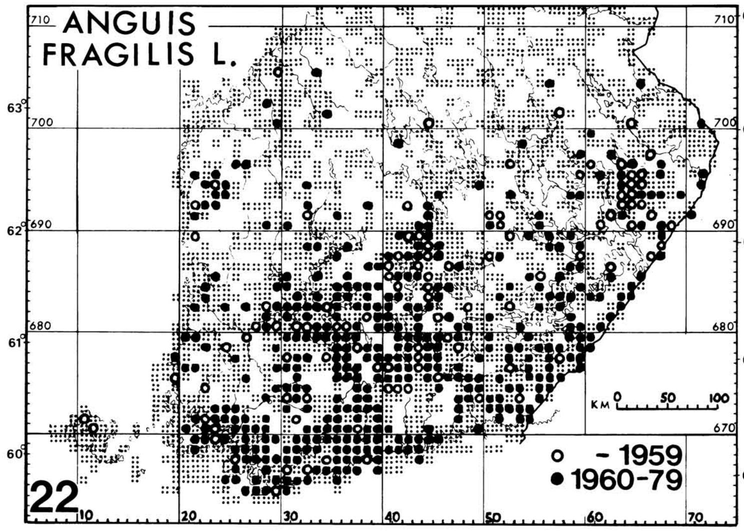
Fig. 21. The northern European distribution of the common lizard, *L. vivipara,* as suggested by the papers of Gislén & Kauri (1959), Bannikov et al. (1977), Dolmen (1978a) and Fig. 19. A.c. = The Arctic Circle.

The species can still be found, e.g. on some islands close to the southern coast of the Finnish mainland, but not on those belonging to the outer archipelago.

Figure 23 presents the 10 × 10 km squares for the blue-spotted morph of the slow-worm in Finland up to the end of 1979. Both the blue-spotted and the unspotted morphs no doubt have much the same range in Finland.

Kivirikko (1940) did not consider the slow-worm a common species anywhere in Finland, but it is more frequently recorded in some parts of the southern coastal areas west of Helsinki than elsewhere. According to Fig. 22 most of the records of the species in 1960—79 refer to the southernmost, central and southeastern parts of southern Finland.

Nowadays, the slow-worm populations of Finland seem to be scarce or rather scarce on average and those local populations reported to



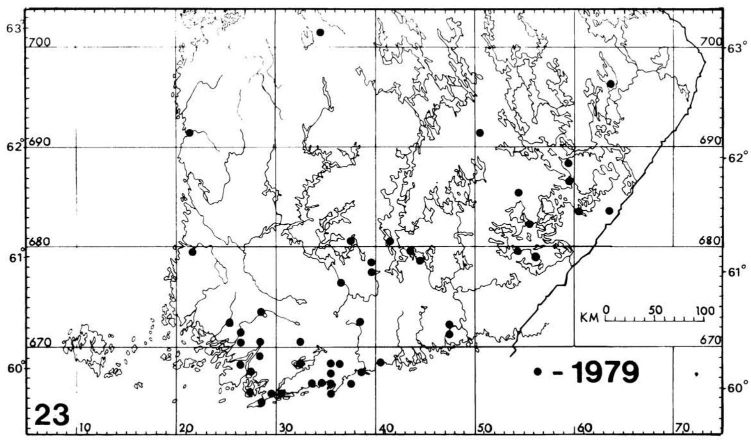
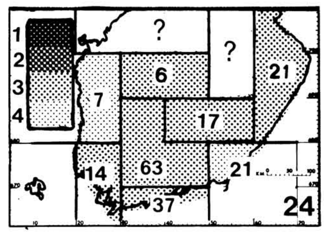


Fig. 22. The squares (10 × 10 km) with records of the slow-worm, *Anguis fragilis* L., in Finland up to the end of 1979. The finely dotted areas correspond to the dots in Fig. 1.

Fig. 23. The records of the blue-spotted morph of the slow-worm, *A. fragilis* in Finland up to the end of 1979.



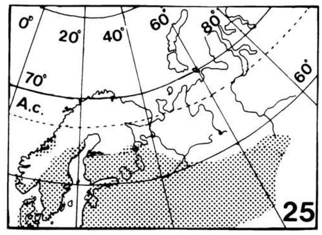


Fig. 24. The provisional population status of *A. fragilis* in Finland in the 1960s and '70s. For further information see the legend to Fig. 6 and the text.

Fig. 25. The northern European distribution of the slow-worm, *A. fragilis*, as suggested by Gislén & Kauri (1959), Bannikov et al. (1977), Dolmen (1978a) and Fig. 22. A.c. = The Arctic Circle.

be abundant or rather abundant are mostly confined to the provinces of Varsinais-Suomi (see Fig. 24, n = 14), Uusimaa (n = 37) and Etelä-Häme (n = 63).

In Sweden the slow-worm extends its range up to about 61°N in all parts of the country, but north of that most records are located on the eastern coast up to 64°30′N (Gislén & Kauri 1959). One inland record in Sweden even refers to about 65°20′N/18°E. In Norway all the records from 1950 onwards have been made in southern and southeastern parts of the country, but there are older finds from the vicinity of Trondheim up to about 65°30′N (Dolmen 1978a). In northwestern USSR the slow-worm is recorded near the lakes of Ladoga and Onega and the northernmost finds refer to 64°N (Bannikov et al. 1977) (Fig. 25).

The grass snake (Natrix natrix) (Figs. 26—28).

According to Kivirikko (1940), the grass snake is found in Oulu (721:42) and Liminka (719:42). Hecht (1928) gives many additional finds for the

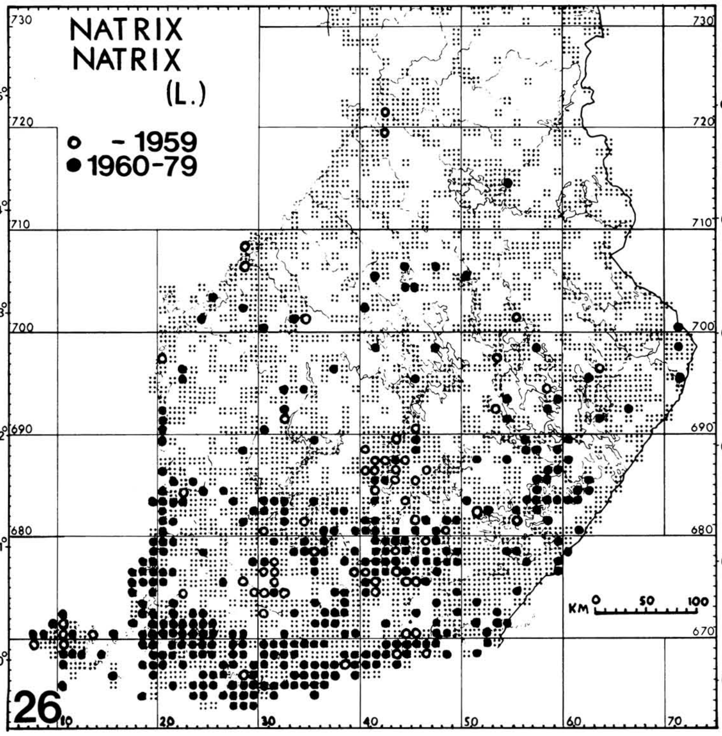


Fig. 26. The squares (10 × 10 km) with records of the grass snake, *Natrix natrix* (L.), in Finland up to the end of 1979. The finely dotted areas correspond to the dots in Fig. 1.

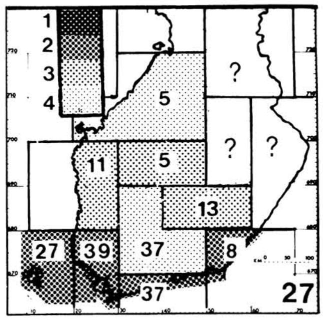


Fig. 27. The provisional population status of *N. natrix* in Finland in the 1960s and '70s. For further information see the legend to Fig. 6 and the text.

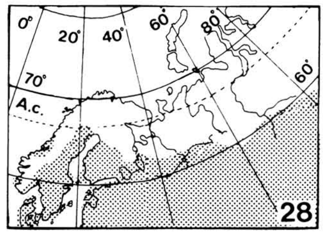


Fig. 28. The northern European distribution of the grass snake, *N. natrix*, according to Gislén & Kauri (1959), Bannikov et al. (1977), Andrén & Nilsson (1978), Dolmen (1978a) and Fig. 26. A.c. = The Arctic Circle.

species in Finnish and Swedish Lapland but he also considers them to be dubious or inexact (p. 562). Moreover, Vainio (1952) reported an old record of the species by A. Broberg in Kittilä, Kapsajoki (about 68°10'N/25°15'E). Since the latter report and those by Hecht (1928) are located so far north, out of the range of the species indicated by e.g. Kivirikko (1940), Kaisila (1949) and Koli (1977) and since there is no way to re-check them, I have chosen to exclude these from Fig. 26. In 1976 the grass snake was found in Paltamo, Mieslahti (714:54).

Forty to fifty years ago the grass snake was rather common here and there in southern and central parts of Finland, but this area also included many places from where it was never recorded (Kivirikko 1940). Accordingly, the occurrence of the species was sporadic. Today the grass snake is most frequently found on the southern and southwestern coast of Finland including the Åland archipelago, and the populations are usually reported to be rather abundant there (Figs. 26, 27). It is unevenly distributed in the inner parts of the southern Finnish mainland and most of the dots north of about 62°N refer to only one record of the species in the square. In the provinces north of 61°N (= 680 N, see the grid in Fig. 27) as well as in Etelä-Häme (n = 37), the grass snake populations are rather or very scarce on average. Moreover, it is worth noting that many of the records from northern and central parts of the Finnish range of the species are from close to the sea coast or big lakes and rivers (Fig. 26). This will be discussed in detail in a later connection.

In Norway there are old finds of the species up to about 65°30', but from 1950 onwards it is recorded only in southern and southeastern parts of the country (Dolmen 1978a). In Sweden it is found as far north as 67°N, but north of about 62°N it seems to avoid the high western uplands (Gislén & Kauri 1959). In the USSR it is recorded near the northern coast of the Ladoga and the Onega lakes up to about 63°N (Bannikov et al. 1977) (Fig. 28).

The smooth snake (Coronella austriaca) (Figs. 29—30).

In Finland the smooth snake occurs only on the mainland of Åland and on one island very close to it. According to Kivirikko (1940) it was recorded in 1881 in Geta (probably 671:10) and in 1892 in Hammarland, but the latter locality is incorrect and should be Geta (probably 671:10) (see Bomansson 1894 and Mela & Kivirikko 1909). Natunen (1900) reported one find from Hammarland, Kattby (669:09) in 1899. In 1921 it was found in Saltvik (probably 670:11) and in 1943 in Jomala (probably 669:10). Two specimens, one found in 1948 in Eckerö, Torp (669:08) and the other in 1949 in Eckerö, Skag (670:09), are included in the collections of the Zoological Museum of the University of Helsinki. Moreover, according to Wickström (1949) one specimen was caught in Sund, Bomarsund (669:12) in 1942 and another in Finström (probably 670:10) in 1943. More than thirty years passed until the species was found again, in 1975, in Geta, Dånö (672:10). The last three records of the species refer to Saltvik, Näs (671:11) in 1978 and Finström, Godby (669:11) in 1978 and 1980.

In the Zoological Museum of the University of Helsinki there is one smooth snake individual labelled "Turun puolesta (= from the vicinity of Turku), leg. H. Olsoni, ded. V. Mannelin", but there are no further details. Moreover, Kivirikko (1940) gives a description of a single snake recorded near Heinola (about 61°12′N/26°05′E) with two rows of blue spots along the back, red underpart and with movements slower than those of the adder or the grass snake. Since it can not be completely denied that the individual was in fact some other species, e.g. slow-worm with blue-spots, and since there are no later records of the species either from Turku or Heinola, I have chosen to exclude these two records from Fig. 29. It is worth emphasizing that there are no verified records of the smooth snake from the mainland of Finland, but, unfortunately, even in modern herpetological literature, the southern parts of the Finnish mainland are still included in the range of the species.

The population status of the species in Åland is unknown but the low number of records seems to indicate that it can be regarded as a rare species there. The smooth snake is listed as an endangered species in Finland by the Finnish Section of the World Wildlife Fund (Malmström 1975) and in Åland it is nowadays protected by a local statute.

In Sweden there are records of the smooth snake up to about 62°30′N, but today its range lies south of 60°N (Gislén & Kauri 1959, Andrén & Nilson 1979a). A law to protect the Swedish smooth snake populations was passed in 1971 but the species still seems to be decreasing in number there (Andrén & Nilson 1976, 1979a, 1980). In Norway it is found only in the southeastern and southern coastal areas (Dolmen 1978a). In the USSR its range extends up to about 59°N in the north, reaching to about 28°E in the west (Bannikov et al. 1977) (Fig. 30).

The adder (Vipera berus) (Figs. 31—33).

In all parts of Finland the adder is rather frequently and evenly recorded up to about 68°30′N but many of the dots in the north refer to only one record of the species from the square (Fig. 31). In 1979 the adder was found in Inari, Riutula (765:49). There are several records of the

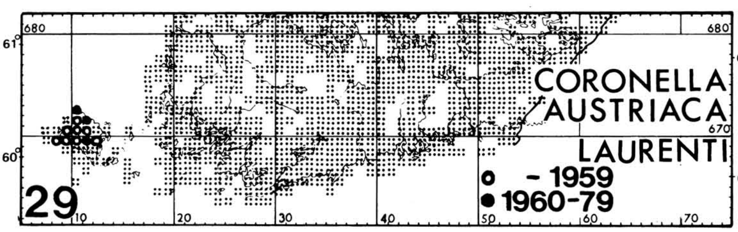


Fig. 29. The squares (10 × 10 km) with records of the smooth snake, *Coronella austriaca* Laurenti, in Finland up to the end of 1979. The finely dotted areas correspond to the dots of Fig. 1.

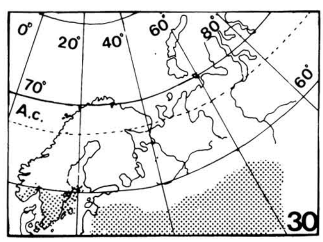
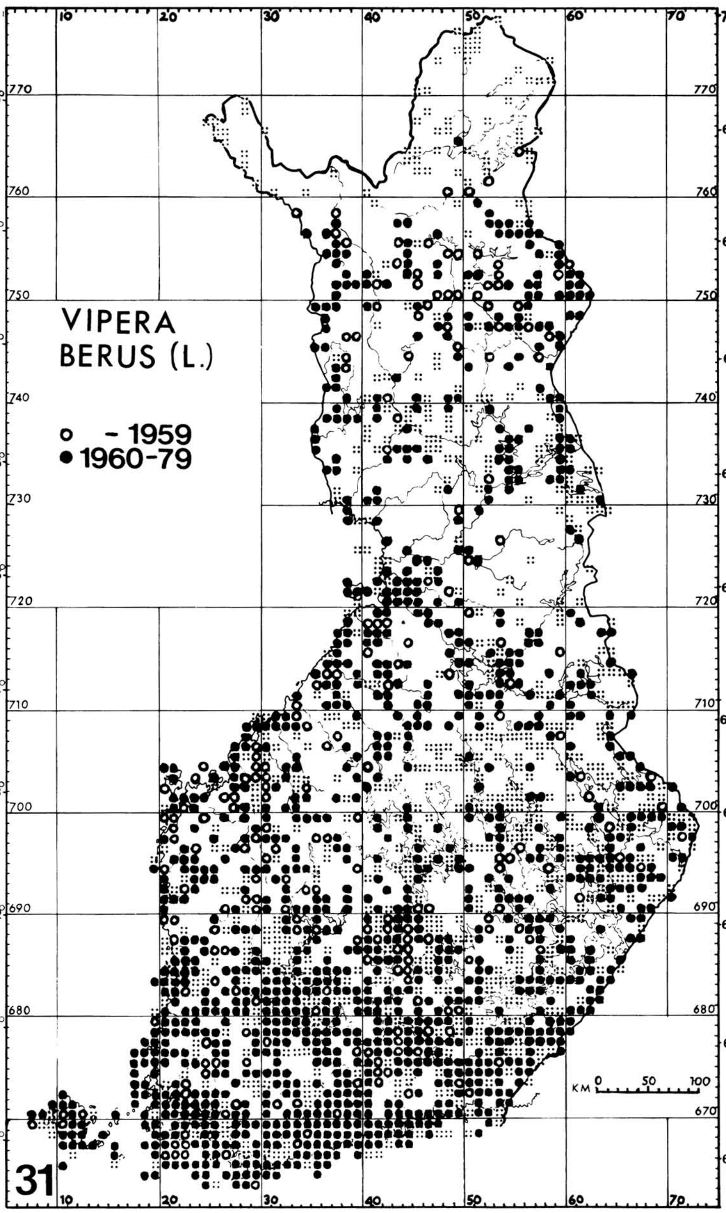
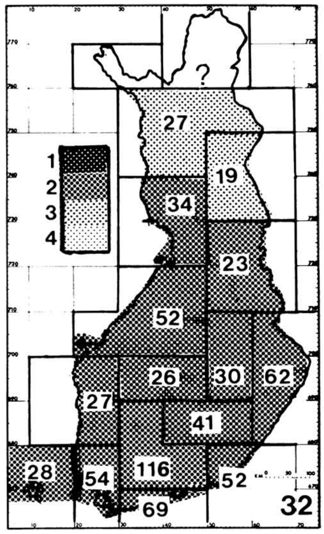


Fig. 30. The northern European distribution of the smooth snake, *C. austriaca*, as indicated by Gislén & Kauri (1959), Bannikov et al. (1977), Dolmen (1978a), Andrén & Nilson (1979) and Fig. 29. A.c. = The Arctic Circle.





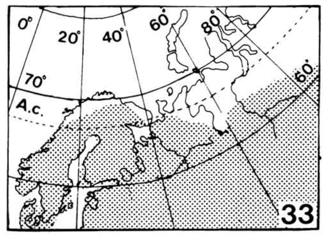


Fig. 31. The squares (10 × 10 km) with records of the adder, *Vipera berus* (L.), in Finland up to the end of 1979. The finely dotted areas correspond to the dots of Fig. 1.

Fig. 32. The provisional populations status of *V. berus* in Finland in the 1960s and '70s. For further information see the legend to Fig. 6 and the text.

Fig. 33. The northern European distribution of the adder, *V. berus*, according to Gislén & Kauri (1959), Bannikov et al. (1977), Andrén & Nilson (1978), Dolmen (1978a) and Fig. 31. A.c. = The Arctic Circle.

species on many islands on the Finnish side of the Baltic Sea and swimming individuals have been found out at sea. Undoubtedly, the adder can easily migrate from one island to another. In the north it can be found rather high up on the slopes of the fells. In some parts of Finnish Lapland, e.g. in Pallas-Ounastunturi, Muonio, Jaurijoki and Värriö, the adder is rather frequently found and some of the local populations are even reported to be rather abundant.

On average, the adder populations in the north can be regarded as rather scarce (Fig. 32). In southern and central parts of Finland including the Åland archipelago the populations seem to be rather abundant on average.

In the 1950s an enquiry was carried out to determine the distribution of the adder in Finland. The records received indicate much the same range for the species as that shown in Fig. 31 (see Lavila 1977a-h). Accordingly, no great change in the range of the species in Finland seems to have taken place in the past thirty years. But, the reports received also indicate that there can be great variation in the local state of the species even within the same 10 × 10 km square.

In Sweden the adder occurs throughout the country (Gislén & Kauri 1959, Andrén & Nilson 1978) and in Norway it is distributed in the north up to about 66°N (Dolmen 1978a). In the USSR it is found near Murmansk but in the area east of 50°E it is not found north of the Arctic Circle (Bannikov et al. 1977) (Fig. 33).

3.2. Trends reported in Finnish amphibian and reptile populations in the 1970s

Table 2 summarizes the reports concerning the Finnish amphibian and reptile populations observed during three or more successive years. In each location the observation period extends, partly at least, to the 1970s. The 440 reports refer to 403 10 × 10 km squares, mostly situated in southern parts of Finland.

Considering all the reports of Table 2, statistical heterogeneity is indicated ($X^2 = 14.691$, $P \sim 0.023$, df = 6). Accordingly, the view that the populations of all the species have changed at equal rates is not supported.

For instance, 78.4 % of the reports of both the adder and the common toad indicate decline in the populations, but in the common lizard and in the common frog the corresponding percentages are much lower, viz. 60.0 and 60.3, respectively (X^2 Rana/Bufo = 4.53, $P \sim 0.035$, df = 1 and X^2 Lacerta/Vipera = 6.94, $P \sim 0.01$, df = 1, Table 2). In general, a declining trend is significantly more often reported than one

Table 2. Trends reported in local Finnish amphibian and reptile populations in the 1970s. The populations were observed during three or more successive years and most reports refer to southern Finland.

	Decreased or disappeared	Increased or no change	Total	Number of 10 × 10 km squares
Triturus vulgaris	20	4	24	24
Bufo bufo	40	11	51	50
Rana temporaria	44	29	73	65
Lacerta vivipara	33	22	55	53
Anguis fragilis	29	10	39	36
Natrix natrix	35	15	50	47
Vipera berus	116	32	148	128
Total	317	123	440	403

X^2heterog. = 14.691, $P \sim 0.023$, df = 6.

indicating an increase or no change ($X^2 = 85.536$, $P < 0.001$, df = 1). Table 1 also seems to support the view that the declining trend is more prominent in *B. bufo*, *V. berus* and, evidently, also in *A. fragilis* and *N. natrix* than either in *R. temporaria* or *L. vivipara* since the percentages of the 10 × 10 km squares with records from before 1960 only are much higher (15.7—22.2 %) for the four species mentioned first than for the two latter species (3.8—5.0 %).

The adder, in particular, was reported to be declining in numbers due to the increase in different types of human activity (Fig. 34). For instance the spreading of the settled areas, new summer cottages built in uninhabited areas, hostility of man, heavy traffic and destruction of winter dens and/or killing of the animals after their departure from their winter dens are usually considered as the primary reasons for the declining trend in local adder populations. It is also worth noting that in the literature up to the end of the 1950s, there were several notes of hundreds of adders found in front of their winter dens in early spring, but in the past twenty years hardly any such observation has been reported. On the other hand, the fields left lying fallow, "banked fields", are often occupied by adder populations which could not inhabit the fields if they were under cultivation. Evidently, small rodents and other prey animals are abundant there, and open terrain may also offer good sites for basking in the sun.

According to Lavila (1977a-h) the decreasing trend in the adder populations was observed already in the 1950s. The reasons proposed are the increasing number of human settlements, uninhabited areas occupied for cultivation, killing of the individuals leaving their winter dens and possibly the number of ants and hedgehogs in the area is also involved in the decline.

One important reason for the increase in mortality among the amphibian and reptile populations is traffic, which is becoming heavier all the time. Table 3 shows the numbers of specimens found killed on the roads near Perniö (668:28) in 1970—73. The common frog, the adder and the grass snake seem to be most exposed to the traffic in the area. Near Inkoo, Fagervik (666:32) 4 adders, 5 slow-worms, 1 common frog and 4 grass snakes were found run over by cars in 1979—81. The latter records were made on dirt roads with rather light traffic.

The role played by chemical pollutants in the state of today's Finnish amphibian and reptile populations is completely unknown.

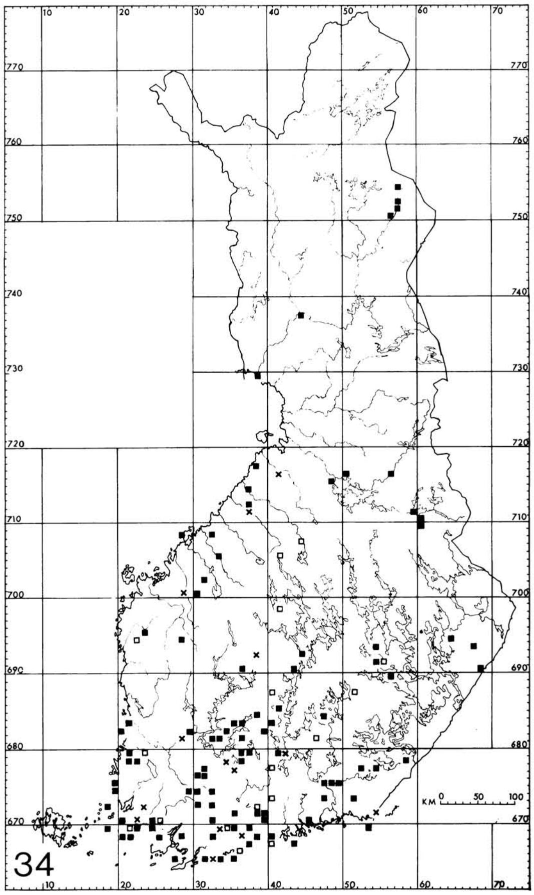


Fig. 34. Trends in the adder *(Vipera berus)* populations in Finland in the 1970s. The reports indicating the observation of the same adder population in three or more successive summers are located in the 10 × 10 km squares of the uniform grid (27°E) system. Symbols: solid square = population(s) decreased or disappeared, open square = population(s) increased and × = no change observed. Additional reports referring to the same squares and indicating the same trend are not shown in the map. If equal number of opposite reports came from the same square "no change" is indicated in the map, otherwise only the most frequently reported trend is shown. See also Table 2.

Considering Finland as a whole, the data about different aspects of mortality among amphibian and reptile populations are still rather scanty. In general, the increasing amount of different types of human activity is involved in the decrease or disappearance of many local amphibian and reptile populations, at least in southern Finland. Table 2 strongly indicates the importance of repeated surveys to monitor the future state of the populations.

Table 3. Amphibians and reptiles killed by traffic near Perniö (668:28), southwestern Finland, in 1970—73.

	Year				Total	
	1970	1971	1972	1973	n	%
Rana temporaria	1	13	12	15	41	42.3
Bufo bufo	1	—	—	2	3	3.1
Anguis fragilis	1	—	4	1	6	6.2
Natrix natrix	2	7	4	8	21	21.6
Vipera berus	2	10	2	12	26	26.8
Total	7	30	22	38	97	100.0

4. Discussion

4.1. Climatic, geographical and historical factors in relation to the ranges of the Finnish species in northern Europe

The data indicating the ranges of the amphibian and reptile species in Norway (Dolmen 1978a), Sweden (Gislén & Kauri 1959), Finland (the present paper) and the USSR (Bannikov et al. 1977) warrant an outline of the marginal parts of the ranges of the Finnish species in northern Europe. The area lying north of 55°N and between 4°E and 60°E is characterized by great geological and climatic differences with a concomitant impact on the distribution of the species. Accordingly, the marginal populations are subject to factors with unequal rates of effects in different parts of the ranges of the species in northern Europe.

Accepting the view of several factors with impacts on the ranges, one can suggest the possible role of some of them, but it is only in accordance with the changes in the ranges that their importance can be assessed. Thus, the records compiled here can be used as the basic information when trends or occasional changes both in the ranges and the status of the local populations of the species are monitored in the future.

The Scandinavian mountain range running through Norway up to the Arctic Sea coast forms a very prominent geographical barrier with a profound influence on the maritime climate of the area. The passes from central Sweden to Norway across the fells are important routes for the westward dispersal of many species (Ekman 1922). From the point of view of amphibians and reptiles, the rivers running in these passes may have facilitated the dispersal both directly and indirectly.

The continental type of climate prevails in the northwestern parts of the USSR but in Norway the maritime climate is predominant. Both Sweden and Finland are intermediate when compared either to Norway or the USSR in this respect. Locally, big lakes and rivers can ameliorate the climatic extremes in the habitats close to them. In the east, the Ural mountains extending along longitude 60°E up to the Arctic Sea form a barrier to the eastward distribution of some of the species discussed in the present paper.

The Gulf of Bothnia and the Gulf of Finland isolate southern parts of Finland from Sweden and Estonia, respectively. Despite the presence of the Åland archipelago with its increasing number of islands between Sweden and Finland, some amphibian and reptile species have not been able to migrate from Åland to the Finnish mainland. Though it is known that some insects may float with the sea currents from the coast of Estonia to southern Finland and the Åland archipelago (Palmén 1944), there is no data concerning amphibians or reptiles in this respect.

Post-glacially, the eastward and southeastward land bridges of southern Finland have maintained important routes of dispersal for many vertebrate and invertebrate species. Undoubtedly, amphibians and reptiles are no exception in this respect. For instance, the common lizard seems to have been able to migrate up to Finland and even to the northernmost parts of Scandinavia until the populations of the species from southern parts of Scandinavia were able to spread there (Voipio 1961, 1963).

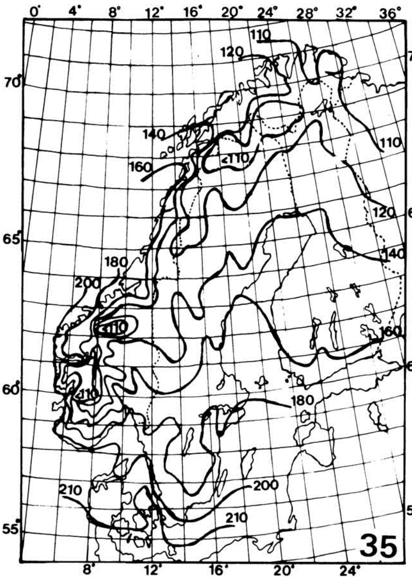
Most of the amphibian and reptile species recorded in Finland are almost equally distributed up in the north both in Sweden and the northwestern USSR. Accordingly, since the disappearance of the ice cover, the species have evidently had enough time for their northward dispersal on both sides of the Baltic. Since the late 1800s up to the present time the climate of Scandinavia has been becoming milder (Johannesen 1970), but no great expansion in the ranges of the Finnish amphibian and reptile species in northern Europe has been detected, despite such an expansion among many bird and mammal species, for example.

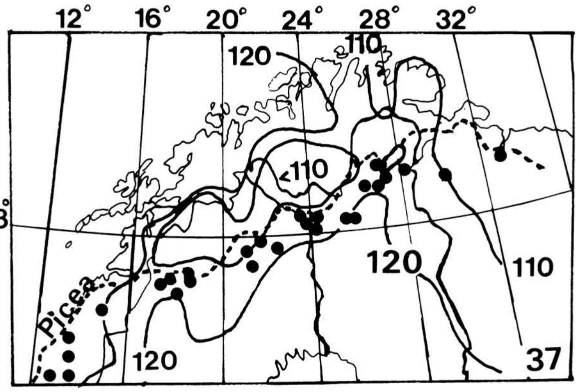
The European pond tortoise, *Emys orbicularis,* is nowadays extinct in Denmark, Sweden, Finland and the northwestern USSR, though it was undoubtedly distributed in these areas, perhaps during the postglacial, warm period (about 5000—500 B.C.). In the latter area, relict populations may have existed up to the 1700s and 1800s (Nilsson 1842, Kaisila 1951, Smith 1951, Gislén & Kauri 1959). Moreover, many European amphibian and reptile species are not distributed further north in Scandinavia than to southern parts of Sweden, and many of the populations there seem to be more or less relict in nature (see Gislén & Kauri 1959, Andrén & Nilson 1980). Changes in the postglacial climate seem to be involved in the decline of the populations, but habitat destruction by man has also had a great influence there. On the other hand, the ranges of many of these species are extended on the eastern side of the Baltic Sea as far as to the Gulf of Finland or close to it (see section 4.2) indicating that historical dispersal factors are also involved in the delimitation of the ranges of these species.

Being poikilothermic, amphibians and reptiles depend entirely on environmental heat to carry out different phases of their life cycles. The climatic maps indicating the annual variation in different thermal gradients in northern Europe seem to have some features in common. The wintertime temperature gradients mostly run from south or southeast to north, northwest or northeast. This is true in the European parts of the USSR as far as the mean surface air temperature in January, the mean and annual minimum temperatures, and the effective minimum temperature (used for the calculation of heat loss from buildings) are concerned (Lydolph 1977). In Fennoscandia the gradients of the mean January temperatures also run from southeast to northeast with some modifications due to the Scandinavian mountain range (Wallén 1970). On the other hand, the summertime temperature gradients in northern Europe run from east or southeast to west or southwest. Thus they follow much more closely the latitudes than do the wintertime temperature gradients. Autumn and spring are intermediate in this respect (Wallén 1970, Lydolph 1977).

Figures 4, 7, 10, 13, 16, 18, 21, 25, 28, 30 and 33 show that the northernmost borders of the ranges of the species in northern Europe run from east or southeast to west or northwest. Accordingly, the summertime temperature gradients, especially those indicating the temperature sums or the length of the vegetation period (Figs. 35, 36), seem to be worth considering when the northern distribution of the species is discussed.

Spells of adverse weather may cause abrupt changes in local populations such as those reported by Olsoni (1943), Haartman (1950) and Klingstedt (1950) in southern Finland or even the extinction of the species in the area, such as that of *Rana sp.* in Iceland (see Hesse 1924). In the long





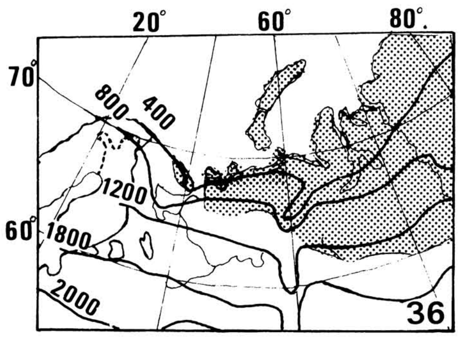


Fig. 35. The normal length (1931—60) of the vegetation period in days (daily mean temperature $\geq$ +6°C) in Fennoscandia (Johannesen 1970).

Fig. 36. Sums of mean daily temperatures during the period when the mean daily temperature is above +10°C in the northwestern USSR. Regions with permafrost are indicated by shading (Lydolph 1977).

Fig. 37. Northernmost records of the adder, *Vipera berus*, in Fennoscandia and southwestern USSR according to Gislén & Kauri (1959), Bannikov et al. (1977), Dolmen (1978a) and Fig. 31. The solid lines indicate the normal length (1931—60) in days of the vegetation period (daily mean temperature $\geq$ +6°C) in Fennoscandia (from Johannesen 1970) and the broken line shows the northernmost parts of the range of the spruce, *Picea abies*, (from Kalliola 1973).

run, the populations on the mainlands, at least, seem to be able to recover.

The possible role of biotic factors including anthropochory in relation to the present ranges of the species is difficult to determine, but it should not be excluded.

The newt species

The majority of the records concerning the newts *T. vulgaris* and *T. cristatus* in Scandinavia and northwestern USSR are from locations close to rivers and lakes. In the west both species have been able to spread from central Sweden up to the Scandinavian mountain range and further westwards to the area of Trondheim in central parts of Norway. Evidently, the long passes with rivers have been important in this respect, and the maritime climate has apparently favoured the establishment of the populations since, both in Norway and western parts of Sweden, the two species are distributed further north than anywhere else.

In Fennoscandia, most records of *T. vulgaris* refer to the area where the annual length of the vegetation period with a daily mean temperature of $\geq$ 6°C is 140 days or longer (Figs. 7 and 35). In the USSR the corresponding factor of the growth period is given as sums of the temperatures when the mean daily temperature has been > 10°C. As indicated in Figs. 7 and 36, the northernmost parts of the range of *T. vulgaris* rather closely parallel the temperature sum gradient of about 1200—1300°C in the European parts of the USSR.

The absence of *T. cristatus* from southern parts of the Finnish mainland is not easy to explain. Evidently, the species has come over from Sweden to the mainland of Åland and spread further eastwards to some small islands of the archipelago. The number of islands between Åland and Finland is higher and the islands lie closer to each other than those between Åland and Sweden, but this does not seem to have faciliated the dispersal of the species as far as to the southwestern coast of the Finnish mainland. Moreover, the same type of coastal landscape prevails in Åland as well as in the Finnish and Swedish coastal areas opposite Åland (Abrahamsen et al. 1977). Sea currents, possible predation by fish and lack of spawning sites are hardly involved since the smooth newt *(T. vulgaris)*, an allied species, is widely distributed throughout the archipelago and both species may even share the same pool, for example. In Britain *T. cristatus* has a preference for chalk or clayey areas (Smith 1951) but in central Norway it has been found only in acid, boggy areas (Dolmen 1980). Historical factors, low rate of dispersal and low population density in Åland seem to be worth consideration when its absence in the southern and southwestern Finnish mainland is assessed.

Figs. 4 and 7 seem to indicate that *T. cristatus* withstand the continental climate of the USSR as well as *T. vulgaris*. The c. 1600°C temperature sum gradient of the vegetation period closely parallels the northernmost border of the range of *T. cristatus* in the USSR (Figs. 34 and 4). The ameliorating effect of the big lakes of Ladoga and Onega on the climate of the nearby areas may have favoured the northward dispersal of *T. cristatus* there (Fig. 4). Moreover, the records of the latter species near the southeastern border of Finland refer to the localities which belong to the area of Karelia with its rich forests and characteristically large number of southern plant species (see Kalliola 1973).

Many of the northern records of both newt species are not only located close to big lakes and rivers but they are also rather separate from each other. Does the present distribution of the species in the north indicate any retreat from the areas possibly earlier occupied by them or have the species been able to disperse further northwards?

The species are site tenacious suggesting a low rate of dispersal, and one may hypothesize that in the long run many of the marginal populations have perhaps died out. In Finland, the northern marginal populations of *T. vulgaris* are separate from each other but the records from 1960 onwards indicate no great change in the range of the species during the last twenty years, at least (Fig. 5). The monitoring of the future state of the marginal populations is important in this respect, too.

The common toad

The common toad *(Bufo bufo)* apparently avoids the higher elevations of the Scandinavian mountain range but it has been able to spread along the passes with rivers from the central parts of Sweden to the Trondheim region where the maritime climate prevails. In Sweden and Finland the northernmost populations of the species are located close to the gradient indicating the normal length of the annual vegetation period of 120 days or longer (Figs. 8 and 35). In the northwestern USSR the species is absent from the area with permafrost and the continentality of the climate may have an impact on its distribution there (Figs. 8 and 36).

The frog species

The ranges of the three Finnish *Rana* species show interesting zoogeographical features. In Fennoscandia the moor frog *(R. arvalis)* is not recorded from western parts of the Scandinavian mountain region, but the common frog *(R. temporaria)* can occupy this area (Figs. 13 and 16). The latter species can be found, e.g., in the regio subalpina of the fells (Ekman 1922), but *R. arvalis* is absent from higher elevations, and not even the passes from central Sweden to Norway have facilitated the dispersal of the latter species to central parts of Norway.

In the USSR east of about 40°E, *R. arvalis* is distributed further northwards than *R. temporaria* (Figs. 13 and 16). The increasing continentality of the climate towards the east does not seem to have affected the northward distribution of *R. arvalis* since it is even recorded from the area of permafrost (Fig. 36). The 400°C temperature sum gradient of the vegetation period seems to parallel rather closely the northern parts of the range of *R. arvalis* as far as to about 90°E in the east.

R. temporaria is absent from those northwestern parts of the USSR with permafrost. East of the Ural mountains its range diminishes very abruptly southwards. Two explanations, at least, are available, viz. the strong selective affect of low winter temperatures on marginal populations of the species in the area and/or the replacement of the species by *R. amurensis*, an Asian species extending its range westwards from the coast of the Pacific Ocean.

The disappearance of *Rana (temporaria?)* from Iceland in the early 1800s shows the disastrous impact of a sudden cold period on the island populations (Hesse 1924). In Finland, the exceptionally cold periods at the beginning the 1940s reduced the populations of *R. temporaria* in southern parts of the country, at least (Olsoni 1943, Haartman 1950 and Klingstedt 1950), but these populations have been able to recover since.

In the USSR the northern border of the range of the marsh frog, *Rana ridibunda*, parallels the c. 1900—2000°C temperature sum gradient of the vegetation period as far as to the Ural mountains but then it turns southwards (Figs. 18 and 36). In Scandinavia this species is absent. The status of *Rana ridibunda* in the *Rana esculenta* complex is still under discussion (see Edendal 1978) and I prefer not to draw any further conclusions.

The common lizard and the slow-worm

The common lizard, *Lacerta vivipara*, occurs throughout Norway, Sweden and Finland and it is absent only from the most arctic parts of the USSR with deep permafrost and with an annual temperature sum gradient of about 300—400°C or less for the vegetation period. The Ural mountains have presented no barrier to the eastward distribution of the species (Figs. 21 and 36).

According to Voipio (1961, 1962, 1963) the species has come over to Finland from the southeast and east after the retraction of the ice sheet. It was able to spread all over Finland and even to northern parts of Scandinavia until the populations of the species from southern parts of Scandinavia reached that area.

The records of the slow-worm *(Anguis fragilis)* up to 1950 in Norway (Dolmen 1978a) indicate that this species has been able to spread to the Trondheim region. The passes from central Sweden have possibly been important routes for dispersal, since there are a few records of the species referring to the uplands of the Scandinavian mountain range (see Gislén & Kauri 1959). Nowadays the species seems to be absent from the Trondheim region (Dolmen 1978a).

In Sweden and Finland the range of the slow-worm lies south of the line indicating the normal length of the vegetation period of 140 days (Figs. 25 and 35). In northwestern parts of the USSR the gradient indicating the c. 1300°C temperature sum of the vegetation period closely follows the northern parts of the range, but near the Ural mountains the corresponding temperature sum gradient is about 1500°C. The high rate of continentality of the climate may affect the distribution of the species in the latter area.

The open waters of the Baltic seem to have been a strong barrier to the dispersal of the species. For instance, it is not recorded with certainty in Gotland and there are only a few records from the islands close to the Finnish and Swedish mainlands. Nowadays, at least, it seems to be absent from the Åland archipelago (Gislén & Kauri 1959 and Fig. 22). One may hypothesize that the spells of adverse weather may be the cause of the extinction of the species in Åland, but, unfortunately, the records are too scanty to indicate any possible period in this respect.

The Finnish populations of the slow-worm originate from the Russian populations of the species, as strongly suggested by the fact that the blue-spotted morph is rather frequently recorded from different parts of Finland and the USSR but is hardly ever found in Norway or Sweden (Voipio 1962, 1963, 1968 and Fig. 23).

The snake species

In Sweden and Finland most records of the grass snake, *Natrix natrix*, refer to the area where the normal length of the vegetation period is longer than 140 days, but in Finland, at least, the species is most common and abundant in the coastal areas with a vegetation period of 160 days or longer. In the USSR the temperature sum gradient of about 1400—1500°C closely follows the northern border of the range of the species (Figs. 28, 35 and 36).

Ekman (1922) and Gislén & Kauri (1959) suggest that in Sweden the northernmost localities of the species are remains of an earlier and wider range. On the other hand, it is noteworthy that the records of *N. natrix* are often from the near vicinity of rivers and lakes, which may also be routes of dispersal. *N. natrix* prefers habitats close to water (Kivirikko 1940) and it swims well, e.g. from one island to another, and can catch small fish as prey. Moreover, the banks of bodies of water may offer good sites for laying eggs and basking in the sun. The ameliorating effect of large bodies of water on the climate of the area is also worth consideration, especially because the climate of Scandinavia has been getting milder throughout this century (Johannesen 1970).

In Sweden and Finland in the 1700s, and perhaps even later, the grass snake was considered a benevolent animal which increased the success of the livestock and so it was fed and kept near houses (Pynnönen 1956, Gislén & Kauri 1959). The heaps of manure located at the back of the cowhouses were good sites for the incubation of the eggs and the microclimate close to human settlements was favourable, too.

Accordingly, anthropochory may be involved in the distribution of the species to some extent, at least, and, e.g. the figure (see Ekman 1922, Fig. 7) referring to the locality of the northernmost grass snake population in Sweden shows the presence of an old farmhouse.

Assuming that the records of the species in Finnish and Swedish Lapland by Hecht (1928) are incorrect, there are no data supporting the reduction of the range of the species in Finland in the 1960s and '70s (Fig. 26). Due to the increasing amount of human activity (e.g. traffic, Table 3), especially in southern Finland, the species may be becoming rarer all the time, but the data available do not warrant any definite conclusion in this respect.

In Norway, the grass snake populations near Trondheim evidently originate from Swedish specimens having crossed the Scandinavian mountain range via the passes with rivers.

In Sweden the curve indicating the northernmost locations for the smooth snake *(Coronella austriaca)* conforms rather well to the vegetational and climatic border called "limes norrlandicus" (Andrén & Nilson 1979a). Moreover, the gradient indicating the normal length of the vegetation period of about 170 days or longer also corresponds well to the line connecting the marginal populations of the species in Norway, Sweden and Finland, thus suggesting the impact of summer temperature on the range of the species in Fennoscandia (Figs. 30 and 35).

C. austriaca is not recorded swimming from one island to another as the grass snake and the adder often do. The smooth snake has been able to spread to Åland, most probably from Sweden, but it is not recorded from the islands between Sweden and Åland. Since the trade between Åland and Sweden has been intensive for many centuries, the possible role of anthropochory should not be excluded here. Moreover, the fissure valley landscape considered to be important for the species in Sweden (Andrén & Nilson 1979a) also characterizes both the Åland archipelago and the southwestern coast of Finland (Abrahamsen et al. 1977), and the number of the islands between Finland and Åland is much higher than between Åland and Sweden.

Accordingly, in Åland, the species seems to live at the outer margin of its range, and considering the scarce populations of the species there it is apparently unable to disperse further eastwards. The occurrence of the species in Åland seems to be due to the earlier history of dispersal. Whether or not anthropochory is involved cannot be determined from the data available.

In the USSR the c. 1800—1900°C temperature sum gradient of the growth period conforms to the northernmost border of the range of the species as far as to the Ural mountains in the east (Figs. 30 and 36).

The adder, *Vipera berus*, is absent from the northern parts of Scandinavia and northwestern parts of Finland where the normal length of the vegetation period is less than 110 days (Fig. 37). Though the species is recorded from the slopes of many fells, e.g. in Finnish Lapland, it seems to have been unable to disperse to the northern coastal areas of Norway with their rather mild maritime climate. On the other hand, at about the same latitude (69°N) in the northwestern USSR, it is found in the area with an annual vegetation period shorter than 110 days (Fig. 37). Moreover, in the USSR it seems to avoid the area with permafrost east of about 40°E (Figs. 33 and 36). The availability of proper winter dens is possibly worth consideration in this respect. In any case, not only the wintertime temperature *"per se"* seems to be involved in the delimitation of the range in the north, since, e.g. in Finland in Sodankylä (67°22'N/26°39'E), where the adder is rather often recorded and the populations are estimated to be rather abundant (Figs. 31 and 33), the frost penetrates much deeper into the soil than, e.g., in Kevo (69°45'N/27°02'E), where despite intensive excursions by biologists for many years the species is never found. In Sodankylä the minimum temperature of the soil recorded at a depth of 50 cm in 1963—70 is —8.5°C, but in Kevo the corresponding figure for 1964—70 is only —3.4°C (Ilmatieteen Laitos 1979).

In Fennoscandia and the northwestern USSR the northernmost parts of the range of the adder and the spruce *(Picea abies)* coincide closely (Fig. 37). The question of whether there are some climatic and/or edaphic factors important to the dispersal of both species there cannot be answered.

4.2. Species extending their ranges close to Finland

Several zoogeographically very deviating amphibian species are extending their ranges rather close to Finland. The Siberian salamander *(Hynobius keyserlingi)*, an Asian Caudata species, is reported from the coast of the Pacific Ocean to about 45°E. In all parts of its range it is found up to the Arctic Circle. Moreover, the western parts of its range border upon the eastern parts of the ranges of *T. vulgaris* and *T. cristatus* (Bannikov et al. 1977).

The fire toad *(Bombina bombina)*, the variegated toad *(Bufo viridis)* and the spade foot toad *(Pelobates fuscus)* extend from the Ural mountain region to the east coast of the Baltic up to about 56—58°N in the north (Bannikov et al. 1977). These species have also spread through Denmark to the southernmost parts of Sweden, the variegated toad as far as to about 58°N on the eastern coast of Sweden (Gislén & Kauri 1959, Andrén & Nilson 1978, 1980).

The tree frog *(Hyla arborea)* and the natterjack toad *(Bufo calamita)* occur in southern and western parts of Europe and they are also found on both sides of the Baltic, the latter species as far as to about 59°N in Estonia (Gislén & Kauri 1959, Bannikov et al. 1977, Andrén & Nilson 1979b, 1980).

The populations of the jumping frog *(Rana dalmatica)* in Sweden and Denmark are considered relicts. The species is found in Sweden up to about 57°N but it is absent from the eastern coast of the Baltic Sea (Gislén & Kauri 1959, Bannikov et al. 1977).

The edible frogs *(Rana esculenta* and *R. lessonae)* are both recorded in Estonia near 59°N as well as along the eastern coast of Sweden up to about 60°30′N (Bannikov et al. 1977, Ebendal 1978).

Only two reptile species are worth consideration in this connection. The sand lizard *(Lacerta agilis)* occurs near 60°N in Estonia and in the area between the lakes of Ladoga and Onega it is found near 62°N (Kivirikko 1940, Palmén 1942, Bannikov et al. 1977). In Sweden it is distributed to about 60°N and the northern populations live in the glacifluvial sand fields, thus indicating an earlier and wider range of the species in the area (Andrén & Nilson 1979c, 1980).

The European pond tortoise *(Emys orbicularis)* is nowadays absent from Fennoscandia and Denmark, but in the USSR there are reports up to about 56°N and some older records even refer to locations further north (Kaisila 1951, Gislén & Kauri 1959, Lehväslaiho 1962, Bannikov et al. 1977).

The records of all the above species in the 1900s indicate no northward extension of the ranges. On the contrary, most of these seem to be declining in number, at least in southern Sweden. Many of these species also have very definite requirements concerning habitat and that is why the destruction of habitats occupied by them as well as the scarcity of new ones diminish the capacity of the species for any dispersal (Andrén & Nilson 1980).

4.3. Threatened amphibian and reptile populations in Europe

Honegger (1978) has summarized the reports on the present status of the amphibian and reptile populations in many European countries. Altogether 46 species or subspecies are considered to be threatened, mostly in central and southern parts of Europe. Most of the declines reported there have taken place during the past twenty to thirty years.

Destruction of habitats was considered the main reason for the decline or the extinction of the populations. In Finland the drainage of peat bogs for increased forest production and the demands of the peat industry nowadays causes very drastic environmental changes. The amphibian populations, in particular, are exposed to this kind of habitat destruction, but there are no data about the populations affected. Moreover, amphibians and reptiles, being part of the food chains in terrestrial and/or aquatic ecosystems, are subject to the effects of biocides and heavy metals. For instance, laboratory experiments indicate that tadpoles of *R. temporaria* exposed to regular or occasional doses of DDT show skeletal abnormalities and hyperactivity. Thus they are more subject to predation (Cooke 1970, 1971, 1972). The adults in turn hide less and their movements become uncoordinated (Cooke 1974).

Exposure to high concentrations of, e.g., lead or copper reduce the hatchability of the eggs and the growth of the tadpoles in *Rana* species (Dilling & Healey 1926, Kaplan & Yoh 1961, Landé & Guttman 1973).

The great quantity of oil and coal annually burned for energy production has released sulphur compounds, such as sulphur dioxide, in to the atmosphere and thus made rain and snow acidic in most parts of Europe including Fennoscandia. In southern Scandinavia a great number of lakes suffer from a subsequent reduction in the pH of the water, with the result that especially the fish fauna has drastically diminished in many of them. Reproduction of the fish is very poor since the hatching percentage of the eggs is low (Almer et al. 1974, Milbrink 1975). Moreover, the minimum value of the pH of water is reached at the time of the thaw, which is also the spawning time for the amphibian species.

Undoubtedly, the changes in the pH of the water have an impact on the development of amphibian embryos and tadpoles, too. According to Hagström (1980) *Rana temporaria* and *Bufo bufo* populations have diminished or died out in some acidified lakes of southern Sweden. This is due to the high mortality of eggs and tadpoles. On the other hand, *T. vulgaris* seems to withstand acidification well and the populations may even increase, possibly due to the disappearance of predatory fish.

In Finland the acid rains may be involved in the decline of the populations of *Araneus* spiders (Palmgren 1979). A sudden break observed in the spawning activities of a local *R. temporaria* population in South Finland may be the result of the melting acid snow lowering the pH of the water in the pool (Palmgren unpubl.).

Collection of and commercial trade in amphibians and reptiles have greatly affected many populations in central and southern Europe, but this is not a problem in Finland, where hardly any species other than *R. temporaria* are collected, and even this species is only taken in small numbers for scientific and educational purposes.

The British and Swiss records indicate that traffic may cause great local losses among amphibian and reptile populations: considerable numbers of individuals of *R. temporaria* and *B. bufo* migrating to and from their spawning sites, and young, metamorphosed individuals leaving their pools are killed (Honegger 1978). In southern Finland some corresponding records referring to *R. temporaria* were made in the 1970s but accurate numbers for the dead animals are mostly lacking (see also Table 3.).

According to Honegger (1978), the populations of *Triturus cristatus, Coronella austriaca* and *Vipera berus* have declined in many European countries. In Finland, *V. berus* is still common but the trend towards a decline in the populations seems to prevail (Table 2 and Fig. 34). The other two species mentioned are rare and they have very limited ranges in Finland. Accordingly, they are easily exposed to the effects of possible habitat destruction, either physical or chemical.

The populations of *Bufo bufo* and *Rana ridibunda* are also considered to be threatened in central Europe (Honegger 1978). The latter species is nowadays absent from Finland. Though the range of *B. bufo* in Finland has shown no shrinking during the past twenty years (Fig. 8), a declining trend among many local populations of southern Finland is often reported (Table 2).

Since it seems as though the declining trend among the herpetofauna of Europe will become more prominent, at least in the near future, monitoring of the state of marginal amphibian and reptile populations, e.g. those in Finland, is important.

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