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Relative regional abundance and colour morphs of the adder (*Vipera berus* L.), grass snake (*Natrix natrix* L.), slow worm (*Anguis fragilis* L.) and common toad (*Bufo bufo* L.) in Finland

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Relative provisional abundances for the adder (*Vipera berus*), grass snake (*Natrix natrix*), slow worm (*Anguis fragilis*) and common toad (*Bufo bufo*) were worked out on the basis of route censuses undertaken in different parts of Finland in 1981–83. The adder and grass snake are most abundant in coastal SW and W parts and the slow worm along the S and SW coast of Finland. The common toad becomes scarcer towards the north but in central parts of the country a zone with higher abundances is indicated. In each species provisional abundances proved to be in accordance ($P = 0.10$–0.05) with another set of corresponding abundances yielded in a survey by the author at the end of the 1970s.

Grey individuals of the adder comprised 42%, brown 19%, bluish 18%, black with vertebral zig-zag stripe 16% and completely black 4%. The censuses of the three years were homogeneous in this respect. Grey adders are scarcer in the eastern and central parts of S Finland, where bluish varieties are more abundant than elsewhere. Brown adders in turn are relatively more frequent in the coastal parts of S Finland and in SE Finland and black adders (with or without dorsal zigzag stripe) comprised >30% of the records only in the central parts of S Finland. Completely black morphs occur in all parts of the Finnish range of the species but in most provinces they made up <5% of the records. In the south they seem to be as rare as they are in the north. Blue-spotted individuals of the slow worm totalled 13% (range of years 4–21%) and most records refer to central and western parts of S Finland.

1. Introduction

During the past twenty years or so provisional atlases of amphibian and reptile species have been worked out in different parts of Europe,including the British Isles (Arnold 1973), France (Castanet 1978), Norway (Dolmen 1978), Finland (Terhivuo 1981) and Denmark (Fog 1980). Surveys dealing with abundances are few but needed e.g. in assessing the status and trends of populations living in different parts of the geographical range of the species. Factors underlying the scarcity of such data may involve the considerable amount of fieldwork, large number of contributors and financial aid needed for many years in such surveys.

In Finland local hunters have been annually censusing Tetraonidae (Aves) populations in different parts of the country since 1964. The total length of the census routes varies between 20 000 and 30 000 kilometres/year (Rajala 1974, Lindén & Rajala 1981). In 1981–83 the contributors were asked to keep a record of three reptile and one amphibian species observed during the census. This aimed at assessing relative abundances of the species in different parts of the country and at yielding data for comparison with another set of provisional abundances based on an enquiry made at the end of the 1970s. An attempt is also made to assess the provisional status of colour morphs of the adder and slow worm.

2. Material and methods

The Game Division of the Finnish Game and Fisheries Research Institute organizes and co-ordinates an annual route census of Tetraonidae (Aves) in different parts of Finland which, at the time of the present survey, took place during the latter half of August. Participation in the census is voluntary for hunters and hunting organizations and does not imply the extending of any special privilege.

In 1981–83 the contributors were asked to record adders (*Vipera berus*), grass snakes (*Natrix natrix*), slow worms (*Anguis fragilis*) and common toads (*Bufo bufo*) during the census. For the purpose of identification they were provided with an illustrated key of the species and brief instructions for assessing the colour morphs of the adder (grey, brown, bluish, black with vertebral zig-zag band, and completely black without the band) and the slow worm (with or without blue spots). They were also asked to return the sheet irrespective of the presence or absence of the species in the census.

The census route method applied to the Tetraonidae incorporates the following instructions: Each census group should consist of three persons who advance slowly along the route line planned beforehand on a map to include the best hunting grounds, such as forest edges, marshes and luxuriant forests. The observers in the three-man chain proceed at equal speed, the person in the ,middle leading the group and keeping the records of observations made. The other two observers walk on both sides about 20 m apart from the leader, the team thus effectively covering a strip 60 m wide. No census should be made during rainy or cold periods (Lindén & Rajala 1981).

In most habitats the 10 m wide belt on both sides of the persons in the three-man chain is too wide for certain detection of any amphibian or reptile species among the vegetation. I therefore gave up calculating the numbers of individuals per unit area and instead considered the numbers of individuals in relation to the total length of the routes and the number of observers.

I keyed each route to the 100 × 100 km squares of the Finnish uniform grid (27°E) system (Heikinheimo & Raatikainen 1971) and grouped them according to the biological provinces of Finland as indicated in Terhivuo (1981). For the length of the routes within the provinces see Table 1.

The contributors were also asked to send records of amphibian and reptile species made outside the time span of the census. This data increased the information on colour morphs of the adder and slow worm and explains why I pooled them with the figures produced by the censuses.

3. Results

3.1. Provisional status of populations in 1981–83

To indicate provisional status and its annual variation in adder populations I calculated the abundances as the mean number of adders/100 km census route by one contributor within each bio-

Table 1. Length (km) and numbers of census routes and observers in the biological provinces of Finland surveyed in 1981–83. Abbreviations for the provinces correspond to those in Figs. 1–4.

Biological province	Length of routes 1981	1982	1983	Total 1981–83	No of routes	No of observ.	Km/ observ.
Varsinais-Suomi (V)	1667	1683	1627	4977	47	139	36
Uusimaa (U)	264	144	309	717	7	21	34
Etelä-Karjala (EK)	1803	1531	1080	4414	52	154	29
Etelä-Häme (EH)	4149	4818	4650	13617	146	441	31
Etelä-Savo (ES)	1807	1428	1591	4826	48	144	34
Satakunta & Etelä-Pohjanmaa (St & EP)	2574	3726	3471	9771	91	273	36
Pohjois-Häme (PH)	1314	2307	1908	5529	59	176	31
Pohjois-Savo (PS)	2022	1313	2120	5455	68	200	27
Pohjois- & Laatokan Karjala (PK & LK)	3477	2349	1911	7737	85	255	30
Keski-Pohjanmaa (KP)	3696	3170	2935	9801	104	308	32
Kainuu (Kn)	3384	3033	2520	8937	77	231	39
Pohjois-Pohjanmaa (PP)	2226	1848	2364	6438	44	132	49
Kuusamo (Ks)	1089	903	1095	3087	23	69	45
Kemin Lappi (KemL)	1027	2058	1782	4867	34	100	49
All provinces	30499	30311	29363	90173	885	2643	34
%	34	34	33	–	–	–	–

Table 2. Mean numbers of the adder (*Vipera berus*) and grass snake (*Natrix natrix*) /100 km route censused in 1981–83. Concordance between the censuses of the three years is according to the formula $k(n-1)W$, where k and n, respectively, refer to numbers of years and biological provinces (with at least one record of the species in any of the three years) and W denotes Kendall's coefficient of concordance.

Biological province	*Vipera berus* 1981	1982	1983	*Natrix natrix* 1981	1982	1983
Varsinais-Suomi (V)	0.9	2.0	2.3	0.2	0.2	1.7
Uusimaa (U)	1.1	0.0	1.0	0.0	0.7	0.0
Etelä-Karjala (EK)	0.6	0.5	1.3	0.2	0.1	0.5
Etelä-Häme (EH)	0.5	0.7	0.7	0.0	0.0	0.1
Etelä-Savo (ES)	0.6	0.7	1.3	0.3	0.1	0.1
Satakunta & Etelä Pohjanmaa (St & EP)	1.5	1.5	1.6	0.4	0.1	0.2
Pohjois-Häme (PH)	0.6	0.4	0.9	0.1	0.0	0.0
Pohjois-Savo (PS)	0.1	0.2	0.3	–	–	–
Pohjois- & Laatokan Karjala (PK & LK)	0.5	0.2	0.7	0.0	<0.1	0.0
Keski-Pohjanmaa (KP)	0.5	0.7	0.9	0.0	<0.1	0.0
Kainuu (Kn)	0.3	0.2	0.1	–	–	–
Pohjois-Pohjanmaa (PP)	0.4	0.3	0.2	–	–	–
Kuusamo (Ks)	0.0	0.1	0.1	–	–	–
Kemin Lappi (KemL)	0.1	0.1	0.2	–	–	–
Number of individuals	160	197	228	23	14	42
Concordance of years		32.0***			15.6***	

logical province (Table 2). The index of concordance shows a statistically significant similarity between the abundances of the three census years which warrants pooling the records according to the province. Based on the pooled data I calculated provisional abundances for the species (Fig. 1, upper bold figures in the provinces) and to show regional heterogeneity in them I applied the χ^2-

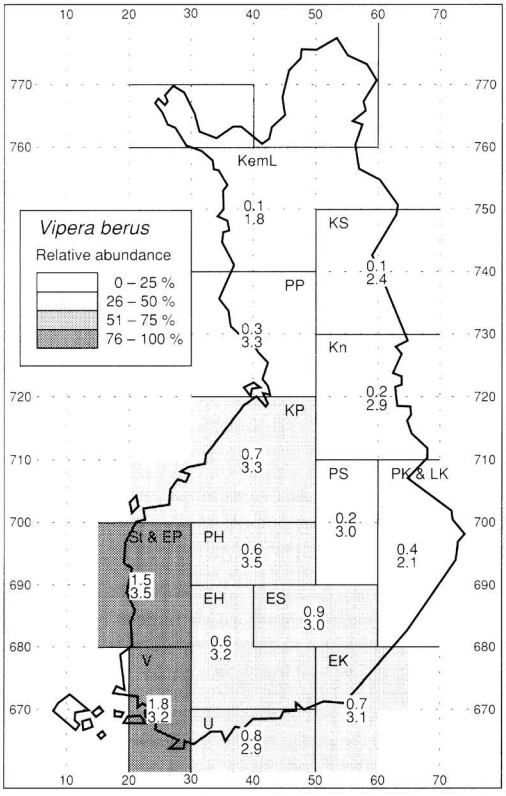

Fig. 1. Relative abundance of adder (*Vipera berus*) in different biological provinces of Finland according to the route censuses undertaken in 1981–83. Upper figures of the provinces indicate the mean numbers of individuals per 100 km route censused and lower figures another kind of abundance index values received through an enquiry in the 1970s. For further information on the latter index see section 4.2 in the text. Shading of provinces follows the upper figures as explained in the text. Abbreviations correspond to the names of the biological provinces indicated in Table 1. For the census data from the different years see Table 2.

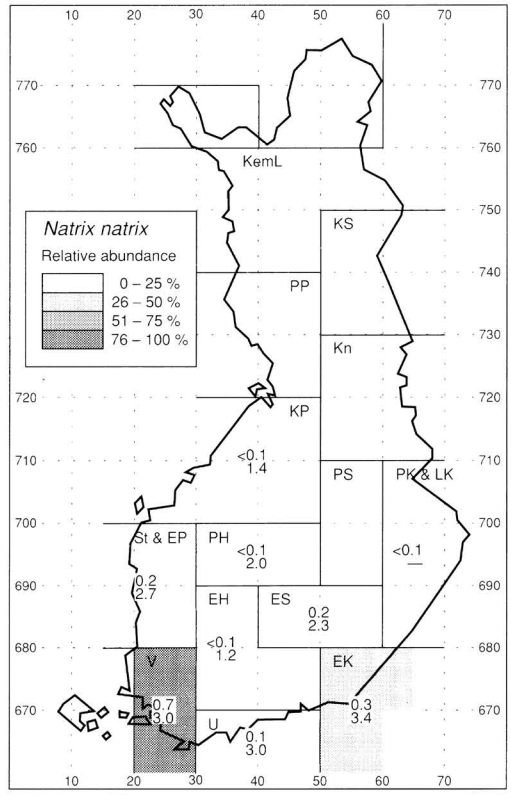

Fig. 2. Relative abundance of grass snake (*Natrix natrix*) in different biological provinces according to the censuses of 1981–83. For additonal data on the indices within the provinces see the legend to Fig. 1 and section 4.2. in the text. For the data from the different years see Table 2.

test to the total lengths of the routes and the numbers of adders in the provinces ($\chi^2 = 280.80^{***}$, $df = 12$, provinces V and U pooled).

To demonstrate relative regional differences I indexed the highest provisional abundance as 100 and compared the other values to it. These relative abundances were grouped into four categories, viz., 0–25, 26–50, 51–75 and 76–100% and in Fig. 1 the provinces are shaded according to the category they represent.

High abundances refer to the southwestern and western coastal parts of S Finland (Fig. 1). Unfortunately, the corresponding data is not available for the Åland archipelago bordering this part of the Finnish mainland. In general, adder populations seem to become scarcer toward the north.

In the grass snake the census data from the three years also show significant concordance

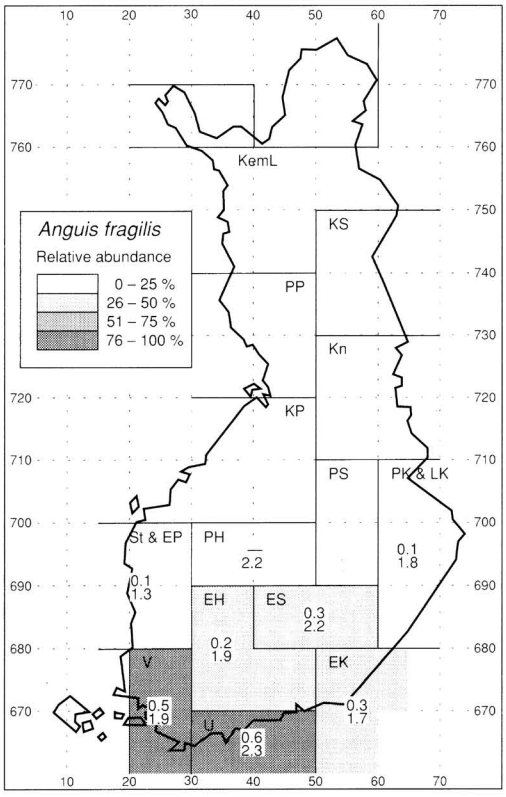

Fig. 3. Relative abundance of slow worm (*Anguis fragilis*) in different biological provinces censused in 1981–83. For additional information on the indices within the provinces see the legend to Fig. 1 and section 4.2. in the text. For the data from the different years see Table 3.

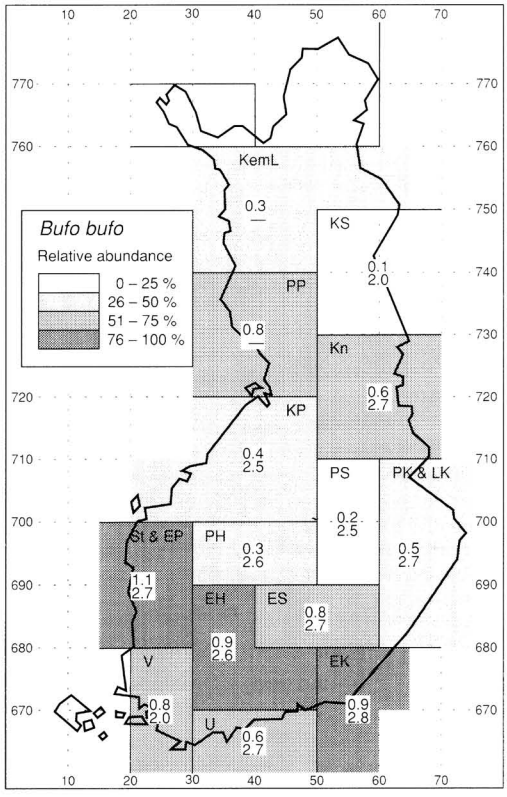

Fig. 4. Relative abundance of common toad (*Bufo bufo*) in different biological provinces censused in 1981–83. For additional information on the indices shown within the provinces see the legend to Fig. 1. and section 4.2. in the text. For the data from the different years see Table 3.

(Table 2) and there are statistically significant differences between the provinces with records (χ^2 = 158.69***, *df* = 7, provinces U and V pooled). High relative abundances based on pooled data are confined to SW parts of southern Finland (Fig. 2). In other parts of S Finland the species is less abundant and it is absent from the central and northern parts of the country.

In the slow worm and common toad the censuses of the three years are homogeneous (Table 3) and the pooled data indicate significant heterogeneity of abundances (slow worm: χ^2 = 34.07***, *df* = 5, common toad: χ^2 = 113.10***, *df* = 12, provinces U and V pooled in both species). Abundant slow worm populations seemingly live in the southwestern and southern coastal provinces of S Finland (Fig. 3). There is a fall-off in the abundances towards the north.

The common toad exhibits a somewhat mosaic like pattern of relative abundances: a zone of provinces with high index values runs from the SE to the NW parts of S Finland and another parallel zone occurs in the central parts of the country (Fig. 4). The general view is, however, that the species

Table 3. Mean numbers of the slow worm (*Anguis fragilis*) and the common toad (*Bufo bufo*)/100 km route censused in 1981–83. For the analysis of concordance between the censuses of the three years see the legend to Table 2.

Biological province	*Anguis fragilis*			*Bufo bufo*		
	1981	1982	1983	1981	1982	1983
Varsinais-Suomi (V)	0.4	0.7	0.3	0.8	0.9	0.7
Uusimaa (U)	1.1	0.7	0.0	1.1	0.7	0.0
Etelä-Karjala (EK)	0.5	0.1	0.3	1.0	0.5	1.4
Etelä-Häme (EH)	0.1	0.2	0.2	0.8	1.1	0.7
Etelä-Savo (ES)	0.2	0.1	0.4	0.3	1.0	1.1
Satakunta & Etelä-Pohjanmaa (St & EP)	<0.1	0.2	0.1	1.4	1.1	0.8
Pohjois-Häme (PH)	–	–	–	0.2	0.2	0.4
Pohjois-Savo (PS)	–	–	–	0.3	0.3	0.1
Pohjois- & Laatokan Karjala (PK & LK)	<0.1	0.1	0.1	0.4	0.5	0.8
Keski-Pohjanmaa (KP)	–	–	–	0.6	0.2	0.4
Kainuu (Kn)	–	–	–	0.4	0.7	0.8
Pohjois-Pohjanmaa (PP)	–	–	–	0.4	0.2	1.7
Kuusamo (Ks)	–	–	–	0.0	0.1	0.1
Kemin Lappi (KemL)	–	–	–	1.0	0.1	0.1
Number of individuals	29	36	29	188	182	204
Concordance of years		6.0°			19.9***	

is more abundant in the southern than in the central and northern parts of Finland.

3.2. Regional status of the colour morphs in the adder and slow worm

The frequencies and percentages of the records for the five colour morphs of the adder in different biological provinces are indicated in Table 4. To demonstrate regional differences between the four main morphs (grey, brown, bluish and black with or without dorsal stripe) I applied the χ^2-test which yielded statistically significant heterogeneity ($\chi^2 = 52.66$***, $df = 24$, the provinces pooled are shown in Table 4). The total proportions of the morphs are, however, similar between the three years ($\chi^2 = 3.36$, ns, $df = 8$, both varieties of black separately considered), implying that the censuses are homogeneous in this respect.

Grey adders comprise 42% of all the records, whereas brown, bluish and black ones (with or without vertebral zig-zag stripe) make up about 20 % each. In most provinces grey adders are more abundant than the other forms and only in the eastern parts of S Finland (province PK&LK) does the form comprise less than 30% of all the records. Brown adders are more abundant on the coast of S Finland and in SE Finland than elsewhere where their relative proportion does not exceed 25%. Bluish adders may be more frequent in the eastern and central parts of S Finland (provinces PH+PS, PK&LK) than in the other provinces. Only in the central parts of S Finland (provinces ES, PH+PS) do black adders (both morphs) total more than 30% of all the records. The relative proportions of the completely black morph does not exceed 14% in any province.

The proportion of the blue-spotted slow worms varies between 4 and 21% according to the year of the census, the mean being 13%. Most records refer to the western and central provinces of S Finland.

4. Discussion

4.1. Factors affecting the censuses

Despite the considerable length of the routes annually censused, rather few records of the four species were obtained (Tables 1–3). The route transect is a very labourious, and from this point of

Table 4. Frequencies of colourmorphs in the adder (*Vipera berus*) and the slow worm (*Anguis fragilis*) according to the reports from different biological provinces of Finland.

	Vipera berus											*Anguis fragilis*				
Biological province or year	Grey		Brown		Bluish		Black (zigzag)		Complete black		Total	Non-spotted		With spots		Total
	n	(%)	*n*	(%)	*n*	(%)	*n*	(%)	*n*	(%)	*n*	*n*	(%)	*n*	(%)	*n*
V	33	(45)	21	(29)	10	(13)	6	(9)	–	(4)	70	17	(95)	1	(5)	18
U	1		1		–		1		3		6	3		–		3
EK	11	(38)	8	(28)	7	(24)	3	(10)	–	–	29	9	(100)	–	–	9
EH	53	(45)	20	(17)	16	(14)	28	(24)	1	(1)	118	14	(74)	5	(26)	19
ES	22	(39)	13	(23)	2	(4)	12	(21)	7	(13)	56	19	(86)	3	(14)	22
St & EP	62	(46)	24	(18)	29	(22)	14	(11)	5	(4)	134	10	(77)	3	(23)	13
PH	9	(31)	2	(6)	14	(33)	6	(27)	1	(4)	32	–	–	–	–	–
PS	6		1		2		7		1		17	–	–	–	–	–
PK & LK	11	(26)	8	(19)	14	(33)	4	(9)	6	(14)	43	7	(100)	–	–	7
KP	31	(42)	11	(18)	12	(20)	15	(19)	1	(1)	70	–	–	–	–	–
Kn	7		5		6		2		–		20	–	–	–	–	–
PP	20	(49)	5	(18)	1	(12)	7	(16)	–	(4)	33	–	–	–	–	–
Ks	1		1		–		–		–		2	–	–	–	–	–
KemL	3		3		5		1		2		14	–	–	–	–	–
All provinces																
1981	83	(45)	34	(18)	33	(18)	27	(15)	9	(5)	186	23	(96)	1	(4)	24
1982	75	(38)	38	(19)	33	(17)	41	(21)	9	(5)	196	30	(88)	4	(12)	34
1983	112	(43)	51	(20)	52	(20)	38	(15)	9	(3)	262	26	(79)	7	(21)	33
Total	270	(42)	123	(19)	118	(18)	106	(17)	27	(4)	644	79	(87)	12	(13)	91

view, inefficient method of surveying amphibian and reptile populations.

A number of factors influence the estimates: some of them are related to the census in the field whereas the others are correlated with specific ecological and behavioural characteristics of the species.

According to the monthly reports of the Finnish Meteorological Institute the mean air temperature of August 1981 in all parts of Finland was 1.5–2.5°C lower than the corresponding mean for the normal period of 1931–60. The total rainfall in August was about the same or somewhat higher than normal but the latter part of the month in particular was rainy. In 1982 the mean air temperature in SW Finland was 0–1°C higher, but in other parts of the country it was 0.5–2.0°C lower, than that of August in the normal period. In most parts of the country the rainfall amounted to 150–200% of that for August of the normal period. In 1983 the mean air temperature in S Finland was 0–1°C, and in the other parts of the country 1.5–2.5°C, lower and the rainfall only 25–75%, of the corresponding values for August in the normal period. This information, considered together with the sums of the provisional abundance indices in Tables 2–3:

	1981	1982	1983
adder	7.7	7.6	11.6
grass snake	1.2	1.2	2.6
slow worm	2.3	2.1	1.4
common toad	8.7	7.6	10.0

implies that even though no census should be undertaken during bad weather perhaps the weather conditions in general were more favourable for the census in 1983 than in the two other years.

Of the 90 173 km of routes censused in the three years 14 400 km (16%) represent those surveyed each year. Because the total length of routes did not vary much between the years (Table 1) the "annual turnover rate" of routes was high, viz., 40–45%. This has evidently increased the variability in the annual data base, hence new areas, contributors and perhaps dissimilarities in the relative proportions of different habitats along the

routes are involved. The specific impacts of these factors is hard to assess. The concordance analysis showed, however, great within-species homogeneity in the provisional abundances of the three years.

The four species have unequal habitat preferences and they also differ in their behaviour, which undoubtedly influences the efficiency of the censuses. For example, the adder and grass snake are diurnal and often bask in the sun, whereas the slow worm and the common frog tend to hide during the daytime and to leave their retreats at dusk. The slow worm avoids wet habitats such as shores and bogs, but the common toad may be frequent in these. Due to these differences the abundances in Figs. 1–4 and Tables 2–3 are rough estimates that can be used only for regional comparisons within the species and that absolutely warrant no comparisons between the species.

4.2. Provisional abundances

A perusal of Figs. 1–4 reveals that the abundant populations of the four species live in the SW and southern parts of the country where climatic conditions are in general more suitable for poikilotherms than elsewhere in Finland. For instance, the growing season is longer, the mean annual number of hours of sunshine is higher, and the mean of annual absolute minimum temperatures of the normal period 1931–60 is higher, than in other parts of the country (Helminen 1987). On the other hand, these provinces host the most dense human population in the country (Rikkinen 1981), land use is more intensive (Pölkki & Ikäheimo 1982) and the number of summer cottages by length of shoreline is higher (Juusela & Vuoristo 1985) than elsewhere. Due to the high traffic (Kaartama 1985) a considerable number of animals is killed annually on the roads there. For instance, of the 702 vertebrates killed on roads and inspected by Iso-Iivari & Kivivuori (1981) in the province of Varsinais-Suomi, amphibians and reptiles comprised about 30%. In the light of these facts the high relative abundances for the species in the southwestern and southern provinces (Figs. 1–4) may be unexpected. One should, however, bear in mind that the census routes were planned to run through habitats representing the best hunting grounds, i.e. habitats that are not so much influenced by factors related to dense human population and intensive land use. For the surveying of populations of the four species in settled and other areas with continuous human impact an additional study is required.

4.3. Provisional abundances related to those from other surveys

In any survey estimating the abundances of animal populations the basic question is whether the indices worked out actually describe the status of populations in the field. In the present study attention is paid to determining the provinces with dissimilar abundances. There is no way of testing the actual relevance of the indices yielded but I made the following attempt to inspect them in relation to another set of provisional abundances obtained in another survey.

Terhivuo (1981) estimated relative regional abundances for Finnish amphibian and reptile species on the basis of about 2700 records referring to different biological provinces in the 1960s and 1970s. These data were received through enquiries where the contributors were asked to describe the abundances according to a scale ranging between 1 and 6 (1 = very scarce, 2 = scarce, 3 = rather scarce, 4 = rather abundant, 5 = abundant and 6 = very abundant). On the basis of these more or less subjective, but by no means necessarily biased answers, provisional mean abundances were calculated for the four species (Figs. 1–4, lower bold figures in the provinces). Allthough this data base differs from that of the present material, provisional comparisons over the country can be made. I applied Spearman's rank correlation to the index values in Figs. 1–4, with the result that the correlation between the two counts proved to be considerably high in the four species (adder: $r_S = +0.538^{o}$, $n = 14$, grass snake: $+0.833^{*}$, $n = 8$, slow worm: $+0.723^{o}$, $n = 7$ and common toad: $+0.719^{*}$, $n = 12$, only those provinces with indices from both counts were included). Thus the indices of the two surveys accord well.

The data by Lavila (1977, 1983) from the 1950s and 1960s shows that the adder becomes scarcer towards the north but its abundance varies

greatly even within the same municipality. The present material shows no contradiction to this statement.

4.4. Colour morphs

The adder exhibits sexual dimorphism, which is rare in snakes. In general, young adders are brown but at sexual maturity males become grey with a black pattern while females remain brown with a dark brown pattern. Bluish coloured individuals are males, whereas melanism is not sex-related (Smith 1951, Andrén in litt.) but hereditary (Ekman 1914) and it appears even in very young individuals. Prior to ecdysis all colour morphs look rather greyish (Andrén in litt.). Thus, dissimilarities in sex-ratio, age structure and colourations related to substrate may be responsible for the dissimilaries observed, though their role is hard to assess with certainty.

In Finland the adder exhibits a wide array of colour morphs: grey, blue, brown, reddish brown and black varieties are common, but a number of intermediate forms have been recorded. The morphs usually have the vertebral zig-zag stripe but in completely black individuals this is lacking (Ekman 1914, Vainio 1932, 1952 and Lavila 1982).

Lavila (1982) based on enquiries undertaken in Finland in the 1950s and 1960s concluded that "dark" adders constitute 55–84% of the population in N Finland (provinces Kn–KemL), whereas in southern and central Finland (provinces V–KP) their proportion is lower, namely 40–56%. He relegated brown, red brown, black and blackish individuals to the "dark" category. Considering the proportions of the "grey" in the present study material the lowest proportions refer to provinces PH, PS, PK&LK, indicating no increasing south-north trend of abundances for grey adders (Table 4).

Gislén & Kauri (1959) reported completely black adders from all parts of Sweden including Lapland. Kjaergaard (1981) considers the black variety as a forest form in Denmark and suggests its rarity in open habitats to be due to a high rate of predation. Being large in size,melanistic adders probably have a selective advantage in e.g. sexual combats between males, while females may have larger clutches than their allies (Andrén & Nilson 1981, 1983). This scenario has been debated by Forsman & Ås (1987). In the present study material a mosaic like pattern of dissimilar abundances rather than any clearcut geographical trend is indicated.

The majority of blue-spotted slow worms are males (Smith 1951) and this is also true in Finland (Voipio 1956, 1962). Voipio (1962) inspected 61 Finnish slow-worms, of which about 30% were blue-spotted. Neither he nor Terhivuo (1981) demonstrated any regional specificity for the morph in Finland. In Sweden and Norway it is extremely rare (Gislén & Kauri 1959, Voipio 1968) and of the 477 individuals studied by Kjaergaard (1982) in Denmark only 1% (9% of the males) had blue spots. The distinction between Finland and the three countries mentioned hinges on dissimilarities in the postglacial dispersal history of slow worm populations. The Finnish slow worms represent the eastern "colchica" morph (or subspecies) whereas those in Sweden and Denmark belong to the nominate form (Voipio 1963, 1968).

In the present survey the proportions of blue-spotted slow worms are lower than in the Finnish material studied by Voipio (1962). Because no sex determination was made in the present material the effect of females (who almost always lack spots) has biased the figures. Inaccurancies in field observations made without catching the individuals may also be noteworthy in this respect. No east-west trend in abundances for the blue-spotted morph was discovered in Finland, though such undoubtedly exists when Fennoscandia as a whole is considered (Voipio 1963).

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