

Ann. Naturhist. Mus. Wien	88/89	B	257–265	Wien, November 1986
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## Faunal and Ecological Characteristics of a Marginal Population of *Microtus agrestis*

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(Mit 2 Verbreitungskarten)

Manuskript eingelangt am 2. Dezember 1985

### Summary

In 1957–1962 and 1977–1985, the small mammal fauna was investigated in the environs of Brtnice in the Bohemian-Moravian Highland (Czechoslovakia). Findings of 64 specimens of *Microtus agrestis* provide new evidence of its occurrence in the study area. There a fragmented and sparse population of *M. agrestis* lives at the limit of its faunal distribution and ecological tolerance. The population is confined to remains of original wetted meadows (2.67) and to water-logged places in woodland (1.30 animals per 100 trap-nights). Draining of such places decreases the extent of or destroys suitable habitats, causing *M. agrestis* to disappear from them. The density of the marginal population is very low; in autumn, only 2.35 animals per 100 TN on average. The population growth rate was found to be very low,  $r = 0.06$  per month. The numbers varied between 0.39 and 3.25 animals per 100 TN. The sex ratio in the total sample was balanced, the weight structure and recruitment of young animals were adequate. The litter size was exceptionally high, however, averaging 5.61 embryos per set (which is by 1.36 embryos higher than the average for the rest of Czechoslovakia). This is probably due to the marginal character of the population in both the faunal and ecological sense. Emigration of individuals from the remains of natural habitats is quite exceptional and individuals from different population fragments probably do not communicate. In the study area, habitats suitable for the stenotopic *M. agrestis* are being destroyed by draining wetlands; and this brings about a decline of this marginal population.

### Zusammenfassung

64 Fänge von *Microtus agrestis* bei Brtnice (Böhmisch-mährisches Hügelland) belegen ein spärliches Vorkommen dieser Art an der Grenze ihrer faunistischen und ökologischen Verbreitungsmöglichkeiten. Die Populationen sind beschränkt auf unmeliorierte feuchte Wiesen (2,67) und vernäßte Stellen in Wäldern (1,3 Individuen pro 100 Falleneinheiten). Die Dichte dieser Randpopulation ist sehr gering (2,35 Individuen pro 100 Falleneinheiten im Herbst). Die Wachstumskurve der Population ist mit  $r = 0,06$  pro Monat ebenfalls sehr gering. Die Wurfgröße ist allerdings mit 5,61 Embryonen sehr groß. Emigration von Individuen aus den Überresten der natürlichen Habitate ist sehr ungewöhnlich und die einzelnen Populationen kommen wahrscheinlich nicht in Kontakt. Die fortgesetzte Zerstörung der Habitate der stenotopen Erdmaus führt zu einem Rückgang dieser marginalen Population.

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## Introduction

Exact studies of the dynamics of ranges of animal species in dependence on extrinsic and intrinsic factors are of theoretical and practical importance. They indicate whether a population of a species is enlarging or diminishing its area, i. e. whether the species is expanding or retreating. In the former case the economic importance of the species may increase; in the latter, on the other hand, the species may gradually become extinct, which signalizes the necessity of its protection.

The present short study of the distribution and ecology of *Microtus agrestis* (LINNAEUS, 1761) in the environs of Brtnice in the Bohemian-Moravian Highland, Czechoslovakia, is a contribution to the clarification of the problems outlined above. At Brtnice, we discovered a population of this vole species which exists at the limits of its distributional and ecological possibilities. The distribution of *M. agrestis* in central Europe and particularly in Czechoslovakia is patchy and thus the species is very suitable for examining questions of range pulsation (see also BAUER 1960; BAUER, KRAPP & SPITZENBERGER 1967; NIETHAMMER 1982, etc.).

## Study Area

Our investigations, aimed at several problems, were carried out in the wider environs of Brtnice (13 kms to the SE of Jihlava) in the Bohemian-Moravian Highland. The area is hilly, lying at elevations of 550–650 m above sea-level. In the N–S direction it is passed by the Brtnice river, receiving a number of tributary brooks and drains from the surrounding valleys and slopes. The area is intensively cultivated (potato growing region). The area is cold and rich in precipitation. The annual mean air temperature is 7.0° C, the average annual total precipitation is 630 mm. The growing season (with daily mean temperatures over 10° C) is 100–120 days.

Woodland covers 25–30% of the area, with Norway spruce and Scots pine predominating. Valleys along brooks contain azonal alder communities. Deciduous broadleaved trees grow in groups or singly. The humid climate and the hilly terrain cause the occurrence of numerous water-logged places and natural as well as artificial ponds surrounded with swampy vegetation. The rather high elevation, abundant precipitation and copious swampy vegetation are the main conditions affording the occurrence of *M. agrestis*.

During the past 10–15 years, treeless water-logged land has been intensively ameliorated and drained and the wetted meadows have been turned into arable land. This results in gradual fragmentation and liquidation of marshy habitats suitable for the occurrence of *M. agrestis*. The population is being disintegrated and liquidated and the occurrence of *M. agrestis* is permanently retreating.

## Material and Methods

Our investigations on small mammals in the environs of Brtnice were irregular and random in 1957–1962 but regular and intensive in 1977–1985. In the latter period 3 trapping efforts were made each year in spring (May), summer (July and

August) and autumn (October and November). Each trapping period lasted 3–5 days so that the traps were exposed for 2–4 nights. The traps were common commercial break-back ones, baited with wick soaked with fat and flour. The traps were set in lines and were spaced around 5 m apart. A trap-line contained 50 traps as a rule. The trap-lines were laid in all habitat types including human dwellings to reveal the structure and diversity of the fauna and to ascertain population dynamics.

In all, 48 510 trap-nights were used, yielding 3 360 specimens of small mammals belonging to 19 species. This material will be evaluated and published elsewhere. The present study is based on data on a total of 64 specimens of *M. agrestis*, which is only about 2% of the total material. The catch of *M. agrestis* was only 0.13 individuals per 100 trap-nights. All individuals were treated in the common mammalogical ways shortly after capture.

Distribution of *Microtus agrestis* in Czechoslovakia: until 1930's no evidence was available of the occurrence of *M. agrestis* in the territory of Czechoslovakia. Scattered findings made in subsequent years were gathered by KRATOCHVÍL, PELIKÁN & ŠEBEK (1956); their map comprises 33 localities. Recently ANDĚRA (1980) evaluated all old and newer data. His synopsis should be supplemented by additional findings of *M. agrestis* in the Žďárské vrchy Hills (ELEDER 1985) and by our own ones in the environs of Brtnice, presented in this paper. This supplemented distribution is shown in Fig. 1.

The map in Fig. 1 shows that *M. agrestis* has a rather continuous distribution only in the mountain systems along the northern border of Czechoslovakia. The picture of the patchy distribution is due, on the one hand, by the populations being confined to higher mountain and submontane localities and, on the other, by lack of field data. Most probably the areas populated by *M. agrestis* are still larger than shown in the map.

Between Bohemia and Moravia, the distribution of *M. agrestis* is insular, forming a stripe from the SW to the NE. This area stretches from the Novohradské hory Mts. through the highest elevation of the Bohemian-Moravian Highland and a more continuous occurrence in the Žďárské vrchy Hills up to the outposts of the Orlické hory Mts. and the Jeseníky Mts. in the NE. Our study area – the environs of Brtnice – lies at the SE margin of this stripe where the distribution of *M. agrestis* has not been exactly known as yet.

#### Distribution of *Microtus agrestis* in the Environs of Brtnice

All findings of *M. agrestis* in the environs of Brtnice are new in the faunal respect. They are further evidence of the distribution of this psychrophilous vole in the Bohemian-Moravian Highland. The map in Fig. 2 shows that most findings have been made in wetted spring areas and in riparian herbaceous vegetation along brooks draining the wetted areas. The findings are rather uniformly distributed over the study area, suggesting that the distribution of *M. agrestis* in higher parts of the Highland is probably of a similar character. One may assume that west of our

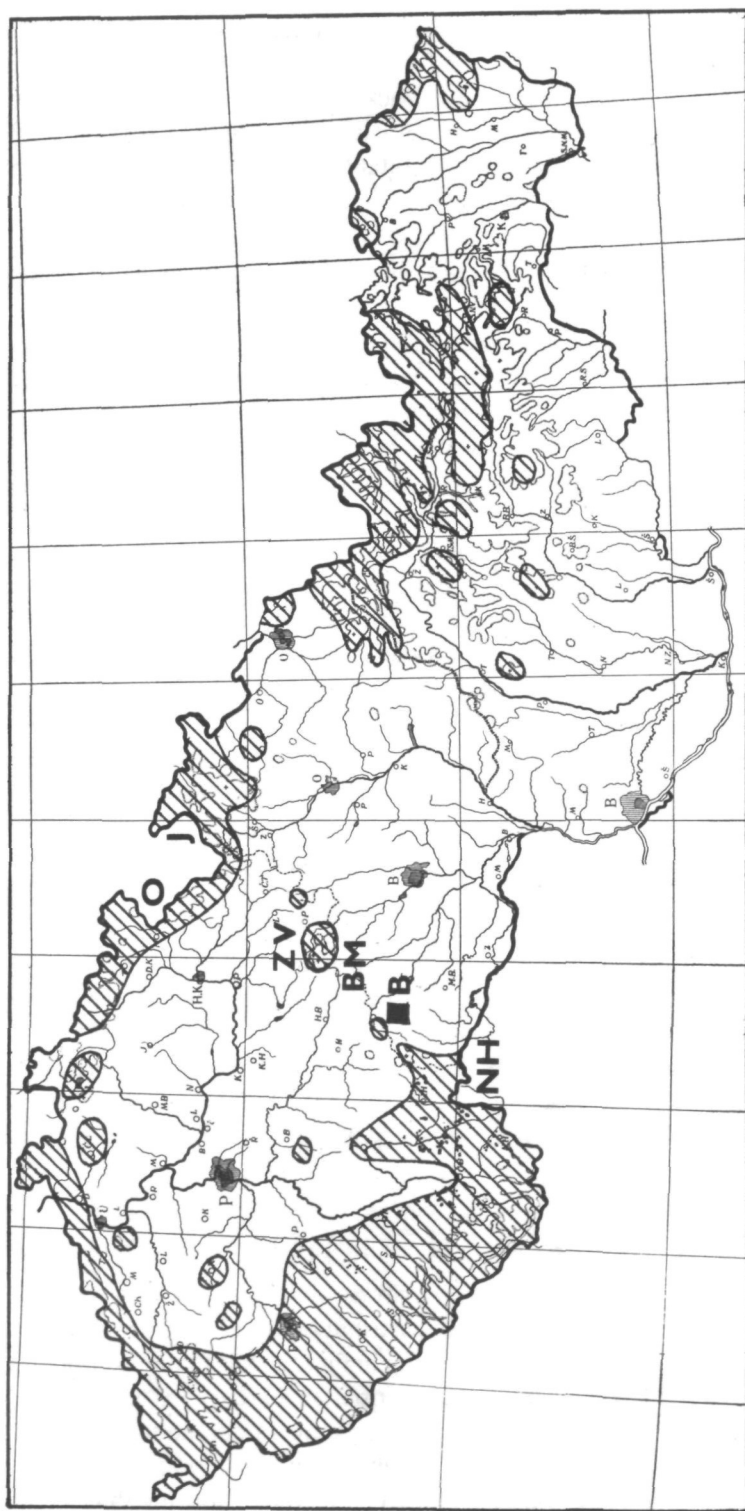


Fig. 1. Distribution of *Microtus agrestis* in Czechoslovakia (adapted from ANDĚRA 1980). NH, Novohradské hory Mts.; B, study area at Brtnice; BM, Bohemian-Moravian Highland; ZV, Žďárské vrchy Hills; O, Orlické hory Mts.; J, Jeseníky Mts.

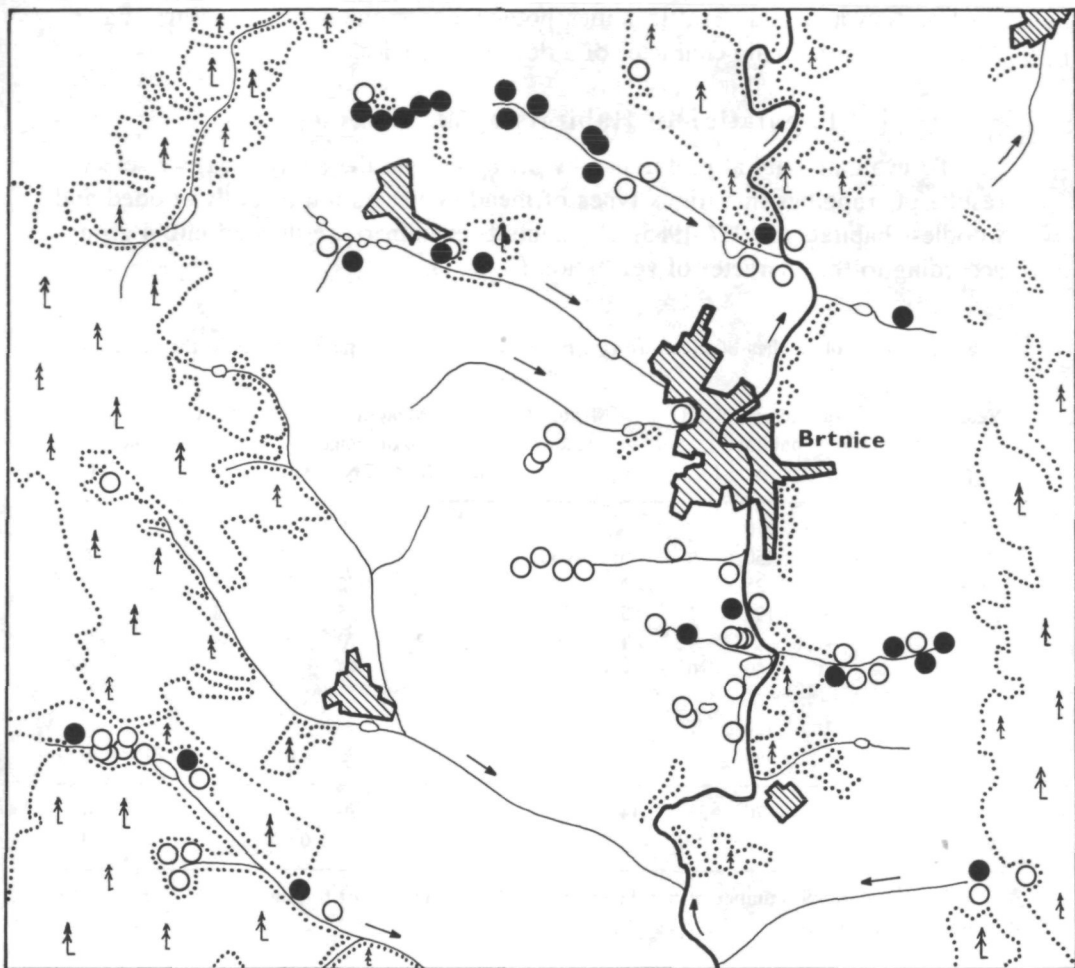


Fig. 2. Study area in the environs of Brtnice. Circles indicate localities searched for *Microtus agrestis*; black circles indicate those in which *Microtus agrestis* was caught.

study area, towards higher elevations of the Highland, the occurrence of *M. agrestis* may be more continuous although limited to wetted localities only. On the contrary, populations living east of our study area are much more fragmentary, fading out at lower elevations.

Beyond doubt, the distribution of *M. agrestis* in our study area was more continuous still several decades ago. The populations were less fragmentary and capable of greater communication along stripes of continuous riparian vegetation. Gradual draining has confined fragments of the original population to remains of the original wetland vegetation. One may assume that the population of *M. agrestis* will continue to decline owing to continuing amelioration and draining of wetted areas. Remains of populations will probably survive only in places quite unfit for

amelioration and in several localities protected as monuments of nature. Patchy distribution is the main character of a declining species.

### Population of Habitats by *Microtus agrestis*

To evaluate habitat preference by *M. agrestis* in the study area, we selected results of trappings in various types of meadow vegetation in both wooded and woodless habitats in 1977–1985. The habitats examined are divided into 4 groups according to the character of vegetation (Tab. 1).

Tab. 1. Review of catches of *Microtus agrestis* obtained from four habitat types in the environs of Brtnice

Year	Natural woodland habitats			Natural meadows			Meadows after drainage			Cultivated meadows		
	S	TN	M.a.	S	TN	M.a.	S	TN	M.a.	S	TN	M.a.
1977	6	770	3	–			2	350	1	6	920	0
1978	1	150	9	3	650	17	–			2	550	0
1979	1	25	0	2	75	2	4	475	2	1	100	0
1980	3	195	1	3	115	3	6	235	1	2	100	0
1981	–			1	60	1	2	70	0	–		
1982	1	50	0	–			1	50	1	–		
1983	–			–			–			–		
1984	1	120	6	–			–			–		
1985	4	460	4	5	410	12	1	90	0	4	245	0
Total	17	1770	23	14	1310	35	16	1270	5	15	1915	0
n/100 TN			1.30			2.67			0.39			0

Explanations: S, number of trap-lines (samples); TN, number of trap-nights; M. a., number of individuals captured.

(a) Herbaceous vegetation on wetted places inside woodland, of natural character. This group comprises trapping data obtained from alder groves along brooks, in swamps with rich herbaceous layer of a natural character, and in wetted unmown stands with *Carex* and *Juncus spp.* in valleys, invariably surrounded by woodland. In these woodland habitats of a more or less natural character we laid a total of 1 770 trap-nights (TN), yielding 17 samples (S) and containing 23 specimens of *M. agrestis*, i. e. 1.30 animals per 100 trap-nights. Of the 17 samples, 9 contained *M. agrestis*, i. e. frequency was 53%.

(b) Natural meadows, mesic to wet, invariably lying outside woodland. They included valley and slope spring areas with natural herbaceous vegetation, with frequent *Cardamine amara* and *Montia fontana*; peat bogs with *Eriophorum vaginatum* and *Carex spp.* (especially *C. rostrata* and *C. canescens*); unmowed parts of meadows around stagnant waters, pools and dead river branches with stands of *Carex spp.*, *Filipendula ulmaria* and single trees (*Salix*, *Alnus*). In the study area such habitats are most frequently although sparsely populated by *M. agrestis*. The

catch obtained from them was 2.67 animals per 100 trap-nights and the frequency in the samples was 86%.

(c) Meadows forming a transitional type between natural and cultivated. Most frequently they were originally wetted and recently drained for regular management, in particular those surrounding unmown riparian vegetation along streams; also drained former wetland, now with a rich vegetation of mesophytic *Poaceae* and partly *Cyperaceae*. In such habitats the population of *M. agrestis* was distinctly fragmented and its density decreased due to draining. In such habitats both the frequency in samples (25%) and abundance (0.39 animals per 100 trap-nights) were very low.

(d) Cultivated meadows, previously drained, now regularly mowed and permanently managed. In spite of a considerable effort (the highest number of trap-nights), not a single specimen of *M. agrestis* was obtained from such habitats. Evidently, the species disappears irreversibly from such habitats when they are drained and regularly managed.

#### Variation in Numbers of *Microtus agrestis*

For this purpose we evaluated only the catches obtained from natural woodland and meadow habitats in the successive years of 1977–1985 (Tab. 2).

It is evident that while the mean catch size increases from spring to autumn due to reproduction, the values of population density and increase are very low. The mean was only 1.61 animals per 100 trap-nights in spring, increasing slightly to 1.86 in summer and the autumn peak averaged only 2.25 animals per 100 trap-nights. These values are very low as compared with, e. g., *M. arvalis* in the same area; the autumn catches of this latter species were up to ten times higher.

Tab. 2. Catch sizes of *Microtus agrestis* obtained from natural woodland habitats and natural meadows in different seasons of the year

Year	May			July–August			October–November			Total		
	TN	M.a.	100TN	TN	M.a.	100TN	TN	M.a.	100TN	TN	M.a.	100TN
1977	210	1	0.48	450	1	0.22	110	1	0.91	770	3	0.39
1978	–			450	14	3.11	350	12	3.43	800	26	3.25
1979	–			–			100	2	2.00	100	2	2.00
1980	195	1	0.51	85	3	3.53	30	0	0	310	4	1.29
1981	60	1	1.70	–			–			60	1	1.70
1982	50	0	0	–			–			50	0	0
1983	–			–			–			–		
1984	120	6	5.00	–			–			120	6	5.00
1985	480	9	1.88	90	2	2.22	300	5	1.67	870	16	1.84
Total	1115	18	1.61	1075	20	1.86	890	20	2.25	3080	58	1.88

Explications: TN, number of trap-nights; M.a., number of individuals captured; 100 TN, number of individuals per 100 trap-nights.

The spring (May) and autumn (October) values can serve to estimate the population growth rate  $r$ . Since *M. agrestis* starts breeding in the study area somewhere in May and ends somewhere in October, the calculated population growth rate  $r = 0.06$  per month (as against 0.99 or more in *M. arvalis*, see PELIKÁN 1981).

The values and variation range of population density in successive years are also very low. The maximum of 5.00 animals per 100 trap-nights in the spring of 1984 is probably accidental. Otherwise the annual means vary between 0.39 and 3.25, i. e. they are very low again. Thus the variation in the numbers of the population under study is rather small. There was no apparent tendency towards high peak densities, not to mention overcrowding.

### Analysis of Population Structure

Among the 64 individuals captured were 29 males and 35 females (54.7%). The predominance of females is statistically non-significant so that the sex ratio in the total catch was balanced. In a fragmented population one would rather expect a significant predominance of males which would be captured more frequently due to their greater spatial activity when searching for very dispersed females. Of the males, 13 were sexually mature (44.8%). Of the females, 17 (48.6%) were sexually mature (11 pregnant, 6 with placental scars). The slight predominance of immature individuals in the sample (53.2%) indicates that this marginal population shows normal reproduction with an adequate recruitment of young animals.

The weight structure in this average population sample was adequate, too. The body weights of males varied within the range 13–48 g, all males over 35 g in body weight being sexually mature. The weight range of females was 17–56 g, with sexually mature ones over 25 g. This is quite consistent with the relations in Czechoslovakian populations of *M. agrestis* (KRATOCHVÍL, PELIKÁN & ŠEBEK 1956, PELIKÁN 1981, ANDĚRA 1981).

However, there was an exceptionally high average litter size. By the number of embryos (11 females) and number of placental scars (2 females) the range was determined as 4–8 embryos per set, the mean being 5.61 embryos per set ( $s_x = 0.35$ ). This mean is very high, compared to other values from Czechoslovakia. For example, in his numerous material ANDĚRA (1981) found a mean of only 4.25, which is a statistically very significant difference ( $t = 3.83$ ,  $P < 0.01$ ).

The structure of our population sample suggests that no disturbances in reproduction apparently occur within the isolated population fragments. Their numbers are very low and individuals (particularly sexually active males) apparently do not emigrate into other population fragments. They are prevented from doing so even by the extensive adverse environment between the isolated remains of suitable habitats. The high litter size is probably due to the fact that the litter size is known to increase not only from the centre towards the periphery of a species' range but also from optimum towards pessimum environmental conditions (see STEIN 1950, 1955). This tends to underline the marginal character of the population



of *M. agrestis* in the environs of Brtnice where the environment suitable for this stenotopic species is continuously deteriorated, disintegrated and disappearing due to man's activities.

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