Acta Theriologica 35 (1–2): 53 – 67, 1990.

PL ISSN 0001 – 7051

The southern range of the root vole in Poland

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Sałata-Piłacińska B. 1990. The southern range of the root vole in Poland. Acta theriol. 35: 53 – 67.

On the basis of the analysis of owl pellets collected in the years 1975 – 1978 and trapping carried out from 1980 to 1982, the southern range of the root vole *Microtus oeconomus* (Pallas, 1776) in Poland was determined. The root vole was found in the food of owls from 29 localities and in 16 trapping locations situated at the edge of the range. This allowed a more precise determination of the boundary of its occurrence and made it possible to find extreme populations of this species. I was noted that beyond the southern limit of the range of *M. oeconomus* the field vole *Microtus agrestis* was a much commoner species.

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Key words: distribution, southern range, *Microtus oeconomus*, Poland

Introduction

The root vole, *M. oeconomus* (Pallas, 1776) a species with a wide distribution throughout the Holoarctic, is the most common rodent of swamps and wetland in northern and central Poland. Across Poland runs a fragment of the southern limit of its compact range in Europe. There are also a number of isolated localities of root vole outside the main area which are remnants of the former, wider range.

In Europe, west of the compact range limit, the root vole can be found in south-western Holland on the islands Noord-Beveland, Schouven-Duiveland, Goere-Overflakkee, and Voorne Putten; in the vicinity of Rotterdam and Utrecht, and in north-eastern Holland in the province of Friesland and the islands Texel, Marken, Schokland and Ramspol (Wijngaarden and Zimmermann 1964). Between the province of Friesland and the Elbe *M. oeconomus* does not appear at present. Its locality on the island of Föhr (the North Frisian Islands), known since the 4th century, does not exist any more (Requate 1955). Remnants of *M. oeconomus* were discovered in early medieval excavations from Elisenhof on the western shores of the Schleswig-Holstein Peninsula. Studies of owl pellets from the Schleswig-Holstein area carried out in the years 1952-1970 did not show the presence of this species on the peninsula. Thus, it is probable that the localities in Itzehoe and Schleswig, recorded by E. Mohr in 1927, do not exist any more, either (Reichstein 1970).

South of the compact range limit in Europe, the root vole occurs on the Small Plain of Hungary: along the Danube (Žitny Ostrov, the Bratislava region, Kolarovo, Rajka) (Méhely 1908, Ehik 1928, Hanzák 1955, Kratochvíl and Rosický 1955, Feriancová-

-Masárová and Hanák 1965, Binder and Štollmann 1975), and at Neusiedlersee (Bauer 1953, 1960); at Balaton (Vasvari 1950, Ehik 1953, Szunyoghy 1954); and between the Danube and the Tisa (Szunyoghy 1954, Topal 1963).

The goal of this work was to determine the present limit of the range of the root vole in Poland. Exact knowledge on this matter is an indispensable prerequisite for tracing changes that take place in the distribution of this species and for studies of the morphology and ecology of populations living at the edges of the range.

Earlier data on the occurrence of *M. oeconomus* in Poland, collected during various faunal, ecological and parasitological investigations, have been included in the "Atlas of Polish mammals" (Raczyński 1983).

Methods and materials

During the first stage of the research, 1975-1978, pellets of owls, almost exclusively barn owls *Tyto alba* were collected in areas of the presumed range limit of the root vole in Poland. At the start and in the course of the field work, the southernmost lacalities of this species were: in the east of Poland – Zwierzyniec, Górecko Kościelne, Guciów (Skuratowicz 1948), Krzyżanowice (Serafińska and Serafiński 1957), the Tomaszów Lubelski region (Cechowicz and Zwolski 1959), Lelów, Koniecpol and Wieluń (Sałata-Piłacińska 1977); in the west – Brodowice near Wołów (Rörig 1909), a locality between Zieliniec and Opole (Schlott 1930/31), Jemielna (Stein 1931), Domasław (Dorosz 1968), Osobowice (Chudoba and Humiński 1961), and Pęgów (Uttendörfer 1932). New data on the distribution of *M.oeconomus* at the edges of its range published during the field work (Markowski and Suskiewicz 1979) and after its completion (Raczyński 1983) could not have been taken into consideration in the choice of the research sites.

Attempts were made to bring up to date the data from the literature from before a few decades, because the range of the root vole may have changed as a result of advancing soil drainage.

Pellets were collected in church belfries and attics, usually in localities situated on river banks. Some 250 churches were searched. Pellets from 99 sites were collected. Out of them remnants of 33,107 individuals of mammals belonging to 28 species were prepared. The presence of the root vole was found in 29 localities, (Table 1).

After two years' break in the field work, towards the end of 1980, the trapping method was used to collect material. Trapping was carried out until the autumn of 1982 in selected biotopes complying with the requirements of *M. oeconomus*. When choosing a biotope, use was made of maps at a scale of 1:100000 and direct inspection in the field. Sometimes it was difficult to find a suitable biotope in a large area, and those found were widely scattered and had small areas, below 0.5 ha.

The mammals were caught using pitfalls, live-traps and snap-traps. They were set on paths of voles near their feeding grounds. The number of traps was not constant, it changed depending on the area of the biotope involved. Usually 20 to 30 traps were set. In a few localities studies were repeated several times. Trapping was carried out in 83 localities situated near the range limit of the root vole, and 526 mammals were caught, of which 334 of the family *Arvicolidae*. The root vole was caught in 16 localities (Fig. 1, Table 1).

Remarks on the range limit of *M. oeconomus* in Poland

On the basis of data from the literature and own research, the contemporary boundary of the range of the root vole in Poland was determined (Fig. 2). Generally, it diverts slightly from the direction of a parallel of lattitude and runs from the north-west to the south-east, roughly between 51°N in the west and 50°N in the east. This

Table 1. The list of localities where *Microtus oeconomus* was searched for using the analysis of owl pellets (P) or trapping (C).
Types of biotopes: I – water-logged meadows with patches of reed or tall sedge, mown at places; II – low bog with abundant herbaceous vegetation; III – water-logged, tussocky meadows with reed; IV – marshy banks of rivers, streams and ditches; V – water-logged acid sedge meadows; VI – mid-field mudy pools overgrown with reed and abundant herbs; VII – marshy banks of ponds; VIII – water-logged pastures with tussocks; IX – transition moors; X – mid-field ground depressions overgrown with reed.

No.	Locality		Number of specimens		Biotope	Year of collection	Co-ordinates of localities of *M. oeconomus*	
			Microtus oeconomus	*Microtus agrestis*			geographical E/N	UTM
1	2	3	4	5	6	7	8	9
1	Bożnów	P	3	-		1977	15°20'/51°37'	WT 21
2	Szprotawa	P	-	2		1977		
3	Iłowa	P	-	1		1977		
4	Klików	C	3	-	III	1981	15°12'/51°28'	WT 10
5	Sobolice	P	-	2		1981		
6	Jagodzin	C	-	-	IV	1980		
7	Węgliniec	C	-	4	VII; IX	1980		
8	Przemków	P	1	-		1977	15°46'/51°32'	WT 51
9	Jędrzychów	P	9	2		1977	16°02'/51°27'	WT 70
10	Lubin	P	2	1		1977	16°10'/51°24'	WS 89
11	Tomaszów Górny	P	-	-		1977		
12	Chojnów	P	-	-		1977		
13	Miłkowice	P	1	-		1977	16°04'/51°16'	WS 77
14	Czerwona Woda	P	-	4		1977		
15	Jędrzychowice	C	-	5	VII; IX	1980		
16	Żarska Wieś	C	-	5	III	1980		
17	Henryków Lubański	P	-	6		1977		
18	Nawojów Łużycki	C	-	1	IV	1980		
19	Nowogrodziec	P	-	5		1977		
20	Sulików	C	-	7	III	1980		
21	Studniska Dolne	P	-	1		1980		
22	Rudzica	P	-	1		1977		
23	Wyręba	C	-	5	III	1980		
24	Biedrzychowice	P	-	3		1977		
25	Oleszna Podgórska	C	-	3	III	1980		
26	Rakowice	C	-	4	VI	1980		
27	Niwnice	C	-	3	I	1980		
28	Lwówek Śląski	P, C	-	14 (P)	I	1977; 1980		
29	Pławna	P	-	2		1977		
30	Marczów	P	-	11		1977		
31	Siedlęcin	P	-	1		1977		
32	Żerkowice	P	-	2		1977		
33	Brunów	C	4	-	II	1980	15°35'/51°09'	WS 46
34	Gorczyca	C	-	4	VII	1980		
35	Czaple	C	-	-	VIII	1980		
36	Pielgrzymka	P, C	1 (P); 10 (C)	4 (P)	VI	1977; 1980	15°48'/51°07'	WS 56
37	Proboszczów	P	1	3		1980	15°47'/51°04'	WS 55
38	Świerzawa	P	-	1		1980		
39	Snowidza	C	4	-	II	1980	16°15'/51°05'	WS 95
40	Luboradz	C	1	-	IV	1980	16°17'/51°04'	WS 86
41	Targoszyn	P	-	1		1977		
42	Wądroże	P	-	-		1977		

1	2	3	4	5	6	7	8	9
43	Malczyce	P	-	-		1977		
44	Szczepanów	P	-	-		1977		
45	Pełcznica	P	-	13		1977		
46	Piława	C	-	9	II	1981		
47	Mietków	C	-	5	II	1981		
48	Marcinowice	C	-	3	VIII	1981		
49	Klecin	C	-	1	I	1981		
50	Proszkowice	C	-	-	VIII	1981		
51	Sobótka	P	-	-		1977		
52	Rogów Sobócki	P	-	-		1977		
53	Tyniec	P	-	-		1977		
54	Niwnik	P, C	-	-	I	1978		
55	Marcinkowice	P	-	-		1978		
56	Szydłowice	P	-	-		1978		
57	Michałowice	P	-	-		1978		
58	Świerczów	P	2	-		1977	17°41'/50°56'	XS 94
59	Bogacica	P	7	1		1977	18°09'/50°58'	BB 05
60	Fałkowice	P	3	3		1977	17°54'/50°58'	YS 05
61	Kup	P	-	7		1977		
62	Kobylno	P	1	53		1977	18°07'/50°47'	BB 03
63	Popielów	P	-	7		1977		
64	Dobrzeń Wielki	P	-	3		1977		
65	Czarnowąsy	P	-	20		1977		
66	Lewin Brzeski	P	-	-		1977		
67	Szydłowiec Śląski	P	-	1		1977		
68	Niemodlin	P, C	-	3 (C)	III; IV	1977; 1981		
69	Tułowice	C	-	-	VII	1981		
70	Przechód	P	-	2		1977		
71	Chrząstowice	C	-	-	X	1981		
72	Lędziny	C	-	4	V	1981		
73	Gosławice	C	-	-	VII	1981		
74	Dębska Kuźnia	C	-	1	V	1981		
75	Biała	P	-	-		1977		
76	Mokra	P	-	1		1977		
77	Obrowiec	P	-	5		1977		
78	Kłodnica	P	-	-		1977		
79	Cisek	P	-	-		1977		
80	Roszowicki Las	P	-	-		1977		
81	Turze	P	-	-		1977		
82	Łubowice	P	-	-		1977		
83	Rudy	P	-	18		1977		
84	Markowice	P	-	-		1977		
85	Ciasna	C	-	2	VIII	1981		
86	Lisów (a)	C	24	2	I; III; IV	1981; 1982	18°43'/50°43'	CB 42
	(b)	C	2	8	IV; V; IX	1982	18°43'/50°43'	CB 42
87	Blachownia	C	6	-	III	1981	18°57'/50°47'	CB 52
88	Kośmidry	C	-	2	IX	1981		
89	Mochała	C	-	4	III	1982		
90	Hadra	C	-	6	III	1982		
91	Boronów	C	-	6	IV; VIII	1982		
92	Psary	C	-	5	II	1982		
93	Wierzbie	C	-	4	III	1981		
94	Koszęcin	C	-	7	III	1981		
95	Bagno	C	-	1	X	1981		

1	2	3	4	5	6	7	8	9
96	Woźniki	C	-	5	III	1981		
97	Winowno	C	-	3	III	1981		
98	Koziegłówki	P	-	1		1977		
99	Kuźnica Pusta	C	-	-	IV	1981		
100	Tworóg	C	-	-	IV	1981		
101	Wieszowa	P	-	8		1977		
102	Niezdara	C	-	-	IV	1981		
102a	Stare Tarnowice	P	-	10		1977		
103	Siewierz	P	-	-		1977		
104	Koniecpol	P	8	-		1975	19°42'/50°47'	DB 02
105	Lelów	P, C	2 (C); 5 (P)	-	II	1975	19°35'/50°41'	DB 01
106	Julianka	C	1	-	I	1978	19°28'/50°46'	CB 01
107	Udórz	C	1	-	II	1981	19°46'/50°28'	DA 09
108	Zawiercie	C	2	-	IV	1981	19°25'/50°30'	CA 89
109	Piotrkowice	P	2	-		1976	20°15'/50°31'	DA 49
110	Jędrzejów	P	4	-		1976	20°18'/50°39'	DB 51
111	Kazanów	P	1	-		1976	20°20'/51°10'	DB 57
112	Chlewiska	P	2	1		1976	20°43'/51°15'	DB 87
113	Jastrząb	P	8	2		1976	20°57'/51°15'	DB 97
114	Iłża	P	10	-		1976	21°15'/51°10'	EB 16
115	Grabowiec	P	6	1		1976	21°21'/51°06'	EB 25
116	Bolmin	P	2	-		1976	20°22'/50°49'	DB 52
117	Strawczyn	P	1	7		1976	20°26'/50°57'	DB 54
118	Chełmce	P	-	2		1976		
119	Piekoszów	P	-	-		1976		
120	Podegrodzie	C	-	8	IV; V	1981		
121	Tumlin	P	-	-		1976		
122	Masłów	P	-	-		1976		
123	Brzezinki	P	-	-		1976		
124	Krajno	P	-	-		1976		
125	Św. Katarzyna	C	-	11	V; IX	1975-1978		
126	Makoszyn	P	-	9		1976		
127	Słopiec Szlachecki	C	-	8	IX	1982		
128	Mostki	C	-	1	V	1978		
129	Kunów	P	5	-		1976	21°17'/50°57'	EB 24
130	Krynki	P	-	1		1976		
131	Momina	P	-	-		1975		
132	Mychów	P	-	-		1975		
133	Waśniów	P	-	3		1975		
134	Szewna	P	-	-		1975		
135	Baćkowice	P	-	-		1977		
136	Opatów	P	-	-		1977		
137	Iwaniska	P	-	-		1976		
138	Zęborzyn	P	2	-		1976	21°43'/51°03'	EB 45
139	Tarłów	P	2	-		1976	21°43'/51°01'	EB 24
140	Słupia Nadbrzeżna	P	5	-		1976	21°48'/50°57'	EB 54
141	Zawichost	P	1	2		1976	21°52'/50°49'	EB 53
142	Pińczów	P	3	-		1976	20°33'/50°31'	DA 69
143	Wiślica	C	-	-	V; VII	1982		
144	Gorysławice	C	-	-	V	1982		
145	Łatanice	C	-	-	VII; VIII	1982		
146	Brzezie	C	-	-	VIII	1982		
147	Chmielnik	C	7	-	II	1981	20°48'/50°36'	DB 80
148	Raków (a)	C	3	-	II; IV	1981	21°03'/50°41'	EB 01

1	2	3	4	5	6	7	8	9
	Raków (b)	C	-	-	IV; VIII	1981		
149	Szydłów	P	-	-		1975		
150	Szczaworyż	P	-	-		1975		
151	Rytwiany	C	-	1	VII	1979		
152	Słomniki	C	-	-	IV	1982		
153	Ilkowice	C	-	-	IV	1982		
154	Janków	C	-	-	IX	1982		
155	Skalbmierz	C	-	-	IV	1982		
156	Ispina	C	-	2	II	1982		
157	Ostrowce	C	-	-	VIII	1981		
158	Świniary	C	-	-	VII	1981		
159	Pacanów	C	-	-	V	1981		
160	Szewce	C	-	-	V	1981		
161	Samborzec	C	-	-	IV	1981		
162	Skotniki	P, C	-	-	IV; V	1976; 1981		
163	Koprzywnica	P	-	-		1976		
164	Jamnica	C	-	1	III	1981		
165	Budy Stalowe	C	-	4	III; IV	1981		
166	Nowy Nart	C	-	8	I	1981		
167	Nowa Wieś	C	-	3	III; IV	1981		
168	Łazów	C	-	1	III; IV	1981		
169	Kolno	C	-	3	III	1981		
170	Łukowa	P	9	9		1979	22°57'/50°22'	FA 38
171	Lubaczów	C	3	-	I	1981	23°05'/50°09'	FA 55
172	Wólka Krowicka	C	9	-	I	1981	23°09'/50°05'	FA 54
173	Makowisko	C	-	1	VI	1981		
174	Zapałów	C	-	3	III	1981		
175	Wólka Zapałowska	C	1	3	III	1981	22°54'/50°06'	FA 45
176	Nowa Grobla	C	-	1	IV	1981		

inclination, parallelling the southern boundary of the compact range of the animal in Europe (Tast 1982), may be a result of its approaching the western limit of the range, along the lower Elbe [in East Germany the southern limit of the range of *M. oeconomus* runs from the north-west to the south-east (Jorga 1971)].

The range limit of the root vole in Poland is not a regular but rather a broken line. Simplifying, it reaches the Sudeten in the west. However, this species could not be found in the southern Lower Silesian Woods (Bory Dolnośląskie) or in the area of Izerskie Foothills (Pogórze Izerskie), despite its occurrence both west (Caminau 14°20'E, 51°20'N) (Creutz and Schipke 1980) and east of this region (localities 33, 36 and 37 in Kaczawskie Foothills [Pogórze Kaczawskie]). Further east, in the area of the Wrocław Plain and Wrocław Ice-marginal Valley (Pradolina Wrocławska) the boundary has a west-east direction. (Names and boundaries of geographical regions after Kondracki 1978). The occurrence of the root vole south of it may be made impossible by two factors: a warm, Atlantic-type climate, and intensive agricultural land use. River engineering and drainage, practised here since a long time, have led to such a drastic disappearance of wet biotopes that also the substitute of the root vole, the field vole *Microtus agrestis* was found to be missing from most pellets coming from this region. No root voles were found to occur south of localities known from the

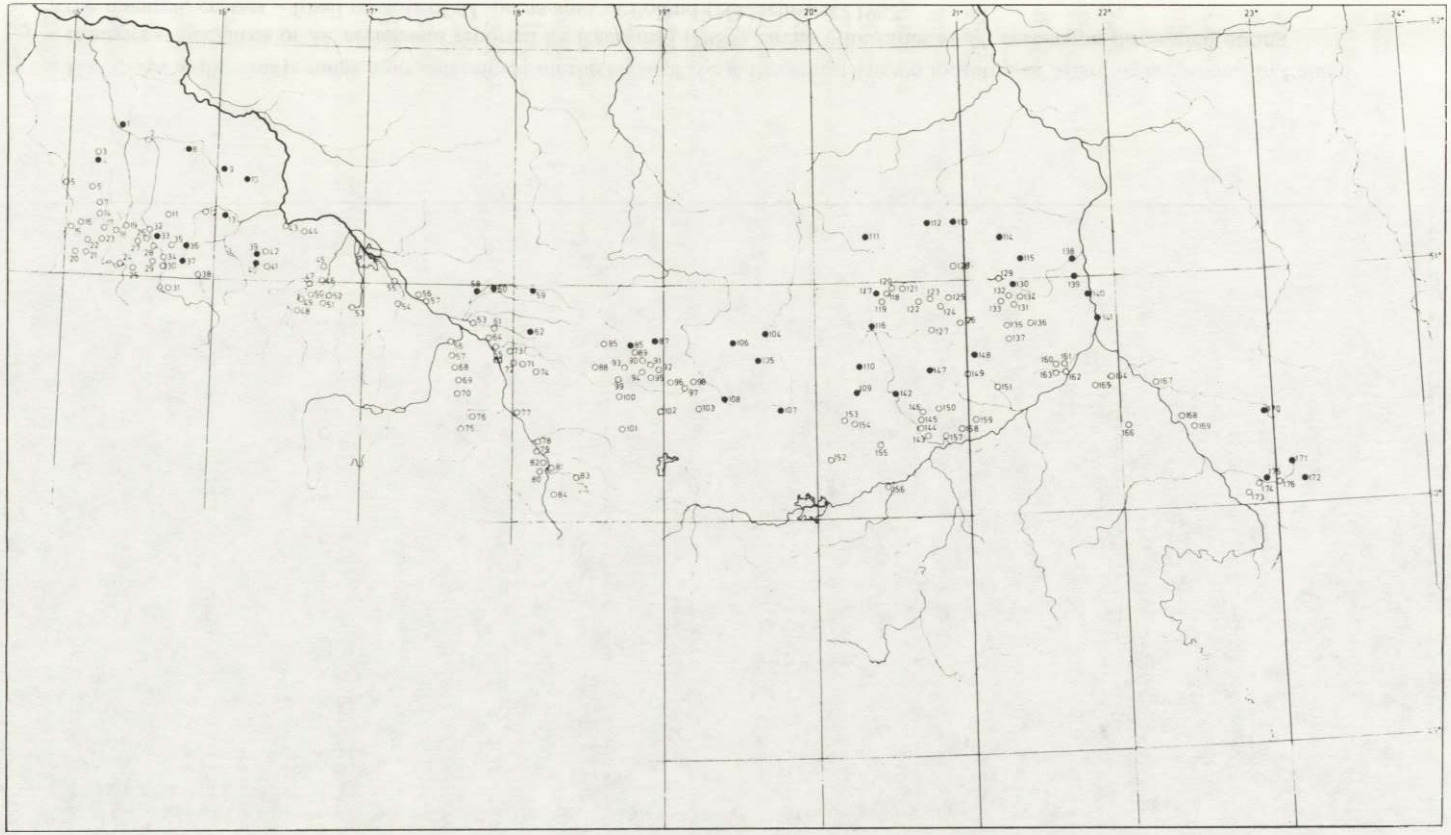

Fig. 1. The distribution of localities where *Microtus oeconomus* was searched for using the analysis of owl pellets or trapping: closed circles - localities at which *M. oeconomus* was found to occur, open circle - localities from which *M. oeconomus* was missing. Numbers of localities are the same as in the table 1.

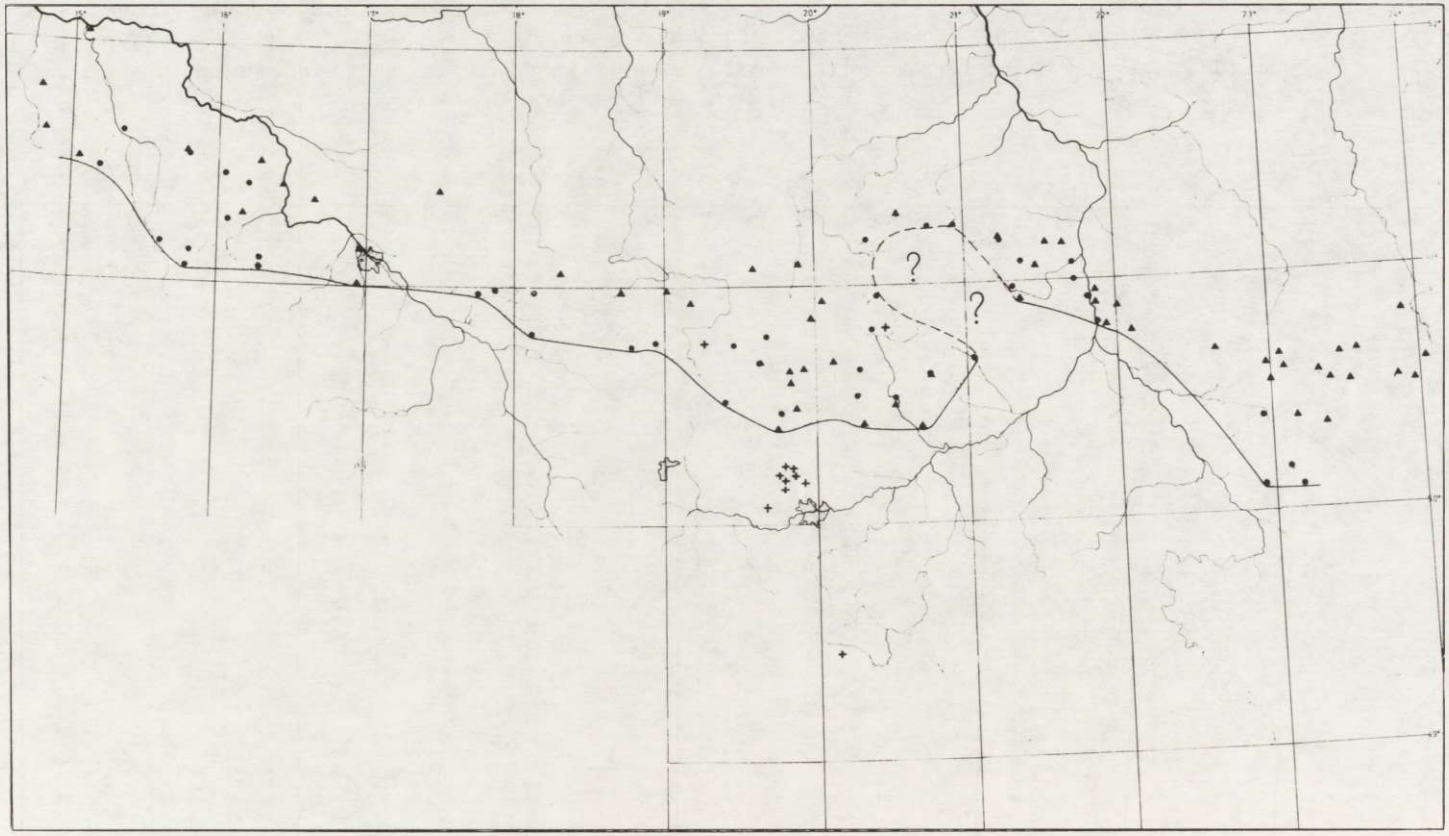

Fig. 2. An approximate range limit determined on the basis of the sothernmost known localities of *Microtus oeconomus* in Poland: triangles — localities of *M. oeconomus* reported by Raczyński (1983), circles – localities of *M. oeconomus* discovered during the research, crosses – fossil records of *M. oeconomus* in Poland (Nadachowski 1982).

literature: Osobowice (Chudoba and Humiński 1961), Domasław (Dorosz 1968), and Pęgów (Uttendörfer 1932).

East of the Odra the boundary turns south-east. It coincides roughly with the watershed between the Stobrawa and Liswarta drainage basins, and that of the Mała Panew. However, no traces of the root vole were found in the uppermost reaches of the Liswarta, despite a relative continuity of waterlogged meadows and reed along its channel.

Farther east the boundary turns clearly south, coinciding with the watershed between the headwaters of the Warta and Pilica, and the drainage basins of the Biała Przemsza and Szreniawa. Then it runs straight east to the Nida river valley. Farther on it probably shifts north, parallelling the upper Vistula valley, and reaches Zawichost.

No root voles were found inside the triangle determined by the extreme localities at Pińczów (no. 142), Zawichost (no. 141) and Wólka Zapałowska (no. 175), and covering most of the Sandomierz Basin. This confirmed the negative results of Kołton (1957) and Cais (1963), who searched for this species in pellets collected in that area. The root vole was not found in the Świętokrzyskie Mountains or the Sandomierz Upland either. Together with the triangle mentioned above, they form a large area penetrating into the compact range of the species (Fig. 2). No root voles were found on the Sandomierz Upland in abundant pellet materials studied by Włodarczyk (1963) or collected in preparation of the present article. However, this species was reported to occur in pellets from Szewna (a locality on the fringe of the Sandomierz Upland) collected by the Mammal Research Institute in 1963 (Raczyński 1983). In the sizeable material I collected in this locality in 1975 there was not a single specimen of *M. oeconomus*.

East of the lower San valley the range limit turns south. The root vole was found to be absent from three localities studied in this area. The species trapped was *M. agrestis*. However, a bit farther east, in the Tarnogród Plateau region, the southernmost localities of the root vole in Poland were recorded: Lubaczów (no. 171), Wólka Zapałowska (no. 175), and Wólka Krowicka (no. 172). A bit more to the south, just across the state boundary or maybe still in Poland, are probably other localities of this species.

Discussion

There are a number of factors controlling the range of the root vole in Poland. Probably the most important are climatic conditions, man-made factors, and their associated biotope factors.

As to the climatic factors, there is a combined impact of the increase in temperature southwards and the intensification of the oceanic character of the climate westwards. It is seemingly incomprehensible that the "oceanity" of the climate does not favour the occurrence of this particularly hygrophilous species. There is a similar case of *Apodemus agrarius*. Its expansion westwards also seems to be checked by the growing impact of the Atlantic climate (Pelz 1980). The range of the root vole in Asia

(Corbet 1978) proves that under a continental climate it may extend much farther south. It may have been a more continental climate of the Plain of Hungary in comparison with the neighbouring areas (Bauer 1960) that enabled the survival of relic localities of the subspecies *M. oeconomus mehelyi* there, in very comfortable biotope conditions (Ehik 1928).

The continental climate is characterised by stable meteorological conditions. The snow cover persisting over a considerable part of the year provides a shelter under which root voles can feed and move safely. Changes in temperature following changes in atmospheric pressure systems bring about sudden thaws, changes in the level of ground water, and the inundation of biotopes situated on lower grounds, and hence, of nests and hiding-places of root voles. Populations living in the centre of the range do not suffer great losses during inundation – they move to neighbouring biotopes for a time (Raczyński *et al.* 1983). Under the sub-optimal conditions of range limit, sudden and frequent changes in temperature during winter and the short duration of the snow cover are especially harmful to this species. In Poland it usually lives in small environmental enclaves surrounded by cultivated fields; hence, it has no natural refuges characteristic of extensive wetland.

The range of the root vole in Europe has dwindled considerably (Tast 1982). This is evidenced by numerous fossil and subfossil findings of this species in areas where it is not recorded at present (Requate 1955, Kowalski 1959, 1961, Janossy 1960, Reichstein 1970, 1972, Nadachowski 1982), as well as by the existence of isolated refuges outside the limits of the compact range.

The rate at which the distribution of the root vole shrinks in modern times may be speed up dramatically by human activity, mainly the elimination from the landscape of environments typical of this species (the reclamation of marshland, the regulation of rivers and streams, peat exploitation, and even turning peat bogs into fish ponds). In all probability it is human impact that has crucially contributed to the disappearance of the root vole from much of the Wrocław Plain and the Wrocław Ice-marginal Valley (Wrocław Pradolina). A comparison of the range of the root vole with a map of low bogs in Poland (Fig. 3) suggests that with the dwindling of these environments the range of this species will shrink too.

Owing to the fragmentary character of the previous data on the occurrence of the root vole in the south of Poland, it is impossible to determine the changes that have taken place in its range over the decades, or even to prove that such changes have taken place at all. The animal was still recorded near most of the southern localities known from the older literature. This concerns the precisely located sites in Silesia, the Nida river valley, and the Zamość region. It turned out, however, that they usually did not lie on the very borderline of the range. In some cases attempts to verify older localities failed. Sometimes these were localities not altogether reliable (Zabrze - Krumbiegel 1948), or described vaguely, *e.g.* Oppelner Land reported by Schlott (1930/31) and quoted by later authors as Opole. Schaefer (1931) claims that the locality mentioned by Schlott was situated between Zieliniec (Gründorf) and Opole, hence near the locality

Fig. 3. The southern range limit of *Microtus oeconomus* seen against a map of major low bogs in Poland (Jasnowski 1975).

no. 62 (Kobylno) and not in Opole as reported by *e.g.* Zimmermann (1942). In other cases [Szewna (Raczyński 1983) or the upper Pilica valley (Markowski and Suskiewicz 1979)] the failure of the latest search need not be a conclusive proof of the absence of the root vole from these areas.

The most probable phenomenon to occur in near future is a perceptible change in the range limit in Kaczawskie Foothills (Pogórze Kaczawskie) and the Częstochowa Upland, where the localities of *M. oeconomus* are scattered widely and occupy small environmental enclaves habitable to this species.

It may be especially interesting to carry out further, more detailed studies in the Liswarta river valley. The range of the root vole ends here in the area of Lisów (locality no 86), despite the fact that there is a belt of biotopes suitable for this species extending southwards, along the river course.

South of the range of the root vole, localities it used to inhabit and that are typical

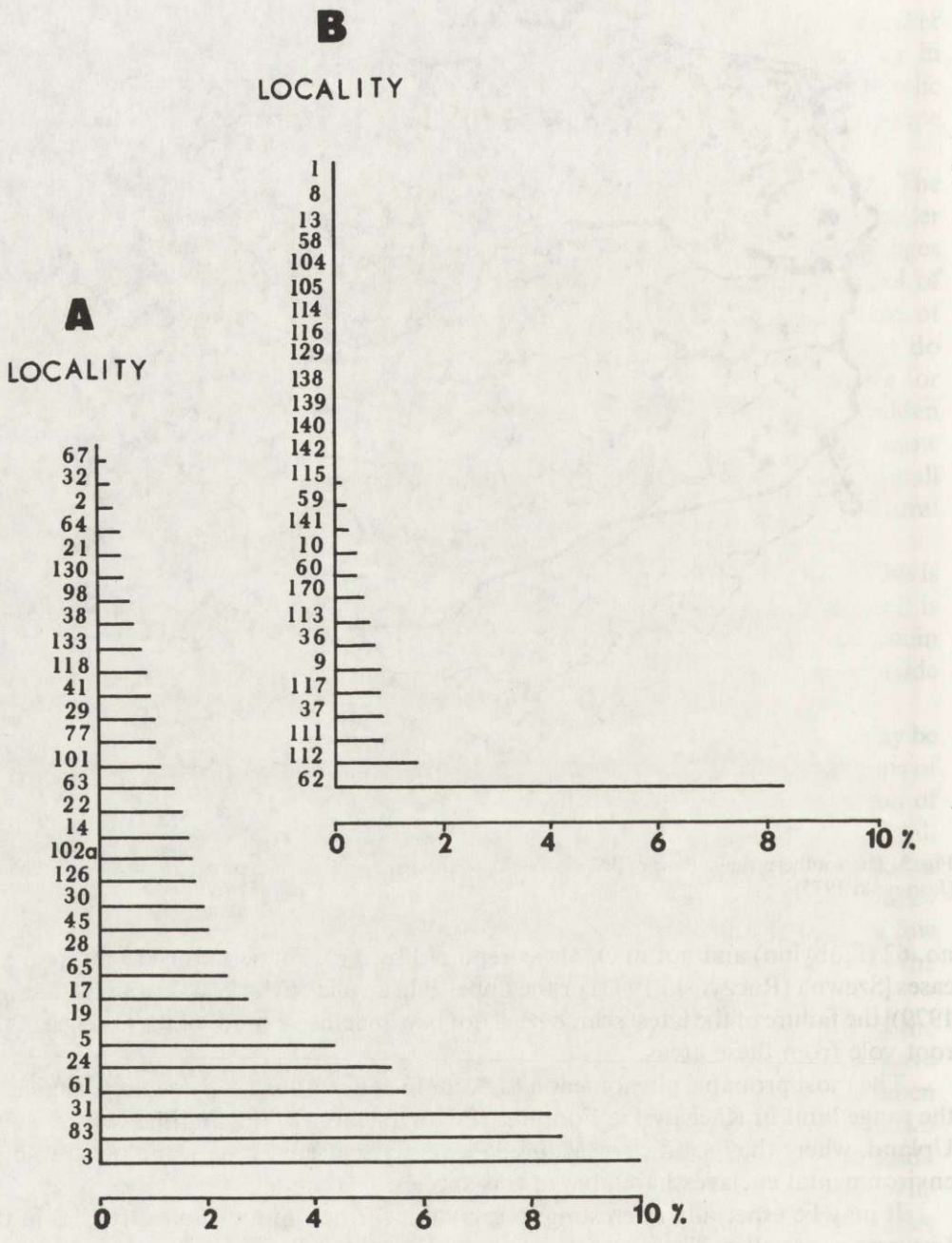

Fig. 4. The proportion of *Microtus agrestis* in the food of owls from localities at which *M. oeconomus* occurred (B) and from those where it was not found in the pellets studied (A). Localities at which neither of the species was found are omitted.

of this species are now usually being colonised by the field vole *Microtus agrestis*. In this part of its range where it has been freed of the competition of the root vole, it colonises waterlogged open biotopes which it used to lose to the competitor. Thus, outside the range of the root vole, the field vole becomes a much more common mammal outnumbering the rival, which is reflected in trapping results (Table 1) and the pellet material analysed (Fig. 4). Only in two localities (nos. 86 and 175), bordering on a wood, both species were trapped. Outside the range, a great number of biotopes in which the field vole was trapped were typical open ones, often at a considerable distance from a wood (localities no. 15, 16, 20, 23, 26, 27, 46, 48, 68, 72, 74, 89, 90, 92, and 120 – Table 1, Fig. 1).

The results of trapping carried out near the limit of its range show that in this area *M. oeconomus* prefers unforested eutrophic waterlogged land with abundant herbaceous vegetation, usually partly overgrown with the reed *Phragmites communis*. It was not caught in localities tending to become transition moors of a mesotrophic character. This confirms the observations of Zimmermann (1942) concerning biotope preferences of *M. agrestis* and *M. oeconomus*, while contradicting trapping results obtained on a high bog at Chlebowo (Rachowiak 1989). Perhaps it is due to the fact that in the biotopes of transition moors and high bogs the root vole gives way to the field vole, at least near the limit of its range, that *M. oeconomus* is not recorded in the Świętokrzyskie Mountains and in the southern part of the Lower Silesian Woods.

On the basis of the data obtained during the field work a possibly precise limit of the range of the root vole in Poland was determined. It is probable that this limit undergoes periodic and also permanent shifts. A precise knowledge of its location at a specific time may be a starting-point for further observations of its shifts and the behaviour of frontier populations.

Acknowledgements: This work, conducted with his kind interest, I would like to dedicate to the memory of my Teacher, Professor W. Skuratowicz. I am grateful for critical but revealing remarks to Prof. Z. Pucek and Dr. A. L. Ruprecht. Particular thanks for co-operation in the field without which the collection of this material would have been impossible are due to Mrs B. Trzmielewska, Mr J. Skibiński, Dr. A. Nowosad, Dr. A. Głazaczow, and my husband.

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Received 5 October 1988, accepted 20 July 1990.