

## Spatial Distribution and Interspecific Interactions in Small Rodent Community of a Lake Coastal Zone

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Use of space and interspecific interactions in a small rodent community were studied in a lake coastal zone. The material was collected by a CMR method on two 1-ha plots: CP — control plot and EP — experimental plot, in four trapping series, in summer and early autumn. After two trapping series all small rodents were removed from EP. On the two plots, seven species of rodents were found; *Clethrionomys glareolus*, *Apodemus flavicollis*, *A. agrarius* and *Microtus oeconomus* were most numerous. On the basis of CMA coefficient and assessment of random nature of occurrences of the pairs of species in the same stations by  $\chi^2$  test, the following competitive interspecific interactions were identified: *A. agrarius/A. flavicollis*, *M. oeconomus/A. flavicollis*, *M. oeconomus/C. glareolus*, and *C. glareolus/A. agrarius* although this last interaction was less marked on EP than on permanently inhabited CP. At the beginning of the experiment, the communities inhabiting CP and EP differed. After the environmental gap was filled, the appearance of community structure on the two plots converged. A similar distribution of principally different space between the species occurring on the two plots took place adequately to their environmental requirements and to the competitive interspecific interactions with the latter being somewhat dependent on the timing of their arrival in the habitat.

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### 1. INTRODUCTION

Competitive interactions between species in small rodent communities have recently been studied in various types of habitats and habitat systems (e.g. Gliwicz, 1981; Hansson, 1983; Chełkowska *et al.*, 1985). In most of the reports it is food (its abundance and supply) that is considered to be a main component of the habitat for which animals compete (e.g. Gliwicz 1981; Hansson 1971; Obrtel & Holišova, 1977).

The habitat structure that implies the number and quality of shelters, nesting sites *etc.* is also regarded as a significant factor in the interspecific interactions making possible a co-existence of various species within given area (Hansson, 1978; Mazurkiewicz, 1984). The important part of this structure is formed by the internal small-scale differentiation within a habitat. It affects the intensity of competitive interactions among species and, as a consequence, makes a significant impact upon

formation of small rodent community structure (Morris, 1983; Adler, 1985).

The lake coastal zone seems to be a promising habitat for a study on interactions among small rodent species. The habitat supports a wide variety of vegetation types (mirroring a zonal variability of soil moisture) that open options for selecting habitats. On the other hand, this zone is a suboptimal one for some of the species because of rather poor food supply (Holišova, 1972).

In the studies concluded so far, a strong competitive interaction between *C. glareolus* and *A. agrarius* was found. *C.g.* was a species that dominated the relationship. It could be explained by its permanent presence in the coastal area in contrast to *A.a.* appearing only seasonally (Kozakiewicz, 1985; Suska, unpubl.).

The aim of this study was to determine the characteristics of the interactions among all the rodent species living within the lake coastal zone. An attempt was also made at identifying causes of different distribution patterns in rodents living in various parts of the coastal habitat.

## 2. STUDY AREA, MATERIAL AND METHODS

The studies were carried out around Mikołajki locality (Great Mazurian Lakes Region, Poland) on the coast of Łuknajno Lake. The studies covered two plots: a control plot henceforth denoted as CP, and an experimental plot (EP) each of 1 hectare size. Live traps were set in permanent double trap sites arranged as

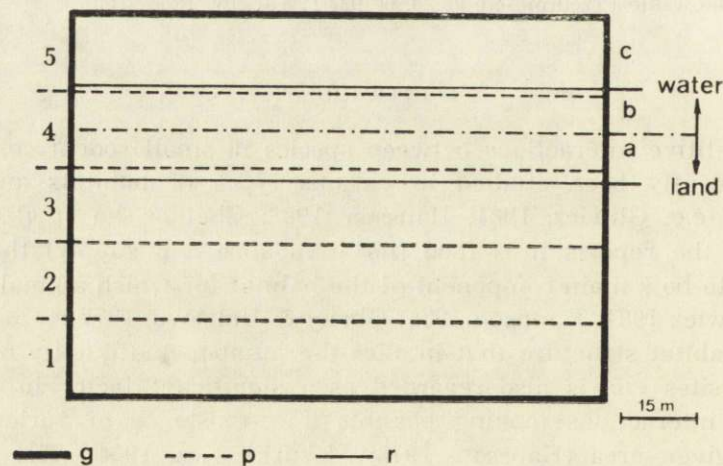


Fig. 1. Outline of experimental plot. 1—5 — numbers denote strips of various degrees of moisture, g — boundaries of the plot, p — boundaries of strips of various moisture of the ground, r — boundaries of vegetation zones, a — forest habitat with alder, b — willow shrubs, c — reed association.

a grid of 15×15 m squares. On water-logged sites the traps were set on special boards keeping them above water level.

On both plots the vegetation cover was similar and arranged along three zones: (a) dry, closest to the mainland, on the relatively dry ground, overgrown by forest community with alder and with many herbaceous components belonging to *Molinio-Arrhenatheretea* class, (b) middle, on very humid ground, overgrown by willow shrubs (partially developed *Salicetum pendantocinereae*), with herbaceous layer dominated by rush elements (*Phragmitetea* class), (c) immersed, overgrown by reed rush (*Phragmitetum* group) forming a complex with aquatic plants (*Lemnetea* and *Potamogetonetea* classes) (Fig. 1).

CP adjoined similar coastal habitats on both sides and, across narrow road with a mid-field afforested belt. EP bordered with similar habitat only on one side, the remaining two bordered with meadows.

The material was collected by CMR method. The traps were inspected twice daily in morning and evening. For each animal caught the date, locality, species and its individual number were registered.

The trapping sessions were carried out on both plots in four weekly series: I — 2 July — 8 July, II — 9 July — 15 July, III — 23 July — 30 July, IV —

Table 1

Numbers of various individuals of particular species of small rodents caught on control (CP) and experimental (EP) plots.

Species	CP	EP
<i>Clethrionomys glareolus</i> (C.g.)	80	112
<i>Apodemus agrarius</i> (A.a.)	23	18
<i>Apodemus flavicollis</i> (A.f.)	16	13
<i>Microtus oeconomus</i> (M.oe.)	16	4
<i>Micromys minutus</i> (M.mi.)	2	3
<i>Mus musculus</i> (M.m.)	0	1
<i>Microtus agrestis</i> (M.a.)	0	2
Total	137	153

29 Aug. — 4 Sept. 1985. After having completed series II on EP all the rodents were caught and carried far from the plot. Thus in the following series the process of filling the population gap on EP was monitored and compared with the situation on the control plot CP. Filling a population gap proceeds on the expense of part of migrating population and takes 2 to 4 weeks (Andrzejewski & Wrocławek, 1962). Thus series III provided an insight into the effects of filling the gap after one week (ie. in the middle of forming the new community) while series IV, six weeks after the removal, helped to assess the community position when the new structure should have already established itself.

In all, 137 various rodents belonging to 7 species were caught on CP, and 153 individuals on EP (Table 1). With multiple catches this altogether made 2267 individual catches.

Data analysis included comparing the proportions of C.g. to the remaining species in entire communities, in groups of rodents, and the proportions of newly marked rodents to previously marked ones between trapping sessions and between plots in analogous series, applying a test for significance of differences among proportions (at  $p=0.05$ ).

## 3. RESULTS

## 3.1. The Numbers and Species Composition in the Rodent Community

In series I and II the numbers on CP and EP differed slightly. On CP plot the number remained at below 50 individuals while on EP increased from about 40 individuals in series I to more than 60 in series II. Later, in series III and IV on CP the numbers increased to almost 70 individuals, on EP in a week after the removal (series III) returned to the level noted in series I to reach the level of about 60 individuals in sixth week after the removal (series IV) (Fig. 2).

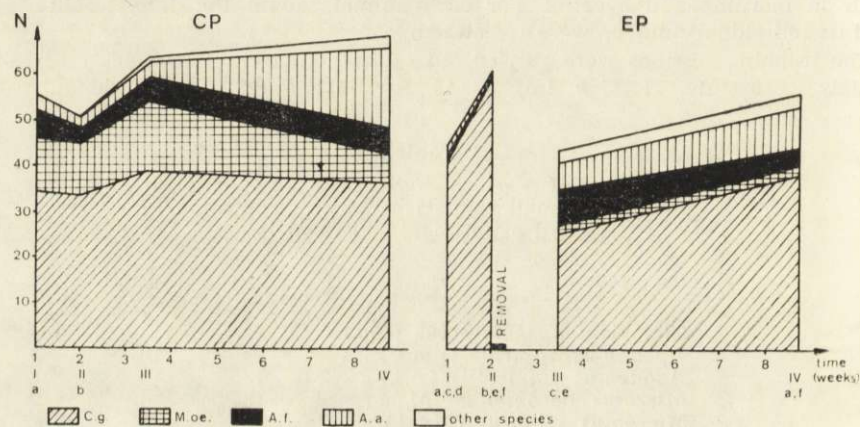


Fig. 2. Changes in density and species composition of rodent communities on the experimental (EP) and control (CP) plots. I, II, III, IV — series of trapping; statistically significant differences between proportions of species: a—a, b—b, c—c, d—d, e—e, f—f.

On both plots *C.g.* dominated numerically throughout the study period. *M.oe.* occurred in fairly large numbers on CP. *A.f.* and *A.a.* were permanently present. On EP plot, prior to removal (series I and II) *C.g.* was almost only species present; after removal (series III and IV) *A.a.*, *A.f.* and *M.oe.* appeared. In general, on CP the species composition of rodent community was similar in all series (with no statistically significant differences among the proportions of species). On EP, the composition was similar in series I and II, and series III and IV, differed significantly between series I and III, I and IV, II and III, and II and IV. In series I and II the composition of species differed significantly between CP and EP while in the next two series (III and IV) the composition of rodent fauna on these two plots became similar (no statistical differences between proportions of species) (Fig. 2).

The numbers of the dominating *C.g.* remained almost unchanged on CP (33—39 individuals) throughout all the series of trapping, while on EP they varied considerably, only in series IV reaching the level almost equalling that found on CP (Fig. 2).

### 3.2. Fractions of Newly and Previously Marked Individuals

In II, III, and IV series of trapping the individuals of *C.g.* and the remaining species marked in this series (newly marked) were considered separately from those marked in any of the preceding series (previously marked).

On CP plot the fractions of newly marked individuals of *C.g.* did not vary in II, III and IV series. There were also similar fractions of newly

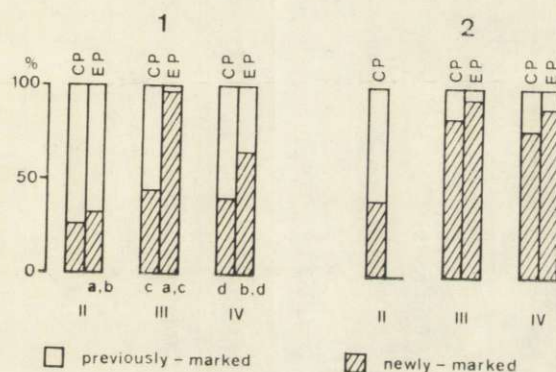


Fig. 3. Proportions of newly marked and previously marked individuals among *C.g.* (1) and remaining rodent species (2) on control (CP) and experimental (EP) plots in series of trapping (II, III, IV); statistically significant differences between proportions of newly marked and previously marked: a—a, b—b, c—c, d—d.

marked *C.g.* in series II on both CP and EP (no statistically significant differences). In series III and IV there was proportionally more newly marked *C.g.* on EP than on CP (statistically significant differences). No statistically significant differences appeared between proportions of newly and previously marked individuals of other species neither for corresponding series on particular plot nor for the series within a plot (Fig. 3).

### 3.3. Use of Space and Co-occurrence of Species in Space

Within each series the centre of individual range was calculated for each rodent using method proposed by Mazurkiewicz (1969). In order to determine spatial distribution of rodents on both plots, each plot was

Table 2  
 Numbers of individual range centres in belts of various degree of soil moisture and Lexis index values for C.g. in series of trapping (I, II, III, IV).

No. of belt	I			II			III			IV				
	Cg	Af	Moe	Aa	Moe	Cg	Af	Moe	Aa	Moe	Cg	Af	Aa	Moe
Control plot														
Land	1	10	6			10	3			13	1			17
	2	7				11				11	1			4
	3	12				11				12	3			9
Water	4	1			1	7	1	2	2	2	1	2	3	6
	5	1		6	4	1	1	9	1	2	2	8	7	6
Lexis' index		4.10			4.67			4.89		4.09				
Experimental plot														
Land	1	25				19				7	5	1		7
	2	7				18				5	2	1		8
	3	3				9				8				5
Water	4	4			1	10	1	4	4	2	4	5	1	9
	5	2		1	1	4	1	2	5	2	2	6	1	6
Lexis' index		10.92			3.37			1.30		3.65				

divided into 15 m wide belts according to variable moisture of the ground — from belt 1 (the driest) to belt 5 (completely submerged in water) (Fig. 1). Within each belt the number of individual range centres for rodents of various species was determined. The type of distribution of number of centres (clustered, random or uniform) among belts was then determined by using Lexis index.

On CP plot the distribution of individual range centres was clustered (Lexis index value from 4.1 to 4.9) in all series. Similar situation prevailed on EP in series I, II and IV (Lexis index values 3.4—10.9). In all these instances the centres of *C.g.* ranges were found mainly in the drier part of the coast (belts 1—3). In series III on EP the distribution of *C.g.* range centres is much less clustered, approaching random type (Lexis index value=1.3) (Table 2).

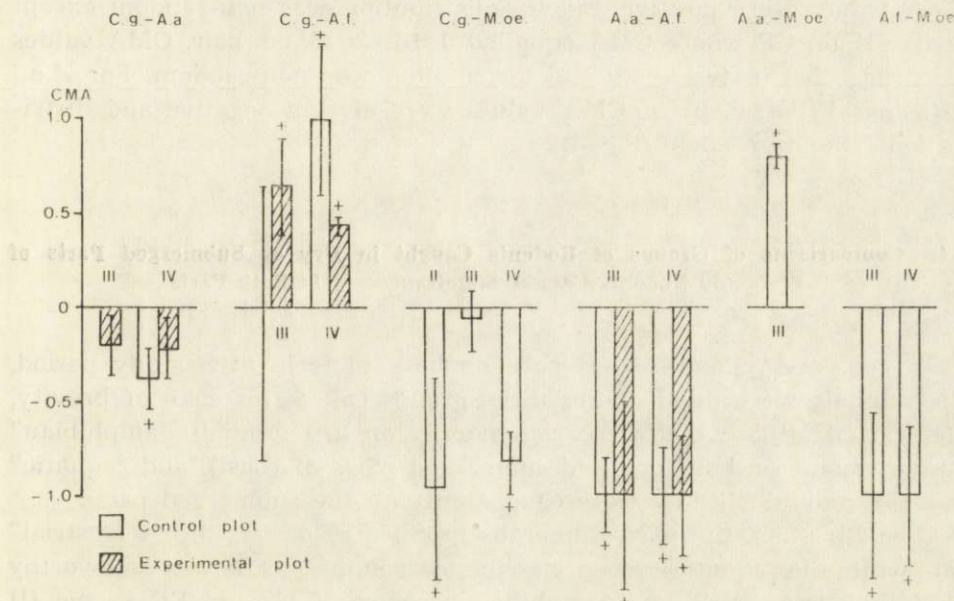


Fig. 4. CMA values and standard deviations (vertical lines) and results of  $\chi^2$  test for pairs of species in subsequent series of trapping (II, III, IV); + — non-random co-occurrence of pairs of species at the same trap stands.

This type of analysis could not be carried out for other species owing to too low numbers of catches within series. It is, however, noteworthy to point out that in case of *A.a.* 26 out of 28 centres on CP, and 15 out of 18 centres on EP were found on submerged ground (belts 4—5). Similarly in case of *M.oe.* individual range centres, 39 out of 42 on CP, and 4 out of 5 on EP were situated within the submerged parts. In contrast, the *A.f.* range centres are situated mainly on dry ground *i.e.* belts 1—3 (18 out of 23 cases on CP, and 11 out of 12 on EP) (Table 2).

The co-occurrence was tested for pairs of species occurring on the same plots, for each trap site, using CMA (Cole's Measure of Association) (Cole, 1949). This coefficient ranges from  $-1$  to  $+1$ , when negative it indicates the tendency of a pair of species to avoid each other, when positive — the tendency to co-occurrence, and when close to 0 — suggests that the two species are randomly distributed in space. The coefficient has been computed only for pairs of species that were caught in at least 10% of sites on the plot. To determine whether the distribution of each species in a pair differed from random distribution a  $\chi^2$  test was employed (at  $p=0.05$ ).

For *C.g./A.a.* pair, the CMA assumed negative values, smaller on CP than on EP, but the distribution of the two species was significantly different from random only in series IV on CP. For the *C.g./A.f.* pair, CMA values were positive and the distribution was non-random except series III on CP where CMA equalled 0. In *C.g./M.oe.* pair, CMA values were negative in two cases and distribution was non-random. For *A.a./A.f.* and *A.f./M.oe.* pairs, CMA values were always negative and distribution was non-random (Fig. 4).

#### 3.4. Comparisons of Groups of Rodents Caught in Dry or Submerged Parts of Plots and Rodents Caught Simultaneously in Both Parts

To compare rodents using space on both plots in each study period, the animals were divided into three groups called, for sake of brevity, "terrestrial" (those that were caught only on dry ground), "amphibian" (those caught on both dry and submerged parts of coast), and "aquatic" (i.e. the individuals that were caught only on the submerged part).

On both plots, the most numerous group of *C.g.* was the "terrestrial" one while the "aquatic" group was the least numerous. It was noteworthy that the "terrestrial" and "amphibian" groups of *C.g.* on EP in the III series were almost of the same strength (Table 3). The remaining species on CP belonged mostly to the "aquatic" group. Among them only *A.f.* appeared permanently, throughout all series' in the "terrestrial" group. On this plot, the "amphibian" group included *M.oe.* in series II and III, and *A.a.* in series IV (Fig. 5). On EP plot almost all species caught there after the removal (series III and IV) belonged to the "terrestrial" or "amphibian" groups (Table 3). Generally, the species composition of the "terrestrial" and "amphibian" groups in series I, II, and IV was similar on both plots (no statistically significant differences among the proportions of species). In series III, in the "terrestrial" group, statistically higher proportion of *C.g.* was found on EP than on CP. In the "aquatic"



Table 3

Number of individuals of *C.g.* and other rodent species in "terrestrial" (T), "amphibian" (Am) and "aquatic" (Aq) groups in series of trapping (I, II, III, IV).

Series	T		Am		Aq	
	<i>C.g.</i>	other	<i>C.g.</i>	other	<i>C.g.</i>	other
Control plot (CP)						
I	24	7	9	0	1	14
II	24	3	9	2	0	12
III	33	8	5	5	2	12
IV	27	7	7	4	2	22
Experimental plot (EP)						
I	24	0	12	0	5	2
II	34	1	18	0	8	1
III	12	10	11	0	3	9
IV	26	7	8	1	5	10

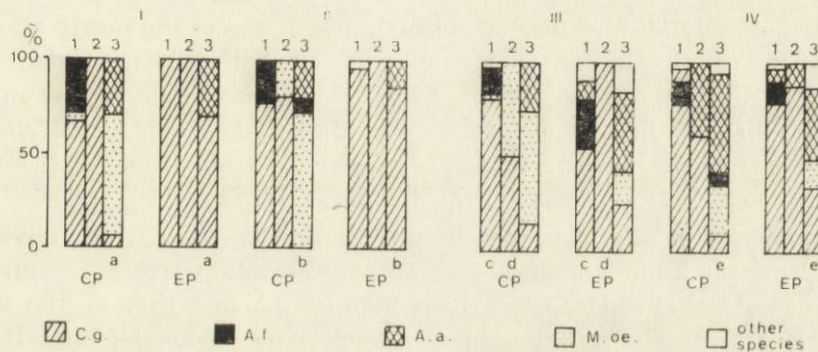


Fig. 5. Species composition of rodents belonging to "terrestrial" (1), "amphibian" (2) and "aquatic" (3) groups on control (CP) and experimental (EP) plots in series of trapping (I, II, III, IV), the statistically significant differences between proportions of species: a—a, b—b, c—c, d—d, e—e.

group, *C.g.* appeared in significantly higher proportions in series I, II, and IV on EP than on CP plot. The species composition of this group in series III was similar on both plots (no statistically significant differences found) (Fig. 5).

#### 4. DISCUSSION

The rodent species found on the Łuknajno Lake coast (Fig. 2) are typical for this type of environment (Pelikán, 1975) particularly in summer and early autumn (Kozakiewicz, 1985; Suska, unpubl.).

As the two experimental plots were identical in respect to their phyto-

sociological characteristics, the differences that have been noted in species composition and population numbers between two initial series of trapping (Fig. 2) derive probably from differences among adjacent habitats. It seems that the presence of higher number of species on CP may stem from more intensive invasion on CP along the coastline and possibly from near tree belts than the invasion on EP plot, partially isolated by meadows. In effect, *C.g.* is the only species permanently inhabiting the coast (Kozakiewicz, 1985). The change in community composition on EP after removal to become similar to that on CP plot (Fig. 2) might stem from two causes. First, there could have been uniform chances for all species to colonize the EP plot created by removal of all its permanent inhabitants (namely *C.g.*). Second cause might be an autumnal increased mobility and tendency to migrate among small mammals (*e.g.* Lidicker, 1962; Kozakiewicz, 1976) that made possible reaching EP by various species of rodents. It is most likely that there was a case of these two factors working together. High mobility of the rodents in the time of study is probably also a cause of the high proportion of the newly marked individuals caught in series III and IV on both plots. It does not pertain to *C.g.* whose proportion of newly marked individuals on CP is similar to that in the previous series. The high proportion of newly marked individuals of *C.g.* on EP has been probably brought about by earlier removal of the rodents from this plot (Fig. 3).

The analysis of the character of distribution of centres of individual ranges and the numbers of *C.g.* in the groups that use space on the coast indicate that this species uses mainly the dry part of the coast (Table 2, Fig. 5). On EP plot, in one week after removal (series III), a changed pattern of centres of ranges of *C.g.* emerged, different from both series I and II and from corresponding period on CP (Table 2). It has been probably caused by emergence of additional species on EP (Fig. 2) and by the fact that it has been just the time of forming a rodent community re-colonizing the plot.

In the sixth week after removal (series IV) the distribution of centres of *C.g.* individuals within EP was similar to that on CP (Table 2). There was again similarity of species composition in "terrestrial" and "amphibian" groups of rodents on both plots (Fig. 5). These two facts indicate that when the same species appear in the area, and the conditions in the community stabilize, the particular species tend to share available space among themselves in a generally similar manner. Yet the differences in the composition of "aquatic" groups of the two plots (Fig. 5) give rise to speculations that, apart from habitat preferences, some other factor could have come into play.

The analysis of CMA coefficient and the assessment of species dis-

tribution by  $\chi^2$  test allows assumption that the interactions within particular pairs of species on both plots are similar (Fig. 4). The CMA values and the results of  $\chi^2$  test confirm the tendency of *C.g.* and *A.f.* to occur together in a shared space. The literature data on the subject are divergent. Andrzejewski and Olszewski (1963) found that these two species tended to avoid joint penetration of an area. Similarly, Obrtel and Holišova (1974, 1977) stating rather significant overlapping between niches of *C.g.* and *A.f.* postulated possibility of strong competitive interactions between the species, depending on season and the resulting food supply in a habitat. In contrast, Gliwicz (1981) found that *C.g.* and *A.f.* did not show marked tendency to avoid each other, and their co-occurrence was rather incidental. It seems that in a lake coastal zone the co-occurrence of *C.g.* and *A.f.* in space was an effect of preference shown by both species towards the dry parts of the plots and that possible competitive interactions are reflected by somewhat small fraction of *A.f.* in the community composition (Fig. 2). With no prospect for species spatial separation the competition may affect the numbers (cf. Grant, 1972).

*A.a.* and *M.oe.* were found to co-exist on the experimental plots while the two species tend to avoid other species as indicated by low CMA values for *C.g./M.oe.*, *A.f./M.oe.*, *A.a./A.f.*, *C.g./A.a.* and the results of  $\chi^2$  test (Fig. 4). A tendency of separation in space *A.a.* and *A.f.* has been also found by Gliwicz (1981). Similar shunning at trapping sites has been confirmed in case of *C.g.* and *A.a.* with the interaction intensity depending on season and type of habitat (Gliwicz, 1981; Chelkowska *et al.*, 1985). In the two pairs of species (*A.a./A.f.* and *C.g./A.a.*) a degree of niches overlap varying in seasons is considered the main reason for interactions. It is suggested that the competition may be stronger between two *Apodemus* species than between these two and *C.g.* (Obrtel & Holišova, 1977). The results of this study has confirmed the trend as CMA values are lower in *A.a./A.f.* pair than in *C.g./A.a.* (Fig. 4).

The literature data pertaining to *M.oe.* point that the species is closely associated with water-logged areas at coastal zones of bodies of water (Zablockaja, 1957). Its habitat requirements (including feeding habits) only slightly overlap those of *C.g.* (Boström & Hansson, 1981). Avoiding co-existence at trapping sites by these *C.g./M.oe* and *A.f./M.oe* pairs is perhaps brought about by spatial separation of the species and by taking over the dry parts by *C.g.* and *A.f.* and the submerged ones by *M.oe.* according to habitat preferences of the species. This hypothesis is further supported by distribution of individual range centres and the proportions of the above species in the groups using different parts of the coastal habitats (Fig. 5, Table 2).

The negative interactions between *C.g.* and *A.a.* (Fig. 4) found in this

study agree with what is known from literature. *C.g.* dominates in the interactions and takes over preferred habitats. This dominating position is explained by permanent presence of *C.g.* in contrast to seasonal appearances of *A.a.* (Kozakiewicz 1985; Suska, unpubl.). Around the turn of summer and in the early days of autumn when *C.g.* is removed from the coast the areas previously occupied by bank voles (dry ground) are invaded by *A.a.* (Suska, unpubl.). The idea that the dominating position of *C.g.* over *A.a.* results from permanent presence of *C.g.* on the coast is further supported by weaker interactions between the two species on EP than on permanently inhabited CP, indicated by lower values of CMA coefficient and the results of  $\chi^2$  test (Fig. 4). The difference in proportions of species within "aquatic" group in series IV (Fig. 5) also supports this explanation. Creating the environmental gap on EP may possibly equal the chances of free colonization of the site for all the species. In this case both individuals of *C.g.* and *A.a.* come from outside the area and they all belonged to the migrating, "worse" fractions of well-settled populations (cf. Kozakiewicz & Kozakiewicz, 1975). At the same time, the study revealed a general tendency of *C.g.* to take over better habitats (dry ones) even after removal of the settled population from EP. It is confirmed by the distribution of the individual range centres and the proportions of species in question in the groups caught in various parts of the coast on EP in series IV (Fig. 5, Table 3). It suggests that the dominating of *C.g.* over *A.a.* results not only from the permanent presence of the former but also that *A.a.* is somewhat weaker in competition than *C.g.* It might be thus stated that the competitive interactions between *C.g.* and *A.a.*, as described above (i.e. shaped by both dominating tendency over *A.a.* and by the permanent presence of *C.g.* in the coastal zone) and previously mentioned interactions between *A.a.* and *A.f.* are the principal factors determining distribution of *A.a.* there.

In conclusion, it may be stated that despite poor food supply, limited facilities for digging burrows, few nesting sites *etc.* (as sites are partially submerged) the rodents use the entire space of the coast. It may so happen owing to possibility of separation of qualitatively different space among species, partially due to their various habitat requirements, partially due to competitive interactions. It agrees well with widely described cases of habitat selection that makes possible co-existence of species with similar habitat requirements within the same area (eg. Larsson 1977; Hansson, 1979; Hallet *et al.*, 1983; Morris, 1983; Adler, 1985).

Creating the environmental gap in the middle of vegetation season and thus giving various species equal chances to settle in the space changes

the relationships in the rodent community in the coast. This brings, among others, certain enrichment to the community, introduces changes to spatial distribution of species and lessens the intensity of some interactions among some species. It seems that the interactions that get established at the beginning of the vegetation season as various species invade the area permanently occupied by *C.g.* are the decisive factors in shaping the community in the coastal zone.

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ROZMIESZCZENIE W PRZESTRZENI GATUNKÓW  
I ODDZIAŁYWANIA MIĘDZYGATUNKOWE W ZESPOLE DROBNYCH GRYZONI  
POBRZEŻA JEZIORA

Streszczenie

Badano sposób rozmieszczenia gatunków w przestrzeni i jego przyczyny oraz oddziaływania międzygatunkowe w zespole drobnych gryzoni pobrzeża jeziora.

Cdłowy prowadzono przy pomocy pułapek żywołownych na dwóch 1-hektarowych powierzchniach: kontrolnej i eksperymentalnej. Obie powierzchnie były identyczne pod względem charakterystyki fitosocjologicznej a roślinność na nich układała się w strefy związane z występującym gradientem wilgotności podłoża (Ryc. 1). Badania prowadzono metodą CMR w czterech 1-tygodniowych seriach połowów latem i wczesną jesienią. Po dwóch pierwszych seriach z powierzchni eksperymentalnej wyłowiono zasiedlające ją gryzonie. Kolejne serie połowów miały na celu sprawdzenie efektów wypełniania się powstałej luki siedliskowej w 1 tydzień i 6 tygodni po wyłowieniu i porównanie powstałej sytuacji z sytuacją na stale zasiedlonej powierzchni kontrolnej.

W sumie na obu powierzchniach stwierdzono występowanie 7 gatunków drobnych gryzoni (Tabela 1).

Struktura gatunkowa całego zespołu początkowo różniła się znacznie pomiędzy powierzchniami. Wytworzenie luki siedliskowej spowodowało pojawienie się na powierzchni eksperymentalnej znacznie większej niż na powierzchni kontrolnej liczby nowoznakowanych osobników *C. glareolus* (Ryc. 3). Na powierzchni eksperymentalnej pojawiły się dodatkowe (w stosunku do okresu przed wyłowem) gatunki gryzoni. W efekcie po wypełnieniu się luki siedliskowej na powierzchni eksperymentalnej skład gatunkowy stał się podobny jak w analogicznym okresie na powierzchni kontrolnej (Ryc. 2).

Porównując skład gatunkowy grup gryzoni różnie wykorzystujących teren pobrzeża oraz rozmieszczenie centrów arealów osobniczych poszczególnych gatunków między pasy o różnej wilgotności podłoża, można stwierdzić, że po wypełnieniu się luki siedliskowej na powierzchni eksperymentalnej (6 tygodni po wyłowieniu) i w analogicznym okresie na powierzchni kontrolnej, występowały te same gatunki gryzoni, które rozmieściły się w przestrzeni w podobny sposób najliczniejsze: *C. glareolus* i *A. flavicollis* — głównie w części suchej, *A. agrarius* i *M. oeconomus* — w części zanurzonej pobrzeża (Ryc. 5, Tabela 2, 3).

Oddziaływania konkurencyjne oceniano wyliczając dla poszczególnych par gatunków współczynnik CMA oraz wartości  $\chi^2$ , określając przypadkowość występowania gatunków w tych samych punktach połowów. Stwierdzono pozytywne oddziaływania między parami *C. glareolus* i *A. flavicollis* oraz *A. agrarius* i *M. oeconomus*, negatywne natomiast między *A. flavicollis* i *A. agrarius*, *A. flavicollis* i *M. oeconomus*, *C. glareolus* i *A. agrarius*. Oddziaływania między ostatnią parą gatunków miały większe nasilenie na powierzchni kontrolnej w stosunku do eksperymentalnej, z której wcześniej usunięto osiedlone tam gryzonie (Ryc. 4). Zaproponowano więc, że na sposób oddziaływań pomiędzy tymi dwoma gatunkami ma m.in. wpływ stałe zasiedlenie pobrzeża przez *C. glareolus* przy okresowym pojawianiu się na tym terenie *A. agrarius*.

Rozdział jakościowo różnej przestrzeni między poszczególne gatunki gryzoni na terenie pobrzeża następuje częściowo adekwatnie do wymagań środowiskowych, częściowo na skutek oddziaływań konkurencyjnych. Oddziaływania międzygatunkowe, których nasilenie w pewnym stopniu zależne jest od kolejności pojawiania się gatunków w środowisku są znaczącym czynnikiem w kształtowaniu zespołu drobnych gryzoni na terenie pobrzeża.