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Response of rodents to an increased and quantitatively diverse food base

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The response of *Clethrionomys glareolus* (Schreber, 1780), *Apodemus flavicollis* (Melchior, 1843) and *Apodemus agrarius* (Pallas, 1771) to a short-term increase and quantitatively diversified food base was studied in the Młociny Forest in Warsaw in four areas situated in an alder swamp. The additional food for the rodents was oats laid 3 days before catching the animals at a number of points situated 15 m apart. Test areas differed in the amount of oats, with 70, 30, 10 or 1 points of oats. This additional food was consumed by 98 % of the caught rodents in which oats was found in the stomach. In all rodent species the contents of the stomach was positively correlated with the per cent of oats in the food. The greatest percent of oats in gastric contents was found in all species in the areas with the greatest number of oat points. The number of rodents feeding at one oat point was inversely proportional to the number of oat points in a given area. The number of rodents caught near a given oat point was higher in the area with a small number of points than in the areas with much additional food.

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Introduction

The spilling of seeds in forests occurs at intervals of several years, the so-called seed years *e.g.* of the oak *Quercus robur* or beech *Fagus silvatica* (Jensen 1985, Jensen and Frost 1986, Tchernyshev *et al.* 1985). During this spilling time in most forest areas large amounts of seeds are available. However, in certain situations fruit is produced by only certain tree species or even by only individual trees. The animals living on seeds take advantage of this suddenly increased food base (Drożdż 1966). It seems that the way and amount of additional food distributed over various areas is important for the animals feeding on seeds.

The purpose of this study was to observe the response of forest rodents to a food base diversified with respect to amount and availability, which was suddenly increased for a short time. The spilling of seeds was simulated by laying out oats in the forest for a short time.

Study area, material and methods

The study was carried out in autumn 1984 in the Młociny Forest which is 10 km north of the centre of Warsaw. The whole forest covers about 50 hectars. The area, where the experiment was carried out, belonged to a complex of *Carici elongatae-Alnetum*, subcomplex *Carici elongatae-Alnetum dryopteridetum cristatus*.

About 50 year old, *Alnus glutinosa* (L.) prevailed, while in the undergrowth the prevailing species were *Impatiens noli-tangre* (L.) and *Aegopodium podagraria* (L.).

There were four experimental areas. Three were 1.2 ha in size and one 1.6 ha. These areas were situated at least 400 m apart. For 6 days oat seeds were exposed in these areas. The areas differed in the number of points of oats exposure and the regularity of its distribution (Fig. 1). The A area contained 70 oat points which were distributed in a network of 15 m between the points. Oats were placed at each point in plastic mugs. The food was distributed evenly over this area *ad libitum*. In area B only 30 oat points were laid, distributed also at 15 m distances. All points were situated in one part of the experimental areas and the food was distributed there evenly, *ad libitum*. In the largest area C (1.6 hectar) oats were placed in only 10 points at 15 m distances in a line across the middle of the area. The fourth area D contained in its centre one oat point serving as a feeding tray for rodents, with oats in a smaller amount in only one heap.

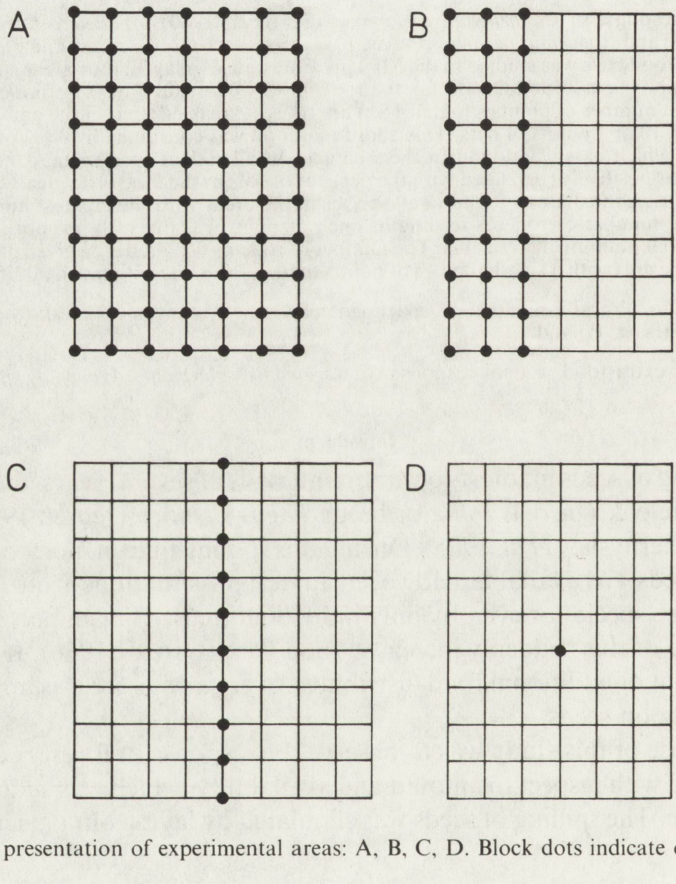

Fig. 1. Schematic presentation of experimental areas: A, B, C, D. Block dots indicate oat points.

After three days of oats exposure (oats were supplemented daily) in all areas killing traps were placed with a bait of wick fried in oil with flour. In three areas of 1.2 ha there were 70 catching points and in area C (1.6 hectar) 90 points. The catching points were always at the oat points. Since in areas B, C and D oats were exposed only in a part of the area, the remaining catching points were situated in the remaining part of the area so that they formed a network of 15 m mesh size. At each catching point two killing traps were placed. The rodents were caught during three successive days. At the same time oats were supplied to the oat points.

The animals were classified into species, weighed, and autopsied. Their reproductive condition was determined. Then the stomach was dissected and frozen at −18°C. The contents were removed and weighed accurately to 0.1 g. The per cent of oats in the whole gastric contents was evaluated visually, accurately to 10%. The presence of characteristic granules of oats starch was checked under the microscope.

During the experiment 214 animals were caught in all four areas. They belonged to 4 species (Table 1). *Clethrionomys glareolus* (Schreber, 1780) prevailed, accounting for 53% of all caught animals. The per cent of *Apodemus flavicollis* (Melchior, 1834) and *Apodemus agrarius* (Pallas, 1771) was similar — 22%. Several *Microtus agrestis* (Linnaeus, 1761) were also caught.

Results

The number of all rodents caught in the experimental areas ranged from 47 to 60 animals (Table 1). Since these areas differed in size, the measure of density was accepted as the number of rodents caught at a given catching point. These values were similar in all experimental areas (statistically insignificant differences) ranging from 0.67 to 0.84 animal per catching point.

Table 1. Number of rodents trapped.

Species	Plot			
	A	B	C	D
Clethrionomys glareolus	26	23	23	41
Apodemus flavicollis	9	17	19	6
Apodemus agrarius	10	7	18	12
Microtus agrestis	3	0	0	0
Total	48	47	60	59

In only 3 out of 214 animals caught in this experiment no oats were found in the stomach. The remaining rodents ate oats. Since each area had a different number of oat points, the mean number of rodents feeding at one point in each area could be calculated. Only the animals with oats in the stomach were counted. The number of animals feeding at one oat point was inversely proportional to the number of oat points in an area. Thus in area A the ratio of the number of animals with oats in the stomach to the number of oat points was 0.68, in area B it was 1.53, in area C – 5.80, and in area D – 59.0. In the last area this means that 59 animals fed at the single oat point.

Then it was checked whether the number of rodents changed at various distances from the oats source. Zone 0 was accepted as the place of oats point, and other zones were situated 15, 30, 45 and 60 m from the source of oats. The accepted measure was the number of rodents caught in a given zone per catching point. Similar numbers of rodents were found in the zones in all areas with the exception of zone 0 in area D (Fig. 2). In zone 0, that is at the site of oats exposure in this area, the number of rodents was higher than in areas A, B and C (Student's t-test, $p < 0.05$).

For establishing to what degree the animals took advantage of additional food the mean per cent of oats in the total contents of the stomach was calculated (Table 2). Using unifactorial analysis of variance it was checked for each rodent species

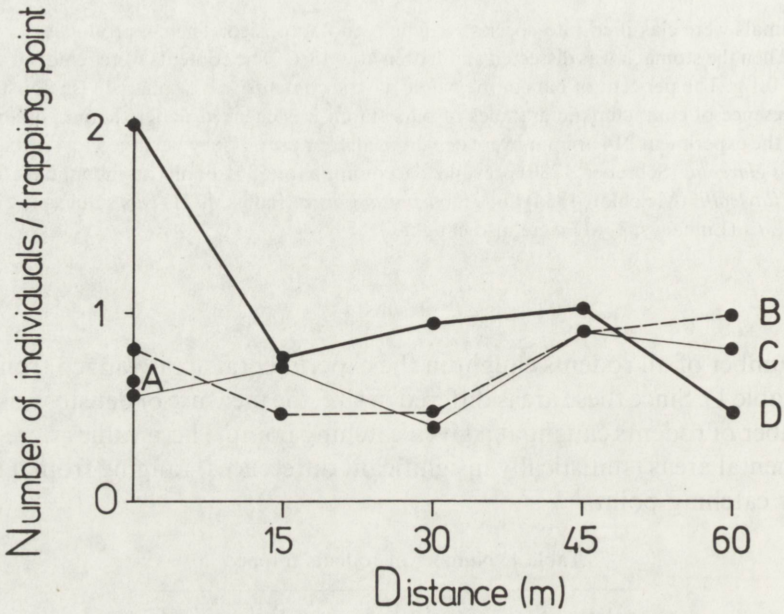

Fig. 2. Density of rodent populations at various distances from the source of additional food.

Table 2. Mean content of oats in the stomach of rodents expressed as per cent of total mass.

Plot	Contents of oats in stomachs (%)		
	C. glareolus	*A. flavicollis*	*A. agrarius*
A	64.3	73.8	89.5
B	43.8	66.9	66.5
C	41.0	64.5	69.2
D	33.5	54.2	40.0

separately whether there was any difference in stomach oats content between areas A, B, C and D. Significant differences were found for all species (*Clethrionomys glareolus:* $F_{3/109}=2.75$, $p<0.05$; *Apodemus flavicollis:* $F_{3/47}=2.88$, $p<0.05$; *Apodemus agrarius:* $F_{3/43}=2.90$, $p<0.05$). The greatest proportion of oats in the stomach contents in all rodent species was found in area A, the lowest proportion in ares D (Table 2). Duncan's test confirmed significant differences between various areas. In all studied species the proportion of oats in the stomach was significantly higher in area A as compared with areas B and C ($p<0.05$) and area D ($p<0.05$). The per cent of oats in various rodent species in area D differed also significantly from that in areas B and C ($p<0.05$). However, no significant differences in oat proportions were found between areas B and C.

In order to determine whether the studied rodents took advantage willingly of the increased food base, we correlated the weight of the stomach contents with the per cent proportion of oats in it. In all species, in all areas, a positive correlation was found (r from 0.7197 to 0. 9926 at $p<0.001$). This means that the increased stomach weights of the rodents was caused by a greater proportion of oats in the food.

The proportion of oats in the stomach contents was similar in the animals in a given area, as evidenced by the absence of correlation between oats proportion in the stomach and the distance from the oats source where the rodents were caught.

Discussion

The appearance of additional food periodically in the environment, *e.g.* seeds of oaks or beeches, raspberries or blackberries, means that the animals having this food in their diet use it readily, and can make this food the main component of their diet (Drożdż 1966) for some time. In most rodents this type of food is found in the stomach at that time (own unpublished observations). This has been confirmed by this experiment, in which most animals used additional food *i.e.* oats artificially introduced in the environment. In 98% of the animals caught oat starch was found in the stomach. In all rodent species the stomach contents was positively correlated with the per cent of oats in food.

The rodents found easily the additional food, irregardless of whether the oats were abundant and evenly distributed (area A) or exposed at only one site in the area (area D). In all areas the rodents found the oats within 3 days.

This experiment also shows that if additional food was abundant everywhere the rodents were not compelled to seek it over large areas. Conversely, the animals actively sought food distributed at certain points in the environment. This was seen by the observation that the greatest number of animals visited the only oats point in the area where oats was least abundant in relation to the remaining areas. The one and only oats point was visited by 59 animals belonging to three rodent species. This was double the number of rodents observed in the experiment of Andrzejewski and Babińska-Werka (1986) in which one oats point was visited by about 30 voles *Clethrionomys glareolus* (other rodent species were found in that area only sporadically). This difference was due to the fact that the present experiment was carried out in autumn, when the size of the rodent population is at its height, while the experiment of Andrzejewski and Babińska-Werka (1986) was done in summer.

The experimental areas in this experiment were at least 400 m apart, and the experiment was carried out at one time. It thus seems that rodents from one area could not pass to other areas. That distance between the areas was accepted considering the results of the investigations of Andrzejewski and Babińska-Werka (1986, and unpubl.) which showed that voles *Clethrionomys glareolus* explored areas in a radius of 300 m, and forest mice *Apodemus flavicollis* explored areas up to 400 m from the oats point.

In this study it was observed that the proportion of oats in rodent stomachs was lower in the area with small amounts of additional food than in the area with low amounts of oats. Oats exposed artificially in the environments is an excellent, high-caloric food for forest rodents, and is readily consumed by them (Faller 1970, Górecki and Gębczyńska 1962). When this food is not very available it may create competition between rodents, resulting in a proportion of oats in the stomach lower than in rodents caught in areas with higher availability of oats. Competition for food between *Clethrionomys glareolus* and *Apodemus flavicollis* in certain situations has been suggested by Andrzejewski (1963) and Andrzejewski and Olszewski (1963).

The question arises as to how the rodents find additional food appearing in their environment. The observations of Babińska-Werka (in print) show that this occurs very quickly. Within several days oats were consumed by *Clethrionomys glareolus*. However, the process of food finding by rodents still remains unknown, although some new data were discovered recently (Andrzejewski and Babińska-Werka 1988). Considering the observations of Mironov (1977), Petrov and Mironov (1972), Bujalska (1988) suggested that oat grains are eaten by some animals at the oats point while other animals carry them away. This hypothesis aroused a discussion (Andrzejewski and Babińska-Werka 1988) which failed to lead to a reliable answer.

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References

Andrzejewski R. 1963. Processes of incoming, settlement and disappearance of individuals and variations in the number of small rodents. Acta theriol. 7: 169–213. – Andrzejewski R. and Olszewski J. 1963. Social behaviour and interspecific relations in *Apodemus flavicollis* (Melchior, 1934) and *Clethrionomys glareolus* (Schreber, 1780). Acta theriol. 7: 155–168. – Andrzejewski R. and Babińska-Werka J. 1986. Bank vole populations: are their densities really high and individual home range small? Acta theriol. 31: 409–422. – Andrzejewski R. and Babińska-Werka J. 1988. Czy nie lepiej zajrzeć do lasu? Wiad. ekol. 34: 78–84. – Babińska-Werka J. 1990. Response of bank voles to a new source of food and its withdrawal. Acta theriol. 35. (in print). – Bujalska G. 1988. Populacje nornicy rudej: Czy rzeczywiście ich zagęszczenie jest małe a areały osobnicze duże? Wiad. ekol. 34: 73–78. – Černyšev N. V., Popov J. and Švarc K. A. 1985. Dinamika čislennosti, stacialnoe raspredelenie melkich mlekopitajuščich na Valdae i faktory ich opredeljajuščie. [In: Voprosy teriologii. V. E. Sokolov, ed.]. Izd. Nauka, Moskva: 100–125. – Drożdż A. 1966. Food habits and food supply of rodents in beech forest. Acta theriol. 11: 363–384. – Faller R. 1970. Ist der ateranbau noch aktuell? Dt. Landw. Presse Jg. 93 (5): 5–7. – Górecki A. and Gębczyńska Z. 1962. Food conditions for small rodents in a deciduous forest. Acta theriol. 6: 275–295. – Jensen T. S. 1985. Seed-seed predator interactions of European beech (*Fagus silvatica* L.) and forest rodents, *Clethrionomys glareolus* and *Apodemus flavicollis*. Oikos 44: 149–156. – Jensen T. S. and Frost N. 1986. Rodents as seed dispersers in a heath-oak wood succesion. Oecologia (Berl.) 70: 214–221. – Mironov A. D. 1977. Vesennee zapasanie korma ryžej polevkoj (*Clethrionomys glareolus* Schreb.). Vest. Leningrad. Univ. 9: 19–29. – Petrov O. V. and Mironov A. D. 1972. Peredviženije ryžej polevki v predelach individual'nogo učastka. Ekologija 1: 101–103.

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