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DAILY ACTIVITY RHYTHM IN RODENTS UNDER NATURAL CONDITIONS

DOBOWA AKTYWNOŚĆ GRYZONI W WARUNKACH NATURALNYCH

Investigations on the daily activity rhythms in two species of rodents, *Apodemus flavicollis* (Melchior, 1834) and *Clethrionomys glareolus* (Schreber, 1780) under natural conditions were carried out from July to September 1959. Animals were trapped in two different environments, in the reserve in the strict sense of the word (Białowieża National Park — BNP, Div. 371) and in the cultivated part of the forest (Zwierzyniec Forest District, Div. 450), for 10—12 days in the middle of each month. The biotype of both these localities was the same (*Querceto carpinetum* Tüxen R., 1937), that is to say, the deciduous forest consisting mainly of hornbeams, oaks and spruces.

Two trapping plots were laid down in both of the localities: one with paths running lengthwise and crosswise, respectively 5 and 10 m apart, with 50 cylinder traps sunk in at the crossings of the paths and the other without paths with 100 double live-traps arranged according to the same pattern. In the latter plot, in each of the 50 points there were 2 double (two-sided) traps, one with a bait and the other without it. Cubes of bread fried in oil were used as a bait.

The trapping plots were inspected 12 times a day at even hours. The rodents caught were marked by the amputation of digits and the excision of a notch in the ear and they were set free in the proximity to the trapping plot. In addition, the hair on the head was cut off in bank voles, which made it possible to recognize a specimen marked before and to distinguish it from others, caught for the first time, at a glance. Each catch was recorded, the animal identified, and the date, hour, and place of catching taken down. Trapping and marking were done by students of zoology during their field training.

Totals of 297 specimens of *A. flavicollis* (BNP — 151, cultivated forest — 146) and 358 specimens of *C. glareolus* (BNP — 182, cultivated forest — 176) were trapped. These specimens were caught repeatedly and so in both localities together there were 507 catches of the yellow-necked field mouse and 1226 catches of the bank vole.

In addition, the catches of the following species were recorded: *Sorex araneus* — 84 catches, *Sorex minutus* — 15 (only in BNP), *Neomys fodiens* — 5, *Talpa europaea* — 1, *Erinaceus europaeus* — 1, *Microtus agrestis* — 8, *Pitymys subterraneus* — 6, *Microtus sp.* — 5, *Arvicola terrestris* — 1, *Dryomys nitedula* — 1, and *Mustela nivalis* — 1.

The numbers of specimens of *A. flavicollis* and *C. glareolus* caught at particular hours of day in each of the three months of observations in the BNP and in the cultivated forest are offered in Table 1. These values were converted into percentages, taking the total of catches as 100%, because the numbers of repeated catches varied. The 24-hour distribution of catches for the three months together is shown in Fig. 1. It points infallibly to the nocturnal nature of activity of *A. flavicollis*. In both the localities its activity begins after dark and reaches the maximum in the night hours; this however extends over the morning hours as

Table 1.
Number of catches of *Apodemus flavicollis* and *Clethrionomys glareolus*
in particular hours of day.

Months	N i g h t					D a y							n
	20	22	24	2	4	6	8	10	12	14	16	18	
<i>A. flavicollis</i> — Białowieża National Park													
VII	11	64	43	13		5		1		1			138
VIII	25	27	21	15								1	89
IX	13	45	26	16		18	15		1				134
n	49	136	90	44		23	15	1	1	1		1	361
<i>A. flavicollis</i> — cultivated forest													
VII	1	4	17	13	5	2			2		1		45
VIII	1	6	12	14	6	6	2	1					48
IX	5	20	7	6	6	5	3	1					53
n	7	30	36	33	17	13	5	2	2		1		146
<i>C. glareolus</i> — Białowieża National Park													
VII	18	18	19	19	13	18	23	26	17	7	13	12	203
VIII	2	13	21	33	21	4	5	3	2	3	5	6	118
IX	16	29	12	18	9	23	9	20	7	9	5	12	169
n	36	60	52	70	43	45	37	49	26	19	23	30	490
<i>C. glareolus</i> — cultivated forest													
VII	44	28	9	15	29	73	15	51	30	19	34	29	376
VIII	7	44	24	35	16	19	11	15	8	8	13	7	207
IX	17	26	21	19	15	18	20	8	2	1		6	153
n	68	98	54	69	60	110	46	74	40	28	47	42	736

well. It is true especially of the BNP, where the number of catches of the yellow-necked field mouse from 6 to 8 a.m. was remarkable (38 during the three months).

An analysis of the 24-hour activity rhythm in the three successive months shows that in *A. flavicollis* the monophasic rhythm is maintained over the whole period of investigations (Fig. 2 a), which is manifested best in July. In August the fall of activity is stopped at 6 a.m. and some activity of animals in the cultivated forest is observed also in the daytime. This tendency is still better visible in September in both of the localities, especially in the BNP, where even a rise in activity can be observed about 6 a.m. This would indicate a change of the decidedly monophasic rhythm of nocturnal activity (July) into a nearly two-phase one with some shifting of activity to the early hours of day as the autumn comes. In autumn (September) the number of individuals active from 8 to 10 p.m. shows

a tendency to increase (Table 1). The maximum of activity of the yellow-necked field mouse in the cultivated forest is generally lower and the duration of activity (including the diurnal activity) somewhat longer as compared with those from the BNP. This fact may reflect the difference in food and shelter conditions between the cultivated forest (no uprooted trees) and the BNP.

The activity of *C. glareolus* is maintained at a fairly high level all day and it is evidently polyphase (Fig. 1, 2 b). Two maxima of the nocturnal activity (at 10 p.m. and 2 a.m.), which do not coincide with the peak of activity of *A. flavicollis* and two distinct peaks of the diurnal activity are observed in both the localities. The latter peaks occur at 6 a.m. (after sunrise) and in the afternoon hours. Starting from 10 a.m. the activity of the bank vole declines and it begins to rise as late as 4 or even 6 p.m.

The activity patterns of *C. glareolus* in the successive months (Fig. 2 b). Two maxima of the nocturnal activity (at 10 p.m. and 2 a.m.), which do not coincide

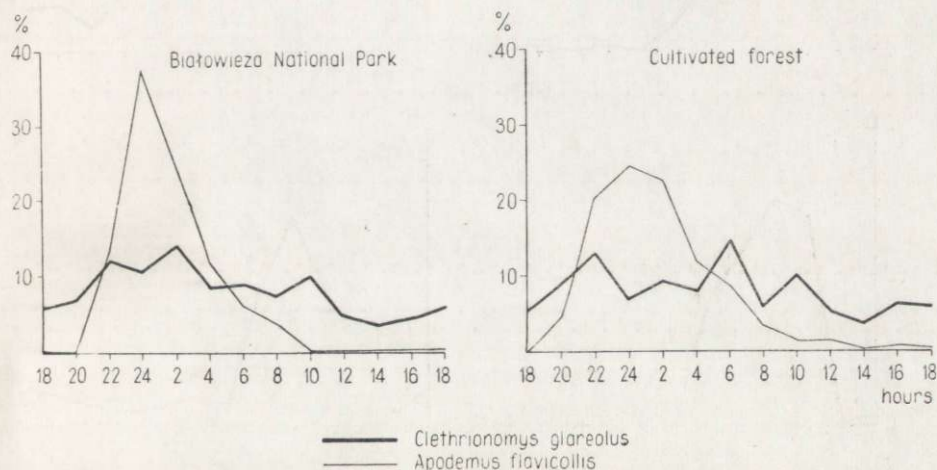


Fig. 1. The 24-hour activity of *Apodemus flavicollis* and *Clethrionomys glareolus* for the three months of investigations together.

with the peak of activity of *A. flavicollis* and two distinct peaks of the diurnal activity are observed in both the localities. The latter peaks occur at 6 a.m. (after sunrise) and in the afternoon hours. Starting from 10 a.m. the activity of the bank vole declines and it begins to rise as late as 4 or even 6 p.m.

The activity patterns of *C. glareolus* in the successive months (Fig. 2 b) show an apparent trend towards a decrease in diurnal activity in favour of the nocturnal activity, this being observable in both of the localities.

In July the nocturnal activity of the bank vole from the BNP is relatively the most levelled. The peak of activity occurs at 10 a.m., whereas its declines are observed at 4 a.m. (at dawn) and at 2 p.m. The activity of the voles from the cultivated forest is obviously polyphase. There are larger peaks of activity at 8 p.m., 6 and 10 a.m.

In August the activity of *C. glareolus* in the BNP is intense at night (maximum peak at 2 a.m.) and greatly reduced in the daytime. A similar activity pattern is shown by the voles from the cultivated forest, but it is more polyphase.

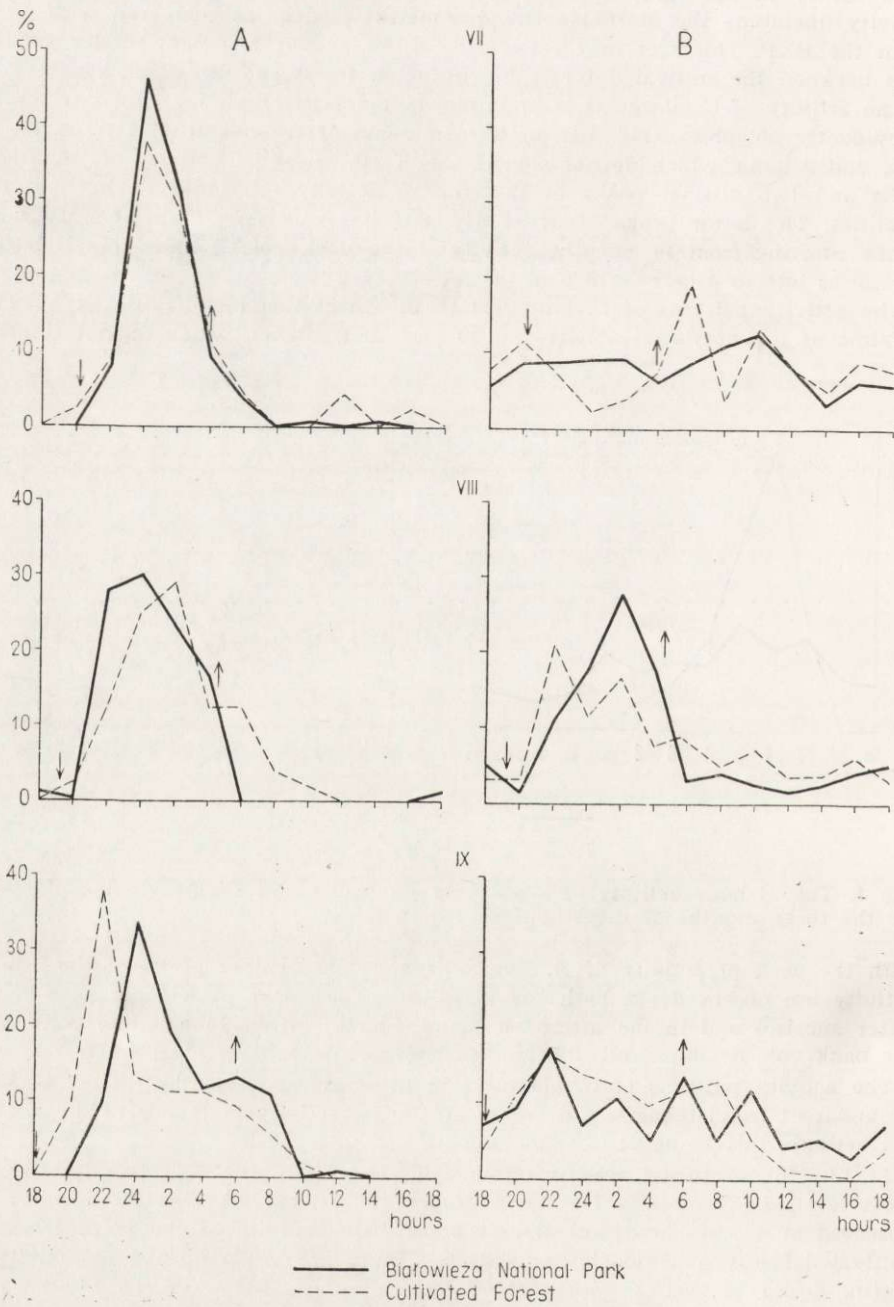


Fig. 2. The 24-hour activity of *Apodemus flavicollis* and *Clethrionomys glareolus* in particular months of investigations.

In September the activity of the bank vole is evidently polyphase again. Its intensity, both in the BNP (63.3%) and in the cultivated forest (75.8%), falls in the night and morning hours. A decrease in activity is observed in both the localities in the afternoon hours.

The results obtained show that the rhythm of 24-hour activity of *A. flavicollis* is monophasic and nocturnal, whereas that of *C. glareolus* is, as a rule, polyphasic and extending over day and night. These data corroborate the earlier observations made on these two species of rodents both under laboratory conditions and in the field by other authors (e.g., Kowalski, 1951; Miller, 1955; Saint Girons, 1959; 1960; 1961; 1962).

The rodents under study are regarded by many authors as antagonistic species. Their mutual influence on the rhythm of daily activity is, therefore, an interesting problem. The observations of the rhythms of daily activity of *A. flavicollis* and *C. glareolus* suggest the possibility of competitive relations between these species (Naumov, 1948; Kowalski, 1951; Brown, 1956, and others).

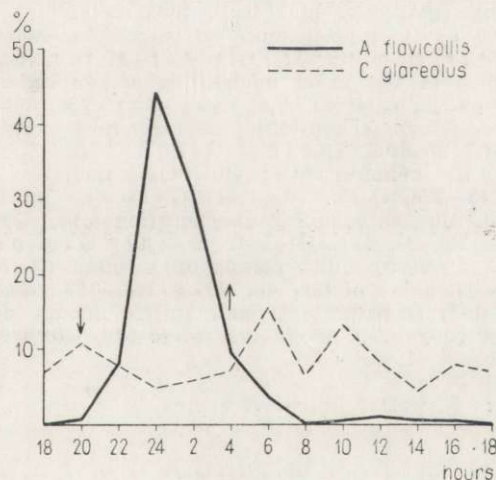


Fig. 3. The 24-hour activity of *Apodemus flavicollis* and *Clethrionomys glareolus* in July for both localities together. The arrows point to sunrise and sunset.

On the basis of their direct observations in the field Andrzejewski & Olszewski (1963) established that in the hours of activity of both the species *C. glareolus* avoids penetrating the region whenever *A. flavicollis* does it. Their meetings are generally aggressive — the offensive party is *A. flavicollis*. In the material collected this is reflected by a relatively small decline of activity in the bank vole in the peak hours of activity of the yellow-necked field mouse (Fig. 1). In July, for instance, when the monophasic and almost exclusively nocturnal activity of *A. flavicollis* is at its best, the maximum activity of *C. glareolus* occurs as late as the early morning or morning hours and its daily activity is greater than in the other months (Fig. 3).

Brown (1956) has found that *Apodemus sylvaticus* (Linnaeus, 1758) and *C. glareolus* living in the same environment show a well-marked day-and-night rhythm, *A. sylvaticus* being chiefly a nocturnal animal and *C. glareolus* a diurnal one. The partial overlapping of their activities occurs at dawn and at twilight.

With practically the same number of specimens of both species, in the trapping plot in the BNP *A. flavicollis* gave twice as many catches as in the cultivated forest. The relation was reversed as regards *C. glareolus*, whose penetration was intenser in the cultivated forest (736 catches against 490 in the BNP). Also this fact suggests that there are antagonistic relations between these two species of rodents and that with the intensified activity of the yellow-necked field mouse the activity of the bank vole becomes partly restrained (cf. Andrzejewski & Olszewski, 1963).

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