A C T A T H E R I O L O G I C A

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Utilization of Nest Boxes by Rodents

[With 1 Table & 1 Fig.]

Utilization of modified Howard nest boxes was estimated in three habitats (forests and shelterbelts). It was found that the boxes were intensively used, as was shown by the remains of food stores in building of nests, most often by *Apodemus flavicollis* and *Clethrionomys glareolus*. These rodents built the largest number of nests during the period of intensive reproduction (April-May), the material for the nests being carried to the boxes from distances up to 30 m (*C. glareolus*). The features distinguishing the nests built by the two species are described. After the young individuals became independent they remained near the place in which they were born. Young voles were trapped at distances averaging 35 m within a period of thirty days from the time they were marked in the nest. A total of 10 species of small mammals of the orders *Insectivora, Rodentia* and *Carnivora* were found to use the boxes during the study period, and eight of these species used them for rearing their young.

1. INTRODUCTION

The large amount of literature on numbers, distribution and structure of the burrows of forest rodents (*e.g.* Sviridenko, 1951; Snigirevskaya, 1952; Popov, 1960) shows that both the place chosen for building the nest and its actual construction vary greatly. The fact that rodents also build nests in different types of boxes imitating holes in trees, distributed in forests for the protection of insectivorous birds and bats, has been known for a long time. Data on the occupation of such holes or boxes are most numerous for *Apodemus flavicollis* (Melchior, 1834) — Likhachev (1955, 1962), Krzanowski (1961) there being fewer cases of such occupation by other species: *Apodemus silvaticus* (Linnaeus, 1758) — Creutz (1953), *Clethrionomys glareolus* (Schreber, 1780) — Likhachev (1955) or *Dryomys nitedula* (Pallas, 1779) and *Muscardinus avellanarius* (Linnaeus, 1758) —

Likhachev (1955), Pielowski & Wasilewski (1960), Krzanowski (1961). Nicholson (1941) was the first to use special nest boxes in his studies on the biology of rodents, and this method was continued by Howard (1949) who, using nesting boxes of his own construction, traced the fate of several generations of *Peromyscus maniculatus bairdii* (Hoy & Kennicot, 1857), while Jackson (1953) and Drummond (1957) examined the biology and ectoparasities of one of the subspecies, *Peromyscus leucopus* (Rafinesque, 1818).

The purpose of this study is to estimate the use made of modified nest boxes of the Howard type by rodents. The material was collected in three different habitats during the period from 1966—1972.

2. METHODS AND STUDY AREA

The nest boxes were sunk into the ground up to the level of the roof, which could be lifted up, while a corridor connected the nesting chamber inside the box with the surface of the ground. Traps situated between the corridor and nesting chamber made it possible to capture the animals visting the box. All the elements from the interior of the box could be easily removed, making detailed inspection of its contents possible. The plan and dimensions of the box are to be found in the study by Ryszkowski & Truszkowski (1970). The boxes were always arranged in a grid of 30×30 m over the areas and were inspected once every two weeks, which ensured that each litter was inspected once or twice during the time the young rodents remained in the nest which, according to Sviridenko (1947, 1951, 1959) is on an average approximately 18 days. The individuals found (even the very young ones) were marked by toe-clipping (Naumov, 1951) using »Wecker« type ophtalmological scissors with a very small blade.

In order to estimate the numbers of rodents in the areas on which the nest boxes were situated captures by the *CMR* method were made in spring, summer and autumn, and the results elaborated by the calendar of captures method (Petrusewicz & Andrzejewski, 1962).

The first test were made from 1966—1967 in a 2.2 ha forest area in the Kampinos National Park, not far from the Field Station of the Institute of Ecology, Polish Academy of Sciences at Dziekanów Leśny near Warsaw (hereinafter termed simply Dziekanów). The area was covered by plant associations of the following type: *Pino-Quercetum, Vaccinio myrtilli-Pinetum* and *Carici elongate-Alnetum* (Traczyk & Traczyk, 1965) The most numerous species of rodents were: *Clethrionomys glareolus, Apodemus flavicollis* and *Apodemus agrarius* (Pallas, 1771).

In 1968 nest boxes were placed on a 4 ha island in Lake Bełdany (Olsztyn voivodship) where there was a numerous introduced population of this species (hereinafter termed Island), in order to make a direct esitmate under field conditions of average litter size and viability of young individuals of *C. glareolus*. The studies made by Traczyk (1965) showed that there were the following phytosociological associations on the island: *Tilio-Carpinetum stachyetosum silvaticae, Circeo-Alnetum* and *Salici-Franguletum.*

During the period from 1970 to 1972 the nest boxes were placed in shelterbelts on the research areas of the Department of Cultivated Field Ecology, Institute

of Ecology, Polish Academy of Sciences at Turew (Poznań voivodship) (hereinafter termed Turew). The shelterbelts consisted chiefly of *Robinia pseudacacia* L. and *Betula verrucosa* Ehrh., with a small admixture of *Quercus* sp. *Larix decidua* Mill. and *Picea exelsa* (Lam.). The undergrowth was scanty, with *Sambucus nigra* L. and *Rubus* sp. occurring in places. In addition to these species typical of forests, rodents connected with open areas were also found in the shelterbelts.

3. RESULTS

3.1. Utilization of Nest Boxes

The percentage of boxes visited by rodents (the grain laid out in them was eaten) in a unit of time can be taken as an index of intesivity of utilization of the boxes. The tests made (Dziekanów, Turew) showed that within 24 hours after putting out grain 75% of the boxes had been visited by rodents, after 48 hours almost 95% and after 72 hours practically speaking all the boxes. These data point to constant intesive penetration by rodents of the area in which they have settled.

3.2. Stores and Remains of Food in the Boxes

Material obtained at Dziekanów (Ryszkowski & Truszkowski, 1970) was used for analysis of the kind of food brought to the boxes and variations in the percentage of nest boxes containing food of the rodents during the year.

The list of food brought into and consumed in the boxes, and remains left by rodents, is fairly varied. It includes:

(a) seeds and fruits of *Quercus* sp., *Corylus avellana* L., *Pinus silvestris* L., fruits of *Sorbus aucuparia* L.,

(b) fragments of fresh green plants (various species) *e.g.*, in spring *Oxalis acetosella* L. was particularly frequently found,

(c) remains of insects eaten (various stages of development),

(d) shells of *Corneus* sp.

The percentage of boxes containing remains and stores of food markedly increased in August and September, which coincides with the ripening period of the acorns and nuts most often encountered at that time in the boxes. Small stores of acorns (up to 30 acorns) were several times observed (Dziekanów, Turew).

3.3. Comparison of Rodents Caught in Live Traps and in Nest Boxes

Trapping carried out during the period from May to September 1967 (Dziekanów) produced a total of 732 captures of rodents (*A. flavicollis* and *C. glareolus*). Comparison was made of average body weights and average interval between captures for individuals of these species in both

types of traps (Table 1). It was found that neither voles nor forest mice caught in nest boxes differ in respect of the parameters examined from individuals of the same species caught in live-traps (differences are not statistically significant).

3.4. Number of Nests Built

The greatest percentage of new nests in relation to the number of boxes was usually found in spring, during the time when the rodents begin intensive reproduction (April-May). During the summer, when reproduction decreases, the number of new nests built also decreases. This decrease ceases in early autumn, when the population numbers are greatest and some of the young rodents build nests in boxes. There are only a few nests in active use in winter (Fig. 1) and thus the number of newly-built nests does not depend in each season of the year on the current numbers of rodents in the study areas.

Table 1

Comparison of individuals of *Apodemus flavicollis* and *Clethrionomys glareolus* caught in 2 kinds of traps.
1 — Average body weight of individual (in g); 2 — Average interval between captures (in days).

	Apodemus flavicollis		*Clethrionomys glareolus*	
	1	2	1	2
Live trap	23.1	14.4	18.4	13.2
Nest box	25.1	14.6	21.9	18.9

Although estimated numbers of rodents may not be exact, due to the areas being too small (Chełkowska & Ryszkowski, 1966), it may be considered that the most numerous species in the study area at Dziekanów was *C. glareolus*, the numbers of which were sometimes, *e.g.* in the spring of 1967, five times greater than those of *A. flavicollis*. The latter species, however, builds the largest number of nests, and far more readily occupies the nest boxes than the voles. The ratios of numbers of nests of *C. glareolus* to those of *A. flavicollis* are significant: in autumn 1966 — 1:3.5; in spring 1967 — 1:3: in summer 1967 — 1:2.5. *A. agrarius*, which also occurs in this area, built no nests in the boxes. Similar figures were obtained in shelterbelts (Turew).

The percentage of boxes in a given area in which rodents built at least one nest during the reproduction season (April-August) can serve as one of the indexes of utilization of nest boxes by rodents. For the area at Dziekanów in 1967 this was 77%, for the Island in 1968 — 86%,

average for shelterbelts at Turew in 1970 — 24%, 1971 — 53%, 1972 — 58%. In the great majority of cases it proved impossible to ascertain why certain of the boxes were not occupied, while others were utilized several times (*e.g.* seven times during the season). The increasing percentage of utilizations of boxes at Turew from 1970—1972, when no great differences were observed in the numbers of forest rodents (Ryszkowski, Goszczyński & Truszkowski, 1973), suggests that like bats and certain species of insectivorous birds (Sokołowski, 1954; Krzanowski, 1961) rodents also may perhaps more readily occupy older boxes which have become more »assimilated into the area«.

3.5. Time of Building and Occupying Nests

The interval between some inspections of nests was 6—7 days. It was observed that during this time rodents of both species are capable of building a complete nest, and therefore the time required to build a nest,

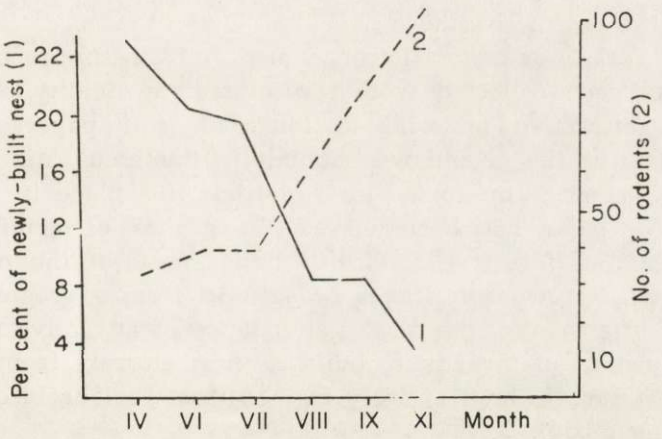

Fig. 1. Participation of newly-built nests (1) and numbers of rodents found (2) on the study area at Dziekanów (1967).

although difficult to establish, is probably a few days. A month after the time of building about 60% of the nests were occupied, and in the majority of cases served only for rearing the young. The number of nests occupied for 3 or more months (nests of males and young individuals) did not exceed 20% of the total.

3.6. Distinguishing Features and Structure of Nests of Rodents

During the study period almost 300 completed nests of rodents were found in the nest boxes, and the decided majority (about 90%) were those of *A. flavicollis* and *C. glareolus*. The large amount of material

made it possible to distinguish the features characteristic of the construction of nests built by these species.

A. flavicollis usually uses oak leaves as material for nest building, less often hornbeam, birch, alder or buckthorn. The nest usually completely fills the nest chamber of the box. The leaves are arranged in layers (which provides isolation of the interior from humidity) around a central bed about 6—8 cm in diameter.

C. glareolus builds very cunningly-made nests from moss, grasses and leaves cut small and various plant fibres. The proportions of the materials used to build the nest vary. In forests the nests are often built almost entirely of moss, while on the Island nests with a large admixture of lime fibres were most often observed. The large oak leaves so characteristic of *A. flavicollis* were not found in in voles' nests. The animal lines the hollow part of the nest with delicate material such as feathers, hairs or very soft moss. Such materials as cotton-wool, soft paper or plastic foil are often found here. The nest, which is shaped like a ball, does not usually fill the entire chamber.

The great variety of material from which voles' nests are built is due to its having been collected from the immediate vicinity of the box. Particularly attractive material (cotton-wool, soft paper) placed in different parts of the island was found in numerous nests of voles situated at distances up to 30 metres from the place in which the cotton-wool or paper had been placed. In groups of coniferous tree growing deciduous forest *A. flavicollis* builds nests of the needles and lines them with a few oak leaves brought in from a greater distance. *C. glareolus* often makes use of the abundance of attractive material in the neighbourhood of the box to build its nest entirely from it, and in this way nests are formed entirely from cotton-wool or birds' feathers (dead birds near box).

Differences were observed in the construction of nests build by the same species. The nests of females of *A. flavicollis* built for rearing their young are large, have thick walls (average weight of dry nest 47.3 g, n=21) and are carefully constructed. The male carelessly arranges a smaller number of loosely placed leaves, often building a bed only covered from the top (average weight of dry nest 26.8 g, n=13).

When the old nest does not completely fill the nesting chamber (after the animal leaves it rapidly sinks due to damp) the rodents built a new nest on top of it, using the old nest as a base. In such cases *A. flavicollis* often carries only a small number of leaves into the old nest left by the vole (10—15% of the weight of the old nest). Young individuals of both species build simplified small nests. In chambers of 2000 cm^3 capacity rodents build nests only about 20% heavier than in chambers with

1000 cm³ capacity (data from 58 nests), showing that there is a certain optimum for both capacity and weight of the nest.

There are usually two passages leading from the interior of the nest — into the corridor of the box and into the interior of the nesting chamber. The use made of the various parts of the nesting chamber were found to vary, *e.g.* the rodent passed urine and excrement in one of the corners, and accumulated stores in another.

About 5% of the nests were not typical in construction, that is, it was difficult to determine which of the species had built it without making direct observations of the animal living there. Some of the nests (about 15%) remained unfinished for various reasons.

3.7. Number of Animals Inhabiting a Box

The box is usually inhabited by one adult rodent, or by a female with its young until the latter become independent. Two nests with young voles were found simultaneously in one box (in 2 cases out of a total of over 100 inspections of litters). The presence of only one female and the considerable differences in the age of the young animals justified the assumption that these were successive litters of the same female of *C. glareolus*. Young, and already independent voles (2—4 individuals from different litters) often inhabit a box (13 observations out of approx. 270 inspections). Two cases were observed of 3 and 4 adults of different sex of *A. flavicollis* being simultaneously present in a box (out of approx. 180 inspections of boxes in which this species was present).

3.8. Dispersion of Young Individuals

It was found that young rodents remain near the place in which they were born for the first period of independent life (15—30 days). Analysis was made of 39 cases of first captures of young voles on the Island, calculating the distance between the place of capture and of birth. They were caught about 30 days after they had been marked in the nest. The average distance of place of capture from the nest was 35 m (7—103 m) [1]: Young individuals of *A. flavicollis* also remain and during the first 15 days of independent life are caught near (20—30 m) the nest box in which they were born (3 observations — Dziekanów, Turew).

3.9. Other Species of Animals Inhabiting Nest Boxes

In addition to the forest rodents — *C. glareolus* and *A. flavicollis* — discussed in detail here, the following species of mammals were also found to occur in nest boxes.

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[1] The author is indebeted to Dr. R. Andrzejewski for placing the calendar of captures at his disposal.

Apodemus silvaticus (L i n n a e u s, 1766) were found 15 times in shelterbelts (Turew). Both the character of their stay there and the type of construction of the nest were similar to those of *A. flavicollis*.

Apodemus agrarius (P a l l a s, 1771) — 9 nests (3 litters) were found in shelterbelts (Turew). In addition to the leaves characteristic of other species of the genus *Apodemus*, material used to biuld the nests also included a large amount of grass. This species, which occurs fairly numerously at Dziekanów, did not build a single nest in boxes during the study period.

Microtus agrestis (L i n n a e u s, 1761) — 7 nests on the Island (number of young in a litter — 7, 5, 2, 3, 3). The nest was built of grass blades bitten in strips, with a large amount of fibres, leaves and feathers.

Microtus arvalis (P a l l a s, 1779) — 11 nests were found and animals observed to inhabit boxes on the edges of shelterbelts (Turew). Also some of the 6 boxes situated in 1971—72 in a lucerne field (in which the numbers of voles varied from 15—200 individuals/ha) were occupied by the animals and used for reproduction (6 litters). The animals used strips of leaves, grasses and bits of lucerne stems to build their nests.

Arvicola terrestris (L i n n a e u s, 1758) — an individual was found living in a box in the shelterbelt adjoining a wet meadow (Turew).

Sorex araneus (L i n n a e u s, 1758) — 3 nests with young were found (numbers in litters: 5, 7, 9 individuals) which had been built from a large amount of leaves cut small and arranged loosely (Dziekanów).

Neomys fodiens (P e n n a n t, 1771) — 7 nests were found, and in three of these cases young were observed to be born there (5, 7, 9 individuals in liters). The structure of the nest varied greatly, moss and large leaves being most often used. The nest is large and loosely arranged. A nest was found which the female had built chiefly of thin, scaling pine bark which it had carried for a distance of over 30 metres. The strong smell coming from the nest due to the large amount of excrement present in boxes containing young, is characteristic of this species. Young rodents (1—2 days old) were encountered among the remains of food left by *Neomys* in boxes (Island, Turew).

Mustella nivalis (L i n n a e u s, 1766) — although no young were found, adult individuals often lived in the boxes, where their excrement acumulated (Turew). Also remains of rodents (chiefly *M. arvalis*) were found in the boxes they visited.

In all 7 species of the order *Rodentia*, 2 species of *Insectivora* and one of *Carnivora* were found to inhabit the boxes.

In addition to mammals wasps, honeybees, hornets and ants (*Hymenoptera*) were found in the boxes, often blocking a considerable percentage

of the boxes, *e.g.* in the summer of 1970 ants occupied 21 and 30% of the boxes in two shelterbelts. Very numerous groups of *Dermaptera* were found in the boxes in summer and autumn.

4. DISCUSSION

On the basis of the material already collected and the observations made it is possible to make initial evaluation of the construction of the nest boxes used and their suitability for studies on reproduction of small rodents.

It would seem that the construction of the boxes made it impossible for the majority of predators (apart from weasels) to enter the rodents' nests. No destroyed nests were found in the habitats visited by numerous predators (Dziekanów, Turew) — *Vulpes vulpes* (Linnaeus, 1758), *Meles meles* (Linnaeus, 1758), *Martes martes* (Linnaeus, 1758), *Sus scrofa* (Linnaeus, 1758) and even when the boxes had been partly dug up and destroyed the predator usually failed to reach the nesting box. *Microtus arvalis,* of which maximum numbers for the district occurred in a lucerne field and were thus exposed to increased penetration by boxes and other predators, successfully reared young in boxes.

The boxes at present in use during the colder parts of the year do not sufficiently protect the animals from cold. This is probably one of the causes of the sporadic inhabitation of boxes in winter (Fig. 1). There is, however, little information available on the subject of the microclimate of artificial shelters for animals (Olszewski, 1966; 1970).

The most important role of nest boxes is the provision of convenient places for animals to give birth and rear their young. In my opinion a box is usually one of a larger number of shelters used simultaneously by adult individuals (apart from females rearing young). Observations of marked individuals in 2—3 neighbouring boxes, their frequent periodical absence from the box they live in and absence of large stores of food, confirm this conclusion.

The model of box used (and possibly artifical shelter in general) is not uniformly attractive to all species of rodent. In the same habitat in which several boxes were occupied by *A. flavicollis* and *C. glareolus, A. agrarius,* which occurred there numerously, was only sporadically found in the boxes. *Mus musculus* Linnaeus, 1758, found regularly during trapping in fields and in shelterbelts (Turew), did not occupy a single box. The utilization of boxes by a species building an extensive network of burrows in cultivated fields — *M. arvalis* — is astonishing. This may have been due to the greater protection from predators afforded to the nest by the box.

As it is usually impossible to find a large number of rodents' nests

under field conditions, the nest boxes, permitting of observations of different kinds being made of the numerous rodent litters in the place of their birth, become a useful instrument in studies on reproduction. They have been used for field estimates of average litter size and the viability of cohorts and litters of the vole (Ryszkowski & Truszkowski, 1970). The data contained in the present study also point to the great possibility of using boxes for studies on the biology and ecology of small mammals. Only fragmentary information has hitherto been obtained on the reproduction of a large number of these species.

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WYKORZYSTANIE SKRZYNEK GNIAZDOWYCH PRZEZ GRYZONIE

Streszczenie

Prowadzone prace miały ocenić przydatność skrzynek gniazdowych do badań biologii i ekologii małych gryzoni. Skrzynki rozmieszczono w lesie w Kampinowskim Parku Narodowym, lesie na wyspie jeziora Bełdany oraz w zadrzewieniach śródpolnych koło Turwi (woj. poznańskie). Stosowano zmodyfikowany model skrzynki gniazdowej użytej przez Howarda (1949).

Stwierdzono dużą intensywność penetracji skrzynek przez gryzonie, gdyż w ciągu 48 godzin odwiedzały one blisko 95% skrzynek. Do skrzynek przynosiły one różnorodny zestaw resztek pokarmu pochodzenia roślinnego i zwierzęcego. W sierpniu i wrześniu procent skrzynek z resztkami i zapasami wyraźnie się zwiększył.

Prowadzone równolegle na powierzchni połowy gryzoni w skrzynkach oraz pułapkami żywołownymi wykazały, że zarówno myszy leśne jak i nornice zamieszkujące skrzynki gniazdowe pod względem analizowanych parametrów nie różnią się od reprezentacji populacji uzyskanej za pomocą pułapek (Tabela 1).

Największą ilość gniazd budowały gryzonie w skrzynkach w okresie szczytowego rozrodu (kwiecień—maj), potem ilość budowanych nowych gniazd malała (Ryc. 1), mimo ogólnego wzrostu liczebności gryzoni na powierzchni. Z badanych gatunków

najliczniej zajmował sztuczne gniazda *Apodemus flavicollis*. W ciągu sezonu rozrodczego gryzonie użytkowały na powierzchni do 90% skrzynek, niektóre z nich wielokrotnie. Nie udało się ustalić przyczyn niezajmowania pewnych skrzynek.

Czas budowy gniazda przez gryzonie wynosił kilka dni. Zbudowane gniazdo służyło zwierzęciu około 30—40 dni, zwykle do wychowu młodych.

Wyróżniono cechy rozpoznawcze oraz strukturę gniazd najliczniej zamieszkujących skrzynki gatunków gryzoni. Stwierdzono, że materiał do budowy gniazda przynoszony jest z jego najbliższego otoczenia (u *C. glareolus* z odległości do 30 m).

Przez pierwszy okres po osiągnięciu samodzielności młode gryzonie przebywają w pobliżu gniazda. W 30 dni po oznakowaniu w gnieździe łowiono młode nornice średnio w odległości 35 m od miejsca urodzenia.

Ogółem stwierdzono przebywanie w skrzynkach 10 gatunków małych ssaków. Ośmiu gatunkom służyły one za miejsce urodzenia i wychowu młodych.