Rodent movements in wheat fields

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Summary. — Nocturnal movements of the lesser bandicoot rat *(Bandicota bengalensis),* the greater bandicoot rat *(B. indica),* and the roof rat *(Rattus rattus)* were monitored in Bangladesh using radio tracking techniques. Results indicated the lesser bandicoot rat is the most important pest in wheat fields. The roof rat is restricted primarily to villages, while the greater bandicoot rat moves between villages and fields. The home range of the lesser bandicoot rat averaged only 18 square meters in mature wheat one week before harvest. Findings indicated that in field application of rodenticides the effectiveness of control will be increased if baits are placed within 2 m of or directly into the rodent burrow systems.

Résumé. — L'étude présentée ici porte sur l'observation de la mobilité de *Bandicota bengalensis* observée par radio-tracking dans des champs de blé au Bangladesh.

L'enregistrement des déplacements nocturnes donne des indications concernant la taille des domaines vitaux instantanés, le degré d'activité en fonction de la lunaison, l'impact de la prédation, ainsi que sur la stabilité dans le temps des domaines vitaux.

Il apparaît que ceux-ci ont une faible surface (12-40 m²) qui varie en fonction des disponibilités alimentaires et des densités. Les modifications de l'environnement, telles que la moisson ou l'inondation, provoquent des déplacements à longue distance du domaine vital instantané : des déplacements de 175 à 250 m ont été observés, avec le franchissement de cours d'eau de 15 m de largeur. Des conclusions sont tirées quant aux modalités d'une lutte efficace dans les champs de blé.

INTRODUCTION

An important component in developing a safe and effective means of rodent control involves the study of various aspects of the species ecology. The « home range » (Burt 1943), or area an animal moves during the daily routine of obtaining

food, water, and cover, is an important consideration. Knowledge of when and where rodents move most frequently can assist in organizing control campaigns that may reduce costs and result in more effective and safe reduction in pest numbers.

In Bangladesh, the most important rodent pest in wheat fields is the lesser bandicoot rat *(Bandicota bengalensis)* (Poché *et al.* 1982). The species damages wheat by cutting stems or panicles and storing large amounts of grain in underground chambers. The storage areas are found within the long burrows, which may extend from 5 to 50 m in length.

In 1979, approximately 12 % of the wheat crop was destroyed by rats before harvest (Poché *et al.* 1982). Investigations revealed that damage was most severe within 6 m of the burrow system and that 95 % of the damage was evident within 10 m.

After rat damage in wheat was identified and quantified in 1979, the Vertebrate Pest Division organized a field control trial for 1980 using 3 rodenticides and a fumigant to evaluate the effectiveness. At the same time, a separate research endeavor was undertaken to monitor rodent movements within and near fields. The purpose of this study was to discern, through the use of radio tracking: (1) the home range of important rodent pests in mature wheat fields and (2) monitor movements or dispersal from fields following the depletion of stored grain in underground burrows, and (3) rodent emigration from fields induced by heavy rainfall.

METHODS

The study was conducted between 27 February and 19 May 1980 near the village of Agrakhola, approximately 10 km WSW of Dacca, Bangladesh. Rats were trapped with Victor[(1)] live traps, using dried fish as bait. Traps were set in two wheat fields and placement was near entrances to lesser bandicoot or greater bandicoot burrow systems.

Captured rats were instrumented with 5 g 164 MHZ transmitters, developed and provided by the Denver Wildlife Research Center. The transmitters were equipped with plastic fasteners to secure the device around the animal's neck. Each trapped animal was identified as to species, sex, weight in grams, and reproductive condition. Animals were released at the original trapping point at dusk on the day following capture.

A portable tracking system was designed for field use. Directional Adcock (H) antennas were used to detect locations of individual animals. A $5 \times 5 \times 10$ cm wood block was attached to each antenna. The upper end of the block was concave and fit securely onto the antenna. A 1.5 cm diameter hole, 4 cm deep, was drilled into the lower portion of the block and a 6 cm long plastic conduit was fitted and glued into the hole. A 1.2 cm dia aluminum conduit, 1 m long, fit into the plastic conduit and was secured with a 5 cm hose clamp. The lower portion of the aluminium conduit was mounted into a 1.5 cm dia hole drilled 4 cm deep into the center of a $30 \times 30 \times 5$ cm wood block. The block was taped securely to a portable table.

(1) Use of the trade name does not imply endorsement by the governments of Bangladesh or the U.S.

A 360° plastic protractor was glued to the upper surface of the block and a 16 penny nail, secured by a hose clamp served as the pointer.

The null method (Cochran and Lord 1963) was used to determine the direction of the signal source. The antenna was rotated in the direction of the animal in question. Two tracking stations, recording data simultaneously, enable triangulation of the coordinates to determine the location of animals in the field.

The table with attached tracking system was oriented so the 0° indicator on the protractor pointed to magnetic north. A beacon (extra transmitter) was positioned on a pole approximately 30 m from the tracking stations and was used to calibrate or adjust the pointer. A compass was used to adjust the needle in accordance with the compass coordinate obtained. Field trials using fixed transmitters determined the accuracy of a plotted animal to within 1 m of the actual position of the transmitter.

As the wheat crop matured, animals were radio-tracked twice weekly from dusk until sunrise and locations taken at 15-minute intervals. After the wheat harvest the location of instrumented animals continued on a weekly basis to determine dispersal times and transmitter functional longevity. A Yagi antenna was used to locate rats within the burrows.

RESULTS AND DISCUSSION

Twelve rodents were trapped and equipped with transmitters and the movements studied : 10 *B. bengalensis,* 1 *B. indica,* and 1 *Rattus rattus.* Table 1 gives the details on each animal tracked. Of the 10 lesser bandicoot rats captured 8 were female. Both males were juveniles, and 6 of the females were subadults (based on unpublished growth data). This would suggest juveniles and subadults

TABLE 1. — Information on radio-tracked rodents in wheat fields near Agrakhola, Bangladesh. * In house.

Species	Animal Number	Sex	Weight (g)	Channel	Field
B. indica	1-1	M	198	4	1
B. bengalensis	1-2	F	162	8	1
B. bengalensis	1-3	F	176	11	1
B. bengalensis	1-4	F	150	9	1
B. bengalensis	1-5	M	154	12	1
B. bengalensis	3-1	F	184	11	3
B. bengalensis	3-2	F	136	10	3
B. bangalensis	3-3	F	138	3	3
B. bengalensis	3-4	F	178	1	3
B. bengalensis	3-5	M	122	7	3
B. bengalensis	3-6	F	198	6	3
Rattus rattus	H*	M	154	2	H

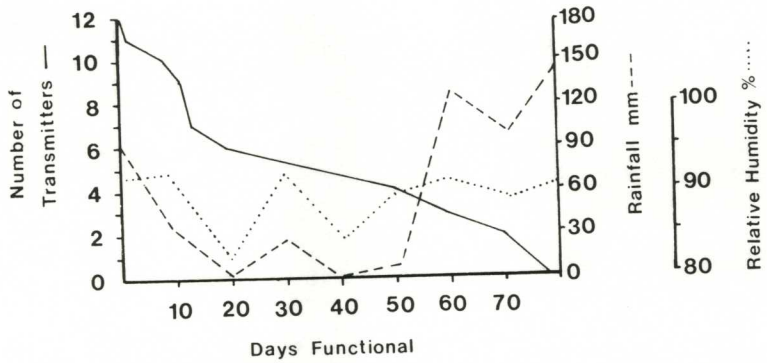

Fig. 1. — The functional life of 5-g transmitters used on rats in Bangladesh.

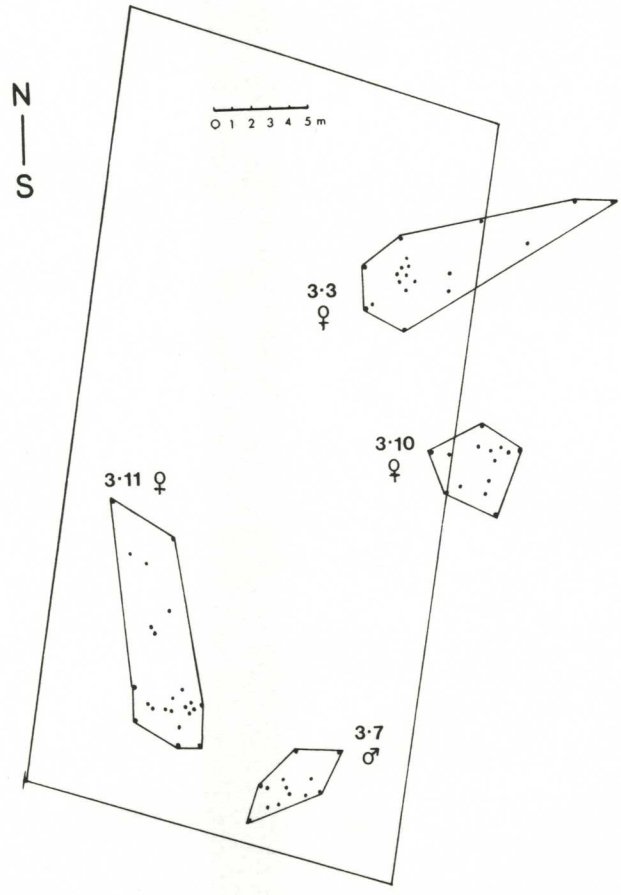

Fig. 2. — The area covered by four lesser bandicoot rats within a wheat field over a one-night period.

disperse from islands after floods subside, while older more « dominant » rats (a function of size) remained on the island-villages (unpublished trapping data).

Transmitter life.

Figure 1 provides details on the functional life of the 5-g, 164 MHz transmitters. The mean life for the 12 devices was 36.4 days, with a range from 1 to 79 days of transmitting ability. The percentage of operational transmitters in days after attachment was : 10 days (83 %), 20 days (50 %), 30 days (50 %), 40 days (50 %), 50 days (33 %), 60 days (25 %), 70 days (17 %), and 80 days (0). Figure 2 depicting rainfall patterns during the study, illustrates the capabilities of the devices remaining operative under high humidity and much precipitation. Throughout the 80-day study period the mean relative humidity at 0600 hours was 90.5 % ranged from 61 to 100 %. A total of 455 mm of rainfall was recorded during the study period.

Activity.

Surface activity of the lesser and greater bandicoot rats varied with the amount of moonlight. On 8 March, for example, the moon did not rise until approximately 2330 hours. Surface activity for 5 instrumented rats in Field No. 3 was restricted to the period from 1 hour after dark to about 20 minutes after the moon rose above the horizon. On 21 April the moon set at 2240 hours after which rat activity on the ground surface increased. During this stage of the wheat crop, the rats are busy cacheing panicles. Rodent movements were recorded until 30 minutes before daybreak.

Moonlight tended to restrict surface activity in the bandicoot rats probably because of the numerous nocturnal predators visiting the fields regularly. On two nights when conducting radio-tracking during a full moon, a lynx *(Felis lynx)* was observed to enter Field No. 3. On 21 March at 2140 hours, the lynx apparently preyed upon a rat, from the sound of the scuffle in the wheat field. Fifteen minutes later animal No. 3-10 was no longer detected. Other predators were observed near the study area : the small Indian civet *(Viverricula indica),* jungle cat *(Felis chaus),* and jackal *(Canis aureus),* all of which are known to prey upon small mammals. Jackals are prevalent and most often observed, but based on the results from a separate study examining jackal food habits, the canid is primarily a scavenger and probably seldom preys on field rodents (unpublished data).

Home range.

The home range of the lesser bandicoot rat in mature wheat fields observed in this study was quite small. Figure 2 pictures the radio-recaptures of 4 lesser bandicoot rats recorded on 8 March. There was no observed home range overlap throughout the study. Judging from the small size of the field (860 m^2), the home range of the rodent was correspondingly small. The average home range size for female lesser bandicoot rats was 20.1 (range 12-40) m^2, as compared to one instrumented male which had an average home range of 15 m^2 (10-20). These data correspond to observations by Poché *et al.* (1982) which showed most activity based on wheat stem cutting, was restricted to within 6 to 8 m of the burrow system center. In mature wheat, the species remains close to

the burrow system and spends most of the time cutting and caching wheat panicles. Radio-tracking data from this study, show that rarely does the lesser bandicoot rat move more than 10 m away from its burrow in wheat fields.

A juvenile male greater bandicoot rat *(B. indica)* was trapped in Field No. 1 and was instrumented and released. Two days later, the rodent was located in an elevated dirt road approximately 30 m from the capture site. One week later, the animal dispersed from the area and moved (Fig. 3) approximately 250 m

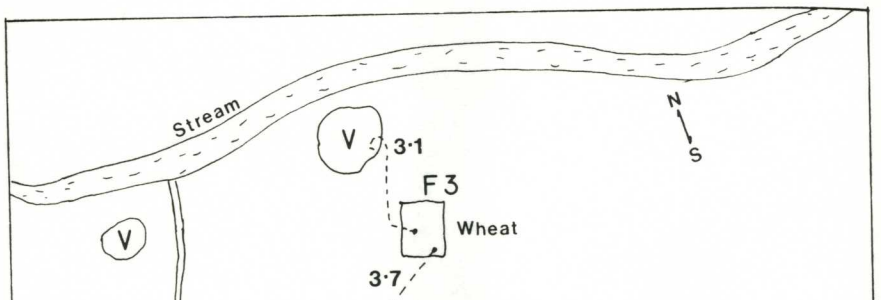

Fig. 3. — Study area showing the movements of individual rats equipped with transmitters.

into an island village. The species excavates shallow burrows and is considered mainly a commensal in India (Arjunwadkar and Gadgil 1974). Our preliminary studies have shown *B. indica* is a poor excavator and requires relatively loose, moist soil to facilitate digging.

Animal No. 3-1, a female *B. bengalensis,* was captured in Field No. 3. The day following capture, and for 4 subsequent weeks, the rodent was located under a village dwelling, approximately 130 m from the original capture point. Throughout this study, the individual was never radio-tracked in the wheat field and its activity remained in close proximity to the village. As with the greater bandicoot rat, Animal 3-1 had its burrow near human habitation in the village and made periodic foraging bouts into neighboring fields.

A male lesser bandicoot rat in Field No. 3 (Animal 3-7) moved approximately 75 m southwest of its burrow and excavated a new burrow system along the edge of a well drained, deep ditch after heavy rains during the week of 20 April. One week later the same animal moved location again (approximately 20 m) and dug another burrow system in the more elevated dirt road.

In Field No. 1, a female lesser bandicoot rat (Animal 1-8) was captured and released near the field center. One week after harvest the signal was no longer detected and it was assumed the transmitter was no longer operational. A week following, however, the animal was located approximately 175 m southwest of the field occupying a new shallow burrow system in the dike of a rice field. To reach the field, the rat swam a 15 m wide stream. Such swimming ability was observed in 1979 and is quite common in the lesser bandicoot rat. In September 1979, rats were trapped on deepwater rice stems in fields flooded with water 2 m deep. The rats could have only reached the area by swimming distances of 5 to 20 m.

One male *Rattus rattus* was equipped with a transmitter and was not located away from the dwelling where initially captured. Unlike in the Philippines where *Rattus* spp. are common field pests (Barbehenn, Sumangil and Libay 1973), roof rats have rarely been captured or reported from fields in Bangladesh. This we speculate is attributed to the aggressive nature of *Bandicota* spp. The lesser bandicoot rat has replaced the Norway rat *(R. norvegicus)* in dominance in larger ports of south Asia (Seal 1960 ; Roberts 1978). In a separate study in which snap traps were set two night each week in wheat fields, 98 % of the captured rats were *B. bengalensis.* The remainder were *B. indica* and the field mouse *(Mus bodooga)* (unpublished data).

This study has shown the home range of the lesser bandicoot rat is highly variable, depending upon the habitat type it occupies and the population density. In Field No. 3, for example, where the rat density was approximately 100 per ha (based on known individuals trapped in the field) the home range size was small and non-overlapping. The greater bandicoot rat moves longer distances and remains close to island villages and higher ground until it is able to move onto the floating rice habitat in late summer.

The lesser bandicoot rat is truly an ecological generalist. As shown with individuals in this study, the home range shifts depending upon climatic conditions and available food. The species is opportunistic in food habits and may consume native vegetation, rice, wheat, or stored foods in villages or in fields. It may dig burrows and cache large quantities of grain, which lessens food stress during periods of little food in the field. As with Animal 1-8 in this study, the species is able to shift home range or burrow locations whenever environmental conditions warrant survival.

Based on field observations, the lesser bandicoot rat frequents a variety of habitats in Bangladesh from urban, rice and other field crops, villages, vacant fields, and floating stems of deepwater rice. The animal is non-selective for soil type or rainfall belt since it ranges from Chittagong to the extreme northwest of the country.

Control implications.

Damage patterns, namely cut patches, surrounding lesser bandicoot rat burrow systems and the findings on local movements obtained from this study on home range, demonstrated bait placement is important in field control with rodenticides. Sustained baiting, as termed in the Philippines (Sanchez and Reidinger 1978), is not directly applicable to Bangladesh. Baits or bait stations should be placed within one meter of lesser bandicoot burrow entrances or applied directly into the burrows. Since movements, for the most part are restricted

in rats occupying the fields, placement of bait stations, such as along the field periphery or at fixed intervals, may not be the most effective approach. Since the species appear to be territorial and defend the area around the burrow system, movements are restricted and not all rats may have access to systematically applied baits.

The lesser bandicoot rat is an aggressive species (Frantz 1973) and will attack intruders into the area near its burrow. Specimens obtained from Dacca warehouses with high rat densities, often had deep body scars, and missing or damaged limbs or tails — a result of agressive interactons with other rats (unpublished data). With these factors considered, after a lesser bandicoot rat moves into a wheat field, the animal excavates a burrow system and defends the immediate area (territory) against neighboring rats when the crop is mature and there is increased intra and interspecific competition for available food resources.

Fulk (1977) excavated 48 *B. bengalensis* burrow systems in Pakistan and found only females with litters or paired adults within individual burrows. Under high densities, such as 430 lesser bandicoot rats per ha (Poché *et al.* 1982), the home range size is more compact. This would imply that movements are further restricted and bait applications would probably be best in small amounts near each burrow system.

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