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Home range of *Gerbillurus paeba* in a southern African coastal dunefield

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Abstract

We studied the home range of *Gerbillurus paeba* (Cricetidae) in dune slacks. Live-trapping was conducted on a fixed grid from March 1981 to July 1982. Average distance moved between captures was calculated from 542 movement records. Home range size (area of the minimum convex polygon) was calculated for all gerbils captured at least 10 times. Average distance moved was 102 m. The longest movement recorded was 577 m. Adult males in the breeding season moved significantly longer distances than adult females. There were no significant differences in distances moved by males and females in the non-breeding season, nor between male and female juveniles. Adult males moved significantly longer distances in the breeding than in the non-breeding season, while adult females moved significantly smaller distances in the breeding season. Home ranges overlapped considerably.

Introduction

This investigation of the home range of *Gerbillurus paeba* (Cricetidae) formed part of a broad ecological study of the species in the Alexandria dunefield in the eastern Cape, South Africa. Information regarding home range can be obtained from repeated recaptures of individuals on a trapping grid. It is important to note that there is no evidence that the trap-revealed home range and the true home range are identical (HAYNE 1949) and that biologists measure, at best, an apparent home range.

This study utilized two methods of measuring home range. The first method gives an index of home range by measuring the average distance moved between captures (BRANT 1962). This method allows maximal use of data, since only two captures per individual are required. It has been widely used (KREBS 1966; WOLFE 1968; BROOKS 1974; SLADE and SWIHART 1983). The second method measures home range area. The smallest convex polygon which contains all of the capture points for an individual is drawn (as described by SOUTHWOOD 1978), and the area of the polygon measured. Although this method has a sample size bias, it has been used by many authors (e.g. PERRIN 1979; JONES and SHERMAN 1983). JENRICH and TURNER (1969) have found the method to be reasonably statistically stable.

Statistical methods, which calculate the probability of occurrence of an individual within a given area, were avoided, since many require the a priori assumption of a particular home range shape (e.g. HAYNE 1949; JENRICH and TURNER 1969), while more recent models (e.g. FORD and KRUMME 1979; ANDERSON 1982), which require no assumptions of shape have not been proven to be applicable other than in specific instances.

Study area

The Alexandria dunefield lining the shores of Algoa Bay is the largest (120 km²) active coastal dune system in South Africa. The major part of the dunefield lies between the mouth of the Sundays River (33° 44' S; 25° 51' E) and Cape Padrone, 48 km eastwards up the coast. The climate is warm temperate,

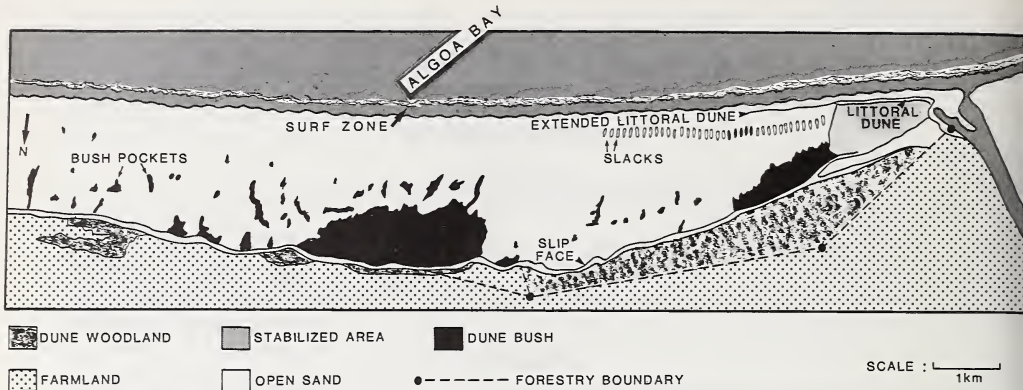


Fig. 1. Map of the western section of the Alexandria dunefield, showing the dune slack habitat. Shaded slacks indicate the study site

but variable. Rain can occur in all months of the year and averages 400–800 mm per annum along the dunefield from W to E. Mean annual temperature for the study period (1981 and 1982) was 17.7 °C. Lowest and highest temperatures recorded were 3.9 and 40.0 °C, respectively.

Fig. 1 shows the dune slack area where trapping was conducted. The area comprises a series of 36 damp hollows separated by bare dune ridges. These are known as dune slacks, i.e. valleys where the water table is close to the surface. They extend in a strip 3.5 km long, parallel to the shoreline. Five slacks were covered by the trap grid. Each slack is approximately 200 m long and 40–50 m wide. Due to the action of predominantly west winds, the slacks migrate eastwards at a rate of 7 m per year. To the south, they are bordered by the beach, to the north, by high dunes.

Vegetation in the slacks is sparse, averaging 2–10 % and rarely exceeds 0.5 m in height. Most abundant plants are two hummock forming species, *Arctotheca populifolia* and *Gazania rigens* and sandgrass, *Sporobolus virginicus*. *G. paeba* is the only rodent species permanently resident in the slacks.

Materials and methods

A mark-multiple recapture programme was carried out for 17 months, from March 1981 to July 1982. The programme is described in detail by ASCARAY (1986). Sampling occurred at three-weekly intervals, yielding a total of 24 samples. A fixed grid marked with metal poles was laid out over six dunes and their five corresponding slacks, chosen as being typical of the area as well as for accessibility. Grid dimensions were 525 × 200 m (area: 10.5 ha). Each trapping session lasted 48 hours; data from the two trap nights were pooled.

Distance between traps was 25 m. Every six weeks, traps were placed round the outside of the grid, (10 traps per side), at distances ranging from 50–200 m from the outermost grid poles, to monitor movement outside the grid. This formed a third trap night. This additional trap information gave a more accurate picture of home ranges of individuals. Each captured gerbil was identified, weighed, its reproductive condition assessed and grid location noted.

Average distance moved was calculated for all gerbils that had been captured on the study grid two or more times, thus including the movements of transient animals. Distances moved within a sample (i.e. between the first and second night of a sample), as well as distances moved between samples were used after a preliminary analysis using Student's *t*-test (ZAR 1984) showed no significant difference ($p > 0.05$) between using all values and using only between-sample values. The data were analysed separately for males and females, adults and juveniles and for the breeding season (September–February) and the non-breeding season (March–August). Movements spanning the boundary between the breeding and non-breeding seasons, or between juvenile and adult status, were discarded. Student's *t*-test was used to test for differences between the categories. A total of 542 movement records was analysed.

Since apparent home range size increases asymptotically with an increasing number of location records (the asymptote representing total home range size), an attempt was made to establish the minimum number of captures that could be used to determine an individual's home range. Home range size (area of the minimum convex polygon) was calculated for 20 gerbils that were captured 10 or more times after 4, 6, 8, 10, 12 and 15 captures. A graph of mean home range size versus number of

captures was plotted. In addition, home range size versus number of captures was plotted separately for three individuals that were captured more than 20 times.

Since the graphs revealed that approximately 20 captures are needed to disclose the home range area of *G. pabea*, and only three gerbils were captured more than 20 times during the study, an indication of the relative size of male and female home ranges was obtained as follows: home range area was calculated for all gerbils that had been captured at least 10 times (14 males and 11 females), using 10 location records for each. Student's *t*-test (ZAR 1984) was used to test for differences between the home ranges. Spatial relationships on the grid were examined by plotting location records for all gerbils captured 10 or more times over the same time period (December, 1981 – May, 1982) on maps of the study grid. Home range areas of 12 males and 10 females were plotted, using the minimum convex polygon method as described by SOUTHWOOD (1978). Location records outside the study grid, obtained from six-weekly trapping sessions, were included. The number of capture records used for each individual ranged 10–15. The home range maps were examined for overlap between members of the same and of the opposite sex.

Results

The average distance moved by all classes of *G. pabea* was 102 m. The longest distances moved by a male and female in one night were 526 m and 577 m, respectively. Average distances moved by the different classes of *G. pabea* in the breeding and non-breeding seasons are summarized in the Table. Adult males in the breeding season exhibited the largest average distance moved (130 m), while adult females in the breeding season moved the smallest distances (68 m).

Data from male juveniles and female juveniles were combined for the breeding and non-breeding seasons to obtain sample sizes suitable for analysis, as breeding season sample sizes were small. There was no significant difference ($p > 0.05$) between distances moved by adult males and adult females in the non-breeding season, but during the breeding season there was a highly significant difference ($p < 0.01$) in their movements, with females moving much smaller distances (68 m) than males (130 m). There was no significant difference ($p > 0.05$) between the movements of male and female juveniles.

Intrasex comparisons showed that adult males moved signifi-

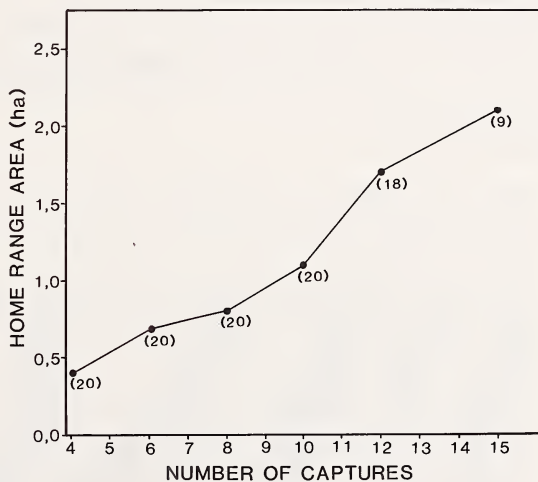


Fig. 2. Increase in home range size with number of captures. The number of individuals used to calculate each point appears in parentheses

Mean distance (m) moved by various classes of *G. pabea* in the breeding and non-breeding seasons

Class	n	Breeding Season			Non-breeding Season			
		Mean distance	SD	Range	n	Mean distance	SD	Range
Adult male	80	130	114	25–526	142	99	91	25–525
Adult female	54	68	62	25–382	137	108	115	25–577
Juvenile male	16	98	77	25–292	38	100	93	25–443
Juvenile female	13	100	73	25–269	62	90	63	25–257

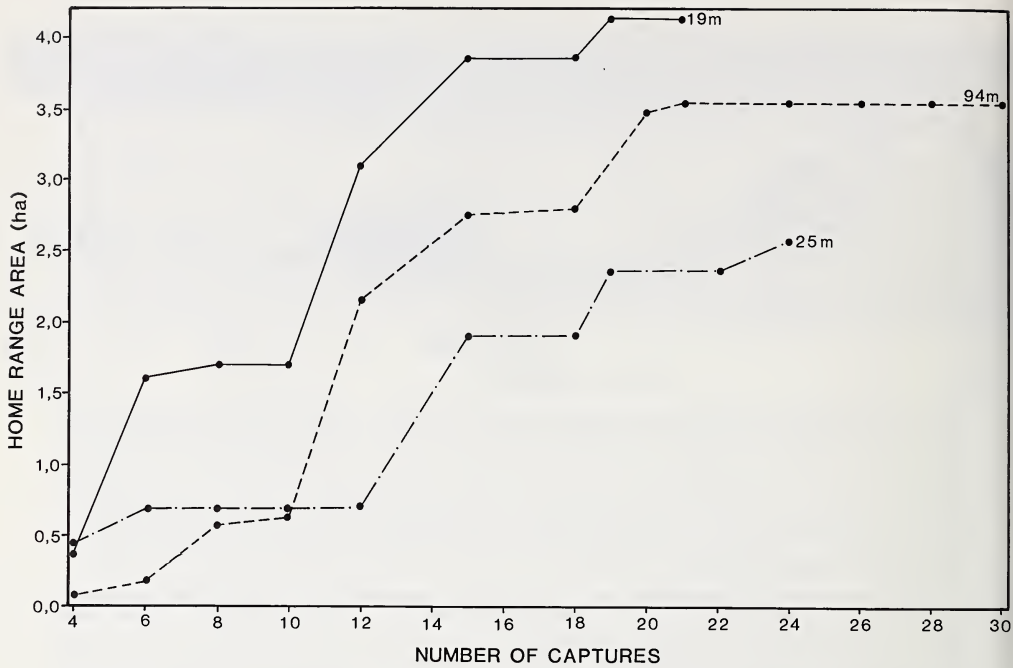


Fig. 3. Increase in home range size with number of captures for three *G. paeba* individuals captured more than 20 times

cantly larger distances in the breeding season than in the non-breeding season, but their movements were not significantly different from those of juveniles in either season. Adult females moved significantly ($p < 0.05$) smaller distances in the breeding season (68 m) than in the non-breeding season (108 m). Adult female movements (68 m) were also significantly ($p < 0.05$) different from those of juveniles (100 m) during the breeding season, but no significant difference was found between adult and juvenile females in the non-breeding season.

A plot of home range size versus number of recaptures for 20 individuals with 10 or more recaptures showed that more than 15 captures are necessary to determine the home range size of *G. paeba*, since at 15 captures the graph had not yet approached an asymptote (Fig. 2). A subsequent plot of home range size versus number of recaptures for three individuals that were captured more than 20 times indicated that the home range size of *G. paeba* is disclosed after approximately 20 captures (Fig. 3). These three individuals had range sizes of 2.56 ha; 3.54 ha and 4.13 ha.

A comparison of 14 male and 11 female home range sizes, all based on 10 location records, showed that male home range size ($\bar{x} = 1.42 \pm 1.17$ ha) is nearly double that of females ($\bar{x} = 0.76 \pm 0.62$ ha). However, Student's *t*-test indicated no significant difference ($T = 1.668$; $p > 0.05$) between male and female home range sizes. This may be due to the small sample sizes and to the great variability in the data – female home range sizes ranged 0.16 ha–1.94 ha, while male home range sizes ranged 0.25 ha–4.64 ha.

The home ranges of 12 males and 10 females captured 10 or more times over the same time period (December 1981–May 1982) are shown in Figs. 4 and 5. Home ranges of both sexes usually included dune ridges, so that most home ranges covered more than one slack. Additional data points from the six-weekly trapping showed that gerbils also visit the dunes to the north of the slacks and the beach. Home ranges generally overlapped extensively, both within, and between sexes.

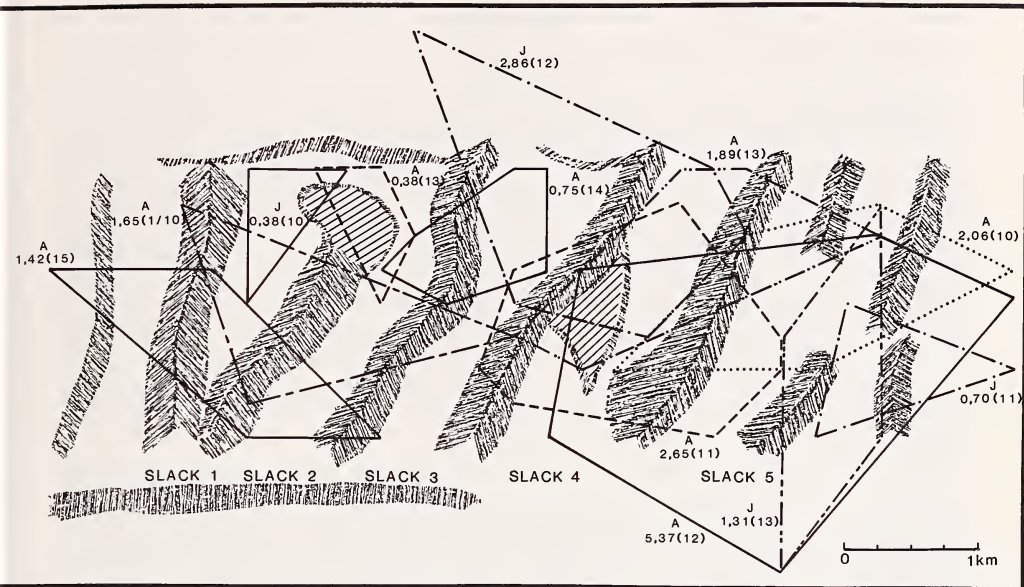


Fig. 4. Home ranges of 12 males present on the study grid from December 1981–May 1982. The age category (A = adult; J = juvenile), home range area (ha) and number of captures from which the area was calculated (in parentheses) of each individual are shown next to each home range

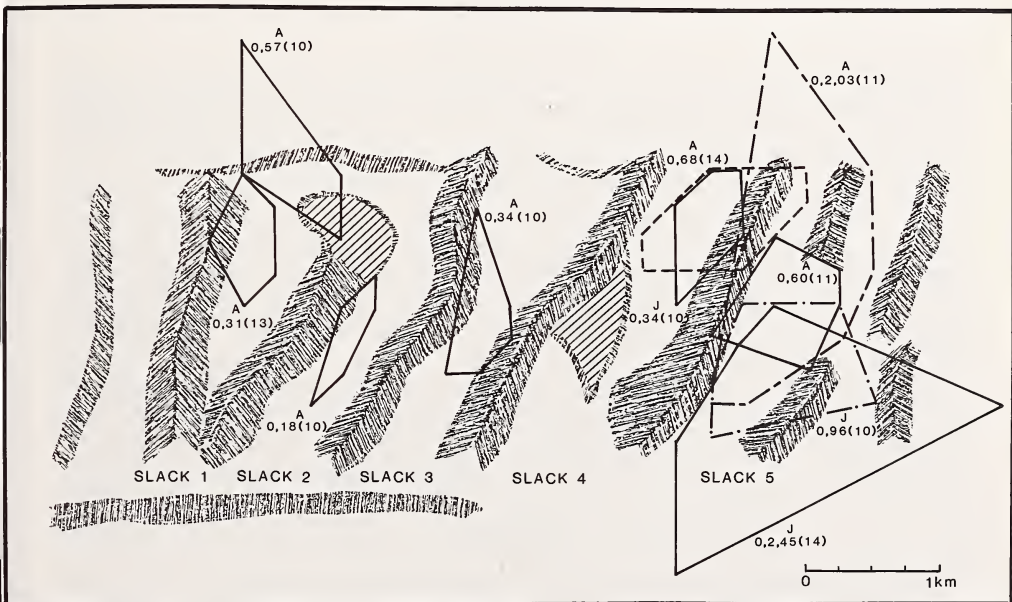


Fig. 5. Home ranges of 10 females present on the study grid from December 1981–May 1982. The age category (A = adult; J = juvenile), home range area (ha) and number of captures from which that area was calculated (in parentheses) of each individuals are shown next to each home range

Discussion

Movement

G. paeba individuals in the Alexandria dunefield move large distances of up to 0.5 km a night in their search for food and mates. LAYCOCK (1975) reports that the maximum distance moved by a marked *G. paeba* individual in the Namib desert was 75 m, but that the foraging distance, as evidenced by tracks, is much greater. Similarly large distances of approximately 350 m a night have been recorded by SCHRODER (1979) for *Dipodomys spectabilis*, a rodent inhabiting a North American desert. These distances are much greater than those reported for rodents inhabiting non-arid areas. *Rabdomys pumilio*, for example, averages movements of 14.8 m (males) and 21.5 m (females) on the Transvaal highveld during the breeding season (BROOKS 1974), while SLADE and SWIHART (1983) report that adult male and female *Sigmodon hispidus* individuals in Kansas, North America, move average distances of 30.8 m and 21.2 m, respectively. Rodents such as *G. paeba*, which inhabit sparsely vegetated areas, presumably need to travel long distances to obtain sufficient food.

There were no significant differences in male and female movements, except during the breeding season, when males moved much longer distances than females. Male rodents commonly increase their movements during the breeding season, as has been shown for *Dipodomys spectabilis* (SLADE and SWIHART 1983), *Clethrionomys glareolus* (MAZURKIEWICZ 1971), *Peromyscus maniculatus* (METZGAR 1979) and *Microtus californicus* (KREBS 1966). These longer movements presumably increase their chances of mating with females. Smaller female movements during the breeding season may be a result of the females' confinement to nest sites. *Rhabdomys pumilio* females also exhibit smaller movements during the breeding season (BROOKS 1974).

Home range area

Apparent home range size increases asymptotically with an increasing number of location records (STICKEL 1954; HAYNE 1949; VAN VLECK 1969). However, most studies of small mammals provide insufficient data to reveal the asymptote (METZGAR and SHELDON 1974). One disadvantage of the minimum convex polygon method is its dependence on sample size, since individuals with a small number of recaptures will appear to have smaller home ranges than individuals that were recaptured many times. STICKEL (1954) claims that home range size is not fully disclosed with fewer than 15 location records, while FLOWERDEW (1976) states that individuals with fewer than 10 captures are often not worth including in home range analysis. Many authors choose an arbitrary minimum number of recaptures to use in calculating home range (VAN VLECK 1969).

Analysis of results from this study showed that the home range of *G. paeba* is disclosed only after approximately 20 captures. Since only three individuals were captured more than 20 times, more data are necessary before an accurate estimate of home range size can be obtained. However, *G. paeba* conforms to the general pattern of cricetid mice in having a large home range (FRENCH et al. 1975). BLAIR (1951) has reported home range sizes of 0.79–4.31 ha for *Peromyscus polionotus leucocephalus*, a rodent which lives under conditions similar to those of *G. paeba*. Large home range sizes in these two species may be a result of the relatively poor environment in which they live.

Male home ranges appear to be much larger than female home ranges. Seasonal changes in home range size may occur, as indicated by the seasonal changes in average distances moved by both male and female gerbils.

The distribution of home ranges falls approximately into two groups, one on the eastern and one on the western side of the grid, with the centre of the grid being relatively

unoccupied. This can be explained as follows: the two slacks forming the eastern end of the grid comprised the largest area of suitable habitat on the grid, hence the greater number of gerbils occurred in that area. The two slacks forming the western end of the grid were smaller and thus offered a smaller area of suitable habitat, while the slack in the centre of the grid was characterized by the presence of a large midden of coarsely fragmented mussel shells, which could have made the substrate unsuitable for burrowing.

There was considerable overlap between male home ranges (Fig. 4) and a lesser degree of overlap between female home ranges (Fig. 5). This difference may be due to the difference in size of male and female ranges: male ranges would be more likely to overlap each other simply because they are larger, and it is more difficult for an animal to maintain an exclusive home range when the range is large. Male and female home ranges overlapped extensively (one can imagine superimposing Figs. 4 and 5). These findings agree with NEL's (1975) statement that there is a fair degree of social tolerance and interaction between *G. paeba* individuals. He reports that gerbils occur singly in burrows, but that the burrows are situated in close proximity to one another. However, since total home range sizes of the gerbils are mostly unknown, and not all individuals present on the study grid are represented on the home range maps, the distribution of home ranges should be interpreted with caution.

Gerbil home ranges were generally not confined to one slack, so dune ridges are regularly crossed. The gerbils may feed on wind-blown insects and detritus (including seeds) which accumulate on the leeward faces of the dunes. The high dunes to the north of the slacks may be visited for the same reason – there is no vegetation on these dunes to provide food. Gerbils also move on to the beach, possibly to feed on driftline debris and on other organisms feeding there. *G. paeba*'s ability to travel long distances at a time thus enables it to utilize the sparse, scattered food resources the slacks and surrounding dunes and beach have to offer.

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Zusammenfassung

Der Aktionsraum von Gerbillurus paeba in einem Küstendünenfeld in Südafrika

Wir untersuchten den Aktionsraum von *Gerbillurus paeba* (Cricetidae) in Dünensenken. Von März bis Juli 1982 wurden in einem festgelegten Koordinatensystem Lebendfallen gestellt. Die zwischen den Fängen durchschnittlich zurückgelegte Wegstrecke wurde aus 542 Bewegungsaufzeichnungen berechnet. Die Aktionsraumgröße (Fläche des minimalen konvexen Polygons) wurde für alle jene *Gerbillurus* berechnet, die mindestens zehnmal gefangen wurden. Die durchschnittlich zurückgelegte Entfernung betrug 102 m, die längste 577 m. Während der Fortpflanzungszeit legten die adulten Männchen signifikant längere Wegstrecken als die adulten Weibchen zurück. Weder zwischen adulten Männchen und Weibchen außerhalb der Fortpflanzungszeit, noch zwischen juvenilen Männchen und Weibchen ergaben sich signifikante Unterschiede hinsichtlich der zurückgelegten Wegstrecke. Adulte Männchen legten während der Fortpflanzungszeit signifikant längere Entfernungen als außerhalb der Fortpflanzungszeit zurück, adulte Weibchen hingegen signifikant kürzere. Die Aktionsräume überschneiden sich erheblich.

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