Some factors influencing the breeding season of *Praomys natalensis*

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As part of a demographic study of *Praomys natalensis* in an agricultural area on the Rhodesian highveld, a preliminary investigation was carried out into some of the factors which might be of importance in determining the timing of its breeding season. Information on breeding and nutrition was obtained by both live and snap trapping. Breeding was confined to the late summer months in natural grassland areas but occurred in winter in wheat fields. Availability of nesting sites was adequate at all times. Analysis of stomach contents indicated that the protein content of the diet was adequate for breeding in all seasons. The possible influence of green grass and insects in the diet is discussed.
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Deel van 'n demografiese studie op *Praomys natalensis* in 'n landbougebied op die Rhodesiese hoëveld was 'n voorlopige ondersoek na sommige faktore wat van belang kan wees om die tyd van die teelseisoen vas te stel. Inligting oor teling en voeding is verkry van diere wat lewendig of dood gevang is. In ongerepte grasvelde was teling beperk tot die laat somer maande, maar het gedurende die winter geskied in koringlande. Daar was altyd genoeg skuilplekke. Analises van maaginhoude het getoon dat daar deurgaans genoeg proteïene in die dieet was om teling te verseker. Die moontlike invloed van groen gras en insekte word ook bespreek.
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The breeding patterns of most African Muridae appear to be seasonal, with a summer peak (Smithers 1971; Delany 1972; Sheppe 1973; Cheeseman & Delany 1979). The breeding pattern of *Praomys natalensis* follows this trend (De Wit 1972; Delany 1974) although there are records of breeding throughout the year in some areas (Coetzee 1965; Smithers 1971) but with summer peaks and troughs in winter. What then are the factors influencing the breeding season?

As part of a demographic study of rodents in an agricultural area, it was noted that *P. natalensis* were breeding during winter in irrigated wheat fields, whilst in nearby natural vegetation no gravid individuals were found (Swanepoel 1978; P. Taylor pers. comm. 1978). This suggests that photoperiodism is not a proximate factor initiating reproduction.

Delany (1974) noted that in Uganda there were two short breeding seasons, coinciding with the East African rains. The influence of rainfall on the breeding cycle has also been studied by De Wit (1972) and Field (1975). They determined that there was a reduction in the length of the breeding season in response to the early onset of the dry season, and conversely, with an early start to the rainy season breeding was advanced by several weeks. This effect of rainfall may act in a number of ways. For example, the effect may be indirect, either on the control of food supply (Sadleir 1969) or by softening the soil and allowing burrows to be dug (Newsome 1969). Alternatively, rainfall may have a direct stimulus, triggering physiological changes within the animal (Keast & Marshall 1954).

In the present study the results of a preliminary investigation into some of those indirect factors which may influence the timing of the breeding season are presented.

Study area

The study area was situated on the farm Merton Park, which is in the Norton district of the Mashonaland highveld, 35 km west of Salisbury (30°47′E 17°52′S). Trapping was carried out in agricultural land and the adjacent natural vegetation. The agricultural land was under continuous cultivation with a crop rotation of soyabeans (summer: December – April) and wheat (winter: May – October). The wheat crop was irrigated using an overhead sprinkler system. The adjacent natural vegetation was made up of a dense sward of *Hyparrhenia* (mainly *H. dissoluta*) dominated grassland interspersed with the occasional bush (*Albizia* sp.) and tree (*Acacia karoo*).

The climate of the area is typical of the Mashonaland highveld with the main rainfall period occurring during summer (October — April). The total rainfall for the Norton area averages 784 mm annually. The soil throughout the study area was characterized by moderately deep, red clay loams, with good permeability.

Methods

Three trapping sessions, each of about a month's duration, were carried out at intervals during the year (1977) coinciding with a particular growth stage of the agricultural crop:

— Early winter (May/June); soon after the wheat had been planted.
— Late winter (August/September); the seed heads of the wheat plants were beginning to fill.
— Summer (December); the wheat had been harvested, the land cultivated, and a soyabean crop planted.

Live trapping was carried out in square grid patterns (Flowerdew 1976) using Sherman-type traps (5 400 trap nights). The trapping covered both the cultivated area and the adjacent natural veld. The mice caught were sexed, marked, weighed and their breeding condition noted. In the male the criterion used to determine breeding condition was the position of the testes (Brooks 1974; Sheppe 1973). In the female, the criterion used were actual signs of pregnancy (Brooks 1974; Delany 1972). All mice were 'aged' into one of five broad age groupings based on mass: toothwear correlations (Swanepoel 1978).

Where possible, on the release of an individual after capture, its escape route was followed and in this way a number of holes in the ground were noted. In addition, an intensive search for holes was made of the natural vegetation areas covered by the trapping grids which had been burnt, that is, possible nesting sites. It was not possible to carry out a similar search in the agricultural land.

Blood samples taken from the rodents were analyzed at Blair Laboratories using starch gel electrophoresis in order to distinguish between chromosomal types (Gordon 1978).

Snap trapping using Museum Special traps was carried out in nearby vegetation corresponding with that occurring on the live trapping grids (750 trap nights). Mice caught were weighed and sexed. The position of the testes in males and presence of embryos in the uterus of females were the criteria used to determine breeding condition. Skulls were preserved and the degree of toothwear on the upper molars was used, together with the relavant masses, to determine 'age groups'.

The stomach contents of the snap trapped mice were preserved in 10% formalin. A visual estimate was then made of the relative amounts of the various constituents (seed material, green leaf or insect remains). This was done on a volume basis using an eight-point scale (Walker 1976). The stomach contents were then dried to a constant weight and the nitrogen content was determined by Kjeldahl analysis (Maynard & Loosli 1969).

Results

Both chromosomal forms of *P. natalensis* (diploid numbers 32 and 36) were found to be present on the study area. Of all individuals caught (n = 237) it was found that 90,2% were of the type 2n = 32. For the purpose of this study the small number of *Praomys* of type 2n = 36 were discarded and thus all results pertain to the type 2n = 32.

Table 1 Reproductive condition of *Praomys natalensis* males in each season as recorded by the percentage of males which have scrotal testes in each age group. Figures in parentheses indicate sample size

	% of males in which the testes were scrotal				
Age class	1	2	3	4	5
June (non-breeding)	0(18)	0(58)	19(42)	100(12)	—
September (breeding)	0(1)	86(18)	100(29)	100(41)	100(17)
December (non-breeding)	33(3)	97(33)	100(60)	100(36)	100(7)

Table 2 Reproductive condition of *Praomys natalensis* females in each season, as recorded by the percentage of females which are either gravid or lactating during that period

	Grassland			Cultivated land		
Month	n	Gravid	Lactating	n	Gravid	Lactating
June	139	1	14	12	—	—
September	55	5	3	137	48	36
December	94	—	—	7	—	—

Reproductive condition

The percentage of males recorded as being in breeding condition in each of the age (mass) classes, per trapping period, is given in Table 1. Those females found to be either lactating or gravid are given as a percentage of the total females caught per session in Table 2.

Breeding sites

Two 0,56 ha areas in the natural grassland were searched for holes, that is, possible nesting sites. In one area there were 22 holes and in the other 26 holes — an average of 43 holes per ha.

As mentioned, no such count was possible in the agricultural area. On releasing individuals and observing escape routes four holes were located in the 0,56 ha area covered by the trapping grid. It is presumed that there were many more. Earth clods left by cultivation were also utilized for refuge. It was also noted that burrows could be dug in the soft cultivated soils within the course of an evening.

Stomach contents

The stomach ingredients could only be divided into three broad categories: seed material (S), green leaf (L) and insect remains (I), as recorded in Table 3. Seed material was recorded in all stomachs throughout the year and was the major constituent in 93% of all stomachs analyzed. The number of stomachs in which insects were recorded varied with the season: in June insect remains were found in only 50% of male stomachs and in 40% of female stomachs, whereas in September and in December over 80% of both male and female stomachs contained insects. Some of the insects ingested were broadly identified from mouth parts: spiders (Arachnida), short-horn grasshoppers (Acrididae), crickets (Gryllidae), beetles (Coleoptera), ants (Formicidae),

Table 3 Seasonal variation in the composition and percentage protein values (dry mass) of the stomach contents of *Praomys natalensis*. Composition recorded in terms of the percentage by volume of seed materials, green leaves and insect remains

	Male					Female				
Month	n	Seed materials	Green leaves	Insect remains	% protein	n	Seed materials	Green leaves	Insect remains	% protein
June (grassland)	16	82,0	4,0	9,0	29,5	10	82,0	6,0	7,0	28,4
September (wheat)	7	41,0	11,0	33,0	22,6	6	43,0	6,0	40,0	26,6
December (grassland)	18	60,0	3,0	33,0	28,1	15	85,0	6,0	12,0	24,5

termites (Macrotermes) and larvae (Diptera). Green leaf was recorded in 31% of stomachs in September, 38% in September and 12% in December.

Even though the constituents of the diet tended to vary quite considerably between seasons there was little variation in the protein content. There was no significant difference ($F(3,5) = 1,59$: ns) between the means of protein content taken for each trapping period.

Discussion

The discontinuous and irregular sampling periods and the short overall time span of the study precludes finite dates being placed on the onset/cessation of breeding seasons. It is really only possible to state that breeding did, or did not, occur during a particular period.

The data in Table 2 indicate that breeding occurred in the grassland areas until early June after which the only females caught in a gravid state or lactating were known to be temporary migrants from the adjacent wheat fields. The seasonality of the breeding cycle as indicated in this study was confirmed by an independent study carried out in nearby grassland, away from the influence of agricultural land (P. Taylor pers. comm.). In that study, monthly trapping results showed that gravid or lactating *P. natalensis* were last recorded in June and had not recommenced breeding by the end of the year. Conversely, in the wheat fields the vast majority of females were gravid or lactating in September. When the wheat was harvested (early October) some of these females found refuge in the adjacent grassland. None of these were gravid or lactating in December.

From Tables 1 and 2 it would appear that it is possibly the female that determines the timing of the breeding season. There were scrotal males in all the sampled populations whether the females were breeding or not. This indicates that the factor(s) influencing the breeding season do so ultimately through the female. There does, however, appear to be some effect on the male in that the age at which the testes become scrotal is delayed during the non-breeding season (Table 1).

Newsome (1969) proposed that availability of breeding sites may play a role in determining the breeding season; with rainfall the soil would be softer and thus burrows dug easily. This might be of importance where burrows/holes are unavailable at other times of the year, such as the water level rising in a flood plain area (Sheppe 1973). However, in the present study holes were available throughout the year. Holes, as such, need not be critical for breeding as Smithers (1971) reports that they can utilize any sort of cover for nesting.

It is known that certain nutritional levels must be attained in the diet of animals to maintain pregnancy and lactation. Apparently, the requirements for protein are greater than for energy during pregnancy (Maynard & Loosli 1969). With respect to the dietary requirements for rats Field (1975) quotes that 7—17% protein in the diet is sufficient to support normal oestrus cycles, with 16% being the optimum required to support reproduction and growth. Irregularity or complete cessation of cycles occur when the protein value in the food drops to 3,5—5%. From the stomach content analysis (Table 3) it would appear that in this regard there are no protein deficiencies in the diet during either the breeding or non-breeding periods.

It has been noted that oestrogens are to be found in growing grass (Millar 1967; Symington 1965). These are known to stimulate oestrus in rodents and it has been proposed that they might act as the proximate factor to trigger the breeding cycle (Field 1975; Taylor & Green 1976). Green grass was available to the rodents in the study area due to normal growth as well as to regrowth after fires. Grass was present in stomach contents taken from all three sessions but was not a regular or major constituent of the diet (Table 3).

Through its constant availability and presence in the diet it might appear that green grass would not provide the triggering mechanism required. However, the actual oestrogenic content of the grass was not monitored. Millar (1967) found that maximum activity of the grass oestrogens was associated with new grass growth occurring within five weeks of the onset of effective rains. Thereafter it declined very rapidly. Whether there are similar surges of oestrogenic activity associated with regrowth after burning or grazing is not known, although Millar (1967) believes it to be a possibility.

Conclusions

From this preliminary study no clear picture has evolved which might indicate the factor that is responsible for the timing of the breeding season of *P. natalensis*. Neither photoperiodic effects nor the availability of nesting sites would seem to provide the proximate factor required to initiate the breeding season. The effect of nutritional status is not so clear. Protein, and therefore by inference energy (Maynard & Loosli 1969), in the diet does not appear to be limiting at any stage. The nutritional role may not, however, be dependent on the simple presence or absence of maintenance requirements. For example, perhaps a surge of protein in the diet, above normal maintenance requirements, is required at the beginning of each season, as might be provided by insects (Field, 1975). Similarly the possibility that green grass in the diet might contain the key in the form of oestrogens cannot be ruled out. Although, green leaf was found in the stomach in all seasons its oestrogenic content was not known. It is also known that insects contain hormones which are known to affect vertebrates (Menn & Beroza 1972; Slama, Romanuk & Sorm 1974) and may in this way provide the necessary stimulus. The increased availability of insects at certain times has been cited as important in the initiation of breeding in grey squirrels (Goodrum 1940) and in *Agama agama* (Marshall & Hook 1960).

The proximate factor(s) responsible for the timing of the breeding season are not apparent at this stage and a more subtle mechanism seems implicated.

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