CHAPTER - I
 FEEDING BEHAVIOUR OF GERBILS I: METHOD OF EATING, MEAL PATTERNS, SAMPLING BEHAVIOUR AND FEEDING RHYTHMS

1. Introduction

Rodents are versatile in feeding behaviour and choice of food, and thus each species requires separate study (Barnett, 1969). However, some kinds of behaviour are common, as there are a number of similar activities which influence feeding (Barnett, 1975). Obviously, such aspects and interrelationships can be looked for while investigating the ethology of new or less known species (Barnett and Prakash, 1975). If it happens to be a pest like gerbils, study of the behaviour is also useful for devising proper methods of control (Chitty, 1954).

Feeding of the group is known, however, largely from observations among rats, the domestic albino and wild type Rattus and among mice, Mus musculus L. (Barnett, 1969). There is marked difference in their choice for foods and method of eating (Spencer, 1953; Barnett and Prakash, 1975). However, both take frequent meals (Southern, 1954; Barnett, 1975), while utilising the time between meals for rest, exploration or some other activity (Bernstein, 1975; Barnett, et al., 1978). But as opposed to mice, the rats feed at fairly regular intervals and display
consistent circadian rhythms in feeding (Siegel and Stuckey, 1947; bare, 1959; Siegel, 1961).

Apart from characteristic meal patterns and feeding rhythms, the other important component of their feeding behaviour is "sampling"; or eating, even though in variable amounts, of all available foods (Barnett, 1956). The behaviour is analogous to exploration of environment and has similarly great survival value (Barnett, et al., 1978). Thus, tasting can help in selection of superior foods (Rozin, 1969). It is, however, of greater value to rats in finding new sources of food (Barnett, et al., 1978) and for avoiding poisoned baits (Rzoska, 1953, 1954; Rozin and Kalat, 1971).

Although feeding behaviour of gerbils has not been analysed to the same extent, some detailed observations have yet been made on dietary self-selection by Mongolian gerbils, Meriones unguiculatus (Harriman, 1969a, 1969b) and on the food of Indian species, Tatera indica indica Hardwicke or T.i. cuvieri Cuvier and Meriones hurrianae Jerdon (Prasad, 1954; Prakash, 1969, 1976). Development of "bait-shyness" in the latter has also been examined (Prakash and Jain, 1971; Cowan, 1978). However, nothing is known about their meal patterns, sampling behaviour, methods of eating or food cycle. Results of the experiments designed to study such important aspects of feeding of T.i. indica are discussed here.
2. Material and Methods

2.1. The subjects: The subjects were wild-caught stock, housed in wire-mesh cages, 1.2 x 1.0 x 0.3 m, or cement tanks, 1.8 x 1.5 x 1.2 m. They were fed on a mixed diet of cereals with cabbage once a week. Water was given ad lib. The cages were kept in a rattery covered on two sides by wire-mesh and canvas screens. The canvas was rolled-up during day-time, from 8 a.m. to 5 p.m.

The number and weight of gerbils included in each experiment is given in Table 1.

2.2. Experimental Procedure: In experiment 1, adult gerbils caged separately were offered wheat (*Triticum aestivum* L.), millet (*Pennisetum typhoides* Burm.), sorghum (*Sorghum vulgare* L.), beans (*Vigna unguiculata* Walp.), slices of melon (*Citrullus vulgaris*) and cabbage (*Brassica oleracea capitata*) on consecutive days. An observer (E) was detailed to watch them eating these foods in sessions of 30 min. each (total observation = 4 hr). 50-Watt red bulbs were used to aid observations. The residue was also examined for condition of grain, husk, etc.

In experiment 2, duration of meals taken by gerbils was timed by an observer (E) using a stop-watch. Observations were made for 3 hr. (6 to 9 p.m.) on each gerbil using red light as source of illumination.
Table - 1

Description of gerbils used in the experiment

<table>
<thead>
<tr>
<th>Expt. No.</th>
<th>Male</th>
<th>Female</th>
<th>Mean Body weight g ± S.E.</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>2</td>
<td>142.00 ± 7.44</td>
<td>131 - 164</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>2</td>
<td>128.75 ± 6.08</td>
<td>118 - 145</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>1</td>
<td>166.50 ± 6.01</td>
<td>158 - 175</td>
</tr>
<tr>
<td>4</td>
<td>7</td>
<td>11</td>
<td>144.16 ± 6.49</td>
<td>88 - 208</td>
</tr>
</tbody>
</table>
Sampling of foods was observed in experiment 3 by cafetaria feeding. Weighed amounts of five foods were offered in the evening; the residue was weighed next day. The choice was kept uniform throughout.

Food intake during the night was measured at regular intervals in experiment 4. Methods described by Siegel (1961) were followed. Thus, weighed amounts of food, wheat or millet, were given in each enclosure at 5 p.m. It was weighed after 2 or 4 hr, and then placed again in cage. The procedure was repeated at the same intervals till 9 a.m. next day. The residue was weighed at 12 noon and 4 p.m. during the day time.

The lights were kept on in the rattery, for about 5 to 10 min., during weighings and replacement of food in night. This did not, however, cause any marked disturbance.

2.3. Analysis of Results: The results were statistically analysed according to methods described by Bailey (1959).

3. Results

The results are illustrated in Figs. 1 to 5 and are described below under separate sections.

3.1. Method of Eating: The gerbils sitting on haunches in the food cup or trays, picked up the food by one or both hands
that remained free. Grains of millet and sorghum were dehusked before eating (Fig. 1). A grain of wheat was, however, held in particular position, e.g. longitudinal to the body axis, and eaten from ends. The larger beans were, however, held at right angles to body axis and gnawed in the middle. The beans invariably broke into halves, each cotyledon showing the portion eaten (Fig. 1).

Wet foods as melon were often eaten directly by mouth, without using hands. Cabbage leaves were pulled out by teeth and shredded before the small pieces were picked up by hand and eaten.

Observations showed that the "urge" to eat melon was much stronger than that for eating any other kind of food.

3.2. Meal Patterns: Feeding commenced as soon as it became dark, except for water melon which was accepted at all hours as described. There were long and short visits to food trays; duration of the former varied from 8 to 35 min. (Fig. 2). Obviously, the short visits lasted very little (<5 min.) when food was merely nibbled at or even sniffed only. Post-meal intervals ranged from 1 to 35 min., but no significant relationship between meal size and post-meal intervals was evident (t = 1.6, P > 0.1).

In the interval between meals, the gerbils either rested or indulged in several activities as shredding paper, making nest, patrolling, grooming and gnawing wood.
Figure 1

Method of eating the different grains — A. Husk of millet, B. Husk of sorghum, C. Pieces of wheat and D. Halves of Frans-beans.
Gerbils showed both long and short visits to food trays. The long visits varied 8 to 35 minutes and the short visits lasted less than 5 minutes.
3.3. Sampling of Foods: The gerbils consumed each of the five foods – wheat, millet, sorghum, maize (*Zea mays*) and barley (*Hordeum vulgare*) offered to them for 5 days, in succession (Fig. 3). Millet was, however, clearly preferred to other four foods (*P* < 0.05). These were eaten in relatively very small amounts, but never completely ignored (Fig. 3). Maize was also hoarded in small amounts in the nest-boxes.

3.4. The Food Cycle: Consumption of food by gerbils was measured at regular intervals during the night, but only twice at the most (12 noon and 4 p.m.) during day-time. However, as canvas screens in the rattery were rolled-up at 8 a.m., the feeding between 5 to 9 or 7 to 9 a.m. also belonged to the dark rather than light period of the day. Taking this into consideration, it would appear that there was practically no day-time feeding. It was restricted only to dark period or night (Fig. 4 and 5).

Food intake over the dark phase, however, did not follow a flat course, though there was considerable individual variation. Intakes measured at 2 hr. intervals particularly revealed that most gerbils had ceased feeding during one or the other time interval. But peaks, and troughs in consumption were neither observed during the same time-interval nor uniformly between the first or second half of dark phase (before and after 12 night). Some gerbils showed two, but others three peaks in consumption (Fig. 4).
Gerbils sampled all the foods offered, but the preference for millet was high; other foods were consumed in small amounts.
Table 4

Consumption and % total consumption of millet by gerbils at 2 hour intervals showing bimodality and trimodality in food cycle of dark period.

<table>
<thead>
<tr>
<th></th>
<th>Consumption by male</th>
<th>Consumption by female</th>
<th>Consumption by gerbils in a colony</th>
</tr>
</thead>
</table>
Figure 5

Consumption and % total consumption of millet by gerbils at 4 hour intervals. Maximum consumption is recorded between 5 to 9 P.M. and minimum 1 to 5 A.M.

- Consumption by male
- Consumption by female
- Consumption by gerbils in a colony
Data of 4-hourly intakes, however, showed a marked build-up between 5 to 9 p.m., followed by decline in consumption during the period 9 p.m. to 1 a.m. (Fig. 5). Minimum intakes were, however, recorded between 1 to 5 a.m., as an increase set in again at the end (Fig. 5). This contradicted the trends discovered earlier in food cycle of gerbils by analysis at shorter intervals of time (Figs. 4 and 5). It was, however, obvious that intensity of feeding did not remain constant. It had certain rhythms.

4. Discussion

Rodents adapt the most convenient way for eating foods (Barnett, 1975), in an attempt obviously to obtain maximum energy in minimum of time (Smith and Follmer, 1972). Thus, the 'methods' have an adaptive basis, and are influenced both by size of species and peculiarity of food material (Barnett, 1969). The effect of size is well-shown by the way the rats and mice eat wheat, e.g. by holding the grain respectively, longitudinal or at right angles to long axis of body (Spencer, 1953). That peculiarity of food material is also important becomes obvious from methods displayed for eating such foods as Scirpus americanus by nutria, Myococaster coyopus (Hailman, 1961), or of various kinds of masts by squirrels (Smith and Follmer, 1972) and voles, Apodemus and Cleithromys (Gorecki and Gebczynska, 1962).
The gerbils, *T. i. indica*, are equivalent to rats in size, and resemble them in using one or both hand, or the mouth directly, to pick and grab food (Barnett, 1956). The resemblance also extends to the manner in which they eat wheat, but the larger Fransbeans are held at right angles to body-axis and nibbled, like mice, at the sides (Spencer, 1953). Thus, the gerbils are also adaptable, and readily modify eating methods to suit requirements. Such flexibility perhaps enables them to eat such hard foods as prickly -pear, *Opuntia dillenii* Haw, during the summer (Prater, 1965) and seeds of *Acasia arabica* in winter (Khan, unpubl. obs.). Whether this contributes to their greater success in the natural environment, needs, however, further investigation. Similarly, the importance of seed-husking in feeding of gerbils, as in heteromyid rodents, has also to be studied (Rosenzweig and Sterner, 1970).

Apart from 'methods', the eating patterns of gerbils and rats are also not exactly alike. Thus, the gerbils do not feed in day-time (Figs. 4 and 5), though even wild rats can refrain from it in some situations (Thompson, 1948). Although this removes the greatest source of variability in their meal pattern data (LeMagnen and Devos, 1970; Panksepp, 1973), they are observed to take large meals in the night which practically equal the 'feeding bouts' of rats (Barnett, *et al.*, 1978). Each meal has also marked satiating effects, as the post-meal intervals are
long (Fig. 2). Such differences are, however, likely in view of distinct habitats that each species prefers in the natural environment, and also because of their habits (Barnett and Prakash, 1975).

Thus, the gerbils inhabit open lands often without much cover (Prater, 1965), where day-time feeding is not possible except on food stored in burrows (Prasad, 1954). They do hoard food, but not in all seasons (Prater, 1965). There is, however, no evidence that such food is eaten, even by the bandicoots, Bandicota bengalensis Gray (Roy, 1974). The gerbils are also fast runners and have a larger home area compared to rats (Barnett and Prakash, 1975). Thus, although they are hyperphagic and have probably high levels of lipogenesis in dark (LeMagnen, et al., 1973), they have to consume larger amounts of food, than rats, at each meal. Whether their alimentary canal shows corresponding modifications, is, however, not known.

However, food intake cycle of gerbils maintained ad libitum under distinct dark-light conditions shows the same changes as have been described for laboratory rat or wild R. norvegicus (Siegel and Stuckey, 1947; Bare, 1959; Siegel, 1961; Barnett, 1975). Thus, consumption in the dark period followed a course largely determined by feeding rhythms, which probably coincide with periods of maximum general activity (Thompson, 1948; LeMagnen and Tallon, 1966). Similarly, individual variations noted in feeding rhythms of gerbils suggest that it is a product of both
internal and external factors (Gilbert and James, 1956; Bolles, 1967). The important external factor may have been obviously light, or changes in it with rising and setting of sun; though a convincing demonstration of this correlation has not yet been made even in case of laboratory or wild rats (Siegel, 1961; Barnett, 1975).

These results also throw light on modal relationship found between eating and darkness (Siegel, 1961). It has been suggested thus that unimodality in eating patterns may be found with brief dark period, while with longer dark intervals bimodality and trimodality are distinct possibilities. In the present experiments dark period extended to about 16 hr each day. Consequently, bimodality and trimodality have also been observed in food cycle of gerbils (Fig.4).

Much like rats, the gerbils also display a marked tendency to sample foods (Fig.3). The behaviour is necessary, as referred to in the introduction, for the formation of favourable feeding habits, whether of positive preference or aversion (Barnett, et al., 1978). Thus, the feeding behaviour of gerbils is essentially similar to that of rats. However, some differences are also obvious.
Summary

The gerbils, like rats, adapt the most convenient way of eating foods. However, meal patterns of gerbils and rats are not exactly alike, but the food cycle in gerbils is influenced by similar internal and external cues, as in the rats. The gerbils also show a tendency to sample foods, which is necessary for formation of favourable feeding habits.