Rec. zool. Surv. India, **97 (Part-2)** : 45-72, 1999

FEEDING BEHAVIOUR OF THE LARGE BANDICOOT RAT *BANDICOTA INDICA* (Bechstein) [Rodentia : Muridae]

R. CHAKRABORTY and S. CHAKRABORTY

Zoological Survey of India, M-Block, New Alipore, Calcutta-700 053

INTRODUCTION

Rodents are versatile in feeding behaviour and in the choice of food. Thus, separate studies on each individual species are necessary. However, except for the stray reports of Jerdon (1874), Blanford (1891), Sridhara and Srihari (1978,1979), Chakraborty and Chakraborty (1982) and Chakraborty (1992)practically no base line data exist on the feeding behaviour and food preference of *Bandicota indica.* A study was therefore conducted on this aspect, in nature as well as in the laboratory.

STUDY AREA

The study was conducted mainly at Sagar Island, the largest delta in the western sector of the Sundarbans and surrounded by the rivers Hugli in the northern and Western sides and river Muriganga in the eastern side. The southern part of the island faces the open sea, the Bay of Bengal. Additional studies were made at Thakurpukur and Behala areas of Western Calcutta.

METHODOLOGY

Specimens were collected by single door wire traps, measuring 40 cm x 20 cm x 12cm. Traps were set in the evening (17.00 hrs. to 19.00 hrs.) and collected in the different hours of night till morning. Observations on the feeding behaviour were made particularly during moonlit nights in nature. Some observations were also made in captivity. Stomachs of 42 adult specimens (both males and females) collected during different months of the year and preserved in 70 per cent Ethyl alcohol. Qualitative and quantitative analysis of the stomach contents (food-items) were made in the laboratory. For the qualitative analysis, reference materials were obtained according to the method of Fall *et al.* (1971). Identified and unidentified components were weighed (wet) to the nearest 0.1 gm.

Food preference, total daily intake (T.D.I.), calorie intake etc., were studied in captivity. Special types of cage as described by Chakraborty (1980) was used for the purpose. Rats were usually maintained individually in separate cages, as there was much fight and aggression when a number of them kept in a single cage. Often the dominant one did not allowed the others to feed in spite of sufficient supply of food.

To obtain the rice powder scented with male and female body odour, one kilogram of fresh powder was provided to individually caged three male and three female rats each with water *ad. libitum.* After 48 hours excess of rice powder was taken out from each cage and packed separately. Detailed methodology for the laboratory study has been described under respective experiments.

FEEDING BEHAVIOUR

The large bandicoot rat usually comes out of the burrow only after dusk and returns at dawn. During the moonsoon and premonsoon months, it mainly feeds on molluscs and crabs and occasionally on fishes and prawns, even from the deep of water. After capturing the prey it takes the same to a particular feeding place which is somewhat clear space inside the bushes and may be easily identified by huge deposits of molluscan shells, scales of fish and hard parts of crabs etc. (Fig. 1). In the monsoon months it also takes the prey on the 'bandh' and sometimes bends and damages the paddy tillers of small area (800 to 1600 sq. cm.) to form a feeding platform causing considerable damage of crop. (Fig. 2).

It holds the snail with the fore paws, and the lower incisors are pushed inside the operculum, while the upper ones are pressed form outside. As a result, body whorl of the shell is either pierced or broken. Then the animal is turned a little downward and the portion of the shell adjacent to the broken region near the penultimate whorl is fragmented in the same way (Fig. 3). This process is repeated till both upper and lower incisors of the predator can be pushed inside to take out the flesh of the snail. The columellar muscle is separated from the columella by dragging. The whole body except the digestive gland is eaten. For mussels, the predator cracks the shell in the region anterior to umbo and opens it with the help of fore-paws and incisors and takes both flesh and fluid. (Fig. 4).

For the species of crabs it turns the prey up side down, places the forelimbs on the body of the prey from behind and crushes the appendages. Then it cracks the shell somewhere at the anterior region to make a hole of sufficient diameter to take out the muscle and fluid (Fig. 5).

During harvesting, the large bandicoot rat regularly visits the neighbouring paddy fields and often settles there, making fresh burrows. Consumption or damage of paddy by this species is more localised at the central part or near the 'bund' of the field. The extent of damage of the paddy during the harvesting season does not appear to be severe at Sagar Island. However, sometimes considerable damage of paddy tillers is done during monsoon.

Vegetable fields, particularly of potato are also favourite foraging ground of *B. indica.* It has been observed that in a potato field of about 800 sq. m., one to three kilogram of potato tubers were dug out by the overnight activity of the species. However, they never consumed more than 30% of a potato tuber. The damage is, therefore, much more than the actual consumption. Green leaves of different vegetables are also consumed by *B. indica,* thereby, hampering the yield. Occasionally, it makes a small opening and takes out seed and placenta of gourd. It is reported to cause heavy damage in a similar manner to the musk melon, that grows on the sandy coastal region of Sagar Island during the dry season. In addition to the different cultivated crops, it regularly visits the bushes near its habitat in search of roots, stems, leaves, fruits, etc. of different plants. Chowdhury (pers. comm.) observed *B. indica* regularly preying upon the birds roosting on the ground of Sagar and adjacent islands. At Kakdwip, adjacent to Sagar Island, Nandi (1984) found *B. indica* attacking a fresh water snake, *Enhydris enhydris* probably for feeding.

QUANTITATIVE AND QUALITATIVE ANALYSIS OF FOOD OBSERVATION IN NATURE

Quantitative and qualitative analysis of food in nature reveals that, the molluscs, fishes, insects, earthworms and certain plants such as grasses, *Colocasia, Derris* sp. etc. are usually consumed in all the seasons, and crabs and prawns usually during the monsoon and paddy and potato during the postmonsoon period (Table 1). Out of 42 stomachs examined, molluscs were found in 28, fishes in 20, insects in 21, grasses in 20, paddy in 11, *Colocasia* in 7, and potato tubers in 6. By weight (wet, species-wise) consumption of the Apple Snail, *Pila globosa,* was the highest (38%) followed by that of paddy (9%) and potato tubers (6%).

Analysis of plant material showed that consumption of seeds and fruits was highest (68%) followed by tubers and fleshy roots (26%) and leaves (5%) with almost total exclusion of aerial stems. Though a definite preference for animal food could be noticed yet, it is interesting to note that, insects which consititute some parts of the regular diet in most of the Indian rodent species (Prasad 1954, Prakash 1962, 1975, Prakash and Kumbkarni 1962, Chakraborty 1977, Sood and Dilber 1977) form only one percent by weight of its diet.

The analysis of the weight of the stomach-contents of the specimens captured in different hours (Table 2) indicates that *B. indica* starts feeding after dusk and continues throughout the night, till it retires into the burrow.

OBSERVATION IN CAPTIVITY

In captivity, experiment was made with *P. globosa,* rice, wheat, Bengal gram and green gram.*B. indica* readily accepted dry whole rice and wheat grains, but not dry whole Bengal gram

Chowdhury, A. Dept. of Marine Science, C. U.

and green gram. Thus, the latter two pulses were provided in broken form. To calculate the water intake, an extra tray with equal amount of water was kept outside the cage as inside. The loss due to evaporation was noted after 24 hours and the same was adjusted during calculation. Consumption of *Pila globosa* in 24 hours was estimated by the following method.

Total weight of *P. globosa* supplied	= A gm.
Total weight of the untouched *P. globosa* after 24 hours	= B gm.
Total weight of the empty shells and operculums after 24 hours	= C gm.
Number of empty shells	= D
Average weight of the digestive gland	= 0.5 gm.
Consumption of *P. globosa* in 24 hours	= A-(B+C)-(D x 0.5) gm.

Total daily intake (T.D.I.)

Single choice : Five adult rats (3M, 2F) were acclimatized for five days providing water *ad libitum* with all the food items used in the experiment. After acclimatization, each item of food was given in sufficient quantity one by one for five days, with water *ad libitum* to all the rats. Table 3 shows the average T. D. I. per rat, calorie intake, water intake and change in the body weight with various food items. It revealed that by weight, T.D.I. with *P. globosa* was significantly higher($p<0.001$) than the other four food items. Among the four plant products, T.D.I. with rice was significantly higher ($P<0.05$) than the others. Though T.D.I. with *P. globosa* was highest (95 gm) but mean calorie intake per gram of body weight per day with that food was lowest (0.141), while mean calorie intake was highest (0.194) with rice. Intake of water was significantly less ($P<0.001$) with *P. globosa* diet than that with other four food items, due to the obvious reason of high water content (74.1%) in the flesh of *P. globosa*. There was no significant difference in the daily water intake with other four food items. Weight loss occurred with all the food items, however, it was minimum with green gram and maximum with wheat.

Double choice : Two food items were provided at a time until all possible combinations (a total of ten) had been given to five individually caged acclimatized specimens (3M, 2F) for five days each. Average daily percentage of consumption is graphed in Fig. 6 and other details provided in table 4. A simple preferential order for *P. globosa* was observed in all the four diadic trials, rice in three out of four, Bengal gram in two out of four, green gram in one out of four, while wheat was never preferred. Consumption by weight was significantly higher ($p<0.001$) in all the four diadic trials with *P. globosa* as one of the component. By weight, consumption was minimum with wheat and green gram combination. However, calorie intake with different

Fig. 1. Feeding place of *B. indica* inside the bushes.

Fig. 2. Damage of paddy tillers by *Bandicota indica* for making the feeding platform.

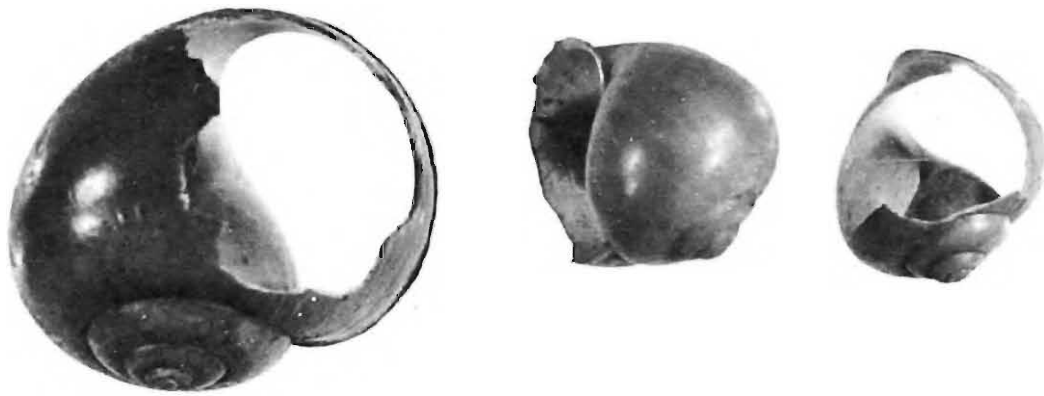

Fig. 3. Broken shells of *Pila globosa* showing the mode of feeding of *B. indica.*

Fig. 4. Broken shells of *Lamellidens marginalis* showing the mode of feeding of *B. indica.*

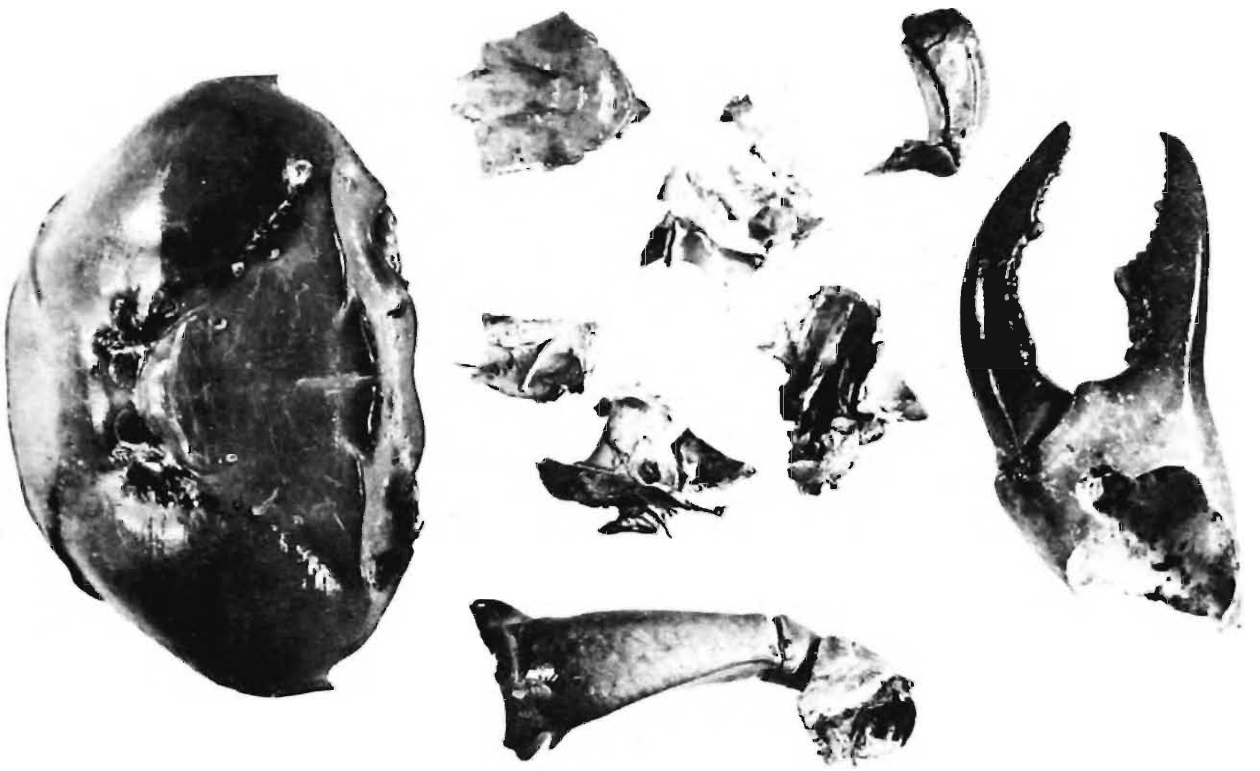

Fig. 5. Broken shells of a crab shwoing the mode of feeding of *B. indica.*

combination of food, varied within a small range of 0.158-0.223 per gram of body weight per day. Consumption of water was significantly less in the diadie trials having *P. globosa* as one of the item ($P<0.001$). Weight loss occurred with all the combinations except two, *viz.*, *P. globosa* + Bengal gram, and Rice + Bengal gram. Maximum weight was lost with wheat and green gram combination.

Multiple choice : In the first experiment a surplus of four food items, *viz.*, *P. globosa*, rice, Bengal gram and wheat along with water *ad libitum* offered for 30 consecutive days to four individually caged acclimatized rats (2M, 2F). In the second, *P. globosa* was replaced by green gram. Average daily consumption of different food items in the first experiment by individual rat for 30 days is graphed in Fig. 7 and other details in table 5. It has been noted that though *P. globosa* was preferred throughout the experiment, yet its consumption considerably decreased in the latter days. Average total consumption by weight came to 0.153 gm. per gm. of rat per day, and that of calorie 0.288. Average daily consumption of different food items by individual rat for 30 days of the second experiment is graphed in fig. 8 and other details are summarised in table 6. Unlike the first experiment, no single food item was preferred for all the 30 days. Average consumption of food came to 0.071 gm. per gm. of rat per day and that of calorie 0.25.

Oil preference : Five specimens (3M, 2F) were offered homogeneously mixed rice powder and oil in the ratio of 90 : 10 (by weight) for five days for each test. Oils tested were coconut, ground nut, mustard and sesame. Various paired and multiple choice tests were conducted utilising the above-mentioned oils. Tests were also conducted with control (without oil) and oil diets. The paired preference tests between oil and control diet showed interesting variation (Fig. 9). There was no significant difference in the consumption of control-mustard oil diet and control-sesame oil diet. In the first two days consumption of oil diet was slightly less than control diet in both cases. However, consumption of coconut oil diet and ground nut oil diet over control diet was significantly higher. Paired preference tests (A total of six) between two different oil diets (Fig. 10) revealed that coconut and ground nut oil diets were significantly preferred over other two oil diets. Coconut and sesame oil diets were insignificantly preferred over ground nut and mustard oil diets respectively. Multiple choice tests with all the four oil diets also showed a similar trend in preference, i.e., Coconut → groundnut → sesame→ mustard (Fig. 11).

Influence of body odour : Two different tests were conducted. In the first, rice powder scented by female large bandicoot rats, along with fresh rice powder were provided at a time to individually caged specimens (3M, 3F) in separate food trays for five days. In the second, same experiment was repeated with rice powder scented with males. Results were summarised in the table 7. In both the tests, consumption of scented powder rice by both the sexes was a little higher than that of the fresh powder, but the differences in the consumption were never significant.

ADDITIONAL OBSERVATIONS ON THE FEEDING BEHAVIOUR IN CAPTIVITY

During the maintenance of the large bandicoot rats in the cages, the following feeding behaviour were observed.

i). *Bandicota indica* though nocturnal in habit, in captivity, it takes the food both during day and night, but consumption during night is much more.

ii) A freshly collected specimen readily accepts the molluscan food and water in the cage even in presence of human beings. However, it tries to drag the food items or even food tray in the nest box in the darkest portion of the cage.

iii) Intraspecific competition in feeding behaviour has been noted in *B. indica.* Similar habit was observed in other species by Barnett and Spencer (1951) and Chitty and Southern (1954). According to them, this carrying back habit has an incidental social value.

iv) When same food item is simultaneously provided in two different types of food trays one familar and other unfamiliar, consumption from the familiar tray is always higher. When the living *P. globosa* as well as only flesh of *P globosa* supplied at a time, it takes live ones only. This, clearly illustrates neophobia in *B. indica.*

v) Amount and nature of faecal matter of the large bandicoot rat varies according to the type of food. Normally it is blackish in colour, but with green vegetable diet it is greenish. With a diet of carrot and beet it is saturn red and carmine respectively. Faecal matter is soft and less in amount with *P. globosa* as diet, while it is much more with rice and other grains.

DISCUSSION

The study of food habit in nature as well as in captivity, revealed that *P. globosa* is the most preferred food followed by rice. Stomach-contents also revealed a wide variety of food items, both plants and animals along with a seasonality in its food habit. Almost similar result was obtained from the stomach-contents analyses of different species of rodents (Hamilton 1941, Jameson 1952, Prasad 1954, Miller 1954, Harrison 1954, Prakash 1962, 1981, Fall *et al.* 1971, Chakraborty 1977, Sood and Dilber 1977). Consumption of a wide variety of food items in nature by *B. indica* as well as by many other species of rodents is obviously to select a best possible balanced diet from the available food resources The ability to select food on the basis of nutritional value is probably wide spread among mammals (Lepkovsky 1948) and the maintenance of a steady weight or growth rate by regulation of calorie intake is a familar phenomenon (Soulairae 1958, Anand 1961 and Barnett 1963). However, a rodent's choice of food is not always determined by need; certain physical properties of food, such as taste, odour or colour are attractive to them irrespective of nutritional value (Barnett *op. cit.).* Hence, it appears that consumption of a wide variety of food items by *B. indica* is not only related to their nutritional value but also to their taste and odour. Seasonality in the food habit is an adaptation which *B. indica* has developed to tide over the unfavourable situation.

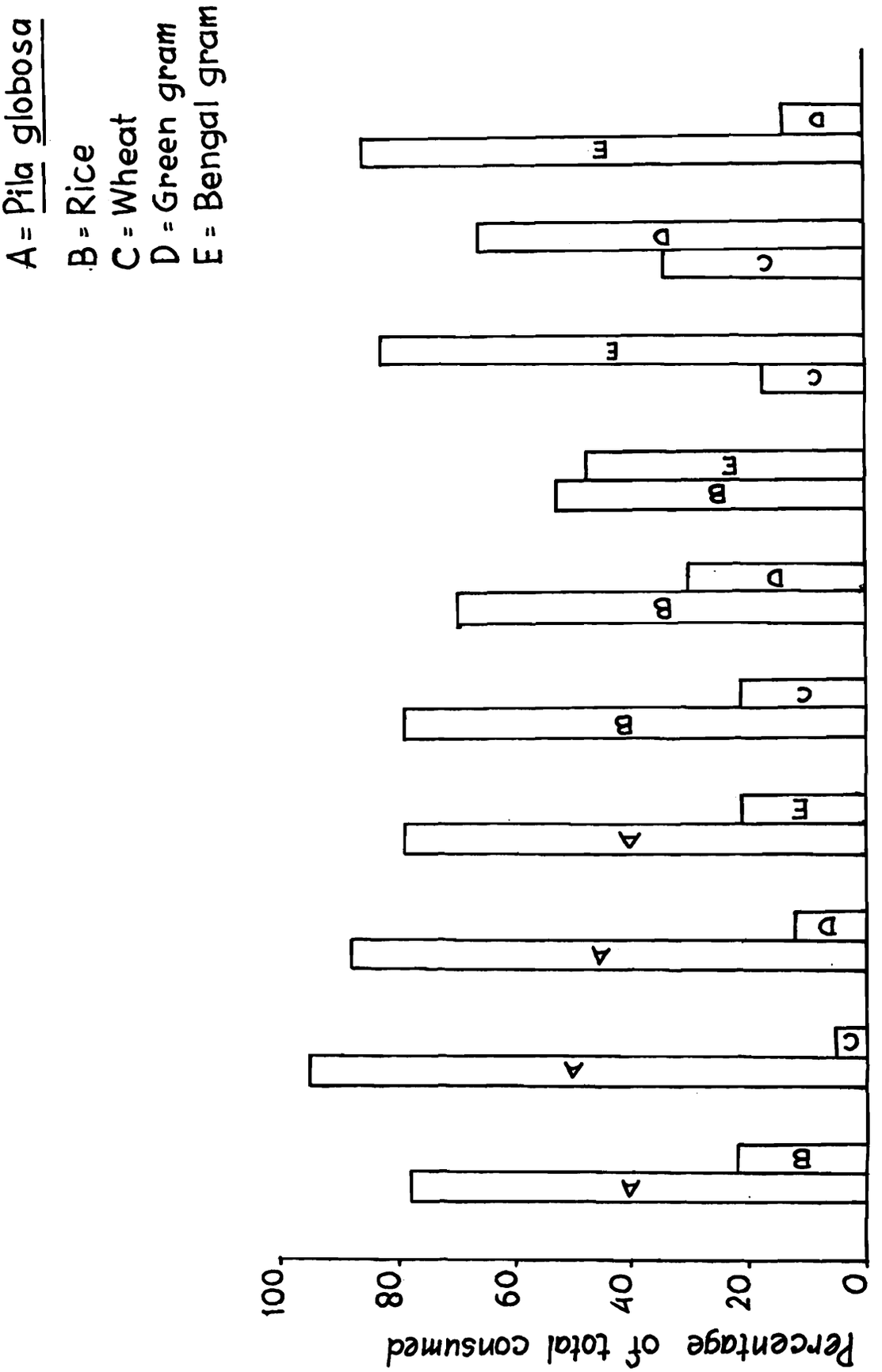

Fig. 6. Study of total daily intake in captivity with two food items provided at a time.

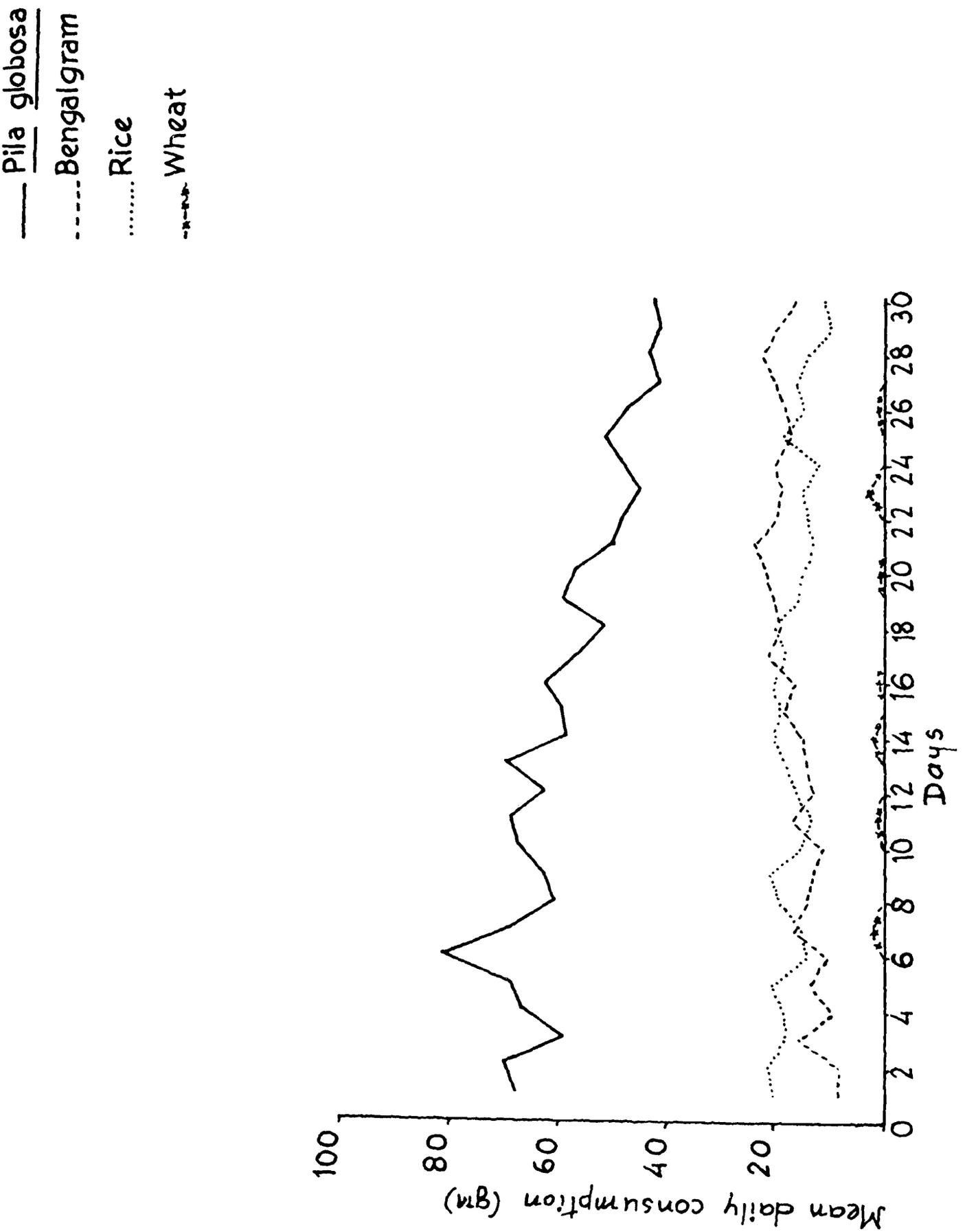

Fig. 7. Daily mean consumption of four food items when provided all at a time with *P. globosa* as one of the items

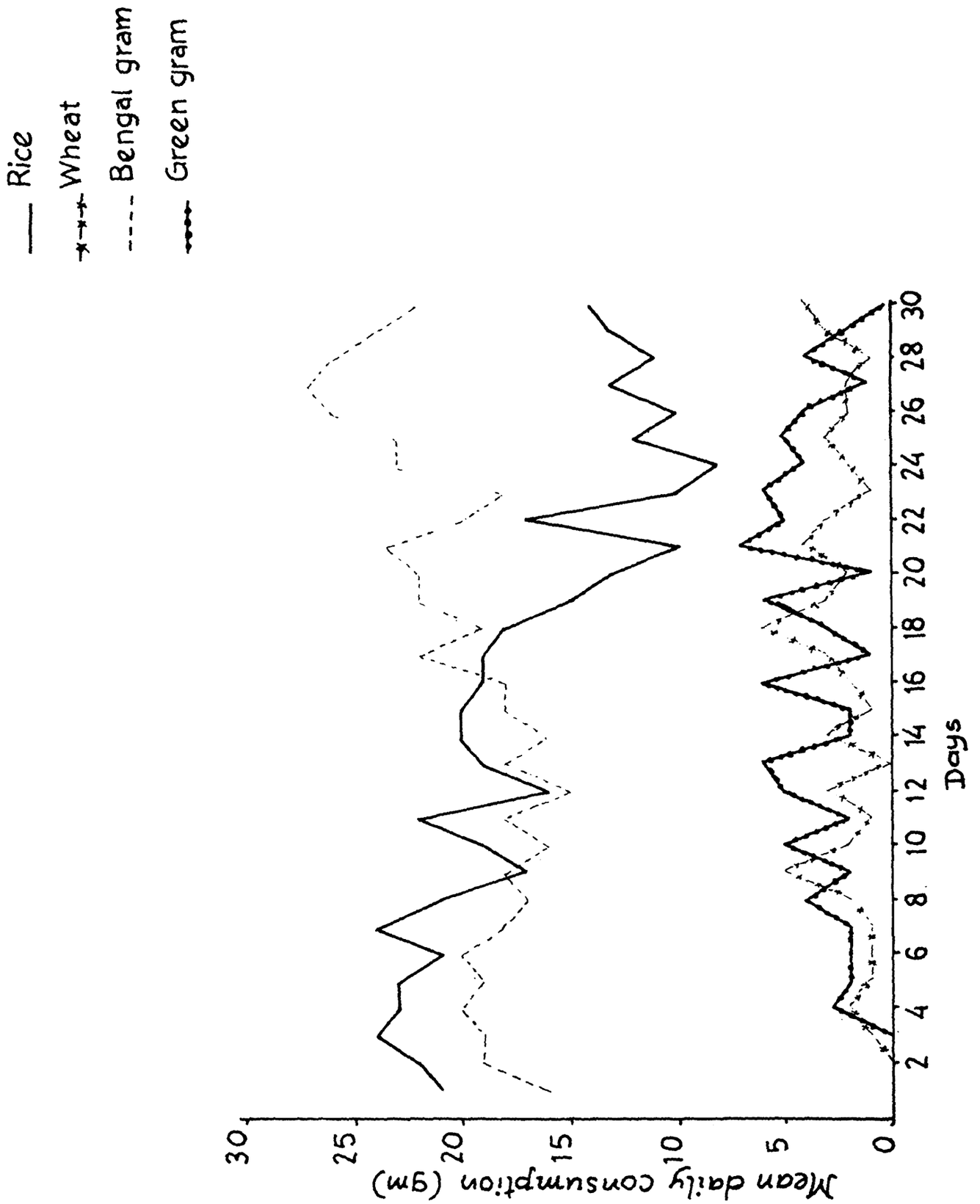

Fig. 8. Daily mean consumption of four food items when provided all at a time without *P. globosa* as one of the items.

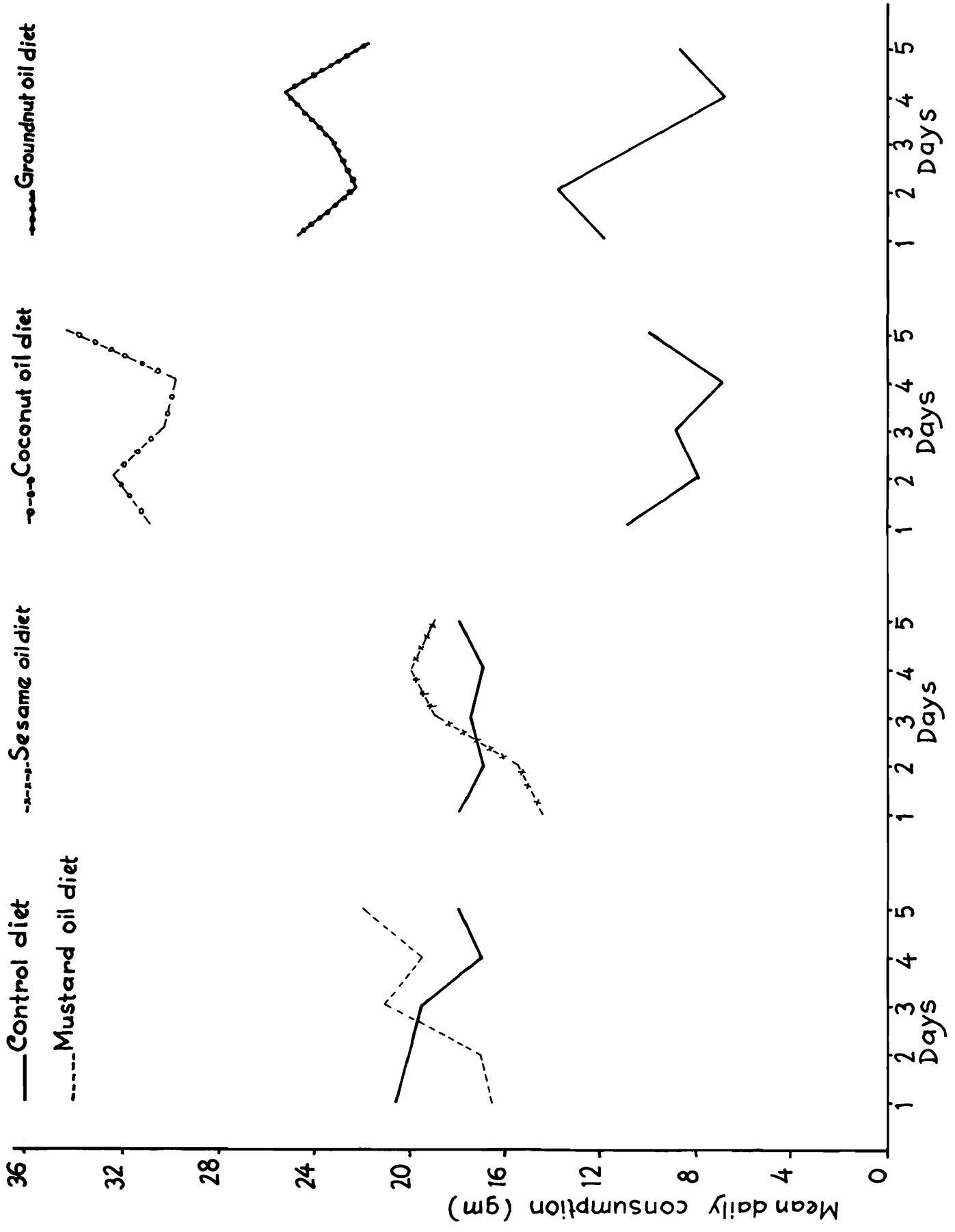

Fig. 9. Paired preference tests between various oils and control diets.

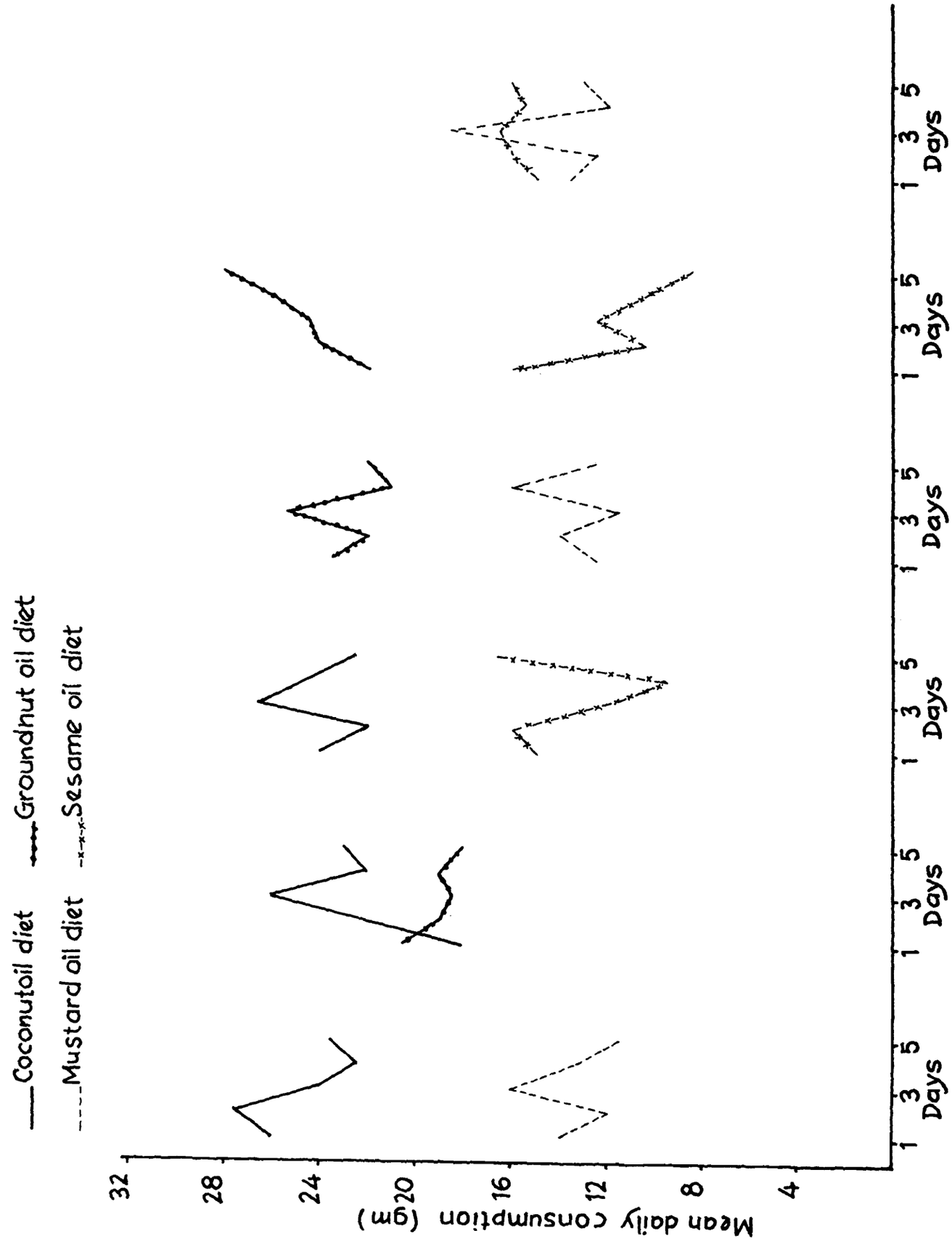

Fig. 10. Paired preference tests between two different oil diets.

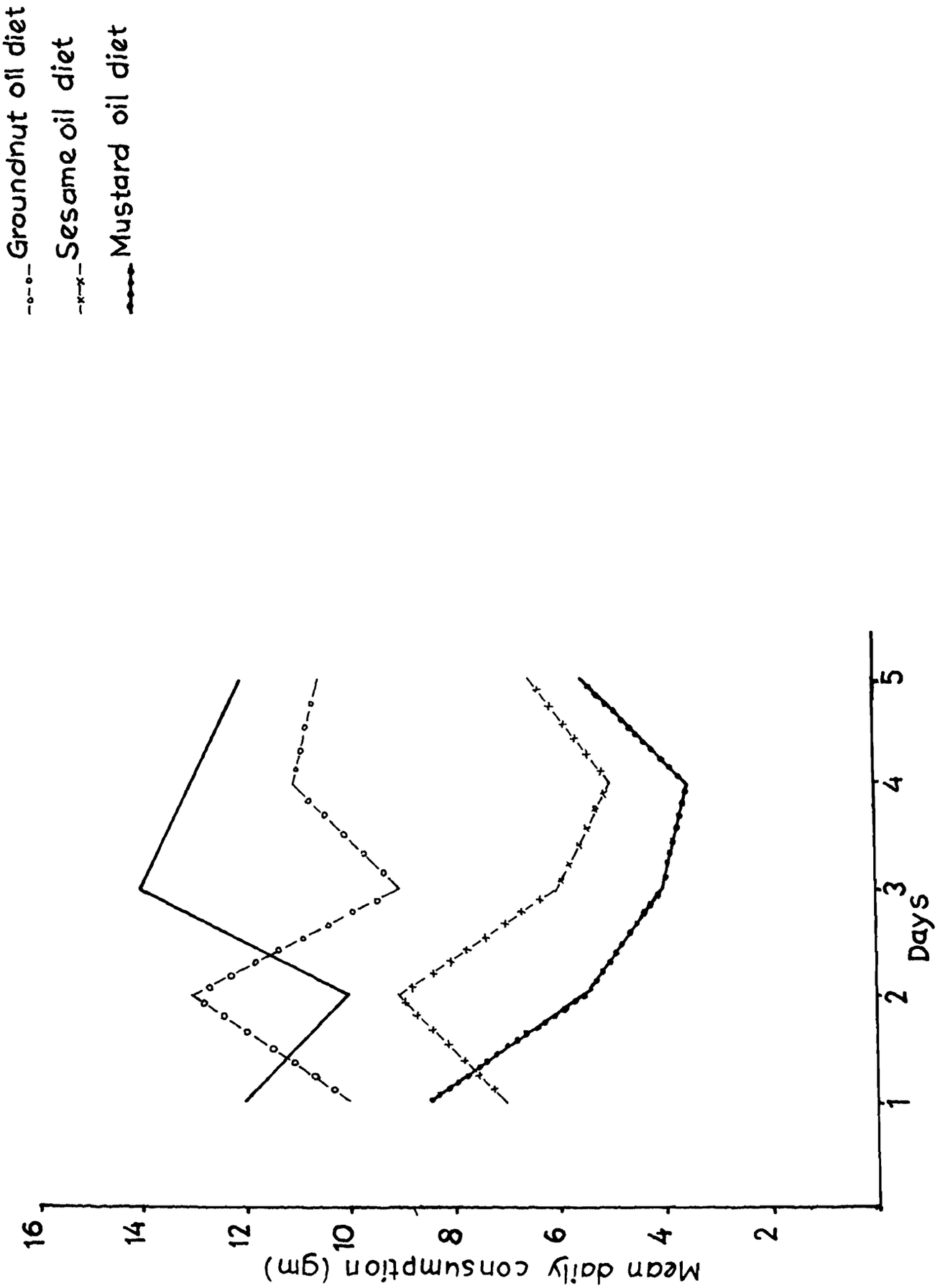

Fig. 11. Multiple choice tests with four oil diets.

The large bandicoot rat is a great predator of molluscs, crabs, fishes, birds and even some species of snakes. Large size, powerful limbs and incisors, ability to swim and run, etc., help the animal in its predaceous habit. In West Bengal, different species of molluscs and crabs are responsible for the damage of various vegetables, seedlings of paddy and wheat. A number of such pestiferous species of molluscs and crabs were found to be regularly consumed by *B. indica* at Sagar Island. Raut and Ghose (1979) also reported predation of *B. indica* on two pestiferous species of molluscs, *viz., Achatina fulica* and *Macrochlamys indica* in the gardens of Calcutta. Thus, the large bandicoot rat although responsible for certain amount of damage to paddy, vegetable, fisheries *etc.,* yet it plays an important role in the biological control of different pestiferous species. Role of rodents in the control of various pest species, specially of insects, have also been pointed out by Prasad (1954), Prakash (1969), Sood and Dilber (1977).

In nature as well as in captivity it has been observed that even when there is sufficient supply of the most preferred food, *i.e. P. globosa,* the large bandicoot rat consumed some amount of other food items, if available. Moreover, it was found that calorie intake became less with only *P. globosa* diet, as compared with other food grains. Thus, it is obvious that when there is choice, *B. indica* selects a number of food items on the basis of nutritional value as well as palatability.

Quantity of food and calorie intake increased with the number of choice, Consumption of wide variety of food items in nature is, therefore, necessary for a steady weight and growth rate.

Mean food or calorie requirement of *B. indica* per day per gram of body weight is much less than that of the much smaller sized species of rodents, *viz., Gerbillus gleadowi, Millardia meltada, Meriones hurrianae* (Prakash *et al.* 1975), *Rattus rattus, Tatera indica* (Sridhara and Krishnamoorthy 1978), *Mus platythrix* (Sridhara and Srihari 1979) and *Mus musculus* (Rao and Prakash 1980). Although food consumption is generally directly related to body weight, yet it has been fairly established that the metabolic rate of the animals increases with the diminishing body size (Schmidt-Nielsen 1973) and food eaten per gram of body weight declines with increasing body weight (Barnett 1975). Therefore, the present finding is in quite agreement with the general principle of food and calorie requirements of animals.

Experiment with multiple choice illustrates the influence of habitat on the food habit of animals. All the rats of the present experiment were collected from paddy growing area and their initial preference for rice may be attributed to the familiarity of rice. Later, with the continuous supply of Bengal gram, rats became acquainted with that food and preferred over rice probably due to more nutritional value or palatability or simply for a change of taste. Medway (1978) found that in Malaysia, natural diet of *B. indica* mainly consisted of plant material including rice, tapioca, sugar cane, *etc.* However, at Sagar Island, *P. globosa* is the most preferred natural diet. This geographical or habitat effect on the food habit of different species of rodent have also been observed (Harrison and Woodville 1950, Barnett 1969, Chitre and Deoras 1966, Spillett 1968, Fall *et al.* 1971). In fact, rodents demonstrate a differential preference to food items depending on the availability of them in the areas of their occurrence.

Studies on oil preference with different species of rodents revealed that addition of oils has positive, negative as well as neutral role in bait acceptance. Moreover, preference for oils is not generalised but selective as in the case of *B. indica.* Addition of some particular oils proved to be effective in *Rattus rattus* (Majumder *et al.* 1969, Khan 1974), *Millardia meltada* (Jain *et al.* 1974, Chopra and Sood 1980), *Bandicota bengalensis* (Durairaj and Rao 1977) and *Golunda ellioti* (Soni *et al.* 1979). However, for *Meriones hurrianae* and *Tatera indica,* addition of vegetable oils did not significantly increase the bait consumption (Prakash *et al.* 1969). Addition of oils decreased the bait acceptance in *Mus musculus* (Rao and Prakash 1980). Reasons for preference or non preference of oils are not clearly understood. According to Barnett (1969) some preferences and some rejections are independent of nutritional value and depend on the palatability. While, Rao and Prakash (1980) opined that decline in T. D. I. with addition of oils in *M. musculus* is due to higher calorie value of the additives. Calorie and nutritional values of all the oils used in the present study are almost the same. It appears that non preference of mustard and seasame oils by *B. indica* due to the pungent smell.

Intraspecific odour increased the bait consumption to some extent but not significantly in both the sexes of *B. indica.* The role of chemical signals among rodent has been reviewed by Shunkle (1977). Intraspecific (Pheromones) and interspecific (Allomones) odours have found to increase the food consumption in a number of Indian rodents (Kumari and Prakash 1979, 1980, Rao and Prakash 1988, Idris 1982, Chopra and Sood 1983, Idris and Prakash 1983). On the contrary, repulsive or offensive action of the interspecific odours have also been reported in a number of rodent species (Subiah 1980, Krishnamoorthy 1981, 1982, Chopra and Sood 1983). However, further study is required to comment on the role of intra or interspecific odours in the bait consumption of *B. indica.*

From the above discussion it is obvious that particular care should be taken for the management of *B. indica* at Sagar Islands, so that a viable population is maintained instead of total eradication. Owing to the obvious difficulty of mixing rodenticides with *P. globosa,* the next preferred food, *viz.,* rice is regarded as the most suitable bait base. Use of rice powder with 10% coconut or groundnut oil is suggested as bait base. However, in agreement with the suggestion of Fitzwater and Prakash (1986), use of mixed baits will be more fruitful for trapping or poison baiting.

SUMMARY

The large bandicoot rat usually feeds only after dusk till the early morning. It regularly goes to the water in search of prey and brings the prey in a particular feeding place. Analysis of stomach contents revealed diversity of food items as well as seasonality, Molluscs, fishes, insects, grasses are consumed throughout the year, crabs and prawns mainly during monsoon,while paddy and potato tuber during post monsoon. In captivity, a simple preferential order for *P. globosa* was demonstrated. Food and calorie intake increased considerably with increase in the number of

choices. Tests with oils revealed the following preference : coconut→ groundnut → sesame → mustard. Consumption of food scented with intraspecific odour was higher than control food. Freshly collected specimens readily accepted water and food. It is responsible for the certain damage of paddy, vegetable, fishery, *etc.*, but at the same time plays an important role in the biological control of a number of pestiferous species.

ACKNOWLEDGEMENT

We are thankful to Dr. J. R. B. Alfred, Director, Zoological Survey of India, Dr. A. K. Ghosh, former Director, ZSI, for providing all the facilities and continuous encouragement. Thanks are due to Dr. R. K. Varshney, Retd. Addl. Director, ZSI, and Dr. V C. Agrawal, Emeritus Scientist, Dr. A. K. Mukherjee, Retd. Dy. Director, ZSI for their valuable suggestions.

We are grateful to the Scientists of the Botanical Survey of India, Calcutta for helping in the identification of the plant material.

We sincerely thank Dr. I. Prakash, Insa Senior Scientist and Dr. A. Chowdhury, Dept. of Marine Science, C. U. for their valuable suggestions.

REFERENCES

Anand, B. K. 1961. Nervous regulation of food intake. *Physiol. Rev.*, 41 : 677-705.

Barnett, S. A. 1963. The Rat : A study in behaviour. Chicago Aldine Press ; London, Methuen.

Barnett, S. A. 1969. The feeding of rodents. Indian Rodent Symp. (1966), Calcutta, PP. 113-123.

Barnett, S. A. 1975. The Rat : A study in behaviour. Chicago University Press.

Barnett, S. A. & Spencer, M. M. 1951. Feeding, social behaviour and intraspecific competition in wild rats. *Behaviour*, 3 : 229-242.

Balanford, W. T. 1891. The fauna of British India, Mammalia. Taylor and Francis, London.

Chakraborty, R. 1992. The Large Bandicoot Rat, *Bandicota indica* (Bechstein). Rodents in Indian Agriculture, Vol 1, 1992, [Eds. Iswar Prakash and P. K. Ghosh] : Scientific Publisher, Jodhpur.

Chakraborty, R. and Chakraborty, S. 1982. Food habit of Large Bandicoot Rat, *Bandicota indica* (Bechstein) in the fields of West Bengal during rainy season. *Rodent Newsl.*, 6 : 27.

Chakraborty, S. 1977. Field observation on the biology and ecology of the Lesser Bandicoot Rat, *Bandicota bengalensis* (Gray) in West Bengal. *Proc. All India Rodent Seminar* (1975), Ahmedabad, pp. 102-112.

Chakraborty, S. 1981 Studies on the systematics and biology of some Oriental rodents. Ph. D. Thesis, University of Calcutta.

Chitre, G. D. and Deoras, P. J. 1966. Observation on the feeding propensity and behaviour of rats. Presented in the'Indian Rodent Symp' (1966), Calcutta.

Chitty, D. And Southern, H. N. (Eds.) 1954. The control of rats and mice. 3 Vols. Oxford.

Chopra, G. and Sood, M.L. 1980. Feeding behaviour of soft-furred field rat, *Rattus meltada* (Gray) : Oils. *Bull. Grain Technol.*, 18 : 204-207.

Chopra, G. and Sood, M. L. 1983. Effect of intra and interspecific odours on the food consumption of *Rattus meltada. Rodent Newsl.*, 7 15-16.

Durairaj, G. and Rao, I. 1977. Feeding behaviour of *Bandicota bengalensis* : Oils. *Proc. All India Rodent Seminar* (1975), Ahmedabad, pp. 115-125.

Fall, M. W., Medina, A. B. and Jackson, W B. 1971. Feeding patterns of *Rattus rattus* and *Rattus exulans* on Eniwetok Atoll, Marshall Islands. *J. Mammal.*, 52 : 69-76.

Hamilton, W. J. 1941. The food of small forest mammals in eastern United States, *J. Mammal.*, 22 : 250-263.

Harrison, J. L. 1954. The natural food of some rats and other mammals. *Bull. Raffles Mus.*, 25 : 157-165.

Harrison, J. L. and Woodville, H. C. 1950. Notes on feeding habits of house rats in Rangoon, Burma. *Ann. appl. Biol.* 37 : 296-304.

Idris, M. 1982. Interspecific odours enhance food consumption of *Tatera indica. Rodent Newsl.*, 6 : 14-15.

Idris, M. and Prakash, I. 1983. Phago-stimulant property of body odours. *Rodent Newsl.*, 7 : 4-5.

Jain, A. P., Prakash, I. and Rana, B. D. 1974. Baits for the control of the soft-furred field rat, *Rattus meltada pallidior* Ryley. *Z. angew. Zool.* 61 : 183-198.

Jameson, E. W. 1952. Food of deer mice, *Peromyscus maniculatus* and *P. boylei*, in the northern Sierra Nevada, California. *J.Mammal.*, 34 : 44-58.

Jerdon, T. C. 1874. The mammals of India. London.

Khan, J. A. 1974. Laboratory experiments on the food preference on the Black Rat *(Rattus rattus* L). *Zool. J. Linn. Soc.*, 54 : 167-184.

Krishnamoorthy, M. 1981. Repulsive or offensive odours in rodents. *Rodent Newsl.*, 5 : 3.

Krishnamoorthy, M. 1982. Repulsive/offensive odours of house mouse. *Rodent Newsl.*, 6 : 3.

Kumari, S. and Prakash, I. 1979. Conspecific odours as a phage stimulant for the Indian gerbil, *Tatera indica indica* Hardwicke. *Indian J. Expt. Biol.*, 17: 981-982.

Kumari, S. and Prakash, I. 1980. Effect of conspecific urine odour on food consumption and shyness behaviour in desert gerbil. *Rodent Newsl.* 4 : 15.

Lepkovsky. S. 1948. The physiological basis of voluntary food intake (Appetite?). Ad. Fd. Res. 1 : 105-140.

Majumder, S. K., Krishnakumari, M. K. and Urs. Y L. 1969. Some observations of food preferences and intake of rats under different ecological conditions. Indian Rodent Symp. (1966). Calcutta. PP. 124-136.

Medway, Lord. 1978. The wild mammals of Malaya (Peninsular Malaysia) and Singapore. Kuala Lumpur.

Miller, R. S. 1954. Food habits of the Wood-mouse, *Apodemus sylvaticus* (Linne, 1758), and the Bank Vole, *Clethrionomys glareolus* (Schreber, 1780), in Wytham Woods, Berkshire. *Sauget. Kund. Mitt.*, 2 : 109-114.

Nandi, N. C. 1984. Bandicoot rat seizing a snake. *J. Bombay nat. Hist. Soc.*, 81 : 183.

Prakash, 1. 1962. Ecology of gerbils of the Rajasthan desert, India. *Mammalia*, 26 : 311-331.

Prakash, 1. 1969. A review of the studies on the food of Indian Gerbils. Indian Rodent Symp. (1966), Calcutta. pp. 147-151.

Prakash, I. 1975. Food of rodents in nature. ICAR Summer Institute Rodentology, Jodhpur, June-July, 1975.

Prakash, I. 1981 Ecology of the Indian Desert Gerbil *Meriones hurrianae*. CAZRI, Jodhpur.

Prakash, I., Fitzwater, W. D. and Jain, A. P. 1969. Toxic chemicals and baits for the control of two gerbils, *Meriones hurrianae* (Jerdon) and *Tatera indica* Hardwicke. *J. Bombay nat. Hist. Soc.*, 66 : 500-509.

Prakash, I., Jain, A. P. and Rana, B. D. 1975. Baits for the control of Hairy Footed Gerbil, *Gerbillus gleadowi* Murrary. *Z. angew. Zool.*, 62 : 349 -359.

Prakash, I. and Kumbkarni, C. G. 1962. Eco-toxicology of Indian Desert Gerbil, *Meriones hurrianae* (Jerdon). 1. Feeding behaviour, energy requirements and selection of baits. *J. Bombay nat. Hist. Soc.*, 59 : 800-806.

Prasad, M. R. N. 1954. Food of Indian gerbil, *Tatera indica cuvieri* (Waterhouse). *J. Bombay nat. Hist. Soc.*, 52 : 321-325.

Rao, A.M.K.M. and Prakash, I. 1980. Evaluation of bait bases for the control of the House Mouse, *Mus musculus bactrianus* Blyth. *Bull. Grain Technol.*, 18 : 111-118.

Raut, S. K. and Ghosh, K. C. 1979. Natural enemies of pestiferous snails in West Bengal, India. *Bull. Entomology*, 20 : 153-155.

Schmidt-Neilsen, K. 1973. Animal physiology. New Delhi.

Soni, B. K., Prakash, I. and Mathur, R. P. 1979. Baits for the control of Indian Bush Rat, *Golunda ellioti gujerati* (Thomas). *Indian J. Rodent.*, 1 : 1-9.

Sood, M.L. and Dilber, D. S. 1977. Food and feeding habits of Northern Palm Squirrel, *Funambulus pennanti* Wroughton. *J. Res. Punjab Agric. Univ.*, 14 : 329 : 331.

Soulairae, A. 1958. Les regulations Phycho-physiologiques de la paim. *J. Physiol. Path. gen.*, 50 : 663-783.

Spillett, J. J. 1968. The ecology of the Lesser Bandicoot Rat in Calcutta. Bombay Natural History Society and John Hopkins University Centre for Medical Research and Training, Calcutta.

Sridhara, S. and Krishnamoorthy, R. U. 1978. General preference and intake of four species of field rodents. *J. Bombay* nat. *Hist. Soc.*, 75 : 129-135.

Sridhara, S. and Srihari, K. 1978. Food preference of the Large Bandicoot Rat, *Bandicota indica. Rodent. Newsl.*, 2 : 5.

Sridhara, S. and Srihari, K. 1979. Comparison of food and calorie intake of *Bandicota indica* and *Mus platythrix. Comp. Physiol. Ecol.*, 4 : 258-260.

Subiah, K. S. 1980. Offensive odour of female *Rattus rattus. Rodent Newsl.*, 4 : 20-21.

Shunkle, S. A. 1977. In 'Chemical signals in vertebrates' (Ed. D. Mullar-Schwarse). pp. 357-376.

Table 1. Frequency of occurrence and percentage of material (by weight) contained in 42 stomachs of *Bandicota indica* from Sagar Island.

Food item	Month of collection and stomach number																			
	March			April			May		June		July				August			September		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Rana sp.	–	–	–	–	–	+	–	–	–	–	+	–	–	–	–	–	–	–	–	–
Puntius sp.	–	+	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–
Chela sp.	–	–	–	–	–	–	+	–	+	–	–	–	+	–	–	–	+	–	–	–
Other fishes	–	–	–	+	–	–	+	–	+	–	–	–	–	+	–	+	–	–	–	+
Pila globosa	+	+	–	–	–	–	–	–	–	–	–	+	–	–	+	+	+	–	+	–
Lamellidens marginalis	–	–	–	+	–	–	–	–	–	–	–	–	+	–	+	–	–	+	–	–
Other molluscs	+	–	–	–	–	–	–	+	–	+	–	–	–	+	–	+	–	–	–	+
Macrobrachium sp.	–	–	–	–	–	–	–	–	–	–	–	+	–	+	–	–	+	–	–	–
Metapenaeus sp.	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–	+	–	–	+	–
Varuna sp.	–	–	–	–	–	–	–	–	–	–	–	+	+	–	–	–	+	–	+	–
Paratelphusa sp.	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–	+	–	–
Belostoma sp.	–	–	–	–	–	–	+	–	–	–	–	–	–	+	–	–	–	–	–	–
Acrotylus sp.	–	–	–	–	+	–	–	–	–	+	–	–	–	–	–	+	–	–	–	–
Erotes sp.	–	–	–	–	–	–	+	–	–	–	–	+	–	–	–	–	–	–	–	–
Other insects	+	+	+	–	+	+	–	–	+	+	–	+	–	–	–	–	–	–	–	–
Pheretima sp.	–	–	–	–	–	–	–	–	+	–	–	–	+	–	–	+	–	–	–	–
Unidentified animals	–	+	–	+	+	–	–	–	–	+	–	–	–	–	–	–	–	–	+	–
Paddy	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Potato	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Phaseolus sp.	–	–	+	–	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–	–
Derris sp.	–	–	–	–	–	+	–	–	–	–	–	–	+	–	–	+	–	–	–	–
Amaranthus sp.	–	–	–	+	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–
Hydrolea sp.	–	–	–	+	–	–	–	–	–	–	–	+	–	–	–	–	+	–	–	+
Colocasia sp.	–	–	–	–	–	+	–	–	–	+	–	–	–	–	–	–	–	–	–	–
Sphenoclea sp.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–	+	–
Grasses	–	–	+	–	+	–	+	+	–	+	–	–	+	+	+	–	–	+	–	–
Unidentified plants	+	+	–	+	+	+	–	+	+	+	+	–	–	+	+	+	–	–	–	–

* Total differs from 100% due to rounding.

Contd.

October		November				December						January					February					Frequency of	*Percent
21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	Occurrence	(By Weight)
–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3	1
–	–	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–		–	–	–	–	4	0.8
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–					4	0.8
–	–	+	–	+	–	–	–	+	–	–	–	–	–	+	–	–	–	–	–	–	–	12	5.5
+	–	+	–	–	+	–	–	–	–	–	–	–	–	+	–	–	+	–	–	–	+	12	3.8
–	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	+	–	–	5	3
–	–	–	+	–	–	–	–	–	–	–	+	–	–	+	–	–	–	–	–	–	–	11	7
–	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–	+	–	–	+	4	0.5
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3	0.3
–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	5	1.1
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	0.4
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	0.1
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3	0.1
–	+	–	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4	0.1
–	–	–	–	–	–	–	–	–	–	–	+	–	+	–	–	–	–	–	–	–	–	12	0.7
–	–	+	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–	–	+	–	–	5	0.3
—	–	–	+	–	–	–	–	–	+	–	+	–	+	–	–		–	–	–	–	–	9	2.6
–	–	–	+	–	+	–	–	–	+	+	+	+	–	–	+	+	–	–	–	–	–	11	9
–	–	–	–	–	–	+	+	–	–	–	+	–	+	–	–	–	–	–	+	–	+	6	6
–	–	+	–	–	–	–	–	–	–	+	–	–	–	–	–	–	+	–	–	+	–	4	0.4
–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4	0.3
+	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–	4	0.5
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	5	0.3
–	–	–	–	–	–	–	+	–	–	–	–	–	–	+	+	+	–	–	–	–	+	7	5.4
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–	5	0.2
+	–	+	–	+	–	+	–	_	+	–	+	–	–	–	+	+	–	+	–	–	–	20	4.3
–+	+	+	+	+	+	–	–	+	+	–	–	–	–	+	–		–	–	+	–	+	24	11
																	–	–	+	+	+		

Table 2. Average weight of the stomach contents (gm) of 42 specimens of *Bandicota indica* captured in different hours (18.00 hrs to 6.00 hrs.). Number of samples given in parenthesis.

Hours	18.00-20.00	20.00-22.00	22.00-0.0	0.0-2.00	2.00-4.00	4.00-6.00
Weight of the stomach contents	23.2(7)	42.4(9)	47.3(4)	51.1(9)	49.1(8)	57.6(5)

Table 3. Meen T.D.I. of food, calorific value, water, and changes in the body weight of *Bandicota indica* when presented five food items one at a time to five individually caged adult animals for five days study period.

Food items	Mean T.D.I (gm) of food/rat	Calories/ gm	Mean Calories consumed/ rat/day	Mean water intake (c.c)/rat/day	Average body weight (gm) of experimental rats				Mean food con-sumption (gm)/gm of rat/day	Mean calories consumed/ gm/of rat/day
					Start	Finish	Diff.	Mean		
Pila globosa	*95	0.97	92.15	**7.2	652	649	–3	650.5	0.146	0.141
Rice	£36	3.48	125.28	22	649	641	–8	645	0.055	0.194
Wheat	28	3.46	96.88	23.4	641	628	–13	634.5	0.044	0.152
Greem Gram	29	3.51	101.79	21	628	627	–1	627.5	0.046	0.162
Bengal Gram	32	3.65	116.16	21.3	627	624	–3	625.5	0.051	0.185

* Significantly high than other food items, P<0.001

** Significantly low than with other food items, P< 0.001

£ Significantly high than other three plant products, P<0.05

Table 4. Mean T.D.I. of food, water, calorific value and changes in the body weight of *Bandicota indica* when five food items were presented, two at a time to five individually caged adult animals for five days study period.

Food items	Mean (gm) of food	Calories/ gm	Mean calories consumed/ rat/day	Mean water intake (c.c.)/ rat/day	Average body weight (gm) of the experimental rats				Mean food food in take (gm)/ gm of rat/ day	Mean calories consumed/ gm of rat/day
						Finish	Differ-ence	Mean		
*1. *Pila globosa* Rice	74	0.97	71.78	**12.4	574.2	646.6	–0.6	646.9	0.146	0.223
	21	3.48	73.08							
*2. *P. globosa*	88	0.97	85.36	**11	646.6	645.8	–0.8	646.2	0.143	0.158
Wheat	5	3.46	17.3							
*3. *P. globosa*	79	0.97	76.63	**9.4	645.8	645.6	–0.2	645.7	0.139	0.178
Green Gram	11	3.51	38.61							
*4. *P. globosa*	74	0.97	71.78	**11	645.6	646	+0.4	645.8	0.145	0.223
Bengal Gram	20	3.63	72.6							
5. Rice	30	3.48	104.4	25.5	646	644.8	-1.2	645.4	0.058	0.204
Wheat	8	3.46	27.68							
6. Rice	26	3.48	90.48	23.5	644.8	643.8	–1.0	644.3	0.057	0.2
Green Gram	11	3.51	38.61							
7. Rice	21	3.48	73.04	26.2	643.8	644	+0.2	643.9	0.062	0.22
Bengal Gram	19	3.63	68.97							
8. Wheat	6	3.46	20.76	27	644	643.2	–0.8	643.6	0.055	0.201
Bengal Gram	30	3.63	108.9							
9. Wheat	11	3.46	38.06	24.3	643.2	641.8	–1.4	642.5	0.049	0.173
Green Gram	21	3.51	73.71							
10. Bengal Gram	30	3.63	108.9	23	641.8	641.6	–0.2	641.7	0.054	0.197
Green Gram	5	3.51	17.55							

* Significantly higher than other six diadic trials, $P<0.001$

* Significantly less than other six diadic trials, $P<0.001$

Table 5. Average daywise consumption of *Bandicota indica* when four food items (*Pila globosa* and three food grains) were provided at a time for thirty consecutive days to four individually caged specimens.

Food items	Daywise mean consumption (gm) of each food item/rat																			
Days–	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Pila globosa	68	70	59	67	69	81	69	61	63	68	69	63	70	59	60	63	57	52	60	58
Bengal Gram	8	8	15	9	13	10	16	14	13	11	16	13	14	15	18	16	21	19	20	22
Rice	20	21	18	18	20	14	15	19	21	15	13	16	18	20	19	20	18	20	16	15
Wheat	—	—	—	—	—	—	2	—	—	—	1	—	—	2	—	1	—	—	—	1
Total	96	99	92	94	102	105	102	94	97	94	99	92	102	96	97	100	96	91	96	96

Contd.

Table 6. Average daywise consumption of *Bandicota indica* when four food grains were provided at a time for thirty consecutive days to four individually caged specimens.

Food items	Daywise mean consumption (gm) of each food item/rat																			
Days–	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Rice	21	22	24	23	23	21	24	21	17	19	22	16	19	20	20	19	19	18	15	15
Wheat	—	—	1	2	1	1	1	2	5	2	1	3	—	3	1	2	3	6	3	2
Bengal Gram	16	19	19	20	19	20	18	17	18	16	18	15	18	16	18	18	22	19	22	22
Green Gram	—	—	—	3	2	2	2	4	2	5	2	5	6	2	2	6	1	3	6	1
Total	37	41	44	48	45	44	45	44	42	42	43	39	43	41	41	45	45	46	46	40

Contd.

										Average body weight(gm)/rat				Mean consumption (gm)/rat/day	Mean consumption (gm)/gm of rat/day	Mean calorie intake /gm of rat/day
21	22	23	24	25	26	27	28	29	30	Start	Finish	Difference	Mean			
51	49	46	49	52	48	42	44	42	43					58.4	0.098	0.095
24	20	19	20	17	18	20	23	20	16					16.2	0.027	0.098
13	14	15	12	18	15	16	14	10	11	589	592	3	590.5	16.4	0.027	0.093
—	—	3	—	—	1	—	—	—	—					0.36	0.0006	0.002
88	83	83	81	87	82	78	81	72	70					91.36	0.153	0.288

										Average body weight(gm)/rat				Mean consumption (gm)/rat/day	Mean consumption (gm)/gm of rat/day	Mean calorie intake /gm of rat/day
21	22	23	24	25	26	27	28	29	30	Start	Finish	Difference	Mean			
10	17	10	8	12	10	13	11	13	14					17.1	0.029	0.1
4	3	1	2	3	4	2	1	3	4					2.1	0.003	0.01
26	20	18	23	23	26	27	26	24	22					20.1	0.034	0.123
7	5	6	4	5	4	1	4	2	—	581	586	5	583.5	3.0	0.005	0.017
47	45	35	37	43	42	43	42	42	40					42.3	0.0171	0.25

Table 7. Influence of body odour on the food consumption in different sexes of *Bandicota indica*.

Type of food items provided	Mean daily intake (gm)	
	Males	Females
	Test I	
A. Rice flour	19	18:5
B. Rice flour scented with females	22	20
Level of significance	Not significant	Not significant
	Test II	
A. Rice flour	17	18
B. Rice flour scented with males	20	21
Level of significance	Not significant	Significant