Pakistan J. Zool., vol. 45(2), pp. 531-536, 2013.

Dietary Habits of the House Rat (*Rattus rattus*) in Urban Rawalpindi, Pakistan

Syeda Rubab Naqvi, Muhammad Mushtaq*, Mirza Azhar Beg, Muhammad Sajid Nadeem and Amjad Rashad Kayani

Department of Zoology, PMAS Arid Agriculture University, Rawalpindi, Pakistan

Abstract.- Dietary habits of the house rat, *Rattus rattus* were studied in the urban areas of Rawalpindi city by analysing the stomach contents. Rats were trapped from general stores and human dwellings of various localities of the city. Reference slides of the relevant materials (grains and cereals) and the stomach contents slides were compared. The results showed that wheat was the most frequently consumed cereal. It was followed by chickpea, millet, barley, lentils (*moong, masoor*), maize, sorghum and peanut. There was a non-significant difference in the winter and summer diets of rats. Stomach contents of rats caught from human dwellings showed more diversity (diversity index = 3.56) than the ones' taken from the general stores (diversity index = 2.87).

Key words: Human dwellings, general stores, stomach contents, dietary diversity.

INTRODUCTION

Rodents are found throughout the world except Antarctica, New Zealand and some of the oceanic islands (Wolf and Sherman, 2007). Success of small rodents is probably due to their small size, short breeding cycle and their ability to gnaw and eat a wide variety of food materials (Prakash, 1988). Some rodents are serious pests to agricultural crops and different stored products. Some commensal rodent species are also responsible for spreading a number of diseases to man and their livestock (Meerberg *et al.*, 2009). The pest species seriously affect the production of farm crops. The cost of managing the rodent depredations is only poorly known (Stenseth *et al.*, 2003). According to FAO (1999), 130 million people could be fed each year with the food spoiled by world's rat and mice population. The house rat is notorious for its role in spreading the bubonic plague (*Yersinia pestis*) that was responsible for taking millions of lives in the Middle Ages. The fleas that live on these rats carry a number of diseases that can seriously harm humans, livestock, and other animals (Grzimek, 2003).

The house rat, *Rattus rattus rufescens* (Gray, 1837) has its origin in South East Asia. It is a cosmopolitan species and has spread through international trade (Meehan, 1984). It is purely an indoor species in Pakistan and is mostly confined to the towns and villages throughout the country (Roberts, 1997). Ahmed *et al.* (1995) reported a large population of the house rat in the grain markets of Rawalpindi city. The house rat is a serious indoor pest in Pakistan. Besides eating the stored grains the rats contaminate them by urinating and defecating on them. An average grain shop in Punjab may have up to 40 rats in it and they cause an annual loss of approximately 4000 mt /year of the stored grains (Ahmed *et al.*, 1995). Mushtaq-ul-Hassan (1993) estimated that from an average village house of central Punjab (Pakistan) about l2,394 kg of bread grains (wheat, barley and maize) are lost to the house rat per year

The present study provides information on the food habits of the house rat in Rawalpindi city.

MATERIALS AND METHODS

Study area

This research study was conducted from October 2010 to July 2011 in the urban areas of Rawalpindi city (33° 36' N, 73° 04' E), located in the Pothwar region of Punjab, Pakistan.

Trapping of rats

House rat were live trapped from human dwellings and grocery stores, using locally made metallic cage traps (42 x 15 x 15 cm) baited with

* Correspondence author: mushtaq@uaar.edu.pk
0030-9923/2013/0002-0531 $ 8.00/0

pieces of fresh fruits. The cage traps were designed to capture one or more specimens during a given operation period. A total of 60 traps were set in 10 different houses @ 6 traps / house. Similarly, another 60 traps were set in 10 different grocery stores @ 6 traps / grocery store. Forty one house rats were trapped (19 from houses and 22 from grocery stores). Most of the trapping campaign was carried out during March to July 2011; hence the seasonal effect could not be studied. Traps were set in the evening and collected the following morning between 5.00 – 8.00 a.m. The captured rats were killed and tagged. The tag carried the specimen number along with other information like place, date of capture and sex of the rat.

Forty one specimens of house rat were live trapped from different areas of Rawalpindi city from October 2010 to July 2011. For each captured individual, standard morphological measurements were recorded, following Aplin *et al*. (2003). Stomachs were removed by cutting the esophagus approximately 1 cm above the stomach and 1 cm below the duodenum and preserved in 70% alcohol. The stomachs were preserved for varying periods of time before examining their contents.

Preparation of reference and stomach content slides

For preparation of reference slides, the expected candidate food materials were collected and their slides were made for identification and comparison of food items present in stomach contents following the modified methods of William (1962) and Ward (1970). The slides of reference materials were studied in detail under a compound microscope. Main features and cellular characteristics of each reference slide were drawn on a note book as free hand drawings and photographs were taken of the main items consumed by the rats (Fig. 1). These drawings, photographs and special characteristics were used to identify the cellular structure of various plant parts/species in the slides of stomach contents.

The stomach contents were preserved in 10% formalin (aqueous saturated solution of formaldehyde) for study purpose. For stomach content analysis, the samples were emptied into a petri-dish; distilled water was added and mixed well with magnetic stirrer for almost ten minutes. Slides were prepared by following the procedure as for reference slides. Four slides were made for each sample. All slides were labeled giving animal number, date and locality of the specimen.

Data analysis and interpretation of results

The slides were studied under the microscope (Olympus, 100 x magnification). A 10 x 10 mm ocular grid micrometer was used to record the frequency of occurrence of different fragments. Each block on the stomach analysis sheet represented one microscope field on the slide, i.e., one of the 100 squares on each. The slides were carefully checked at 10 x magnification and each identifiable item found on the slide was noted. The number of fragments of each plant species was calculated and the total number of fragments recorded following Hansen *et al*. (1971). The overall percent relative frequency was calculated as below:

$$\text{Relative Frequency (\%)} = \frac{\text{Total number of fragments of a given plant species}}{\text{Total number of fragments analyzed}} \times 100$$

Frequency of occurrence and percentage dry weight of each food item was computed as in LaVoie (1987).

To determine the degree of dominance of food items in the stomach samples, Berger-Parker Index (Berger and Parker, 1970) was calculated through equation: $d = N\ (max) / N$

Whereas N is total number of fragments of all food items and N (max) is number of fragments of the most abundant food items. The reciprocal of the index was calculated through equation 1/d.

One Factorial Analysis of Variance (ANOVA) was used to work out the difference of frequency of consumption of different food items. Duncan's Multiple Range Test (DMRT) was used to establish the difference of consumption among various food items (Steel and Torrie, 1980). Student's t-test was applied to record the difference in frequency of different food items between both the sampled localities (stores and houses). A 95% level of significance was used in all the tests.

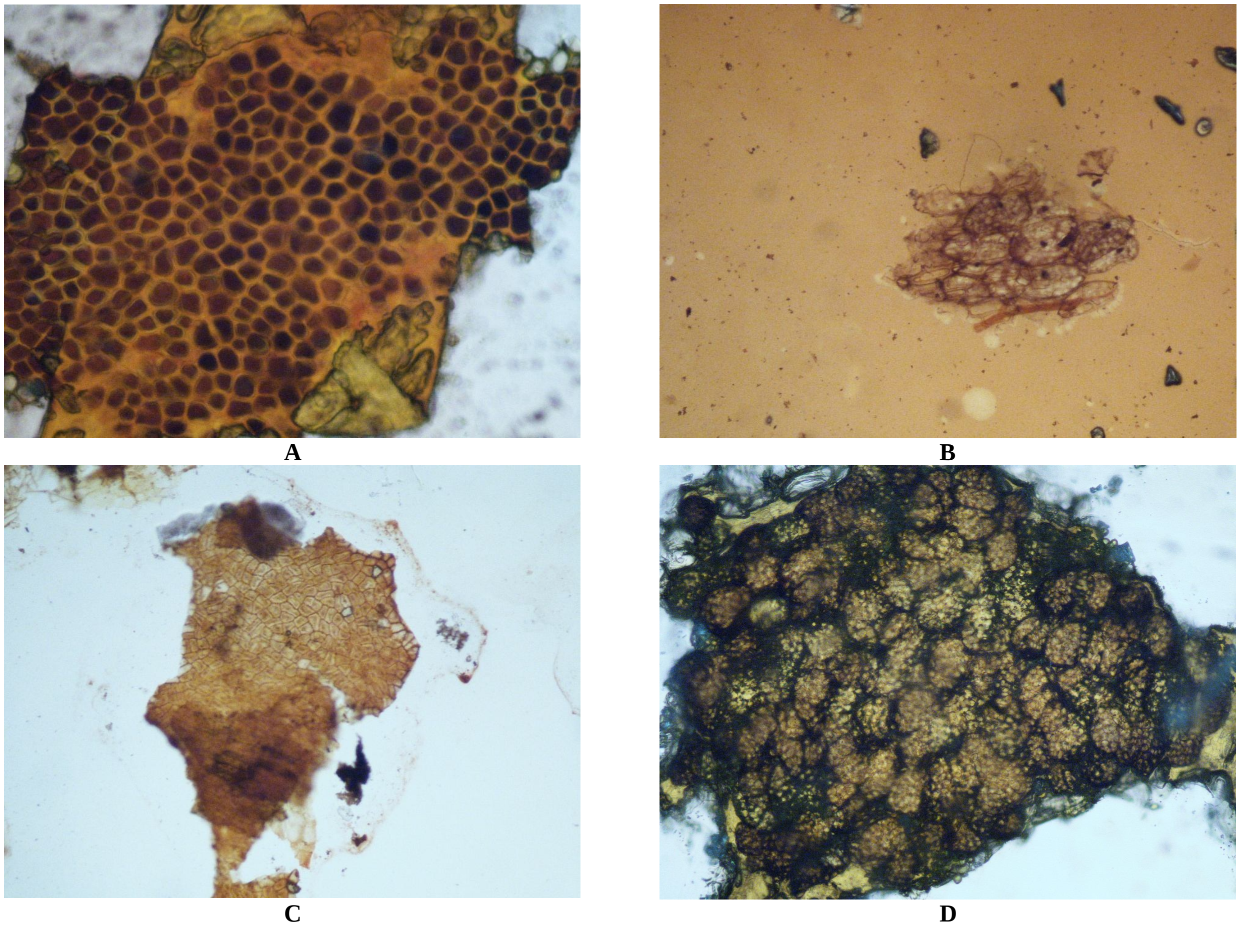

Fig. 1. Structure of food particles from a reference slide and from rat stomach; A, wheat seed tissue from a reference slide; B, chick pea tissue from a rat stomach; C, barley tissue from a reference slide; D, peanut tissue from a rat stomach. All magnifications: X10.

RESULTS AND DISCUSSION

The results showed that the house rat mainly consumed grains and cereals both in the houses and stores in the area. In our study area, wheat (number of fragments averaged across the slides examined = 170.68±18.63) was the most consumed food item of the diet of the house rat (Fig. 2) followed by chickpea (82.16±16.52), millet (72.47±13.91), moong (61.21±11.91), rice (55.3±11.71), masoor (46.95±10.62) and barley (36.95 ±16.43). The least consumed food items were maize (6.05±2.54), sorghum (4.81±1.67) and peanut (1.36±0.21). In addition to the plant based materials, animal matter (3.07±0.52), sand / soil particles (2.45±0.38) and some unidentified materials (2.51±0.39) were also recovered from the stomach contents. Like frequency of occurrence, percent dry weight (Fig. 3) of wheat (35.20%), chickpea (15.20%), millet (11.40%), moong (10.50%), rice (9.50%), masoor (8.60%) and barley (6.70%) dominated in the diet. Maize, sorghum and animal matter were weighed less than 1%, while peanut and sand/soil particles were recorded in negligible amounts.

A comparison of the diets of the house rat captured from the cereals and grain stores and houses (Table I) showed that in the case of stores (n = 22), wheat was the most frequently consumed food item (196.24±41.84) followed by the chickpea (74.09±15.80), millet (69.41±14.80), barley

(59.77±12.74), moong (49.05±10.46) and masoor (42.92±9.15) with maize (10.68±2.28); sorghum (4.43±0.94) and peanut (2.44±0.52) being the least preferred food items. One factorial ANOVA revealed a significant difference among the frequency of food items. Duncan's Multiple Range Test (DMRT) showed that wheat was consumed in

Table I.- Comparison of the mean (± SE) number of fragments across slides examined of different food items recovered from stomach contents of house rat, *Rattus rattus* trapped from the houses and stores of Rawalpindi urban during 2010-11.

Food item	Houses (n = 19)	Stores (n = 22)
Wheat	141.08±23.88 a	196.24±41.84 a
Chickpea	91.51±22.75 b	74.09 ±15.80 b
Millet	76.03±23.69 bc	69.41 ±14.80 b
Rice	41.55±13.32 cd	67.18 ±14.32 b
Moong	75.30±20.14 bc	49.05±10.46 bc
Masoor	51.62±17.07 c	42.92±9.15 bc
Barley	10.53±7.26 d	59.77±12.74 b
Maize	0.68±0.68 d	10.68±2.28 c
Peanut	0.11±0.11 d	2.44±0.52 c
Sorghum	5.25±3.08 d	4.43±0.94 c
Sand/soil particles	2.78±0.44 d	2.17±0.46 c
Animal parts	4.28±1.01 d	2.02±0.43 c
Unidentified items	2.42±0.77 d	2.59±0.55 c
F values	10.43	12.21
Probability	0.00	0.00
LSD (0.05)	36.46	43.11

Similar letters are non-significant to each other (P >0.05)

significantly higher quantities than all other food items, while chickpea, millet, rice, barley, moong and masoor though varied in frequencies, but were non-significant to each other; however their share was significantly higher than the remaining food items. Almost similar preference pattern was observed in the diet of the house rats captured from houses (n=19). Here too, wheat was the most dominant item of the diet (141.08±23.88), followed by the chickpea (91.51±22.75), millet (76.30±23.69), moong (75.30±20.14), masoor (51.62±17.07) and rice (41.55±13.32). The share of barley and sorghum was only 10.53±7.26 and 5.25±3.08, respectively, while the other items were recorded in minute quantities. ANOVA depicted a significant difference in the frequency of food items and the DMRT showed that wheat was consumed in

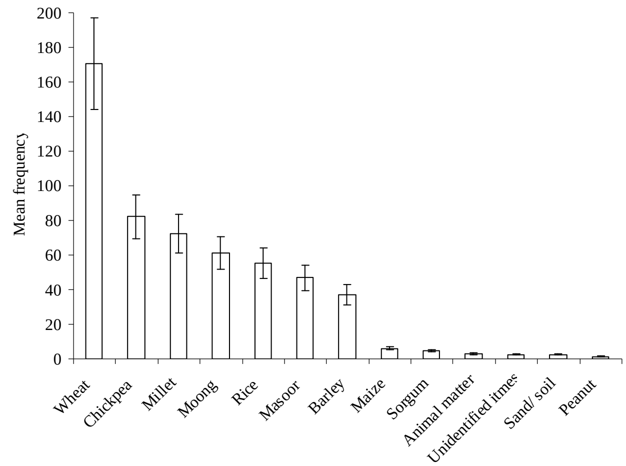

Fig. 2. Frequencies (mean±SE) of occurrence of different food items in the stomach contents of the house rat, *R. rattus* (n = 41) captured from Rawalpindi urban areas, during 2010-11.

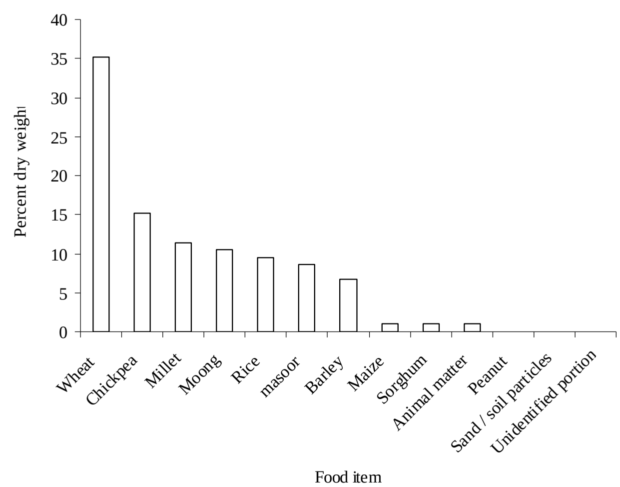

Fig. 3. Percent dry weight of different food items recovered from the stomach contents of the house rat, *R. rattus* (n = 41) from Rawalpindi urban areas, during 2010-11.

significantly higher quantities than all other food items, while chickpea, millet and moong were found in significantly higher amounts than the remaining items. Though the consumption of rice and masoor was low, yet they were consumed in significantly higher proportion than the remaining food items like barley, maize, peanut and sorghum.

A comparison of the diets of rats affecting the stores and houses revealed that barley, maize and peanut were consumed in significantly higher proportion ($P < 0.05$) in the stores than in the houses; animal matter was recorded more in the houses than the stores and there was a non-significant difference ($P > 0.05$) in the consumption of all other food items at the two locations.

The stomach contents analysis of the house rat showed the feeding preference of plant material (grains and cereals) over the others, which is also supported from previous studies in different parts of the world (Yabe, 1979; Mushatq-ul-Hassan, 1993; Sasikala and Neelanarayanan, 2009), while in contrast to some localities of Karachi (Lathiya *et al*., 2008), where the insects constitute the major components of their diet that may depend upon the availability of insects. The consumption of wheat over all the other food items is difficult to explain; in case of houses, groundnut would be the most abundantly available material, so its preference is understandable. Yet a similar pattern of consumption in the stores supports the preference of the house rat for wheat that needs to be addressed.

Berger-Parker Index for diversity in food items of the house rat (Table II) reflected that the diet of rats of houses (3.56) was more diversified as compared to the rats of the grains and cereals stores (2.87). This may be due to the availability of a limited type of food items and the limited opportunities for consumption, which forced the house rat to adapt alternative options in the houses. In case of stores, there is abundance of the favored food items and dietary choices were limited owing to availability of fewer food items.

The house rats of Rawalpindi urban area seem to be heavily dependent on the wheat for their food. The findings of the present study are in line with Mushtaq-ul-Hassan (1993) in the rural areas of central Punjab, Pakistan where almost the same food items were recovered from the stomachs of the house rat. He considered the house rat as the most destructive mammalian pest in Pakistan. He estimated that l2,394 kg of bread grains (wheat, barley and maize) had been lost to the house rat per year, from an average village house of the central Punjab (Pakistan). Similarly Ahmed *et al*. (1995) estimated that on an average, a grain shop contained up to 40 rats in the Punjab (Pakistan) and calculated the annual losses due to rats would approximately be 4000 mt /year. Yabe (1979) reported that stomach contents of house rat captured from the residential areas of Japan contained 94.4% of plant material.

Table II.- Berger-Parker Index for diversity index of the stomach contents of the house rat, *Rattus rattus* from urban Rawalpindi during 2010-11

Locations	Total no. of food particles (N)	Max. abundant food items (Nmax)	Berger-Parker index $d=N_{max}/N$	1/d
Houses (n = 19)	9560	2681	0.28	3.56
Stores (n = 22)	12,826	4317	0.33	2.87

In the current study it was observed that insects (animal matter) were regularly consumed by the rats in Rawalpindi area. Previous literature also reveals that insects are also important component of the rodents' diet, especially trapped from the residential areas. Jamil (1990) reported that insects accounted for 12.9% of the total diet of house rats captured from the urban areas of Faisalabad, Pakistan. Similarly, Lathiya *et al.* (2008) reported that the stomach contents of the house rats captured from Karachi, Pakistan, contained rice and insects as important components of their diet.

The findings of this study indicate that the house rat is a generalist consumer and it can change its feeding habits, depending upon the availability of food materials and can cause heavy losses to the stored products. Consequently, rat population needs to be managed through appropriate methods.

REFERENCES

AHMED, E., HUSSAIN, I. AND BROOKS, J.E., 1995. Losses of stored foods due to rats at grain markets in Pakistan. *Int. Biodet. Biodeg.*, 125-133.

APLIN, K.P., BROWN, P.R., JACOB, J., KREBS, C.J. AND SINGLETON G.R., 2003. *Field methods for rodent studies in Asia and the Indo-Pacific.* ACIAR Monograph No., 100, pp 223.

BERGER, W.H. AND PARKER F.L. 1970. Diversity of planktonic Foramenifera in deep sea sediments. *Science*, **168**:1345-1347.

FAO, 1999. *The state of food insecurity in the world.* Food and

Agricultural Organization of United Nations. UK, pp. 32.

GRZIMEK, B. 2003. *Grzimek's Animal Life Encyclopedia*: Mammals (N. Schlager, D. Olendorf, M. McDade, eds.). Order: Rodentia, Vol. 16, 2nd Ed. Farmington Hills, MI: Gale Group.

HANSON, R.M., MOIR A. S. AND WOOD-MANSEE S. R. 1971. *Drawing of tissue of plants found in herbivore diets and the litter of grassland.* IBP. Tech. Report No. 70. Grass Land Biomes.

JAMIL, M., 1990. *Food Habits of Rattus rattus in Faislabad city*. M. Phil. thesis, Univ. Agric. Faisalabad, Pakistan.

LATHIYA, S.B., AHMED, S.M., PERVEZ, A. AND RIZVI, S.W.A., 2008. Food habits of rodents in grain godowns of Karachi. *J. stored Prod. Res*., **44**: 41-46.

LAVOIE, G.K., 1987. *Food habit data and analysis*. Monograph copy, pp 3.

MEEHAN, A.P. 1984. *Rats and mice, their biology and control.* Rentokil, East Grinstead, Sussex, UK.

MEERBURG, B.G., SINGLETON, G.R. AND KIJLSTRA, A., 2009. Rodent-borne diseases and their risks for public health. *Crit. Rev. Microbiol*., **35**: 221–270.

MUSHTAQ-UL-HASSAN, M. 1993. *Population dynamics, food habits and economic importance of house rat (*Rattus rattus*) in villages and farm house of Central Punjab (Pakistan).* (unpublished) Ph. D. thesis, Univ. Agric, Faisalabad, Pakistan, pp 250.

PRAKASH, I., 1988. *Rodent Pest Management,* CRC Press, Boca Raton, pp. 480.

ROBERTS, T.J., 1997. *The Mammals of Pakistan* (revised ed.). Oxford Univ. Press, Karachi, Pakistan, pp. 525.

SASIKALA, G. and NEELANARAYANAN, P., 2009. Food and reproductive habits of *Rattus rattus*. *Annl. Pl. Protec. Sci*., **17**: 247-248.

STEEL, R.G.D. AND TORRIE, I.H., 1980. *Principles and procedures of statistics.* McGraw Hill, New York, pp. 481.

STENSETH, N.C., HERWIG, L., SKONHOFT A., DAVIS, S.A. PECH, R.P., ANDREASSE, P., SINGLETON, G.R., LIMA, M., MACHANGU, R.M., MAKUNDI, R.H., ZHANG, Z., BROWN, P.R., SHI, D., WAN, X., 2003. Mice, rats, and people: the bio-economics of agricultural rodent pests. *Front. Ecol. Environ.*, **1**: 367–375.

WARD, A.L., 1970. *Stomach content and fecal analysis. Methods of Forage identification.* U. S. Deptt. Agric., Pub. No., **1147**: 146-158.

WILLIAM, O., 1962. The techniques for studying microtine food habits. *J. Mammal.*, **43**: 365-368.

WOLF, J. AND SHERMAN, P.W., 2007. *Rodent Societies: An ecological and evolutionary perspective*. Chicago, University of Chicago press. 610 pp.

YABE, T., 1979. The relation of food habits to the ecological distribution of Norway rat and roof rat. *Jap. J. Ecol*., **29**: 235-244.

(Received 12 December 2012, revised 4 March 2013)