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Infestation of Rodents (Rodentia: Muridae) Among Houses in Kashan, Central Iran

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Abstract.- Rodents are the most frequent of mammals around the world. The commensal rodents, including rats and mice are carriers or reservoirs of about 200 diseases in man and animals around the world. Rats and mice cause serious damages to all kinds of structures, too. This study was carried out to show prevalence of domestic murid infestation among residencies in the city of Kashan. In this research study, 400 residential houses from different regions of Kashan were checked out to detect the murid infestation and its damage rates. Rodents were observed in the 57.75% (231 houses) of 400 houses in this study. Three kinds of rodents were identified by species level including: 33 (91.6%) of *Mus musculus*, 2 (5.5%) of *Rattus norvegicus* and 1 (2.7%) of *R. rattusus* of Muridae family. The realised data of this study let us to conclude that rodent infestation in the houses of Kashan is a pest problem which may be leaded to the human health problem. This infestation is related to the many factors, which the most important of them are included: species of Muridae family, ages of buildings, main structure material of buildings and awareness of owners from the rate of rodent damages to their houses.

Keywords Rodents, house infestation, commensal rodents, Kashan, Iran

INTRODUCTION

Domestic rodents which belong to Muridae family of Myomorpha are well known commensal animals. These are considered as economic pests and cause public health problems because their close association with humans and on addition, the incisor teeth of rodents grow continuously, and hence they must gnaw to keep them worn down. They are also known as good jumpers, climbers and swimmers (Etemad, 1985; Brooks *et al*., 1990; Baker *et al*., 2006; Timm, 2006; Shu-Yu *et al*., 2006; West and Messmer, 2010).

It has been well documented that the commensal rodents, including: rats and mice are carriers or reservoirs about 200 diseases in man and animals. The human and animal foods and food catering areas and facilities are contaminated by their fur, urine and droppings which are leaded to transmitting different kinds of the diseases around the world. The most medical and public health importance of them are salmonellosis, leptospirosis, haemorrhage fever, trichinosis, chagas, leishmaniasis, scrub typhus, rickettsial pox, lymphocytic choriomeningitis, rat-bite fever, hanta virus haemorrhagic pulmonary syndrome, Venezuelan equine encephalitis (*Alphavinus*), powassan encephalitis (*Flavivinus*), rabies, Rocky Mountain spotted fever, tularemia, eosinophilic meningitis, taeniasis, cryptosporidia, *Trypanosoma lewisi* and *Hymenolopis diminuta*. Additionally, they may be sources of swine dysentery, brucellosis, sarcoptic mange, and tuberculosis, all of which affect livestock or pets (Karimi, 1977; Hoshvar, 1987; Warren and Mahmoud Adel, 1990; Rasti *et al*., 2000; Abu-Madi *et al*., 2001; Hilton *et al*., 2002; Linardi and Botelho, 2002; Singleton *et al*., 2003; Svobodova *et al*., 2003; Baker *et al*., 2006; Hanafi-Bojd *et al*., 2007; Mushtaq *et al*., 2008; Anonymous, 2010).

Rats and mice cause serious damages to all kinds of structures if they are allowed access to them. Damage by rodents has been documented in homes, apartments, hotels, office complexes, retail

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businesses, manufacturing facilities, food processing and warehouse facilities, public utility operations (especially power and electronic media operations), farm and feed storage buildings, and other structures (Zomorodi, 1985; Burgess, 1990).

The three most common species of pest rodents, which encountered by citizens in Iran are the Norway rat (*Rattus norvegicus*), the roof rat (*R. rattus*) and the common house mouse (*Mus musculus*) (Burgess, 1990; Fasihi *et al*., 2000).

Despite of high murid infestation in the buildings in the different regions of Iran, there is little information regarding murids in Iran. The majority studies of commensal rodents in Iran have paid attention to ecto and endo parasites of rodents or referred to their fauna not to their economic importance or biology as the urban pests (Kia *et al*., 2009; Pakdad *et al*., 2012).

Therefore, this study was carried out to show prevalence of domestic murid infestation among residencies in the city of Kashan, central of Iran in 2008.

Carrying out such a study from point of domestic murid infestation outbreak and its effective factors in a city of Iran is very rare. These factors were rodent species and their frequencies, ages of the buildings, material structures of the buildings, control methods and number attempts to reduce the rodent population in the buildings were monitored in the current study. The obtained results of the current study, regarding murids in Kashan are nobles and would draw the strategy of their control methods.

MATERIALS AND METHODS

In this prospective research study, 400 residential houses from different regions of Kashan were checked out to detect the murid infestation and its damage rates. The houses had been selected randomly by cluster method.

Entire of houses, including rooms, basement and furniture, were inspected to find the rodents or evidence of droppings and urine, signs of damage from gnawing, locating nests and identifying sounds of their activity at night. Once rodent activity was detected, the house with these conditions was evaluated as infested murid house in this study. The live trapping was carried out in the infested houses to catch the rodents. The collected rodents were killed using chloroform and transferred to the entomology lab to identify. Different keys of Iranian rodent fauna were used to identify the trapped rodents (Etemad, 1979; Anonymous, 2000; Fasihi *et al*., 2000; Khaghani, 2007).

A questionnaire was distributed among the owners to fill that to evaluate the rate of murid knowledge among the owners and assessing the rate of infestation in the buildings. The requested information was: ages of the buildings, material structures of the buildings, control methods and number attempts to reduce the rodent population in the buildings and the kinds of observed rodents.

All the data were recorded and analysed using Chi- squared statistical method.

RESULTS

Rodents were observed in the 57.75% (231 houses) of 400 houses in this study. In this research study, 36 rodents were trapped of 15.6% of infested houses. Three kinds of rodents were identified by species level including: 33 (91.6%) of *Mus musculus*, 2 (5.5%) of *Rattus norvegicus* and 1 (2.7%) of *R. rattusus* of Muridae family. However, the data of the questioners indicated that the owners have observed the rodents in the 231 of the houses, which they have been identified as *M. musculus* (93.1%), *R. norvegicus* (7.8%) and (2.6%) *R. rattusus* of Muridae family, based on the shapes of the droppings and size and colour of observed rodents.

Results of this research showed that there was a relation between the age of buildings and observing the rodents indoor the houses. The main value of house ages was 21.9 ±16.8 years. The rate of age houses was between 1-100 years.

Calculated overall chi-squares among the different age-levels of buildings indicated that there were significant differences among the different age-levels of buildings regarded to the rodent infestation. (Chi-square: 49.2, df = 4, P-value < 0.0001). All calculated chi-squares between each two different levels were significant difference ($p < 0.05$, df = 1), except levels of 10-19 and 20-29 year old buildings and level of 40-49 and 50 < year old

buildings (Table I). The maximum and minimum infestations to the rodents were recorded from the houses with 40-49 and 0-9 year olds, respectively.

Table I.- Frequency of murid rodent infested houses according to the age of houses in Kashan (2008-2009)

Age of building (Years)	No. of houses	No. of houses not infested (%)	No. of houses infested (%)
0-9	86	59 (68.60)	27 (31.40)
10-19	90	47 (52.20)	43 (47.80)
20-29	109	43 (39.40)	66 (60.60)
30-39	74	18 (24.30)	56 (75.70)
40-49	21	1 (4.80)	20 (95.20)
50 < year	20	1 (5.00)	19 (95.00)
Total	400	169 (42.30)	231(57.80)
Mean ± S.D		15.8 ± 10.2	27.3 ± 19.4

Table II.- Frequency of murid rodent infested houses according to the structure material of buildings in Kashan (2008-2009).

Structure material of buildings	No. of houses	No. of houses not infested with rodents (%)	No. of houses infested with rodents (%)
Brick - iron	319	157 (49.2%)	162 (58.8%)
Concrete	5	3 (60%)	2 (40%)
Traditional brick and clay	76	9 (11.8%)	67 (88.2%)
Total	400	169 (42.3%)	57.8 (231%)

Results of this study indicated that there was a significant relation between structure materials of buildings and detecting murid rodents in the houses (Chi-square: 35.79, df = 2, P-value < 0.0001). Murid rodents were observed in the 58.8% of houses using modern brick and iron as the main structure materials. But 88.2% of houses with clay and traditional brick were infested with murid rodents. Murid rodent infestation was observed in the 40% of houses using concrete (Table II). All calculated chi-squares between each two different levels were significant difference ($p < 0.05$, df = 1), except using level of brick - iron and concrete in the buildings (Chi-square: 0.229, df = 1, P-value = 0.632) (Table II). The frequency details of murid rodent infested houses according to the structure material of buildings in Kashan (2008-2009) are presented in the Table II.

Analysis of the questioners indicated that in the 96.5% of damaged houses, the owners have applied at least a control method against murid rodents including: poisonous baiting, destroying and filling the canals of the rodents and trapping, with the frequencies of 64.5%, 9.5% and 36.5%, respectively. In addition, the results of this study have revealed that the owners have carried out the reduction of the rodent population, continuously, at numerous times over the different periods in their properties. Table III shows that the maximum rate of the applied methods against the murid rodents has been 8 and more than 8 with the frequency of 47.6%.

Table III.- Frequency of attempts of using methods against murid rodents in Kashan (2008-2009).

Attempts	Numbers	Percentage
0	8	3.4
1-3	84	36.4
4-7	29	12.6
8 and 8 <	110	47.6
Total	231	100

The obtained results of this study indicated that the mean value of number of attempts to reduce the rodent population were, 5.7 3.8, 6.2 ± 3.8 and 9 ±1.7 times belong to the house mouse, Norway rat and roof rat, respectively. In addition, the mean value of recurrent the rodent infestation were recorded 1.9,1 and 0.8 months for the house mouse, Norway rat and roof rat, respectively, in the current study.

DISCUSSION

Murid rodent infestation is a worldwide phenomenon including Iran (Hoshvar, 1987; Baker *et al.*, 2006; Timm, 2006). Observing murid rodents in the more than 50 year old buildings in this study revealed that murid rodent infestation has been a chronic problem in Kashan; because significant damages have been taken place over several months or years by feeding on the different stuff by murid rodents (Etemad, 1985; Prakash and Mathur, 1987).

Results of this study indicated that the rate of murid rodents in Kashan was high with 57.5% of

400 houses. This is similar to the results of Murphy and Marshall who reported that 50% of the houses were found to have mouse infestations.

Majority of rodent damages in Kashan are based on the three murids, *Rattus norvegicus*, *R. rattus* and *Mus musculus* according to the present study. This is accordance to the all researchers who indicated that the majority of rodent infestation are related to the murid rodent (Fasihi *et al*., 2000; Vaziri, 2000; Ghadirian and Ashrafzadeh, 2007; Hanafi-Bojd *et al*., 2007). Vaziri (2000) and Ghadirian and Ashrafzadeh (2007) have reported several species as the main reason of rodent damages in Iran. Three species, which are mentioned above are in their list.

It is assumed that the main agent of murid rodent infestation in Kashan was *M. musculus* in this study, with the greatest population of rodent presence (91.6%) in the infested houses, but Hanafi-Bojd *et al*. (2007) have reported that *R. norvegicus* has been the main rodent in Bandar Abbas, south of Iran.

This study showed that there was significant relationship between the rate of infestation and the age of buildings (Table I). There is a dramatic increase in the rate of rodent infestation with increasing the ages of buildings (Table I). The older building, the more houses were observed with rodent infestation and their damages and more health problems for the residents. This is consistent with a study which was carried out in England. Langton *et al*. (2001) concluded that rat infestations significantly was more common in older properties with dilapidated structures. Murphy and Marshall (2003) in another study have explained similar views. They concluded that rodent infestations were significantly linked to indicators of poor constructional integrity within the housing stock.

The structure material of houses can also affect the rate of rodent infestation. It has been shown in the present study that 88.2% of houses, which had been built with clay and traditional brick, infested with rodents significantly greater than the houses, which used the other materials in their building structures (Table II). These rates were 58.8% and 40% of houses using modern break and iron and concrete as the main structure materials, respectively (Table II). This is confirmed by Murphy and Oldbury (2002), who stated that domestic mouse infestations were increased with poor structural maintenance in the buildings.

Combination effects of age and main structure materials are other points to interpret the high rate of rodent infestation in the houses of Kashan during this study. For example, rodent infestations were observed in the 40% of houses, which used concrete as the main structure materials. It is seemed that the rate of rodent infestation should not be as high as that observed among the houses using concrete in this study. Then it is assumed that the age of houses and main structure materials, together, play a role in this story. Another point regarding the pest rodent problem in Kashan is the recurrent of the rodent infestation. The applied several attempts, to eradicate the population of the rodents in the houses, which were undertaken in this study, reveal this fact that the recurrence the infestation is a main pest problem. However, the various applied methods to reduce the rodent population are another reason to find this fact that the rodent pest problem is a complicated subject.

The pest rodents' problem in Kashan is a biological case too, because there are three different species of domestic rodents around the buildings with different densities, behaviours and physiology. In this matter, results of this study explain that the eliminating of house mouse population is easier than the control of the rat population. This result is accordance to the report of Hanafi-Bojd *et al*. (2007) because after applying the control methods in Bandar Abbas, they did not trap any house mouse, while the both rats were trapped again. The mean value of attempts in the terms of eradicating/eliminating house mouse population in Kashan, during the present research, was recorded 5.7 ±3.8; however, they were recorded 6.2 ±3.8 and 9 ±1.7 attempts regarding Norway and roof rats, respectively. In contrast to the mean value of attempts to eradicate/eliminate the rodent population, the mean value of the recurrent period of the house mouse infestation is longer than this value regarding Norway and roof rats, during this study. It means that the interval time to repeat the control method against the rodents regarded house mouse has been longer than this period in the terms of the two other rats. On the other hand both values,

viz., the number of attempts to control the house mouse population and recurrent period, support each other, less the number of attempts the longer recurrent period of mouse infestation. This trend is shown by other two rodents in this study.

In the current study rodent activities including evidence of droppings and urine, signs of damage from gnawing, locating nests and identifying sounds of their activity at night was used as indirect methods to predict commensal rodent population. This method has been used by other researchers in USA and Sierra Leone for evaluating damage by rodents as wild life and assessing the risk of rodent infestation and lassa fever in refugee camps, respectively (Timm, 1979; Bonner *et al.*, 2007).

In the current study the reflection of the resident views on domestic rodent infestations in their houses was considered. The data was collected on the number of attempts to control the commensal rodent population and re-infestation period in the resident premises of Kashan. The role of the people to control the population of rodents, has been discussed by other researchers in the different countries (Pai *et al.*, 2003). This study has been carried out for the first time in the central of Iran.

CONCLUSIONS

It is concluded that rodent infestation in the houses of Kashan is a pest problem which may lead to the human health problems. This infestation is related to the many factors including species of Muridae family, ages of buildings construction material of buildings and awareness of owners about the extent of rodent damage to their houses. However, the data of interval between the rodent infestation and the number of attempts to reduce the rodent population are essential to eradicate the rodents by environmentally friendly methods.

REFERENCES

ABU-MADI, M.A., LEWIS, J.W., MIKHAIL, M., EL-NAGGER, M.E. AND BEHNKE, J.M., 2001. Monospecific helminths and arthropod infections in an urban population of brown rats from Doha, Qatar. *J. Helminthol.*, **75**: 313-320.

ANONYMOUS, 2000. *Order of Rodentia; Introduction and identification key*. Ferdowsi University of Mashhad, Mashhad.

ANONYMOUS, 2010. *Protection from rodent-borne diseases with special emphasis on occupational exposer to hantavirus*. US Department of Defence, Washington.

BAKER, R. O., BODMAN, G. R. AND TIMM, R. M., 2006. *Rodent-proof construction and exclusion methods.* Clemson University and Cornell University, Cooperative Extension, Internet Center for Wildlife Damage Management, http://icwdm.org. (Accessed 13 March 2011)

BONNER, P.C., SCHMIDT, W.P., BELMAIN, S.R., OSHIN, B., BAGLOLE, D. AND BORCHERT, M., 2007. Poor housing quality increases risk of rodent infestation and lassa fever in refugee camps of Sierra Leone, *Am. J. trop. Med. Hyg.*, **77**: 169-175.

BROOKS, J.E., AHMAD, E., HUSSAIN, I., MUNIR, S. AND KHAN, A.A., 1990. *A Training manual on vertebrate pest Management*. Denver Wildlife Research Center and National Agricultural Research Centre USDA/APHIS/S&T Pakistan Agricultural Research Council, International Programs Research Section, Islamabad, pp. 115-122.

BURGESS, N. R. H., 1990. *Public health pests, a guide to identification, biology and control.* Chapman & Hall, London.

ETEMAD, E., 1979. *Rodents and identification key of them, Vol. 1*. National Association of Natural Source Protection and Human Environment, Tehran.

ETEMAD, E., 1985. Biology and behaviour of rodents. In: *Health, economic and military importance of rodents* (ed. Anonymous), Sepah Pasdaran Enghelab Islami, Tehran, pp. 22-32.

FASIHI, M. T., SHAHROKHI, M. B. AND KHORSHIDI, M. R., 2000. *Fauna of rodents in Hormozgan Province.* Paper Book of the 2nd Conference of Applications of Biosystematics Studies on Rodents of Iran, Mashhad, Iran, pp. 9-15.

GHADIRIAN, T. AND ASHRAFZADEH, M. R., 2007. *An assessment on the rodent fauna of Qeshm Island.* Abstract Book of the 2nd Conference of Applications of Biosystematics Studies on Rodents of Iran, Mashhad, Iran, p. 18.

HANAFI-BOJD, A.A., SHAHI, M., BAGHAII, M., SHAYEGHI, M., RAZMAND, N. AND PAKARI, A., 2007. A study on rodent ectoparasites in Bandar Abbas: the main economic southern seaport of Iran. *Iranian J. environ. Hlth. Sci., Engin.*, **4**: 173-176.

HILTON, A.C., WILLIS, R.J. AND HICKIE, S.J., 2002. Isolation of *Salmonella* from urban wild brown rats (*Rattus norvegicus*) in the west Midlands, UK. *Int. J. environ. Hlth. Res.*, **12**: 163-168.

HOSHVAR, Z., 1987. *Introduction on geographical medicine of Iran.* Central Bureau of Jahad Daneshgahi, Tehran.

KARIMI, Y., 1977. *Plague and identification of it*

epidemiology. Pasteur Institute of Iran, Tehran.

KHAGHANI, R., 2007. Health hazardous of rodents in urban area, ports and control methods; a review. *J. Army Univ. med. Sci. Iran*, **4**: 1071-1078.

KIA, E.B., MOGHDDAS-SANI, H., HASSANPOOR, H., VATANDOOST, H., ZAHABIUN, F., AKHAVAN, A.A., HANAFI-BOJD, A.A. AND TELMADARRAIY, Z.**,** 2009**.** Ectoparasites of rodents captured in Bandar Abbas, Southern Iran. *Iranian J. Arthropod-Borne Dis.*, **3**: 44-49.

LANGTON, S.D., COWAN, D.P. AND MEYER, A.N., 2001. The occurrence of commensal rodents in dwellings as revealed by the 1996 English House Condition Survey, *J. appl. Ecol.*, 38:699-709.

LINARDI, P. M. AND BOTELHO, J. R., 2002. Prevalence of *Trypanosoma lewisi* in *Rattus norvagicus* from Belo Horizonte, State of Minas Gerais, Brazil. *Mem. Inst. Oswaldo Cruz, Rio de Janeiro*, **97**: 411-414.

MURPHY, R.G. AND MARSHALL, A., 2003. *House conditions and the likelihood of domestic rodent infestations in an inner city area of Manchester*. Research Institute for the Built and Human Environment, University of Salford, U.K.

MURPHY, R.G. AND OLDBURY, D.J., 2002. Rat control by local authorities within the UK. In: *Proceedings of the fourth International Conference on Urban Pests* (eds. S.C. Jones, J. Zhai and W.H. Robinson), Charleston, South Carolina, USA 7-10 July 2002. pp. 413–420.

MUSHTAQ, M., HUSSAIN, I., SHEHZADI, B., SHAHEEN, M., MAHMOOD, M. S., RAFIQUE, A. AND MAHMOOD-UL-HASSAN, M., 2008. Occurrence of some zoonotic microorganisms in faecal matter of house rat (*Rattus rattus*) and house mouse (*Mus musculus*) trapped from various structures. *Pakistan Vet. J.*, **28**: 171-174.

PAI, H.H., HONG, Y.J. AND WANG C.H., 2003, A community-based surveillance on determinants of rodent infestation. *Kaohsiung J. med. Sci*., **19**:13-8.

PAKDAD, K., AHMADI, N.A., AMINALROAYA, R., PIAZAK, N. AND SHAHMEHRI, M., 2012. A study on rodent ectoparasites in the North district of Tehran, Iran during 2007-2009. *J. Paramed. Sci.*, **3**:27-31.

PRAKASH, I. S. AND MATHUR, R. P., 1987. *Management of rodent pests*. Indian Council of Agricultural Research, New Delhi.

RASTI, S., MOUBEDI, I., DEHGHANI, R. AND DORODGAR, A., 2000. The survey of gastrointestinal helminthes of mice in Kashan. *J. Facul. Vet. Med., Univ. Tehran*, **55**: 57-59.

SHU-YU, W., YU-THE, K. L. AND HON-TSEN, U., 2006. Population ecology of the Southeast Asian house mouse (Muridae: *Mus musculus castaneus*) inhabiting rice granaries in Taiwan. *Zool. Stud.*, **45**: 467-474.

SINGLETON, R. G., SMYTHE, L., SMITH, G., SPRATT, D. M., APLIN, K. AND SMITH, A. L., 2003. Rodent diseases in south east Asia and Australia. *Biol. J. Linn. Soc*., **84**: 565-583.

SVOBODOVA, M., VOTÝPKA, J., NICOLAS, L. AND WOLF, P., 2003. *Leishmania tropica* in the black rat (*Rattus rattus*): persistence and transmission from asymptomatic host to sand fly vector, *Phlebotomus sergenti*. *Microbes and Infection*, **5**: 361-364.

TIMM, R. M., 2006. *House mice*. University of California, Hopland Research and Extension Center, http://icwdm.org/handbook/rodents/HouseMice.asp. (Accessed 13 March 2011).

TIMM, R.M., 1979. *How to evaluate wildlife damage control programs – Rodents*, Department of Forestry, Fisheries and Wildlife, University of Nebraska, Lincoln.

VAZIRI, A. S., 2000. Control management of hazardous rodents. *Paperbook of the 2nd Conference of Applications of Biosystematics Studies on Rodents of Iran, Mashhad, Iran*, pp. 153-166.

WARREN, K. S. AND MAHMOUD ADEL, A. F., 1990. *Tropical and geographical medicine; Viral haemorrhagic fevers*. McGraw-Hill Book Co, New York.

WEST, B.C. AND MESSMER, A., 2010. *Commensal rodents*. USU Extension in cooperation with CNR—Quinney Professorship for Wildlife Conflict Management, Jack H. Berryman Institute, Utah Division of Wildlife Resources, Utah Department of Agriculture and Food USDA/APHIS Animal Damage Control.

ZOMORODI, A., 1985. Mice problems in ports and store. In: *Health, economic and military importance of rodents* (ed. Anonymous), Sepah Pasdaran Enghelab Islami, Tehran, pp. 116-121.

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