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Distribution and Diversity of Rodent Populations at Various Habitats in Sharkia Governorate

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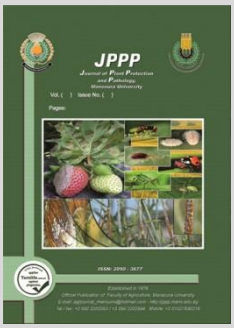

ABSTRACT

A survey of rodent species, their distribution and diversity, was carried out at three different habitats (i.e. urban houses, rural houses and drainage channels); in El-Ibrahemia District, Sharkia Governorate, Egypt; from December 2017 to November 2019. A total of 320 individuals, four species, of family Muridae, were trapped from the three studied habitats. Rodent species were: the roof rat, *Rattus rattus* (Linn.), the predominate species (114 & 96 individuals); followed by the Norway rat, *R. norvegicus* (Berk) (30 & 23 individuals); the Nile rat, *Arvicanthis niloticus* (18 & 15 individuals) and finally the house mouse, *Mus musculus* (Linn.) (11 & 13 individuals) during the 1st and 2nd years, respectively. The highest rodent population recorded in summer, followed by autumn, spring and winter. Males outnumbered females. The drainage habitat had the highest diversity indices; Shannon-Weaver index H′= 1.045 and 0.891; Simpson index D= 0.642 and 0.558 and evenness J′= 0.951 and 0.811; during the 1st and 2nd years, respectively. This was followed by the rural and urban houses habitats. In contrast, the highest number of individuals was captured from the urban house habitats (160 individuals) followed by drainage habitats (85 individuals) and rural house habitats (75 individuals). Previous information should help rodent control planners in adjusting and fine-tuning their control strategies and programs by using the proper control tools suitable for the existing species in their respective habitat.

Keywords: Commensal rodent species, survey, distribution, diversity indices, urban house, rural house and drainage habitats.

INTRODUCTION

Order Rodentia represents about 43% of the mammalian species of the world (Huchon*et al.*, 2002). It has the most diversified species in terms of morphology, physical abilities and the various environments they are able to occupy (Hadjoudj *et al.*, 2015). Rodents causes serious problems both in agriculture, through their destructive feeding habits, and in public health, by spreading diseases such as plague, salmonella, hantavirus and wails disease (Prakash, 1988 and Meerburg *et al.*, 2009).Every year, rodents consume food crops that can feed 200 million people for a one year in Asia (Singleton, 2003). In Egypt, changes in the agro-ecosystem, during the last 40 years, have had a great effect on the distribution and abundance of field rodent populations (El-Sherbiny, 1987).

The changes in the Egyptian agroecosystems, through desert reclaiming and increase in food and shelter in these areas had a great effect on the distribution and abundance of different rodent species in Egypt (Abdel-Gawad, 2010). About 51 species of rodent occurred in Egypt, belonging to sub-order; Myomorpha. Eleven species fall under family Muridae, subfamily; Murinae (genera: *Rattus*, *Arvicanthis*, *Mus*, *Acomys* and *Nesoke*) are commensal and domestic animals found in abundant numbers, while five families have low abundance in desert and semi-desert (Hoogstral *et al.*, 1963). Wire-box traps are one of the methods used in survey studies, as well as to estimate the population density of rodents (Desoky, 2015). Many researchers studied the population density of rodent species in Egypt (Abd El-Azeem, 2008, Metwaly *et al.*, 2009, Hegab *et al.*, 2013, Desoky *et al.*, 2014, Rizk *et al.*, 2017, Mostfa *et al.*, 2018 and Abd El-Galil, 2019).The diversity of species varied in relation to many factors such as favorite climatic conditions, preferred habitat type, preferred crops (Salit *et al.*, 1982). Diversity indices provide important information about rarity and commonness of species in a community. The ability to quantify diversity in this way is an important tool to understand community structure (Hadjoudj *et al.*, 2015). In addition, diversity indices provide more information than simply the number of species present, they serve as valuable tools that enable us to quantify diversity in a community and describe its numerical structure (Jing-yuan *et al.*, 2008 and Vipin Chaudhary *et al.*, 2017).This information should help rodent control planners in adjusting and fine-tuning their control strategies and programs by using the proper control tools suitable for the existing species in their respective habitat.

The present study aimed at investigating the distribution, density and diversity of rodent populations trapped from three different habitats in El-Ibrahemia District, Sharkia Governorate, Egypt, to be used in the development of future rodent control programs in urban, rural and village habitats.

MATERIALS AND METHODS

Study area:

The study was conducted in El-Ibrahemia District (30° 72′ N, 31° 56′ E), Sharkia Governorate, during two successive years from December 2017 to November 2019. Rodents trapped from three different areas/habitats:

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1- **Urban houses**: this habitat included many houses (about 50 houses) in El-Ibrahemia District. All of these houses are concrete buildings consisting of several floors (minimum two floors). On some roofs of these houses, there are places for breeding domestic birds such as poultry and pigeons. Streets are 6 to 10 meters wide, and the houses are very close to each other.
2- **Rural houses**: this study carried out in Tal-Mohamed and Abu Desouqi Villages, El-Ibrahemia District. They included many houses (about 50 houses). Some of these houses made of concrete, others of mud bricks. Most of the houses surrounded by agricultural lands and have barns for raising livestock and birds and feed storages.
3- **Drainage**: this site is a drainage channels, serving as waste discharge, of agricultural lands and residential areas, for nearby villages at El-Ibrahemia district. Channels surrounded with many large trees on both sides.

Data collection:

Rodents were trapped using wire-box traps with spring doors (27X14X10 cm).In each habitat, 25 traps used once a month. They baited with fresh bait (taameia/bread pieces/tomato slices). The traps set at 6 pm and collected next morning at 7 am. Trapped individuals transferred directly to the laboratory for sex identification and classification according to the key of Osbron and Helmy (1980).The collected data organized according to species; age and sex.

Data analysis:

The collected data used to obtain the following measurements:

- **Species richness:** which represented as the number of different species captured on each habitat (Horn *et al.*, 2012).
- **The relative abundance index(RAI%):**was determined using the following formula(Gomez Villafane and Bush, 2007):

$$RAI = \frac{\text{Number of specimens captured}}{\text{Number of traps x number of nights}} \times 100$$

- **The frequency (Fr):**of capturing species presented as the percentage ratio of the number of captured individuals for this species and the total number of captured individuals of all species from a habitat(Hadjoudj *et al.*, 2015).
- **The Shannon-Weaver index (H′):** was determined in order to describe the diversity in the rodent community (Krebs, 1998). It is based on proportional abundance of each species in a community using Shannon and Weaver (1949) formula:

$$H' = -\sum_{i=1}^{s}(Pi)*[LN(Pi)]$$

Where H′ is index of species diversity, s is the total number of species, Pi is proportion of each species in the habitat and LN(Pi) is natural logarithm of proportion.

- **Simpson Index of diversity (D):** measures the likelihood of any two individuals drawn from a somewhat large community belonging to different species (Simpson, 1949). It is measured by the following equation:

$$D = 1 - \frac{\Sigma\,[ni\,(ni-1)]}{N\,(N-1)}$$

Where ni is the total number of rodent of a particular species and N is the total number of rodent of all species.

- **The evenness index:** of rodents indicates how the species distributed in the community (Horn *et al.*, 2012). The evenness index (E) was calculated by the ratio of observed diversity to maximum diversity using the following equation:

$$E = \frac{H'}{H_{max}}$$

Where H′ is Shannon-Weaver index and H_{max} is natural logarithm of total number of species.

RESULTS AND DISCUSSION

Rodent distribution and classification:

Results in Table (1) showed the distribution of four rodent species, belonging to 3 genera (*Rattus*, *Arvicanthis* and *Mus*) from fam. Muridae, in El-Ibrahemia District, Sharkia Governorate, Egypt, during December 2017 till November 2019. In the urban house habitat both the roof rat (*Rattus rattus* Linn.) and the house mouse (*Mus musculus* Linn.) were recorded. However, in both rural houses and drainage habitats the three rat species; the Roof rat, the Norway rat (*R. norvegicus* Berk) and Nile rat (*Arvicanthis niloticus* Desm.); were recorded. On the other hand, the Norway rat and Nile rats were not found in the urban houses habitat while the house mouse was also not found in both rural houses and drainage habitats. The highest number of rodents captured during the two years was recorded from the urban houses habitat (160 individuals) followed by the drainage and rural houses habitats, 85 and 75 individuals, respectively. Results showed that the total numbers of males were more than females during the two years in all study habitats except in the 2nd year in the drainage habitat, the number of males and females found to be equal. The roof rat was dominant species in the urban houses habitat with 75 & 61specimens, frequency (Fr) 87.21 & 82.43% and relative abundance index (RAI) 25 & 20.33% in the 1st and 2nd years, respectively. It was followed by the house mouse; *M. musculus* with 11 & 13 specimens, Fr= 12.79 & 17.57% and RAI= 3.67 & 4.33% during the two years, respectively. From rural houses habitat, *R. rattus* was also the most captured species with 27 & 32specimens, Fr=75 & 82.05% and RAI= 9 &10.67% in the 1st and 2nd years, respectively. At the drainage habitat, the most dominant species was the Norway rat; *R. norvegicus* with 25 & 20 specimens, Fr= 49.02 &58.82% and RAI= 8.33&6.67% during the two years, respectively. It was followed by the Nile rat; *A. niloticus* with 14 & 11 specimens (Fr= 27.45 & 32.35%; RAI= 4.67 & 3.67%) and the roof rat; *R. rattus* with 12 & 3 specimens (Fr= 23.53&8.82%; RAI= 4&1%) during the 1st and 2nd years, respectively.

Table 1. Number of males (M), females (F), total (T), frequency (Fr %), and relative abundance index (RAI %) for rodent species captured in each habitat during the two years 2017/2019

Habitats		Species								Total		Traps nights/ year
		Rattus rattus		*Rattus norvegicus*		*Arvicanthis niloticus*		*Mus musculus*				
		1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	
Urban houses	M	39	34	0	0	0	0	6	5	45	39	300
	F	36	27	0	0	0	0	5	8	41	35	
	T	75	61	0	0	0	0	11	13	86	74	
	Fr%	87.21	82.43	0	0	0	0	12.79	17.57	100	100	
	RAI%	25.00	20.33	0	0	0	0	3.67	4.33	28.67	24.67	
Rural houses	M	16	17	2	1	2	3	0	0	20	21	300
	F	11	15	3	2	2	1	0	0	16	18	
	T	27	32	5	3	4	4	0	0	36	39	
	Fr%	75.00	82.05	13.89	7.69	11.11	10.26	0	0	100	100	
	RAI%	9.00	10.67	1.67	1.00	1.33	1.33	0	0	12.00	13.00	
Drainage	M	5	2	15	10	8	5	0	0	28	17	300
	F	7	1	10	10	6	6	0	0	23	17	
	T	12	3	25	20	14	11	0	0	51	34	
	Fr%	23.53	8.82	49.02	58.82	27.45	32.35	0	0	100	100	
	RAI%	4.00	1.00	8.33	6.67	4.67	3.67	0	0	17.00	11.33	

1st= first year; 2nd =second year.

Results in Table (2) showed that the total collected rodents were 173 and 147 individuals at El-Ibrahemia District, Sharkia Governorate, during the 1st and 2nd year, respectively. It is also clear that, *R. rattus* was the predominate species with 114 & 96 individuals followed by *R. norvegicus* with 30 & 23 individuals then *A. niloticus* 18 & 15individuals and finally *M. musculus*11 & 13individuals in the 1st and 2nd years, respectively. The highest number of rodents was in the summer months (67&60 individuals) followed by autumn (40&32 individuals), spring (37&32 individuals) and winter (29&22 individuals) in the 1st and 2nd years, respectively. On the other hand, the maximum numbers of trapped rodent recorded in August (38 individuals) in the 1st year and in July (23individuals) in 2nd year, while the lowest numbers was recorded in February and December (14 & 5individuals) in the 1st and 2nd year, respectively. It is also clear that, the numbers of each rodent species differed from month to another, it increased during the summer months, and decreased during the winter months.

The distribution of rodent species are influenced by seasonal changes in temperature and relative humidity, availability of food, from different crops, nesting sites and water sources, as well as the degree of habitat sophistication and variabilities induced by the constant changes in human activities(EL-Sherbiny *et al.*, 1993). Also, it depends on the inter-and intra-specific competition within and between species in the community, and any activities affecting rodents' life necessities, mainly food, shelter and water sources (El-Sherbiny, 1987, Abd El-Gawad, 2010, Desoky *et al.*, 2018 and Mostfa *et al.*, 2018). Similar findings acquired by Youssef (1996). He recorded three rodent species *Rattus rattus*, *R. norvegicus* and *M. musculus*at Kafr El-Sheikh Governorate in flour and rice mills. *R. rattus* out-number other species in the two mills. Hegab *et al.* (2013) in their study at Sharkia Governorate surveyed five rodent species, from three different sites namely *R. rattus frugivorus*, *R. norvegicus*, *M. musculus*, *R. rattus alexandrines* and *Acomys cahrinus*. Rizk *et al.* (2017) recorded five species of rodent and *R. rattus* was the predominant species in the two habitats at Sohag Governorate. Mostfa *et al.* (2018) surveyed three rodent species i.e. *R. norvegicus*, *R. rattus frugivorus* and *M. musculus* at 3different sites in Kafr El-Sheikh Governorate.

Table 2.Monthly and seasonal distribution of different rodent species at El-Ibrahemia District, Sharkia Governorate during December 2017 to November 2019

Months	*Rattus rattus*				*Rattus norvegicus*				*Arvicanthis niloticus*				*Mus musculus*				Total	
	1st		2nd		1st		2nd		1st		2nd		1st		2nd		1st	2nd
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%		
Dec.	8	33.33	5	100.00	1	6.67	0	0.00	0	0.00	0	0.00	1	6.67	0	0.00	15	5
Jan.	6	38.89	7	77.78	3	16.67	1	11.11	2	11.11	1	11.11	0	0.00	0	0.00	18	9
Feb	7	42.86	6	75.00	1	7.14	2	25.00	0	0.00	0	0.00	0	0.00	0	0.00	14	8
Winter	21	38.30	18	81.82	5	10.64	3	13.64	2	4.26	1	4.55	1	2.13	0	0.00	29	22
Mar	9	31.58	6	66.67	2	10.53	2	22.22	2	10.53	0	0.00	0	0.00	1	11.11	19	9
Apr	8	41.18	7	70.00	1	5.88	0	0.00	0	0.00	2	20.00	1	5.88	1	10.00	17	10
May	10	39.13	9	69.23	3	13.04	1	7.69	1	4.35	3	23.08	0	0.00	0	0.00	23	13
Spring	27	37.29	22	68.75	6	10.17	3	9.38	3	5.08	5	15.63	1	1.69	2	6.25	37	32
Jun	12	34.48	10	66.67	4	13.79	2	13.33	3	10.34	2	13.33	0	0.00	1	6.67	29	15
Jul	11	32.35	11	47.83	6	17.65	7	30.43	5	14.71	3	13.04	1	2.94	2	8.70	34	23
Aug	15	34.21	13	59.09	5	13.16	4	18.18	2	5.26	1	4.55	3	7.89	4	18.18	38	22
Summer	38	33.66	34	56.67	15	14.85	13	21.67	10	9.90	6	10.00	4	3.96	7	11.67	67	60
Sep	13	30.00	9	60.00	4	13.33	3	20.00	3	10.00	2	13.33	1	3.33	1	6.67	30	15
Oct	9	35.29	6	60.00	0	0.00	1	10.00	0	0.00	1	10.00	2	11.76	2	20.00	17	10
Nov	6	46.67	7	87.50	0	0.00	0	0.00	0	0.00	0	0.00	2	13.33	1	12.50	15	8
Autumn	28	35.48	22	66.67	4	6.45	4	12.12	3	4.84	3	9.09	5	8.06	4	12.12	40	33
Total	114	35.69	96	65.31	30	11.15	23	15.65	18	6.69	15	10.20	11	4.09	13	8.84	173	147

1st: first year; 2nd: second year.

Population density, age and sex distribution:

The roof rat; *Rattus rattus*:

The results in (Table 3) illustrated that the total numbers of *R. rattus* individuals were 114 (60 males and 54 females) during the 1st year and 96 (53 males and 43 females) during the 2ndyear.The highest numbers of *R. rattus* recorded in the summer with 38&34 individuals and the lowest numbers in the winter (21 & 18 individuals) during the 1st and 2nd years, respectively. According to monthly distribution, the highest numbers was recorded in August (15 & 13 individuals), while the lowest numbers was obtained in January and November in the 1st year and in December in 2nd year. On the other hand, the total numbers of mature and immature for roof rat; *R. rattus* were 89 & 25 individuals during the 1st and 75 & 21 individuals in the 2nd year.

The Norway rat; *R. norvegicus*:

The total numbers of *R. norvegicus* were 30 individuals (17 males and 13 females) during the 1st year and 23 individuals (11 males and 12 females) during the 2ndyear (Table 4).The highest numbers of *R. norvegicus* was obtained in the summer months and the lowest numbers was in the winter and the autumn months. It is appear also that, the total numbers of mature and immature for *R. norvegicus* was 25 & 5 individuals in the 1st year and 20 & 3 individuals in the 2nd year, respectively.

The Nile rat; *Arvicanthis niloticus*:

Results in Table (5) revealed that the total numbers of *A. niloticus* individuals were 18rats (10 males and 8 females) during the 1st year and 15 rats (8 males and 7 females) during the 2nd year. The population of *A. niloticus* was varied from month to another, the numbers increase through the summer months, while the lowest numbers recorded in the winter months during two years. The presented results showed that total numbers of mature and immature for *A. niloticus* were 15 & 3 and 13 & 2 individuals in the 1st and 2nd years, respectively.

The house mouse; *Mus musculus*:

Table (6) showed that 11 and 13 individuals of the house mouse; *M. musculus*, were captured during the 1st and 2nd year, respectively. The population of males was more than females during the first year were (6 and 5individuals). However, in the 2nd year, the opposite was occurred, where the number of males and females were (5 and 8individuals). The highest numbers of *M. musculus* recorded in the autumn during the 1st year and in the summer during the 2nd year. On the other hand, zero immature individuals, of *M. musculus*, registered through the two studied years.

Table 3. Monthly, seasonal, sex and age distribution of *Rattus rattus* at El-Ibrahemia District, Sharkia Governorate during December 2017 to November 2019

Months	No.		Males						Females						Total			
	1st	2nd	1st			2nd			1st			2nd			1st		2nd	
			Im.	M.	T.	Im.	M.	T.	Im.	M.	T.	Im.	M.	T.	Im.	M.	Im.	M.
Dec.	8	5	1	4	5	0	2	2	1	2	3	0	3	3	2	6	0	5
Jan.	6	7	0	3	3	0	4	4	0	3	3	0	3	3	0	6	0	7
Feb.	7	6	1	3	4	0	3	3	0	3	3	1	2	3	1	6	1	5
Winter	21	18	2	10	12	0	9	9	1	8	9	1	8	9	3	18	1	17
Mar.	9	6	1	4	5	1	3	4	0	4	4	1	1	2	1	8	2	4
Apr.	8	7	0	3	3	2	3	5	1	4	5	0	2	2	1	7	2	5
May.	10	9	1	4	5	2	4	6	2	3	5	1	2	3	3	7	3	6
Spring	27	22	2	11	13	5	10	15	3	11	14	2	5	7	5	22	7	15
Jun.	12	10	2	5	7	2	2	4	1	4	5	2	4	6	3	9	4	6
Jul.	11	11	3	4	7	1	4	5	2	2	4	1	5	6	5	6	2	9
Aug.	15	13	2	6	8	1	6	7	3	4	7	2	4	6	5	10	3	10
Summer	38	34	7	15	22	4	12	16	6	10	16	5	13	18	13	25	9	25
Sep.	13	9	1	5	6	2	3	5	2	5	7	1	3	4	3	10	3	6
Oct.	9	6	0	5	5	1	3	4	1	3	4	0	2	2	1	8	1	5
Nov.	6	7	0	2	2	0	4	4	0	4	4	0	3	3	0	6	0	7
Autumn	28	22	1	12	13	3	10	13	3	12	15	1	8	9	4	24	4	18
Total	114	96	12	48	60	12	41	53	13	41	54	9	34	43	25	89	21	75

1st: First year; 2nd: Second year; Im: Immature; M: Mature; T: Total.

Table 4. Monthly, seasonal, sex and age distribution of *Rattus norvegicus* at El-Ibrahemia District, Sharkia Governorate during December 2017 to November 2019

Months	No.		Males						Females						Total			
	1st	2nd	1st			2nd			1st			2nd			1st		2nd	
			Im.	M.	T.	Im.	M.	T.	Im.	M.	T.	Im.	M.	T.	Im.	M.	Im.	M.
Dec.	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0
Jan.	3	1	1	1	2	0	1	1	0	1	1	0	0	0	1	2	0	1
Feb.	1	2	0	0	0	0	1	1	0	1	1	0	1	1	0	1	0	2
Winter	5	3	1	2	3	0	2	2	0	2	2	0	1	1	1	4	0	3
Mar.	2	2	0	1	1	0	0	0	0	1	1	0	2	2	0	2	0	2
Apr.	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0	0
May.	3	1	0	2	2	0	1	1	0	1	1	0	0	0	0	3	0	1
Spring	6	3	0	3	3	0	1	1	0	3	3	0	2	2	0	6	0	3
Jun.	4	2	1	2	3	1	1	2	1	0	1	0	0	0	2	2	1	1
Jul.	6	7	0	2	2	0	3	3	1	3	4	1	3	4	1	5	1	6
Aug.	5	4	0	3	3	0	1	1	0	2	2	0	3	3	0	5	0	4
Summer	15	13	1	7	8	1	5	6	2	5	7	1	6	7	3	12	2	11
Sep.	4	3	1	2	3	1	0	1	0	1	1	0	2	2	1	3	1	2
Oct.	0	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	1
Nov.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Autumn	4	4	1	2	3	1	1	2	0	1	1	0	2	2	1	3	1	3
Total	30	23	3	14	17	2	9	11	2	11	13	1	11	12	5	25	3	20

1st: First year; 2nd: Second year; Im: Immature; M: Mature; T: Total.

Table 5. Monthly, seasonal, sex and age distribution of *Arvicanthis niloticus* at El-Ibrahemia District, Sharkia Governorate during December 2017 to November 2019

Months	No.		Males						Females						Total			
	1st	2nd	1st			2nd			1st			2nd			1st		2nd	
			Im.	M.	T.	Im.	M.	T.	Im.	M.	T.	Im.	M.	T.	Im.	M.	Im.	M.
Dec.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jan.	2	1	0	1	1	0	1	1	0	1	1	0	0	0	0	2	0	1
Feb.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Winter	2	1	0	1	1	0	1	1	0	1	1	0	0	0	0	2	0	1
Mar.	2	0	0	0	0	0	0	0	0	2	2	0	0	0	0	2	0	0
Apr.	0	2	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	2
May.	1	3	0	1	1	0	1	1	0	0	0	1	1	2	0	1	1	2
Spring	3	5	0	1	1	0	3	3	0	2	2	1	1	2	0	3	1	4
Jun.	3	2	0	2	2	0	1	1	0	1	1	0	1	1	0	3	0	2
Jul.	5	3	1	2	3	0	1	1	1	1	2	1	1	2	2	3	1	2
Aug.	2	1	1	1	2	0	0	0	0	0	0	0	1	1	1	1	0	1
Summer	10	6	2	5	7	0	2	2	1	2	3	1	3	4	3	7	1	5
Sep.	3	2	0	1	1	0	2	2	0	2	2	0	0	0	0	3	0	2
Oct.	0	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1
Nov.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Autumn	3	3	0	1	1	0	2	2	0	2	2	0	1	1	0	3	0	3
Total	18	15	2	8	10	0	8	8	1	7	8	2	5	7	3	15	2	13

1st: First year; 2nd: Second year; Im: Immature; M: Mature; T: Total.

Table 6. Monthly, seasonal, sex and age distribution of *Mus musculus* at El-Ibrahemia District, Sharkia Governorate during December 2017 to November 2019

Months	No.		Males						Females						Total			
	1st	2nd	1st			2nd			1st			2nd			1st		2nd	
			Im.	M.	T.	Im.	M.	T.	Im.	M.	T.	Im.	M.	T.	Im.	M.	Im.	M.
Dec.	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0
Jan.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Feb.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Winter	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0
Mar.	0	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1
Apr.	1	1	0	1	1	0	0	0	0	0	0	0	1	1	0	1	0	1
May.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spring	1	2	0	1	1	0	0	0	0	0	0	0	2	2	0	1	0	2
Jun.	0	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1
Jul.	1	2	0	0	0	0	2	2	0	1	1	0	0	0	0	1	0	2
Aug.	3	4	0	1	1	0	2	2	0	2	2	0	2	2	0	3	0	4
Summer	4	7	0	1	1	0	4	4	0	3	3	0	3	3	0	4	0	7
Sep.	1	1	0	0	0	0	0	0	0	1	1	0	1	1	0	1	0	1
Oct.	2	2	0	1	1	0	1	1	0	1	1	0	1	1	0	2	0	2
Nov.	2	1	0	2	2	0	0	0	0	0	0	0	1	1	0	2	0	1
Autumn	5	4	0	3	3	0	1	1	0	2	2	0	3	3	0	5	0	4
Total	11	13	0	6	6	0	5	5	0	5	5	0	8	8	0	11	0	13

1st: First year; 2nd: Second year; Im: Immature; M: Mature; T: Total.

Previous data showed that males out-numbered females in the three habitats and during the two years this may be due to that males are more agile while females restricted themselves in the nests to avoid inappropriate climate conditions and caring for their young. Similar findings obtained by Abd El-Azeem (2008) and Metwaly (2009). They found that numbers of males are more than females. Rizk *et al.* (2017) reported that numbers of males were more than females in their study during two successive years at three different places at Sohag Governorate. Desoky *et al.* (2018) observed that the sexual ratio decreased in the winter when the males are more than the females.

Rodent species diversity at different habitats:

Among the three studied habitats, the drainage habitat recorded the highest values of diversity indices, Shannon-Weaver index (*H′*= 1.045 and 0.891), Simpson index (*D*= 0.642 and 0.558) and evenness (*J′*=0.951 and 0.811) in the 1st and 2nd years, respectively, probably due to less human disturbance and availability of vegetation cover (Table 7). Followed by the rural houses give (*H′* = 0.734 and 0.677), (*D*= 0.417 and 0.376) and (*J′*= 0.668 and 0.616), while the urban houses recorded the lowest values of (*H′*= 0.382 and 0.465), (*D*= 0.226 and 0.294) and (*J′*= 0.552 and 0.671) in the 1st and 2nd years, respectively. On the other hand, species richness was the same number in the drainage and rural houses habitats (3 species) and was 2 species in the urban houses. In contrast, the highest number of individuals captured from urban houses 160 individuals followed by drainage and rural houses habitats 85 and 75 individuals, respectively.

Jing-yuan*et al.*(2008) and Vipin Chaudhary *et al.* (2017) mentioned that the diversity index is one of the most important metrics for measuring community stability.

The (*H′*) value increases when each individual of community belongs to a different species, which indicates

the highest diversity, and the evenness (*J'*) also increased due to the more equal distribution. The least species diversity and evenness of rodent recorded from urban houses habitat with maximum relative abundance index (trap success) during two studied years, which is corresponds with several previous investigations. Prakash *et al.* (1996) and Vipin Chaudhary *et al.* (2017) in their study of the diversity for small mammals in India, illustrated that the least species diversity indices usually found in areas of maximum trap success. These results obtained from this study was consistent with those by (Hadjoudj *et al.*, 2015) who cleared that the evenness values when close to one, it means that the individuals of a species tends to be in balance between them.

Table 7. Diversity indices for rodents at different three habitats at El-Ibrahemia District, Sharkia Governorate

Diversity index		Urban houses	Rural houses	Drainage
Species richness		2	3	3
Total abundance of individuals		160	75	85
Shannon-Weaver Index	1st	0.382	0.734	1.045
	2nd	0.465	0.677	0.891
Simpson Index	1st	0.226	0.417	0.642
	2nd	0.294	0.376	0.558
Evenness	1st	0.552	0.668	0.951
	2nd	0.671	0.616	0.811

1st: first year; 2nd: second year.

CONCLUSION

Information about diversity and distribution of rodent species populations in rural, urban and village habitats is very important in planning future IPM programs. By providing information about the rodent species available, the most dominant species, the combination of different species, and the relativity of different species to each other in the same habitat, rodent control planners should be able to adjust their management strategies using the proper control tools suitable for the existing species in their respective habitat.

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توزيع وتنوع تعداد القوارض في بيئات مختلفة بمحافظه الشرقيه

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أجريت هذه الدراسة في مركز الإبراهيمية بمحافظة الشرقية بجمهورية مصرالعربية بهدف حصر أنواع القوارض وتوزيعها وتنوعها في ثلاثة بيئات مختلفة وهي المنازل الحضرية والريفية والمصرف الصحي) وذلك من شهر ديسمبر 2017 إلى نوفمبر 2019م. وكان العدد الكلي للقوارض 320 فردا ينتمون إلى أربعة أنواع من عائلة Muridae من البيئات الثلاثة محل الدراسة. وكانت الأنواع المتحصل عليها هي: الفأر المتسلق الذي يعتبر أكثر الأنواع شيوعا 114 و 96 فأر ، يليها الفأر النرويجي 30 و 23 فأر ثم الفأر النيلي مسجلا 18 و 15 فأر ، وأخيرًا فؤيرة المنازل 11 و 13 فؤيرة خلال العام الأول والثاني على التوالي. وبشكل عام فإن أعلي تعداد للقوارض في المناطق الثلاثة قد تم تسجيله في فصل الصيف يليه الخريف ثم الربيع وأخيرا فصل الشتاء. كما أظهرت النتائج أن عدد الذكور يفوق عدد الإناث في البيئات الثلاثة خلال عامي الدراسة. وسجلت بيئة المصرف الصحي أعلى قيم لمؤشرات التنوع وهى مؤشر شانون ويفر (1,045 ، 0,891) ، ومؤشر سيمبسون (0,642 ، 0,558) ومؤشر التوازن (0,951 ، 0,811) خلال العامين الأول والثاني على التوالي ،يليها بيئة المنازل الريفية والحضرية. وعلي العكس من ذلك ، تم الحصول على أكبر عدد من القوارض فى المنازل الحضرية (160 فردًا) يليها بيئة المصرف الصحي والمنازل الريفية (85 و 75 فردًا) علي التوالي. ينبغي أن تساعد المعلومات السابقة القائمين علي وضع خطط مكافحة القوارض في تعديل وتحسين استراتيجيات وبرامج المكافحة باستخدام الأدوات المناسبة للمكافحة تبعا للأنواع الموجودة كلا في بيئتها.