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Population trends of ectoparasites associated with *Rattus rattus alexandrinus* (L.) at Sohag and Assiut regions, Upper Egypt

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Abstract
Survey of ectoparasites infesting the grey bellied rat, *Rattus rattus alexandrinus* (L.) at Sohag and Assiut districts was conducted during the period from Feb. 2019 to Jan. 2020. In the two areas, survey exhibited presence of three species of mites viz., *Dermanyssus* sp., *Glycyphogus* sp. and *Ornithonyssius* sp., one species of hart tick, *Hyalomma* sp., two species of fleas, *Xenopsylla cheopis* (Rothschild) and *Pulex irritans* (L.) and one species of lice *Poolyplax spinulosa* (Brumeister). Results of population fluctuation showed that the ectoparasites (lice, fleas and mites) were recorded with variable densities in the two areas. The highest density was recorded during spring and summer months, whereas the lowest one was recorded in winter. Lice showed the highest density followed by mites, then fleas. In Sohag area, lice showed the highest percentage of ectoparasites captured (50%) followed by mites (40%), fleas showed the lowest percentage (10%). In Assiut area, also lice showed the highest percentage (40%) followed by fleas (35%) then mites (25%). Ectoparasites recorded in this study may play a role in transmitting dangerous diseases to man and domestic animals, so these results may be considered in rodent control.

Keywords: *R. r. alexandrinus*, mites, ticks, lice, fleas, ectoparasites

Introduction
Rodents with external arthropod parasites may play an important role in the distribution of the arboviruses, streptococcal infections, choriomeningitis, plague, tularemia, leptospirosis, and liver disease etc. [1]. External parasites include insects (fleas) and acarnies (mites), some of which are permanent like lice, while most mature ticks and fleas are temporary parasites. Rodents are known to harbor four groups of arthropod parasites: fleas, ticks, mites, and lice.
Ectoparasites are irritating pests of humans and animals. Some external parasites can transmit biological or mechanical infectious agents to humans or animals and spread the infection. The level of infection, intensity, and activity of these vectors depend on factors such as the abundance of various hosts, environmental conditions, and locomotion [2]. The objective of this study is to survey the external parasites on the grey bellied rat, *Rattus r. alexandrinus* (L.).

Materials and Methods
To study the population fluctuation of external parasites, rats were captured monthly, and were brushed, then the number of lice, fleas, and mites were counted. The average number for each season of the year was estimated. This work was done in the two areas by Sohag and Assiut regions (2019 to 2020).

Study area
Studies were conducted at Sohag and Assiut Regions, Upper Egypt during February 2019 – January 2020 year to identify the external parasites associated with the Alexandrian rat. This rat center houses and may transfer parasites or diseases to humans and animals.

Rat capturing and classification
The method of Soulsby (1982) [3] was used for conducting the survey. Traps were baited with vegetables and bread and placed in rodent activity areas such as, kitchens and walkways. The captured rats were transported to the laboratory in perforated metal boxes to provide good ventilation and an environment conductive to transiting animals. Rats were identified and classified to species level using the method of Meerburg *et al*. (2009) [4].

In the two study areas, fifty rats of *Ratus r. alexandrinus* were collected.

Survey for ectoparasites

To survey the ectoparasites, rodents were euthanized under diethyl ether anesthesia. The unconscious rats were placed on clean white tiles. From head to neck, trunk and tail, the external parasites were expelled from the rat's body by cleaning the brush with the help of a hand brush on cotton wool soaked in formalin. Visible external parasites such as ticks that can be removed easily without brushing teeth have been removed with a pair of tweezers.

Collected parasites were kept in sample bottles containing 70% alcohol, sorted, and transferred to a microscope slide for identification. Mites and ticks were identified according to keys created by [5-8]. The percentage of rat ectoparasites = number of ectoparasites collected from examined rats / total number of rate ectoparasites examined x 100.

Results and Discussion

Data in Table (1) represented three species of mites viz., *Dermanyssus* sp., *Glycyphagus* sp., *Ornithonyssius* sp., and one species of hard tick, *Hyalomma* sp., on the grey bellied rat. Also, two species of fleas *Xenopsylla cheopis* (Rothschild) *Pulax irritans* (L.) and one lice, *Polyplax spinulosa* (Brumeister) were recorded. Data in Fig. 1 A reported the monthly fluctuation of lice, fleas and mites on *R. r. alexandrinus* in Sohag and Assiut areas during the four seasons. The lice were recorded during the period of study except in January (Sohag) and February (Assiut). The highest population density was recorded during spring and summer months, followed by autumn, whereas the lowest density was recorded during winter months. Regardless of months, the population density of lice was relatively higher in Sohag area than Assiut area (fig. 1B). Fleas were recorded with low density in Sohag area during the period from March to October, and absent from November 2019 to February 2020. In Assiut area fleas were recorded during all months of study except in January. The population density in Assiut area was much higher than that in Sohag area (Fig. 1B). In the two areas, flea density was much higher in spring and summer months than that in Autumn and Winter months (Fig. 1B).

Mites were encountered during the period of study in the two areas, except in January and February in Sohag and January in Assiut area. Also, in lice and fleas, the highest population density was recorded in spring and summer, followed by autumn, whereas, the lowest density was recorded in winter (Fig. 1A). Despite months, the population density of mites was relatively higher in Sohag area than that in Assiut area (Fig. 1B).

Generally, the ectoparasites, lice, fleas and mites were found to infest *R. r. alexandrinus* during the period of study except in some winter months. The highest population density of the ectoparasites was recorded in hot months (spring and summer), and the lowest was observed in cold weather (winter). Table (2) shows that the highest percentage of ectoparasites was lice with a rate of 50% and 40% followed by 40% and 25%, while the percentage of fleas was 10% and 35% at Sohag and Assiut regions, respectively. The lowest infestation rate for the rat was fleas (10%) at Sohag Region.

Vatandoost *et al*. (2003) [9] and Telmadarraiy *et al*. (2004) [10] reported that most medically important rodents belong to the families muridae and cricetidae. Rodents and their associated ectoparasites may play a role in many diseases, such as plague, which is transmitted by mice flea *Xenopsylla cheopis* and Weil disease, an acute form of leptospirosis transmitted by urine of the infected mice. In agreement with our results, the captured rodents were infected with parasites of arthropods. The collected external parasites were identified as *X. cheopis*, *Ixodes* spp., *Polypex* spp. [11]. Also, Eslami *et al*. (2018) [12] recorded three species of rat ectoparasites *Polyplax spinulosa* (66%), *Laelaps nuttalli* (61%), and *Liponyssoides muris* (10%). Moreover, Wang *et al*. (2020) [13] found that *P. spinulosa* had nearly doubled its host range by parasitizing at least six endemic rodent species in Australia.

Regardless of months, lice exhibited the highest population density, followed by mites whereas, fleas showed the least population density, this may be attributed to that fleas visit rats for feeding only, but lice and mites are permanent parasites on hosts. In agreement with the present results, the highest average density of ectoparasites associated with grey bellied rat was observed during spring and summer seasons, and the lowest was recorded during winter [14]. In previous results, [15] similar results in his studies on rodents and their ectoparasites in cultivated and newly reclaimed areas. The ectoparasites recorded in the present study were found also by Moghddas-Sani (2009) [16] in their work on ectoparasites infesting rodents. Study of population dynamics is of much important before rodent control program.

Table 1: Taxonomic list of ectoparasites recorded on *R. r. alexandrinus* at Sohag and Assiut regions during 2019/2020.

Ectoparasites	A partial taxonomic		
	Order	**Family**	**Scientific name**
Lice	Phthiraptera (Anopulra)	Polyplacidae	*Polyplax spinulosia* (Brumeister, 1839)
Fleas	Siphonaptera	Pulicidae	*Xenopsylla cheopis* (Rothschild, 1903) *Pulax irritans* (Linnaeus, 1758)
Mites	Acari (Mesostigmata)	Dermanyssidae Glycyphagidae Macronyssidae	*Dermanyssus* sp. *Glycyphagus* sp. *Ornithonyssius* sp.
Ticks	Acari (Ixodida)	Ixodidae	*Hyalomma* sp.

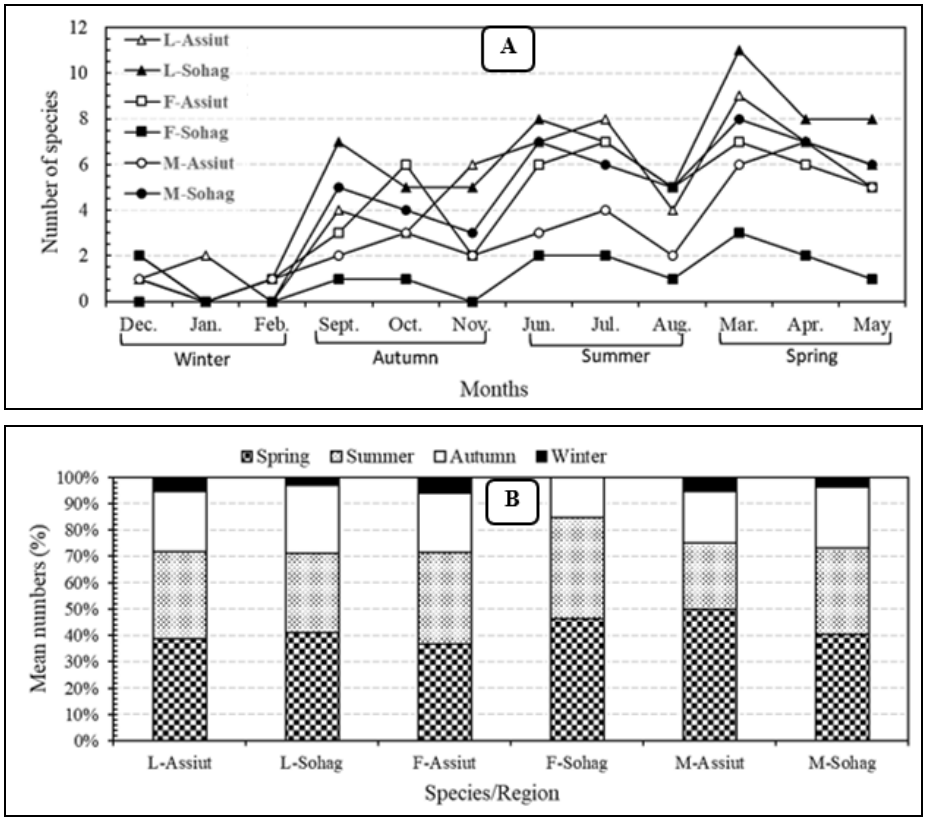

Fig 1: Monthly fluctuations (A) and mean numbers as a percentage (B) of external parasites on *R. r. alexandrinus* at Sohag and Assiut regions during 2019/2020 season; L: lice; F: fleas and M: mites and ticks.

Table 2: The percentage of identified external parasites on *Rattus r. alexandrinus* at Sohag and Assiut regions during 2019/2020.

Ectoparasites	Number and percentage (%) of rat ectoparasites			
	Sohag		Assiut	
	No.	%	No.	%
Lice	66	50	57	40
Fleas	13	10	49	35
Mites and Ticks	53	40	36	25
Total	132	100	142	100

Conclusion

All known external parasites were common parasites of rats. Infested rats near human habitations in the area warrant possible rodent-borne diseases among the residents, thus, an investigation of the occurrence of rodent-borne diseases among the dwellers may provide epidemiologic pattern related to such diseases including vectors of zoonotic diseases. This finding is therefore a critical step to estimate and assess the status of rodent infestation in the study areas. In view of this, community-wide rodent control strategies with a strong emphasis on community participation must be employed to prevent rapid spread of rodent population.

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