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EFFICACY OF CERTAIN INSECTICIDES AGAINST RAT FLEA (*XENOPSYLLA CHEOPIS*) AMONG RODENT SPECIES IN CAIRO GOVERNORATE, EGYPT

By

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Abstract

The efficacy of malathion, chlorpyrifos and deltamethrine to oriental rat flea, *Xenopsylla cheopis* associated different rodent species was carried out in Cairo Governorates. The results indicated that the Lc_{50} values were1.972, 1.023 and 0.185 % for Malathion, Chlorpyrifos and Deltamethrine, respectively. The values of Lc_{90} were 4.452, 2.269 & 0.456 % for the three insecticides respectively. Data also indicated that deltamethrine was effective on fleas than malathion and chlorpyrifos. The slope function was 3.625, 3.70 & 3.267, respectively.

Key Words: Rodent, Fleas, Malathion, Chlorpyrifos, Deltamethrine, Insecticides.

Introduction

Fleas are bloodsucking parasites of birds and mammals in the order Siphonaptera. Adult fleas are flattened from side to side and are wingless. The larvae are pale and caterpillar-like. Fleas can travel rapidly by jumping, using their legs and spring-like mechanism the body. They are capable of spectacular leaps, covering distances up to one hundred times their body length. Only adult fleas feed on blood, which they obtain with their piercing/sucking mouthparts. Fleas larvae feed on organic debris in bedding or in sleeping areas, and in dust and lint debris in carpeting. However, they are commonest in areas where animals sleep. Female fleas lay eggs in these areas. The eggs take about two weeks to hatch, depending on temperature. Larval fleas look very different from the adults, having long body hairs, and appearing caterpillar- or worm-like, without eyes or legs. Larvae spin a skin cocoon before transforming into adults. The complete life cycle from egg to egg takes 3-4 weeks depending on food availability and temperature; the warmer temperature the faster the fleas life cycle. Adult fleas are capable of living long period, particularly at cold temperatures, without feeding. In a few instances, fleas are known to live one or two months without a blood meal. Some fleas are responsible to transmit for a number of medical and veterinary problems. The most severe infectious disease spread by fleas is the plague, caused by *Y. pestis* (Stenseth *et al*, 2008). Fleas are Known as vectors of murine typhus (endemic typhus fever, *Rickettsia typhi*), and played a role in the rural epidemic typhus fever (*R. prowuzeki*) in the USA (WHO, 1989). The flea-borne spotted fever caused by *Rickettsia felis* emerged and could be found in many countries worldwide (Perez-osorio *et al*, 2008). The cat fleas have also been proven to harbor and sometimes transmit *Bartonella henselae,* the causative agent of the cat-scratch disease (Chomel *et al*, 2006; Billeter *et al*, 2008). Additionally, fleas are hosting helminthes, *Dipylidium caninum* and *Hymenolepis diminuta*, respectively parasites of camivores and rats (Duchemin *et al*, 2006). In tropical areas, *Tangiasis* caused by *T. penetrasis* a human disease directly linked to the parasitism of humans by fleas (Reiss, 1966). However, to many of general population, the insidious attacks by fleas on people and domestic animals causing irritation, blood loss, and severe discomfort are equally important as disease threat. *Xenopsylla cheopis* is common in many tropical and warm temperate envi-

ronments around the world, although it probably arose in north-eastern Africa. This flea is the primary vector of *Y. pestis* the agent of plague (Bitam *et al*, 2006), and is involved in transmission of murine (endemic) typhus (Brouqui and Raoult, 2006) and parasitic helminthes (Bordes *et al*, 2007). Bartonella sp have also been detected (Reeves *et al*, 2007). In fact, *Xenopsylla cheopis* is widely disseminated on various species of rodents in different parts of the world. In Egypt records were given by Abdou and Smaan (1962), Hoogstraal (1956), Arafa *et al.* (1973); Rifaat *et al.* (1969); Morsy *et al.* (1982) and Mahmoud *et al.* (2008).

The present work was planned to investigate the efficacy of Malathion, Chlorpyrifos and Deltamethrine chemical insecticides against the rat flea, *Xenopsylla cheopis* associated with the different rodent species trapped from Cairo Governorate.

Materials and Methods

The method described by Rifaat *et al*. (1969) for capturing and transporting of rodents to research laboratory was adopted throughout the present study. The study was done from June 2014 to November 2014. Wire box traps were baited and distributed in selected residential houses before sunset and collected next morning before sunrise. Distributed traps will be collected next morning and enclosed in separate white bag to avoid escape fleas and transported to laboratory (Elsheikha *et al*, 2009). In laboratory animals were anaesthetized with diethyl ether and fleas were collected on white sheet by using a stiff hard brush (WHO, 1970). Fleas collected were exposed to 4 concentrations of each insecticide (Malathion, Chorpyrifos and Deltamethrin). Papers 5 x 1.5 cm, tapered at one end impregnated with each concentration for each insecticide used was kindly provided by the WHO. A test paper and a control paper impregnated with oil alone were inserted into each of the test tubes. Into each tube, 10 fleas were transferred by means of the aspirator unit. Each tube was closed by fine-mesh gauze and the exposure period began. The tubes are placed vertically in rack under one of the halves of the kit box so that the fleas were kept in darkness during the exposure period. Each concentration was replicated 4 times with concurrent control. At the end of 60 minutes exposure period, the tubes were transferred to clean tubes containing clean non-impregnated paper. After 24 hours, the fleas examined and mortality counts were calculated. The method described by Finney (1952) and the logarithmic-probability was used to evaluate the relationship between concentrations and mortality. The slope (b) function ratio was also calculated.

Results

The results are shown in tables (1& 2).

Table 1: Response of fleas to different concentrations of insecticides in Cairo Governorate.

Insecticide	Concentration%	No. of fleas	Died	Alive	Mortality %
Malathion	1.0	40	7	33	17.5
	2.0	40	19	21	47.5
	3.0	40	26	14	65
	4.0	40	38	2	95
Chlorpyrifos	0.5	40	5	35	12.5
	1.0	40	19	21	47.5
	1.5	40	30	10	75
	2.0	40	34	6	85
Delta-methrin	0.1	40	8	32	20
	0.2	40	22	18	55
	0.3	40	28	12	70
	0.4	40	36	4	90

Table 2: Insecticides efficacy against fleas in Cairo Governorate.

Insecticides	Lc values & Lower and upper		Lc_{50}/ Lc^{90}	Slope (b)	Toxicity in-dex based on		Folds based on	
	Lc_{50}	Lc^{90}			Lc_{50}	Lc^{90}	Lc_{50}	Lc^{90}
Malathion	1.145&1. 972 and 2.85	3.020&4.452 and 21.38	0.44	3.625 ± 0.5	9.38	10.24	1	1
Chlorpyrifos	0.877&1.023 and 1.174	1.174&2.269 and 3.139	0.45	3.70 ± 0. 5	18.08	20.09	1.92	1.96
Delta-methrine	0.154&0.185 and 0.215	0.365&0.456 and 0.667	0.40	3.267 ± 0.5	100	100	10.65	9.76

Discussion

The insecticidal efficacy of Malathion, Chlorpyrifos and Deltamethrine was evaluated against oriental rat flea (*X. cheopis*). The lethal concentration (Lc) 50 & 90 of population percent were obtained from the established regression log concentrate-response lines. The results indicated that Deltamethrine was more effective to fleas than Chlorpyrifos and Malathion. The lethal concentration values (Lc_{50}) were, 1.972, 1.023 and 0.185 % for Malathion, Chlorpyrifos and Deltamethrine, respectively. The same finding and trend were obtained with (Lc_{90}) showed the values of 4.452, 2.269 and 0.456 % for Malathion, Chlorpyrifos and Deltamethrine, respectively. Data of the slope of the established regression lines indicated that the investigated population of fleas showed almost the same degree of response homogeneity toward Malathion, Chlorpyrifos and Deltamethrine. The slope values were 3.625, 3.70 and 3.267 for Malathion, Chlorpyrifos and Deltamethrine, respectively. Taking the values of lc_{50} and lc_{90} of Deltamethrine as a base line for comparison (Sun, 1950), the relative frequencies of Malathion and Chlorpyrifos reached 9.38 & 18.08 based on Lc_{50} and 10.24 & 20.09 based on Lc_{90}, respectively. Also taking the values of Lc_{50} and Lc_{90} of Malathion as a base line for comparison the relative frequencies of Chlorpyrifos and Deltamethrine reached 1.92 & 10.65 based on Lc_{50} and 1.96 & 9.76 based on Lc_{90}, respectively. The density of flea infesting domestic rodents in Egypt was reported by several investigators. Soliman *et al*. (2010) reported that the commonest flea species that attacked rodents at Menoufia Governorate were *X. cheopis*, *L. segnis* and *C. canis*. Mahmoud *et al.* (2008) found that the commonest fleas species attacking rodents at Suez, Menoufia, Giza, Damietta and Beni-Suef Governorates, were *X. cheopis*, *C. felis, L. segnis* and *P. irretans.* Shoukry *et al*. (1986) in North Sinai Governorate identified two species of flea; *X. cheois* and *C. segnis*. The same author *et al*. (1987) reported that fleas were the predominate ectoparasites in Ismailia Governorate. These fleas were *X. cheopis* (682), *Echidnophaga gallinacea* (667) and *Ctenocephlides segnis* (41). Morsy *et al*. (1988) in Alexandria City reported that fleas represented the main ecto-parasite infesting commensal rodents. These fleas in a descending order of abundance were *X. cheopis*, *L. senis*, *C. felis* and *P. irritans*. Zeese *et al.* (1990) in Sharkia Governorate identified five species of fleas from domestic rodent species, which were *X. cheopis L. segnis*, *c. felis* C. *canis* and *P. irritans*. Khalid *et al.* (1992) showed that *X. cheopis* the main ectoparasite on the rodent hosts over the year, the highky infested rodent was *R. norvegicus*. Morsy *et al*. (1986) in Suez Governorate studied the fleas that attacked the different rodent species (*Mus musculus*, *Rattus rattus*, *Rattus norvegicus*, *Acomys cahirinus* and *Sekeetamys culurus*), and identified in a descending order of abundance; *Xenopsylla cheopis*, *Pulex irritans*,

Ctenocephalides felis, *C. segnis* and *Echidnophaga gallinacean.*

Regarding insecticides against fleas, Soliman and Mikhail (2011) reported that Bendicarb was more effective than Diazinon and Pirimiphos-methyl against fleas were collected from domestic rodents at Dakahlia Governorate. The Lc_{50} values were 0.389, 1.039 & 2.056 % for Bendicarb, Diazinon and Pirimiphosmethyl, respectively. Abroad, Ratovonjato (1998) showed that *X. cheopis* for urban areas in Madagascar were resistance to DDT and pyrethroids (Deltamethrin, Lambdacyhalothr- in, Permethrin), but were susceptible to 1% Bendiocarb and Pirimiphosmethyl. Rato- vonjato *et al.* (1998) carried out field study for the efficacy of different insecticides against *X. cheopis* over the years 1997-98 in urban areas in Antananarivo, Madagascar; found that Deltamethrin was inefficient in causing a decrease of the flea index. Conversely, immediately after the treatment with Bendiocarb and Pirimiphosmethyl, the flea index decreased significantly. Arvind Kumar *et al.* (2007) tested the toxicity of Malathion on two species of rat fleas namely *X. cheopis* and *X. astia* in Distt Baghpat of western Uttar Pradesh. The mortality of 82.15% was recorded in *X. cheopis* and 85.71% in *X. astia* after exposed for one hour. Males of both species showed more sensitivity to insecticide than females. Shyamal *et al*. (2008) reported the development of resistance in rat fleas to DDT at 4.0%, Malathion at 5.0%, Deltamethrin at 0.05% and tolerance to Permethrin at 0.75% in all the four blocks of Nilgiris hill district. The development of resistance was attributed to the extensive use of insecticides in tea plantations and agricultural sectors where the domestic/ peri-domestic rodents lived their natural habitats and intermingle with each other. Yi *et al.* (2008) studied the resistance rates of *X. cheopis* at Lc_{50} values of Malathion (0.0165), Propoxur (0.117), Dichorovos (0.0202) Pe-rmethrin (0.0002), Deltamethrin (0.0038) and Fendona (0.0087) for the different insecticides, respectively, that 4.78, 16.42, 2.08, 1.70,1.66 & 2.94 times. They concluded the large amount and constant of flea insecticides might lead to the marked resistance.

Burgess (2010) reported that synthetic pyrethroids were commonly used especially against lice infestation as they cause less ecological problems and are available as sprays, vaporizing mats, mosquito coils or in combination with physical means such as bed-nets Singh and Mann (2013) stated that fleabites may produce psychological distress and that treatment consisted of eradication of flea infestation in the source pet-animal. They added that Permethrin acts by its agonist action at voltage-gated sodium channels (VGSC) in nervous systems of insects. Selective point mutations in α-subunit gene of VGSC result in nerve insensitivity, resulting in resistance known as knockdown resistance (kdr). Dantas-Torres *et al*. (2013) used different commercial products with insecticidal, repellent or both properties for dogs. They found that a combination of Imidacloprid 10% and Flumethrin 4.5% has proven effective to prevent tick and flea infestations in dogs under field conditions and the infection by some vector-borne pathogens they transmit. Ratovonjato *et al*. (2000) studied the susceptibility of *X. cheopis* collected from different rural areas in Madagascar (Ambodislarivo, mandoto, Analaroa and Besoa) to Deltamethrin (0.025%), Cyfluthrin (0.15%), DDT (4%), Propoxur (1%) and Bendiocarb (0.1%). *X. cheopis* collected from Mandoto and Analaroa showed to tolerance to Deltamethrin and Cyfluthrin, but was susceptible to Propoxur and Bendiocarb. Fleas collected from Besoa were resistant to DDT, tolerant to Deltamethrin and Cyfluthrin, but susceptible to Propoxur and Bendiocarb.

In Egypt, Mikhail *et al*. (2011) in a field survey study reported that the flea index at Ismailia and Matrouh Governorates found

the highest indices (8.93 & 7.68), while El-Fayoum and North Sinai Governorates showed the lowest ones (1.09 & 1.68). Dakhalia showed moderate flea index of 4.52. The highest number was recorded on *R. norvegicus* in places easy to dig barrows and suitable medium for fleas breeding. The lowest number was recorded on *Mus musculus* and *Acomys cahirinus*. The oriental rat flea, *Xenopsylla cheopis* was the highest frequency distribution for all domestic rodent species, while, the stick-tight flea, *Echidnophaga gallinacea* was the lowest which recorded at Ismailia and Dakahlia only. El-Bahnasawy *et al*. (2012) reported that the outbreak of plague at the Libyan Egyptian borders may occur due to the high density of rodents and their fleas in many Egyptian Governorates should be embarked a control program to rodents and fleas. The toxicity of insecticides to fleas was reported by several investigators.

Conclusion

The outcome results showed that Cairo Governorates were distinguished by the presence of high population density of rodents which more heavily infested with fleas. Their intimate association with man is of great potential danger as disseminators of serious pathogens. In addition, the outbreaks of plague at State of Libya near the Egyptian border and the high density of fleas parasitic on rodents at most Governorates, that should be embarked a control program to rodents and their fleas.

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