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 Lc50 values were 1.972, 1.023 and 0.185 % for Malathion, Chlorpyrifos and Deltamethrine, respectively. The values of Lc90 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. prowazekii) 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 carnivores and rats (Duchemin et al, 2006). In tropical areas, Tungiasis caused by T. penetrantis 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), Arafä et al. (1973); Rifäat 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 Rifäat 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 (Elsheikh 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, Chlorpyrifos 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 rank 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>
<thead>
<tr>
<th>Insecticide</th>
<th>Concentration%</th>
<th>No. of fleas</th>
<th>Died</th>
<th>Alive</th>
<th>Mortality %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malathion</td>
<td>1.0</td>
<td>40</td>
<td>7</td>
<td>33</td>
<td>17.5</td>
</tr>
<tr>
<td></td>
<td>2.0</td>
<td>40</td>
<td>19</td>
<td>21</td>
<td>47.5</td>
</tr>
<tr>
<td></td>
<td>3.0</td>
<td>40</td>
<td>26</td>
<td>14</td>
<td>65</td>
</tr>
<tr>
<td></td>
<td>4.0</td>
<td>40</td>
<td>38</td>
<td>2</td>
<td>95</td>
</tr>
<tr>
<td>Chlorpyrifos</td>
<td>0.5</td>
<td>40</td>
<td>5</td>
<td>35</td>
<td>12.5</td>
</tr>
<tr>
<td></td>
<td>1.0</td>
<td>40</td>
<td>19</td>
<td>21</td>
<td>47.5</td>
</tr>
<tr>
<td></td>
<td>1.5</td>
<td>40</td>
<td>30</td>
<td>10</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td>2.0</td>
<td>40</td>
<td>34</td>
<td>6</td>
<td>85</td>
</tr>
<tr>
<td>Delta-</td>
<td>0.1</td>
<td>40</td>
<td>8</td>
<td>32</td>
<td>20</td>
</tr>
<tr>
<td>methrin</td>
<td>0.2</td>
<td>40</td>
<td>22</td>
<td>18</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td>0.3</td>
<td>40</td>
<td>28</td>
<td>12</td>
<td>70</td>
</tr>
<tr>
<td></td>
<td>0.4</td>
<td>40</td>
<td>36</td>
<td>4</td>
<td>90</td>
</tr>
</tbody>
</table>
Table 2: Insecticides efficacy against fleas in Cairo Governorate.

<table>
<thead>
<tr>
<th>Insecticides</th>
<th>Lc values &amp; Lower and upper</th>
<th>Lc50/Lc90</th>
<th>Slope (b)</th>
<th>Toxicity in-dex based on Lc50</th>
<th>Folds based on Lc50</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malathion</td>
<td>1.145 &amp; 1.972 and 2.85</td>
<td>3.020 &amp; 4.452 and 21.38</td>
<td>0.44</td>
<td>3.625 ± 0.5</td>
<td>9.38 10.24 1 1</td>
</tr>
<tr>
<td>Chlorpyrifos</td>
<td>0.877 &amp; 1.023 and 1.174</td>
<td>1.174 &amp; 2.269 and 3.139</td>
<td>0.45</td>
<td>3.70 ± 0.5</td>
<td>18.08 20.09 1.92 1.96</td>
</tr>
<tr>
<td>Delta-methrine</td>
<td>0.154 &amp; 0.185 and 0.215</td>
<td>0.365 &amp; 0.456 and 0.667</td>
<td>0.40</td>
<td>3.267 ± 0.5</td>
<td>100 100 10.65 9.76</td>
</tr>
</tbody>
</table>

Discussion

The insecticidal efficacy of Malathion, Chlorpyrifos and Deltamethrin was evaluated against oriental rat flea (X. cheopis). The lethal concentration (Lc) 50 & 90 of population percent were obtained from the established regression log concentration-response lines. The results indicated that Deltamethrin was more effective to fleas than Chlorpyrifos and Malathion. The lethal concentration values (Lc50) were 1.972, 1.023 and 0.185 % for Malathion, Chlorpyrifos and Deltamethrin, respectively. The same finding and trend were obtained with (Lc90) showed the values of 4.452, 2.269 and 0.456 % for Malathion, Chlorpyrifos and Deltamethrin, 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 Deltamethrin. The slope values were 3.625, 3.70 and 3.267 for Malathion, Chlorpyrifos and Deltamethrin, respectively. Taking the values of Lc50 and Lc90 of Deltamethrin as a base line for comparison (Sun, 1950), the relative frequencies of Malathion and Chlorpyrifos reached 9.38 & 18.08 based on Lc50 and 10.24 & 20.09 based on Lc90, respectively. Also taking the values of Lc50 and Lc90 of Malathion as a base line for comparison the relative frequencies of Chlorpyrifos and Deltamethrin reached 1.92 & 10.65 based on Lc50 and 1.96 & 9.76 based on Lc90, 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 Governors, were X. cheopis, C. felis, L. segnis and P. irretans. Shoukry et al. (1986) in North Sinai Governorate identified two species of flea; X. cheopis 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 Ctenocephalides 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. irretans. 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. irretans. Khalid et al. (1992) showed that X. cheopis the main ecto-parasite on the rodent host over the year, the highly infested rodent was R. norvегicus. 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 Sekeetamyx culurus), and identified in a descending order of abundance; Xenopsylla cheopis, Pulex irritans,
Ctenocephalides felis, C. segnis and Echidnophaga gallinacea.

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, LambdaCyanhalothrine, Permethrin), but were susceptible to 1% Bendicarb 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 Pirimiphos-methyl, 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 Baghat 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 (kdrr). 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, Analoro and Besoa) to Deltamethrin (0.025%), Cyfluthrin (0.15%), DDT (4%), Propoxur (1%) and Bendiocarb (0.1%). X. cheopis collected from Mandoto and Analoro 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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