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Macrochelid Mite, *Macrocheles muscaedomesticae* (Acarina: Macrochelidae) as a Biological Control Agent Against House Fly, *Musca domestica* (Diptera: Muscidae) in Egypt

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ABSTRACT

Numerous species of macrochelids (Acarina: Mesostigmata) have shown capability to attack housefly larvae and eggs but it is presumed that only a few of them play a significant role in the control of flies in nature. *Macrocheles muscaedomesticae* (Scopoli) is one of several mites that feeds on eggs, newly hatched and small larvae of house fly *Musca domestica* L. This study provide avidence that macrochelid mite is attacking not only housefly larvae and eggs but also on housefly adults. *Macrocheles muscaedomesticae* mite was reared in the laboratory on house fly frozen eggs and first instar of larvae at constant conditions of 28°C±1 and 90% relative humidity using sterilized artificial diet. The mean incubation period of eggs, total immatures, female longevity were 0.7, 4.0 and 25.2 days, respectively when fed on frozen eggs meanwhile means were 0.8, 7.0 and 22.6 days when fed on first instar larvae of *M. domestica*. The total consumption of female was 131.1 eggs/female or 82.7 larvae. Results of the present study showed that the mean mortality percentages of eggs due to predation of three levels of predator 2, 5 and 10 individuals were 57.2, 74.9 and 96.5 after 5, 4, 2 days, respectively. Also, the larval stage of *M. domestica* was introduced with three levels of 10, 20 and 25 individuals for each level of predatory mite 2, 5 and 10 adults, respectively. Results revealed that the best results were recorded at the level of 5 mites, where the mean mortality percentage of larvae was 100% after one day when introduced with 10 housefly's larvae but it was 96% after two days when introduced with 20 housefly's larvae and 76.2% after three days when introduced with 25 houseflies larvae at level of 5. In addition, the present study provide evidence that mites can consume the housefly adult stage. Our findings indicated that the best results were recorded at the level of 10 mites where the mean mortality percentages of adults were 83.55%, the fly died after two days of one prey treatment, 62.5% after four days of two preys treatment while it was only 55.57% after three days of three preys treatment.

Key words: *Macrocheles muscaedomestiace*, house fly, predation, biocontrol

INTRODUCTION

A number of mite's species encountered in dung are predators on nematodes, oligochaetes or arthropods. Family Machrochelidae is one of the six families of the suborder Gamasida and some species of this family prey on different stages of house fly (Krantz, 1983). Several species of this family are predacious on the eggs and first-instar larvae of the house fly and cause substantial

reductions in house fly production from manure (Axtell, 1961, 1963, 1964). The pioneering study of Filipponi and coworkers in Italy on the biology of Macrochelidae associated with synanthropic flies verified that macrochelid mites hold considerable promise as a means of controlling fly populations (Filipponi, 1960, 1964). The macrochelid mite, *Macrocheles muscaedomesticae*, is the most common mite in poultry manure. The reddish-brown mite, slightly less than 1/16 inch in size, feeds on house fly eggs and first-instar larvae and it can consume upto 20 house fly eggs per day. Mites are found on the outermost layer of the manure, particularly on its peak. Macrochelids can cause substantial reductions in house fly numbers but large mite populations are required for appreciable impact. Rates of predation by *M. muscaedomesticae* and *Fuscuropoda vegetans* (O'Donnell and Axtell, 1965; Willis and Axtell, 1968; Axtell, 1969) have been studied extensively under a variety of experimental conditions and results were variable. The mite *M. muscaedomesticae* (Scopoli) is one of the most abundant predators of fly immatures in poultry production systems (Peck and Anderson, 1969; Axtell, 1970; Stoffolano Jr. and Geden, 1987; Geden and Stoffolano Jr., 1988). There are several advantages that make *M. muscaedomesticae* an attractive bio-control agent such as short development time, high attacking rate, ability to reproduce on alternative prey and proclivity for dispersal into new fly breeding areas via phoresy (Filipponi and Perrelli, 1967; Axtell, 1969; Filipponi and di Delupis, 1963; Ito, 1973; Farish and Axtell, 1971). Geden and Axtell (1988) found that 54 fly immatures were destroyed per predator per day, at 15 and 35°C, predation rates of *M. muscaedomesticae* were 5.0 and 36.3 per day, respectively. Al-Dulaimi (2002) revealed that *Macrocheles glaber* (Müller) is one of several mites that feeds on eggs, newly hatched and small larvae of house fly *Musca domestica* L. This mite was reared in the laboratory on house fly frozen eggs at constant conditions of 28°C±1 and 90% relative humidity using sterilized horse dung substrate. The predation rate of adult female and male on frozen eggs was (18, 3) eggs/mite/day.

The aim of this study is to investigate developmental stages of *Macrocheles muscadomestica* and its potential to control different stages of *Musca domestica* using three levels of this predator.

MATERIALS AND METHODS

House fly culture reared on artificial diet consisted of 9 g powder milk and 5 g yeast dissolved in 100 mL water in addition to 100 g fine bran (Wilkins and Khalequzzaman, 1993). The mixture was stirred and put into the cups 3 cm from the top. The cups were transferred to an entomological glass cages (60×35×40 cm) which used for rearing house fly larvae under laboratory conditions (25±5°C, 60±5% RH) and a 12:12 light:dark cycle (Palacios *et al*., 2009).

These cages were covered with mesh screen with cloth sleeve opening at top. When adult house fly emerged in cages, granulated sugar and milk soaked cotton wool balls were provided in petri dishes as food to house fly adults. The emerged flies were also fed with full fat fresh milk in petri dishes. After two days of fly emergency, the beakers containing larval food was placed for egg laying process, then beakers were removed from cages after 2-3 days when eggs were visible and attached to food along the sides of beakers. The food was changed after 2-4 days depending upon the numbers of larvae per beaker. The beakers were kept in separate cage for fly emergency (Ahmed and Irfanullah, 2007).

Macrocheles muscaedomesticae was found with huge numbers associated with house fly culture reared at laboratory of Economic Entomology and Agricultural Zoology Department, Faculty of

Agriculture, Menoufia University, Egypt. Nymphs were reared in a plastic container (15 cm long, 10 cm wide, 5 cm in depth, the cover had a window 5×5 cm screened with fine polyester mesh) and kept in an incubator at 28°C. One container was used to rear mites fed on house fly adults and eggs and the other fed on house fly larvae. Food was added daily.

To study the developmental stages of mite, petri dishes were taken that were 5 cm in diameter inwhich 1 g of sterilized poultry dung was placed, some drops of water was added, then a couple of newly emerges mites were transferred to lay eggs. Ten replicates were used that examined twice daily, kept at 28°C and incubation period was calculated by rearing egg singly until hatching, then other immature stages period were determine by adding either eggs or larvae of house fly, tangle foot was used to prevent mite escaping. Newly emerged females were separated singly to determine its longevity. The same rearing cells were used to determine the number of consumed eggs by mite's female, daily ten eggs were add to each female reared singly, ten replicates were used.

To study the effect of predatory number on the consumption rate of house fly eggs, 40 eggs were added to 2, 5, 10 females and daily observation was done to determine the number of destroyed eggs using microscopic examination, the emerged house fly larvae were removed and replaced with eggs.

As for house fly larval stage, three counts were used (10, 20 and 25 larvae) for each level of predator numbers (2, 5 and 10 females of *M. muscaedomesticae*) to determine the consumption rate and the probability of competition between mite individuals. Daily examination was conduct, corrected and mortality was calculated. The adult stage of house fly was introduced by (1, 2 and 3 adult flies) for each level of mites (2, 5, 10 and 15 females) experiment was prolonged for five days, respectively at 28°C. Control used without mites, mortality percentages of eggs, larvae and adult fly were calculated and corrected using (Abbott, 1925).

Data was statistically analyzed using computer Program COSTAT 22 (1998) according to the method of Snedecor and Cochran (1967).

RESULTS AND DISCUSSION

Biology of *Macrocheles muscaedomesticae*: Table 1 showed the duration of *Macrocheles muscaedomesticae*, developmental stages when fed on eggs or larvae of *Musca domestica* at 28°C.

Data showed that the mean of incubation period of *M. muscaedomesticae* egg durated 0.7 day when fed on *M. domestica* eggs, this period was nearly the same (0.8 day) when fed on larvae of fly. The total immatures of *M. muscaedomesticae* female was ranged 3.5:4.5 with mean of 4.0 days

Table 1: Biological aspects of *Macrocheles muscaedomesticae* adult females feed on *Musca domestica* eggs and larvae at 28°C

	Feed on *M. domestica* eggs at 28°C				Feed on *M. domestica* larvae at 28°C			
Biological aspects	Total	Mean	Range	SE	Total	Mean	Range	SE
Incubation period	3.5	0.7	0.5:1.000	0.7±0.220	4.0	0.8	0.5:1.000	0.8±0.220
Total immatures	20.0	4.0	3.5:4.500	4.0±1.570	35.0	7.0	6.0:8.000	7.0±3.580
♀ longevity	126.0	25.2	25.5:27.00	25.2±10.96	113.0	22.6	21.0:25.00	22.5±9.840
Daily consumption ♀	27.0	5.4	4.0:7.000	5.4±1.790	19.0	3.8	3.0:5.000	3.8±1.790
Total consumption ♀	655.5	131.1	94.0:168.0	131.1±42.04	413.5	82.7	60.0:120.0	82.7±37.57

Values are Mean±SE (n = 5)

Table 2: Effect of different levels of predatory mite *Macrocheles musacaedomesticae* feeding on *Musca domestica* eggs and larval stage

	Percentage mortality of eggs or larvae (day)					
Level of predator	1st	2 nd	3rd	4 th	5 th	Mean
Introducing 40 eggs						
2	19.0	37.0	55.0	75.0	100	57.2
5	37.0	75.0	87.5	100.0	-	74.9
10	93.0	100.0	-	-	-	96.5
Introducing 10 larvae						
2	36.4	83.3	100.0	-	-	73.2
5	100.0	-	-	-	-	100.0
10	83.3	100.0	-	-	-	91.7
Introducing 20 larvae						
2	13.6	22.0	56.0	84.0	100	55.2
5	92.0	100.0	-	-	-	96.0
10	66.6	100.0	-	-	-	83.3
Introducing 25 larvae						
2	12.4	27.0	36.0	77.0	100	50.5
5	40.2	88.3	100.0	-	-	76.2
10	53.3	73.3	100.0	-	-	75.5

when fed on fly eggs while the mean of this period was prolonged to 7.0 days when fed on the larvae of *M. domestica*. The female longevity was longer when fed on fly eggs ranged from 25.5-27 days with mean of 25.2 days while it lasted only 22.6 days when the mite fed on fly larvae.

The daily consumption per female was observed and data showed that mites consumed from 4-7 eggs day^{-1} with mean number of 5.4 eggs day^{-1} female^{-1}, while the female of *M. muscaedomesticae* consumed 3:5 larvae day^{-1} with mean of 3.8 larvae day^{-1}. The mean total consumption rate of fly eggs was 131.1:82.7 eggs or larvae/♀.

In compare with data obtained by Al-Dulaimi (2002) on the biology of *Macrocheles glaber* reared on 28°C, our results showed that *M. muscaedomesticae* egg hatch after only 0.7 days while it was 1.34 days for *M. glaber* but the immature stages was longer for *M. muscaedomesticae* (4.0 days) while it was only 2.67 days in case of feeding on fly eggs. The female longevity of *M. muscaedomesticae* was shorter (25.2 days) than *M. glaber* (27.8 days).

Effect of prey stage, number and the predatory level on predation rate

Egg prey: Table 2 cleared the mortality percentage due to predation of different levels of predator 2, 5 and 10 individuals. As for egg stage, the mortality percentage was 19% one day after introducing 40 eggs to two predatory individuals, this percentage increased to 100% five days after introducing with mean of 57.2%. Five predatory individuals consumed 37% from eggs one day after introducing completely destroyed all eggs after four days with mean of 74.9% mortality. The fourty eggs of *M. domestica* were completely destroyed two days after introducing 10 predatory individuals.

Larvae prey: The larval stage of *M. domestica* was introduced with three levels 10, 20 and 25 individuals for each level of predatory mite 2, 5 and 10 adults.

The ten larvae of *M. domestica* were destroyed after three days when exposed to 2 or 10 mite individuals after two days while all larvae were destroyed at the first day at the level of 5 predatory

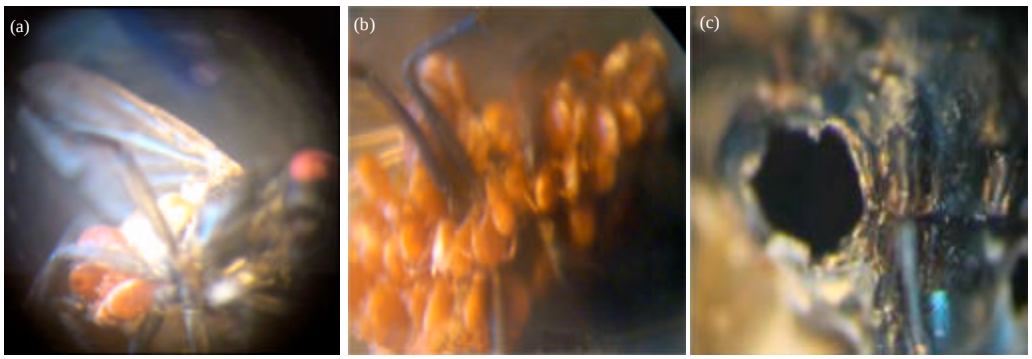

Fig. 1(a-c): (a) *Macrocheles muscaedomesticae* attack housefly, (b) Large numbers of predators on housefly and (c) Big hole on ventral surface of housefly after feeding predators. (These photos were taken by a light microscope by Dr. Hany heikal 2013)

Table 3: Effect of different levels of predatory mite *Macrocheles musacaedomesticae* feeding on *Musca domesticate* adult stage

	Mortality % of adult (day)					
Level of predator	1st	2nd	3rd	4th	5th	Mean
Introducing one adult						
2	0.0	0.0	33.3	33.3	100	33.32
5	0.0	0.0	0.0	0.0	100	20.00
10	66.7	100.0	-	-	-	83.35
Introducing two adult						
2	0.0	16.7	83.3	100.0	-	50.00
5	16.7	16.7	66.7	100.0	-	50.03
10	0.0	66.7	83.3	100.0	-	62.50
Introducing three adult						
2	0.0	22.2	88.9	100.0	-	52.78
5	0.0	22.2	66.7	100.0	-	47.23
10	0.0	66.7	100.0	-	-	55.57
15	44.4	88.9	100.0	-	-	77.77

mites. On the other hand, introducing 20 larvae of fly due to mean mortality of 55.2, 96.0 and 83.3%, all larvae destroyed after 5 days by two predatory individuals while only 2 days were satisfied to destroy all larvae when 5 or 10 predatory individuals were used.

Increasing the larval stage number to 25 individuals showed approximately the same results recorded mean mortality were 50.5, 76.2 and 75.5% when 2, 5 and 10 predatory individuals were used, respectively.

Adult prey: The predation of *Macrocheles muscaedomesticae* was observed too in adult stge of *Musca domesticate*, it was the first record of preying *M. muscaedomesticae* on the housefly adult, cleared this predation and how mites can completely destroy the fly Fig. 1a, b and c. Data in Table 3 proved that two or five predatory mites levels were able to kill the introduced adult fly during the third day with average mortality percentage of 33.3% while the adult flies in all replicates were destroyed during the fifth day. As for the level of 10 predators, the introduced fly was completely killed in all replicates at the second day.

Introducing two adult flies for the three levels of predator (2, 5, 10 individuals) recorded 50, 50.03 and 62.5% mean mortality with the same adult results of killing the two adult fly four days after introducing, respectively.

Four levels of mites 2, 5, 10, 15 individuals/3 adult flies were used, data proved that the 1st and 2nd levels killed fly in all replicates after 4th days, 3rd and fourth levels were able to destroy flies after three days only.

The present study introduced some important information about the control of *Musca domestica* using the most common and abundant mite in poultry and farm manure *Macrocheles muscaedomesticae*, the previous reported studies used this mite against fly eggs and larvae (Geden and Axtell, 1988; Geden *et al*., 1988; Al-Dulaimi, 2002) in our study, data proved that we can control adult fly also by this mite. However, the reported rates of predation are extremely variable according to the methods used for evaluation, our study estimated the effect of different levels of both predator and prey. The most suitable data proved that both 5 and 10 levels were able to control egg and larvae stages of fly. The ratio of predator and eggs (1:4), predator and larvae (2:5), predators adult fly (5:2) showed promising rate to control this pest on poultry and farm manures.

REFERENCES

Abbott, W.S., 1925. A method of computing the effectiveness of an insecticide. J. Econ. Entomol., 18: 265-267.

Ahmed, S. and M. Irfanullah, 2007. Toxicity of pyrethorids co-administered with sesame oil against housefly *Musca domestica* L. Int. J. Agric. Biol., 9: 782-784.

Al-Dulaimi, S.I., 2002. Predation by the mite *Macrocheles glaber* (Muller) (Acarina: Macrochelidae) on the house fly *Musca domestica* L. with some notes on its biology. Bull. Iraq Nat. Hist. Mus., 9: 7-11.

Axtell, R.C., 1961. New records of North American Macrochelidae (Acarina: Mesostigmata) and their predation rates on the house fly. Ann. Entomol. Soc. Am., 54: 748-748.

Axtell, R.C., 1963. Effect of Macrochelidae (Acarina: Mesostigmata) on house fly production from dairy cattle: Nlanure. J. Econ. Entomol., 56: 317-321.

Axtell, R.C., 1964. Phoretic relationship of some common manure-inhabiting Macrochelidae (Acarina: Mesostigmata) to the house fly. Ann. Entomol. Soc. Am., 57: 584-587.

Axtell, R.C., 1969. Macrochelidae as biological control agents for synanthropic flies. Proceedings of the 2nd International Congress of Acarology, July 19-25, 1967, Sutton Bonington, England, pp: 401-406.

Axtell, R.C., 1970. Integrated fly-control program for caged-poultry houses. J. Econ. Entomol., 63: 400-405.

Farish, D.J. and R.C. Axtell, 1971. Phoresy redefined and examined in *Macrocheles muscaedomesticae* (Acarina: Macrochelidae). Acarologia, 13: 16-29.

Filipponi, A. and G.D. di Delupis, 1963. On the food habits of some macrochelids (Acari: Mesostigmata) associated in the field with synanthropic f lies. Riv. Parassitol., 24: 277-288.

Filipponi, A. and M.G. Petrelli, 1967. Autoecology and capacity for increase in numbers of *Macrocheles muscaedomesticae* (Scopoli) (Acari: Mesostigmata). Riv. Parasitol., 28: 129-156.

Filipponi, A., 1960. Macrochelidi (Acarina: Mesostigmata) Foreticidi nosch. Risultati parzialidi una indagine ecologica in carso nell agro pontino. Parasitologia, 2: 167-172.

Filipponi, A., 1964. The feasibility of mass producing macrochelid mites for field trials against houseflies. Bull. World Health Organiz., 31: 499-501.

Geden, C.J. and J.G. Stoffolano Jr., 1988. Dispersion patterns of arthropods associated with poultry manure in enclosed houses in Massachusetts: Spatial distribution and effects of manure moisture and accumulation time. J. Entomol. Sci., 23: 136-148.

Geden, C.J. and R.C. Axtell, 1988. Predation by *Carcinops pumilio* (Coleoptera: Histeridae) and *Macrocheles muscaedomesticae* (Acarina: Macrochelidae) on the house fly (Diptera: Muscidae): Functional response, effects of temperature and availability of alternative prey. Environ. Entomol., 17: 739-744.

Geden, C.J., R.E. Stinner and R.C. Axtell, 1988. Predation by predators of the house fly in poultry manure: Effects of predator density, feeding history, interspecific interference and field conditions. Environ. Entomol., 17: 320-329.

Ito, Y., 1973. The effects of nematode feeding on the predatory efficiency for house fly eggs and reproduction rate of *Macrocheles muscaedomesticae* (Acarina : Mesostigmata). Med. Entomol. Zool., 23: 209-213.

Krantz, G.W., 1983. Mites as Biological Control Agents of Dung-Breeding Flies, with Special Reference to the Macrochelidae. In: Biological Control of Pests by Mites, Hoy, M.A., G.L. Cunningham and L. Knutson (Eds.). University of California, Berkeley, pp: 91-98.

O'Donnell, A.E. and R.C. Axtell, 1965. Predation by *Fuscoropoda vegetans* (Acarina: Uropodidae) on house fly *Musca domestica*. Ann. Entomol. Soc. Am., 58: 403-404.

Palacios, S.M., A. Bertoni, Y. Rossi, R. Santander and A. Urzua, 2009. Efficacy of essential oils from edible plants as insecticides against the house fly, *Musca domestica* L. Molecules, 14: 1938-1947.

Peck, J.H. and J.R. Anderson, 1969. Arthropod predators of immature diptera developing in poultry droppings in Northern California: Part I. Determination, seasonal abundance and natural cohabitation with prey. J. Med. Entomol., 6: 163-167.

Snedecor, G.W. and W.G. Cochran, 1967. Statistical Methods. 6th Edn., Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, India, Pages: 593.

Stoffolano Jr., J.G. and C.J. Geden, 1987. Succession of manure arthropods at a poultry farm in Massachusetts, USA, with observations on *Carcinops pumilio* (Coleoptera: Histeridae) sex ratios, ovarian condition and body size. J. Med. Entomol., 24: 214-222.

Wilkins, R.M. and M. Khalequzzaman, 1993. Environmental interactions of pesticides: Synergism of permethrin by simazine against the housefly. Proceedings of the International Brighton Crop Protection Conference Weeds, Volume 1, November 22-25, 1993, Brighton, UK., pp: 157-162.

Willis, R.R. and R.C. Axtell, 1968. Mites predators of the house fly: Acomparison of *Fuscoropoda vegetans* and *Macrocheles muscadomesticae*. J. Econ. Entomol., 61: 1669-1674.