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The Scuttle Fly, *Megaselia scalaris* (Loew, 1866) (Diptera: Phoridae): A New Threat on Laboratory Mass Production of Fruit Flies

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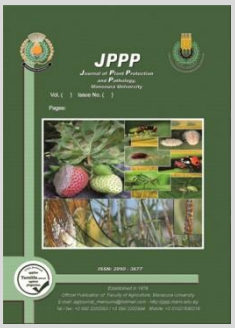

ABSTRACT

The scuttle fly, *Megaselia scalaris* is an omnivorous species, capable of exploring a large variety of environments and ecological niches. It is known as an important detritivore species with maggots feeding on a variety of food of both animal and plant origin. *M. scalaris* was investigated as a severely-infesting pupal-adult parasitoid on the laboratory mass culture of the two tephritid species of the peach fruit fly, *Bactrocera zonata* (Saunders) and the Mediterranean fruit fly, *Ceratitis capitata* (Wiedemann) reared in laboratory of Horticultural Insects Research Department, Plant Protection Research Institute, Agricultural Research Center, Egypt. Pupae of the two species of fruit flies resulting from experiments to evaluate efficiency of certain essential oils (Clove, Lavender and Neem) as stomach poison against larval instars in treated artificial diet were separately collected till emergence. Three days post emergence, all emerged flies were investigated dead with empty body cavities and huge numbers of strange larvae and pupae were observed inside their abdominal cavity which were identified as, *M. scalaris*, *Eurytoma martellii* Domenichini, 1960 (Hymenoptera: Eurytomatidae) and *Drosophila hydei* Sturtevant,1921 (Diptera: Drosophilidae). The first species was major predominant, whereas the latest two species were rare. Thus, it is concluded that these species especially *M. scalaris* may form a threat factor for laboratory mass production of many species of insects such as tephritid fruit flies.

Keywords: Parasitism, myiasis, nutritional behavior, facultative and opportunistic parasites.

INTRODUCTION

The scuttle fly is a widely distributed species which has been reported feeding on a large variety of materials, most often decaying plant and animal materials, but including living plants and animals, and more unusualfood sources such as paint and boot polish. *M. scalaris* is a cosmopolitan polyphagous small fly with ability of exploiting variety of ecological niches. Different life history stages act as detritivore, parasite, and parasitoid of wide spectrum of plant and animal matter under natural andlaboratory conditions. (Disney, 2008 and Diyes *et al*., 2015). *M. scalaris* is a species of Phoridae whose larvae are extremely opportunistic, feeding on a very wide variety of organic material (Smith, 1986 and Disney, 1994). Moreover, it is involved in facultative myiasis (Harwood&James, 1979 and Disney, 1994) and has been found parasitizing arthropods (Arredondo-Bernal and Trujillo-Arriaga, 1994) and causing intestinal (Singh *et al*., 1988), urogenital (Singh and Rana, 1989), cutaneous and ophthalmic myiasis in humans representing potential medical significance (Wright, 1927; Biery *et al*., 1978 and Brown&Oliver, 2007). The scuttle fly is known to breed in a wide range of decaying organic matter and is often observed near dirty floor drains and mausoleums (Disney, 2008). Widely considered a pest of annoyance, *M. scalaris* also associated with facultative myiasis, an invasion of vertebrate tissues by larvae (Day *et al*., 2004 and Hall&Gerhardt, 2009). Although there are reported cases of reptile myiasis, there are only a few reports of myiasis in snakes, particularly corn snake, *Elaphe guttata*, eggs (Da Silva *et al*., 1999 and Jacobson, 2007) and an investigation of ocular myiasis caused by *M. scalars* on a western hognose snake, *Heterodon nasicus* (Diclaro II *et al*., 2011). The present study aimed to find out how dangerous *M. scalaris* is for mass production of *B. zonata* and *C. capitata* under laboratory conditions.

MATERIALS AND METHODS

Laboratory experiments were conducted to evaluate potentiality of certain essential oils (Clove, *Syzygium aromaticum*; Lavender, *Lavendula angustifolia* and Neem, *Azadirachta indica*) against immature stages of the peach fruit fly, *B. zonata* and The Mediterranean fruit fly, *C. capitata* in larval artificial diet. These experiments took place during July, 2021 of very extremely hot time. Eggs of each species of fruit flies were separately put on larval artificial media (Afia, 2007) in plastic cups (5 cm in diameter) till the full grown larvae (3rd instar larvae) which allowed to pupate in little amounts of fine sand in plastic vials. After that, all pupae of each species were separately collected and kept in plastic tubes for five days and transferred to Petri dishes till adult emergence that delayed for 3-5 days. After three days of emergence, all emerged flies were dead and observed as remains or crumbling bodies without entrails. Also, hundreds of strange larvae and pupae were investigated which individually collected to identify in the Reference Insect Collection, Survey and Taxonomy Department, Plant Protection Research Institute, Agricultural Research Center, Egypt.

RESULTS AND DISCUSSION

Results

Pupae of both *B. zonata* and *C. capitata* resulted from larval artificial diet of fruit flies treated with different

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concentrations of Clove, Lavender and Neem were separately collected in plastic tubes for five days, and then transferred to glass Petri dishes two days before emergence. After three days of adult emergence, all emerged flies were investigated as dead with emptied abdomens or empty body cavities which invaded and devoured by hundreds of strange larvae which were left to pupate. Adults emerged from these pupae were identified as the phorid species, *M. scalaris*. Also, low numbers of eurytomatid (*E. martellii*) and drosophillid (*D. hydei*) were identified (Table, 1).

Table 1. Characteristics of identified species

Characteristics	Identified species		
Scientific name	*M. scalaris* (Loew, 1866)	*Eurytoma martellii* Domenichini, 1960	*Drosophila hydei* Sturtevant,1921
Order	Diptera	Hymenoptera	Diptera
Family	Phoridae	Eurytomatidae	Drosophilidae
Occurrence	Predominant	Rare	Rare
Behavior	Omnivorous	Larval-pupal parasitoid of flies	Saprophytic
Danger	+++++++	+	-

Discussion

Most of insect species are monophagous having a limit behavior of nutrition, but, several species of insects have wide spread for nutritional behavior (polyphagous). *Megaselia scalaris* consider one of these polyphagous insect species showing a detrivore nutritional behavior on waste, junk and garbage, asfacultativeoropportunisticparasitoid on insects and other organisms and also causing myiasis in human and certain animals. In this observations, authors investigated *M. scalaris* as opportunistic pupal-adult parasitoid of laboratory culture of the two species of fruit flies (*B. zonata* and *C. capitata*) changing nutritional behavior as a saprophyte species on larval artificial diet consisting of wheat bran, brewer's yeast, sugar, sodium benzoate, citric acid and water. Several authors all over the world confirmed different nutritional behavior of *M. scalaris* that can be categorized as follows:

Saprotrophics: Several authors stated that the scuttle fly was known to be a detrivore species breed in a wide range of decaying organic matters where, larvae are extremely opportunistic, feeding on a variety of organic material (Smith, 1986; Disney, 1994 and Disney, 2008). El-Miniawi (1966), in Egypt, investigated *M. scalaris* invaded the powdery-carrot artificial diet for larvae of the Mediterranean fruit fly *C. capitata*. Karunaweera *et al*. (2002) firstly detected larvae of *M. scalaris* which completed its life-cycle on ripe bananas, in addition to *Bactrocera* spp. Moretti *et al*. (2009) recorded breeding of 138 specimens of *M. scalaris* in a piece of sardine, *Sardinella brasiliensis*, in Brazil. Other reports, about existence of *M. scalaris* on waste, junk and garbage; were recorded in several localities. An infestation of *M. scalaris*, was found by Pocklington (2015) in deteriorating 19th century fluid-preserved specimens contained in a glass tank in Oxford University Museum of Natural History where ethanol levels were inadequate to maintain specimen preservation and a vast amount of fluid had evaporated, leaving specimens exposed and in a state of decomposition. Aly *et al*. (2017), in Egypt, illustrated forensic insects of eighteen species of necrophagous, necrophilous, omnivorous and accidental insects. Twelve species of Diptera and three species of Coleoptera and Hymenoptera were collected from carcasses. The dipteran species were predominant on corpses. The most important forensic insects were represented by *Sarcophaga carnaria, Wohlfahrtia magnifica, Chrysomya albiceps, Lucilia cuprina, Muscina stabulans, M. scalaris* and genus *Nasonia*. Talebzadeh *et al.* (2017) collected *M. scalaris* and other dipteran and coleopteran species from 12 human cadavers during determining insect fauna of human corpses in Tehran district. Choudhury *et al*. (2018) studied capability of *M. scalaris* to minimize scientific disposal issues associated with barely degradable matter, often ranging approximately 7% in Indian municipal solid waste. Feeding process yielded an optimal weight reduction of 35% over a period of 11 days subjected to environmental conditions.

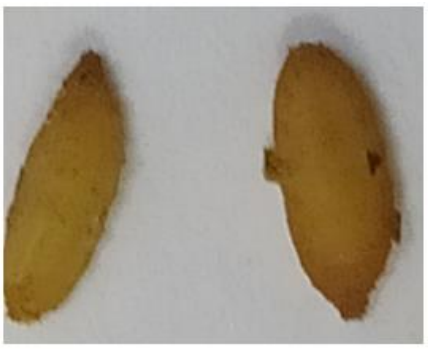
Parasitoid on insects: Many researchers showed that *M. scalaris* can attack other insect species as bees, mantids and others. Soares *et al*. (2006) firstly recorded *M. scalaris* as a parasitoid in nests of *Mischocyttarus cassununga* wasp in Brazil. Costa *et al*. (2007) reported, in Brazil, for the first time *M. scalaris* infesting laboratory colonies of *Triatoma brasiliensi*. *M. scalaris* larvae were found feeding inside bugs. Pupae were found in esophagus and intestinal regions of *T. brasiliensis* through dissection. Batista-Da-Silva (2012) investigated a phoretic association and facultative parasitism between *M. scalaris* and blowflies under natural conditions in mangrove swamp in Brazil investigating that all collected specimens of blowflies had third instar larvae of *M. scalaris* or eggs attached to their bodies. Mongiardino Koch *et al*. (2013) firstly recorded *M. scalaris* infesting laboratory stocks of praying mantis (*Parastagmatoptera tessellata*). The scuttle fly, is a cosmopolitan species with a broad niche as it performs as detritivore, facultative parasite and parasitoid. *M. scalaris* larvae were found feeding inside adult mantids. After that pupae were found inside abdominal cavity and around body. Debnath and Roy (2018) considered *M. scalaris* as one of the facultative endoparasitoids of *Apis mellifera* in India. Authors identified parasitoid larvae emerged from stiff-unfolded winged dead bees as *M. scalaris*. Further observation revealed that parasitized bees contained empty body cavities. Matured phorid maggots emerged from dead honey bees on an average 6 days after collection with range of 1-14 larvae per honey bee. Maximum 12 pupae per honey bee were found after 18 days of collection with emergence of adults at 22nd day. Infestation rate was highest in May and lowest in January. Noknoy *et al*. (2020), in Thailand, found scuttle fly larvae which genetically and morphologically identified later after emergence as *M. scalaris* inside bodies of soldier termites *Macrotermes gilvus*. Sabo *et al*. (2020) detected *Megaselia* spp. in a honeybee colony at the University apiary in eastern Slovakia during summer 2018 that was extremely hot and long. Small parasitoid phorid larvae were observed emerging from the sealed bee brood. Also, parasitized bee larvae and pupae contained emptied body cavities. Results of Souza *et al*. (2020) confirmed parasitic and frugivorous habits of *Megaselia* larvae indicating that *M. scalaris* behaved as primary parasitoid of *Isognathus caricae* larvae under laboratory conditions. El-Hawagry *et al*. (2021) recorded *M. scalaris* as an endoparasitoid attacking colonies of southern green stink bug *Nezara viridula* for the first time inside rearing cages in Egypt. Tang *et al*. (2021) identified *M. scalaris* as parasitic flies from *Spodoptera frugiperda* collected in four regions of China attacking pest larvae and

pupae. All of these studies supported the observations of the present one.

Parasitoid on other organisms: Several researchers recorded scuttle fly as endoparasitoid for many organisms such as El-Wakil (2000) who exposed six of terrestrial snail species to *M. scalaris* and found significant differences in percentage of snail mortalities. Some of the exposed snails such as *Eobania vermiculata, Theba pisana, Helicella vestalis* and *Eremina desertorum* were almost parasatized after four weeks. Andreotti *et al*. (2003) firstly reported the presence of *M. scalaris* as a parasitoid of *Boophilus microplus* tick females causing reduction in tick egg production. Zwart *et al*. (2005) observed larvae of *M. scalaris* in abdominal lymph sac of the amphibian of *Dendro batestinctorius* and in lesions due to fungal infection on leg of *Litroria infra frenata*. Diyes *et al*. (2015) firstly investigated opportunistic parasitism of *M. scalaris* on spinose ear tick, *Otobius megnini*. Tick samples from ear canals of 14 horses were brought to laboratory. Several days later, larvae of *M. scalaris* were found feeding on immature stages of *O. megnini*. Completed pupae were found attached to adult ticks and all nymphs were found dead. Lau *et al*. (2017) found, edible wild mushroom *Boletus griseipurpureus*, as potential selective host for *M. scalaris* in peat swamp forests in Malaysia. Azzam and El-Abd (2021) studied role of malacophagous insect *M. scalaris* in controlling terrestrial snails of *E. vermiculata* under semi field conditions. Releasing *M. scalaris* within *E. vermiculata* plots indicated an extrusive relation between time and mortality rates either of juvenile or mature snails.

Myiasis: Reports indicated that this species cause myiasis in different organs of humans and other animals. Singh and Rana (1989) firstly recorded a case of urogenital myiasis in a patient with transverse myelitis in India. Larvae of *M. scalaris* were recovered repeatedly from urine of the patient. Hira *et al*. (2004) reported myiasis in nasopharynx and a leg wound in two patients hospitalized for more than 72 hours in Kuwait. After 14 days, 'worms' were seen in the original dressing of a 35-year-old Iranian man admitted to Orthopedic Unit of the hospital with multiple lacerations and fractures. Larvae were identified as those of *M. scalaris*. Wakid (2008) firstly reported *M. scalaris* as a causative agent of urinary human myiasis of a five-year-old Saudi girl in Saudi Arabia. Ghavami and Djalilvand (2015) reported, in Iran, urogenital myiasis of *M. scalaris* larvae in the urine of an 18year-old man. Solgi *et al*. (2017) investigated *M. scalaris*-urinary myiasis occurring in a 60-yr-old Iranian male patient. Also, researchers investigated *M. scalaris* causing myiasis in other animals as mullosces, snakes, pythons and frogs. Da Silva *et al*. (1999) described a case of myiasis in snake of *Crotalus durissus terrificus* caused by *M. scalaris* in Brazil. Diclaro II *et al*. (2011) found late instar larvae of the scuttle fly near the right eye of a live captive-reared western hognose snake, *Heterodon nasicus*. Dissection and removal of snake's dorsal cranial bones revealed tissue degradation of the infected eye, the optic nerve and brain case that may be the factors of snake death. Vanin *et al*. (2013) described a case of myiasis caused by *M. scalaris* in an Indian python (*Pythonmolurus bivittatus*) reared in aterrarium in Italy. López *et al*. (2016) reported first case of myiasis in a South American wild anuran *Hypsiboa scaingua* that was identified as *M. scalaris*.

Larvae of *M. scalaris* with shreds of *B. zonata*



Pupae of *M. scalaris*

Adult of *M. scalaris*

Adult of *E. martellii* parasitized on pupae of fruit flies

Adult of *D. hydei*

CONCLUSION

The scuttle fly, *M. scalaris* could alter its nutritional behavior having wide range of nutritional substrates or sources and showing different nutritional behavior as saprophytic, facultative or opportunistic parasitoid (on many species of organisms as insects and others) and sometimes cause myiasis. For this reason it is be concluded that this species may form a threat factor for laboratory mass production of many species of insects such as tephritid fruit flies.

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الذبابة الفرارة: تهديد جديد للتربية المعملية المكثفة لذباب الثمار

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الملخص

تعتبر الذبابة الفرارة من الأنواع واسعة الانتشار فى البيئات المختلفة وذات طبائع غذائية متفاوتة، فهى غالبا من الحشرات المترممةعلى البقايا النباتية والحيوانية. وقد شوهدت الذبابة الفرارة بأعداد كبيرة كطفيل على عذارى والحشرات الكاملة لذبابتى ثمار الخوخ وفاكهة البحر المتوسط والمرباة معمليا بقسم بحوث حشرات الحاصلات البستانية- معهد بحوث وقاية النباتات- مركز البحوث الزراعية. ففى تجربة لدراسة فعالية بعض الزيوت الطبيعية (القرنفل، اللافندر والنيم) كسموم معدية ليرقات ذباب الثمار، جمعت عذارى كلا النوعين منذباب الثمار كل على حدة والناتجة من البيئة الصناعية لليرقات والمعاملة بالزيوت الطبيعية حتى خروج الحشرات الكاملة. وبعد خروج الحشرات الكاملة لذباب ثمار الفاكهة بثلاثة أيام شوهدت كلها ميتة وفارغة من الأحشاء الداخلية مع وجود قتات من بقاياها الخارجية ومعها أعداد هائلة من اليرقات والعذارى والتى تم تعريفها على أنها حشرات الذبابة الفرارة والتنتواجدت بأعداد هائلة اضافة الى طفيل من غشائيات الأجنحة ونوع من ذباب الدروسوفيلا واللذان شوهدا بأعداد قليلة. وعلى هذا يمكن استنتاج أن حشرات الذبابة الفرارة تشكل تهديداكبيرا وتمثل خطرا قادما على التربية المعملية المكثفة لكثير من الحشرات مثل ذباب ثمار الفاكهة.