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Short Communication

Rearing the house fly predator *Carcinops pumilio* (Erichson) (Coleoptera: Histeridae) using eggs and larvae of *Drosophila melanogaster* (Meigen) (Diptera: Drosophilidae) as prey

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A method was successfully developed for rearing the predatory beetle *Carcinops pumilio* Erichson (Coleoptera: Histeridae) on the eggs and larvae of *Drosophila melanogaster* (Meigen) (Diptera: Drosophilidae) in the laboratory. This technology would be useful in mass rearing *C. pumilio* in biological control programs against house flies.

Key words: Carcinops pumilio, Drosophila melanogaster, rearing.

INTRODUCTION

In the study of arthropods in poultry manure, the key predator of house fly larvae encountered was the beetle *Carcinops pumilio* Erichson (Coleoptera: Histeridae) (Achiano and Giliomee, 2003, 2005a, b, 2006a, b). It is also considered as a major predator in the suppression of synanthropic flies in poultry houses in the USA (Legner, 1971; Geden and Stoffolano, 1987) and in Britain (Bills 1973, Conway, 1973). In order to study the biology of this important species in the laboratory, finding a suitable rearing method became essential. Such a rearing method could also lead to the development of mass rearing techniques which would be a prerequisite for utilizing *C. pumilio* as a biological control agent against house flies.

An earlier attempt to breed *C. pumilio* using larvae of the house fly *Musca domestica* L. as source of prey proved to be unsuccessful, a result also obtained by other workers such as Smith (1975) and Geden (1984). Geden (1984) observed that the glut of older larvae, which escaped predation, disrupted histerid pupation and oviposition sites. Furthermore, *C. pumilio* readily feeds only on the eggs and 1st instar larvae, with the result that very large numbers of house flies would have to be reared to provide it with these stages in mass rearing, which would make it economically unviable (Geden, 1984).

In the course of taking samples for arthropods in the poultry manure, *Drosophila* sp. was encountered (Achiano and Giliomee, 2005a). Since Geden (1984) and Fletcher et al. (1991) mass bred *C. pumilio* on colonized *Coproica hirtula* (Rondani) and *Drosophila repleta* (Wallaston) respectively, it was decided to attempt utilizing *D. melanogaster* (Meig.) (Diptera: Drosophilidae) in the same way.

The aims of this study were, therefore, to colonize *D. melanogaster* on a medium other than poultry manure and then to exploit it as prey for *C. pumilio.*

MATERIALS AND METHODS

All experiments were carried out in the laboratory at the University of Stellenbosch, Stellenbosch, South Africa (33° 54´S; 18° 57´E) from 20 September 1999 to 21 October 2000, at an ambient temperature of about 22°C.

Colonization of *Drosophila melanogaster*

One litre house fly medium made up of bran wheat (0.5 kg), milk powder (75.0 g), yeast (5.0 g), Na-methyl hydroxybenzoate (1.5 g) and water (820 ml), was placed in 2 litre milk containers, which had its top removed. A number of *D. melanogaster* individuals collected from a progeny bred at the Department of Genetics, University of Stellenbosch was then introduced. After 5 days all the adults were removed by using a 60 W light source to attract them. The container without adults was placed in a small house fly cage. Cages were

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placed in a room with natural lightening system. Adults appeared after 11 days. The fly medium was remoistened after every 5 days, maintaining it at about 60 - 75% moisture level.

The flies were reared through five generations on house fly medium, but thereafter on a *Drosophila* sp. medium of which the formula was obtained from the Department of Genetics. The constituents of the medium were: water (550 ml), sugar (10.0 g), agar (4.0 g), maize meal (75.0 g), yeast (6.0 g), methylium (0.5 g) and alcohol (2.0 ml) brought to boil for about 5 min. The freshly prepared medium was cooled at room temperature for 24 h before exposing it to adult *D. melanogaster*. This change in rearing medium became necessary as a result of fungal growth in the house fly rearing medium, the need to remoisten it and the unpleasant fermentation scent subsequently emanating from it. An attempt was made to rectify the fungal growth by applying the method of Geden (1984), who mechanically agitated the fly rearing medium on days 2 and 3 post-preparation to disrupt the mycelia mats and aerate the medium, yet there was still fungal growth. The dense fungal growth accelerated the drying up of the medium. Both the adult and especially larvae could not move freely due to masses of mycelia and hyphae of the fungi, which subsequently had a deleterious effect on the fecundity of *D. melanogaster*. A high fecundity rate was observed after switching from the housefly to the *Drosophila* rearing medium, with the subsequent advantage that remoistening was no longer required and fungi did not appear.

Mass-rearing of *Drosophila melanogaster* in the laboratory

Ten milk containers (2 litres) with the top removed were filled with 1 litre of prepared *Drosophila* rearing medium and exposed to adult *D. melanogaster* for 5 days in a cage. The containers were then transferred to a new cage whereupon adult flies emerged after another 6 days. In 20 days there were many *D. melanogaster*, which the one litre medium could support for a period of four weeks of continuous reproduction of the flies. Therefore, newly prepared *D. melanogaster* medium was introduced every four weeks.

When there was the need to increase the population in a cage, the adults, which are positively phototactic, could be extracted from another cage by illuminating a bottle with a 60 W light source. The mouth of the bottle is inserted into the opening of the cage, and light shone from the bottom of the bottle. After enough *D. melanogaster* adults have been extracted, the mouth is quickly covered and the flies transferred into a new cage. To obtain adults of the same age several milk containers with *Drosophila* rearing medium were exposed to the adult flies for 24 h and transferred into a new cage.

Beetle collection and rearing

C. pumilio adults were collected from the University Farm at Elsenburg (33° 51´S; 18° 50´E) on 21st September 1999. A liter of manure was collected just below the tip of the manure cone and placed in a 5 litre tin container. It was then filled with water and stirred. The *C. pumilio* adults that floated and those that moved on the inside of the container were removed with a camel's hair brush and quarantined for 10 days to clear them from the mite, *Macrocheles muscaedomesticae* (Scopoli) (Acarina: Macrochelidae). Wade and Rodriguez (1961) mention that the life span of this mite is 7 - 10 days. This was done prior to introducing them to the *Drosophila* rearing medium in order to avoid contamination and subsequent feeding by the mite on the *C. pumilio* eggs, as was observed by Smith (1975). The quarantined *C. pumilio* adults were kept in containers with wet tissue throughout the 10 days to avoid dehydration. Even though these precautions were taken, problems involving the invasion of the mite still occurred, a situation also encountered by Smith (1975) and Geden (1984).

A chemical means of 'demiting' the beetles was attempted, using 0.3g tricyclotin (Peropal®) dissolved in 250 ml of water in a beaker. *C. pumilio* adults were placed in the solution for one minute and strained. They were then dried in a hand paper towel and later transferred into 75% alcohol for a further duration of one minute and strained and dried again. Mortality that occurred during this procedure was so high (>75%) that it was considered not feasible, as even those which did not die became lethargic, coupled with irregular movements.

A further attempt was made to 'demite' the beetles by applying Geden's (1984) method in which beetles were first shaken in talc baby powder for one minute, transferred to a 70% ethanol for 30 s, and then allowed to dry. After two additional talc-alcohol treatments, beetles were placed in containers with water saturated dental wick and held for three days. Mortality among beetles was higher than 60%, compared to Geden (1984) who had more than 40% mortality following this process. This procedure was also discarded in view of the high mortality.

Cultural methods such as dividing the different rearing activities in space and time, cleaning of containers and rearing spaces regularly before handling another culture, creating isolation between cultures by placing them on blocks, which in turn were placed in a tray of water, were then employed. These methods brought the population of mites down considerably, resulting in the increase of the numbers of *C. pumilio* larvae.

Ten pairs of both sexes of adult *C. pumilio* were added to each of ten 2 litre milk containers with 400 ml of *Drosophila* rearing medium previously exposed to adult *D. melanogaster* for two weeks. About 150 ml of *M. domestica* rearing medium, which was to provide a place for egg laying and a refuge for the adult beetles (also exposed to the adult *D. melanogaster* for seven days), was added on top of the *Drosophila* medium with the adult beetles. The contents was left for 15 days for the emergence of 1st and 2nd instar larvae after which the adult *C. pumilio* parents were removed manually by sieving to prevent overstocking and cannibalism. The contents were then placed back in the cage containing *D. melanogaster* adults of which the progeny provided a continuous source of prey. By day 20 after the beetles were introduced, large numbers of both 1st and 2nd instar *C. pumilio* larvae could be observed. Before they were removed the adult *C. pumilio* were often found in the *M. domestica* rearing medium whilst 1st and 2nd instar larvae were mostly found in the interface of the two media. The 1st and 2nd instar larvae of *D. melanogaster* were mostly found in the *Drosophila* rearing medium. Meanwhile the adult *D. melanogaster* moved in and out of the milk container to feed and lay their eggs. By day 30, the ten 2 litre containers were transferred to an open 21.5 litre rectangular plastic container which was covered with organdy. At this stage most or all the *C. pumilio* larvae were in their 2nd instar or pre-pupa stage and did not require much provision.

The contents of the containers were monitored for the emergence of adult beetles, which happened around day 40. After the first appearance they were left for a further five days before extraction by sieving. The sieved contents with *C. pumilio* larvae was returned into the 21.5 litre container and left for a further five days for the last extraction of adults by sieving.

RESULTS AND DISCUSSION

The two sieving yielded about 600 *C. pumilio* adults, proving that the species can successfully be reared on *D. melanogaster* as prey. *D. melanogaster* appears to be an ideal candidate as a source of prey for mass rearing *C. pumilio* due to its short developmental time of about ten days, as was observed by Ashburner (1989). It is inexpensive and easy to breed, and has a very high biotic

potential. Furthermore, it can be maintained on a substrate other than poultry manure which tends to emanate bad odour. Also due to its small size, all larval instars are readily fed on by 2nd instars and adults of *C. pumilio*.

However, from 100 female beetles a progeny of only about 600 were obtained in about a 50 days time, indicating a rather low rate of increase. This was possibly due to the low temperature experienced during the duration of rearing. An increase in temperature to 30°C would increase the rate of oviposition and reduce the rearing time by about 60% (Geden, 1984; Achiano and Giliomee, 2005c, 2006b).

Since the media formulated successfully supported all stages of *C. pumilio*, it could form the basis for the continuous rearing of this major predator, an essential requirement for using this species in the development of an integrated pest management programme for filth flies found in poultry manure.

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