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L. LIMONTA, D.P. LOCATELLI

Observations on *Muscidifurax zaraptor* Kogan & Legner and *Nasonia vitripennis* (Walker) (Hymenoptera Chalcidoidea Pteromalidae) parasitoids of *Musca domestica* L.

Abstract - Influence of temperature and humidity on development and on search capability and parasitization of *Musca domestica* pupae, at different depths of organic clay loam, of *Muscidifurax zaraptor* Kogan & Legner and *Nasonia vitripennis* (Walker) was studied. Developmental period is longer at 20°C than at 27°C in both species. The mean developmental period of *M. zaraptor* is not significantly different varying r.h. (40-60-80±5%). *N. vitripennis* has similar behaviour, except at 20°C and 40±5% r.h.. *M. zaraptor* shows a greater ability than *N. vitripennis* in locating and parasitizing *M. domestica* pupae at different depths (1, 2, 3 cm).

Riassunto - *Osservazioni su* Muscidifurax zaraptor *Kogan & Legner e* Nasonia vitripennis *(Walker) (Hymenoptera Chalcidoidea Pteromalidae) parassitoidi di* Musca domestica *L.*

E' stata studiata l'influenza della temperatura e dell'umidità sullo sviluppo e sulla capacità di ricerca e di parassitizzazione di pupe di *Musca domestica* a varie profondità di terriccio organico di *Muscidifurax zaraptor* Kogan & Legner e di *Nasonia vitripennis* (Walker). Per entrambe le specie si osserva un periodo di sviluppo più lungo a 20°C che a 27°C. Il ciclo medio di sviluppo di *M. zaraptor* non è significativamente diverso a differenti valori di U.R. (40-60-80±5%). Analogo comportamento si osserva per *N. vitripennis*, eccetto che a 20°C con 40±5% U.R.. *M. zaraptor* mostra una maggiore abilità rispetto a *N. vitripennis* nell'individuare e parassitizzare le pupe di *M. domestica* a differenti profondità (1, 2, 3 cm).

Key words: *Muscidifurax zaraptor*, *Nasonia vitripennis*, *Musca domestica*, parasitization, depths.

INTRODUCTION

Entomophagous arthropods are important control agents of synanthropic fly population; there are several natural enemies, which are able to control the huge repro-

ductive potential of *Musca domestica* L.. The most efficient species belong to Hymenoptera Chalcidoidea Pteromalidae which develop on pupae, and directly affect the number of emerged adults (Legner & Brydon, 1966; Legner, 1967; Axtell, 1970; Legner & Dietrick, 1974; Rutz & Axtell, 1979, 1981; Kunast *et al.*, 1986; Meyer *et al.*, 1990; Lysyk, 1991; Petersen & Cawthra, 1995; Weinzierl & Jones, 1998; Floate *et al.*, 1999; Bobadilla *et al.*, 2002). Increasing the number of enemies of the eggs and larvae achieves few results as the decrease in the number of adults is masked by the high natural mortality rate, which exceed 90% of eggs laid by *Musca domestica* L. (Bellini & Galgano, 2000).

The ability of pupal parasitoid Pteromalidae to locate the target pest and to oviposite is affected by temperature and by host and parasitoid density. *Muscidifurax raptor* Girault & Sanders can lay eggs with a temperature of up to 20°C, while *Spalangia endius* Walzer is inhibited; quite the contrary occurs with higher temperatures (Ables & Shepard, 1976; Legner, 1977).

Rueda & Axtell (1985), in research to determine the presence of parasitoids in caged-layer poultry houses, by monitoring pupae of *M. domestica* at varying depths of poultry manure, found *M. raptor*, *M. zaraptor* Kogan & Legner and *Pachycrepoideus vindemiae* (Rondani) in pupae to a depth of 3 cm; at 10 cm only pupae parasitized by *S. cameroni* Perkins, *S. endius* and *S. nigroaenea* Curtis were found; no parasitoids emerged from pupae collected at a depth of 15 cm. King (1997) observed that *M. raptor* produces less offspring when it develops in pupae of *M. domestica* present in the substrate, compared to others placed on the surface.

There exist numerous reference on their biology and ethology but it is important to improve the knowledge on the use of some species of Pteromalidae, particularly in order to evaluate the influence of temperature and humidity on development and on the ability of finding hosts at different depths. In this paper some of these aspects on *Muscidifurax zaraptor* Kogan & Legner and *Nasonia vitripennis* (Walker) are investigated.

MATERIALS AND METHODS

Rearing of Muscidifurax zaraptor *Kogan & Legner and* Nasonia vitripennis *(Walker)*

The species were reared in an air conditioned room at 27±1 °C, 70±5% r.h. (photoperiod 14Light:10Dark), on *Musca domestica* L.; pupae between 36 and 48 hours old, that allow the development of parasitoids of standard dimensions, were used (Coats, 1976; Moon *et al.*, 1982). The development from egg to adult takes between 13-15 days for *Nasonia vitripennis* (Walker) and 18-20 days for *Muscidifurax zaraptor* Kogan & Legner[1].

Influence of temperature and humidity on the development of parasitoids

10 couples of Hymenoptera and 100 pupae of *M. domestica* were used.
After 3 days, pupae were individually placed in polipropylene vials (Ø 1 cm, h 5 cm)

[1] *N. vitripennis e M. zaraptor,* reared at Istituto di Entomologia agraria, come from Ruggeri S.r.l. (Crespellano BO-I) and from "Società Emmeci di Magalotti Claudio" (Gambettola FC-I) respectively.

closed with a thin net (25 mesh) and incubated at 20±1 °C and 27±1 °C at different relative humidity values (40-60-80±5% r.h.; photoperiod 14Light:10Dark).
Four repetitions were carried out for each test.

Search for hosts at different depths

5 couples of Hymenoptera were used to parasitize 100 pupae of *Musca domestica* L.. Pupae of *M. domestica* were placed on the surface and at different depths (1, 2, 3 cm) of organic clay loam[(2)], with a mean starting humidity of 48.14%, in an air conditioned room at 27±1 °C and 70±5% r.h. (photoperiod 14Light:10Dark).

Parasitized pupae of *M. domestica* were counted after 10-12 days. The mean number of emerged adults of *M. domestica* was recorded.

Four repetitions were carried out for each test.

The results were analysed with SPSS 10.0 per Windows (one-way ANOVA and Duncan's test).

RESULTS

Influence of temperature and humidity on the development of parasitoids

Independently of temperature, the mean number of emerged adults of *M. zaraptor* and *N. vitripennis* is significantly lower with 40±5% r.h. (tables 1-2).

Table 1 - Mean number (±S.E.) of emerged adults of Muscidifurax zaraptor *Kogan & Legner and mean developmental period (±S.E.) at different temperature and humidity.*

r.h.±5%	Mean number of emerged adults (± S.E.)		Mean development period (± S.E.)	
	20±1 °C	27±1 °C	20±1 °C	27 ±1 °C
40	34.5 ±3,0 a	27.0 ±3,0 a	36.2 ±0.6 a	19.2 ±0.8a
60	52.7 ±4,2 b	51.5 ±2,6 b	36.0 ±1.1 a	18.2 ±0.8a
80	48.5 ±3,7 b	57.0 ±3,8 b	36.7 ±1.0 a	18.5 ±0.9a

Values followed by different letters are significantly different for 95% confidence interval (Duncan's test).

Table 2 - Mean number (±S.E.) of emerged adults of Nasonia vitripennis *(Walker) and mean developmental period (±S.E.) at different temperature and humidity.*

r.h.±5%	Mean number of emerged adults (± S.E.)		Mean development period (± S.E.)	
	20°C	27°C	20°C	27°C
40	33.8 ±4.6 a	43.5 ±4.7 a	22.7 ±0.5a	13.2 ±0.2 a
60	59.0 ±3.5 b	68.0 ±5.2 b	21.2 ±0.5b	13.7 ±0.2 a
80	68.5 ±3.9 b	77.7 ±3.7 b	20.5 ±0.3b	13.2 ±0.2 a

Values followed by different letters are significantly different for 95% confidence interval (Duncan's test).

(2) Composition: dark and light peats, lignine and cellulose fibres, bovine and horse manure, clays.

A longer period of development is observed at 20°C for both species. The mean development period of *M. zaraptor* does not significantly vary with different values of r.h.. Similar behaviour is observed in *N. vitripennis*, except with 40% r.h. and 20°C.

Search for hosts at different depths

The emerging of *Musca domestica* adults, from pupae present at the various depths tested, is not influenced by the distance from the surface (tab. 3).

M. zaraptor shows a higher ability than *N. vitripennis* in finding and parasitizing pupae of *M. domestica* at different depths; even at 3 cm 31.5% of emerging is observed, while in *N. vitripennis* a similar value is observed at 1 cm and the number of emerged adults is lower than 10% at the other depths. Significant differences are not observed on the mean number of *M. zaraptor* emerged adults at 0 and 1 cm and a gradual decrease of individuals is observed by increasing the depth.

Table 3 - Mean number (± S.E.) of emerged adults of Muscidifurax zaraptor *and* Nasonia vitripennis *from pupae of* Musca domestica *L. placed at different depths of organic clay loam and mean number (± S.E.) of adults of* M. domestica *emerged under the same conditions without parasitoids.*

Depth (cm)	*Muscidifurax zaraptor*	*Nasonia vitripennis*	*Musca domestica*
0	95.2±2.9a	95.5±2.1a	97.0±1.1a
1	83.7±5.9a	33.2±4.1b	94.2±1.6a
2	63.7±6.4b	10.0±2.3c	92.7±2.3a
3	31.5±4.9c	7.5±1.9c	90.7±2.8a

Values followed by different letters are significantly different for 95% confidence interval (Duncan's test).

CONCLUSIONS

On the whole, the optimum conditions for development of *Muscidifurax zaraptor* and *Nasonia vitripennis* occur at 27°C and 60-80% r.h.. These characteristics are useful in practice, as cattle sheds, pigsties, poultry farms, where parasitoids can be used to control flies, are humid-warm environments. Both species are able to emerge with 40% environmental humidity, although with a lower number of adults than occurs with the two other values of tested r.h..

Various authors observed that temperature affects development and reproduction of *N. vitripennis* (Moursi, 1946a, b; Schneiderman, 1956; Saunders, 1966; Clark & Kidwell, 1967). Mann *et al.* (1990) shows that mean development time of *M. zaraptor* at 20, 25, 30 and 35°C is 30.6, 22.8, 14.1 and 14.2 days respectively. Legner (1977) noted in *M. zaraptor* a higher fertility rate and a higher number of parasitized hosts at 29°C compared to 21°C both with low (5-10%) and high (60-70%) r.h.. Abraham

& König, (1977) observed that the number of emerged adults of *N. vitripennis* decreases with temperatures lower than 20°C and higher than 30°C.

Both species show a similar ability in locating pupae placed on the surface. *M. zaraptor* must be considered the most suitable one in the field, as it can reach the host even at 3 cm depth of organic clay loam with a parasitization of 30% of pupae of *M. domestica*. Legner (1977) found pupae parasitized by *M. zaraptor* to 2 cm in oat flakes and Rueda & Axtell (1985) to 3 cm of depth of poultry manure. These results underline the importance of continuing the research at greater depths, as the activity of the parasitoid can be influenced by the composition and the humidity of the substrate. A further parameter to consider is temperature which, if higher than 45°C, as occurs in heaps of dung or of rotting organic matter, can also limit the development of the host.

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PROF. LIDIA LIMONTA, PROF. DARIA PATRIZIA LOCATELLI - Istituto di Entomologia agraria, Via Celoria 2, I–20133 Milano. E-mail: lidia.limonta@unimi.it; daria.locatelli@unimi.it

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