

INFLUENCE OF THE DENSITY OF *CHRYSOPERLA*  
*MEDITERRANEA* (HÖLZEL, 1972) (NEUROPTERA:  
CHRYSOPIDAE) ADULTS ON ITS LABORATORY  
REPRODUCTION POTENTIAL

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The reproductive potential of *Chrysoperla mediterranea* (HÖLZEL, 1972) was investigated, when adults were subjected to different densities per rearing unit. Couples after emergence were placed into rectangular cages of 450 cm<sup>3</sup>, fed enzymatic protein hydrolysate of yeast and kept in a climatic chamber at 20±1 °C, RH 70–80% and 16h-photophase. The treatments were repeated six times utilizing 1, 2, 3, 4, 5, 6 and 7 couples with a couple/volume ratio of 1/450, 1/225, 1/150, 1/112, 1/90, 1/75 and 1/64 cm<sup>3</sup>, respectively. It was observed that the average pre-oviposition period for one couple was 5.8±0.3 days while for the other treatments it was 7–8 days. For the oviposition period no significant differences were found, 100 days being obtained on the average, but for the daily and total oviposition the results showed differences among the treatments with one couple per rearing unit showing the greatest fecundity (520±26.0 eggs/female). By increasing the couple numbers, the total oviposition capacity decreased, becoming more marked from four couples per rearing unit, with only 270.0±103.0 eggs/female when seven couples were utilized (density 1/64 cm<sup>3</sup>). Longevity was equally affected by density and for a single couple, it was 138.3±11.2 days for the males and 117.8±12.8 days for the females. In comparison, the reduction was in the order of 50% for both sexes when the density was seven couples per chamber.

Key words: green lacewing, *Chrysoperla*, biology, rearing units

## INTRODUCTION

Research on Neuroptera: Chrysopidae, and especially that devoted to species of the genus *Chrysoperla* STEINMANN, 1964, has stressed the importance of this predaceous group for the biological control of a number of arthropod pests in many important crops. Thus, when one wishes to make releases of these entomophagous insects in integrated pest management programs (IPM) (TAUBER *et al.* 2000), it is necessary to establish laboratory colonies for the production of different developmental forms.

Using the current rearing techniques of adults for green lacewings, KARELIN *et al.* (1989) determined that the density of adults per rearing unit was an important factor in the egg production of *Chrysoperla carnea* (STEPHENS, 1836) “sensu

lato". By utilizing 30 couples per  $\text{dm}^3$  the best fecundity was obtained, however, in about 25 days there was a reduction in egg production, and the destruction of adults was suggested. ARÁUJO and BICHÃO (1990) demonstrated that the best performance of adults of the same species was obtained with one couple/ $40 \text{ cm}^3$  and the destruction of the rearing material after 35–40 days. Considering the number of adults in the rearing units, the couple/volume ratio, maintenance of the adults, the size and the shape of the rearing boxes, a huge variation is found, stressing that essential experimental conditions are critical and there is a need for the determination of suitable rearing conditions for each species (FINNEY 1948, 1950, MORRISON & RIDGWAY 1976, FERRAN *et al.* 1981, MORRISON 1985, SISSOKO 1987, NÚÑEZ 1988, SAMSØE-PETERSEN *et al.* 1989, VENZON & CARVALHO 1992, RIBEIRO *et al.* 1993). Thus, the aim of this study was to determine the suitable density for rearing and time for the destruction of *Ch. mediterranea* (HÖLZEL, 1972) adults through the evaluation of the main biological parameters in the adult stage.

## MATERIAL AND METHODS

The experiment was conducted in a chamber at  $20 \pm 1 \text{ }^\circ\text{C}$ , RH 70–80% and 16-hour photophase by utilizing 1, 2, 3, 4, 5, 6 and 7 couples of *Ch. mediterranea* placed in transparent plastic boxes of  $12.8 \times 7.0 \times 5.0 \text{ cm}$  (about  $450 \text{ cm}^3$ ) feeding on enzymatic protein hydrolysate of yeast. The couple/volume ratio was of 1/450, 1/225, 1/150, 1/112, 1/90, 1/75 and 1/64  $\text{cm}^3$ , respectively. A piece of  $5.0 \times 6.0 \text{ cm}$  folded paper was placed on the bottom of each rearing unit as a shelter, and for oviposition, a strip of 2 cm wide absorbent paper of white color was put on the upper part of the rearing boxes, and was utilized soon after mating. The experimental scheme was a completely randomized design with seven treatments and six replications. The evaluated parameters were: pre-oviposition period, daily oviposition and total number of eggs/female, males' and females' longevity and time of maintenance of the adults in rearing chamber.

## RESULTS AND DISCUSSION

The results appear in Table 1. The observed pre-oviposition period of *Ch. mediterranea* may be divided into two groups. The first one showed an average of  $5.8 \pm 0.3$  days and the other one ranged from 7.2 to 8.2 days. In terms of the increased number of couples per rearing units, there was a lengthening of the pre-oviposition period; making it evident that the maximum density must be no more than 1 couple per  $112 \text{ cm}^3$ . By comparing treatments 2, 3 and 4 to the first one, an increase of 27% was observed. However, considering the treatments of 5, 6 and 7 couples, the pre-oviposition period was increased by 41%, confirming the results of SAMSØE-PETERSEN *et al.* (1989) for adults of *Ch. carnea* maintained un-

der a crowded regime. Another factor which may affect the pre-oviposition period in *Ch. mediterranea* is adult feeding and individuals provided with a feeding regime considered optimum (for example yeast + honey 1:1) had a pre-oviposition period ranging from 5.5 to 6.5 days.

The results obtained for the oviposition period discovered that there were no significant differences among the several densities utilized. Even the mean obtained for the adults of treatment 7 of  $92.3 \pm 7.3$  days was not different significantly from the others. The tests showed that the increase in density may be able to reduce the oviposition period and thus to affect the oviposition capacity and the time of maintenance of the adults in rearing.

The daily average fecundity for couples kept singly (1 couple), was of  $6.2 \pm 0.9$  eggs/female, significantly different from the other treatments, the general mean of which was of  $3.3 \pm 0.1$  eggs/female. It was found that independently of the density of adults utilized, beyond 1 couple/chamber, there was an average reduction of about 50% in the daily oviposition capacity of *Ch. mediterranea*, stressing the importance of the insect number per rearing unit on the daily oviposition capacity of this species. An important aspect which often makes it difficult the maintenance of adults is the oviposition site of the eggs which are deposited on different surfaces of the cage, complicating their collection. By attaching the absorbent paper strips to the rearing unit lid 90 to 100 % of the eggs were deposited there, which made their collection easier.

Considering the total number of eggs, the results were still more evident, showing that the isolated couples had a fecundity significantly superior to all the other treatments. The means obtained for treatments 2 to 6 were very close to each other, however, treatment 7 was very different and its mean is a half of that of treatment 1. A general comparison of those results showed that treatment 6 (1 couple/75 cm<sup>3</sup>) with a mean of  $356.3 \pm 42.3$  eggs/female, seeming to be the limit to that type of rearing.

Considering that the adults were fed only on enzymatic yeast hydrolysate and comparing this to the results obtained by CARVALHO *et al.* (1996) upon the reproductive capacity of adults of *Chrysoperla externa* (HAGEN, 1861) and *Ch. mediterranea* fed on different artificial diets, it is clear that the diets utilized strongly influence fecundity. Those species of green lacewing and when kept singly on other diets could produce on the average, 2,200 eggs, or four times the number of eggs obtained for treatment 1. So, one can imagine that changes of the diet will be able to influence and induce a substantial increase in oviposition capacity, even when the females were kept in a collective regime, but, more research on *Ch. mediterranea* adults is necessary. In addition to the density, feeding, temperature, relative humidity and photoperiod factors, it is necessary to study the shape of the rearing

**Table 1.** Periods of pre-oviposition, oviposition, daily and total fecundity, and longevity of males and females of *Chrysoperla mediterranea* under different densities

Couples per box	Period (days)		Fecundity (N.)		Longevity (days)	
	Pre-oviposition	Oviposition	Daily	Total	Males	Females
1	5.8 b	106.5 a	6.2 a	520.0 a	138.3 a	117.8 a
2	7.2 a	116.2 a	3.2 b	350.3 ab	97.0 b	102.2 ab
3	7.8 a	109.5 a	3.2 b	317.0 ab	117.0 a	100.3 ab
4	7.2 a	119.8 a	3.8 b	421.0 ab	94.7 b	87.7 bc
5	8.0 a	111.5 a	3.1 b	320.9 ab	89.5 b	86.2 bc
6	8.2 a	106.7 a	3.4 b	356.3 ab	84.0 bc	80.7 bc
7	8.2 a	92.3 a	3.2 b	270.9 b	70.0 c	68.3 c

units. KARELIN *et al.* (1989) stated that the substitution of rectangular cages for cylindrical ones resulted in an increase of 27 to 30% in the coefficient of the utilization of the cage area by *Ch. carnea* adults.

Survival of the adults kept singly or under collective regimes must be observed independently of the experimental conditions. For example, females' longevity was shorter than that of males' in relation to density, and with a reduction trend of longevity in both sexes has been observed. For the males, except treatment 2, the density reduction was gradual, except for treatment 7 with mean of  $70.0 \pm 3.7$  days, which differed significantly from the others. By comparing treatments 1 and 7, a reduction in the longevity of about 50% was noticed. For the females, the results were similar and longevity was reduced in relation to the increase of adults per rearing unit. The longevity means observed in case of the couples kept collectively ranged from 68.2 to 102.2 days.

In general and considering the females' longevity and ending the rearing of lacewing adults, it was verified that they are factors intrinsically related to the species. SAMSØE-PETERSEN *et al.* (1989), MORRISON and RIDGWAY (1976), KARELIN *et al.* (1989) and ARAÚJO and BICHÃO (1990) working on *Ch. carnea* "sensu lato" and RU *et al.* (1976) dealing with *Chrysoperla rufilabris* (BURMEISTER, 1839), suggested that the adults should be destroyed after 15–40 days of confinement. Thus analyzing the results obtained for the daily and total fecundity and longevity of the *Ch. mediterranea* females, it is apparent that the best reproduction performance of the adults reared collectively and fed on enzymatic protein hydrolysate of yeast, is with a maximum of 1 couple/112 cm<sup>3</sup> (treatment 4). As regards the destruction of adults, it is apparent that it should be accomplished only after 75 to 85 days when 80 to 90% of the oviposition has been realized.

## REFERENCES

- ARAÚJO, J. & BICHÃO, M. H. (1990) Biotecnologia de produção de *Chrysoperla carnea* (Stephens) (Neuroptera: Chrysopidae). *Bol. San. Veg. Plagas* **16**: 113–118.
- CARVALHO, C. F., CANARD, M. & ALAUZET, C. (1996) Comparison of the fecundities of the Neotropical green lacewing *Chrysoperla externa* (Hagen) and the West-Palaeartic *Chrysoperla mediterranea* (Hölzel) (Insecta: Neuroptera: Chrysopidae). Pp. 103–107. In CANARD, M., ASPÖCK, H. & MANSELL, M. W. (eds): *Pure and Applied Research in Neuropterology*. Proc. 5th International Symposium on Neuropterology, Cairo, Egypt.
- FERRAN, A., LYON, J.-P., LARROQUE, M.-M. & FORMENTO, A. (1981) Essai d'élevage de différents prédateurs aphidiphages (Coccinellidae, Chrysopidae) à l'aide de poudre lyophilisée de couvain de reines d'abeilles. *Agronomie* **1**: 579–586.
- FINNEY, G. L. (1948) Culturing *Chrysopa californica* and obtaining eggs for field distribution. *J. Econ. Entomol.* **41**: 719–721.
- FINNEY, G. L. (1950) Mass-culturing *Chrysopa californica* to obtain eggs for field distribution. *J. Econ. Entomol.* **43**: 97–100.
- KARELIN, V. D., YAKOVCHUK, T. N. & DANU, V. P. (1989) Development of techniques for commercial production of the common green lacewing, *Chrysopa carnea* (Neuroptera: Chrysopidae). *Acta Entomol. Fennica* **53**: 31–35.
- MORRISON, R. K. & RIDGWAY, R. L. (1976) Improvements in techniques and equipment for production of a common green lacewing, *Chrysopa carnea*. Pp. 1–5. *Agric. Res. Serv. S-143*, USDA, EUA.
- MORRISON, R. K. (1985) *Chrysopa carnea*. Pp. 419–426. In SINGH, P. & MOORE, R. F. (eds): *Handbook of Insect Rearing*, vol. 1. Elsevier Publishers, Amsterdam.
- NÚÑEZ, E. Z. (1988) Ciclo biológico y crianza de *Chrysoperla externa* y *Ceraeochrysa cincta* (Neuroptera: Chrysopidae). *Rev. Per. Ent.* **31**: 76–82.
- RIBEIRO, M. J., CARVALHO, C. F. & MATIOLI, J. C. (1993) Biologia de adultos de *Chrysoperla externa* (Hagen) (Neuroptera: Chrysopidae) em diferentes dietas artificiais. *Ciênc. e Prát.* **17**: 120–130.
- RU, N., WHITCOMB, W. H. & MURPHEY, M. (1976) Culturing of *Chrysopa rufilabris* (Neuroptera: Chrysopidae). *Fla. Entomol.* **59**: 21–26.
- SAMSØE-PETERSEN, L., BIGLER, F., BOGENSCHÜTZ, H., BRUN, J., HASSAN, S. A., HELYER, N. L., KÜHNER, C., MANSOUR, F., NATON, E., OOMEN, P. A., OVERMEER, W. P. J., POLGÁR, L., RJECKMANN, W. & STÄUBLI, A. (1989) Laboratory rearing techniques for beneficial arthropod species and their prey/hosts. *Z. PflKrankh. PflSchutz.* **96**: 289–316.
- SISSOKO, F. (1987) *Influence de la photopériode sur la fécondité et la diapause chez Chrysoperla mediterranea* (Hölzel) (Neuroptera: Chrysopidae). Thèse de Doctorat de 3ème Cycle. Université Paul-Sabatier, France. 71 pp.
- TAUBER, M. J., TAUBER, C. A., DAANE, K. M. & HAGEN, K. S. (2000) Commercialization of predators: Recent lessons from green lacewings (Neuroptera: Chrysopidae: *Chrysoperla*). *Amer. Entomol.* **46**: 26–38.
- VENZON, M. & CARVALHO, C. F. (1992) Biologia da fase adulta de *Ceraeochrysa cubana* (Hagen) (Neuroptera: Chrysopidae) em diferentes dietas e temperaturas. *Ciênc. e Prát.* **16**: 315–320.

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