University of Ljubljana,
Biotechnical Faculty,
Agronomy Department,
Institute of Phytomedicine
Head: Prof. Dr. Lea Milevoj

Research paper
Raziskovalno delo

REARING OF THE COMMON GREEN LACEWING, *Chrysoperla carnea* Stephens, IN THE LABORATORY

Lea MILEVOJ[1]

ABSTRACT

A method for succesive rearing of the common green lacewing, *Chrysoperla carnea* Stephens, on adult food consisting of milk, eggs, fruit, sugar, yeast in the form of small grains and wheat germ stuffing 'Kalčko' was established. For the first time the common green lacewing, *Chrysoperla carnea* Stephens, was reared in this way on improved artificial food described in the study, which contains wheat germ stuffing 'Kalčko'. Larvae were reared on green peach aphid, *Myzus persicae* Sulz. A test of the efficiency of *Chrysoperla carnea* of the green peach aphid on hydroponically grown peppers was done. Reproduction of the common lacewing, *Chrysoperla carnea* Stephens, was successful under laboratory conditions. The artificial diet specially prepared for the purpose had a favourable effect on the fecundity of females. The larvae developed well when they were fed on the green peach aphid, *Myzus persicae* Sulz. Because an abundant supply of aphids was provided and additional obstacles were used so that the larvae did not find one another, cannibalism was reduced. Natural mortality of subjects during reproduction time was moderate. The application of eggs of *Chrysoperla carnea* attached to cotton gauze is an appropriate method for target introduction into greenhouses on a smaller scale.

IZVLEČEK

GOJENJE NAVADNE TENČIČARICE (*Chrysoperla carnea* Stephens) V LABORATORIJSKIH RAZMERAH

V raziskavi je izdelana metoda za laboratorijsko gojenje odraslih osebkov navadne tančičarice (*Chrysoperla carnea* Stephens) na umetni hrani predvsem iz domačih sestavin (mleko, kokošja jajca, sadni sladkor, kvas v zrncih in nadev iz pšeničnih kalčkov "Kalčko"). Prvič je tako navadna tančičarica (*Chrysoperla carnea* Stephens) gojena na navedeni izboljšani umetni hrani, ki vsebuje nadev iz pšeničnih kalčkov 'Kalčko'. Ličinke so gojene na sivi breskovi uši (*Myzus persicae* Sulz.). Preverjena je še učinkovitost navadne tančičarice za sivo breskovo uš (*Myzus persicae* Sulz.) na hidroponsko gojeni papriki v rastlinjaku. Razmnoževanje navadne tančičarice (*Chrysoperla carnea* Stephens) je potekalo uspešno v laboratorijskih razmerah. Pripravljena dietna hrana je ugodno vplivala na plodnost samic. Ličinke tančičaric so dobro uspevale, če so se hranile na sivi breskovi uši (*Myzus persicae* Sulz.). Dodajanje listnih uši v presežku in postavljanje dodatnih ovir, je preprečilo, da se ličinke niso našle (srečale) med seboj in je tako kanibalizem zmanjšan. Naravna smrtnost osebkov med razmnoževanjem je bila na sprejemljivi ravni. Aplikacija jajčec vrste *Chrysoperla carnea* Stephens prek gaze, je primerna metoda za manjše ciljne vnose v rastlinjake.

[1] Associate Prof., Ph. D. Agr. Jamnikarjeva 101, SI-1111 Ljubljana, P. O. Box 2995

INTRODUCTION

Biological pest control uses the natural competition relationships among organisms for target reduction of populations of phytophagous organisms. Releases of predatory organisms, reproduced in the laboratory, in both field crops and greenhouses are one of the main methods for biological control (Milevoj, 1992, 1996, 1997).

The common green lacewing, *Crysoperla carnea* Stephens, is considered to be one of the common predators in Slovenia (Devetak, 1992). It lives in the field from April on, when it leaves winter shelters, that is, mainly unheated or uninhabited buildings.

The adults of *C. carnea* feed on honeydew, pollen and carbohydrates (Smith, 1922, Hagen; 1950, quoted from Hassan, 1974). Larvae are cannibals, which also suck from aphids and other tiny animals. In this way they feed in the field. In greenhouses they feed, according to our observations, only if they happen to get in through ventilation openings, open doors or if they are intentionally introduced there. They can be reared or proliferated in the laboratory on different kinds of diet and then they are target transferred to greenhouses or greenhouses with plastic cover for aphid control (Hassan, 1974). Components of the artificial diet on which *C. carnea* is reared have been known for a long time, but they differ from laboratory to laboratory. In the 1950s Hagen (1950) (quoted from Hassan, 1974) tested different types of food for the rearing of imagoes, which consisted of meat extract, albumen, yeast, sugars and also honey. In the 1960s and 1970s the diet was improved by Hagen and Hassan (quoted from Hassan, 1974). The diet was investigated in Germany, at the BBA Institute in Darmstadt, and described in 1978. It was still further developed in the years 1988 and 1989. Among its components, yeast, honey, sugar, eggs, milk, and flour have been reported by Stelzl and Hassan (1992). Standard components of such a diet are (Hassan, 1993) honey, sugar, yeast, hydrolisate of yeast and casein, yolk, and water, with the addition of ascorbic acid and preserving agents. Among 65 components of 4 types of diet, 23 amino acids have been reported by Hasegowa, Niijima and Matsuka (1991). Niijima (1995) stresses the importance of chemically defined diets of *C. carnea*. In his study he compares the diet that contains 65 components including 18 amino acids, 6 minerals, and 11 vitamins. Effects of the type and quantity of artificial food on the development and survival of larvae till pupation have been described by Mc Ewen, P., Canard, M. Aspak, H. Mansell, M. (1994).

Recently, techniques of the application of the species *C. carnea* for commercial purposes were also studied, but they are not quite developed yet. A technique for applying eggs of *C. carnea* for biological control of different species of aphids in the field has been reported by Sengonca and Löchte (1997). The possibilities for microcapsulation of liquid food have been described by Yazlovetskii (1990). The efficient application of the species *C. carnea* for biological control of *Aphis gossypii* on cucumbers grown in greenhouses has been reported by Ushchekov (1989).

The intent of the study was to investigate the rearing of *C. carnea* in the laboratory along with the possibility of their planned introduction into greenhouses for the sake of biological control of the population of aphids, which is reported here.

MATERIALS AND METHODS

For the rearing of individual developmental stages of *C. carnea*, insectaria were made of 5-mm thick Plexiglas. Insectaria (A) used for the rearing of imagoes were rectangular boxes with the following dimensions: 30 cm in length, 20 cm in width, 15 cm in height. The upper part of each insectarium was covered with a lid fitted with a net made of synthetic fibre with holes of about 0.1 mm in cross-section. Insectaria (B) used for the rearing of larvae were made of the same material as above (A). Their size was 44 cm in length, 34 cm in width, and 10 cm in height. The lid was fitted with a net made of synthetic fibre as above. Insectaria (C) used for the development of pupae were also made of Plexiglas, their size being 21 cm in length, 13.5 cm in width, and 13 cm in height. They were covered with a lid fitted with a small net. Each type of insectarium was also additionally suitably equipped for the rearing of *C. carnea*.

The adults of *C. carnea* (18 subjects) were first found in a half-built apartment house, in the vicinity of Ljubljana, on March 25, 1994 (10 females and 8 males). They were transferred to the insectarium A, on the bottom of which a Petri dish (9 cm diameter) with moist dental tampons was placed to maintain moisture. Diet food, which consisted mainly of the following locally purchased constituents, was applied to polyvinyl strips:

milk (sterilised, homogenised),
eggs (farm-laid),
fruit sugar (E. Merck, Darmstadt),
yeast in the form of small grains (Brewer's dry yeast, Biotop, Mediacor d.o.o. Celje), and
wheat germ stuffing (Kalčko, Sub Sole d.o.o. Celje).

All the ingredients were mixed with an electric mixer and either wheat germ stuffing was added for thickening the mixture or milk was used for thinning. The prepared food was refrigerated until it was used.

The adults were carefully transferred to the insectarium A. Prior to that they had been exposed to CO_2 for a short while. Then they were rapidly placed to the insectarium A, covered with cotton gauze and a lid, and incubated at room temperature 20-25°C, 16 h light and 8 h night. Every second day the insectaria were cleaned, and two strips smeared with food were placed vertically along the inner lateral sides of the insectarium. The cotton gauze with eggs was transferred to the insectarium B and new cotton gauze was placed in the insectarium A.

Larvae were reared in the insectarium B. Several layers of filter paper were placed on the bottom and dental tampons were used as above to maintain moisture. The aphid *Myzus persicae* Sulz. was used as larval food. It was reared, for the purpose, on Brussel sprouts, *Brassica oleracea* var. *gemmifera* DC., cv. Hercules. Aphids reproduced well on this cv., so that they completely covered the leaves. Abundant supply of aphids was added on the leaves of Brussel sprouts in order to prevent cannibalism of the larvae. The larvae were incubated for 14 hours of light and 10 hours of night. The incubator was illuminated by 4 cold-white neon bulbs with a total capacity of 160 W (4 X 40 W). The temperature of the incubation was 23-27°C.

When the pupation occurred, the pupae were transferred to the insectarium C, which was in the same incubator as the insectarium B and was covered with white paper. The moisture was maintained by using dental tampons as above. The insectaria were cleaned every second day, and the food was changed or added. The subjects were counted and transferred if necessary or removed.

In August the eggs of *C. carnea* attached to cotton gauze were transferred to a greenhouse with hydroponically grown peppers to attempt their practical application. The intent was to control the population of the green peach aphid, *Myzus persicae* Sulz., which reproduced naturally on the peppers.

RESULTS

Three days after the adults of *C. carnea* were collected in spring, placed in the insectarium A and fed on prepared artificial diet, they laid the first eggs on the cotton gauze with which the insectarium was covered under the lid. The cotton gauze with eggs, which were counted, was transferred to the insectarium B two days after the commenced oviposition. The eggs, 129 in total, were then found attached to the cotton gauze. After a 7-day incubation the first larvae emerged from the eggs and were subsequently fed on the green peach aphid. Due to cannibalism, the larvae ate some of the eggs and also some of the larvae ate their own kind. Yet enough of them were left for our observation of their development. The larvae were counted and separated with several layers of filter paper, so that they did not find one another and that they were occupied with aphids which were also among the layers of filter paper. The first pupae developed 3 weeks after the oviposition, and imagoes of the new generation emerged after 14 days. The latter were placed in another insectarium for incubation, while the new population of imagoes was fed on artificial diet. Results of this part of the study are presented elsewhere.

Table 1: Mortality of imagoes of the first generation of *Chrysoperla carnea* Stephens after they were fed on artificial food in 1994

Date	March 25	May 6	May 19	May 30	June 6	June 27	June 29	July 8
Number of subjects	18 8 males 10 females	14 4 males 10 females	10 3 males 7 females	7 2 males 5 females	6 1 male 5 females	2 1 male 1 female	1 female	1 female

It should be mentioned that the reproduction of subjects of later generations, which were the descendants of those from 1994/95, successfully continued till 1995, when the rearing was stopped.

Tables 1 and 2 shows the mortality and oviposition of females. During the first months their fecundity was quite high. The most eggs were laid in April, May and June, then the intensity of oviposition started to decrease and natural mortality increased. The last female died on July 8, with a life span of 104 days in 1994 (after the preceding wintering stage).

The test of the efficiency of *C. carnea* for biological control of the green peach aphid on peppers was also successful. The plants, which were infested with aphids, were covered with cotton gauze infested with eggs of *C. carnea*. When the embryonic development took place, the larvae hatched and started feeding on aphids. They noticeably reduced the number of aphids per 1 m^2 of peppers over a period of 14 days below the critical stage.

Table 2: Oviposition of *Chrysoperla carnea* Stephens when reared on artificial diet in 1994

Date	Number of females	Total number of laid eggs	Number of eggs laid per female
March 30	10	10	1
March 31	10	129	12.9
April 01	10	165	16.5
May 15	7	203	29
June 06	5	145	29
June 08	3	93	31
June 15	3	18	6
June 24	3	14	4.7
July 04	1	4	4
July 11	1	0	0
July 13	0	0	0

The common lacewing was reared successfully on artificial food specially prepared for the purpose. The development of one generation takes about 35 days using the rearing method reported here. A number of authors who reared the species at different temperatures have been quoted by Hassan (1974). Thus the duration of the development differs according to Butler and Ritche (1970), if temperature is constant or it varies. The same author (Hassan, 1974) reports that the green peach aphid, *Myzus persicae* Sulz., which was used in the present investigation, belongs to preferential food of *C. carnea*. We believe that the rearing method of *C. carnea* reported here may be introduced for practical application for the needs of biologic control by vegetable growers with small plots.

CONCLUSIONS

1. Reproduction of the common lacewing, *Chrysoperla carnea* Stephens, was successful under laboratory conditions.
2. The artificial diet specially prepared for the purpose had a favourable effect on the fecundity of females.
3. The larvae developed well when they were fed on the green peach aphid, *Myzus persicae* Sulz.
4. Because an abundant supply of aphids was provided and additional obstacles were used so that the larvae did not find one another, cannibalism was reduced.
5. Natural mortality of subjects during reproduction time was moderate.
6. The application of eggs of *C. carnea* attached to cotton gauze is an appropriate method for target introduction into greenhouses on a smaller scale.

LITERATURE

Devetak, D. (1992): Present knowledge of the Megaloptera, Raphidoptera and Neuroptera of Yugoslavia.- Current research in Neuropterology, Proceedings of the Fourth International Symposium on Neuropterology. Toulouse, 107-118.

Hassan, S. A. (1974): Die Massenzucht und Verwendung von *Chrysopa*-Arten (Neuroptera, Chrysopidae): zur Bekämpfung von Schadinsekten.- Z. Pflanzenkr. Pflanzenschutz 81, 10, 620-637.

Hassan, S. A. (1993): Massenzucht von Florfliegen (*Chrysoperla carnea*) auf der Grundlage eines mechanisierten Verfahrens zur Herstellung der Futterdiät unter besonderer Berücksichtigung von Hygienemassnahmen bei der Herstellung der Diät und in der Massenzucht.- Nachrichtenbl. Dtsch. Pflanzenschutzdienstes, 45, 196-197.

Hasegawa, M., Niijima K., Matsuka M. (1989): Rearing *Chrysoperla carnea* (Neuroptera, Chrysopidae) on chemically defined diets.- Appl. Entomol. Zool., 24, 1, 96-102.

Injac, M., Sivèev I., Vukoviæ, M. (1978): Razvoj zlatooke (*Chrysopa carnea* Steph.) u programu integralne zaštite jabuke.- Zast. Bilja 29, 146, 371-379.

Letardi, A., Coffarelli V. (1990) Effect of using a liquid semi-artifical larval diet on the rearing of *Chrysoperla carnea* (Steph.) (Planipennia, Chrysopidae).- Redia 73, 1, 79-88.

Mc Ewen, P., Canard, M. Aspak, H. Mansell, M. (1996): Possible effects of artificial food on the development and survival of *Chrysoperla carnea* (Stephens) larvae in the laboratory and in the field (Insecta: Neuroptera, Chrysopidae).- Pure and applied research in neuropterology. Proceedings of the Fifth International Symposium on Neuropterology Cairo, Egypt, 2-6 May 1994.

Milevoj, L. (1992): Parazitoida *Aphidius matricariae* Hal. in *Diaeretiella rapae* (M'Intosh) (Hym., Aphidiidae) na *Rhopalosiphum padi* L. (Hom., Aphididae) v Sloveniji.- Res. Rep. Biot. Fak. Uni Lj, 59, 163-167.

Milevoj, L. (1996): A study on *Aphelinus asychis* Walk. in Slovenia.- Res. Rep. Biot. Fak. Uni Lj, 67, 115-120.

Milevoj, L.(1997): Effects of food on the adult coccinelids (*Coccinella septempunctata* L.).- Res. Rep. Biot. Fak. Uni Lj 69, 137-140.

Niijima, K. (1995): Nutritional studies and artifical diet of *Chrysopa septempunctata*.- Bulletin of the Faculty of Agriculture Tamagawa University 35, 129-157.

Samsoe-Peterson, L. et al. (1989): Laboratory rearing techniques for 16 beneficial arthropod species and their pray/hosts.- Z. Pflanzenkr. Pflanzenschutz 96, 3, 289-316.

Sengonca, C., Löchte C. (1997): Development of a spray and atomizer technique for applying eggs of *Chrysoperla carnea* (Stephens) in the field for biological control of aphids.- Z. Pflanzenkr. Pflanzenschutz, 104, 3, 214-221.

Stelzl, M., Hassan S. (1992): Über die Zucht von *Micromus angulatus* Steph. (Neuroptera, Hemirobiidae), einer neuen Nützlingsart zur Bekämpfung von weichhautigen Schadarthropoden in Gewächhäusern.- Appl. Entomol. Zool., 114, 1, 32-37.

Uschekov, A. (1989): *Chrysopa perla* for aphid control.- Zashch. Rast. Moskva 11, s. 20-22.

Yazlovetskii, I., Abashkin A., Keiser L. (1990): The mass rearing of *Chrysopa carnea*.- Zashch. Rast. Moskva 1, 27-28.