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Green lacewing: Promising predator of soft bodied insects

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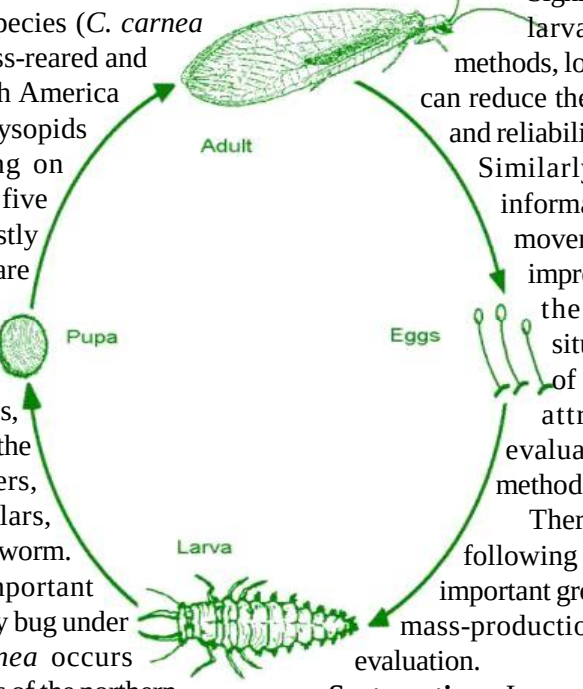
Chrysoperla carnea Stehens known as the common green lacewing is an insect in the Chrysopidae family of the order Neuroptera. Although the adults feed on nectar, pollen and aphid honeydew, the larvae are active predators and feed on aphids and other small insects. *Chrysoperla* spp. long have been considered as important naturally occurring predators in many horticultural and agricultural cropping systems, including vegetables, fruits, nuts, fibre, forage crops, ornamentals, greenhouse crops and forests. Worldwide they also rank as some of the most commonly used and commercially available natural enemies. For many years, two *Chrysoperla* species (*C. carnea* and *C. rufilabris*) have been mass-reared and marketed commercially in North America and Europe. The larvae of chrysopids have been recorded as feeding on seventy different prey species in five insect orders. The preys are mostly from the order Homoptera and are predominantly aphids on low growing vegetation. On crops, the larvae have been reported as attacking several species of aphids, red spider mites, thrips, whitefly, the eggs of leafhoppers, leaf miners, psyllids, small moths, caterpillars, beetle larvae and the tobacco budworm. They are considered to be important predators of the long-tailed mealy bug under glasshouse condition. *C. carnea* occurs naturally in many growing regions of the northern hemisphere. It is considered an important aphid predator in cotton crops in Russia and Egypt, sugar beet in Germany and vineyards in Europe. It has been found to be effective at controlling the cotton whitefly, *Bemisia tabaci*, in cotton crops in Pakistan. The presence of the larvae on the foliage was found to inhibit visitation and oviposition by *B. tabaci* which suggests the larvae may produce a volatile semiochemical which repels the whitefly. Although the larvae are effective as biological control agents, in open air environments the adult lacewings tend to disperse widely. They may remain in the original release location if they have sources of nectar, pollen or honeydew to feed on in the general vicinity.



Chrysoperla spp. are used in integrated pest management (IPM) systems in two principal ways: (a) periodic release of mass-reared individuals and (b) manipulation of the habitat, e.g., to attract or conserve naturally occurring field populations. Recent experiments have focused on improving both approaches. Significant new developments in artificial larval diets, mechanized production methods, long-term storage and quality control can reduce the cost and increase the availability and reliability of mass-reared *Chrysoperla* spp. Similarly, a re-examination of existing information on the chemical ecology and movement of lacewings reveals ways for improving the ability to attract and retain their populations in agricultural situations. Furthermore, the efficacy of procedures for both releasing and attracting *Chrysoperla* is to be evaluated rigorously with quantitative methods under field conditions.

There has been recent progress in the following crucial areas of research with this important group of predators: (a) systematics (b) mass-production (c) field applications and (d) evaluation.

Systematics : In case of green lacewings in the genus *Chrysoperla*, much sound systematic research has been accomplished, but the final chapter has yet to be written, especially relating to *Chrysoperlacarnea*. This species (or complex) is highly important in both natural control as well as augmentation biological control. However, there is substantial variability in the biological traits of this species. In the eastern and midwestern United States there are two distinct and reproductively isolated entities: *C. carnea*, which is the most common in agriculture, and *C.*

downesi, which is associated with evergreen trees. However, in the western United States, there is greater variability between populations. The systematics of this group must be resolved in order to achieve maximum success in biological control programmes.

Mass-production : The commercialization of biological control depends upon the ability of insectaries to produce and market efficiency, a highly reliable and relatively inexpensive supply of natural enemies. Achieving these objectives first requires efficient, standardized mass-rearing procedures: (a) the use of inexpensive, nutritious diets (b) mechanized and space-efficient production systems (c) reliable storage methods and (d) periodic evaluation of natural enemy quality. In each of these areas, research has made practical and economically beneficial advances in mass-rearing of *Chrysoperla.* However, the effective marketing of natural enemies and the education of targeted customers continue to be serious issues in need of attention.

Rearing: Currently, rearing of larvae constitutes the most costly aspect in *Chrysoperla* mass-production because all three instars are largely predaceous. Most insectaries depend on mass-produced insect prey as food, which is relatively expensive compared with artificial diets. The development of an artificial diet should continue to receive a high priority. Lacewing larvae will feed and develop on either liquid or solid diets. Although some automation is available for producing and encapsulating liquid diets, the cost has remained relatively high. Recent research has resulted in a fully artificial, solid or semisolid diet that apparently offers significant advantages over other diets. Adult dietary requirements often present major practical problems for mass-rearing and marketing predators. Mass-rearing of insects (especially cannibalistic Early research on *C.carnea* nutrition yielded relatively inexpensive and effective artificial diets that sustain high rates of egg production. With these diets, females of all species of *Chrysoperla* tested thus far can produce 500 to 1,000 eggs in ~30 days. This successful diet provides a fine example of the practical benefits derived from fundamental research in insect nutrition.predators) requires considerable space and manual labor; currently, space-efficient, automated mass-rearing systems for *Chrysoperla* are under development. These systems include compact holding units for adults, mechanical devices for feeding adults and harvesting eggs, mechanized methods for presenting the larval diet, and automated systems for packaging larval-rearing units. When fully developed, such mechanized systems would enhance production greatly andreduce costs drastically. Progress thus far illustrates the advantages (biological and economic) that can accrue when engineers and biologists combine their expertise in solving practical problems.

Quality control: The standardized production of high quality natural enemies is crucial for both the practice of biological control and users' perception of biological control as a dependable pest management tactic. However, the quality of commercially marketed natural enemies can be variable because there are no strict quality control standards. For example, in a recent evaluation of shipments from insectaries, growers' orders for *C. carnea* were not filled consistently with the correct species, and cannibalism significantly reduced the survivorship of lacewings in transit. Such problems can be overcome through greater care in maintaining correctly identified, pure colonies and improved procedures during mass-production and packaging. In viewing the overall issue of quality control, we believe that it is essential for the insectaries industry to develop standards that promote the reliability and standardization of commercially produced natural enemies.

Proper exploit of *Chrysoperla* spp. either through periodic release of mass-reared individuals or manipulation of the habitator conserve their populations through augmentation can suppress the different soft bodied insect in many crop eco-system.Skillful utilization of these natural enemies may be functional component in the integrated pest management (IPM) strategies.

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