

HOW DO LADYBIRDS [*COLEOMEGILLA MACULATA LENGI* (COLEOPTERA:
COCCINELLIDAE)] FEED ON GREEN LACEWING EGGS [*CHRYSOPERLA
RUFILABRIS* (NEUROPTERA: CHRYSOPIDAE)] ?

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Intraguild predation, a common interaction among arthropods (Polis et al. 1989), has been investigated recently in aphidophages (Rosenheim et al. 1993; Lucas et al. 1998). Sessile stages of coccinellids, gall midges, and lacewings (eggs, moulting individuals, and pupae) were shown to be highly vulnerable to intraguild predators (Lucas et al. 1998). Several defensive mechanisms have already been described for eggs of aphidophages, including chemical protection (Eisner et al. 1996), structural protection (Canard and Duelli 1984), and behavioural avoidance through the selection by females of protected oviposition sites (E. Lucas, and J. Brodeur, unpublished data).

Eggs of green lacewings (Neuroptera: Chrysopidae) are laid individually on 6- to 8-mm stalks which may provide defense against arthropod predators (Canard and Duelli 1984). According to Hinton (1981), eggs of chrysopids are protected against (i) vertebrate predators by their small size, (ii) nonclimbing invertebrates by their position on a stalk, (iii) invertebrates able to climb the stalk by their tough chorion, and (iv) large predators able to reach them from the leaf surface by their inability to press them against a rigid surface in order to eat them. The egg pedicel was shown to reduce cannibalism significantly in species with actively searching larvae (Duelli and Johnson 1991). Further, destalked eggs were more susceptible to predation by coccinellid beetles than stalked eggs (Chen and Young 1941 in Eisner et al. 1996). However, predatory mites are known to prey on stalked lacewing eggs (Alrouechey et al. 1984). Furthermore, stalked eggs of another lacewing species, *Ceraeochrysa cubana* (Hagen), were vulnerable to ant predation, and Eisner et al. (1996) described the behaviour of attacking ants as follows: "an ant ascended a stalk, straddled the egg, and cut the egg from the stalk with its mandibles." Another neuropteran, *Ceraeochrysa smithi* (Navas), coated her stalks with droplets of an oily fluid, improving egg protection against ants (Eisner et al. 1996). We recently showed in the laboratory that eggs of *Chrysoperla rufilabris* Burmeister were susceptible to predation by the twelve spotted ladybeetle *Coleomegilla maculata lengi* Timberlake (Lucas et al. 1998). Further experiments were undertaken to describe the behavioural strategies used by juvenile and adult *C. maculata lengi* to feed on lacewing eggs.

Adults and larvae of *C. rufilabris* and *C. maculata lengi* were purchased from Groupe Biocontrôle Inc. (Sainte-Foy, Quebec, Canada). Upon receipt, they were reared in the laboratory on the potato aphid *Macrosiphum euphorbiae* Thomas and maintained at $20 \pm 1^\circ\text{C}$ and 60–70% RH under a photoperiod of 16 h light and 8 h dark. The coccinellids were starved for 24 h prior to testing to increase their motivation to forage. Tests were carried out in the laboratory at $25 \pm 1^\circ\text{C}$ and 70% RH. Five eggs of *C. rufilabris* were glued (Lepage bondfast) at their stalk on the upper surface of a potato leaf (cv. Norland) in a manner analogous to their natural position and distribution (scattered). One individual of *C. maculata lengi* was then introduced to the system. Fifteen replicates were done separately with adult and 1st and 4th instars of *C. maculata lengi*. During the day, one period of observation (30 min) was made on the predatory behaviour of each coccinellid. After 24 h, the number of eggs eaten was recorded and compared using a *G* test (likelihood ratio).

A greater proportion of lacewing eggs were eaten by 4th-instar coccinellids (63/75 = 84%) and adults (60/75 = 80%). First instars consumed significantly fewer eggs (23/75 = 31%) ($G_2 = 50.42$, $p < 0.0001$). Adult ladybirds did not eat any egg in 13% of exposures, and 1st-instar ladybirds did not eat any egg in 27% of exposures. All 4th instars ate at least one egg ($G_2 = 3.68$, $p > 0.05$). Detailed observations showed all stages of *C. maculata lengi* to successfully attack lacewing eggs by using different behaviours depending on age. First instars grasped the stalk and climbed until they reached the base of the egg with their mandibles (but did not pull it down) ($N = 15$). In other experiments, 1st instars were also observed eating eggs on the lower surface of a leaf. Fourth instars moved forward over the stalk and bent it down until they reached the egg ($N = 17$), and adults stood upright on their hind legs to eat the egg directly off the stalk ($N = 5$). In some cases (<10%), the stalk was broken.

Our observations and those of others (Eisner et al. 1996) confirm that lacewing eggs, despite the presence of the pedicel, can be easily eaten by predators. All stages of *C. maculata lengi* have the capacity to eat lacewing eggs, the behaviour of the beetle changing with age. During their development, the weight, size, and physical capacity of the larvae increased considerably (see Lucas et al. 1997). Old larvae, too heavy to climb an egg stalk, were sufficiently strong and heavy to bend the stalk. First instars were unable to bend the stalk, but were sufficiently small and light to climb it, as do 1st instars of lacewings, mites (Alrouechey et al. 1984), and small ants (Eisner et al. 1996). Protective devices such as a tough chorion or difficult handling (see above) were not effective against ladybird predation. The greatest failure of young larval predators could be attributed either to nondetection of eggs or to climbing failure.

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