Green Lacewings

(Chrysoperla carnea) as predators of box psyllids

Summary

Lacewing larvae *(Chrysoperla carnea)* could potentially be one of the most important biological control agents for psyllid pests of box plants. Laboratory trials showed that 3rd instar lacewing larvae were efficient predators on eggs and nymphal stages of *Psylla buxi*. For instance, 60% of 3rd - 4th instars *P. buxi* inside the cupped shoots of the box plant were consumed by a single introduction of 3rd instars lacewing larvae. Releases of 20, 3rd instar lacewing larvae per box plant under field conditions resulted in a 73% reduction in psyllid nymph numbers.

1 Introduction Biology and Behaviour

Psyllids (Homoptera: Psyllidae) are amongst the most important insect pests of box plants. Two species of psyllid have been identified in Southern England and Wales, *Psylla buxi* and *Spanioneura fonscolumbii,* both of which are specific to box plants. They are phloem feeders, using their piercing stylet to suck nutrients from the phloem tissues. Feeding by *P.* buxi nymphs causes the cupping of the terminal shoots that is often a characteristic symptom of box plants undergoing psyllid attack. *P. buxi* nymphs stay within the cupped leaves and exude a white secretion, which provides protection from predation and dehydration. In the case of *S.* fonscolumbii, although no cupping of leaves occurs, the white secretions are excreted directly on to the young shoots causing more cosmetic damage to the plant than the secretion from *P. buxi.* Feeding by both psyllids can result in retarded growth of box plants in addition to the cosmetic damage.

Figure 1. Photograph of a lacewing larva (C.carnea) showing a pair of mandibles

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Biological control of insect pests is an environmentally friendly approach to pest control in which an organism, a predator for example, is used to control a pest. High value plants, such as box, are the most suitable for biological control. We believe, from our work, that psyllid pests can be controlled through proper monitoring and correct timing of release of appropriate predators. Box psyllids are naturally regulated under field conditions by several insect predators such as the anthocorid bug, *Anthocoris nemorum* (Hemiptera:

Anthocoridae), ladybird beetles (Coleoptera: Coccinellidae), earwigs *(Dermaptera: Forficulidae)* and the green lacewing, *Chrysoperla cornea* (Neuroptera: Chrysopidae). The green lacewing is actually the least common of the predators that we have found in our studies (Muhammad et al. in preparation). However, we have concentrated on this species because it is easy to mass-produce and is already commercially available. Green lacewings have been extensively used to control a range of insect pests (Daane et al 1996; Hagley & Miles 1987). They are commonly found in vegetation containing grasses and herbs, and attack aphids, whiteflies, and eggs of a number of insect pests.

In our experiments, lacewing larvae were seen to readily attack and consume psyllid nymphs and adults. The lacewing larva attacks its prey using its powerful sickle-shape mandibles (Figure 1), which immobilise the prey instantly. The prey is then sucked dry of its body contents until only the transparent skin is left behind. The sucking process usually takes from several minutes to an hour depending on the size of the psyllid. Usually the first prey only takes a few minutes to consume and the time increases with each additional prey. Although the lacewings seem to attack prey of different sizes at random they appear to find it easier to handle smaller prey.

2. Methodology

The evaluation of green lacewing larvae as a potential biological control agent against all larval stages of *P* buxi was carried out under laboratory, glasshouse and field conditions. The type of experiments and treatments were as follows:

Table. l Experiments carried out

Expt. no.	Expt. Type.	Replicates	Treatment
1	Laboratory	9	Release of individual 11st,2nd and 3rd instar lacewing larvae on box shoots infested with only *P. buxi* eggs
2	Laboratory	9	Release of individual 2nd and 3rd instar lacewing larvae on box shoots containing 3rd and 4th instar *P. buxi* larvae
3	Glasshouse	4	Release of 20, 3rd instar lacewing larvae on box plants taken from the field
4	Field	4	Release of 10 and 20, 2nd and 3rd instar lacewing larvae in the field.

In the laboratory experiments, the box shoots (field collected, 10-15 leaves per shoot, eggs and larvae inside the cupped leaves) were exposed to lacewing larvae. In the first experiment, the shoots were taken from the field during the month of April where *P.buxi* were at the egg stage and this was confirmed by microscopic dissection of the buds. The shoots containing the egg stage were exposed to 1st, 2nd and 3rd instar lacewing larvae. Similarly in the second experiment, the box shoots with P.*buxi* at the 3rd - 4th instar stages were exposed to 2nd and 3rd instar lacewing larvae. In each treatment, each shoot together with a single lacewing larva was placed in an experimental arena where the shoots were placed in a cup of water.

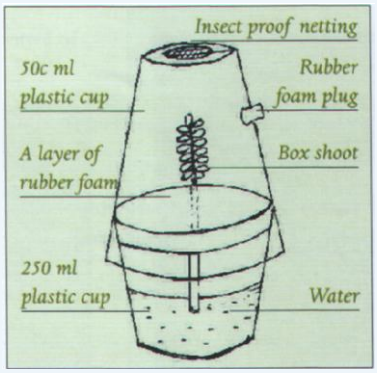

Figure 2 A diagram of boxwood shoot B. sempervirens) *placed* in *plastic cup/ experimental arena*

A rubber sponge prevented insects from drowning and the arena was enclosed in insect proof netting. (Figure 2). The effects of the treatments were analysed based on the number of adult psyllids emerging from the treatments.

In glasshouse experiments, 20, 3rd instar lacewing larvae were released on 10year old (about 2 feet high) box plants taken from the field and naturally infested with an unknown number of 2nd and 3rd instar P. buxi larvae. Eight plants were taken from the field and planted in big pots in a glasshouse. Four plants each were used for the treatments and controls. Infestation was confirmed by observations of larvae in the cupped leaves and white secretions produced. Examinations of the shoots were done after two weeks of lacewings release.

In the field, experiments were carried out on 7 year-old variegated box plants, which were infested with both *P. buxi* and Spanioneura *fonscolumbii.* A total of 15 plants were randomly assigned to 5 groups of 3 plants. Treatments were:

Untreated control
10 x 2nd instar larvae per plant
10 x 3rd instar larvae per plant
20 x 2nd instar larvae per plant
20 x 3rd instar larvae per plant

Prior to lacewing release, 15 shoots about 4 cm long from each plant were taken at random and microscopically examined to confirm the presence of psyllid nymphs. Two weeks after release a further 15 shoots from the treated and control plants were examined for the presence of psyllids. Data were checked for normality and homogeneity of variances using Minitab Release 12 (Anderson - Darling and Barlet Test). The non normally distributed data were transformed using log transformation and the means were differentiated using the least significant difference test.

3. Results

Lacewing larvae feeding on psyllid eggs and nymphs in the laboratory

All three lacewing instars were observed attacking psyllid eggs. In the first experiment, shoots were used containing psyllid eggs but no nymphs. Psyllid numbers were significantly lower, at the end of the experiment, in treated as compared with the control arenas ($P < 0.001$) (Table 2). The 3rd instar was the most efficient egg predator as compared to 2nd and 1st instars. However, there were no significant differences between 1st and 2nd instar treatments. The shoots which were not exposed to any lacewings tended to wilt as the emerging psyllids fed on the phloem tissues. The shoots where 3rd instar lacewings were released were in the best overall condition and 3 of the released lacewing larvae successfully developed into adults.

instar were found dead and failed to reach the adult stage.

Table 2. The effect of releasing 1st, 2nd and 3rd instar lacewings on shoots infested with P buxi eggs. Means ± standard errors.

Lacewing larvae	Mean no. *P buxi* nymph/shoot (± standard error)	No of lacewing adults emerging
1st instar	4.5 ± 0.41	0
2nd instar	3.1. ± 0.31	0
3rd instar	0.33 ± 0.24	3
Control	9.78 ± 0.57	0

In the second experiment, where similar tests were carried out on boxwood cuttings infested with 3rd - 4th instar P buxi larvae, analysis of variance showed a significant difference ($P < 0.001$) between the treatments. The release of a single 2nd or 3rd instar lacewing larva was effective in reducing psyllid numbers in comparison with an untreated control ($P < 0.001$) (Table 3). However, there was no significant difference between 2nd and 3rd instar lacewing larvae treatments. The 3rd instar lacewing larvae were the most effective control agents resulting in the greatest reduction in psyllid numbers. In comparison with the control where a mean of 2.25 psyllids successfully emerged as adults per cupped leaf, the release of a single 2nd instar lacewing reduced psyllid numbers by 40%, and the release of a single 3rd instar lacewing by 65%.

Table 3. The number of P. buxi adults emerging from infested shoots following introduction of a single lacewing larva when psyllids were at the 3rd - 4th instar stage

Treatment	No. cuttings	No. cupped leaves	Mean no. P. buxi/cup (± standard error)	No. lacewing adults emerging
Control	9	46	2.25 ± 0.55	0
2nd instar lacewing	9	58	1.13 ± 0.47	2
3rd instar lacewing	9	53	0.67 ± 0.63	7

Release of 3rd instar lacewing larvae on plants infested with *P. buxi* nymphs under glasshouse conditions

Two weeks after release of the lacewing larvae there was a considerable reduction in psyllid numbers on experimental as compared with control plants ($P < 0.001$) (Table 4). However, none of the lacewing larvae were observed to reach adulthood.

Table 4. The impact of releasing 20, 3rd instar lacewing (C. carnea) larvae on boxwood plants (B. sempervirens) infested with P. buxi larvae

Treatment	Replication (no. of plants)	No. cupped leaves examined	Mean no. of cupped shoots per plant containing psyllids (± standard error)
C. carnea	4	40	0.5 ± 0.29
Control	4	40	35 ± 0.75

Releases of lacewing larvae against *P. buxi* under field conditions

Comparison within the same treatment, before and after lacewing release showed that a significant reduction of psyllid nymph numbers of 53.2% to 72.9% occurred per plant (Table 5). The highest predation rates were achieved by releasing lacewing larvae at the rate of 20 per plant, irrespective of instar, with mean reductions of 71.4% and 72.9% recorded in treatments with 2nd instar ($P < 0.01$) and 3rd instar ($P < 0.05$) lacewing larvae respectively. Although at this stage it is still difficult to quantify exactly how many psyllids were eaten by each lacewing, a substantial reduction in the psyllid population was observed as compared to the control ($P < 0.001$) where no significant change in the psyllid population was recorded.

Table 5. Effect of release of 2nd and 3rd lacewing larvae on psyllid numbers, under field conditions

Treatment (lacewings released)	Mean psyllid nymphs/ plant (before release) (± standard error)	Mean psyllid nymphs/ plant (after release) (± standard error)	Percentage reduction (± standard error)
10 x 2nd instar/plant	16.0 ± 3.06	6.67 ± 2.03	60.4 ± 5.79
20 x 2nd instar/plant	17.6 ± 0.67	5.0 ± 1.53	71.4 ± 9.29
10 x 3rd instar/plant	20.7 ± 4.10	9.0 ± 0.58	53.2 ± 8.14
20 x 3rd instar/plant	24.3 ± 5.33	6.7 ± 1.67	72.9 ± 0.77
Control	19.0 ± 6.03	18.3 ± 3.84	2.6 ± 9.72

4 Discussion and conclusions

All instars of lacewing larvae effectively reduced the numbers of psyllids, although optimal control was achieved using third instars. A diet of psyllids was sufficient to result in the development of lacewings through to the adult stage only in a third of the cases where third instars were used. This suggests either that the number of psyllid eggs on the shoots was insufficient to support lacewing development or that psyllid eggs alone cannot provide the necessary nutrients for successful lacewing development.

Both second and, particularly, third instar lacewing larvae significantly reduced psyllid numbers on shoots in the laboratory while third instars were effective on box plants brought into a glasshouse. However, none of these third instar larvae went on to develop into adults. Black ants, which were found in substantial numbers on the plants, could be responsible for this as some of the lacewing larvae were observed to be attacked by them. Ants are known to feed on honeydew produced by the psyllids and at the same time they protect them against intruders. It is improbable, given the fact that the ants were 'farming' the psyllids, that they were themselves responsible for preying on the psyllids.

In the field, inundative release of both 2nd and 3rd instar lacewing larvae significantly reduced numbers of psyllids indicating that these predators can be effective biological control agents for P. buxi and S. fonscolumbii. Correct timing and release rates

of lacewings are probably important for the complete control of psyllid pests and these must be investigated further.

References

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