The Role of Beneficials - Are Some Predators Better Than Others at Finding and Consuming *Helicoverpa*?

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Introduction

Australian cotton production relies heavily on the use of pesticides for control of *Helicoverpa* spp. As a result insecticide resistance has become a major problem (Daly and Paschalidis 1994). With current problems of resistance in *Helicoverpa armigera* (Hubner) to pesticides and the importance of aiding resistance management in Bt cotton, greater emphasis has been placed on research that investigates the role of beneficial insects as control agents of *Helicoverpa*. To date, this has largely been done by investigating total predator abundance relationships with prey abundance (Stanley 1997). The role of individual predator species has not been widely investigated and our understanding of their roles in control of pests is limited. If predators are to be utilised in cotton growing systems it is imperative to understand the role of individual species. This will aid in the assessment of the ability of total predator populations to control *Helicoverpa* and other secondary pests. As many of the predator species found in cotton are generalist feeders this work includes an understanding of how each species performs given that relative abundance of prey types varies in cotton fields.

Objectives

The aim of this study was to compare predator species to see if there were differences in their ability to find and consume *Helicoverpa* eggs in cotton. Three areas were investigated: the performance of predators at different prey densities; their ability to find *Helicoverpa* when aphids were present at different densities; and how well they could find *Helicoverpa* prey on different sized plants.

Selection of predators

Three predator species were selected for this study. The species were *Nabis kinbergii* (Reuter) (Damsel bugs), *Dicranolaius bellulus* (Guerin-Meneville) (Red and blue beetles) and *Coccinella transversalis* (Fabricius) (Transverse ladybirds). Predators were field collected as this represented a more realistic view of field populations and because they were available throughout the cotton growing season. The three species also represented both hemipteran and coleopteran predators and each species exhibited different behaviours. One was an ambush predator (*N. kinbergii*), one a ground dweller (*D. bellulus*) and one aphidophagous (*C. transversalis*).

Experimental conditions

Experiments were conducted at UNE Armidale over the 1996/7 cotton growing season. The experimental arena consisted of potted Sicala V2 cotton plants grown in glasshouse conditions and transferred to an environment cabinet. The experiments were conducted using individually caged plants that contained one predator. Prey consisted of freshly laid *H. armigera* eggs from UNE culture or field collected aphids individually painted onto plants. The number of eggs and/or aphids consumed over 24 hours was used to determine if differences occurred between predator species within each experiment.

Experiments

Three different sets of experiments were done. Firstly, the effect of five low (1, 5, 10, 15 and 20) and four high (20, 40, 80 and 160) densities of eggs on consumption by each predator species were compared. Secondly, the number of eggs consumed when nil, low, equal and high numbers of aphids were present was compared. Finally an experiment was done to test if plant size affected consumption of eggs. This was done by measuring the number of eggs consumed on pre-squaring, squaring and flowering plants by each predator species. Within each experiment there were at least five replicates of each treatment.

Results and Discussion

Figures 1 and 2 show the effects of low and high *Helicoverpa* prey density on the ability of each predator species to consume eggs. There is no significant difference in the proportion of eggs consumed at either low or high prey density within species. However, *C. transversalis* consumed significantly less eggs than *N. kinbergii* at low prey densities ($p<0.05$, d.f. = 2,86). A downward trend does occur for all species at the high prey densities but this result was not statistically significant. These results indicate that some predators are able to both find and consume *Helicoverpa* prey numbers greater than those that would normally be found in the field. However, the high egg densities causing this trend are rarely seen in cotton. The more important test is how the predators perform at realistic (low) prey densities. All predator species (but not all individuals within species) tested here were able to consume low densities of *Helicoverpa* prey with the exception of *C. transversalis* which were unable to find eggs at a density of one per plant. Given that this level of predation has not been seen in the field there must be other factors that affect predation. These may include searching ability and prey preference.

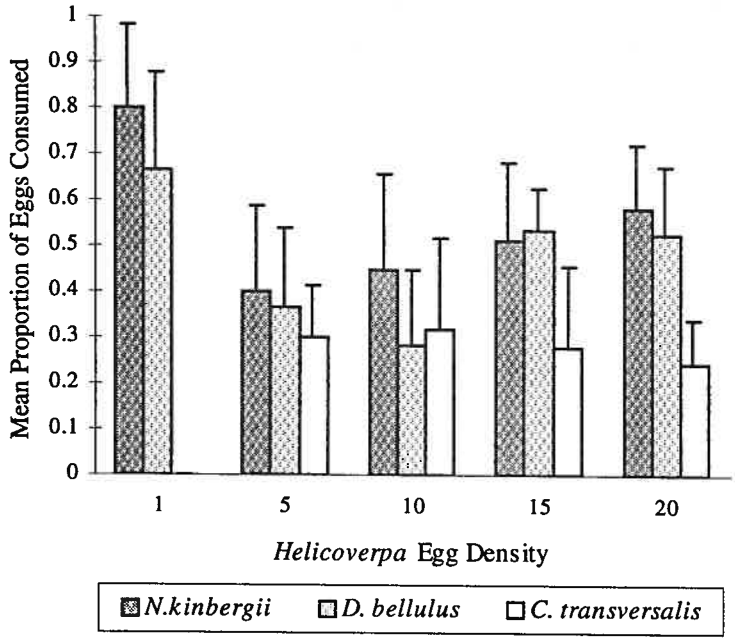

Figure 1. The proportion of *Helicoverpa* eggs consumed at low densities by three predator species. Bars indicate standard errors.

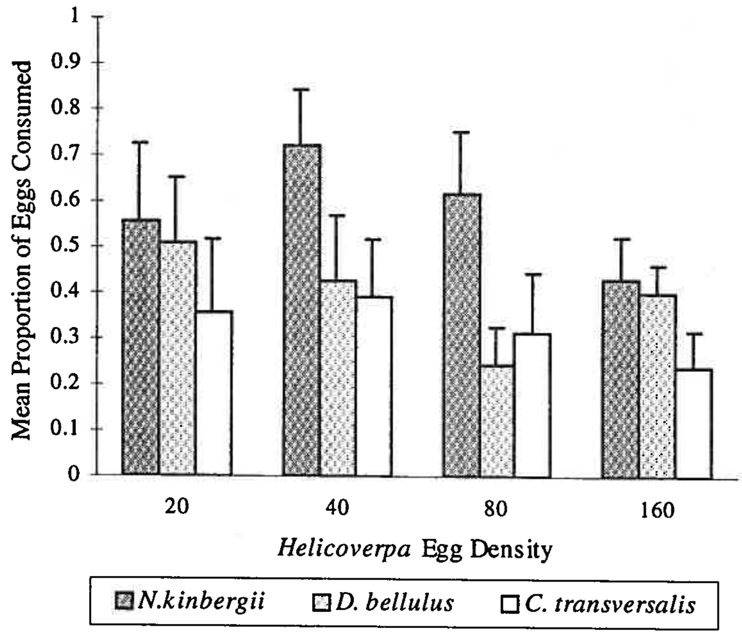

Figure 2. The proportion of *Helicoverpa* eggs consumed at high densities by three predator species. Bars indicate standard errors.

One of the factors affecting consumption of *Helicoverpa* may be that predators are consuming other types of prey present in the cotton fields. Figure 3 shows that when predators are offered an equal number of alternate prey (in this case the cotton aphid *Aphis gossypii* Glover) with *Helicoverpa* eggs, the number of eggs consumed remains the same.

That is, they do not prefer one prey type to the other. This may be because the low numbers (20) of prey offered meant that the predators needed both types of prey. Figure 4 shows that when higher numbers of alternative prey are offered there was a slight decline in the number of *Helicoverpa* eggs consumed. This was, however, only statistically significant in *D. bellulus* ($p<0.05$, d.f. = 2,22). Ables *et al.* (1978) also found that overall the number of target prey consumed by predators declined as alternative prey numbers increased. However, there were differences between predator species. In their study the predators *Geocoris punctipes* (Say) ate more *Heliothis virescens* (F.) eggs when aphids (*Aphis gossypii*) were present at low densities compared to other predators which ate less target prey at the same aphid density.

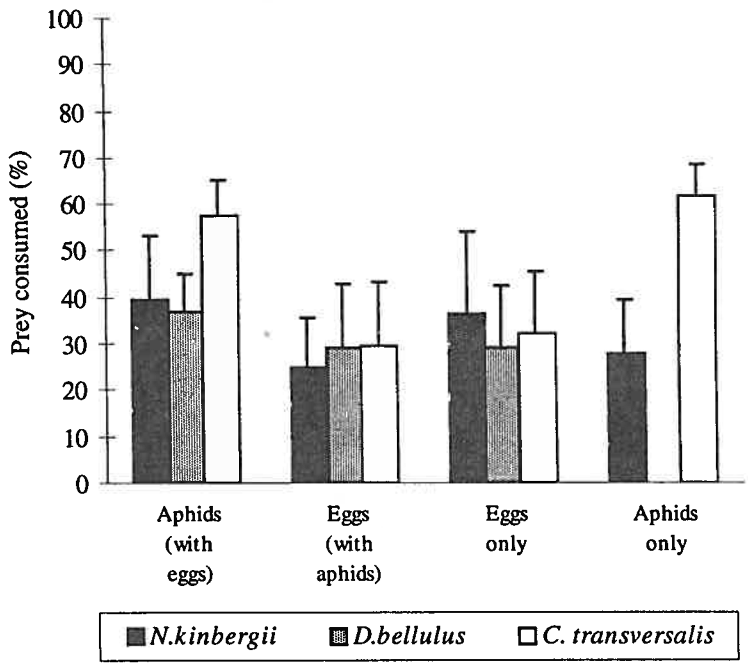

Figure 3. The number of aphids or eggs consumed when presented in equal numbers. Note there was no 'aphid only' treatment for *D. bellulus*. Bars indicate standard errors.

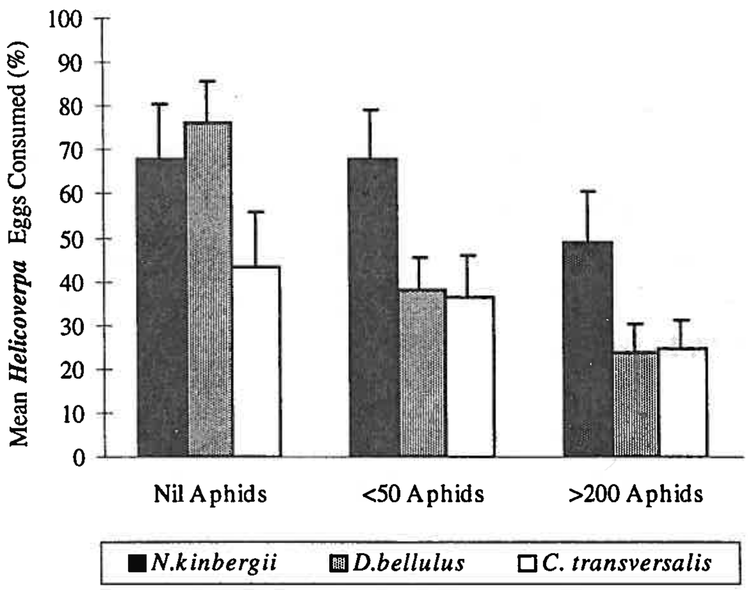

Figure 4. The number of *Helicoverpa* eggs consumed by predators in the presence of different densities of aphids. Bars indicate standard errors of the mean.

Another factor that is likely to limit the ability of predators to consume *Helicoverpa* eggs is their ability to find them on the plant at such low numbers. Figure 5 shows that the number of eggs consumed differs with plant size. There was a significant difference ($p<0.05$ d.f.= 4,67) in the number of eggs consumed on large plants and small plants.

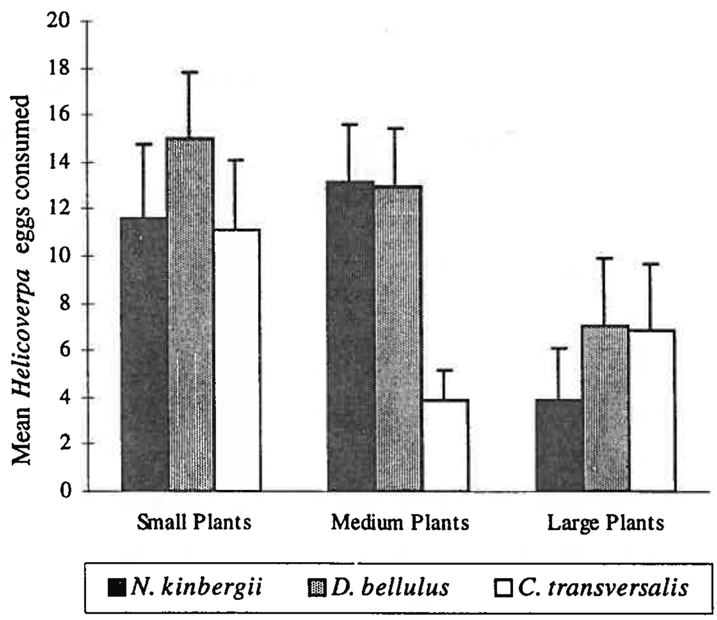

Figure 5. The number of *Helicoverpa* eggs consumed on small (seedling), medium (pre-squaring) and large (flowering) cotton plants by different predator species.

Conclusion

Studies on predators in laboratory conditions indicated that predators can find and consume *Helicoverpa* eggs under both low and high densities and in the presence of alternative prey. However, this ability changes with each species. Given that low levels of *Helicoverpa* prey (compared with other prey sources) are usually present in cotton, it is important to assess whether the predators can find such low numbers. Certainly some *N. kinbergii* and *D. bellulus* can often find and consume as little as one egg on a plant. Further study is required to see if this can also be done in field conditions.

Whilst laboratory trials are not fully indicative of what happens in the field these trials do highlight that differences occur between species. In most cases *C. transversalis* ate less than the other two species. This warrants further investigation on this species as the reason for the variation is unknown. The results of this study also show that including factors other than just prey density are important in understanding how effective these predators are as potential control agents of *Helicoverpa.* All species consumed aphids and it is likely that they will feed on other prey found in cotton such as mites (Wilson *et al.* 1998) and white fly. It is therefore important to test on consumption of *Helicoverpa* by each predator species in the presence of other alternative prey.

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