Institution: Canterbury Christ Church University

Unit of Assessment: Agriculture, Veterinary and Food Science (6)

Title of case study: Optimizing the use of the ladybird *Chilocorus nigritus* (F.) as a biocontrol agent

1. Summary of the impact

Research carried out at Canterbury Christ Church University (CCCU) since 1998 has led to the establishment of the ladybird, *Chilocorus nigritus*, as a viable biocontrol agent (BCA) in UK glasshouses. However, integrated pest management (IPM) programmes involving *C. nigritus* sometimes inexplicably fail. The specific impact claimed here relates to research at CCCU, in collaboration with the Royal Botanic Gardens Kew and the Natural History Museum, which has improved the efficacy of utilising *C. nigritus* for biocontrol.

Specifically, this research has:
1) optimised protocols for growth and use of *C. nigritus*,
2) resulted in changes in practice at the Royal Botanic Gardens Kew, and
3) changed the advice given by the companies selling *C. nigritus* as a biocontrol agent.

2. Underpinning research

Please note that numbered citations refer to outputs in section 3.

The ladybird, *C. nigritus* was introduced into the UK at the Wye campus of Imperial College London in 1992 and in 1993 a general release licence was obtained under the Wildlife and Countryside Act (1981). Since then, it has been reared and sold in the UK as a biological control agent (BCA) for armoured scale insects. These scale insects are serious pests of temperate and tropical crops, both in glasshouses and in temperate and tropical regions. *Chilocorus nigritus* therefore forms an important part of the increasing armoury of BCAs available to organic growers and those practising IPM.

All research was undertaken at CCCU by Dr **Ponsonby** (employed CCCU 1995 to present), who coordinated collaborations, authored papers and supervised PhD students working on the project. Underpinning research was published between 1998 and 2007 [1-6]. The impact claimed here relates to the changes in protocols, practice and advice that principally derive from the work published in 2007, and the subsequent interpretation and application of that work (see [7]).

The key findings of the underpinning research can be summarised as follows:

1) Climatic conditions: In collaboration with Imperial College London and Wyebugs (a company providing insect diagnostic and support services and the major UK supplier of *C. nigritus*), Dr **Ponsonby** and colleagues established the climatic conditions required for the mass rearing of *C. nigritus* and its main prey, *Abgrallaspis cyanophylli*, and the conditions required for efficacious deployment in glasshouses and field situations [1,2].

2) Prey-Relations and deployment: Introductions of *C. nigritus* sometimes fail to establish, even when conditions are apparently favourable. Work undertaken at CCCU from 1998 addressed the complexities of the prey relations of *C. nigritus* in the context of glasshouse use [3-6]. This research determined the prey densities necessary for successful establishment of *C. nigritus*, identified the preferred prey species/combinations and documented indicators of plant/prey interactions that may affect the efficacy of *C. nigritus* as a BCA [3-6].

In combination, this research led to clearly defined work practises and the publication of definitive introduction rates for *C. nigritus* [7].

3. References to the research

1) **Ponsonby, D.J.** and Copland, M.J.W. (1998) Environmental influences on fecundity, egg viability and egg cannibalism in the Scale Insect Predator, *Chilocorus nigritus* (F.) (Coleoptera: Coccinellidae). *BioControl* 43, 39-52.
2) **Ponsonby, D.J.** and Copland, M.J.W. (2000) Environmental effects on the development and survival of the scale insect *Abgrallaspis cyanophylli* (signoret) (Homoptera: Diaspididae) in relation to its use as a host for rearing biological control agents. *Biocontrol Science and Technology* 10, 583-594.
3) **Ponsonby, D.J.** and Copland, M.J.W. (2000) Maximum feeding potential of larvae and adults of the scale insect predator, *Chilocorus nigritus* (F). with a new method of estimating food intake. *BioControl* 45, 295-310.
4) Boothe, R.A. and **Ponsonby, D.J.** (2006) Searching behaviour in *Chilocorus nigritus* (F.) (Coleoptera: Coccinellidae). *Communications in Agricultural and Applied Biological Sciences* 71: 253-261.
5) **Ponsonby, D.J.** and Copland, M.J.W. (2007a) Aspects of prey relations in the coccidophagous ladybird *Chilocorus nigritus* relevant to its use as a biological control agent of scale insects in temperate glasshouses. *BioControl* 52: 629-640.
6) **Ponsonby, D. J.** and Copland, M. J. W. (2007b) Influence of host density and population structure on egg production in the coccidophagous ladybird, *Chilocorus nigritus* F. (Coleoptera: Coccinellidae). *Agricultural and Forest Entomology* 9, 287-298.
7) **Ponsonby, D.J.** (2009) Factors affecting utility of *Chilocorus nigritus* (F.) (Coleoptera: Coccinellidae) as a biocontrol agent. *CAB Reviews: Perspectives in Agriculture, Veterinary Science, Nutrition and Natural Resources* 4, No. 046, 20 pp. doi: 10.1079/PAVSNNR20094046.

All work has been published in peer-reviewed journals and this remains the only peer-reviewed literature available on climatic conditions required for the growth and rearing of *C. nigritus*. Peer-reviewed papers have been cited within the academic (peer-reviewed) and non-academic literature and were extensively cited in a major recent international text book on Coccinellid (ladybird) ecology.

4. Details of the impact (indicative maximum 750 words)

Please note that lettered citations refer to evidence sources in section 5 and that numbered citations refer to outputs in section 3.

The ladybird, *C. nigritus* is economically important as a BCA in many parts of the World. It has few natural enemies, reproduces rapidly in response to pest numbers and has an excellent capacity to coexist in stable relationships with other natural enemies of pests. Work at CCCU has allowed the provision of a suitable, sustainable control of armoured scale insects in UK glasshouses where previously none existed [A] and has informed the use of the species internationally [B,C].

Within the UK, *C. nigritus* is particularly important in situations where pesticide use is problematic (e.g. in butterfly houses, or in botanical collections open to the public). As these are also the situations where the unsightly damage caused by scale insects is often of most concern, effective and safe control of the pest is a priority. Beneficiaries therefore include both biocontrol companies selling this species and users of this BCA.

As a direct consequence of this work, *C. nigritus* now occupies a small, but extremely important, sector of the BCA market, with sales by WyeBugs, and through them by BCP ltd (Certis Europe), steadily increasing as protocols for efficacious use have improved [A]. At present *C. nigritus* is the only commercially available BCA for armoured scale insect control in the UK. Worldwide, this BCA also continues to gather economic importance in both tropical and subtropical regions, and it now forms an important part of the natural enemy complex of IPM programmes globally (e.g. [B,C]).

Research findings on prey relations and population monitoring pest management have modified and informed the advice given by biocontrol companies to glasshouse managers in the UK, Europe

and around the world. Such advice includes the climatic conditions required for successful establishment in glasshouses, suitable times of the year for introductions, information on the type of prey (pest) present and the likely effect of the introduction on pest populations, modification of cultural practices (e.g. cease hosing down during introductions) and advice on deployment of the beetle in IPM systems.

Interaction with beneficiaries include the following examples.
1) Biocontrol trials at the Royal Botanic Gardens Kew (2009-2010) which directly resulted in changes to how Kew handles release of the BCA [D].

2) Advisory meetings with pest control staff at the Eden Project (2008) which informed them of the conditions needed for the BCA to be effective and indicated the specific pest combinations most likely to result in successful deployment of the beetle [E].

Impact has therefore specifically occurred where *C. nigritus* has been released as a BCA and specific beneficiaries therefore include the Royal Botanic Gardens Kew (2009 and 2010) [D] and the Eden Project (2009) [E]. For these beneficiaries, the availability of effective BCAs is particularly important given the reputational value they place on not using pesticides. Numerous butterfly farms and indoor landscapes have also benefited from this work [A] and there is strong evidence on product websites and from verbal communication that the research has been used by biocontrol companies and growers worldwide to modify production processes and pest management practice (e.g. [B,C]).

5. Sources to corroborate the impact

List of independent corroborators for whom the research has had particular impact.

A) Wyebugs Ltd. **(Contact ID.1)**

B) Bugs for Bugs, Australia. **(Contact ID.2)**

C) Citrus Research International, South Africa. **(Contact ID.3)**

D) Royal Botanic Gardens, Kew. **(Contact ID.4)**

E) Eden Project. **(Contact ID.5)**