

POTENTIAL OF NATIVE INSECT PREDATORS FOR BIOLOGICAL CONTROL

Two Case Studies

Patrick DE CLERCQ

Laboratory of Agrozoology
Department of Crop Protection
Ghent University
Belgium



Ladybirds and biological control in Belgium,
27 November 2003

ACTIVITIES OF THE LABORATORY OF AGROZOOLOGY, DEPT CROP PROTECTION

- Devising integrated and biological pest control strategies in field and greenhouse crops
- Designing mass production procedures for arthropod biological control agents, with emphasis on predators
- Evaluating side-effects of pesticides on natural enemies
- Evaluating non-target effects of biocontrol agents



Ladybirds and biological control in Belgium,
27 November 2003

EXOTIC ARTHROPODS AT THE LABORATORY OF AGROZOOLOGY

- Both non native pests and natural enemies are being reared and studied in confined conditions
- Exotic pests reared belong to EPPO A2 quarantine list (i.e., already present but not widely distributed) and Belgian risk category 2
- Main exotic natural enemies reared are *Podisus maculiventris* (since 1989) and *Harmonia axyridis* (since 1998); occasionally, some natural enemies are purchased for experimental or biocontrol purposes (*Encarsia formosa*, *Phytoseiulus persimilis*...)



Ladybirds and biological control in Belgium,
27 November 2003

NATIVE ALTERNATIVES TO EXOTIC PREDATORS

- Research programme focusses on:
 - *Picromerus bidens* vs. *Podisus maculiventris*
 - *Adalia bipunctata* vs. *Harmonia axyridis*
- Potential of native species is assessed in relation to cost-effectiveness of rearing, biocontrol capacity and non-target effects



Ladybirds and biological control in Belgium,
27 November 2003

PODISUS MACULIVENTRIS

- Predatory pentatomid feeding on a wide range of insect prey, mainly soft-bodied lepidopterous and coleopterous larvae, in a diversity of habitats
- Natural distribution from Canada into Mexico and the West Indies: strains with different climatic adaptedness
- Good control potential against a.o. Chrysomelidae (Colorado potato beetle) and Noctuidae in glasshouses
- Easily reared on various factitious prey and artificial diets
- Introduced for biocontrol purposes in several European and Asian countries repeatedly since the 1930s, but never established; used since 1997 in European glasshouses to suppress caterpillar outbreaks



Ladybirds and biological control in Belgium,
27 November 2003

The exotic predatory pentatomid *Podisus maculiventris*



Ladybirds and biological control in Belgium,
27 November 2003

PODISUS MACULIVENTRIS

- Risk assessment:
 - ERBIC (Netherlands): mainly based upon wide food range considered « high-risk »
 - EPPO: features on « List of widely used BCAs » (i.e., relatively safe) as « commercially used BCA », mainly based on lack of establishment
 - No longer allowed for release in a number of European countries, others require registration
- Alternatives: *Picromerus bidens*; hymenopteran and tachinid parasitoids; microbial agents (bacteria, viruses)

PICROMERUS BIDENS

- Palaearctic predatory pentatomid associated with a wide diversity of plants and feeding mainly on lepidopterous and coleopterous larvae
- Natural distribution from North Europe into China and North Africa: strains with different climatic adaptedness; (inadvertently?) introduced and established in north western North America
- Control potential largely unknown: some studies on forest pests (incl. sawfly larvae) and Colorado potato beetle
- Rearing complicated by obligatory diapause in egg stage and low fecundity

The native predatory pentatomid *Picromerus bidens*



Performance of *Podisus maculiventris* and *Picromerus bidens* on different diets

Species	Nymphal period (days)	Fecundity
Lepidoptera larvae		
<i>P. maculiventris</i>	21	750-1000
<i>P. bidens</i>	27	100-200
Artificial diet (meat/liver)		
<i>P. maculiventris</i>	23	400-600
<i>P. bidens</i>	?	?

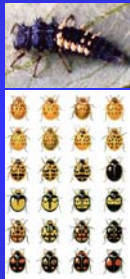
Predation by fifth instar *Podisus maculiventris* and *Picromerus bidens* on fifth instar *Spodoptera littoralis* larvae

Species	No. of prey killed
Petri dish (during total stadium)	
<i>P. maculiventris</i>	9.7
<i>P. bidens</i>	11.2
Plant (during 48 h)	
<i>P. maculiventris</i>	4.6
<i>P. bidens</i>	6.2

HARMONIA AXYRIDIS

- Polyphagous coccinellid predator attacking a wide range of arthropod prey, including tetranychids, aphids, coccoids, psyllids, and immatures of coleopterans and lepidopterans; some feeding on pollen and nectar; mainly arboreal
- Natural distribution in Central to East Asia; intentionally and accidentally introduced and established in North America (late 1980s); there is evidence that establishment in Europe and North America is strain dependent
- Recognized control potential against different aphid pests in a variety of agroecosystems
- Non-flying strain 'Coccipode' commercialized by Biotop since 2000
- Easy rearing on facultitious foods (*Ephestia* eggs) and high fecundity

The exotic ladybeetle *Harmonia axyridis*



HARMONIA AXYRIDIS

- Risk assessment:
 - ERBIC (Netherlands): considered « high-risk » based upon wide food range, intraguild predation and probability of establishment
 - EPPO: features on « List of widely used BCAs » as « successfully introduced classical BCA » in some Mediterranean countries (since 1964!)
 - Not allowed for release in a number of European countries, others require registration
 - Reported to be a nuisance pest in North America
- Alternatives: *Adalia bipunctata*; syrphid flies; lacewings; predatory heteropterans; hymenopteran aphid parasitoids; microbial agents (fungi)

ADALIA BIPUNCTATA

- Polyphagous coccinellid predator attacking a wide range of arthropod prey, with emphasis on aphids; some feeding on pollen and nectar, mainly arboreal
- Widely distributed in Europe, Central Asia and North America
- Commercialized for control of different aphid pests in various agroecosystems
- Lower nutritional plasticity than *H. axyridis*, but rearing is possible on facultitious foods (*Ephestia* eggs); fecundity and egg hatch may be affected by diet

The native ladybeetle *Adalia bipunctata*



Development and fecundity of coccinellids reared on gamma-irradiated or deep frozen *Ephestia* eggs or on live pea aphids

Diet	Developmental duration (days)	Immature survival (%)	Fecundity / Egg hatch (%)
<i>Harmonia axyridis</i>			
Irradiated eggs	17.7	87.5	762
Frozen eggs	17.6	90	590
Pea aphids	17.8	77.5	622*
<i>Adalia bipunctata</i>			
Irradiated eggs	16.7	87.5	793 / 20
Frozen eggs	17.1	55.0	580 / 27
Pea aphids	17.5	40.0	290 / 62

* Fed in larval stage on frozen *Ephestia* eggs

Predation by third and fourth instar *Harmonia axyridis* and *Adalia bipunctata* on *Myzus persicae* adults

Species	No. prey killed during 24 h
Third instar	
<i>H. axyridis</i>	12.1
<i>A. bipunctata</i>	6.1
Fourth instar	
<i>H. axyridis</i>	91.3
<i>A. bipunctata</i>	56.7

Note: Third and fourth instar larvae of *H. axyridis* and *A. bipunctata* weigh ca. 4.5 and 2 mg, and 15 and 5 mg, respectively

CONCLUSIONS

- Future of *Podisus maculiventris* as a biocontrol agent for caterpillar and CPB control in Europe is uncertain; the native pentatomid *Picromerus bidens* may be an alternative if difficulties in mass production can be overcome
- It is expected that *Harmonia axyridis* will be (largely) abandoned as an aphid biocontrol agent in Europe; establishment of the species in Europe needs to be further substantiated; if mass production can be optimized, *Adalia bipunctata* may be a viable alternative, particularly for the control of smaller aphids
- More and more European countries will set up legislation for importation and release of non native natural enemies, based upon preparatory work by FAO, OECD, EPPO and ERBIC, but no harmonisation is expected within a European framework

INITIATIVES ON REGULATION OF IMPORT AND RELEASE OF EXOTIC BCAs

- Regulation of the import and release of exotic biological control agents has been imposed in different countries outside (USA, Canada, Australia,...) and inside Europe (Sweden, Norway, UK, Austria,...) but procedures differ in criteria and detail
- Some countries have a legal framework but do not impose regulation in practice (e.g., Belgium)
- Many countries are expected to develop regulation in the near future (e.g., in the framework of the commitments they made for the Convention on Biological Diversity)
- Different international bodies have been trying to elaborate guidelines during the last decennium
- Result is confusion and uncertainty for biocontrol practitioners

INITIATIVES ON REGULATION OF IMPORT AND RELEASE OF EXOTIC BCAs

- International Plant Protection Convention (FAO):
« Code of conduct for the import and release of exotic biological control agents » (ISPM3)
 - First published 1996, currently under review to incorporate technical guidelines OECD risk assessment
 - Binding for member states, but currently normative rather than compulsory law (this should change after incorporation of technical guidelines)

INITIATIVES ON REGULATION OF IMPORT AND RELEASE OF EXOTIC BCAs

- European and Mediterranean Plant Protection Organisation (EPPO):
 - « First import of exotic biological control agents for research under contained conditions » (PM 6/1) (1999)
 - « Import and release of exotic biological control agents » (PM 6/2) (2000)
 - normative framework for member states, based on ISPM3, for national authorities to translate into technical rules
 - « List of biological control agents widely used in the EPPO region » (PM 6/3) (2003)
 - 'countries may presume ... that these agents can be introduced and used safely' (BCAs used for min. 5 years in 5 EPPO countries without evident problems)

INITIATIVES ON REGULATION OF IMPORT AND RELEASE OF EXOTIC BCAs

- Organisation for Economic Co-operation and Development (OECD):
« Guidance for information requirements for regulation of invertebrates as biological control agents »
 - envisages characterisation, risk assessment and efficacy testing for invertebrate BCAs
 - technical guidelines under development (input from a.o. ERBIC)
 - quickscan for BCAs used for > 5 years without adverse effects (historical information); full scan for other or new BCAs (full assessment)

INITIATIVES ON REGULATION OF IMPORT AND RELEASE OF EXOTIC BCAs

- Evaluating Environmental Risks of Biological Control Introductions into Europe (ERBIC):
FAIR-project supported by European Commission and co-ordinated by Joop van Lenteren (Wageningen University)
 - assessed risk status of the main invertebrate BCAs used in Europe
 - developed detailed guidelines for risk assessment: potential for establishment, dispersal, host range, direct and indirect effects on non-targets (see BioControl 48: 3-38)
 - high risk indices were calculated for *Harmonia axyridis* and *Hippodamia convergens*

INITIATIVES ON REGULATION OF IMPORT AND RELEASE OF EXOTIC BCAs

- Case study: the situation in The Netherlands
 - Flora- en faunawet (2002): « Het is verboden om dieren en eieren van dieren in de vrije natuur uit te zetten »
 - 'Flora- en faunawet' is currently being adjusted considering the situation of biological control as a part of sustainable agriculture; permission for import/release of BCA species is based on OECD/ERBIC risk assessment procedures (*Harmonia* will no longer be allowed)
 - Original formulation of this law is comparable with that in the 'Natuurdecreet van 21 oktober 1997' and 'Besluit Vlaamse Regering van 21 april 1993' in Flanders; both of these laws provide legal framework for exceptions and permissions