NAPPO
North American Plant Protection Organization
Organización Norteamericana de Protección a las Plantas

4. Host-Specificity Testing:

4.1 Selection of non-target test arthropods

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Biological Control Expert Group Workshop
Ottawa, Ontario, Canada
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Canada

Background

- Why is this needed?

Background

- Detailed ecological studies and increasing awareness of the environment led to discoveries of unintended effects
  - *Rhinocyllus conicus*
  - *Compsilura concinnata*
  - *Cactoblastis cactorum*
  - *Microctonus aethiopoides*

Background

Harmonia axyridis

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From The Times February 7, 2008

Ladybird knocks spots off squirrel's migration

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Asian harlequin ladybird now dominant species

By Charles Clover, Environment Editor and Graham Tibbetts

ated: 6:01pm GMT 06/02/2008

ian harlequin ladybird has become the dominant species in the south east of England in
an four years, scientists have said.

ıe-grown ladybirds put to flight by alien invasion
lequin invader threatens to wipe out ladybirds
ı late' to halt invasion by giant ladybirds

nwide survey shows that the insect, which originated in Japan, has gone from a handful
tings in 2004 to virtually total coverage of the South East and is now found as far afield
land, Northern Ireland and Wales.

Asian harlequin ladybirds (left) and two harlequin larvae eating a 7-spot larva (right)

s voracious appetite and longer breeding period there are fears it could threaten the
l of the 46 domestic ladybird species.

5/ealadyb106.xml (1 of 4)2008-02-07 8:31:15 AM

Public interest charts the impact of the most invasive ladybird on earth - 7th February 2008

The Harlequin Ladybird has gone from a biological control agent to potentially the "most invasive ladybird on earth", scientists from across Europe announced today through the publication of a special issue of the journal BioControl.

Contained within the special issue is evidence from the UK Harlequin Ladybird Survey (a collaborative project between the Centre for Ecology & Hydrology, Cambridge University and Anglia Ruskin University) which demonstrates how the Harlequin has spread rapidly and its numbers have soared across the UK since first arriving in the South East of England in 2004. Through a pioneering on-line recording system members of the public have registered their sightings with photos to give reliable data. Over 20,000 records of Harlequin Ladybirds, many of multiple individuals, have been logged since the survey was launched in March 2005.

Dr Helen Roy from the Centre for Ecology & Hydrology who works on the UK Harlequin Ladybird Survey, and was one of the two co-editors of the special issue, commented:

"The Harlequin Ladybird is an extremely unwelcome addition to the UK but through this on-line survey we have been able to track its movements and are now beginning to use the survey to understand more complex aspects of the ecology of the Harlequin Ladybird within the UK. This book is not the end of our research, and the public can still contribute through the website www.harlequin-survey.org "

Welcoming the new study, Joan Ruddock, Minister for Climate Change and Biodiversity said:

"I am pleased that our funding has helped to establish the UK Harlequin Ladybird Survey as a good example for recording the distribution for non-native species. This research is important because it demonstrates how quickly an invasive species can spread and become established. I was delighted by the great public response to the survey, showing the important role the public have to play in helping to conserve wildlife."

Additional Information

The UK Harlequin Ladybird Survey was established by CEH, Cambridge University and Anglia Ruskin University through the National Biodiversity Network (NBN) Trust and with start-up funding from Defra.

http://www.ceh.ac.uk/news/news_archive/2008_news_item_03.html (2 of 3)2008-02-07 8:17:58 AM

Background

Results "Five (Belgium) and seven (Britain) of eight species studied show substantial declines attributable to the arrival of *H. axyridis*."

Main conclusion "… these analyses show *H. axyridis* to be displacing native ladybirds with high niche overlap, probably through predation and competition."

"Predatory ladybirds are known to provide a major ecosystem service by regulating pest insects. Although *H. axyridis* is an effective biological control agent in crop systems …, it is unclear whether it can fulfil all the functional roles of the species it is displacing. *Harmonia axyridis* is rapidly expanding its global range: our results imply that this will cause ecological extinctions … of native species, notably deciduous tree specialists, over large areas."

Diversity and Distributions, (Diversity Distrib.) (2012) **18**, 717–725

Diversity and Distributions — A Journal of Conservation Biogeography

BIODIVERSITY RESEARCH

Invasive alien predator causes rapid declines of native European ladybirds

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ABSTRACT

Aim Invasive alien species (IAS) are recognized as major drivers of biodiversity loss, but few causal relationships between IAS and species declines have been documented. In this study, we compare the distribution (Belgium and Britain) and abundance (Belgium, Britain and Switzerland) of formerly common and widespread native ladybirds before and after the arrival of *Harmonia axyridis*, a globally rapidly expanding IAS.

Location Europe

Methods We used generalized linear mixed-effects models (GLMMs) to assess the distribution trends of eight conspicuous and historically widespread and common species of ladybird within Belgium and Britain before and after the arrival of *H. axyridis*. The distribution data were collated largely through public participatory surveys but verified by a recognized expert. We also used GLMMs to model trends in the abundance of ladybirds using data collated through systematic surveys of deciduous trees in Belgium, Britain and Switzerland.

Results Five (Belgium) and seven (Britain) of eight species studied show substantial declines attributable to the arrival of *H. axyridis*. Indeed, the two-spot ladybird, *Adalia bipunctata*, declined by 30% (Belgium) and 44% (Britain) over 5 years after the arrival of *H. axyridis*. Trends in ladybird abundance revealed similar patterns of declines across three countries.

Main conclusion Together, these analyses show *H. axyridis* to be displacing native ladybirds with high niche overlap, probably through predation and competition. This finding provides strong evidence of a causal link between the arrival of an IAS and decline in native biodiversity. Rapid biotic homogenization at the continental scale could impact on the resilience of ecosystems and severely diminish the services they deliver.

Keywords
Biological control, biological invasions, citizen science, Coccinellidae, *Harmonia axyridis*, population decline.

DOI: 10.1111/j.1472-4642.2012.00883.x
http://wileyonlinelibrary.com/journal/ddi

Information requirements

4.0 Host Specificity Testing

4.1 Selection of non-target test arthropods: typically, species, genera and other taxonomically closely-related arthropods and arthropods recorded as hosts in the literature, on museum labels or in other unpublished collection records, agriculture pest reports, etc.; hosts of close relatives (i.e. in the same genus) of the candidate agent; unrelated arthropods having physical and ecological similarities to the pest, rare and endangered species (or their surrogates), beneficial species that may be encountered, species of cultural or indigenous significance, and economically important arthropods.

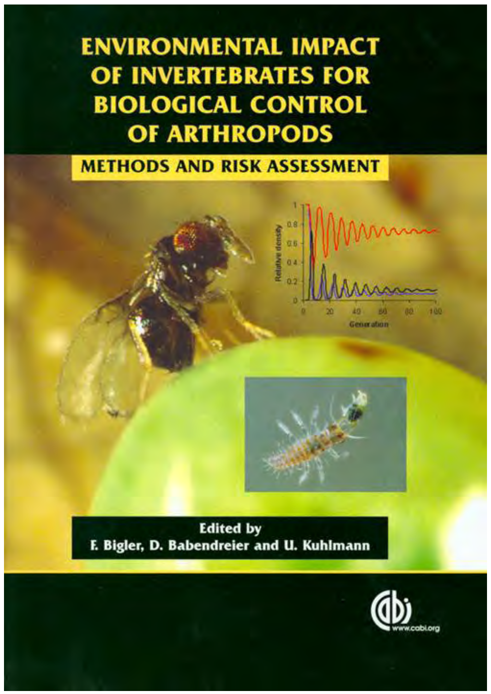
Host-range Testing

- Recommended testing procedures
  - use the same methods as phytophagous (weed) biological control agents … a good model for insect (entomophagous) biological control agents
- These are built around a Centrifugal Phylogenetic Method (Wapshere 1974)
- Non-target test lists normally involve **50+** species
- But …

Challenges for entomophagous agents

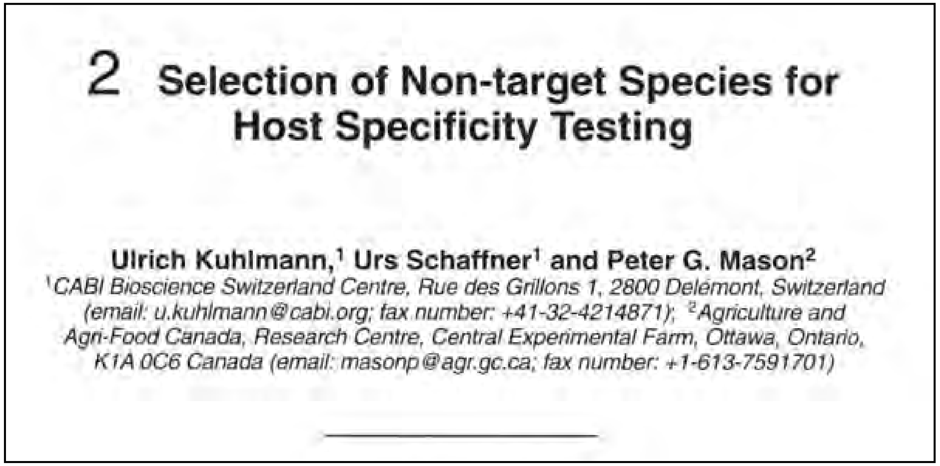
- Taxonomy and phylogenetic relationships of many arthropod groups still poorly known, thus centrifugal phylogenetic approach is limited
- Lack of information on biology and rearing make assembling test lists difficult
- Rearing a large number of test arthropod species is much more difficult and time consuming than test plant species

Can host range testing be done without costs being prohibitive?



- Sands (1997) proposed that using a limited number of carefully selected test species can reveal valuable and interpretable results

Multiple Criteria Selection Method



2 Selection of Non-target Species for Host Specificity Testing

Ulrich Kuhlmann,[1] Urs Schaffner[1] and Peter G. Mason[2]

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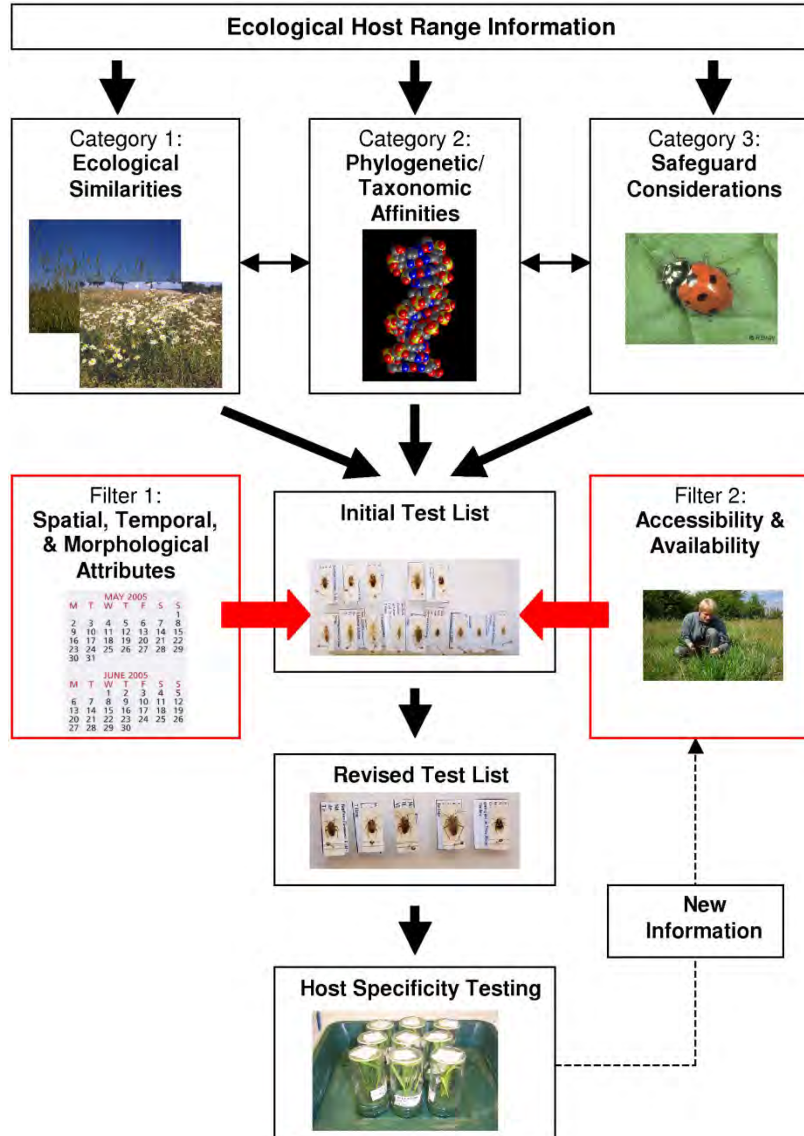
- Enables careful selection of test species to satisfy criteria for interpretable results



Ecological Host Range

Ecological host range studies in area of origin

1) **Study biocontrol agent host range**

   - determine potential host specificity (range limits) & number of species to test **(Initial Test List)**

2) **Potential for sympatry**

   - potential vulnerability of related & outgroup species (refined test list) **(Category 1)**

3) **Taxonomy & phylogenetic relationships**

   - preliminary list of species that could be tested **(Category 2)**

4) **Accessibility of non-target species**

   - reduction in the number of species to be tested to a manageable level **(Filter 2)**

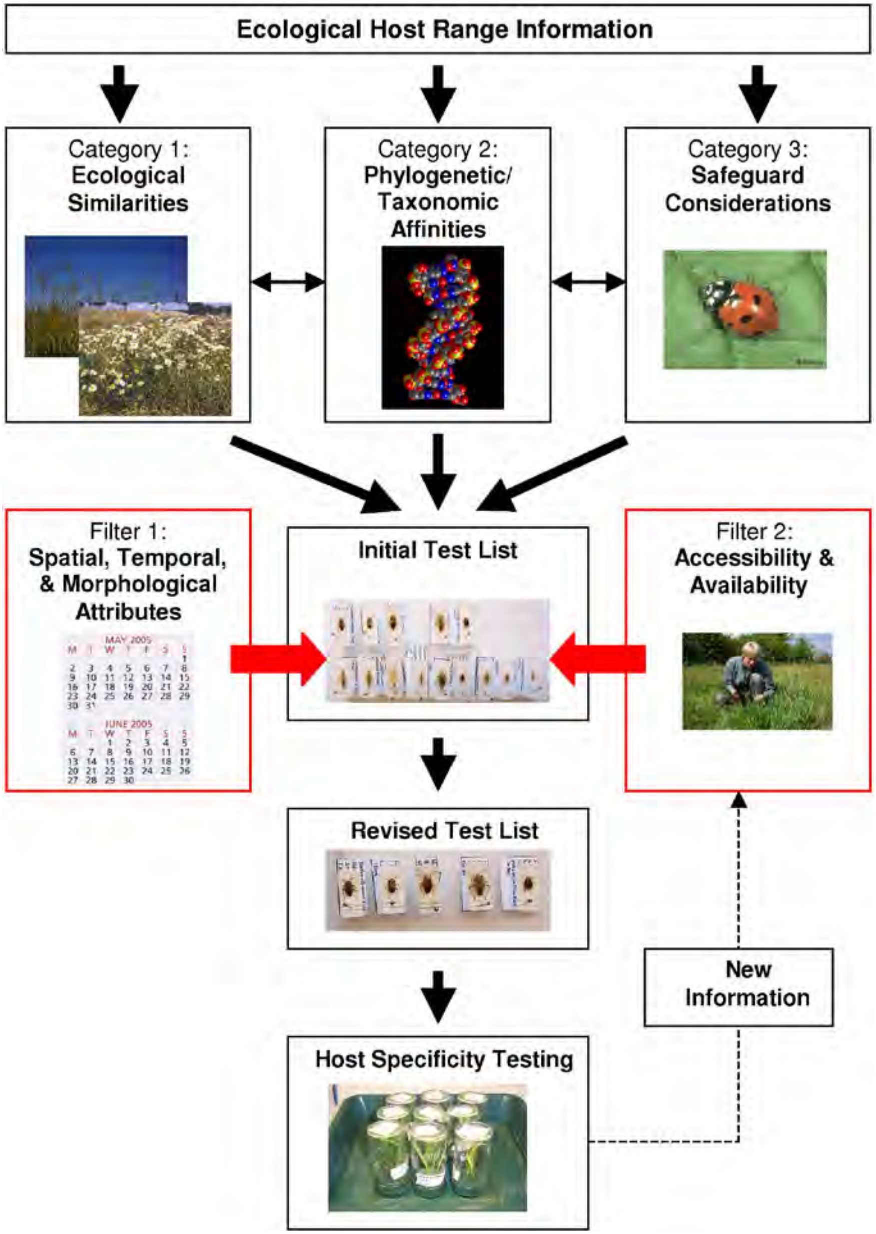
Ecological host range studies in area of introduction

1) **Determine what is known about the biology of potential non-target species (Category 1)**
   - determine species which are best known
   - identify gaps that need to be studied
2) **Taxonomy & phylogenetic relationships (Category 2)**
   - preliminary list of native species that could be tested
3) **Beneficial, Threatened and endangered species (Category 3)**
   - identify species at risk that may be encountered where the agent is to be released
   - identify species that are known to control other pests in the target systems (e.g. greenhouse)
4) **Spatial, temporal, morphological attributes (Filter 1)**
   - identify species that occur at the same time of year, same region and are physically similar to the target pest
5) **Accessibility of non-target species (Filter 2)**
   - reduces the number of species to be tested to a manageable level

Revised Test List

Once host specificity testing is initiated, new information can provide guidance on whether a species:

- could be dropped from the test list (e.g., the BCA has very specific cues needed to attack a host)
- Should be added to the test list (e.g., the feeding niche of a new non-target species was discovered and is similar to the feeding niche of the target pest)



Ceutorhynchus obstrictus – North America

Non-target species	Selection criteria
Curculionidae Ceutorhynchinae **Ceutrorhynchini** *Ceutorhynchus americanus* Buchanan *Ceutorhynchus neglectus* Blatchley	*same genus, same tribe, biology known, same / adjacent habitat, same or different feeding niche*
Mononychini *Mononychus vulpeculus* (Fabricius) **Phytobini** *Rhinoncus triangularis* (Say)	*same subfamily, same feeding niche, host plant in same or adjacent habitat*
Anthicidae *Anthicus flavicans* LeConte	*not taxonomically related, same host plant, similar size, associated feeding niche*
Chrysomelidae Alticinae *Psylliodes punctulata* Melsheimer	*not taxonomically related, same host plant, similar size, associated feeding niche*
Coccinellidae Scymninae **Hyperaspini** *Hippodamia convergens* Guérin-Méneville	*not taxonomically related, same host plant or habitat, associated feeding niche, beneficial species*
Melyridae *Collops vittatus* Say	

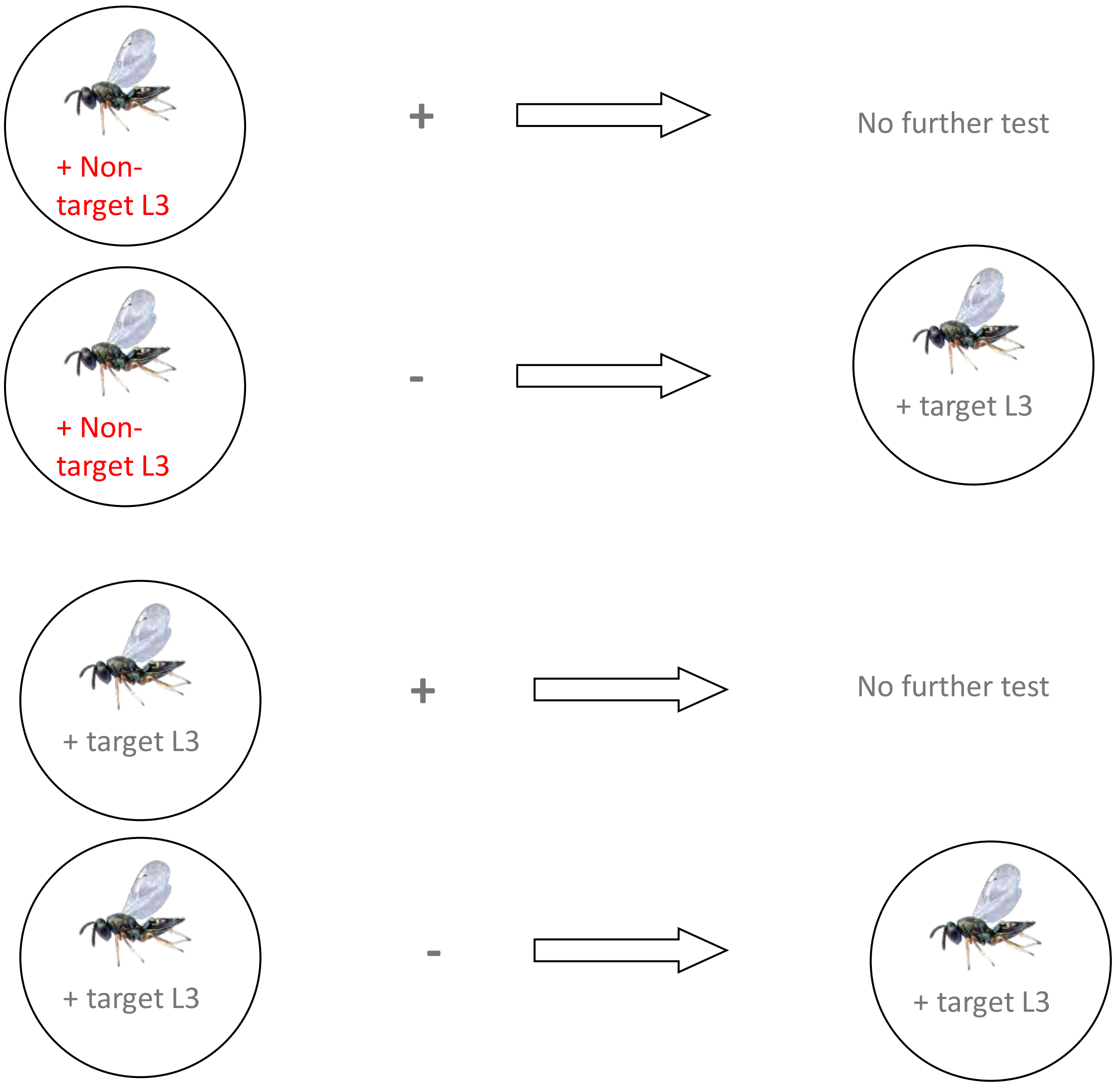
8 potential non-target test species

Ceutorhynchus obstrictus – Europe

Non-target species	Selection criteria
Curculionidae Ceutorhynchinae Ceutrorhynchini *Ceutorhynchus alliariae* H. Brisout *Ceutorhynchus constrictus* (Marsham) *Ceutorhynchus erysimi* (Fabricius) *Ceutorhynchus pallydactulus* (Marsham) *Ceutorhynchus rapae* Gyllenhal *Ceutorhynchus roberti* Gyllenhal *Ceutorhynchus scrobicollis* Neresheimer & Wagner *Ceutorhynchus turbatus* Schultze *Ceutorhynchus typhae* (Herbst)	*same genus, same tribe, biology known, same / adjacent habitat, same or different feeding niche,* ***weed biocontrol agents***
Glocianus punctiger (Sahlberg) *Hadroplontus litura* (Fabricius) *Microplontus edentulus* (Schultze) *Mogulones borraginis* (Fabricius) *Mogulones crucifer* (Pallas)	*same tribe, biology known, same / adjacent habitat, different feeding niche,* ***weed biocontrol agents***
Baridinae *Baris coerulescens* Scopoli	*same family, different subfamily, different feeding niche, similar size, biology known*
Chrysomelidae Alticinae *Psylliodes chrysocephala* (L.) **Coccinellidae Coccinellinae Coccinellini** *Coccinella septempunctata* L.	*not taxonomically related, same habitat, similar size, beneficial species*

17 potential non-target test species

Host specificity testing



Actual species tested (15)

Non-target species	Selection criteria
Ceutorhynchus typhae (Herbst)	Same feeding niche, adventive in NA, habitat overlap
Ceutorhynchus constrictus (Marsham) *Ceutorhynchus turbatus* Schultze *Ceutorhynchus peyerimhoffi* Hustache *Mogulones borraginis* (Fabricius)	Same feeding niche, candidate weed biological control agent
Ceutorhynchus pallydactulus (Marsham)	Different feeding niche, same host plant
Ceutorhynchus alliariae H. Brisout *Ceutorhynchus roberti* Gyllenhal *Ceutorhynchus cardariae* Korotyaev	Different feeding niche, candidate weed biological control agent
Ceutorhynchus erysimi (Fabricius)	Different feeding niche, adventive in NA, habitat overlap
Ceutorhynchus neglectus Blatchley *Ceutorhynchus omissus* Fall	Congener, same feeding niche, habitat overlap, on native plant hosts
Ceutorhynchus sp.nr. *nodipennis* Dietz	Congener, same feeding niche, different habitat, on native plant hosts
Ceutorhynchus americanus Buchanan	Congener, different feeding niche, habitat overlap, on native plant hosts
Mononychus vulpeculus (Fabricius)	Same feeding niche, different habitat, same subfamily

Where do we go from here?

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4. Host-Specificity Testing:

4.2 Laboratory Tests

4.3 Information from area of origin

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