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

NAPPO Regional Standards for Phytosanitary Measures Biological Control Agent Information

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Background and information requirements. Why standards are needed.

- Accurate information on biology is needed to make informed decisions about the efficacy and potential deleterious effects of using one species to control one or more other species, particularly if the agent of interest is deliberately introduced from one biogeographic region into another. Deliberately introduced species are almost always used to try and control an introduced species which has become invasive but rarely they may be used against a species native to the region of introduction.

- Information needed is listed in Section 3 of the Regional Standards for Phytosanitary Measures. Version 12.

3.1 Taxonomy, scientific name, full classification (Order, Family, Genus, species, and author/describer of the species), synonymy, common name(s) [if any], and name of the taxonomic authority confirming identity of the biocontrol agent

- NAPPO regulations, Biocontrol suppliers and taxonomists all agree that a correct species identification is essential. Without this nothing can be discussed meaningfully. An incomplete name is not sufficient to search for relevant literature on the agent or allow it to be introduced and released or mass produced for sale. An wrong name leads to the wrong information that could have serious consequences because it does not apply to the species of interest. Example of a complete species name, with family placement:
- *Musca domestica* Linnaeus (Diptera: Muscidae)

For greatest chance of accurate identification a taxonomist needs:

- Sufficient specimens, of both sexes if possible, in good condition (intact adults, preserved appropriately) for taxonomic study and identification.
- Accurate and complete labelling. Specimens without labels indicating provenance, collection date, host, etc. have no scientific value. And, for the taxonomist, knowing where the specimens originated from (country, region) may be critical to identifying it correctly.

Specimen labels

The data associated with specimens and recorded on their labels are a permanent record of research that is as important as the specimens themselves. Specimens without data are scientifically worthless.

Labels should provide accurate, unambiguous locality information that includes latitude and longitude.

Label data should be in a format that maximizes the efficiency with which the data can be extracted into databases, data retrieval systems and geographic information systems.

The importance of keeping voucher specimens has increased with renewed interest in biological control and biodiversity studies and the realization that different biotypes of a single species may have quite different biological characteristics (Huber 1998: Journal of Natural History, 32:3, 367-385)

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Available as pdf from: http://biologicalsurvey.ca

Label Data Standards for Terrestrial Arthropods

A brief prepared by the
Biological Survey of Canada (Terrestrial Arthropods)

Biological Survey of Canada (Terrestrial Arthropods)
Document series No. 8 (2001)

Examples of specimen data labels

- **Collection information**:

Netherlands: Limburg, Valkenburg

50°52'N 5°50'E, 6.vii.2015, J. T. Huber

Ex *Trialeurodes vaporariorum* on cabbage leaf

- **Information on insectary material submitted for identification**:
- CANADA: British Columbia, Vancouver, ex lab. culture of parasitized nymphs of grape whitefly, *Trialeurodes vittata* (Quaintance) on *Vitis* leaves emerged on 8.vi.2015, original collection from South Korea, Incheon.

Triapitsyn, S. V. in Heraty, Yanega & Triapitsyn 2013, http://entmuseum.ucr.edu/specimen_preparation/index.html

Voucher specimens

Voucher specimens deposited in natural history collections are the only reliable means to verify the identity of species used in biological studies.

Errors in specimen identification can enter a study in several ways:

- Subsequent recognition of multiple species in a complex of closely related species, or changes in species limits.
- Subsequent recognition of variation in traits of populations that affect morphology, ecology, behaviour or physiology.
- Subsequent recognition of errors or omissions in keys or guides used for identification.
- Misidentification of an organism by a trained researcher inexperienced in the systematics of that taxon (an occasional problem).
- Misidentification of an organism by untrained or poorly trained "consultants" offering contract identifications (a frequent problem).

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Available as pdf from: http://biologicalsurvey.ca

The Role of Voucher Specimens in Validating Faunistic and Ecological Research

A brief prepared by the
Biological Survey of Canada (Terrestrial Arthropods)

Biological Survey of Canada (Terrestrial Arthropods)
Document series no. 9 (2003)

Voucher specimens and label data standards

- Specimens with collection data have scientific value. Without data they are scientifically worthless.
- Studies based on specimens that are later discarded or lost cannot be checked again. Such studies may well become worthless, e.g., if biological control agents are misidentified and no voucher specimens are kept the misidentification, of the original specimens at least, cannot be corrected.
- Triapitsyn, S. V. in Heraty, Yanega & Triapitsyn 2013, http://entmuseum.ucr.edu/specimen_preparation/index.html

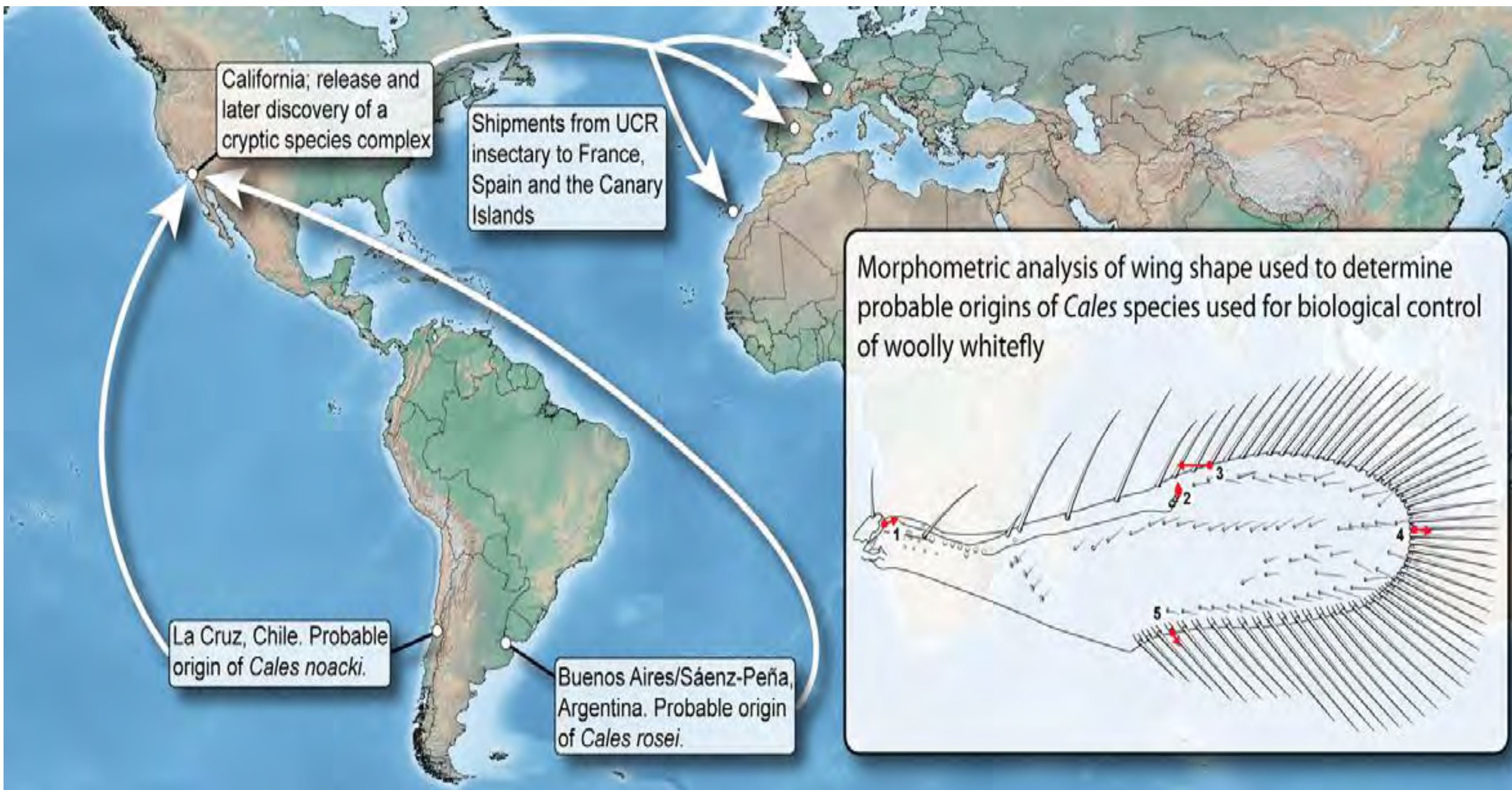
3.2 Methods used to identify the biocontrol agent

- Classical method is using morphology, external and internal, of various life stages, usually the adult. Still essential today for identifying species.
- Supplemented in last two decades with molecular methods (barcoding, etc.).
- Gariepy & Roitberg (2013). New tools in biological control: molecular markers and mathematical models. Chapter 4 in Mason & Gillespie: Biological control programmes in Canada 2001-2012.

The dead can talk: Museum specimens show the origins of a cryptic species used in biological control.

Jason L. Mottern, John M. 2014. *Biocontrol* **71**: 30-39.

Biological control populations of *Cales noacki* comprise a cryptic species complex.
Wing shape was analyzed to determine the South America origin of each species.
Shape analysis is useful for morphological character discovery.
Specimen vouchering should be a critical component of biological control programs.



3.3 Location of reference specimens (national collection)

- First described from Ireland by Walker in 1842. Specimen preserved in Dublin.
- Then described from USA under a different name by Ashmead in 1887. Specimen preserved in Washington.
- Then described again several times under yet more names from Austria and The Netherlands by Soyka in 1949 and 1950. Specimen preserved in Vienna.
- Finally, described (again!) from Italy by Jesu in 2002. Specimen preserved in Portici.
- Over a 160 year period the species described many under different names.
- All specimens available for study so the synonymies could be established based on the original specimens.

3.4 Natural geographic range, other areas where introduced, and expected attainable range in North America (also habitat preference and climate requirements)

- For the petition to introduce an agent NAPPO requires:
- Natural geographic range (based on literature search, specimens in collections [taxonomists may be able to help with collection data].
- Where has the agent been introduced previously.
- Expected attainable range in North America. This depends on habitat and climate requirements of the agent, so this should be supplied as accurately as possible.

Projected distribution of *Peristenus digoneutis* (Braconidae) on *Lygus* bugs

- Composite Match Index maps (CLIMEX)

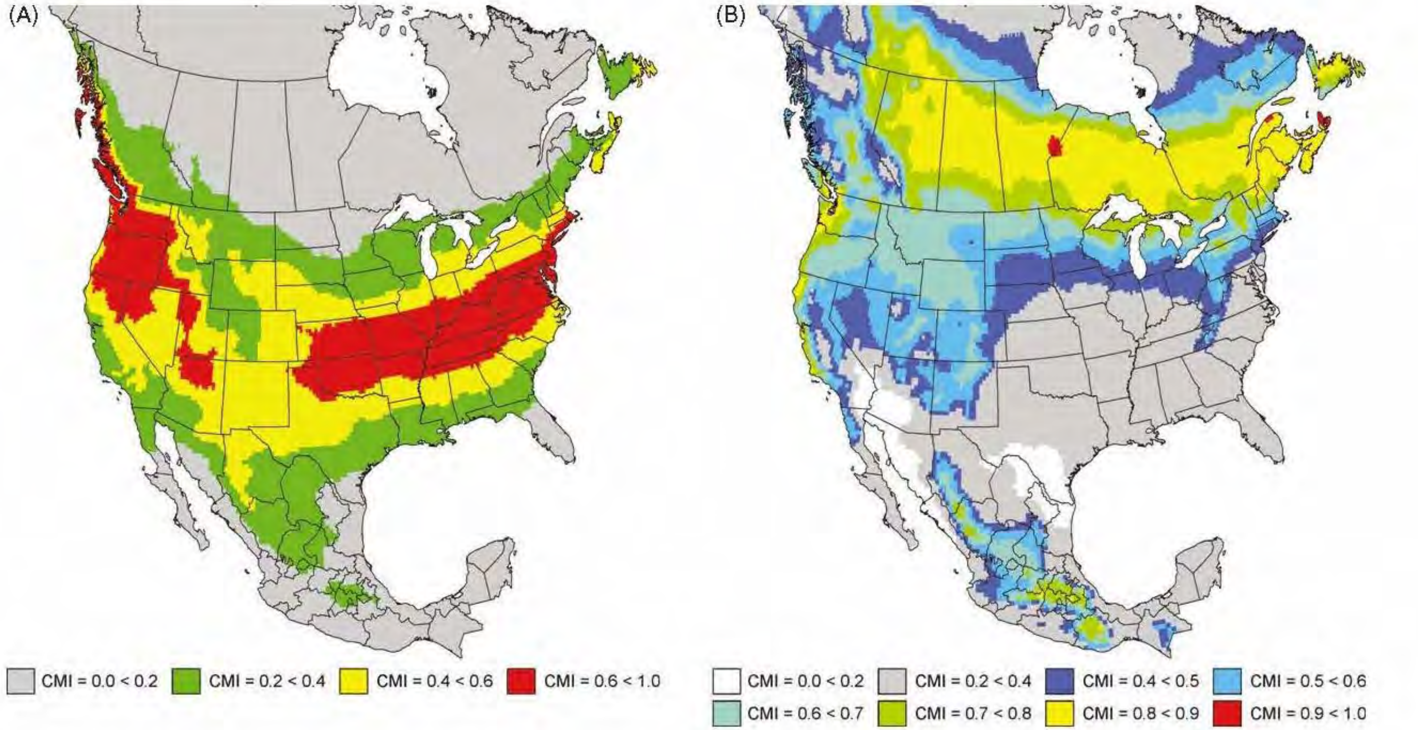


Figure 4 Map depicting Composite Match Index (CMI) between a delineated region surrounding Kiel, Germany and North America for (A) the winter period 1–28 January and (B) the summer period 1–29 July. A CMI value of >0.7 indicates that *Peristenus digoneutis* populations would have the potential to persist within those regions. A value of CMI = 1 indicates an exact match with the 'home' location.

3.5 Source of the agent (laboratory/rearing/containment facility, original collection locality, names of collector and identifier)

- If from a commercial facility the origin of the stock should be given, together with the collector name and, especially who identified the species and where are the vouchers from the original collections deposited.
- If the species is being reared in a containment facility but permission for release has not yet been given this must be stated.
- The name of the current laboratory or rearing facility.

3.6 Host/biocontrol agent interactions (e.g., predator, parasitoid, pathogen, parasite, competitor, antagonist)

- The most important thing to know is what kind of interaction is involved. While it might seem obvious initially that a species is a parasitoid, predator, pathogen, plant feeder, pollinator, or competitor (or sometimes a mixture of these!) detailed study might show otherwise.
- E.g. Some parasitoids may turn out to be facultative or obligate hyperparasitoids.
- E.g. Some predators may be found to prefer a non-target host. Detailed studies are needed to elucidate the interaction. The goal is to avoid introducing or releasing species that ultimately proof to be ineffective or, worse, deleterious to the environment (greenhouse system or whatever).

3.7 Biology and reproductive potential (including dispersal capacity and damage inflicted on target pest)

- Besides the type of interaction (treated under 3.6) an agent should be shown to be effective before mass production for sale or release.
- Important to know its reproductive potential and dispersal ability.
- E.g. spiders, some mites, and larvae of Lepidoptera such as budworms disperse passively often for long distances using silk threads that are caught by air currents.

3.8 Known host range

- A literature search is the place to begin. Unpublished records and museum specimens are additional information sources.
- BUT depending on the accuracy of the identification, many ‘hosts’ are actually not the correct host for the biological control agent under study. This is because the species or either host or agent were misidentified, or the association was incorrectly made, e.g., it was thought to be a primary parasitoid when it was in fact a secondary parasitoid (hyperparasitoid) or competitor.
- Basic problem is poor observation and experimentation to check what the correct host really is.

3.9 History of past use as a biocontrol agent

- If the biocontrol agent is widely used and the plan is to introduced it into a new country for the first time, it is important to detail past experiences with the agent in other areas or countries, or in different ecosystems (e.g., greenhouse vs field) or against different hosts.

3.10 Purity of the mass cultures

- It is extremely important to ensure the species being propagated for sale or release is free of pathogens, parasites, parasitoids, and hyperparasitoids.
- Scientific names of any of these should be given.
- Methods for assessing the purity of the stock must be explained in detail. This includes how often the stock is checked for contaminants.
- Another problem is whether the stock is becoming inbred and thus loses its effectiveness, either in terms of reproducing and dispersing properly or in terms of controlling the pest.

3.11 Standard operating procedures

- How will the biocontrol agent be handled in containment (i.e., before sale to customer or release in the environment (contained place such as greenhouse or otherwise).
- Trade secrets on rearing, etc. are not the issue but rather safety to prevent accidental release before approval is given.

3.12 Closely related genera and species in North America

- For important groups of parasitic insects excellent catalogues and databases exist and can be searched.
- Chalcidoidea online catalogues, e.g. the Universal Chalcidoidea Database by John Noyes.
- Ichneumonoidea. Taxapad by D. Yu and K. van Actherberg and K. Hostmann. This is available on a memory stick through the International Society of Hymenopterists (Craig Brabant – Treasurer). Also search the web for "home of Ichneumonoidea." A very useful site to find "partners" of a particular species (rather loose associations are often reported but still recorded).
- Ecologically similar species of the biocontrol agent should be listed. E.g., if already one or more native species known why should a foreign species be introduced for mass culture and release?

Commercially reared Hymenoptera parasitoids in Canada

About 70 species of parasitoids and predators approved for commercial use; at least 20 of them are Hymenoptera parasitoids.

Chalcidoidea:

- *Aphelinus abdominalis*
- *Aphytis melinus*
- *Anaphes iole*
- *Encarsia formosa*
- *Eretmocerus californicus*
- *Leptomastix dactylopii*
- *Metaphycus helvolus*
- *Muscidifurax (2 species)*
- *Nasonia vitripennis*
- *Pediobius foveolatus*
- *Spalangia endius*
- *Trichogramma* (*5 species*)

Braconidae:

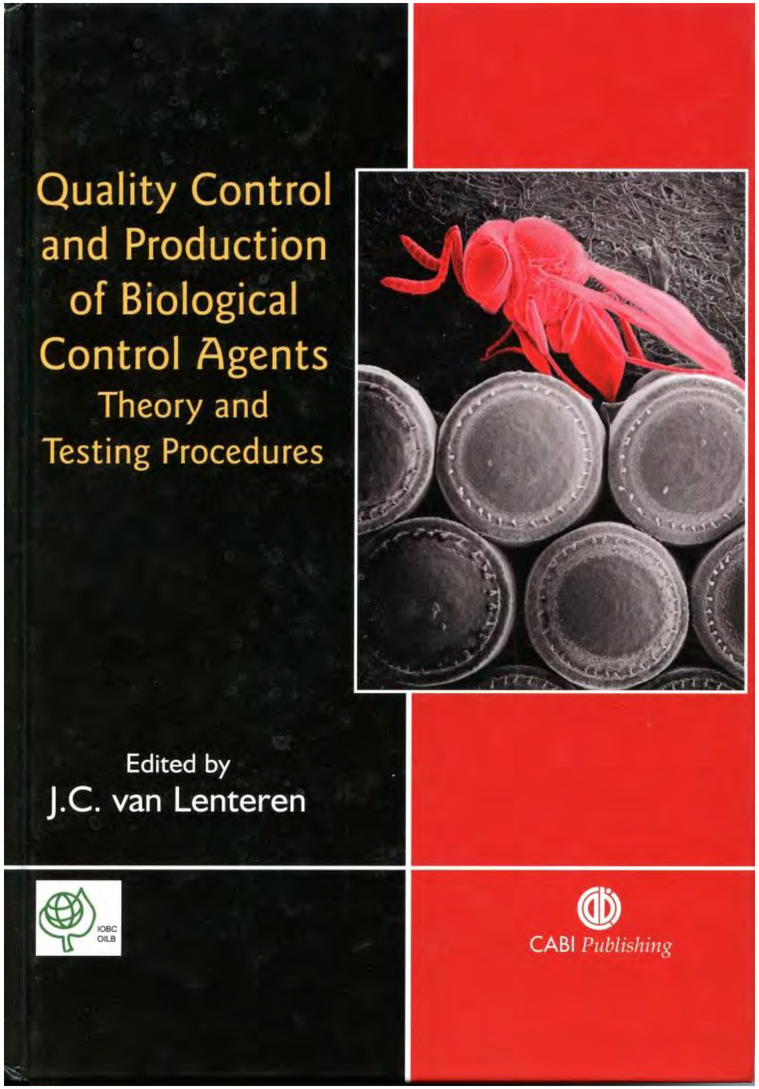
- *Aphidius* (*2 species*)
- *Dacnusa sibirica*

Many more species reared in Mexico and USA.

Taxonomic specialists/centres for various parasitic Hymenoptera

- *Trichogramma*. Richard Stouthammer/John Heraty. University of California, Riverside.
- *Encarsia*. Andrew Polaszek, Natural History Museum, London and John Heraty, UCR.
- *Aphelinus*. Jim Woolley, Texas A&M University. Keith Hopper, USDA, Newark, Delaware.
- Pteromalidae on filth flies (*Spalangia*, etc.). Gary Gibson, CNC + others.
- Other parasitic Hymenoptera. Taxonomists in USNM (Mike Gates, Bob Kula, Matt Buffington) and in CNC.

Major reference for anyone mass producing biological control agents



The tiny parasitoid wasp, as viewed from above in a differential interference contrast (DIC) micrograph. The 0.75 millimetre-long wasp belongs to the family Aphelinidae, one of the most effective groups of biological pest control agents. The female wasps lay their eggs in scale insects, which are then killed by the wasp larvae. (Andrew Polaszek / Natural History Museum)