Regulatory approval processes for release of *Puccinia* spp. for biological control of *Carduus* and *Centaurea* spp. in the United States

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*Puccinia carduorum* and *P. jaceae var. solstitialis* have been evaluated and proposed for introduction into the United States (US) for biological control of musk thistle (*Carduus nutans*) and yellow star-thistle (*Centaurea solstitialis*), respectively. In each case, limited non-target infections were noted under containment greenhouse conditions. Also in each case, a related *Puccinia* species from the US was used in greenhouse comparisons with the candidate agent to resolve questions about potential non-target effects in nature. A strain of *P. carduorum* already present on slenderflower thistle (*Carduus tenuiflorus*) in California, USA, was used in comparison with the candidate isolate from musk thistle. The yellow starflower thistle rust infected safflower (*Carthamus tinctorius*) under greenhouse conditions, and a US isolate of safflower rust, *Puccinia carthami*, was used for comparison. During each risk assessment, interest groups were informed about conclusions that non-target species would not likely be damaged by the use of either organism. Artichoke and safflower growers in California, and representatives of the US Fish & Wildlife Service (F&WS) working with listed (Endangered or Threatened) plant species, were included as contacts. All requests for additional tests were honoured. The state departments of agriculture in Virginia and California, where releases were proposed, also provided approval to federal regulators. Proposals for release of each candidate also were reviewed by the Technical Advisory Group (TAG) and the Animal and Plant Health Inspection Service (APHIS), based on the recommendation of the TAG. A field study for *P. carduorum* was approved for one location in Virginia, and the rust has subsequently spread across the US to California. Notice of the proposal for *P. jaceae* has been published in the Federal Register for comment. A Finding of No Significant Impact (FONSI), thus concluding the approval process, is expected from APHIS. Release of *P. jaceae* is planned in CA, if approved.

Biology and host range of the Brazilian thrips *Pseudophilothrips ichini*, a candidate for biological control of *Schinus terebinthifolius*: US quarantine tests

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Brazilian peppertree, *Schinus terebinthifolius* Raddi (Anacardiaceae), is an evergreen shrub or small tree native to Argentina, Paraguay and Brazil. This invasive plant, known as aroeira, aroeira-vermelha or aroeirada-praia in Brazil, was introduced into the United States as a landscape ornamental in the 19th century. Brazilian peppertree readily invades disturbed sites as well as natural communities where it forms dense thickets of tangled woody stems that completely shade out and displace native vegetation. It is a serious problem for natural resource managers in Florida and Hawaii, USA, because it reduces the biodiversity of the native plant and animal communities. In addition, direct contact with a toxic resin present in the leaves, flowers, and fruits can irritate the skin and respiratory passages of sensitive humans. Exploratory surveys conducted in Brazil produced several promising insect natural enemies. One of the most damaging is the thrips *Pseudophilothrips (= Liothrips) ichini* (Hood) (Thysanoptera: Phlaeothripidae). Feeding by the nymphs and adults kills the meristems and causes flower abortion. This type of feeding damage suppresses the growth rate of young plants and curtails seed production.
in mature trees. Host-specificity studies (no-choice development, no-choice and multiple choice oviposition tests) were conducted in the Florida, USA, quarantine laboratory using 30 plant species in 11 families. Laboratory tests indicated that *P. ichini* is capable of continuous reproduction only on Brazilian peppertree and its congener *S. molle* L., a prized ornamental tree in California native to Peru that is becoming invasive in some areas. If approved for release in the USA, *P. ichini* is unlikely to survive in the arid environment where *S. molle* thrives in California. In addition, field surveys in Brazil confirmed that under natural conditions where both *Schinus* species coexist, *S. molle* is not attacked by *P. ichini*.

The nature of risk from biological control

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Risk is a relative concept commonly used when uncertainty can be quantified. The probabilities of possible outcomes are estimated, such as risk of damage to a non-target species from a biological control agent. “Acceptable risk” is used when uncertainty is quantified to the subjective satisfaction of a viewer. Uncertainty is measured by the deviation from “expected values”, which may also be difficult to quantify. Thus, when probabilities of different outcomes are unknown, uncertainty is transformed into risk, where probabilities of outcomes are weighted according to their likelihood of occurrence. Each potential outcome is weighted by its probability of occurrence (by past trends, subjective judgments, experimentation etc.), and the weighted outcomes are summed to arrive at a mean, or expected, value. Incomplete information complicates objective estimates of risk, so the subjective valuation of risk is biased, and usually overstated. Herein lies the problem for biological control. Most risk (and most fears) in biological control is measured by the assumption of potential damage to non-target species. However, there is an equal risk to non-target species from not using biological control to manage invasive pests. Also, it is difficult to isolate the exclusive impact of potential risk by biological control agents on non-target species, mainly because environmental factors other than natural enemies influence risk, and if omitted, bias (overestimate) estimates of risk. It is also difficult to compare across different types of risk. Clearly, in biological control, the risk to non-target species from a macrocyclic, autoecious rust fungus such as *Puccinia chondrillina* or *Uromyces heliotropii*, is far less than the potential risk from an oligophagous or polyphagous biological control agent. It is argued that the term “the risk from biological control” is meaningless and a risk analysis model is proposed for use with biological control of weeds.

(This presentation was a keynote address for Theme 3)

Host-specificity investigations of a gall midge for the biological control of alien invasive hawkweeds in North America

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Several hawkweed species of Eurasian origin have been deliberately or accidentally introduced into other parts of the world and some have become invasive weeds. Thus, in New Zealand, where there are no indigenous *Hieracium* spp., *Hieracium pilosella* is a severe weed in pastures, reserves and national parks. *H. caespitosum*, *H. glomeratum*, *H. praealtum* and *H. aurantiacum* are weeds in rangelands, national parks and clear-cut areas in North America. One of several insect species studied for the biological control of hawkweeds in New Zealand is the multivoltine gall midge *Macrolabis pilosellae*. Gall midge attack leads to shorter stolons and reduced numbers of leaves and flower heads. Host-specificity investigations carried out for New Zealand showed that the gall midge is at least genus-specific, developing on *H. pilosella*, *H. caespitosum* and *H. praealtum*. Therefore, *M. pilosellae* was selected as a potential biological control agent of alien invasive hawkweeds in North America. In