The prospects for biological control of *Rubus niveus* in the Galapagos Islands

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The Problem

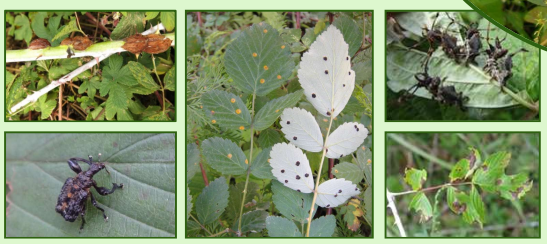
- *R. niveus* is native to Indochina and was introduced around the world for its sweet fruit; it was first introduced into the Galapagos in the in1970s and is now present on the five main islands (Santa Cruz, San Cristóbal, Isabela, Floreana and Santiago)
- *R. niveus* is a weed of both agricultural and natural systems - it can form impenetrable spiny thickets which can outcompete native vegetation, alter the habitat of native fauna and decrease biodiversity. The endemic *Scalesia pedunculata* forest on Santa Cruz Island is currently threatened by *R. niveus*
- Successful eradication of goats from the islands has led to an increase in the distribution of *R. niveus.* As a result, *R. niveus* has been declared one of the worst invasive weeds in the Galapagos archipelago. It is also declared a noxious weed in the state of Hawaii, USA
- *R. niveus* is currently being controlled using chemicals which is expensive, labour intensive and often impractical. It is an ideal target for a biological control programme

Objectives

1. Undertake a molecular study to determine the centre of origin of *R. niveus* in the Galapagos
2. Conduct field surveys in the native range to identify natural enemies and determine which have potential as CBC agents for *R. niveus*

2. Natural Enemy Surveys

- Field surveys were used to compliment existing literature on natural enemies of *R. niveus*; surveys have been conducted in three distinct regions of China and India



Natural enemies identified on *R. niveus*

- Surveys revealed a suite of natural enemies, from both countries. Those with the most potential as a CBC agent include the following:
  1. **Insects** - an unidentified leaf-rolling weevil and sawfly from China
  2. **Fungi** - two rust species (*Phragmidium* spp. and *Hamaspora* spp.) and a Cercosporoid fungus (tentatively identified as *Mycosphaerella confusa*). Rust fungi have successfully controlled *R. constrictus* and *R. fruitcosus* in Chile and Australia respectively and therefore have great potential

Biological Control

Classical biological control (CBC) uses co-evolved, highly specific natural enemies (arthropods, pathogens) from a plant species' native range for control in its Introduced invasive range. CBC aims to reduce the plant's vigour and, thereby, its competitiveness and invasiveness to provide self-sustaining control.

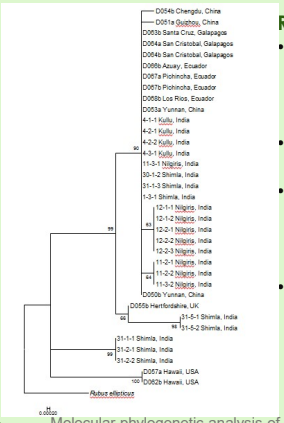
1. Molecular Analysis

- Literature suggests that *R. niveus* was introduced into the Galapagos from India (via Kenya, South Africa and Florida) through the horticultural trade and as an ornamental
- As natural enemies can be highly host specific it is critical to confirm the centre of origin of *R. niveus* in order to find a suitable CBC agent

Collection of leaf material for molecular analysis

Method

- Young leaves of *R. niveus* were collected and stored in zip lock bags with silica gel for molecular analysis
- Samples from the Galapagos islands and Ecuador are to be compared with those from India and China to determine the centre of origin. Plants from Hawaii and the UK are also included in the study
- 2 primer pairs (*rbc*L and *trn*L) selected for analysis



Molecular phylogenetic analysis of Rubus samples based on combined *trn*L-*trn*F and *rbc*L sequence data

Results

- Molecular work is currently ongoing to complete the work for both primer pairs and may require additional primers
- Molecular work for Indian samples completed in country
- Initial results do not yet give a clear indication of where *R. niveus* in the Galapagos and Ecuador originated from (either China or India)
- Hawaiian population of *R. niveus* has been introduced from a different location to those in the Galapagos

Conclusion

- *R. niveus* is an ideal candidate for CBC in the Galapagos as there are no endemic species of *Rubus* or species of Rosaceae. There are however 19 native *Rubus* species present in Ecuador, including *R. glaucus,* a species with economical importance. Once an agent is selected these species would be tested as part of host rang testing to ensure they are not attacked
- Surveys in China and India have identified a number of agents with potential for classical biological control of *R. niveus.* Results of the molecular study will determine which of these agents to prioritise for further assessment

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