The potential for biological control of the two invasive *Rubus species*, *R. ellipticus* var. *obcordartus* and *R. niveus* in Hawaii (Phase 2)

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Cover photo: *Rubus ellipticus* infected with the *Pseudocercospora/Pseudocercosporella* leafspot pathogen in its native Indian range.

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1. Executive Summary

The research conducted during the second phase of the project assessing the potential for biological control of the Hawaiian-invasive species *Rubus ellipticus* and *Rubus niveus* built on the first project phase which was undertaken as a scoping study in 2012. During this first phase survey sites were identified in the Shimla district and the Kullu valley/India and a range of damaging arthropods and fungal pathogens associated with the target weeds were collected and deposited. The second project phase reported on here also benefitted from a scoping study conducted in parallel for the Galapagos Islands (funded by the Ecuadorian Government) to investigate potential biological control agents of *Rubus niveus* in its native range for control of this species which is invasive in the Galapagos Islands.

During the second project phase altogether three field surveys were conducted in the Asian native range of the two *Rubus* species; two surveys in India covered previously visited as well as new sites in the Shimla district and the Kullu valley, and additionally new sites in the Nilgiri Hills in southern India; one survey in China covered sites in the provinces Yunnan, Guizhou and Sichuan. Voucher specimens were deposited with the respective nationally mandated institutes/organizations. Identification of arthropod species collected in India was undertaken by Indian taxonomists, while identification of fungal specimens was based on field observations and preliminary laboratory studies undertaken at NBAIR. Arthropod and fungal specimens collected in China were preliminarily assessed using the CABI facilities in Beijing.

Based on identifications, literature searches and field observations selected natural enemies have been prioritized for further evaluation as potential biocontrol agents. From India these comprise seven arthropod species including a leaf rolling moth [*Acleris enitescens*] and beetles species in the genera *Aphthona, Apoderus, Oomorphoides*, *Sibinia* and *Coraebus*) as well as three fungal pathogens including two *Phragmidium* spp. and a *Pseudocercospora* sp / *Pseudocercosporella* sp. leafspot. From China these encompass with respect to the arthropods the beetle *Coraebus* cf *quadriundulatus,* a currently unidentified leaf-rolling beetle (Attelabidae), an unidentified sawfly (Tenthredinoidea) and an unidentified tortricid moth as well as a rust pathogen, *Phragmidium* sp. and a *Pseudocercospora* sp /

Pseudocercosporella sp. leafspot. Timely export permission for prioritized agents could not be secured from the respective Indian authorities due to internal organizational politics, thus it was not possible to undertake preliminary host specificity assessments of prioritized agents within the frame of this project phase. Official permission for export of the insects *Aphthona piceipes*, *Oomorphoides* sp. *Sibinia* sp. and *Coraebus coerulens* from India was granted by the respective authorities on April 25th 2016 thereby enabling future export and evaluation. Export of potential agents from China was not within the remit of this project phase, however, in the future export procedures can be facilitated through the CABI China office in Beijing. Inoculation studies with a *Phragmidium* rust, prioritized as a result of the field work conducted in China, was undertaken at the CABI China laboratory and showed the genotype of *R. ellipticus* invasive in Hawaii to be susceptible to the pathogen. These studies furthermore provided initial evidence for the existence of *formae speciales* (host-adapted strains) within this *Phragmidium* rust.

Initial molecular studies carried out as part of the scoping study conducted for Galapagos to elucidate the geographic origin of their invasive *R. niveus* genotype also including Hawaiian samples of this plant species. While neither conclusive nor comprehensive preliminary findings from these studies indicate that India rather than China might be the source of the *R. niveus* introduction into Hawaii. Comparable work to elucidate the origin of the *R. ellipticus* introduction into Hawaii has not yet been undertaken.