3.4 Parasitoid Host Ranges: Comparing Studies From the Laboratory and Field

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Laboratory assays are used to assess the host specificity of parasitoids being considered for use as importation biological control agents. The extent to which results from these assays predict the host specificity expressed in the field is an important question in biological control risk assessment. A common observation from the literatures on arthropod weed biological control agents and on entomopathogens of insects is that field host ranges are narrower than laboratory host ranges, but relatively few studies have investigated this for parasitoids (Heimpel and Mills, 2017). Here we briefly review studies comparing field and laboratory host ranges in parasitoids and then report on results from two empirical studies – one involving an aphid parasitoid that invaded North America where it is providing some control of the soybean aphid, *Aphis glycines* Matsumura (Hemiptera: Aphididae), and another involving a potential biological control of a bird-parasitic nest fly that has invaded the Galapagos Islands where it is attacking Darwin's finches.

Review of the Literature: A few studies have compared laboratory and field host ranges for parasitoids used in biological control. In some of these there was evidence that these two measures of host range were quite similar (e.g., Haye *et al.*, 2005, 2015; Toepfer *et al.*, 2008; Yang *et al.*, 2008). In other cases, however, the host range found in the field was narrower than that expressed in the laboratory (Morehead and Feener, 2000; van Driesche *et al.*, 2003). In the study done by Morehead and Feener (2000), parasitoid egg injections showed that the ant parasitoid *Apocephalus paraponerae* Borgmeier (Diptera: Phoridae) could develop in nine ant species but only used one of these in the field. This suggests that suitable hosts are not always used in the field even if they are available. We know of a single case suggesting a broader field than laboratory/physiological host range, but this was due to methodological problems in which individuals of a suitable host were offered in a non-suitable condition of diapause in laboratory trials (Barratt, 2004).

 Proceedings of the 5th International Symposium on Biological Control of Arthropods (eds. P.G. Mason, D.R. Gillespie and C. Vincent)

Laboratory and field host specificity in the aphid parasitoid *Aphelinus certus*: *Aphelinus certus* Yasnosh (Hymenoptera: Aphelinidae) is a parasitoid that is native to Asia but that has invaded North America on its own during or before 2015 and is now found in North American soybean fields attacking the soybean aphid (Heimpel *et al.*, 2010; Frewin *et al.*, 2010). Laboratory studies have shown that *A. certus* has a relatively broad host range, attacking and developing well in most offered species in the aphid subfamily Aphidinae (Kaser, 2016; Hopper *et al.*, 2017). Field surveys have shown that this parasitoid can indeed attack aphids other than the soybean aphid in the field, including the grain aphids *Rhopalosiphum padi* (L.) and the English grain aphid, *Sitobion avenae* (Fabricius), both of which were attacked in lab assays. In addition it was reared from the North American native aphid species *Aphis monardae* Oestlund. However, parasitism that *A. certus* displays on soybean aphids in the field in North America suggest patterns typically associated with a specialist in the sense that *A. certus* populations are tightly linked to that of soybean aphid and show strong density dependence at the per-field level (Kaser, 2016). Sampling studies suggest that *A. certus* is capable of attacking non-target hosts in the field but that its dynamics are mainly tied to soybean aphid while this aphid is dominant in North American landscapes (Kaser, 2016).

Laboratory and field host specificity in *Conura annulifera*, a parasitoid of *Philornis* flies: *Conura annulifera* (Walker) (Hymenoptera: Chalcididae) is a parasitoid known in the literature from puparia of bird-parasitic flies in the genus *Philornis* (Diptera: Muscidae). This parasitoid is native to mainland South America and is being considered as an importation biological control agent of the invasive *P. downsi* Dodge and Aitken in the Galapagos Islands (Boulton and Heimpel, 2017). Laboratory studies comparing *C. annulifera* parasitism on *P. downsi* and other fly, lepidopteran and hymenopteran species indicated that it attacked only *P. downsi* (Bulgarella *et al.*, 2017). This result was corroborated by in-field choice studies conducted in mainland Ecuador, the native range of *C. annulifera*. In these studies *C. annulifera* parasitism was compared in artificial bird nest boxes containing *P. downsi* and in experimental containers containing non-target hosts in the families Sarcophagidae and Calliphoridae. *C. annulifera* was reared only from *P. downsi* in bird nests.

Conclusions: We conclude that the results of laboratory studies of parasitoid host range tend to be upheld in field studies. Ecological filters can reduce specificity in the field to some extent but suitable hosts that coincide with parasitoids in time and space will likely be attacked in the field. Our work with *Aphelinus certus* suggests also that pest organisms that dominate the host spectrum will be attacked at a higher rate than targets and that during this time the parasitoids may exhibit population-level patterns often attributed to specialists like density-dependent responses to target host populations.

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