

Poster 31: *Vespula* Biocontrol in New Zealand Revisited

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Social wasps are a pest in many temperate regions of the world, and much research effort has been invested in developing control strategies (Beggs *et al.*, 2011). In New Zealand, where there are no indigenous social wasps, introduced *Vespula* species have become invasive.

The German wasp, *Vespula germanica* (Fabricius) (Hymenoptera: Vespidae), native to Europe and northern Africa, was first to arrive in New Zealand. Its arrival is dated to 1944, when queens hibernating in a shipment of aircraft parts made it from Europe at the end of World War II (Thomas, 1960). Despite efforts to eradicate nests, *V. germanica* quickly spread through most of the North Island and parts of the upper South Island. Arrival of the common wasp, *Vespula vulgaris* (L.) (Hymenoptera: Vespidae), which is native to Europe and parts of Asia, is less clear. It may have arrived several times since the early 20th century, but it only became abundant in the 1970s (Donovan, 1984). It spread rapidly and displaced the German wasp, especially in the upper South Island beech forest habitat (Harris, 1991).

Both species are now widespread throughout New Zealand, and in some habitats can be the most common insect encountered (Beggs, 2001; Gardner-Gee and Beggs, 2013). Nest densities can reach 34 nests per hectare (Moller *et al.*, 1990), with inter-annual population dynamics highly responsive to wasp density and to spring weather conditions, similar to the dynamics in the native range (Lester *et al.*, 2017). Wasp biomass in New Zealand is estimated to supersede that of birds and introduced rodents and mustelids combined (Thomas *et al.*, 1990).

Wasps have a detrimental impact on both native ecosystems (Beggs, 2001) and human health (Dymock *et al.*, 1994; Low and Stables, 2006), and they cause economic losses to primary industries (MacIntyre and Hellstrom, 2015). They become particularly abundant in habitats where copious quantities of honey dew are produced by indigenous scale insects (Coelostomidiidae) (Gardner-Gee and Beggs, 2013), and more recently by the exotic giant willow aphid, *Tuberolachnus salignus* Gmelin (Hemiptera: Aphididae), which invaded New Zealand in late 2013.

Control methods applied to date include nest destruction, trapping, baiting, and biological control. A biological control programme against *Vespula* wasps in New Zealand began in the late 1970s (Donovan, 1992). Over 200,000 cocoons of parasitoids of the genus *Sphecophaga* were released between 1985 and 1996 (Beggs *et al.*, 1996; Donovan *et al.*, 1989), but it was evident that they were having difficulty becoming established, and their impact on *Vespula* population dynamics was negligible (Beggs *et al.*, 2008).

Despite further agents being lined up as potential future candidates, the biocontrol programme was discontinued prematurely following the release of *Sphecophaga* spp.

A discovery of a mite in wasp nests in New Zealand in 2011 sparked new interest in reviving the biocontrol programme. The mite, which was new to science at the time of discovery and has recently been described (Fan *et al.*, 2016), was associated with rapid collapse of wasp nests it was found in (B. Brown, personal observation). Further investigation revealed that the mite is not a direct parasite of wasps, but the feeding mode of the mite is disruptive to wasps (B. Brown, personal observation). It is suspected that the mite's feeding is insufficient to cause nests to collapse and there is another mechanism at play. Investigation of pathogens associated with the mites is currently underway.

In 2016 permission was granted to re-introduce new genetic stock of *Sphecophaga*. The rationale in revisiting *Sphecophaga* was that insects collected for the original introductions came from a geographic range that poorly matched the geographic origin of *Vespula* in New Zealand, and that better-matched parasitoids may have a better capacity to evade nest hygiene and have an impact on *Vespula* populations. Recent DNA analysis has determined that the origin of New Zealand's common wasp is in all likelihood south-western UK (Lester *et al.*, 2014). A 2016 trip to the south-western UK resulted in the collection of new *Sphecophaga* and, having passed through one generation in containment in New Zealand, this new genetic stock is expected to be released into the wild by late 2017.

We are now entering a new stage in the revived classical biocontrol programme. Three candidate agents are lined up for investigation. Two parasitic flies, the hoverfly *Volucella inanis* (L.) (Diptera: Syrphidae) and the thick-headed fly *Leopoldius* sp. (Diptera: Conopidae), are likely to be joined by the wasp nest beetle, *Metoecus paradoxus* (L.) (Coleoptera: Ripiphoridae). The beetle was listed as a potential candidate in the 1980s programme, but the two flies have not been identified as candidate agents until now.

These three agents target different life stages of wasps and we anticipate their impacts to be complementary: *Volucella* is an ectoparasite of wasp larvae, *Leopoldius* parasitizes adult wasps, and *Metoecus* is an internal parasite of young wasp larvae, and becomes an ectoparasite of later-instar wasp larvae and wasp pupae (Heitmans and Peeters, 1996). *Volucella* and *Metoecus* have already been detected at potential collection sites in the UK, which we intend to visit in August/September 2017. *Volucella* was found in high abundance in the 2016 trips to collect *Sphecophaga* from the UK. A fair bit is known about its biology, and it is therefore prioritised as top of the candidate list. *Metoecus* has a complex life cycle (Heitmans and Peeters, 1996), which could make it quite difficult to perform tests on in containment, and therefore currently it sits at the bottom of the priority list.

Some of these candidate agents can attack other vespids, which is considered an advantage: the entire family Vespulidae is absent from New Zealand's indigenous fauna, and any potential future invaders could thus be targeted by these oligophagous agents.

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