MELITTOBIA SPP. AS PARASITOIDS OF BUMBLE AND LUCERNE LEAFCUTTING BEES AND THEIR CONTROL IN NEW ZEALAND

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SUMMARY

Two species of *Melittobia* can attack nests of bumble bees, *Bombus* spp., and lucerne leafcutting bees, *Megachile rotundata* (F.), and cause economic losses in bee stocks and pollination. *Melittobia* females are active from late spring until late autumn and the species are multivoltine. Early stages of *Melittobia* attack are insidious, and a high reproductive potential means that almost total destruction of bee nests can occur within a few weeks of attack. Simple and cost effective control techniques that virtually eliminate *Melittobia* from bee nests are described. Eradication is impossible, because Mason wasp, *Pison* spp., native *Hylaeus* spp. of bees and other hosts act as feral reservoirs of *Melittobia*.

INTRODUCTION

Three species of *Melittobia* occur in New Zealand, *M. hawaiiensis* Perkins, *M.acasta* (Walker) and *M. australica* Girault (Macfarlane and Palma 1987). Collectively, these species occur throughout most of the world (Dahms 1984a). Adult *Melittobia* spp. are 1.0-1.6 mm long and the females in particular can be very similar (Dahms 1984a), so even now species recognition can often be difficult.

Melittobia primarily parasitise final instar larvae, prepupae and the younger pupae of many species of nest building bees and wasps (Donovan 1980; Dahms 1984b). In New Zealand, known feral hosts include native *Hylaeus* bees (Donovan 1980), the mason wasps, *Pison spinolae* Shuckard (Cumber 1953) and *P. morosum* Smith, and possibly the German wasp *Vespula germanica* (F.) (Macfarlane and Palma 1987).

Melittobia prepupae overwinter within the host cell. Adults emerge in spring/early summer and mating occurs in or near the host cells (Dahms 1984b). Females attack nearby cells in the same nest, or fly to more distant hosts. Females chew a hole into host cells, where they sustain themselves on the host's body fluids laying eggs for up to 36 days. These activities of *Melittobia* females often kill the host as does feeding of even a few *Melittobia* larvae. Unmated females lay about a dozen eggs, all of which produce males. Mated females can produce more than 100 offspring, of which 87-99% are female (Dahms 1984b). Often several females attack the same host, and up to 1,000 progeny may develop on the largest hosts. During summer, development from egg to egg takes 2 to 3 weeks and several generations are produced per season.

The capacity of *Melittobia* to destroy the nests of two kinds of valuable pollinators: bumble bees, *Bombus* spp., and the lucerne leafcutting bee, *Megachile rotundata* (F.), is examined in this paper. As well, the methods for the control of *Melittobia* are outlined. The significance of some alternative hosts as parasitoid reservoirs is assessed.

Bumble bee colonies are founded by queens in spring/early summer, reach peak bee numbers by early/late summer, and are abandoned by late summer/autumn (Donovan and Macfarlane 1984). Lucerne leafcutting bees managed for pollination of lucerne are incubated in December, released on the crop in January, and hives are removed from the field in late March/early April (Donovan and Macfarlane 1984). Feral leafcutting bee adults are active from October to April.

METHODS

Survey of *Melittobia* occurrence

From 1970 until 1989 colonies of feral bumble bees and *Vespula* wasps were collected from bumble bees hives or natural sites (Macfarlane *et al* 1984), and the nests

of leafcutting bees and mason wasps were gathered from leafcutting bee hives to study their biology. Separate trap nests for *Hylaeus* were set out, and mason wasps also used these nest holes. Study sites for all species were mostly in Marlborough or Canterbury with one in Westland for *Hylaeus*.

Bumble bee colonies were monitored for *Melittobia* at least twice a season and as frequently as once every 2 or 3 weeks. During this study over 2,000 bumble bee colonies settled in field hives or were transferred to hives from natural sites or from laboratory rearing. The brood of active bumble bee colonies in hives was temporarily uncovered to allow for inspection for *Melittobia*.

From the first release of introduced leafcutting bees in New Zealand in 1971, the surfaces of nest boards, nest straws and hives have been examined for *Melittobia* females. During the mid-late nest building period in February/March, laminated grooved nest boards were parted to check nests for *Melittobia* entry/exit holes in the cells. Several hundred reproductively isolated populations of 10,000-500,000 leafcutting bees were examined, and a sample of at least 10 g (100-120 cells)/hive was normally inspected.

At the end of the season unopened cells of all hosts were cut into to allow an inspection of their contents.

Control measures

To minimise the spread of *Melittobia acasta* the complete brood of parasitised bumble bee colonies was promptly removed from the hive and deep frozen. The hive was then sprayed with a household can containing pyrethroid insecticide to kill any remaining female *M. acasta*. Bumble bee adults were transferred to a clean hive.

In late summer/autumn, when the leafcutting bees were mostly over-wintering prepupae, cells infected with *Melittobia* at various developmental stages were cool stored at 2-3 °C to decrease or halt *Melittobia* activity. Thereafter, these cells were examined periodically for the response of *Melittobia*.

RESULTS

In bumble bees and leafcutting bees we observed that most female *Melittobia* remained within the host cells or amongst gaps between the cells, so very few were visible on the outside surfaces. This made detection of low *Melittobia* populations difficult. As *Melittobia* emergence proceeded and the supply of suitable stages of the host diminished, then rapidly increasing numbers of females searched for hosts outside the host cells. Hence parasitism became progressively more obvious as the intensity of attack increased.

October was the earliest that *M. acasta* were found in bumble bee colonies but it was most commonly seen from mid January until the end of February. *M. acasta* population development lagged by about 3 weeks in managed populations of leafcutting bees. All stages of *Melittobia* were then observed in leafcutting bees until early May, if hives remained in the field until winter.

Bumble bees

Between 1978 and 1984, *M. acasta* was found in 17 *Bombus hortorum* (L.) colonies (13% parasitism) and five *B. ruderatus* (F.) colonies (3% parasitism), which started in hives on Banks Peninsula and near Taitapu. At Lincoln, the worst attack of field origin occurred along a gorse hedge, when 17% of 60 *B. hortorum* colonies were affected in January/February 1989.

At the end of December 1987, *B. hortorum* colonies became contaminated with *M. acasta* during laboratory rearing. By February 1988, 31% of 151 colonies were parasitised despite the removal of 40 colonies infested in the laboratory. By contrast, between 1970 and 1989 over 350 *B. hortorum* colonies started in field hives at three sites in Christchurch remained free of *M. acasta*.

If parasitism occurs during the early growth of a bumble bee colony then no new queens are produced. The later development of colones can be halted prematurely by *M. acasta,* which contributes to reduced production of new queens.

At Taitapu, Kaituna and Prices Valleys on Banks Peninsula reinfestation of bumble bee colonies with *Melittobia* occurred inconsistently from one season to the next

after infested brood was removed. There was no reinfestation at Lincoln or Conway Flats.

Leafcutting bees

Within 3 weeks of their first release in 1971, migrant leafcutting bees had nested in nail holes and drinking straws, inserted into other blind tunnels on a farm building, 150 m from the release site at Seddon, Marlborough. About 2 months later, on April 8, 2% of 157 leafcutting bee cells in these drinking straws were infested with all stages of *M. hawaiiensis*.

From 1972-1975, *Melittobia* occurred annually in almost all leafcutting bee populations and parasitism increased from 0.02% to 11.3%. By early 1975, *Melittobia* had killed 64% of 8,370 cells in two hives from Wairakei near Taupo.

In early 1981, many thousands of *Melittobia* emerged from 185,000 nests in hives from a farm near Seddon. These nests had been held at ambient temperatures for several years previously. Their owner applied Ortho fly killer D-8 (= Naled) between packets of drinking straws and drilled boards. Within a few days dead *Melittobia* were piled up to 10 mm thick on projecting timbers, and an estimated 70% of the bee prepupae were parasitised. The leafcutting bee adults were not killed. Similarly in the Wairau Valley a population of about a million cells, which had also not been cool stored, was almost eliminated by *M. acasta* between 1984 and 1987. These bees were worth at least $50,000. Other growers in Marlborough have also experienced important losses.

The first demonstration of the effectiveness of cool storage was seen on 30 June 1973, when all *Melittobia* were found dead in cells of leafcutting bees which had been stored at 3-4 °C since May 6. Since then properly cool stored leafcutting bee cells have been free of live *Melittobia* when incubated in December.

Alternative hosts

In early March 1971, *M. hawaiiensis* was found infesting all 10 cocoons of the mason wasp *P. spinolae* collected on the same farm building as the first leafcutting bees in New Zealand. *Melittobia* was found in 12.5% of 8 *P. spinolae* cocoons at Conway Flats in January 1977. Nests of *P. morosum* from Te Pirita, Canterbury, and Kaituna Valley, Banks Peninsula contained *Melittobia* in their cocoons.

Prepupae of *Hylaeus* spp. and *H. relegatus* (Smith) from Whataroa, Westland, and Canterbury have been attacked by *Melittobia* spp., but usually less than 10% were parasitised.

In 1988, *M. acasta* was found in an abandoned *V. germanica* nest collected near Lincoln, Canterbury (Donovan 1989), but otherwise no *Melittobia* have been taken from small wasp nests started in bumble bee hives or more than 1,000 successful feral colonies collected in New Zealand.

DISCUSSION AND CONCLUSIONS

Melittobia are the worst parasitoids of bumble bee colonies and leafcutting bees in New Zealand. Major losses in valuable stocks of these bees can easily happen unless an effort is made to maintain bee stocks free of this pest.

With bumble bees *Melittobia* control requires prompt removal of parasitised colonies, because the emergence of tens of thousands of female *M. acasta* from a large colony will begin to contaminate adjacent colonies. It is prudent not to collect bumble bee colonies from locations where *M. acasta* are found in most years. Control in bumble bees is uncomplicated except for the problem of early detection of parasitism.

Melittobia can annihilate the pollinating forces of leafcutting bees within a few years, with consequent losses in returns from pollination fees and/or seed returns, and sale of surplus bee cells (Donovan and Read 1984). The differing life cycles of *Melittobia* and leafcutting bees allow for a simple and cost effective method for the control of this pest. In early May when the first frosts begin all stages of *Melittobia* can be found in cells of leafcutting bees in the field. The presence of live *Melittobia* prepupae only by mid winter suggests that other stages cannot survive more prolonged cold periods. In contrast leafcutting bee nesting normally ceases by late March, and the bulk of progeny become winter surviving prepupae. The control recommendation is to

store nests at 2-3 °C from late March-early April. At this time of year, at this temperature, all *Melittobia* die. Control in leafcutting bees is thus easy and relatively inexpensive.

Elimination of *Melittobia* from managed leafcutting and bumble bees cannot be achieved because of invasions from alternative hosts. Mason wasps and twig nesting native bees are apparently amongst the more important reservoirs of *Melittobia* and nesting sites near hedges or buildings seem more likely to be affected by *Melittobia.* Recently Macfarlane and Palma (1987) drew attention to *Melittobia* as enemies of vespid wasps, but in New Zealand and overseas there is no unequivocal evidence of *Melittobia* attacking brood in active colonies.

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