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The introduced English wasp *Vespula vulgaris* (L.) (Hymenoptera: Vespidae) newly recorded invading native forests in Tasmania

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Abstract The social wasp *Vespula vulgaris* (L.), an introduced species that has caused extreme ecological damage in New Zealand, is reported from southern Tasmanian forests for the first time. In mainland Australia, this wasp has been present in the Melbourne area since 1958 and our retrospective analysis places it in Hobart since 1995. In the present paper, we document *V. vulgaris* in natural areas in southern Tasmania, well away from human habitation. Malaise trap samples collected since 1997 from nine sites at the Warra Long-term Ecological Research area in southern Tasmania revealed the widespread presence of both *V. vulgaris* and *V. germanica* (F.), another introduced species of concern. Analysis of microsatellite DNA markers showed no evidence of hybridisation between the two species. The potential impact of this newest social insect threat to Australian native biota is discussed.

Key words common wasp, English wasp, European wasp, invasive species, social insects, *Vespula germanica*, *Vespula vulgaris*, World Heritage Area.

INTRODUCTION

Social insects are among the most successful invaders of new habitats worldwide (Moller 1996). In particular, introduced social Hymenoptera sometimes become major urban and agricultural pests (New 1994) and can become permanent additions to invaded natural communities, modifying them in myriad but as yet often poorly understood ways.

Vespula wasps are notorious as invaders around the world. The European or German wasp, *Vespula germanica* (F.), has been introduced into North America, Chile, South Africa and New Zealand (Moller 1996). Likewise, the range of the English or common wasp *Vespula vulgaris* (L.) has expanded considerably over its native Holarctic distribution. In New Zealand it was recorded as early as 1921 and sporadically thereafter (Thomson 1923; Donovan 1984). First recorded in Dunedin in 1983 and in Christchurch in 1984, *V. vulgaris* has now largely replaced *V. germanica* over much of the South Island, where it presents a major threat to insect and bird populations in native beech (*Nothofagus*) forests (Harris *et al*. 1991; Clapperton *et al*. 1994). In native New Zealand beech forests, average densities of *V. vulgaris* reach 12 nests per ha with as many as 31 nests per ha at some sites (Beggs 2000).

In Australia, *V. vulgaris* was established in Melbourne by 1961 (Anonymous 1962) and reported to be common in the surrounding area by 1990 (Crosland 1991). The first reports of *V. germanica* from mainland Australia were in 1977 (Spradbery & Maywald 1992). It has expanded its range considerably over the past several years, being primarily associated with human habitation in urban and semi-urban environments in south-eastern Australia (Gullan 1999). In the present paper, we report the establishment of *V. vulgaris* in native forests in Tasmania for the first time and discuss its potential as an environmental threat. We also provide an update on the status of this species in the Melbourne area.

Detection of *V. vulgaris* in native Tasmanian forests

In March 1999, 77 wasps, then identified as *V. germanica*, were obtained by us from nine Malaise traps placed at 200–500-m intervals at various altitudes (60–220 m a.s.l.) in the Warra Long-term Ecological Research site, southern Tasmania (43°04´S, 146°40´E), an area managed by Forestry Tasmania. This site covers 15 900 ha and has a mean annual precipitation of 1477 mm, rather evenly distributed through the year. The predominant vegetation is wet sclerophyll forest, with *Eucalyptus obliqua* as the dominant tree species.

Wasp samples were sent to R. W. Matthews for inclusion in a survey of the genetic diversity and relationships of *V. germanica* populations in Australia. When the specimens were genotyped at three microsatellite loci (see Goodisman *et al*. in press), it was immediately clear that the Malaise samples contained two different species. Probability tests implemented by the program GENEPOP 3.1c (Raymond & Rousset 1995) rejected the hypothesis of Hardy–Weinberg and genotypic disequilibrium for all loci ($P < 0.0001$), a result that is expected when samples are obtained from two

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genetically differentiated taxa. The genetic data also provided no evidence of hybridisation between the two species, with no shared alleles at any of the three loci. Subsequent morphological examination of the specimens confirmed the identities of 27 of the 77 Malaise-trapped individuals as *V. vulgaris*, corresponding exactly to the genetic findings.

As with so many other introduced species, *V. vulgaris* probably entered Tasmania via a seaport. Examination of the Forestry Tasmania Insect Collection located a single worker specimen of *V. vulgaris* from Hobart in February 1995. However, in the Tasmanian Department of Primary Industry Collection, all 95 *Vespula* specimens collected from 12 localities since 1959 are *V. germanica* (P. B. McQuillan, pers. comm., 2000). Thus, *V. vulgaris* may have been present in the Hobart region since at least 1995, but has gone undetected. This is not surprising, as *V. vulgaris* and *V. germanica* are phenotypically quite similar, varying mostly in the colour pattern of the frons and pronotum (Donovan 1984).

A similar situation also appears to have existed in Tasmanian native forests. Intensive collections of *Vespula* were made from various localities in the Pelion Plains/Mount Ossa World Heritage Area in 1990–1991. All were *V. germanica* [51 specimens deposited in the Australian National Insect Collection (ANIC), Canberra; I. D. Naumann, unpubl. data], although these data were not included in the published baseline studies of this World Heritage Area (Naumann 1998). However, retrospective analysis of all *Vespula* workers taken by continuous Malaise trap collections at the Warra site since November 1997 shows both *Vespula* species to have been present, with *V. vulgaris* increasing in numbers (Table 1). Occasional queens (1–16 per season) of both species have also been collected. Taken together, these data confirm that *V. vulgaris* has been present in natural habitats in southern Tasmania since at least 1997.

With the discovery of *V. vulgaris* in Tasmania, we attempted to confirm whether *V. vulgaris* still existed in the Melbourne area in the summer of 1999–2000. Our efforts revealed that *V. germanica* is now the dominant species in the Melbourne area. However, on 9 March 2000, several specimens of *V. vulgaris* were collected by Dr Ross Field at Olinda, in the Dandenong Ranges area (identity confirmed by K. L. Walker, pers. comm., 2000). Checks of three museum collections (i.e. ANIC, Museum Victoria, Agriculture Victoria) revealed only older specimens of *V. vulgaris*, all collected between 1958 and 1987 from various Melbourne suburbs.

Thus, while we can confirm that *V. vulgaris* continues to survive in some areas east of Melbourne, these urban populations appear to have undergone a dramatic decline in recent years. Gullan (1999) suggests that *V. vulgaris* prefers cooler areas than *V. germanica* and that rainfall patterns and other unknown biotic factors may limit the survival of *V. vulgaris*. In mainland Australia, *V. germanica* generally seems to thrive best in the conditions provided in suburban habitats with ample food and protected nest sites. However, in Tasmania both species currently coexist in relatively undisturbed habitats.

Table 1 Numbers of workers of *Vespula germanica* and *Vespula vulgaris* captured by Malaise traps at Warra Long-term Ecological Research site in southern Tasmania 1997–1999

Species	1997–1998	1998–1999	Total
Vespula germanica	29	251	280
Vespula vulgaris	30	199	229
Total	59	450	509

Potential impact of *V. vulgaris* on natural areas in Tasmania

Given that the climate of Tasmania is similar to that of the northern part of the South Island of New Zealand and that the wet sclerophyll forests dominated by *Eucalyptus obliqua* offer habitat reminiscent of the beech forests of New Zealand, it seems likely that *V. vulgaris* will flourish in Tasmania, with populations potentially becoming quite large. In New Zealand, Donovan (1984) found *V. vulgaris* nests to be up to sixfold larger and queen production to be 23-fold greater than for the same species in its native England. In New Zealand, honeydew sources derived from scale insects and lerps nourish wasp populations. These are relatively scarce in Tasmanian forests (R. Bashford, unpubl. data), but heavy flowering by various plants such as *Eucryphia*, *Bauera*, and *Banksia* may be expected to provide abundant alternative nectar sources.

It also seems likely that the additive effects of the arrival of a second species of social wasp in Tasmania will dramatically increase the potential for ecological damage, particularly in World Heritage Areas. Prior to the arrival of *V. vulgaris* in Tasmania, the impact of *V. germanica* in some parts of Tasmania was described as resulting in a 'severe local reduction of spiders and insects . . . with foraging wasps preying cannibalistically on each other' (Spradbery & Maywald 1992). In New Zealand, Harris (1991) showed that prey biomass captured by *V. germanica* and *V. vulgaris* in some areas was similar to that of the entire insectivorous bird fauna, with considerable dietary overlap.

Other impacts may be more subtle and unsuspected. Because they are polyphagous voracious feeders, social wasps can thrive in natural ecosystems by exploiting native biota, sometimes in quite unexpected ways. For example, *V. germanica* has been reported to eat the eyes of newly hatched parrots (Jackson 1996). In another example, *V. vulgaris* was recently implicated as important for seed dispersal of a native North American *Trillium*, thereby influencing the genetic and demographic structure of these plant populations (Jules 1996). Clearly, social wasps have the potential to severely impact on or even extirpate vulnerable prey species and to restructure entire communities (see also Fordham 1991; Beggs 2000).

Of related interest is that another social hymenopteran recently became established in Tasmania (Semmons *et al*. 1993). *Bombus terrestris* L., a primitive social bumblebee, has since spread over the length of the island, including parts of the Warra research site. They are potentially ideal pollinators for a number of so-called 'sleepers', which are introduced weed species currently present at low densities. Thus, bumblebees may increase weed problems (Hogendoorn 2000). Interestingly, bumblebees and *Vespula* species competitively interfere with each other in nectar foraging behaviour elsewhere (Thomson 1989).

The social, ecological and economic implications of invasive social insects are enormous. Now, more than ever before, introduced social insects should be of national concern for Australia. Spradbery and Maywald's (1992) prognosis that 'the European wasp is in Australia to stay' seems to be true but the invasion of Tasmania by *V. vulgaris* and *B. terrestris* emphasises the urgent need for a federally supported initiative aimed at better understanding the impact and control of these insects. From the perspective of a conservation biologist, Moller (1996) details the multiple opportunities offered by research on invasive social insects.

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