Yellowjacket Wasps (Hymenoptera: Vespidae) Trapped in Alaska with Heptyl Butyrate, Acetic Acid and Isobutanol

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ABSTRACT

Eight species of vespine wasps were captured in traps near Fairbanks, Delta Junction and Palmer, Alaska, during 2003 and 2004. These were *Vespula vulgaris* L., *V. acadica* (Sladen), *V. consobrina* (Saussure), *V. rufa* (L.)(=*intermedia* [Buysson]), *Dolichovespula maculata* (L.), *D. arenaria* (F.), *D. norwegica* (F.)(=*albida* [Sladen]), and *D. norvegicoides* (Sladen). Workers and males of *V. vulgaris* were captured primarily in traps baited with the combination of acetic acid and isobutanol. Workers of *V. acadica*, *V. consobrina*, and *V. rufa* were captured primarily in traps baited with heptyl butyrate. Queens and workers of *D. maculata* were captured primarily in traps baited with acetic acid, or acetic acid plus isobutanol. The small numbers of *D. arenaria*, *D. norvegicoides*, and *D. norwegica* captured did not permit treatment comparisons. Season-long trapping indicated a presence of *V. acadica, V. consobrina, and V. rufa* workers from late June through July, *D. maculata* from early July into early August, and *V. vulgaris* from late July to early September. The earliest wasps captured were queens of *V. vulgaris* and *D. maculata* in late May, while the latest wasp captured was a worker of *V. vulgaris* the first week of October, in Palmer.

Key Words: social wasps, Vespinae, *Vespula*, *Dolichovespula*, trapping, attractant

INTRODUCTION

There is little information available on the abundance, distribution, or seasonality of social wasps (Vespidae, Vespinae) in Alaska, despite their likely widespread and recurring pest status. Many species of yellowjackets, which belong to the genera *Vespula* and *Dolichovespula* (Greene and Caron 1980), are often stinging hazards to people, pets, and livestock. An early report from the Harriman Alaska Expedition (Kincaid 1900) listed only two species: *Dolichovespula norwegica* (F.) (as *Vespa marginata* Kirby) from Kukak Bay, and *D. arenaria* (F.) (as *Vespa borealis* Kirby) collected in Sitka. Distributions given for vespid wasps of North America by Miller (1961), Wagner (1978), Akre *et al.* (1980), Eck (1984), and Carpenter and Kojima (1997) indicate that *D. norwegica* (= *albida* Sladen), *D. adulterina* (Buysson) (= *arctica* Rohwer), *D. arenaria*, *D. norvegicoides* (Sladen), *D. alpicola* Wagner, *D. maculata* (L.), *Vespula vulgaris* (L.), *V. acadica (Sladen), V. austriaca* (Panzer), and *V. rufa* L. [= *intermedia* (Buysson)] are present in Alaska. The pest status of *V. vulgaris*, the common yellowjacket, in Alaska is indicated by Shippey (1994) (cited in Barnes *et al.* 1996).

Chemical attractants useful in trapping and monitoring yellowjacket wasps include heptyl butyrate (Davis *et al.* 1969), and acetic acid plus isobutanol (Landolt 1998). Heptyl butyrate is a strong attractant for *Vespula pensylvanica* (Saussure) (Davis *et al.* 1973), and also attracts significant numbers of *V. squamosa* (Drury) and some members of the *V. rufa* species group: *V. atropilosa* (Sladen), *V. acadica*, *V. consobrina* (Saussure), and *V. vidua* (Saussure) (Grothaus *et al.* 1973, MacDonald *et al.* 1973, Howell *et al.* 1974, Reed and Landolt

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2002, Landolt *et al.* 2003). Acetic acid plus isobutanol is attractive to some members of the *V. vulgaris* species group: *V. germanica* (F.), *V. pensylvanica*, *V. vulgaris*, and *V. maculifrons* (Buysson), as well as to *V. squamosa*, *Vespa crabro* L. and several species of *Polistes* (Landolt 1999; Landolt *et al.* 2001). Acetic acid or isobutanol alone are also weakly attractive to some species of social wasps (Landolt *et al.* 1999, Reed and Landolt 2002), and acetic acid was co-attractive with heptyl butyrate for trapping *V. pensylvanica* (Landolt 1998).

In this study, we sought to determine and compare the responses of species of social wasps in Alaska to heptyl butyrate, acetic acid, and isobutanol, particularly to test the hypothesis that yellowjackets in the genus *Dolichovespula* and the *V. vulgaris* species group are primarily attracted to acetic acid and isobutanol, while yellowjackets in the *V. rufa* species group are primarily attracted to heptyl butyrate. We also sought to confirm information on the species of social wasps that are present in Alaska and determine the seasonal pattern of abundance of species that are likely to be pestiferous. We report here the results of trapping tests that provide significant information on yellowjacket wasp responses to chemical lures, and on the seasonality of several species of Vespinae in Alaska.

MATERIALS AND METHODS

Dome or Trappitt® traps (Gempler's, Belleville, Wisconsin, USA) were used to capture attracted wasps. These traps are pear-shaped with clear plastic tops and opaque yellow bottoms within which is placed a drowning solution. Wasps enter the trap through the invaginated bottom of the trap. Attractants were dispensed from polypropylene vials with holes in the lid for chemical release. Each vial contained chemical attractant on cotton balls. Vial sizes, active ingredient load amounts, and hole diameters selected were based on results of previous studies of wasp responses, as well as chemical release rates from vials under laboratory conditions. At ambient laboratory temperature (22.5 °C), estimated rate of release of compounds from vials with 3 mm diam holes is 200 ug heptyl butyrate per hour (Landolt *et al.* 2003), 8.2 mg acetic acid per hour (Landolt and Alfaro 2001), and 10 mg isobutanol per hour (using gravimetric methods reported in Landolt and Alfaro 2001). Vials were suspended at the top of the inside of the trap. Traps also contained 200 to 300 ml of a drowning solution which was 0.125% unscented detergent and 2% boric acid in water. Traps were placed a minimum of 20 m apart, and were placed at a height of 1.0 to 1.5 m on vegetation or on fences. Traps were checked once per week, at which time the drowning solution was replaced, and lures were replaced every month, which would be before the attractant in the dispenser was depleted.

2003 Trapping Test. Five sets of traps were placed on the campus of the University of Alaska, Fairbanks North Star Borough, Alaska, during the second week of July, 2003. Trap treatments at each location were: 1) an unbaited trap as a control, and traps baited with 2) acetic acid, 3) isobutanol, 4) acetic acid plus isobutanol, 5) heptyl butyrate, and 6) acetic acid plus heptyl butyrate. Each chemical (10 ml load) was dispensed from its own 15 ml vial with a 3 mm diam hole. Trap sites were in the vicinity of forested tracts, agricultural land, and a horticultural garden.

2004 Trapping Test. Traps were set up in early May at three locations, as pairs of traps baited with two chemical attractants: heptyl butyrate and acetic acid plus isobutanol. Heptyl butyrate (10 ml load) was dispensed from a 15 ml vial with a 3 mm hole and acetic acid plus isobutanol was provided as a mixture of the two compounds (10 ml load) in a single 15 ml vial with a 6 mm diameter hole. Four pairs of traps were placed on the main campus of the University of Alaska, Fairbanks, five pairs of traps were placed at the University of Alaska field site at Delta Junction,

Southeast Fairbanks Borough, and four pairs of traps were placed at the University of Alaska field site at Palmer, Matanuska-Susitna Borough. Trap sites were near both forested and agricultural lands. Traps at Fairbanks and Palmer were maintained until the third week of September and traps at Delta Junction were maintained until the first week of October.

Insects captured in traps were placed in pre-labeled plastic locking freezer bags. A separate bag was used for each trap and for each day the trap was checked. These were stored in a freezer until bag contents were analyzed. Descriptions, illustrations, and keys in Miller (1961), Wagner (1978), Akre *et al.* (1980), and Eck (1984) were used to identify captured vespine wasps. Taxonomy used here follows that of Carpenter and Kojima (1997). Voucher specimens are deposited in the James Entomological Collection at Washington State University, Pullman, WA, and with the USDA, ARS Subarctic Agricultural Experiment Station in Fairbanks, AK.

For each species, means for wasps captured per trap per week in 2003 were compared between chemical attractant treatments using ANOVA and Tukey's test (DataMost 1995) to determine differences among means. Similar data for 2004 were compared using a paired *t*-test. For developing seasonality profiles for each species, numbers of wasps captured in each trap per week were averaged for the traps at each site. Unless stated otherwise, data analyses and results are for worker wasps.

RESULTS

The most abundantly trapped wasp in both years and at all three study locations was *V. vulgaris*. In 2003, 508 worker *V. vulgaris* were captured in traps. In 2004, 4 queens, 1825 workers, and 36 males of *V. vulgaris* were captured. In 2003, *V. vulgaris* workers were primarily in traps baited with the combination of acetic acid and isobutanol, with no or few wasps in unbaited traps and traps baited with acetic acid, isobutanol, heptyl butyrate, or acetic acid plus heptyl butyrate (Table 1). In 2004, *V. vulgaris* workers again were primarily in traps baited with acetic acid plus isobutanol, with nearly none in traps baited with heptyl butyrate (Table 2). The same pattern was seen for *V. vulgaris* males in traps (Table 2). The four *V. vulgaris* queens were captured in traps (in late May and early June) baited with acetic acid plus isobutanol. Workers were captured between mid June and early October, and males from late July into late September. Workers were most abundantly trapped from mid July into late August 2004 (Figure 1A).

In 2003, 9 worker *V. acadica* were captured in traps, primarily in traps baited with heptyl butyrate (Table 1). In 2004, the 42 worker and 4 queen *V. acadica* captured were all in traps baited with heptyl butyrate

Table 1.
Mean ± SE numbers of wasps captured per trap, for unbaited traps (CONTROL), and for traps baited with acetic acid (AA), isobutanol (IB), heptyl butyrate (HB), acetic acid plus isobutanol (AAIB), and acetic acid plus heptyl butyrate (AAHB). Fairbanks, Alaska, 2003.

Wasps (workers)[1]	CONTROL	AA	IB	AAIB	HB	AAHB
V. vulgaris	5.0 ± 1.8a	8.0 ± 4.3a	11.2 ± 5.6a	60.0 ± 32.9b	1.6 ± 1.4a	15.8 ± 10.0a
D. maculata	0.0 ± 0.0a	12.2 ± 7.1c	1.6 ± 0.7ab	7.6 ± 3.1bc	0.6 ± 0.6a	4.8 ± 2.3ab
V. acadica	0.0 ± 0.0a	0.0 ± 0.0a	0.0 ± 0.0a	0.0 ± 0.0a	1.6 ± 0.8b	0.2 ± 0.2a

[1] For each species, means followed by the same letter are not significantly different at $P \leq 0.05$ by Tukey's test. N = 5.

Table 2.
Mean ± SE numbers of wasps captured per trap, for traps baited with heptyl butyrate (HB) and for traps baited with acetic acid plus isobutanol (AAIB). Fairbanks, Delta Junction and Palmer, Alaska, 2004.

Wasps[1]	HB	AA/IB
V. vulgaris workers	0.46 ± 0.27a	140.18 ± 46.10b
V. vulgaris males	0.07 ± 0.07a	3.08 ± 0.87b
D. maculata workers	0.31 ± 0.17a	33.92 ± 15.17b
D. maculata queens	0.00 ± 0.00a	2.0 ± 0.72b
V. acadica workers	3.54 ± 0.91b	0.00 ± 0.00a
V. consobrina workers	1.38 ± 0.53b	0.00 ± 0.00a
V. rufa workers	1.54 ± 0.42b	0.00 ± 0.00a

[1] For each species, means followed by the same letter are not significantly different at P≤0.05 by a paired *t*-test. N = 13.

(Table 2). Three of the queens were captured in late June and one in mid September. Workers were captured from mid June to mid September 2004 (Figure 1B).

In 2003, only three *V. consobrina* and one *V. rufa* were captured; all were workers in traps baited with heptyl butyrate. In 2004, 17 *V. consobrina* and 20 *V. rufa* workers were captured, all in traps baited with heptyl butyrate (Table 2). *Vespula consobrina* workers were captured in traps from 7 July to 3 August in Delta Junction and from 12 June to 19 July in Fairbanks. Worker *V. rufa* were captured in traps from 29 June to 27 July in Delta Junction, from 12 June to 19 July in Fairbanks, and two were in traps on 5 August in Palmer.

In 2003, 134 worker *D. maculata* were captured. Numbers of bald-faced hornets in traps baited with acetic acid, and with acetic acid plus isobutanol, were significantly greater than in unbaited traps (Table 1). In 2004, 445 worker and 27 queen *D. maculata* were captured. Most were captured in traps baited with acetic acid plus isobutanol. In both years, very few were captured in traps baited with heptyl butyrate (Table 2). No male *D. maculata* were captured in these traps. Queens were captured from mid May to early June, and workers from late June into late August (Figure 1C).

In this study, too few *D. arenaria* (9) *D. norvegicoides* (2), or *D. norwegica* (2) wasps were captured for any statistical analysis, while no *D. alpicola*, *D. adulterina*, or *V. austriaca* wasps were captured.

DISCUSSION

The species captured in traps during this study in the vicinities of Fairbanks, Delta Junction, and Palmer, Alaska, vary somewhat from those species reported by Miller (1961), Akre *et al.* (1980), Eck (1984) and Carpenter and Kojima (1997). *Vespula consobrina* were captured in traps at two of the three sites (Fairbanks and Delta Junction), despite its indicated absence from most of Alaska by both Miller (1961) and Akre *et al.* (1980). The nearest collection locations in those references are in the southernmost Alaska panhandle, northern British Columbia, and southeastern Yukon. The absence of *D. adulterina*, *D. alpicola*, and *V. austriaca* in traps could have been the result of their absence in the areas trapped, or a lack of response to the lures.

The seasonal patterns of wasp captures in traps indicate a broad period during which they could be pestiferous; from early July to early September. Of most interest as a pest is the common wasp *V. vulgaris*, because of its abundance and its scavenging

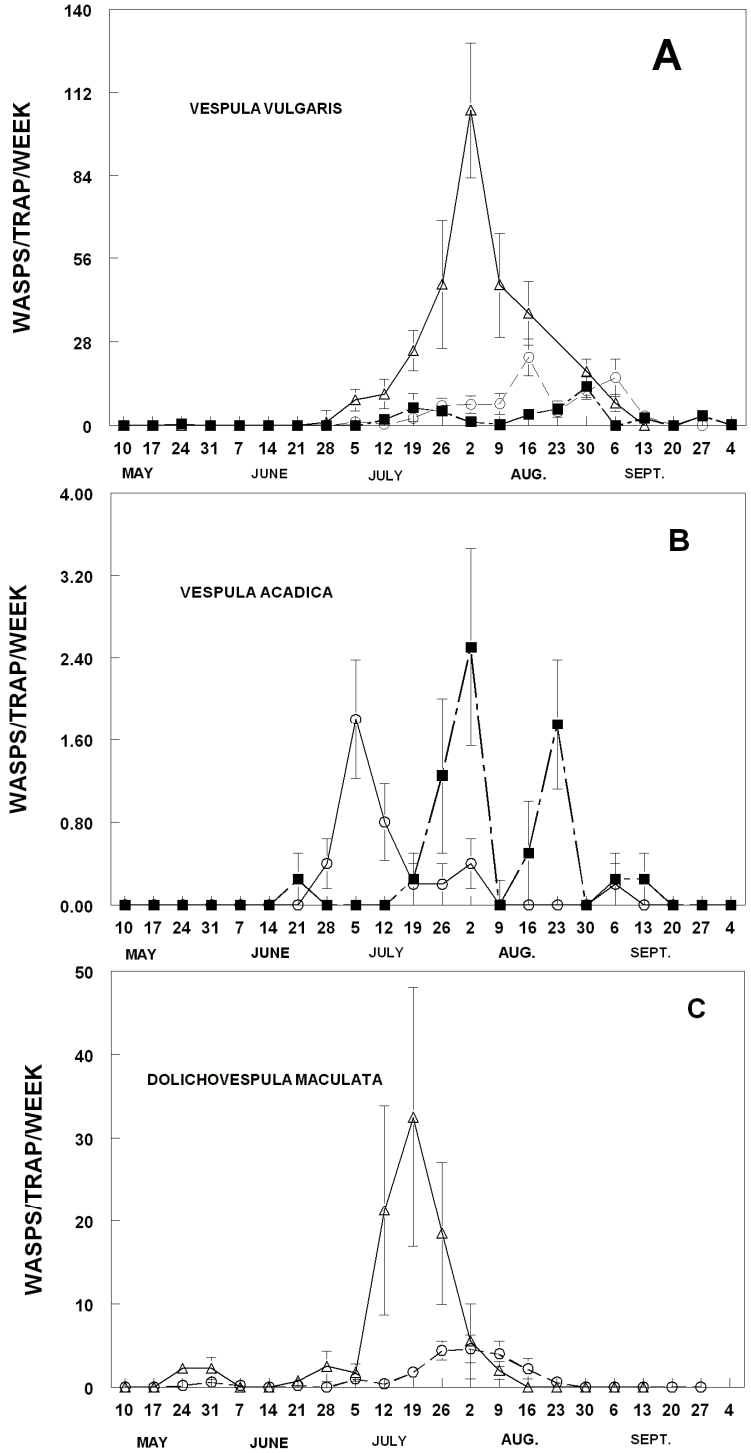

Figure 1. Mean ± SE numbers of female *V. vulgaris* (A), *V. acadica* (B) and *D . maculata* (C) in traps baited with acetic acid and isobutanol, through the 2004 field season. Lines do not imply dependence of data. Sites are Fairbanks (open triangles), Delta Junction (filled squares), and Palmer (open circles).

behavior which bring it into frequent contact with people (Akre *et al.* 1980). The bald-faced hornet, *D. maculata,* may also be pestiferous in Alaska due to its abundance during July and August. Other species of wasps captured, such as *V. acadica,* and *V. consobrina*, are less likely to be pestiferous because they are not known for scavenging habits, occur in smaller colonies, and do not occur in high densities, compared to species such as *V. vulgaris* (Akre *et al.* 1980).

The patterns of responses of wasps in Alaska to different chemical attractants are consistent with results from trapping studies in other areas of North America. The three members of the *V. rufa* species group (*V. acadica*, *V. consobrina*, and *V. rufa*) were attracted to heptyl butyrate, and were not captured in significant numbers in traps baited with acetic acid plus isobutanol. This pattern was seen in Washington State, where *V. atropilosa*, a *V. rufa* species group member, was attracted to heptyl butyrate and not to acetic acid plus isobutanol (Landolt 1998), and in Michigan, where *V. consobrina* and *V. vidua*, both *V. rufa* species group members, exhibited the same response pattern (Reed and Landolt 2002). In the present study, the only member of the *V. vulgaris* species group present was *V. vulgaris.* Unlike species in the *V. rufa* group, it was attracted to acetic acid plus isobutanol and not to heptyl butyrate. This pattern matches results of earlier studies (Landolt 1998, Landolt *et al.* 1999, Reed and Landolt 2002), where *V. flavopilosa* Jacobson, *V. germanica*, *V. maculifrons*, and *V. vulgaris,* all *V. vulgaris* species group members, were trapped with acetic acid plus isobutanol and not with heptyl butyrate. *Vespula pensylvanica* (another *V. vulgaris* group member), however, is clearly attracted to both lures (Landolt 1998). The response by *D. maculata* to acetic acid plus isobutanol and lack of a response to heptyl butyrate is consistent with earlier studies. In Maryland and in western Washington (Landolt *et al.* 2001), as well as in Michigan (Reed and Landolt 2003), *D. maculata* workers were trapped with acetic acid, but more so to acetic acid plus isobutanol. In this study, numbers of workers of *D. maculata* captured in traps baited with acetic acid plus isobutanol were not significantly higher than with acetic acid alone. The small numbers of workers of *D. arenaria*, *D norvegicoides*, and *D. norwegica* trapped here are not suitable for statistical analyses, and indicate either a very weak response to the lures, or very low population densities.

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