

Social wasps trapped in the Czech Republic with syrup and fermented fruit and comparison with similar studies (Hymenoptera Vespidae)

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Abstract

Eight species of social wasps were trapped in the Czech Republic and Slovakia with syrup as bait. *Vespa crabro* L., *Vespula germanica* (F.), and *Vespula vulgaris* (L.) dominated trap catches at most sites, comprising 32, 28, and 35% of the wasps trapped respectively. Nearly all wasps captured were females of the worker caste. Greatest diversity of wasps in traps was from late July into early August. A capture of one *Polistes nimphus* (Christ) was a new elevational record for this species in the Czech Republic. Nearly all *Vespula* wasps trapped were species in the *Vespula vulgaris* species group, with *Vespula rufa* (L.) conspicuously absent from traps.

Key words: wasp, yellowjacket, *Vespula*, *Vespa*, *Polistes*, bait, trap.

Introduction

Temperate species of social wasps (Vespidae) can be pestiferous insects that damage fruit, sting people and their animals, and nest within or on human habitations (Beyr, 1944; Spradbery, 1973; Akre *et al.*, 1980; Zahradník, 1987; Boller and Baur, 2000). Maximum pest status is in late summer, when their colony sizes are peaking for the season. Some wasps are pests in orchards and vineyards in late summer when they feed on ripe fruit and are a stinging hazard to agricultural workers. They also are of concern in apiaries where they feed on honey and prey on honey bees, and in some food processing plants where they are a hazard to workers as they scavenge for food. In some areas, they are also a danger to people at many outside venues such as fairs, campgrounds and picnics when they are attracted to food items and garbage.

Wasp workers forage both for protein-rich foods that are fed to larvae and for sugar-rich foods that they consume and feed to larvae (Spradbery, 1973). However, the foraging habits of different species of wasps vary. The foraging habits of some wasp species bring them into frequent contact with people, when they are attracted to meats, fruits, sweets, and even garbage. Wasp foraging behaviour also provides opportunities to develop lures and traps for capturing and killing wasps, either for research purposes or for population reduction. For example, Kemper and Dohring (1967) used many natural and processed food materials as bait for pestiferous social wasps; Boller and Baur (2000) compared attractiveness of six mixtures of natural lures for wasps, in Switzerland; D'Adamo *et al.* (2003) trapped *Vespula germanica* (F.) with cat food (Whiskas) in Argentina; Ross *et al.* (1984) compared attractiveness of different meat extracts for trapping *V. germanica* and *Vespula maculifrons* (DuBuysson) in eastern North America; Christie (1992) showed superiority of grenadine syrup over other sweet baits (cola, ginger ale, honey) and

meats as attractants for trapping *V. germanica*; Wegner and Jordan (2005) trapped numbers of 4 species of *Vespula* with two citrus-based sodas in Ohio; Spurr (1995, 1996) compared protein-rich food baits and sweet baits for trapping *V. germanica* and *Vespula vulgaris* (L.) in New Zealand. These and other studies show that both meat-based and sugar-based food materials can be used to trap or bait many species of social wasps.

Additionally, wasps can be trapped with chemicals that may be the basis for wasp attraction to some of these natural food materials. Davis *et al.* (1968, 1969, 1972) discovered attraction of *Vespula pensylvanica* (Saussure) in Oregon and Washington to several butyrate esters, which may be based on wasp attraction to fruits. Butyl and hexyl butyrates for example are components of apple odour (Hern and Dorn, 2001; Coracini *et al.*, 2004). A number of species of wasps are attracted to acetic acid with isobutanol (Landolt, 1998; Landolt *et al.*, 1999, 2006; Reed and Landolt, 2002). Both of these compounds are microbial fermentation products which can occur in fermented sugary solutions (Utrio and Eriksson, 1977). Day and Jeanne (2001) in Wisconsin trapped *Vespula vidua* (Saussure) wasps in traps baited with the pear odorant 2,4-ethyl decadienoate. Comparisons of food baits and chemical lures were made by Day and Jeanne (2001) and Wegner and Jordan (2005). Most of these studies have intended to maximise numbers of wasps captured, and detailed the species of wasps captured in those locations.

The objective of this study was to determine the species composition of wasps trapped with a syrup and fermented fruit bait in orchards in central Europe; what wasps are present and respond to this types of baits. Our results provide new information on the trapping of wasps with a sweet bait in this geographic area, and provide a basis for additional studies to optimise this technique for sampling or for reducing wasp populations to protect fruit and people.

Materials and methods

General

This research was conducted predominantly in or near fruit orchards in towns and villages of the Czech Republic, and in one orchard in southwestern Slovakia. These study sites possess a variety of habitats due to differences in altitude, degree of disturbance and human activity, and proximity to natural forest area. Six study sites were in the area of the Bohemian Forest (= Šumava Mts.) and its foothills; and other 10 sites were in different parts of Bohemia, Moravia, and Slovakia.

The bait used in all (16) traps of this study was a commercial syrup of different kind purchased in grocery stores, diluted 1:5 in water, with 3 to 5 small pieces of cut fruit added. The type of fruit added varied with the location and season. The apples were used in the major number of traps. The trap was a standard PET bottle of 1.5–2 l volume. The trap was hung from a branch of a tree ca. 1.5 m above the ground. It is assumed that the bait of diluted syrup and fruit became fermented in the traps, and thus became attractive to wasps. Traps were placed in the field near the end of May 2005 at some sites and in early August at other sites, and were maintained until late September or early October, depending on the site (see study site details below). Generally, one trap was set up and maintained at each site. Traps were emptied of wasps every 2 weeks, and the bait was replaced every 2 weeks.

Study sites

All localities are listed in order: part of country, locality, number of faunistic mapping code, description of trapping site, altitude, trapping period, and name of collector.

1. SW Bohemia, Rohanov (6848), small orchard in the centre of a village, 740 m a.s.l. Trapping: 25 May to 18 Sep 2005, L. Dvořák.
2. SW Bohemia, Budětice (6747), small orchard in the centre of a village, 500 m a.s.l. Trapping: 27 May to 27 Sep 2005, V. Turek.
3. SW Bohemia, Kašperské Hory (6847), a complex orchard on SW periphery of the town, 725 m a.s.l. Trapping: 30 May to 20 Sep 2005, L. Dvořák.
4. SW Bohemia, Modrava (6946), urban area on W periphery of the village, 990 m a.s.l. Trapping: 1 June to 5 Oct 2005, L. Dvořák.
5. SW Bohemia, Březník (7046), Norway spruce forest with most trees killed by bark beetle outbreak, 1165 m a.s.l. Trapping: 3 June to 9 Sep 2005, L. Dvořák.
6. SW Bohemia, Stožec (7148), urban area on N periphery of the village, 775 m a.s.l. Trapping: 11 Aug to 6 Oct 2005, L. Dvořák.
7. S Bohemia, Blatná (6549), cultivated garden area with fruit trees on W periphery of the town, 430 m a.s.l. Trapping: 28 May to 1 Oct, P. Bogusch.
8. W Bohemia, Čechovice (6447), small orchard on periphery of the village, 487 m a.s.l. Trapping: 5 June to 28 Aug 2005, I. Fenclová.
9. W Bohemia, Horní Bříza (6146), orchard in the centre of the town, 367 m a.s.l. Trapping: 4 June to 30 Aug 2005, I. Fenclová.

10. W Bohemia, Plzeň – Litice (6246), small orchard near Nad Přehradou street, 330 m a.s.l. Trapping: 8 to 28 Aug 2005, E. Honzíková.
11. Cent. Bohemia, Praha – Kunratice (5952), small uncultivated park with old trees in the centre of town, 270 m a.s.l. Trapping: 1 June to 3 Aug 2005, P. Kment.
12. S Moravia, Brno – Ořešín (6765), old cherry orchard, 400 m a.s.l. Trapping: 17 June to 30 Sep 2005, I. Malenovský.
13. Cent. Moravia, Olomouc – Bělidla (6469), several small orchards in the town, 215 m a.s.l. Trapping: 13 June to 4 Sep 2005, M. Mañas.
14. Cent. Moravia, Přerov (6570), orchard, 212 m a.s.l. Trapping: July to 3 Oct 2005, D. Vepřek.
15. N Moravia, Ostrava (6275), near small orchard, 230 m a.s.l. Trapping: June 19 to Oct 16 2005, M. Roháčová.
16. SW Slovakia, Bratislava – Dúbravka (7868), small orchard, 200 m a.s.l. Trapping: 3 June to 20 Sep 2005, T. Čejka.

For map of studied localities see figure 1 (locality No. 16 from Slovakia is not included).

Wasps collected were identified using Mauss and Treiber (1994). Voucher specimens are deposited in the collection of the senior author and in the Moravian Museum, Brno, Czech Republic. Our taxonomic nomenclature follows that of Carpenter (1996) and Carpenter and Kojima (1997).

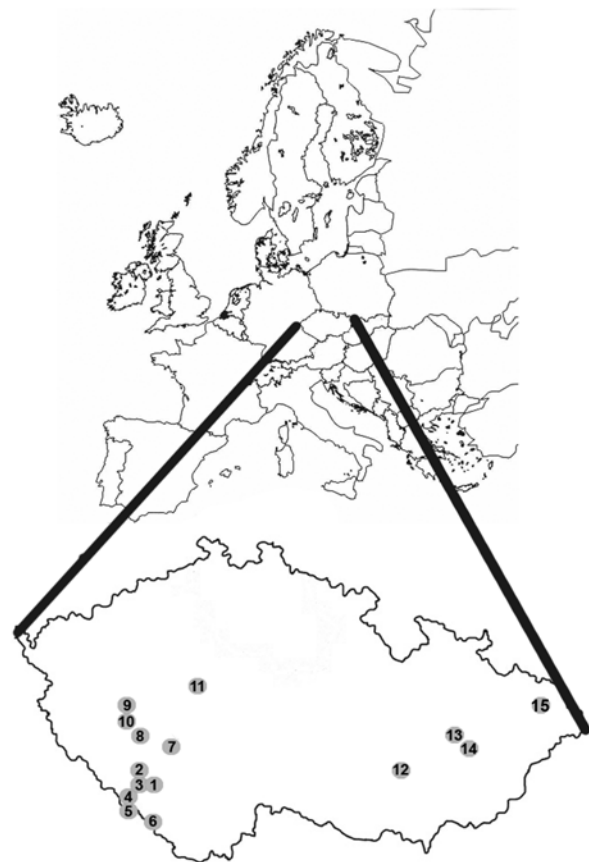


Figure 1. A schematic map of localities under study in the Czech Republic. Locality from Slovakia is not included.

Results

In total, 1018 social wasps belonging to eight species [*Vespa crabro* L., *V. germanica*, *V. vulgaris*, *Vespula rufa* (L.), *Dolichovespula media* (Retzius), *Dolichovespula saxonica* (F.), *Polistes dominulus* (Christ), and *Polistes nimphus* (Christ)] were trapped during this study (see table 1 and figures 2-3 for detailed results). *V. crabro*, *V. germanica*, and *V. vulgaris* dominated trap catches throughout the study sites (28% to 35% of the total, for each species) (table 1, figure 3). Five other species were captured in traps only sporadically and in small numbers. These ranged from only 0.1% of the total for *P. nimphus* to 2.3 % of the total for *D. media*. The three species of wasps that were trapped most abundantly were also trapped in most study sites (12, 10 and 14 of the 16 sites, for *V. crabro*, *V. germanica*, and *V. vulgaris* respectively). Sites with the largest numbers of wasps trapped (284 and 216 individuals) were the same sites that had the highest numbers (7) of species of wasps captured at sites 12 and 14 (Brno and Přeřov).

No rare species of Vespine wasps were captured in these traps. All species of wasps trapped are common members of the central European fauna, except *D. media* which exists sporadically in humified forested areas. Two subspecies/colour forms of *V. crabro* sensu Archer (1992) live in central Europe. The typical west European *V. crabro germana* Christ (orange ocellar triangle, red scutellum, and often red stripes on mesonotum) was abundantly trapped in our study sites, while the east European *V. crabro crabro* L. (black ocellar triangle and mesonotum, black or almost black scutellum) was trapped in small numbers at localities No. 12 and 14 (Brno and Přeřov) only.

The major part of trapped insects represent members of several families of Diptera. Representatives of other groups became in smaller numbers, e.g. Lepidoptera, Coleoptera, Mecoptera or Ensifera. No honeybees were trapped. Among Hymenoptera (excluding social wasps), the only bumblebee *Bombus lapidarius* (L.) was captured at locality No. 10.

Discussion

Although our results here are the first for this area of Europe, they are similar in some ways to those of other studies of social wasp responses to food baits. For exam-

ple, the largest numbers of wasps that were trapped in this investigation, included members of the *Vespula vulgaris* species group. Two of the three most abundantly trapped wasps in the Czech Republic were members of this species group: *V. vulgaris* and *V. germanica* (35.3% and 28.0% of trap catch respectively). These two species were among the most common wasps captured in traps with food baits, in other relevant investigations (Ross *et al.*, 1984; Spurr, 1996; Day and Jeanne, 2001; Reed and Landolt, 2002; Wegner and Jordan, 2005). In other areas of the world, other members of the *V. vulgaris* species group such as *V. pensylvanica*, *V. maculifrons*, and *Vespula flavopilosa* Jacobson, were abundantly trapped with sugar-rich or sweet food baits (Aldiss, 1983; Christie, 1992; Spurr, 1996; Day and Jeanne, 2001; Wegner and Jordan, 2005). Species belonging to the *V. rufa* group were abundantly or consistently captured neither in this study nor in others studies focusing on the responses of wasp to sweet materials (Christie, 1992; Spurr, 1996; Day and Jeanne, 2001; Wegner and Jordan, 2005). The prevalence of wasps of the *V. vulgaris* species group in traps with sweet food baits is likely related to their habit of scavenging on fruits, saps, and the foods and garbage of humans, in addition to scavenging carrion and preying on live insects. In contrast, wasps of the *V. rufa* species group, that are known to forage primarily for live insect prey, are not commonly seen on food or garbage, and are generally not captured in numbers in traps baited with either sweet baits or meats (e.g. Akre *et al.*, 1980). Additionally, wasps of the *V. vulgaris* group species generally are much more abundant late in the season, in comparison to wasps of the *V. rufa* group species, which, on average, have a shorter colony duration and a smaller maximum colony size (Duncan, 1939; Akre *et al.*, 1980).

The three commonest species of wasp trapped, *V. vulgaris*, *V. germanica*, and *V. crabro*, were abundant in our traps throughout the summer into October. Other studies have shown that their colonies can persist into November (Duncan, 1939; Archer, 1992, 1993, 2002; Kemper and Dohring, 1967; Pekkarinen and Hulden, 1995; Zahradník, 1987) while colonies of other wasps, such as *V. rufa*, *Dolichovespula* spp., and *Polistes* spp., decline, earlier in the season, between August and September (Archer, 1992, 2002; Kemper and Dohring, 1967; Pekkarinen and Hulden, 1995; Zahradník 1987). Their largest numbers of the three latest taxons were captured in late July to early August.

Table 1. Numbers of social wasps trapped during the study. Explanations: n = mean number of each species in all samples; % = mean percentage representation of each species in all samples; D = dominancy of each species in all samples (n and percentage); F = frequency of the occurrence (number of localities for each species).

species	n	%	D	F
<i>V. crabro</i>	20.1±3.8	29.9±0.25	322 (31.6%)	12
<i>V. germanica</i>	17.8±3.7	20.9±0.2	285 (28.0%)	10
<i>V. vulgaris</i>	22.4±0.5	39.0±0.2	359 (35.3%)	14
<i>V. rufa</i>	0.4±0.1	3.6±0.06	6 (0.6%)	5
<i>D. media</i>	1.4±0.5	2.1±0.03	23 (2.3%)	6
<i>D. saxonica</i>	0.4±0.2	3.3±0.06	6 (0.6%)	3
<i>P. dominulus</i>	1±0.4	1.2±0.02	16 (1.6%)	5
<i>P. nimphus</i>	0.06±0.05	0.2±0.003	1 (0.1%)	1

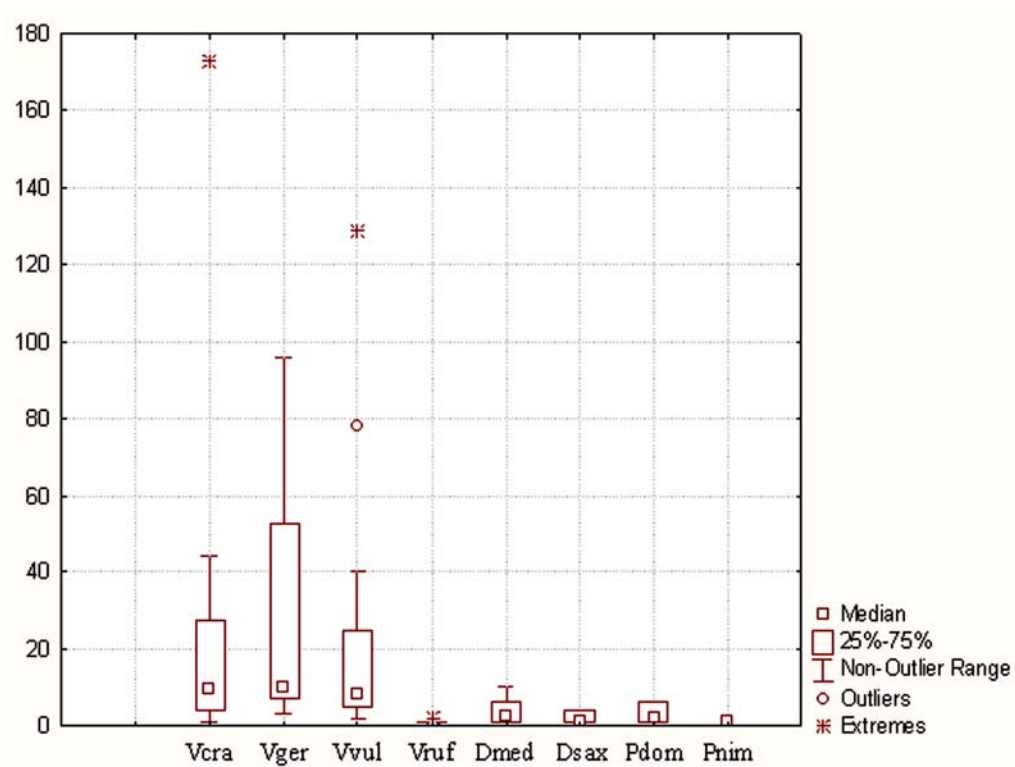


Figure 2. Variability of abundances of particular wasp species trapped in sites under study. (Vcra = *Vespa crabro*, Vger = *Vespula germanica*, Vvul = *Vespula vulgaris*, Vruf = *Vespula rufa*, Dmed = *Dolichovespula media*, Dsax = *Dolichovespula saxonica*, Pdom = *Polistes dominulus*, Pnim = *Polistes nimphus*).

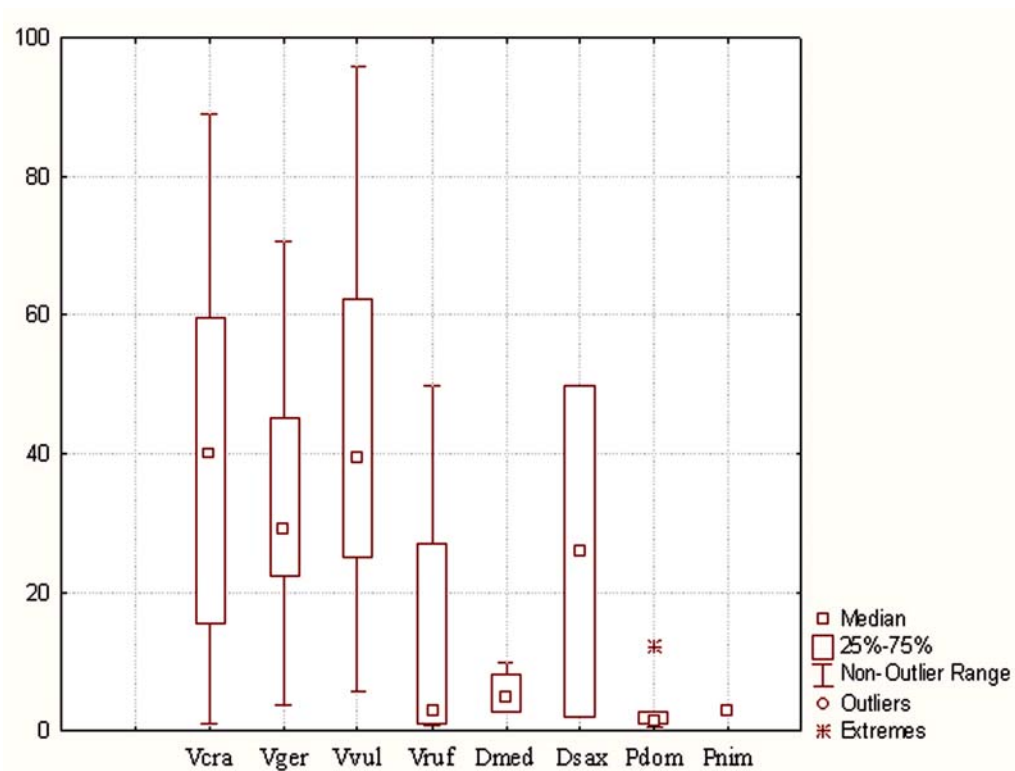


Figure 3. Variability of relative abundances (%) of particular wasp species trapped in sites under study. (Vcra = *Vespa crabro*, Vger = *Vespula germanica*, Vvul = *Vespula vulgaris*, Vruf = *Vespula rufa*, Dmed = *Dolichovespula media*, Dsax = *Dolichovespula saxonica*, Pdom = *Polistes dominulus*, Pnim = *Polistes nimphus*).

A striking difference between our results and prior reports of wasps trapped with food baits is the dominance of the hornet *V. crabro* in our traps (31.6% of all wasps captured). This species is present but not-native in North America and is not reported in traps with food baits in the United States (Christie, 1992; Wegner and Jordan, 2005). However, it has been trapped in Maryland and in Tennessee with the chemical lure of acetic acid with isobutanol (e.g. Landolt *et al.*, 1999; J. Oliver and P. J. Landolt unpublished data).

Wasp species of the genus *Dolichovespula* are generally not scavengers and they are not captured abundantly in food bait traps. For example, Wegner and Jordan (2005) captured 66 *Dolichovespula maculata* (L.) and no other *Dolichovespula* species out of 24,487 wasps trapped with fruit juice and soft drink baits. However, *D. media* was the 4th most abundant wasp in our traps baited with syrup and fruit in our traps. *D. maculata*, the Nearctic sister-species, is consistently captured in traps baited with acetic acid and isobutanol in North America (Landolt *et al.*, 1999, 2006; Reed and Landolt, 2002; Day and Jeanne, 2001), indicating a response of this species to volatiles from sweet materials. Other species of this genus have been trapped incidentally and in small numbers either with sweet baits or with sugar fermentation volatiles. In this study, we captured a few *D. saxonica* at localities Nos. 5, 12, and 14 (Břežník, Brno and Přerov). Reed and Landolt (2002), Landolt *et al.* (2006) and Day and Jeanne (2001) trapped small numbers of *Dolichovespula arenaria* (F.) with lures of acetic acid with isobutanol and Landolt *et al.* (2006) captured small numbers of *Dolichovespula norvegica* (F.) and *Dolichovespula norvegicoides* (Sladen) in acetic acid/isobutanol traps.

Polistes wasps, primarily *P. dominulus*, were captured in traps regularly but only in small numbers (five localities, 16 specimens – 1.6%). The one specimen of *P. nimphus* trapped during this study was at locality No. 6, at Stožec. *P. dominulus* is a non-native wasp in the USA (Hathaway, 1981) and is considered to be invasive. It has been trapped in small numbers in recent years in the USA, both in traps baited with sweet soda drinks (Wegner and Jordan, 2005) and acetic acid and isobutanol (Landolt *et al.*, 1999; Day and Jeanne, 2001; Reed and Landolt, 2002). In North America, *Polistes fuscatus* (F.) and species closely related to it have also been captured in traps baited with sweet soda drinks (Wegner and Jordan, 2005) and in traps baited with acetic acid with isobutanol (Landolt *et al.*, 1999).

Eight wasp species were trapped in the 2005 season during this study. This diversity is comparable to that reported for other trapping studies. For example, Day and Jeanne (2001) trapped six wasp species in Wisconsin, Landolt *et al.* (2006) trapped eight species in Alaska, while Reed and Landolt (2002) and Wegner and Jordan (2005) trapped nine species in Michigan and in Ohio respectively. The numbers of specimens trapped in this study were relatively low compared to other studies. The composition of the wasp species trapped in this study was similar to that observed of wasps on fermented fruits in southern and southwestern Bohemia in 2004 and 2005 (L. Dvořák, unpublished data) and in

Germany by Kemper and Döhring (1967). *V. crabro*, *V. germanica* and *V. vulgaris* were the dominant species on fruits in those studies, as they were in our syrup and fruit-baited traps. The observed absence of *V. crabro* and/or *V. germanica* in some of our higher elevation traps is expected because those species become rare or absent at altitudes more than 800 m a.s.l.

V. crabro dominated trap catches in this study at six of the 16 sites, while *V. germanica* dominated at three, and *V. vulgaris* dominated at four sites. *V. crabro* was not trapped at localities 3–5 which are at a higher elevation and site 13, where overall numbers of wasps captured were very low. *V. germanica* was not trapped at localities 1 (low numbers of wasps trapped), 4–6 (higher elevation), 10 and 15 (no reason is postulated). *V. vulgaris* was not trapped at localities 5 and 7 (no reason is postulated, because this euryecious species can be present over a wide range of habitats).

Throughout this study, only females (almost all workers) were trapped regularly. Day and Jeanne (2001) captured primarily females but also good numbers of *V. maculifrons* males and smaller numbers of *V. germanica* males in traps baited with acetic acid with isobutanol, while Landolt *et al.* (2006) captured significant numbers of *V. vulgaris* males in traps, also with acetic acid/isobutanol lures. In both studies however, the males made up a small percentage of wasps trapped. Only several males were trapped in this study with syrup and fruit, namely one *V. crabro* and one *P. dominulus* at locality No. 2 (Budětice), two *V. crabro* at locality No. 12 (Brno), one *P. dominulus* at locality No. 14 (Přerov), and two *V. crabro* at locality No. 15 (Osstrava). The ratio of males to all trapped wasps was ca. 1/145.

The most interesting distributional find of this study is that of *P. nimphus* from locality No. 6 (Stožec). This species is somewhat thermophilous and is limited to warmer areas of Central Europe. The finds above 700 m a.s.l. are very rare. The specimen trapped by us represents the highest elevational record for that species in the Czech Republic (L. Dvořák and J. Straka, unpublished data).

Conclusions

Syrup is a relatively good attractant for social wasps because interesting species composition in traps.

The main result of this study is the fact that trapping wasps with natural attractants is very good supplemental method for faunistic research of social wasps.

Trapping with syrup can be also used as method of biological control of the most pestiferous species – *V. crabro*, *V. germanica* and *V. vulgaris* represented 95% of all trapped wasps.

Low numbers of wasps in traps can be a result of several factors; poor response to the bait, low density or absence of wasps, and competition from nearby food sources such as fermenting fruits.

The greatest number of species was trapped between the 2nd half of July and the 1st half of August. This is the best time for trapping to obtain a faunistic sample.

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