ISSN 1211-8788 *Acta Musei Moraviae, Scientiae biologicae* (Brno)
93: 105–130, 2008

Social wasps (Hymenoptera: Vespidae) trapped with beer bait in European open ecosystems

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Dvořák L., Castro L. & Roberts S. P. M. 2008: Social wasps (Hymenoptera: Vespidae) trapped with beer bait in European open ecosystems. *Acta Musei Moraviae, Scientiae biologicae* (Brno) **93:** 105–130. – Social wasps (Hymenoptera, Vespidae) were trapped using beer bait traps in European open ecosystems in 2007. During this study, 4015 wasps of 10 species were trapped at 144 locations. The following species were trapped: *Polistes dominula* (Christ, 1791), *Polistes nimpha* (Christ, 1791), *Vespa crabro* Linnaeus, 1758, *Vespula germanica* (Fabricius, 1793), *V. rufa* (Linnaeus, 1758), *V. vulgaris* (Linnaeus, 1758), *Dolichovespula media* (Retzius, 1783), *D. saxonica* (Fabricius, 1793), *D. sylvestris* (Scopoli, 1763), and *D. omissa* (Bischoff, 1931). *V. vulgaris* and *V. crabro* were the eudominant species with more than 30 % of individuals. The third most common species was *V. germanica* with more than 13 % of individuals. *D. media*, a species formerly recognised as rare or uncommon, had 9 %. A very interesting result of the study is one trapped specimen of *D. omissa*, a social parasite species.

Key words. Vespidae, *Vespa*, *Vespula*, *Dolichovespula*, *Polistes*, Europe, beer, bait traps, open ecosystems

Introduction

Dvořák & Landolt (2006) showed that bait traps are very attractive for some European wasp species. Their material was not as extensive as similar studies from North America (see Landolt *et al*. 2005 for a comparison), so more widespread research was needed. Dvořák (2007) has published results of wasp trapping using beer bait at 131 forest sites in Europe. This paper expands the scope of the previous study by focusing the research on open habitats using the same methodology. The aim of the paper is to characterize the fauna of social wasps attracted by beer traps in open areas and to compare the data with the results from forest sites.

Methods

Wasps were trapped by a very simple method. A 1.5 or 2 litre colourless, transparent polyethylene (PET) bottle was filled with 0.5 litres of beer. The PET bottle was hung on a tree branch approximately 1.5 m above the ground; the entrance was easily accessible.

Research was focused on open ecosystems, so the traps were situated in the middle of an open site with a minimum area of 2 ha, not in the ecotone. Installation of the traps was made around the 10th of July (plus or minus several days) and recovered after 30–35 days. In several cases, the installation of the traps was somewhat later. A single trap was placed at each site.

The data are only from 2007 with no replication in previous years, and have not been statistically evaluated because of a lack of critical information on the individual trapping sites.

The data for each location are listed in the following order: Country abbreviation (AUT – Austria, BEL – Belgium, CZE – Czech Republic, EST – Estonia, FRA – France, GER – Germany, HUN – Hungaria, ITA – Italy, SER – Serbia, ESP – Spain, SVK – Slovakia, UK – United Kingdom) with serial number, county and/or geographic unit, locality/location (with number of faunistic code in CZE, SVK, BEL, and UK), biotope, moisture parameters of site (W = wet, damp, M = mesic, D = dry, xerophilous), height of underbrush during the installation and recovery (average) [0 = no or sporadic vegetation (up to 70% of locality), 1 = low (up to 30 cm), 2 = medium (up to 75 cm), 3 = high (up to 1.5 m), 4 = very high (more than 1.5 m)], altitude, coordinates (if available), date of installation and recovery, and name of the collector. The localities of the ALARM project (Assessing LArge scale environmental Risks for biodiversity with tested Methods, see http://www.alarmproject.net/alarm/) are marked as disturbed or undisturbed. Disturbed = simple landscapes dominated by a single land use type. In these study sites these are agricultural or other anthropogenic habitats with very little natural or semi-natural vegetation. Undisturbed = diverse landscapes of a mosaic of semi-natural, agricultural and anthropogenic habitats. This project has relatively strict rules for dividing the landscape into disturbed or undisturbed, so we use this category for ALARM sites only.

The trapping sites are shown in Fig. 1.

The abbreviations used in the figures and in Table 1:

Pdom . . . . . *Polistes dominula*
Pnim . . . . . *Polistes nimpha*
Vcra . . . . . *Vespa crabro*
Vger . . . . . *Vespula germanica*
Vruf . . . . . *Vespula rufa*
Vvul . . . . . *Vespula vulgaris*
Dmed . . . . . *Dolichovespula media*
Dsax . . . . . *Dolichovespula saxonica*
Dsyl . . . . . *Dolichovespula sylvestris*
Domi . . . . . *Dolichovespula omissa*

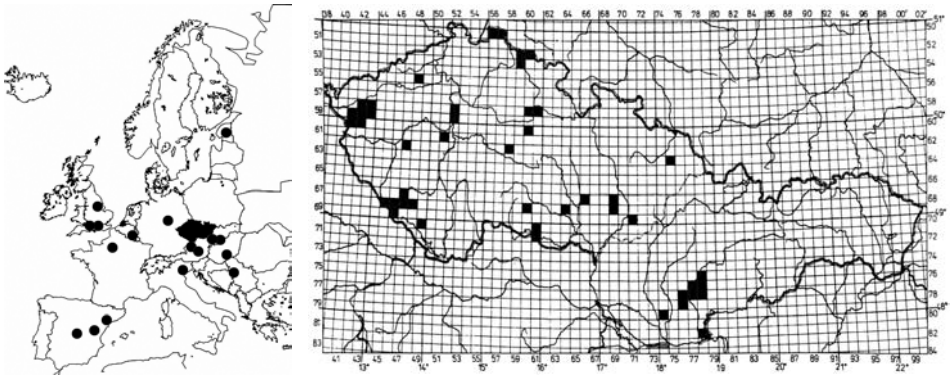

Fig. 1. A schematic map of Europe with the studied localities (left). Localities in the Czech Republic and Slovakia are shown in the faunistic mapping grid (right).

Material

Localities under study

AUT 1 Upper Austria, Mühlviertel, Klaffer am Hochficht, Wegscheider Wiese, poor meadow, M1, 770 m a.s.l., 48°43′8″ N, 13°51′56.7″ E, 13.vii.–17.viii.2007, Thomas Engleder

AUT 2 Upper Austria, Mühlviertel, Klaffer am Hochficht, Stadl-Au, peatbog, W2, 620 m a.s.l., 48°42′29.4″ N, 13°51′15.5″ E, 13.vii.–17.viii.2007, Thomas Engleder

AUT 3 Upper Austria, Mühlviertel, Ulrichsberg, Enzianwiese, mowed poor meadow, M1, 640 m a.s.l., 48°41′13.5″ N, 13°50′40.6″ E, 13.vii.–17.viii.2007, Thomas Engleder

AUT 4 Upper Austria, Mühlviertel, Aigen, Untergrünwald, peatbog, W3, 820 m a.s.l., 48°40′8.1″ N, 14°0′22″ E, 13.vii.–17.viii.2007, Thomas Engleder

AUT 5 Upper Austria, Mühlviertel, Schlägl, Breitenstein, mowed poor meadow, D1, 790 m a.s.l., 48°38′31.5″ N, 13°56′7.7″ E, 13.vii.–17.viii.2007, Thomas Engleder

AUT 6 Upper Austria, Mühlviertel, Haslach, Öko-Insel, wetland near Grosse Mühl river, M3, 500 m a.s.l., 48°35′5.7″ N, 14°2′6.6″ E, 13.vii.–17.viii.2007, Thomas Engleder

AUT 7 Styria, middle Enns valley, Aigen/Ennstal, extensive cattle pasture on southern slope, D1, 773 m a.s.l., 47.51813053250° N, 14.11772855040° E, 19.vii.–22.viii.2007, Silke Heinrich

AUT 8 Styria, middle Enns valley, Aigen/Ennstal, extensive meadow near a lake, W1, 661 m a.s.l., 47.51739570510° N, 14.13148292030° E, 19.vii.–22.viii.2007, Silke Heinrich

AUT 9 Styria, middle Enns valley, Aigen/Ennstal, intensive meadow in the floodplain of Enns river, M1, 649 m a.s.l., 47.5258794647° N, 14.11494792880° E, 19.vii.–22.viii.2007, Silke Heinrich

AUT 10 Upper Austria, Enns valley/ foothills of the Alps, Reichraming, sheep pasture and meadow on northfacing slope, M1, 490 m a.s.l., 47.89114141280° N, 14.50788090210° E, 20.vii.–23.viii.2007, Silke Heinrich

AUT 11 Upper Austria, Enns valley/ foothills of the Alps, Reichraming, south-facing cattle pasture (with an adjacent meadow), D1, 437 m a.s.l., 47.89755435900° N, 14.46802990280° E, 20.vii.–23.viii.2007, Silke Heinrich

AUT 12 Upper Austria, Enns valley/ foothills of the Alps, Reichraming, south-facing cattle pasture and with a few fruit trees, D1, 447 m a.s.l., 47.89860786400° N, 14.49608512000° E, 20.vii.–23.viii.2007, Silke Heinrich

BEL 1 Belgium, Lorrain, Luxembourg province, Sainte-Marie/Semois, Bertauvaux, FR318405, meadow, D1, 350 m a.s.l., 49.6697665° N, 5.55367469° E, 6.vii.–19.viii.2007, Jean-Luc Renneson

CZE 1 Bohemian Forest foothills, Benešova Hora, 6848, pasture E of a village, M1, 730 m a.s.l., 49°07´32.7″ N, 13°42´15.3″ E, 7.vii.–7.viii.2007, Libor Dvořák

CZE 2 Bohemian Forest foothills, Rohanov, 6848, managed meadow N of a village, M1, 750 m a.s.l., 49°08´10″ N, 13°42´10″ E, 8.vii.–8.viii.2007, Libor Dvořák

CZE 3 Bohemian Forest, Kašperské Hory, 6847, steppe slopes W of a town, D1, 755 m a.s.l., 49°08´30.2″ N, 13°32´06″ E, 10.vii.–8.viii.2007, Libor Dvořák

CZE 4 Bohemian Forest, Rovina, 6846, wet meadow in W part of a former village, W2, 895 m a.s.l., 49°09´31″ N, 13°24´32.5″ E, 10.vii.–14.viii.2007, Libor Dvořák

CZE 5 Bohemian Forest, Nová Hůrka, 6845, mire W of a village, W1, 895 m a.s.l., 49°08´45.9″ N, 13°19´11.6″ E, 10.vii.–14.viii.2007, Libor Dvořák

CZE 6 Bohemian Forest, Modrava, 6946, Rokytecká slať bog, wet meadow, W2, 1090 m a.s.l., 49°01´02.8″ N, 13°24´55.7″ E, 11.vii.–14.viii.2007, František Stíbal

CZE 7 Bohemian Forest, Spálenec, 7049, wet meadow NW of a settlement, W3, 780 m a.s.l., 48°55´38″ N, 13°58´00.9″ E, 11.vii.–15.viii.2007, Libor Dvořák

CZE 8 Podbeskydská pahorkatina, Sviadnov, 6375, crop field, D2, 290 m a.s.l., 49°40´53.93″ N, 18°19´29.15″ E, 10.vii.–9.viii.2007, Veronika Ďurinová

CZE 9 Praha-Trója, 5852, vineyard, D3, 276 m a.s.l., 50°07´05″ N, 14°24´53″ E, 10.vii.–9.viii.2007, Jitka Schlägelová

CZE 10 Bohemian Forest foothills, Čepice, 6747, steppe of Čepičná Nature Reserve, D1, 450 m a.s.l., 49°16´21″ N, 13°35´60″ E, 14.vii.–16.viii.2007, Václav Turek

CZE 11 Českomoravská vrchovina, Frýdnava, 6258, road between fields, M1, 454 m a.s.l., 49°47´10.53″N 15°28´47.86″E, 15.vii.–22.viii.2007, Kamil Holý

CZE 12 Litenčické vrchy hills, Střílky, 6869, small orchid meadow NW of a village, D1, 337 m a.s.l., 49°8´46.13″ N, 17°12´28.46″ E, 11.vii.–11.viii.2007, Dušan Vepřek

CZE 13 Litenčické vrchy hills, Chvalnov, 6869, Přehon Nature Monument, small orchid meadow at N margin of a village, D1, 340 m a.s.l., 49°10´14.05″ N, 17°14´5.77″ E, 11.vii.–11.viii.2007, Dušan Vepřek

CZE 14 Litenčické vrchy hills, Litenčice, 6869, amphitheatre of former brickworks SW of a village, D1, 358 m a.s.l., 49°11´52.57″ N, 17°12´18.13″ E, 11.vii.–11.viii.2007, Dušan Vepřek

CZE 15 Litenčické vrchy hills, Roštín, 6869, steppe slopes by Kotojedka stream NW of a village, D1, 280 m a.s.l., 49°11´53.54″ N, 17°16´8.67″ E, 11.vii.–11.viii.2007, Dušan Vepřek

CZE 16 Litenčické vrchy hills, Lebedov, Těšánky, 6769, old orchards at terraces above the Kotojedka stream, D1, 253 m a.s.l., 49°12´56.43″ N, 17°17´4.74″ E, 11.vii.–11.viii.2007, Dušan Vepřek

CZE 17 Litenčické vrchy hills, Zdounky, 6769, orchid meadow with shrubs SE of a town, D1, 250 m a.s.l., 49°13´17.37″ N, 17°19´34.44″ E, 11.vii.–11.viii.2007, Dušan Vepřek

CZE 18 Prakšická vrchovina hills, Drslavice, 6971, dry terrace meadows N of a village, formerly managed, Terasy – Vinohradní Nature Monument, D1, 230 m a.s.l., 49°3´27.71″ N, 17°36´13.91″ E, 14.vii.–14.viii.2007, Dušan Vepřek

CZE 19 Prakšická vrchovina hills, Drslavice, 6971, dry meadows ca. 2 km NNE of a village, Vrchové – Chrástě Nature Monument, D1, 300 m a.s.l., 49°3´55.66″ N, 17°36´38.44″ E, 14.vii.–14.viii.2007, Dušan Vepřek

CZE 20 Brdy Mts. foothills, Rymaně, 6151, fallow field, M 1, 410 m a.s.l., 49°51´43,13″ N, 14°16´56,85″ E, 14.vii.–15.viii.2007, Magda Hrabáková

CZE 21 České středohoří hills, Písečný vrch hill nr. Bečov, 5548, grass steppe, D2, 250 m a.s.l., 50°25´45″ N, 13°45´ E, 17.vii.–21.viii.2007, Pavel Tyrner

CZE 22 Slavkovský les Mts., Prameny, 5942, Mokřady pod Vlčkem Nature Reserve, wet meadow, W 2, 754 m a.s.l., 50°2´29.23″ N, 12°44´18.12″ E, 10.vii.–9.viii.2007, Přemysl Tájek

CZE 23 Slavkovský les Mts., Prameny, 5942, Křížky National Nature Monument, heather moor, D 1, 806 m a.s.l., 50°3´57.76″ N, 12°44´54.85″ E, 10.vii.–9.viii.2007, Přemysl Tájek

CZE 24 Slavkovský les Mts., Prameny, 5942, Upolínová louka National Nature Monument, wet meadow, W 2, 796 m a.s.l., 50°4´2″ N, 12°44´46″ E, 10.vii.–9.viii.2007, Přemysl Tájek

CZE 25 Slavkovský les Mts., Kladská, 5942, Tajga, peat-bog, W 0, 804 m a.s.l., 50°1´51.6″ N, 12°41´17.65″ E, 10.vii.–9.viii.2007, Přemysl Tájek

CZE 26 Slavkovský les Mts., Kladská, 5942, wet meadow near turning to Mýtský pond, W 2, 796 m a.s.l., 50°2´2.81″ N, 12°41´35.46″ E, 10.vii.–9.viii.2007, Přemysl Tájek

CZE 27 Slavkovský les Mts., Prameny, 5942, wet managed meadow by Mýtský pond W of a village, W 2, 812 m a.s.l., 50°3´4.63″ N, 12°41´32.6″ E, 10.vii.–9.viii.2007, Přemysl Tájek

CZE 28 Slavkovský les Mts., Horní Kramolín, 6042, Podhorní slatě mire, wet meadow, W 2, 694 m a.s.l., 49°57´30.64″ N, 12°48´12.88″ E, 10.vii.–10.viii.2007, Přemysl Tájek

CZE 29 Slavkovský les Mts., Sítiny, 5942, managed meadow W of a village, M 2, 746 m a.s.l., 50°1´49.94″ N, 12°45´22.7″ E, 10.vii.–9.viii.2007, Přemysl Tájek

CZE 30 Slavkovský les Mts., Krásno, 5842, Krásenské rašeliniště mire, dry exploited peat-bog W of a village, without vegetation, D 0, 714 m a.s.l., 50°6´22.5″ N, 12°45´31.01″ E, 10.vii.–10.viii.2007, Přemysl Tájek

CZE 31 Slavkovský les Mts., Bečov nad Teplou, 5942, Bečovské stráně slopes, dry meadow W of a town, D 2, 590 m a.s.l., 50°5´0.4″ N, 12°49´23.63″ E, 11.vii.–9.viii.2007, Přemysl Tájek

CZE 32 Slavkovský les Mts., Nové Kounice, 5843 wet meadow SSE of a village, W 2, 685 m a.s.l., 50°7´21.18″ N, 12°56´46.56″ E, 11.vii.–9.viii.2007, Přemysl Tájek

CZE 33 Slavkovský les Mts., Lázně Kynžvart, 6041, pasture, M 1, 618 m a.s.l., 49°59´53.88″ N, 12°37´36.65″ E, 10.vii.–9.viii.2007, Přemysl Tájek

CZE 34 Slavkovský les Mts., Lazy, 5941, pod Lesným mire, wet meadow, W 2, 816 m a.s.l., 50°3´3.82″ N, 12°37´1.76″ E, 10.vii.–9.viii.2007, Přemysl Tájek

CZE 35 Slavkovský les Mts., Lazy, 5941, submontane meadow W of a village, M 2, 802 m a.s.l., 50°3´1.23″ N, 12°38´5″ E, 10.vii.–9.viii.2007, Přemysl Tájek

CZE 36 Slavkovský les Mts., Kladská, 5942, wet meadow, W 3, 816 m a.s.l., 50°1´31.68″ N, 12°40´9.24″ E, 10.vii.–9.viii.2007, Přemysl Tájek

CZE 37 Slavkovský les Mts., Mnichov, 5942, meadow under Pluhův bor site N of a village, W 2, 724 m a.s.l., 50°3´23.01″ N, 12°46´6.34″ E, 10.vii.–9.viii.2007, Přemysl Tájek

CZE 38 Slavkovský les Mts., Nová Ves, 5942, by Dominova skalka rock, meadow S of a village, M 3, 746 m a.s.l., 50°4´13.81″ N, 12°47´18.8″ E, 10.vii.–9.viii.2007, Přemysl Tájek

CZE 39 Slavkovský les Mts., Ovesné Kladruby, 6042, pasture, M 1, 718 m a.s.l., 49°56´57.78″ N, 12°47´30.81″ E, 11.vii.–10.viii.2007, Přemysl Tájek

CZE 40 Slavkovský les Mts., Michalovy Hory, 6042, pasture NW of a village, M 2, 530 m a.s.l., 49°54´22.26″ N, 12°47´5.13″ E,12.vii.–15.viii.2007, Přemysl Tájek

CZE 41 Slavkovský les Mts., Odolenovice, 5943, managed meadow, M 1, 672 m a.s.l., 50°5´18.48″ N, 12°54´57.51″ E, 11.vii.–9.viii.2007, Přemysl Tájek

CZE 42 Slavkovský les Mts., Hamrníky, 6042, gardener´s colony, M 1, 552, m a.s.l., 49°57´16.66″ N, 12°41´27.59″ E, 10.vii.–10.viii.2007, Přemysl Tájek

CZE 43 Frýdlantská pahorkatina, Višňová-Předlánce, 5056, managed wet meadows in the Smědá river floodplain, M2, 220 m a.s.l., 50°58´42″ N, 15°1´59″ E, 17.vii.–17.viii.2007, Pavel Vonička

CZE 44 Frýdlantská pahorkatina, Horní Řasnice, 5057, former sandpit, D2, 380 m a.s.l., 50°58´29″ N, 15°12´41″ E, 20.vii.–19.viii.2007, Pavel Vonička

CZE 45 Východolabská tabule, Zminný near Dašice, 6060, between fields, M2, 233 m a.s.l., 50°01.963´ N, 15°51.735´ E, 13.vii.–13.viii.2007, Petr Bogusch

CZE 46 Východolabská tabule, Veská, 6060, Vesecký kopec sand dune, D3, 234 m a.s.l., 50°02.725´ N, 15°51.216´ E, 13.vii.–13.viii.2007, Petr Bogusch

CZE 47 Podyjí, Čížov, 7161, garden in a village, M1, 430 m a.s.l., 48°52´45.78″ N, 15°52´18.57″ E, 12.vii.–12.viii.2007, Václav Křivan

CZE 48 Podyjí, Mašovice, 7161, Mašovická střelnice, steppe, D1, 400 m a.s.l., 48°50´51.79″ N, 15°28´21,82″ E, 12.vii.–12.viii.2007, Václav Křivan

CZE 49 Podyjí, Vranovská Ves – Hostěrádky, 7061, steppe, D2, 390 m a.s.l., 48°55´59.58″ N, 15°56´17.93″ E, 12.vii.–12.viii.2007, Václav Křivan

CZE 50 Českomoravská vrchovina highland, Štěměchy, 6860, garden in a village, M1, 650 m a.s.l., 49°11´40.25″ N, 15°42´36.37″ E, 12.vii.–12.viii.2007, Václav Křivan

CZE 51 Giant Mts., Labská Bouda, 5259, spring in glacier corrie, W2, 1273, 50°46´12.57″ N, 15°32´55.16″ E, 11.vii.–15.viii.2007, Jan Vaněk

CZE 52 Giant Mts., Úpské rašeliniště bog, 5260, peat-bog, W1, 1431, 50°44´12.06″ N, 15°42´25.42″ E, 12.vii.–16.viii.2007, Jan Vaněk

CZE 53 Giant Mts., Luční Bouda, 5260, mountain meadow, D1, 1416, 50°44´10.05″ N, 15°41´57.1″ E, 12.vii.–16.viii.2007, Jan Vaněk

CZE 54 Giant Mts., Hříběcí Boudy, 5359, meadow, M2, 778, 50°40´37.92″ N, 15°37´48.97″ E, 12.vii.–16.viii.2007, Jan Vaněk

CZE 55 Východolabská tabule, Bukovina nad Labem, 5860, sedimentation pit, D0, 235 m a.s.l., 50°06´56.4″ N, 15°49´43.9″, 11.vii.–17.viii.2007, Miroslav Mikát

CZE 56 Východolabská tabule, Hradec Králové, 5861, Na Plachtě Nature Monument, meadow, M1, 240 m a.s.l., 50°11´14.3″ N, 15°51´38.4″ E, 11.vii.–14.viii.2007, Miroslav Mikát

CZE 57 Prague, Praha-Kunratice, Paběnice, 5952, unused field between streets Vídeňská and Dobronická, M2, 295 m a.s.l., 50°00´40″ N, 14°28´23″ E, 16.vii.–20.viii.2007, Petr Kment

CZE 58 Bobravská vrchovina hills, Silůvky, 6864, slope between the fields, M2, 290 m a.s.l., 49°06´34″ N, 16°27´38″ E, 18.vii.–18.viii.2007, Erich Kment

CZE 59 Drahanská vrchovina highland, Ochoz u Brna, 6766, mowed meadow NE of a village, M1, 390 m n.m., 49°15.5´ N, 16°45´ E, 22.vii.–26.viii.2007, Libor Mikulica

CZE 60 Drahanská vrchovina highland, Ochoz u Brna, 6766, mowed meadow NW of a village, M2, 350 m n.m., 49°15.5´ N, 16°43.5´ E, 22.vii.–26.viii.2007, Libor Mikulica

CZE 61 Rokycanská pahorkatina hills, Rokycany, 6247, managed meadow W of a town, in the Klabava stream floodplain M2, 350 m a.s.l., 49°44´43.04″ N, 13°34´32.42″ E, 15.vii.–18.viii.2007, Václav Říš

CZE 62 Rokycanská pahorkatina hills, Rokycany, 6247, managed meadow E of a town, W3, 365 m a.s.l., 49°44´51.74″ N, 13°36´43.96″ E, 15.vii.–18.viii.2007, Václav Říš

CZE 63 Rokycanská pahorkatina hills, Rokycany, 6247, former field E of a town, D4, 382 m a.s.l., 49°45´8.93″ N, 13°38´8.45″ E, 15.vii.–18.viii.2007, Václav Říš

ESP 1 Teruel, Orihuela del Tremedal, 40°32´36″ N, 1°41´04″ W, grassland in the middle of open *Pinus sylvestris* forest, D1, 1495 m a.s.l., 16.vii.–15.viii.2007, Leopoldo Castro

ESP 2 Teruel, Orihuela del Tremedal, 40°31´51″ N, 1°41´39″ W, clearing in mixed *Pinus sylvestris* / *Quercus pyrenaica* forest, D2, 1760 m a.s.l., 16.vii.–15.viii.2007, Leopoldo Castro

ESP 3 Barcelona, Garraf Mts., Sitges, low garrigue with *Pinus halepensis*, D2, 209 m a.s.l., 41.26564767° N, 1.84248698° E, 13.vii.–17.viii.2007, Jara Andreu, natural site

ESP 4 Barcelona, Garraf Mts., Sitges, low garrigue with *Pinus halepensis*, D2, 203 m a.s.l., 41.26538587° N, 1.84327077° E, 13.vii.–17.viii.2007, Jara Andreu, natural site

ESP 5 Barcelona, Garraf Mts., Viladellops (Olèrdola), low garrigue with *Pinus halepensis*, D3, 216 m a.s.l., 41.31123395° N, 1.73368093° E, 13.vii.–17.viii.2007, Jara Andreu, disturbed site

ESP 6 Barcelona, Garraf Mts.,Viladellops (Olèrdola), low garrigue with *Pinus halepensis*, D3, 207 m a.s.l., 41.31051816° N, 1.73368165° E, 13.vii.–17.viii.2007, Jara Andreu, disturbed site

ESP 7 Toledo, Quintos de Mora, open forest, D2, 826 m a.s.l., 39°24´26.79″ N, 4°03´32.65″ E, 10.vii.–16.viii.2007, Daniel Chamorro Cobo

ESP 8 Toledo, Quintos de Mora, open forest with grassland, D0, 810 m a.s.l., 39°23´59.57″ N, 4°03.48´.69″ E, 10.vii.–16.viii.2007, Daniel Chamorro Cobo

ESP 9 Toledo, Quintos de Mora, open forest with grassland, D0, 772 m a.s.l., 39°23`05.62″ N, 4°04´05.49″ E, 10.vii.–16.viii.2007, Daniel Chamorro Cobo

ESP 10 Ciudad Real, Los Cortijos, woody crops, D0, 729 m a.s.l., 39°17´38.90″ N, 3°59´46.76″ E, 10.vii.–16.viii.2007, Daniel Chamorro Cobo

ESP 11 Ciudad Real, Los Cortijos, cereal crops, D0, 774 m a.s.l., 39°19´03.76″ N, 4°01´13.90″ E, 10.vii.–16.viii.2007, Daniel Chamorro Cobo

ESP 12 Ciudad Real, Los Cortijos, woody crops, D0, 776 m a.s.l., 39°19´35.43″ N, 4°01´44.07″ E, 10.vii.–16.viii.2007, Daniel Chamorro Cobo

EST 1 Järvamaa, Koeru, semi-natural meadow, M1, 115 m a.s.l., 58°58.327´ N, 26°03.244´ E, 19.vii.–22.viii.2007, Kersti Püssa, natural site

EST 2 Järvamaa, Koeru, semi-natural meadow, M2, 118 m a.s.l., 58°58.273´ N, 26°02.512´ E, 19.vii.–22.viii.2007, Kersti Püssa, natural site

EST 3 Lääne-Virumaa, Väike Maarja, semi-natural meadow, M1, 128 m a.s.l., 59°09.159´ N, 26°16.954´ E, 19.vii.–22.viii.2007, Kersti Püssa, disturbed site

EST 4 Lääne-Virumaa, Väike Maarja, semi-natural meadow, M2, 130 m a.s.l., 59°08.994´ N, 26°16.821´ E, 19.vii.–22.viii.2007, Kersti Püssa, disturbed site

FRA 1 Ile-de-France, Marchais, wheat field, D2, 179 m a.s.l., 48°31.351´ N, 2°03.488´ E, 11.vii.–12.viii.2007, Aurélie Pottier & Agnès Rortais, disturbed site

FRA 2 Ile-de-France, Longchęne, field of wheat and maize, D2, 204 m a.s.l., 48°38.234´ N, 2°01.137´ E, 12.vii.–13.viii.2007, Aurélie Pottier & Agnès Rortais, undisturbed site

FRA 3 Ile-de-France, Marchais, managed meadow, M2, 157 m a.s.l., 48°31.441´ N, 2°02.624´ E, 11.vii.–12.viii.2007, Aurélie Pottier & Agnès Rortais, disturbed site

FRA 4 Ile-de-France, Bonnelles, managed meadow, M2, 204 m a.s.l., 48°36.335´ N, 2°00.588´ E, 12.vii.–13.viii.2007, Aurélie Pottier & Agnès Rortais, undisturbed site

GER 1 Lower Saxony, Rossbach, fields, W2, 212 m a.s.l., 51°19′37″ N, 9°48′35″ E, 11.vii.–10.viii.2007, Catrin Westphal, natural site

GER 2 Lower Saxony, Rossbach, field margin, M4, 236 m a.s.l., 51°10′13″ N, 9°48′13″ E, 11.vii.–10.viii.2007, Catrin Westphal, natural site

GER 3 Lower Saxony, Rossbach, pasture with bushes, M4, 278 m a.s.l., 51°19′39″ N, 9°48′5″ E, 11.vii.–10.viii.2007, Catrin Westphal, natural site

GER 4 Lower Saxony, Rossbach, meadow with bushes, M4, 235 m a.s.l., 51°19′34″ N, 9°49′47″ E 11.vii.–10.viii.2007, Catrin Westphal, natural site

GER 5 Lower Saxony, Barterode, pasture, M3, 297 m a.s.l., 51°32′13″ N, 9°46′12″ E, 11.vii.–10.viii.2007, Catrin Westphal, disturbed site

GER 6 Lower Saxony, Barterode, stream margin, W4, 209 m a.s.l., 51°32′54″ N, 9°44′35″ E, 11.vii.–10.viii.2007, Catrin Westphal, disturbed site

GER 7 Lower Saxony, Barterode, meadow, M1, 229 m a.s.l., 51°32′3″ N, 9°44′55″ E, 11.vii.–10.viii.2007, Catrin Westphal, disturbed site

GER 8 Lower Saxony, Barterode, field, M3, 261 m a.s.l., 51°35′24″ N, 9°46′56″ E, 11.vii.–10.viii.2007, Catrin Westphal, disturbed site

HUN 1 Bács-Kiskun, Great Hungarian Plain: Kiskunság, Tázlár, managed meadow, M0, 129 m a.s.l., 46°31′13.8″ N, 19°30′16.5″ E, 2.viii.2007–4.ix.2007, György Kröel-Dulay & László Somay, natural site

HUN 2 Bács-Kiskun, Great Hungarian Plain: Kiskunság, Tázlár, pannonian sand steppe, D0, 130 m a.s.l., 46°31′10.3″ N, 19°31′9.4″ E, 2.viii.–4.ix.2007, György Kröel-Dulay & László Somay, natural site

HUN 3 Bács-Kiskun, Great Hungarian Plain: Kiskunság, Soltvadkert, managed meadow, M0, 119 m a.s.l., 46°34′52.6″ N, 19°27′29.1″ E, 2.viii.–5.ix.2007, György Kröel-Dulay & László Somay, disturbed site

HUN 4 Bács-Kiskun, Great Hungarian Plain: Kiskunság, Soltvadkert, pannonian sand steppe, D0, 120 m a.s.l., 46°34′39.8″ N, 19°28′57″ E, 2.viii.–5.ix.2007, György Kröel-Dulay & László Somay, disturbed site

ITA 1 Livenza (Pordenone), managed meadow, D4, 36 m a.s.l., 46°1.53′ N, 12°29.38′ E, 25.vii.–7.ix.2007, Lorenzin Patrizia, natural site

SER 1 Vojvodina – Srem, Fruška gora Mt., Grabovo, fallow/meadow, M2, 170 m a.s.l., 45°10′20.03″ N, 19°37′11.57″ E, 15.vii.–19.viii.2007, Aleksandar Ćetković, natural site

SER 2 Vojvodina – Srem, Fruška gora Mt., Beočin, fallow/meadow, M2, 240 m a.s.l., 45°11′09.96″ N, 19°43′03.05″ E, 15.vii.–19.viii.2007, Aleksandar Ćetković, disturbed site

SVK 1 Hronská pahorkatina hills, Čifáre, 7776, dry sites in old cherry orchard, D2, 210 m a.s.l., 48°13′15″ N, 18°23′12″ E, 11.vii.–10.viii.2007, Vladimír Smetana

SVK 2 Hronská pahorkatina hills, Beša, 7876, steppe, D1, 180 m a.s.l., 48°08′28″ N 18°24′34″ E, 11.vii.–10.viii.2007, Vladimír Smetana

SVK 3 Hronská pahorkatina hills, Jesenské údolie, 7876, dry meadow, D2, 180 m a.s.l., 48°09´10″ N 18°24´50″ E, 11.vii.–10.viii.2007, Vladimír Smetana

SVK 4 Hronská niva lowland, Levické rybníky Protected Area, 7778, wet meadow by a pond, W4, 154 m a.s.l., 48°11´17″ N 18°37´02″ E, 11.vii.–10.viii.2007, Vladimír Smetana

SVK 5 Ipeľská pahorkatina hills, Kusá hora Nature Reserve, 7777, rock forest-steppe, D0, 200 m a.s.l., 48°14´19″ N 18°35´58″ E, 11.vii.–10.viii.2007, Vladimír Smetana

SVK 6 Štiavnické vrchy hills, Skala hill, 7677, rock forest-steppe, D2, 238 m a.s.l., 48°18´10″ N 18°31´35″ E, 12.vii.–10.viii.2007, Vladimír Smetana

SVK 7 Štiavnické vrchy hills, Jabloňovce, 7678, managed submontane meadow, M1, 370 m a.s.l., 48°19´10″ N 18°48´04″ E, 12.vii.–10.viii.2007, Vladimír Smetana

SVK 8 Štiavnické vrchy hills, Uhliská, 7578, submontane meadow, M2, 640 m a.s.l., 48°23´45″ N 18°45´00″ E, 12.vii.–10.viii.2007, Vladimír Smetana

SVK 9 Ipeľská pahorkatina, Chľaba, 8178, steppe, 205 m a.s.l., D1, 47°50´ N, 18°48´57″ E, 8.vii.–4.viii.2007, Peter Šima

SVK 10 Podunajská Rovina lowland, Tvrdošovce, 7974, Panské lúky inland salt marsh, 115 m a.s.l., D1, 48°06´02″ N, 18°02´08″ E, 7.vii.– 16.viii.2007, Peter Šima

UK 1 Wiltshire, Homington Road, SU13242776, open arable agricultural landscape, M1, 55 m a.s.l., 51.049° N, 1.8125° W, 11.vii.–12.viii.2007, Stuart P. M. Roberts

UK 2 Wiltshire, Coombe Bissett Down, SU11072557, open, sheep grazed calcareous grassland, M1, 110 m a.s.l., 51.0294° N, 1.8435° W, 11.vii.–12.viii.2007, Stuart P. M. Roberts

UK 3 Wiltshire, Tottens Down Barn, SU11382422, open arable agricultural landscape, with fallow field and barley, M1, 140 m a.s.l., 51.0172° N, 1.8391° W, 11.vii.–12.viii.2007, Stuart P. M. Roberts

UK 4 Wiltshire, Odstock, SU14392642, cattle grazed grasslands some re-seeded and some damp semi-natural with *Juncus*, W1, 51.037° N, 1.7961° W, 50 m a.s.l., 11.vii.–12.viii.2007, Stuart P. M. Roberts

UK 5 Wiltshire, Britford, SU16312842, ungrazed mowed tall grass meadow, M2, 51.0549° N, 1.7687° W, 45 m a.s.l., 11.vii.–12.viii.2007, Stuart P. M. Roberts

UK 6 Wiltshire, Salisbury, Waterloo Road, SU15192950, suburban garden, M1, 50 m a.s.l., 51.0646° N, 1.7846° W, 11.vii.–12.viii.2007, Stuart P. M. Roberts

UK 7 North Lincolnshire, Caistor, Caistor Moor, TA088012, fallow/unmanaged meadows, D3, 25 m a.s.l., 53.496259° N, 0.361376° W, 8.vii.–8.viii.2007, Alan Phillips

UK 8 North Lincolnshire, Grimsby, Irby Dales (1), TA193054, grass and scrub valley, occasionally grazed, D3, 35 m a.s.l., 53.531719° N, 0.201579° W, 9.vii.–9.viii.2007, Alan Phillips

UK 9 North Lincolnshire, Grimsby, Irby Dales (2), TA186050, previously felled woodland now replanted with Oak saplings, M3, 45 m a.s.l., 53.528283° N, 0.212286° W, 9.vii.–9.viii.2007, Alan Phillips

UK 10 North Lincolnshire, Grimsby Bradley, TA239049, edge of small, young, Cherry and Oak wood/copse (3m high), surrounded by arable land, M2, 20 m a.s.l., 53.526163° N, 0.132416° W, 9.vii.–9.viii.2007, Alan Phillips

UK11 Nottinghamshire, Clumber Country Park, South Lawns, SK627740, grassland/parkland dotted with trees, periodically grazed by sheep, M2, 45 m a.s.l., 53.259307° N, 1.061552° W, 11.vii.–11.viii.2007, Alan Phillips

UK 12 Hampshire, North Hayling, SU732034, garden bordering open grazing areas, M1, 0 m a.s.l., 50.82494522° N, 0.960607929° E, 16.vii.–16.viii..2007, George R. Else

UK 13 Berkshire, Lambourn, SU4076, open arable agricultural landscape, M2, 160 m a.s.l., 51.49° N, 1.41° W, 11.vii.–15.viii.2007, Simon Springate

UK 14 Berkshire, Lambourn, SU3776, open arable agricultural landscape, M2, 150 m a.s.l., 51.48° N, 1.45° W, 11.vii.–15.viii.2007, Simon Springate

UK 15 Berkshire, Lambourn, SU3974, open arable agricultural landscape, M2, 121 m a.s.l., 51.47° N, 1.43° W, 11.vii.–15.viii.2007, Simon Springate

UK 16 Berkshire, Lambourn, SU4073, open arable agricultural landscape, M2, 111 m a.s.l., 51.46° N, 1.42° W, 11.vii.–15.viii.2007, Simon Springate

UK 17 Berkshire, Lambourn, SU3877, open arable agricultural landscape, M1, 121 m a.s.l., 51.46° N, 1.44° W, 11.vii.–15.viii.2007, Simon Springate

UK 18 Berkshire, Chilterns, SU6285, open, horse grazed calcareous grassland, M1, 145 m a.s.l., 51.52° N, 1.097° W, 13.vii.–17.viii.2007, Simon Springate

UK 19 Berkshire, Chilterns, SU6180, open arable agricultural landscape with calcareous semi-natural grassland, M2, 92 m a.s.l., 51.52° N, 1.11° W, 13.vii.–17.viii.2007, Simon Springate

UK 20 Berkshire, Chilterns, SU6180, open, cattle grazed agricultural landscape with nearby mixed plantation, M1, 130 m a.s.l., 51.52° N, 1.11° W, 13.vii.–17.viii.2007, Simon Springate

UK 21 Berkshire, Chilterns, SU6178, open, cattle grazed agricultural landscape, M2, 43 m a.s.l., 51.50° N, 1.11° W, 13.vii.–17.viii.2007, Simon Springate

UK 22 Berkshire, Chilterns, SU6277, open reed bed, D3, 48 m a.s.l., 51.49° N, 1.11° W, 13.vii.–17.viii.2007, Simon Springate

Results and discussion

General

During our study, 4015 wasps of 10 different species were trapped at 144 trapping sites (see Table 1). The following wasp species were trapped: *Polistes dominula* (Christ, 1791), *P. nimpha* (Christ, 1791), *Dolichovespula media* (Retzius, 1783), *D. saxonica* (Fabricius, 1793), *D. sylvestris* (Scopoli, 1763), *D. omissa* (Bischoff, 1931), *Vespa crabro* Linnaeus, 1758, *Vespula germanica* (Fabricius, 1793), *V. rufa* (Linnaeus, 1758), and *V. vulgaris* (Linnaeus, 1758). *V. vulgaris* and *V. crabro* were the eudominant species with more than 30 % of individuals. The third most common species was *V. germanica* with more than 13 % of individuals. *D. media* was the fourth most common species with 9% (Fig. 2).

All the four most common species were also euconstant (occurred in at least 39 % of sites): *V. vulgaris* (103 localities, 72 %), *V. crabro* (80 localities, 56 %), *V. germanica* (71 localities, 50 %), and *D. media* (57 localities, 40 %). Other species occured sporadically: *V. rufa* (16), *P. dominula* (7), *P. nimpha* (4), *D. saxonica* (1), *D. sylvestris* (1), and *D. omissa* (1). No wasps were captured in 21 localities. For more details, see Table 1. The four most common species in the current study are probably the only temperate European species being regularly and often trapped with various bait traps in different biotopes, as it is evident from the studies of Dvořák & Landolt (2006), Landolt *et al*. (2007), and Dvořák 2007. *Vespa orientalis* is the only other European species which can be trapped in large numbers using this type of baited trap (Bacandritsos *et al*. 2006).

The log transformed results of the numbers of the trapped specimens appear in Fig. 3 (The log transformation is used for more transparent results due to the high disproportion between the numbers of different wasp species.). This graph also shows that *V. vulgaris* and *V. crabro* were the most common species, followed by *V. germanica* and *D. media*. Other species occurred irregularly.

Geographical patterns

Every trapping site was assigned to one of the following four geographical groups: (a) islands – UK, (b) northern Europe – EST, (c) southern parts of Europe – ESP, SER, (d) central Europe – AUT, BEL, CZE, GER, HUN, ITA, SVK. Results are influenced by the different numbers of localities in appropriate geographical groups (22, 4, 14, 104) and, of course, the number of wasps (1002, 27, 88, 2898). Several aspects dividing these four areas are noticeable in Fig. 4. The United Kingdom has an absolute superiority for the representation of *V. vulgaris* (Fig. 4a). *V. germanica* and *D. media* are also abundant, while *V. crabro* has, in absolute terms, the lowest representation of all geographical regions (see Fig. 4a–d). This result may be influenced by the fact that *V. crabro* has an uneven distribution in the UK. Results from northern Europe (Fig. 4b) cannot be evaluated because of the small number of samples (4 localities in EST). It is evident that *V. germanica* is the most common species in our southern European samples (Fig. 4c), which can be also characterised by relatively high numbers of *P. dominula* and *P. nimpha*. All these three species are the most common in the studied parts of ESP (Madero

Montero 1988). The relatively high representation of *V. vulgaris* is based on the results from SER, where it is plentiful, while it is rare in our Spanish samples. The majority of the samples originate from central Europe. The two species, *V. vulgaris* and *V. crabro* are the two most abundant wasps in central Europe in our results (Fig. 4d). *V. germanica* and *D. media* are less common (Fig. 4d), probably because the first species is slightly thermophilous and the second one prefers forest ecosystems.

Altitudes

The representation of social wasps at diverse altitudes differs from the results of forest trapping (Dvořák 2007). The proportional representation of *V. vulgaris* and *V. crabro* is more or less similar at diverse altitudes (Fig. 5a–c), but the results differ in two other species. Evidently *D. media* is more common in forest sites and its representation is lower, while *V. germanica* prefers open habitats of many types and it is relatively common in our results (Fig. 5a–c). Similarly, as in forest trapping results (Dvořák 2007), *V. vulgaris* was the most common species in all three groups, the results differing in its relative abundance and in the numbers of other species associated with it. A "lowland" category (0–340 m a.s.l., 75 localities, Fig. 5a) has a relatively high representation of *V. crabro* (32%), which has its optimum occurrence in lowland floodplain forests and oak forests (Niedl & Deneš 1969, Smetana 2004, Dvořák & Roberts 2006) and of *V. germanica* (14%), which is eurytopic but a little silviphobic and it prefers open sites at lower altitudes (Kemper & Döhring 1967, Niedl & Deneš 1969, Madero Montero 1988, Edwards 2002a, Dvořák & Roberts 2006). A "medium" category (350–745 m a.s.l., 39 localities, Fig. 5b) is very similar to the lowland category. It differs by slightly lower numbers of *V. vulgaris*; whereas *V. crabro* and *V. germanica* have the same representation and *D. media* is more common than at other altitudes (compare Fig. 5a–c). Most interesting are the results of the "mountain" category (750–1760 m a.s.l., 30 localities, Figs 5c, 5d). Similar to the 2006 forest trapping results (Dvořák 2007), *V. vulgaris* has an absolute majority at this altitude (67%). This species is known as eurytopic in many countries (Wengris 1962, Edwards 2002b, Dvořák & Roberts 2006). The species assemblage in open habitats at this altitude is much richer than in forest trapping (Dvořák 2007). For example, *V. crabro* has a relatively high representation here (21%). Although the records come from few sites and up to 900 m a.s.l. only (see Table 1), we suspect that *V. crabro* can inhabit semi-open sites and ecotones at these altitudes. Also *V. germanica* has a relatively high representation in the mountain regions (4%) which includes three sites in central Europe up to 800 m a.s.l. and two sites in mountains of Spain (Table 1). This species is plentiful in southern Europe and can occur also at higher altitudes in Spain (Madero Montero 1988). Our record from 1495 m a.s.l. (ESP 1) is interesting.

Humidity

The results of wasp representation in sites with different humidity levels are difficult to explain. The only obvious fact is, that *V. vulgaris* had the highest percentage representation in mesic sites (Fig. 6c) and relatively low in humid ones (Fig. 6b).

BELLMANN (1999: 117) notes that the species prefers open terrain, dry to moderate. A very interesting result is the similar representation of *V. germanica* in all types of sites (Fig. 6a–c) while this species inhabits mainly open sites in warmer regions (KEMPER & DÖHRING 1967, MADERO MONTERO 1988, DVOŘÁK & ROBERTS 2006). The authors have insufficient data to determine why the predominantly forest species *V. crabro,* had the lowest representation in mesic open sites (Fig. 6c) and why the other predominantly forest species, *D. media*, showed completely different representation to that noted in forest trapping (DVOŘÁK 2007).

Height of the underbrush

All localities were divided into five groups according to the height of underbrush: 0 = no or sporadic vegetation (up to 70% of locality), 1 = low (up to 30 cm), 2 = medium (up to 75 cm), 3 = high (up to 1.5 m), 4 = very high (more than 1.5 m). Very common in all categories was *V. vulgaris*. The numbers of this species more or less increased with the height of the underbrush (Fig. 7). This is probably not due to any higher preference for taller vegetation, but because of the limiting effects of taller vegetation on other species. On the other hand, *V. germanica* showed similar representations in all categories except the tallest underbrush, where this species had a lower percentage of representation. (Fig. 7). *D. media* had the highest representation in low growing vegetation up to 30 cm (Fig. 7b). None of the other wasp species showed any visible trend (Fig. 7).

Different biotopes

Almost all the biotopes had one feature in common: the dominance of *V. vulgaris* (Fig. 8). The only exceptions are gardens, where *D. media* was the most common (Fig. 8f, strongly influenced by the results from the UK). The other data more or less reflect the ecological requirements of all species. For example, *V. germanica*, as a xerophilous species (KEMPER & DÖHRING 1967, MADERO MONTERO 1988, DVOŘÁK & ROBERTS 2006) had the highest representation at steppe sites (Fig. 8a), while *D. media* was found only sporadically in dry steppes and fields (Fig. 8a, e).

Disturbance

All locations included in the ALARM field site network were divided into disturbed and undisturbed sites. Disturbed landscapes are dominated by a single land use type. In these study sites there are agricultural or other anthropogenic habitats with very little natural or semi-natural vegetation. Undisturbed landscapes have a mosaic of semi-natural, agricultural and anthropogenic habitats. The two species, *V. vulgaris* and *V. germanica*, had visibly higher representations in disturbed sites (Fig. 9a). Both species are common at secondary sites and in urban areas (KEMPER & DÖHRING 1967, PAWLIKOWSKI 1990, MÓCZÁR 1996, DVOŘÁK & ROBERTS 2006). The differences are higher than in a previous study that focused on forest sites (DVOŘÁK 2007). *V. crabro* had a much higher representation in natural sites, while the percentage in disturbed and undisturbed sites was the same for *D. media* (Fig. 9b).

Comments on individual wasp species

Vespa crabro Linnaeus, 1758 was the second most common species in this study (Figs 2–3, Table 1), a situation similar to that reported for forested sites (Dvořák 2007). It was very common in the whole of Europe except the United Kingdom (Fig. 4), where it has a restricted distribution. The numbers of this species decreased from lower altitudes to higher altitudes (Fig. 5), as in forest sites (Dvořák 2007). Very interesting are the proportions associated with moisture (Fig. 6): *V. crabro* was more common at humid and dry sites than at mesic ones, where another species, *V. vulgaris*, was eudominant. *V. crabro* showed the lowest numbers in gardens, while the representation in other biotopes was almost equal (Fig. 8). The representation at natural sites was much higher than in disturbed ones (Fig. 9). These results agree with published data, which indicate that the species has its optimum occurrence in lowland floodplain forests and oak forests, but it can also inhabit other habitats (Wengris 1962, Kemper & Döhring 1967, Niedl & Deneš 1969, Madero Montero 1988, Archer 1997, Smetana 2004, Dvořák & Roberts 2006).

Vespula germanica (Fabricius, 1793) was the third commonest species (Figs 2–3, Table 1). As a thermophilous species (Kemper & Döhring 1967, Madero Montero 1988, Dvořák & Roberts 2006), it was the commonest species in southern Europe (Fig. 4c) and relatively rare at higher altitudes (Fig. 5c). Surprisingly, this species had almost the same representation in mesic, dry and humid sites (Fig. 6a–c). It had very low representation in sites with vegetation higher than 1.5 m (Fig. 7e). As a xerophilous species, *V. germanica* had the highest representation in steppes and pastures (Fig. 8a, c). This species was almost twice as plentiful at disturbed sites than at natural ones (Fig. 9). Smetana (2004) mentioned *V. germanica* as a species preferring forest-steppe areas. Most authors (Kemper & Döhring 1967, Madero Montero 1988, Edwards 2002a, Dvořák & Roberts 2006) ranked this species as ubiquitous and preferring open sites.

V. vulgaris (Linnaeus, 1758) was the most common species in our study (Figs 2–3, Table 1). As an oligoeurythermic species (sensu Gusenleitner 1975), it is quite rare in southern parts of Europe and at lower altitudes (see Figs 4–5). This species absolutely dominates in the open habitats of high altitudes (Fig. 5c), even more than in forest habitats (Dvořák 2007). *V. vulgaris* is the most common species in mountainous areas, mainly in forests (Madero Montero 1988, Kuhlmann 1999, 2001, 2002). This species was commonest at mesic sites, where it has more than half of the individuals (Fig. 6). A very interesting result is the very high representation of this species at the sites with tall vegetation (Fig. 7d,e). During the research, *V. vulgaris* was the commonest species in different types of open sites except gardens (Fig 8). It had more than 50% of the individuals at disturbed sites; the dominance at natural sites was not so obvious (Fig. 9).

Vespula rufa (Linnaeus, 1758) is only irregularly trapped with baited traps (see also Dvořák & Landolt 2006, Dvořák 2007), and only 23 specimens were trapped during our study (Table 1). This figure is too small for any evaluation.

Dolichovespula media (Retzius, 1783) was the fourth most common species with 9 % representation (Figs 2–3, Table 1). As in the forest trapping (Dvořák 2007), it has the highest representation in the British Isles and northern Europe (Fig. 4a, b). In

comparison with the forest results, *D. media* had the highest representation at medium altitudes (Fig. 5b). *D. media* was evidently more common in humid and mesic sites than in dry ones (Fig. 6) and had the highest percentage at sites with low vegetation up to 30 cm in height (Fig. 7b). The results from different biotopes cannot be explained easily. *D. media* is predominantly a species of forest and bushy sites (Dvořák & Roberts 2006, Mauss & Treiber 1994: 46, Bellmann 1999: 127), so its occurrence in different open biotopes (Fig. 8) depends on the presence of trees and bushes in the neighbourhood. It was a very common species in gardens (Fig. 8f); the results are strongly influenced by the data from the UK, where *D. media* is a recent colonist that occurs commonly in gardens (Else 1997). Most authors have reported *D. media* as a relatively rare species occurring in different forest types (Niedl & Deneš 1969, Kuhlmann 1999, 2001, 2002, Smetana 2004, Dvořák & Roberts 2006). Dvořák (2007) noted this fact with two possible explanations: (i) the good response of this species to baited traps and (ii) probably a significant increase of numbers of *D. media* in Europe. It seems that after further years of study both hypotheses seem to be correct. *D. media* seems to be spreading in Europe and is becoming more and more common.

Dolichovespula saxonica (Fabricius, 1793), *D. sylvestris* (Scopoli, 1763) and *D. omissa* (Bischoff, 1931) were trapped only as single specimens (Table 1). All these species prefer forest and bushy sites (Kemper & Döhring 1967, Dvořák & Roberts 2006, Blüthgen 1961) but they are not regularly attracted to bait traps (Dvořák & Landolt 2006, Landolt *et al*. 2007, Dvořák 2007).

Polistes dominula (Christ, 1791) and *P. nimpha* (Christ, 1791) were trapped in low numbers (10 and 6 specimens, respectively) (Table 1). The species of the genus *Polistes* inhabit various open sites (Dvořák & Roberts 2006, Mauss & Treiber 1994, Bellmann 1999). They are relatively regularly attracted to baited traps, but usually in very small numbers (Dvořák & Landolt 2006, Landolt *et al*. 2007, Dvořák 2007). Maybe both species can be trapped in higher numbers in traps set close to the ground, because both species prefer to fly through the grass and herb vegetation (L. Dvořák, unpubl. data). On the other hand, *P. dominula* was trapped in tree crowns using red wine and beer as attractants in Italy (L. Dvořák, unpubl. data).

Conclusion

As Dvořák (2007) has previously noted, beer is a very good attractant for several species of social wasps. This method can be recommended as a useful method for social wasp research. In total, four wasp species (*Vespa crabro*, *Vespula vulgaris*, *V. germanica*, and *Dolichovespula media*) are regularly trapped with beer in open ecosystems. The other trapped species either (i) can be trapped more or less regularly, but in small numbers only (*Vespula rufa*, *Polistes dominula*, *Polistes nimpha*) or (ii) show a very low response to bait traps (*Dolichovespula sylvestris*, *D. omissa*).

This study continued the research of 2006, which focused on wasp trapping using the same methodology in forest ecosystems. The results are relatively similar for the species assemblage and reflect the situation of *Vespa crabro*, *Vespula germanica*, *V. vulgaris*, and *Dolichovespula media* only, because these four species showed a good

response to various attractants (this study, Dvořák 2007, and Landolt *et al*. 2007). These four species seem to be the only species regularly attracted to bait traps in temperate Europe.

The results may be influenced by wasp numbers varying between individual years and also due to the apparent low response of members of genera *Dolichovespula* (except *D. media*) and *Polistes* to bait traps. The results of similar trapping projects do not reflect the real proportions in the wasp assemblage in the study areas. From this point of view, baited traps appear to be an excellent and effective method for social wasp research.

Acknowledgements

The authors would like to thank all the people who participated in the research. They are mentioned in the list of localities. We would like to thank Koos Biesmeijer and the field staff of the Focal Site Network of the EU FP6 Integrated Project ALARM (Assessing LArge scale environmental Risks for biodiversity with tested Methods – GOCE-CT-2003-506675) for organizing the wasp trapping on their sites. Michal Horsák (Masaryk University, Brno, Czech Republic) has created Fig. 3.

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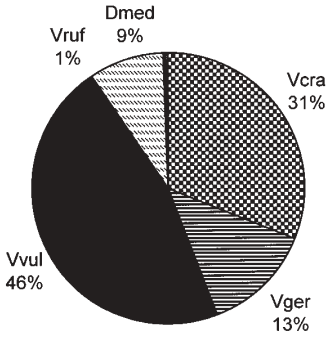


Fig. 2. Wasp species representation during the study.

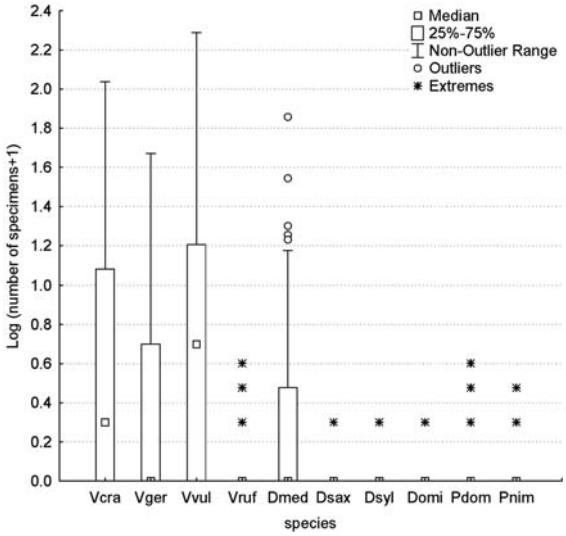


Fig. 3. Variability of abundance of individual species within collected samples. The original numbers were log transformed.

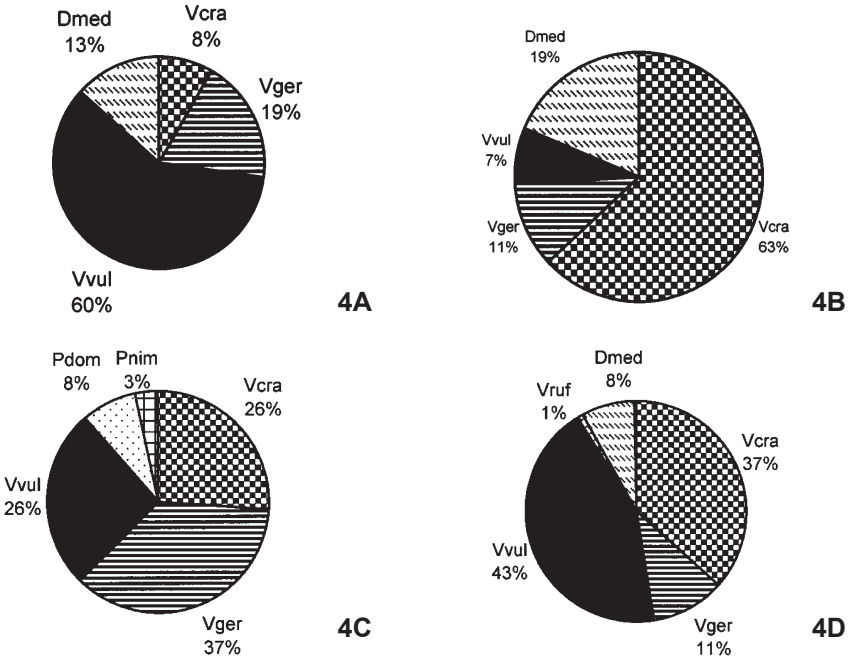
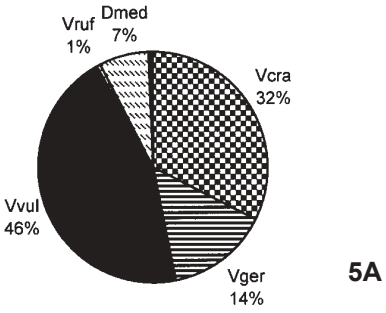
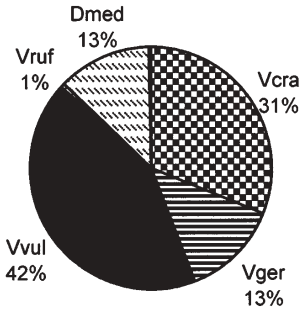


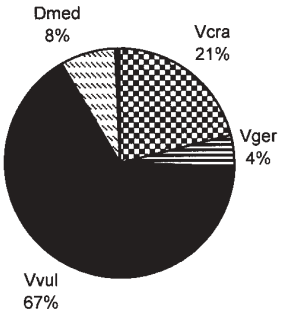
Fig. 4. Wasp representation in the British Isles (A), northern Europe (B), central Europe (C), and southern Europe (D).



5A



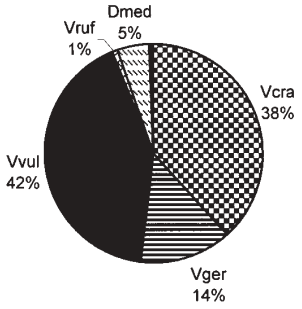
5B



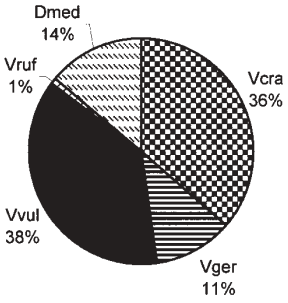
5C

Fig. 5. Wasp representation at lower altitudes (A: 0–340 m), at medium altitudes (B: 350–745 m), and at mountain altitudes (C: 750–1760 m).

Fig. 6. Wasp representation at dry (A), humid (B), and mesic (C) open sites.



6A



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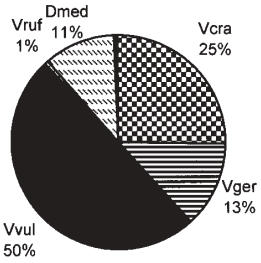

6C

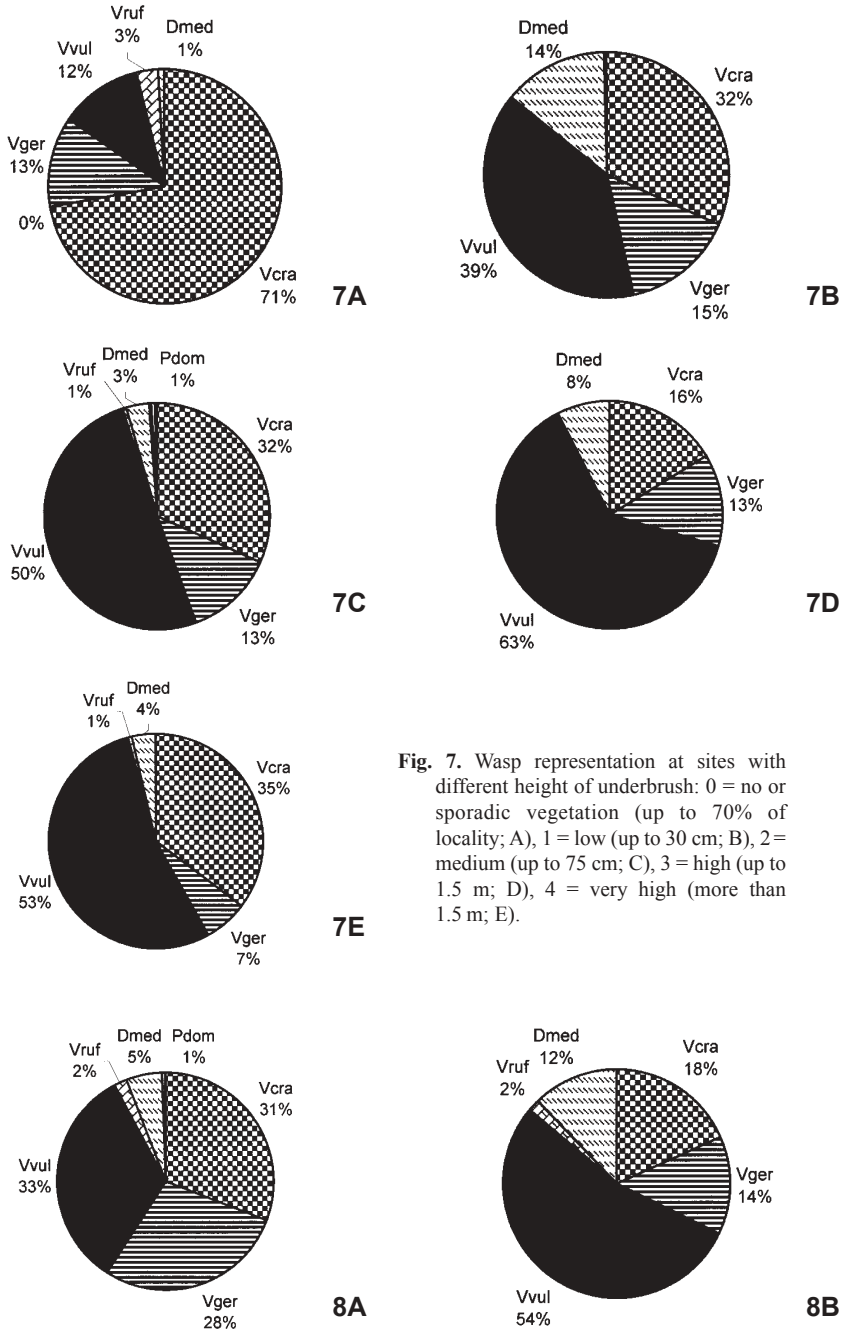

Fig. 7. Wasp representation at sites with different height of underbrush: 0 = no or sporadic vegetation (up to 70% of locality; A), 1 = low (up to 30 cm; B), 2 = medium (up to 75 cm; C), 3 = high (up to 1.5 m; D), 4 = very high (more than 1.5 m; E).

Fig. 8. Wasp representation at different types of open sites: steppes (A), peat-bogs (B). To be continued.

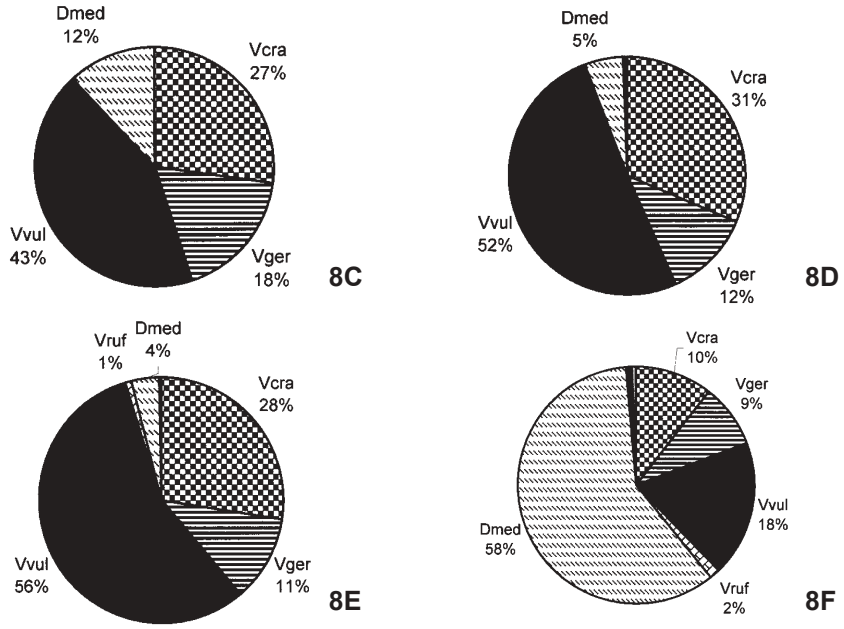

Fig. 8. Wasp representation at different types of open sites: pastures (C), meadows (D), fields (E), and gardens (F).

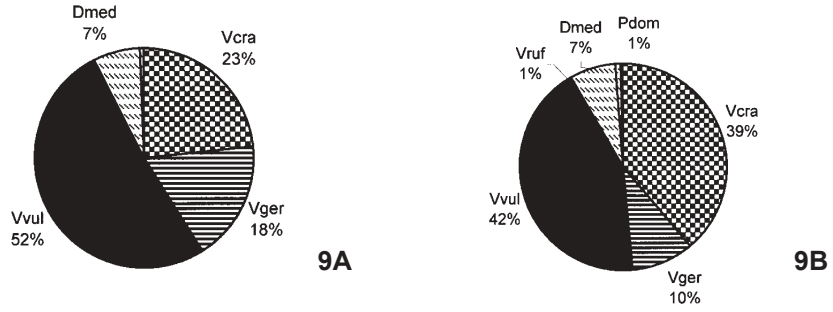

Fig. 9. Wasp representation at disturbed (A) and undisturbed (B) sites.

State code	Locality number	Vcra	Vger	Vvul	Vruf	Dmed	Dsax	Dsyl	Domi	Pdom	Pnim	All
AUT	1			3		4						7
AUT	2	6	9	17		8						40
AUT	3	27	2	73		4						106
AUT	4	3		13								16
AUT	5	15	6	158		17					1	197
AUT	6	27		4		2						33
AUT	7	18	6	15		5						44
AUT	8	30	25	12		19						86
AUT	9	11	32	35		12						90
AUT	10	23	4	18	1	14						60
AUT	11	23	12	36		6						77
AUT	12	53	1	35		10						99
BEL	1	3	5	14								22
CZE	1	7	1	2								10
CZE	2	14	1	2		1						18
CZE	3	2										2
CZE	4	19		12								31
CZE	5			2								2
CZE	6				1							1
CZE	7	3		21		1						25
CZE	8			2								2
CZE	9		1	12								13
CZE	10	1		2		5						8
CZE	11			2		1						3
CZE	12	4		5								9
CZE	13	9	2	2								13
CZE	14	5	3	2								10
CZE	15	6	2	12								20
CZE	16	108	6	35		2						151
CZE	17	11		5								16
CZE	18	21		14								35
CZE	19	16	2	11		1						30
CZE	20	6								1		7
CZE	21		4									4
CZE	22											0
CZE	23	1		1								2
CZE	24											0
CZE	25											0
CZE	26											0
CZE	27											0
CZE	28			2		2						4
CZE	29											0
CZE	30	2		2	1							5
CZE	31	6										6
CZE	32			3		1						4
CZE	33	1				2						3
CZE	34											0
CZE	35											0

Table 1. Wasp numbers from each trapping site during the study. Part 1. (Continued.)

State code	Locality number	Vcra	Vger	Vvul	Vruf	Dmed	Dsax	Dsyl	Domi	Pdom	Pnim	All
CZE	36			1								1
CZE	37			1								1
CZE	38											0
CZE	39	16	2			2						20
CZE	40	4	2	2								8
CZE	41			2								2
CZE	42	1										1
CZE	43	33	2	5								40
CZE	44	23	23	15							2	63
CZE	45	5	3	3		2						13
CZE	46	29				4						33
CZE	47	6		1		1						8
CZE	48	12	3	4	2	1						22
CZE	49	5		4	1	1						11
CZE	50	7	12	21	3	71	1			1		116
CZE	51			1								1
CZE	52											0
CZE	53											0
CZE	54			2					1			3
CZE	55	72	8	3	2	1						86
CZE	56	72		32	1	3						108
CZE	57	5	8	11								24
CZE	58	16		2								18
CZE	59	6	3	8								17
CZE	60	7	5	15								27
CZE	61	46	5	19		4						74
CZE	62	9	2	10								21
CZE	63	34	6	26		4						70
ESP	1		2									2
ESP	2			1								1
ESP	3		2							1	1	4
ESP	4		3							1		4
ESP	5											0
ESP	6											0
ESP	7											0
ESP	8		1									1
ESP	9											0
ESP	10											0
ESP	11			1								1
ESP	12			2								2
EST	1					1						1
EST	2	1	1	2								4
EST	3	16	2			4						22
EST	4											0
FRA	1	42		14								56
FRA	2	26		6	2							34
FRA	3	25		50								75
FRA	4	22		26		2						50

Table 1. Wasp numbers from each trapping site during the study. Part 2. (Continued.)

State code	Locality number	Vcra	Vger	Vvul	Vruf	Dmed	Dsax	Dsyl	Domi	Pdom	Pnim	All
GER	1	35	2	15	2							54
GER	2	5	2	33		1						41
GER	3	4	3	20								27
GER	4			4	1							5
GER	5	12		18		1						31
GER	6	4		5								9
GER	7	1	4	20	1	1						27
GER	8		8	20								28
HUN	1		1									1
HUN	2	1	3									4
HUN	3											0
HUN	4											0
ITA	1											0
SER	1	14	11	8						2		35
SER	2	9	13	11						3	2	38
SVK	1	1	8									9
SVK	2		9	9								18
SVK	3		8	1								9
SVK	4	11				1						12
SVK	5			4								4
SVK	6	1	1	4		1						7
SVK	7	10	4	4								18
SVK	8	14	18	193		3						228
SVK	9	19	21	11						1		52
SVK	10											0
UK	1		7	19		1						27
UK	2		37	34	1	11						83
UK	3		3	5								8
UK	4			9		14						23
UK	5		2	1		4						7
UK	6	4		12		34						50
UK	7		46	103	1	4						154
UK	8		5	37		8						50
UK	9		3	72	1	16						92
UK	10			5	2	1						8
UK	11	48		8		2						58
UK	12	3	5	3		12		1				24
UK	13	2	15	38		6						61
UK	14		12	112		4						128
UK	15		2	18								20
UK	16	4	5	17								26
UK	17			18		6						24
UK	18	11	21	21		1						54
UK	19			5								5
UK	20	10	17	19								46
UK	21		7	19		5						31
UK	22	2	3	15		3						23
Sum	–	**1246**	**525**	**1844**	**23**	**358**	**1**	**1**	**1**	**10**	**6**	**4015**

Table 1. Wasp numbers from each trapping site during the study. Part 3.