THE WASPS, ANTS AND BEES (HYMENOPTERA: ACULEATA) OF ALLERTHORPE COMMON IN WATSONIAN YORKSHIRE REVISITED

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INTRODUCTION

Allerthorpe Common is probably one of the most recorded sites in Watsonian Yorkshire, although there are few records before the 1920s when Fordham started recording. The Common is a site of about 2030ha some ten miles south east of York (SE7647) and was a lowland heathland. According to Fordham (1922), the Common was made up of dry and wet areas carrying heather, cotton grass, birch scrub and bare sandy patches and was subject to fires which were sometimes extensive. During the mid-1960s, most of the Common was planted with conifers, so that the areas of wet and dry heathland became much reduced and those that remained were invaded by birch, oak and sallow unless kept open. The rides were kept open and were sufficiently wide to provide nesting and foraging sites for aculeates, although much bramble had been removed. More recently, during the 2000s, some woodland clearance has been carried out mainly to provide suitable habitat for breeding nightjars and some bramble has reappeared. A report of the aculeate wasps and bees of the Common, before and after coniferization, was provided by Archer (1989). Because of the recent management changes, it was decided to make a repeat study to investigate species differences from those found by Archer (1989).

SAMPLING METHODS

Since the previous study of Archer (1989), all the records have been placed in an electronic database. During the formation of this database eight new recorders for the Common have been found (J.M.B., 1936; J.D. Coldwell, 1997; R. Crossley, 1999; J.R.D., 1901; M.L. Denton, 1985; A. Grayson, 1994; P. Kendall, 2004; R.C.L. Perkins, 1928). To take account of these new records, it was decided to reappraise the data. The records were divided into three time periods: 1901–1967 (13 recorders, with records mainly by W.J. Fordham), 1971–1999 (nine recorders, with records mainly by M.E. Archer) and 2004–2008 (the revisited records, with two recorders, mainly made by the author).

For each visit, usually of approximately three hours, the author recorded all species of aculeate wasps and bees and usually collected them with a hand net for later identification. The methods used by the other recorders are unknown but were likely by using hand or sweep nets.

Due to poor weather conditions, the author sometimes had to make more than one visit during the third period to make a complete survey of the Common. As such, the 39 visits represent 32 surveys distributed throughout the year as follows: March (1), April (4), May (6), June (7),

July (6), August (6) and September (2). During the second period between 1972 and 1990, the author made 76 visits to the Common which cannot now be converted into surveys. For the first period it is also not possible to indicate the number of surveys. For example, Fordham made a minimum of 166 visits with often only one species being recorded on each visit. The total number of visits made by Fordham cannot be known since the day number, and the month, may not have been recorded. From the Fordham Cards and Fordham specimens in museums, he recorded 110 solitary species consisting of 61 solitary wasps and 49 solitary bees.

THE NUMBER OF SPECIES

Table 1 shows the number of solitary and social species and the number of records for the solitary species for the three periods. Few records were made of the DEB (Dryinidae, Embolemidae, Bethylidae) species and no records of the Formicidae were made during the third period. The most species rich families of solitary wasps in all three periods were the Crabronidae followed by the Pompilidae, and of solitary bees were the Andrenidae and Halictidae followed by the Apidae. A full list of species with authorities and periods when recorded is given in the Appendix. In the following account, the nomenclature is mainly according to Kloet & Hincks (1978) with an up-to-date checklist from the Bees, Wasps and Ants Recording Society (BWARS) web pages at http://www.bwars.com.

More species and records were reported during the first period than each of the second and third periods. The total number of species and records are similar for the second and third periods although during the second period more solitary wasps and fewer solitary bees were reported than during the third period. Particularly noticeable are the loss of chrysid records during the third period, the gradual loss of pompilid and eumenine species and records during the second and third periods and the loss of megachilid species during the second and third periods.

Forty species were only recorded during the first period. Three species (*Symmorphus crassicornis*, *Mellinus crabroneus*, *Ceropales maculata*) have become extinct in Yorkshire and 15 species are aerial nesters (species of *Trypoxylon*, *Crossocerus*, *Passaloecus*, *Megachile*). The relevance of these aerial nester species will be considered later in the paper. The remaining 22 species, usually recorded on one to three occasions, are rare (e.g. *Andrena praecox*, *Lasioglossum lativentre*, *Sphecodes ferruginatus*, *Coelioxys rufescens*), widespread (e.g. *Crossocerus elongatulus*, *Andrena lapponica*, *Lasioglossum cupromicans*) or at their northern limit in Yorkshire (e.g. *Pompilus cinereus*, *Colletes fodiens*, *Andrena angustior*) (Archer, 2002).

A further 28 solitary species were only recorded during the second and third periods. Three species (*Cerceris arenaria*, *Sphecodes ephippius*, *S. reticulatus*) have become new species for Yorkshire; eleven species are probably new species being recorded on many occasions on the Common

TABLE 1 — THE NUMBER OF SPECIES AND RECORDS PER ACULEATE FAMILY OR SUBFAMILY RECORDED FROM ALLERTHORPE COMMON DURING PERIOD 1 (P1, 1901–1967), PERIOD 2 (P2, 1971–1999) AND PERIOD 3 (P3, 2004–2008)

	No. species				No. records			
	P1	P2	P3	Total	P1	P2	P3	Total
Solitary wasps								
Dryinidae	2	4	0	5	2	4	0	6
Chrysididae	7	5	0	7	16	7	0	23
Tiphiidae	1	1	1	1	3	3	1	7
Mutillidae	1	1	1	1	7	3	6	16
Pompilidae	12	10	6	14	67	40	17	124
Vespidae: Eumeninae	6	5	3	7	23	6	3	32
Sphecidae	1	1	1	1	40	13	17	70
Crabronidae	37	22	25	45	293	143	119	555
Total solitary wasps	67	49	37	81	451	219	163	833
Solitary bees								
Colletidae	5	2	5	6	38	13	16	67
Andrenidae	21	16	15	25	121	65	79	265
Halicitidae	17	12	19	24	121	95	133	349
Megachilidae	9	3	2	10	31	15	28	74
Apidae	11	8	11	15	52	42	42	136
Total solitary bees	63	41	52	80	363	230	298	891
Total solitary species (TSS)	130	90	89	161	814	449	461	1724
TSS minus Dryinidae	128	86	89	156	812	445	461	1718
Social species								
Formicidae	2	4	0	5				
Vespidae: Vespinae	2	3	6	6				
Apidae	12	11	13	17				
Total social species	16	18	19	28				
Total aculeate species (TAS)	146	108	108	189				
TAS minus Dryinidae	144	104	108	184				

(e.g. *Priocnemis perturbator* (8 records), *Lindenius albilabris* (12), *Lasioglossum leucozonium* (23), *Sphecodes ephippius* (23), *Megachile versicolor* (17), *Nomada lathburiana* (7)). The remaining 14 species, usually recorded on one to three occasions, are rare (e.g. *Caliadurgus fasciatellus*, *Lasioglossum morio*, *Sphecodes crassus*), widespread (e.g. *Andrena fulva*, *Nomada goodeniana*) or at their northern limit in Yorkshire (e.g. *Mimesa lutaria*, *Andrena minutula*) (Archer, 2002).

For Archer visits in the third period, the mean number of solitary species recorded per survey was 12.8 (range 3–23). Most solitary species were recorded during June (Table 2) with a gradual fall-off before and after June.

Based on the number of records, the commonest solitary wasps from all three periods were *Ammophila sabulosa*, *Crabro cribrarius*, *C. peltarius*,

TABLE 2 — THE NUMBER OF SOLITARY SPECIES RECORDED PER MONTH FROM THE ARCHER ALLERTHORPE PERIOD

	Mar	Apr	May	Jun	Jul	Aug	Sep
Mean	3	8.3	14.0	16.9	14.3	12.3	5.5
Range	3	6–9	8–19	11–23	12–18	9–16	5–6

Oxybelus uniglumis and *Mimesa equestris* which are all subterranean nesters. Other common solitary wasps recorded during the first period were *Priocnemis exaltata*, *Crossocerus pusillus*, *C. quadrimaculatus*, *C. tarsatus*, *Ectemnius lapidarius* and *Diodontus tristis*, which are subterranean nesters except for *E. lapidarius* which is an aerial nester. Except for *D. tristis* during the second period, all these species were less frequently recorded during the second and third periods while *E. lapidarius* was not recorded during the second period and *P. exaltata*, *C. tarsatus* and *E. lapidarius* were not recorded during the third period.

Similarly, the commonest solitary bees from all three periods were *Andrena barbilabris*, *A. clarkella*, *Lasioglossum calceatum*, *L. fratellum* and *L. rufitarse* which are all subterranean nesters. Other common solitary bees only found in one or two periods were for the first period (*Hylaeus communis*, *Andrena denticulata*, *Lasioglossum albipes* and *Coelioxys elongata*); for the first and second periods (*Colletes succinctus*, *Halictus rubicundus* and *Nomada rufipes*); for the second period (*Sphecodes geoffrellus* and *Nomada panzeri*); for the second and third periods (*Sphecodes pellucidus*, *Megachile willughbiella* and *Nomada leucophthalma*) and for the third period (*Andrena subopaca*, *Lasioglossum leucozonium*, *L. villosulum* and *Megachile versicolor.*

Of the social species, *Bombus distinguendus* and *B. humilis* have become extinct in Yorkshire only being recorded during the first period. *Bombus muscorum* and *B. barbutellus* were not recorded during the third period with *B. muscorum* having been lost from the Common although *B. barbutellus* may still be present (Archer, 2002). Although the social wasps were poorly recorded during the first and second periods, *Dolichovespula media* was a new species for the Common during the third period (Archer, 2002).

SPECIES QUALITY

According to Shirt (1987) and Falk (1991), of the solitary species, five are Red Data Species (*Symmorphus crassicornis*, *Mellinus crabroneus*, *Andrena ruficrus*, *Coelioxys quadridentata*, *Nomada roberjeotiana*) and from Falk (1991) the following nationally scarce species: *Lasioglossum quadrinotatum* with National Notable A Status (Na) and *Methocha ichneumonides*, *Andrena humilis*, *A. nigriceps*, *Sphecodes crassus* and *S. ferruginatus* with National Notable B Status (Nb).

TABLE 3 — THE HIGH QUALITY SPECIES OF SOLITARY WASPS AND BEES FROM ALLERTHORPE COMMOM RECORDED DURING THE THREE PERIODS (P1, P2, P3)

	Very rare	Rare	Scarce
Chrysis viridula			P1
Methocha articulata			P1, P2, P3
Anoplius viaticus			P1, P2
Calliadurgus fasciatellus			P2
Ceropales maculata		P1	
Symmorphus crassicornis	P1		
Diodontus tristis			P1, P2
Mellinus crabroneus	P1		
Andrena humilis			P3
Andrena nigriceps			P1
Andrena ruficrus	P1, P2, P3		
Lasioglossum quadrinotatum			P1
Sphecodes crassus			P3
Sphecodes ferruginatus			P1
Coelioxys quadridentata	P1		
Nomada roberjeotiana		P1, P2	

Recent work by the Bees, Wasps and Ants Recording Society indicates that *Lasioglossum quadrinotatum* should be downgraded and the additional species, *Chrysis viridula*, *Calliadurgus fasciatellus*, *Anoplius viaticus*, *Ceropales maculata* and *Diodontus tristis* should be given a National Scarce Status. To take account of these changes, Archer (1999, 2002) has developed a national quality scoring system of high and low quality scoring species. High quality species have a scarce (equivalent to Nb), rare (equivalent to Na) or very rare (equivalent to RDB) status while low quality species have a universal, widespread or restricted status. The DEB species are not included in this scheme as there is insufficient information about their national distribution. The high quality species with the periods during which they were recorded are given in Table 3.

By adding the Archer status values of each solitary species from the three periods, the national quality scores of 371, 182 and 171 can be calculated (Table 4). Dividing the national quality scores by the respective number of species gives the species quality scores (SQS) of 2.90, 2.12 and 1.92. Caution is needed in accepting the SQS for the first period since species status values may show temporal change. However, there does seem to have been an increasing loss of SQS from the first to third periods with the loss of high quality species (Table 3).

Species quality scores have been found to be relatively independent of area of the site under study, so that SQS can be used to compare sites of different areas (Archer, 1999). The SQS of studied sites in Yorkshire can be placed into one of three classes (Archer, 2003): first class, 2.4–2.9; second class 1.8–2.3; and third class, 1.2–1.7. Therefore, Allerthorpe

TABLE 4 — THE ARCHER NATIONAL QUALITY SCORES OF THE SOLITARY SPECIES FROM ALLERTHORPE COMMON RECORDED DURING THE THREE PERIODS (P1, P2, P3)

	Status	No. species			Species quality			Combined	
		P1	P2	P3	P1	P2	P3	No. species	Species quality
Universal	1	75	58	55	75	58	55	85	85
Widespread	2	40	22	30	80	44	60	55	110
Scarce	8	7	4	3	56	32	24	10	80
Rare	16	2	1	0	32	16	0	2	32
Very Rare	32	4	1	1	128	32	32	4	128
Total		128	86	89	371	182	171	156	435

Species Quality Scores (SQS) – P1 371/128 = 2.9
P2 182/86 = 2.1
P3 171/89 = 1.9
Combined 435/156 = 2.8

Common can be considered a first class site during the first period and a second class site during the second and third periods.

The social wasps and bumblebees of the third period and the ants are all common and widespread species except for *Bombus jonellus* which tends to be restricted to heathlands and moorlands.

ESTIMATING THE POTENTIAL NUMBER OF SOLITARY WASP AND BEE SPECIES

One of the problems in the study of any site is the difficulty of knowing how many more species are present at a site, but as yet unrecorded. Recent advances in non-parametric statistical procedures offer a way of addressing this problem. The presence/absence estimate of Chao (in Colwell & Coddington, 1994) is based on the number of species that are observed in one (singleton) or two (doubleton) visits. The First Order Jackknife procedure depends only on the singletons (Heltshe & Forester, 1983). Because some aculeate species are only active in the spring or summer it is advisable that records are taken throughout the months of adult activity. The software to carry out the statistical procedure was provided by Pisces Conservation Ltd.

The statistical procedures were run for the second and third periods using the author's solitary species data. For the 76 visits of the second period, the data were grouped by the month and year variables resulting in 42 samples. For the third period the 32 surveys were treated as the samples. The software takes species recorded on 1, 2, etc. visits at random 100 times, each time calculating a mean estimate of potential species diversity. When a small number of visits are considered, the estimates are erratic, but as more visits are selected the estimates may stabilise giving confidence in them. The species diversity estimates are shown in Figs 1 and 2 and Table 5 shows the final potential species richness after all the

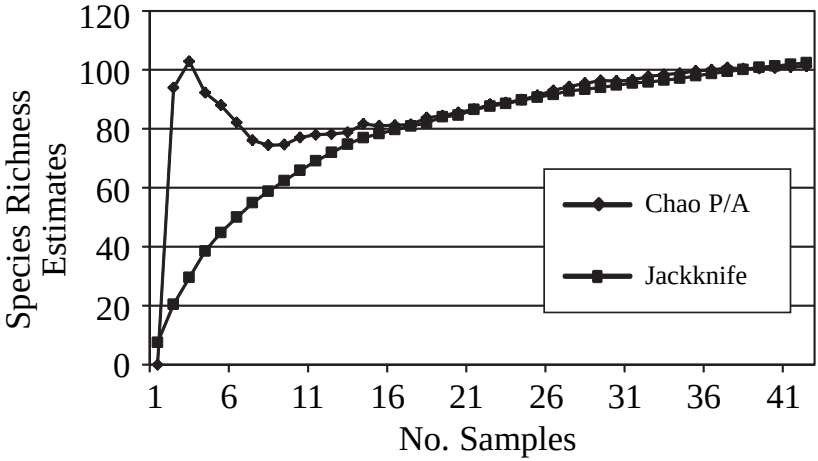

Fig. 1 — Species richness estimates using the presence/absence of Chao and Jackknife procedures for Period 2 of Allerthorpe Common.

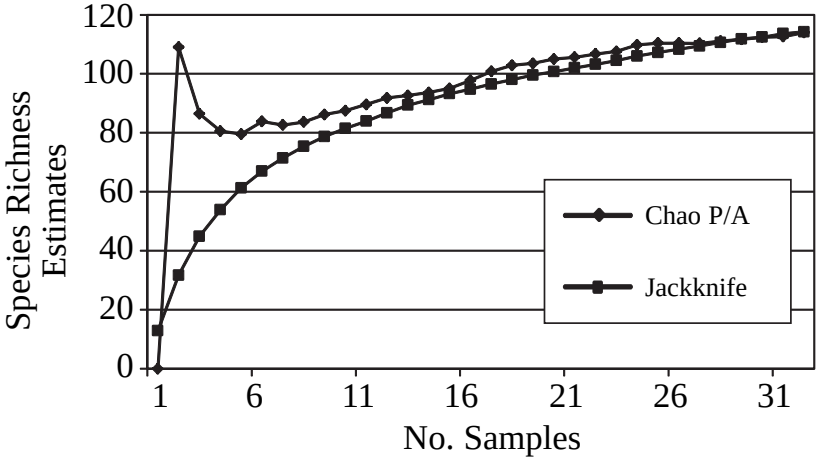

Fig. 2 — Species richness estimates using the presence/absence of Chao and Jackknife procedures for Period 3 of Allerthorpe Common.

samples have been considered. The estimates for the two periods do stabilise and the two procedures predict similar potential numbers. The third period shows an increase of potential numbers of species compared with the second period.

Cleptoparasitic Load

The cleptoparasitic load (CL) is the percentage of aculeate species that are cleptoparasitic (or parasites) on other host aculeates. Wcislo (1987) showed that parasitic behaviour among bees was more frequent in temperate than tropical regions (N=114 samples, between 5–80° N). Wcislo indicated that parasitic rates are higher in temperate regions, as host populations are more synchronised in their life-history characteristics than in tropical regions. This finding probably does not hold for hot desert regions where the occurrence of rainfall would tend to synchronise life history characteristics. Wcislo also reviewed the wasp literature, reaching the same conclusion but did not carry out a numerical investigation.

From a review of the literature, Wcislo found that the CLs for bees in Europe varied from 16–33%, a range of 17%. For 30 Yorkshire sites, the CLs for the solitary bees varied from 21.2–40.5%, a range of 19.3% (Archer, unpublished) so supporting Wcislo (1987). The CLs for the three periods fall within this range (Table 6).

The CLs of solitary wasps from 30 sites also fall within a similar range of 10.3–25.0%, a range of 14.7% (Archer, unpublished), so the Wcislo hypothesis may also apply to the solitary wasps. The CLs for the first and second periods fall within this range, but below this range for period three because of the failure to record any chrysid species (Table 6).

Aerial Nester Frequency

The aerial-nester frequency (AF) is the percentage of non-parasitic aculeate species that have aerial nest sites. Aerial nesters use old beetle burrows in dead wood, central stem cavities (e.g. bramble), old snail shells, or crevices in cob walls, old mortar, or nests exposed on the surface of rock or other hard material. Subterranean nesters nest in the soil, usually in burrows dug by them, but sometimes existing holes and crevices are used after being altered.

The AF for the three periods for the solitary species are given in Table 7. From a sample of 30 Yorkshire sites, the very variable AFs for solitary wasps were between 0–90% and for solitary bees between 6.7–40.0% depending on the availability of nest sites (Archer, unpublished). The AF for all the British species of solitary wasps is 46.2% and solitary bees is 17.9%. The AF for the solitary wasps for the first period is similar to the British data but lower for the second and third periods, with the third period being slightly higher than the second period. The AFs for the solitary bees show a similar pattern to the solitary wasps except that the AF for the third period, which approaches the British data, is much higher than the second period.

DISCUSSION

Was the recording of 40 solitary species only in the first period due to a loss of species from the Common by periods two and three or because they were unlikely to be recorded again during periods two and three due

TABLE 5 — ESTIMATES OF SPECIES RICHNESS FOR PERIODS 2 AND 3 OF ALLERTHORPE COMMON USING CHAO PRESENCE/ABSENCE AND FIRST ORDER JACKKNIFE PROCEDURES

	Period 2		Period 3	
	Chao	Jackknife	Chao	Jackknife
No. species recorded	79	79	88	88
No. species estimated	101	102	114	114
95% confidence limits	81–121	88–117	92–135	104–125
% of estimated species recorded	78.2	77.5	77.2	77.2

TABLE 6 — THE RELATIVE FREQUENCY OF THE CLEPTOPARASITIC (OR PARASITOID) SPECIES AMONG THE SOLITARY SPECIES FOR PERIODS 1, 2 AND 3 FROM ALLERTHORPE COMMON

	No. possible hosts (H)			No. cleptoparasites (C)			Cleptoparasitic load CL = 100×C(H+C)		
	P1	P2	P3	P1	P2	P3	P1	P2	P3
Solitary wasps	53	36	34	11*	8*	2*	17.2%	18.2%	5.6%
Solitary bees	43	27	34	20	14	18	31.8%	34.2%	34.6%

* *Methocha articulata* excluded as its host is non-aculeate

TABLE 7 THE NESTING HABITS OF THE SOLITARY SPECIES FOR PERIODS 1, 2 AND 3 FROM ALLERTHORPE COMMON

	Aerial nesters (A)			Subterranean nesters (S)			Aerial nester frequency AF + 100×A(A+S)		
	P1	P2	P3	P1	P2	P3	P1	P2	P3
Solitary wasps	25	9	10	28	27	24	47.2	25.0	29.4
Solitary bees	7	2	5	36	25	29	16.3	7.4	14.7

to their rarity? These 40 species were not due to greater recording effort since the number of records made during the second and third periods (906 records) exceed those made during the first period (812 records) (Table 1).

Evidence supporting the loss of species is the three species that have become extinct in Yorkshire and the loss of aerial nesters due to the loss of bramble and dead wood nesting sites due to afforestation. The remaining species were usually only recorded on one to three occasions so might have been present during the second and third periods. The rare, and probably also the northern limit species, would always likely be difficult to record, while the species with a widespread Yorkshire distribution probably rarely visited the Common because their required resources were absent or rarely found on the Common.

Similarly, were the 28 solitary species only recorded during the second and third periods due to gains or rarities unlikely to be recorded during the first period? Evidence supporting these gains are the three new Yorkshire species and the probable new species recorded on many occasions. Again, the species usually only recorded on one or two occasions might have been present during the first period. Except for the extinctions from, and the new species for Yorkshire, the arguments for the other species may seem reasonable, but there will always be some uncertainty as to which holds true to use for each species.

Using the wasp and bee data, except for the Dryinidae, Embolemidae and Bethylidae which are often not recorded, Allerthorpe Common can be compared with other Yorkshire sites. With 100 or more species recorded during each of the three periods (Table 1), Allerthorpe Common may be considered an excellent site in a Yorkshire context. Few other Yorkshire sites have this informal designation: Thorne Moor (113 species, Archer, 2011), Hatfield Moor (153 species, Archer, 2011), Strensall Common (137 species, Archer, 2011), Crow Wood (119 species, Archer & Burn, 1995), Pollington Quarry (122 species, Archer, 2006) and two sites on Blaxton Common (together 131 species, Archer 1995, 2010). The all-time number of species for Allerthorpe Common (179) would place it at the top of these excellent sites, and from period 1 (142) in second position (Table 1). As a consequence of coniferization, the total number from the second period (100), third period (108) and second and third periods combined (116) places the Common at the bottom of the excellent sites.

The species diversity estimates based upon the Archer samples show a slight increase from period two to period three (Table 4). This increase can be related to an increase in the AF for the solitary bees (Table 6) caused by the re-appearance of *Hylaeus* spp. due to the increase of dead bramble stems providing nesting sites as a consequence of some woodland clearance.

CONCLUSIONS

1. With 100 or more recorded wasp and bee species for each of the recording periods, Allerthorpe Common is one of the few excellent sites in Yorkshire. The number of species decreases from the first recording period to the second and third periods.
2. The species quality scores of solitary species decrease from the first period indicating a change form a first class site to a second class site during the second and third periods.
3. The decrease in species and species quality scores is mainly due to the coniferization of the site after the first period.
4. The species differences between the first recording period and the second/third periods can be explained by the occurrence of local extinctions and range expansions and/or the difficulties in recording rare and northern limit species.
5. The species estimates indicate a small increase in the number of

aculeate species during the third period compared with the second period, probably related to the removal of some trees and the regrowth of bramble.

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APPENDIX
LIST OF RECORDED SPECIES DURING PERIOD 1 (P1), PERIOD 2 (P2) AND PERIOD 3 (P3)

DRYINIDAE: *Aphelopus melaleucus* (Dalman) (P2), *Anteon ephippiger* (Dalman) (P2), *A. gaullei* Kieffer (P2), *A. jurineanum* Latreille (P1), *A. pubicorne* (Dalman) (P1,P2). CHRYSIDIDAE: *Elampus panzeri* (Fab.) (P1,P2), *Pseudomalus auratus* (Linn.) (P1,P2), *Hedychridium ardens* (Latreille *in* Coquebert (P1), *Chrysis impressa* Schenck (P1,P2),

C. rutiliventris (Abeille de Perrin) (P1,P2), *C. viridula* Linn. (P1), *Trichrysis cyanea* (Linn.) (P1,P2).
TIPHIIDAE: *Methocha articulata* Latreille (P1,P2,P3).
MUTILLIDAE: *Myrmosa atra* Panzer (P1,P2,P3).
FORMICIDAE: *Formica lemani* Bondroit (P1,P2), *Lasius niger* (Linn.) (P2), *Leptothorax acervorum* (Fab.) (P1), *Myrmica rubra* (Linn.) (P2), *M. ruginodis* Nylander (P2).
POMPILIDAE: *Priocnemis exaltata* (Fab.) (P1,P2), *P. parvula* Dahlbom (P1,P2,P3), *P. perturbator* (Harris) (P3), *P schioedtei* Haupt (P1,P3), *Calliadurgus fasciatellus* (Spinola) (P2), *Pompilus cinereus* (Fab.) (P1), *Episyron rufipes* (Linn.) (P1,P2), *Anoplius nigerrimus* (Scopoli) (P1,P2,P3), *A. viaticus* (Linn.) (P1,P2), *Arachnospila anceps* (Wesmael) (P1,P2,P3), *A. spissa* (Schiødte) (P1,P2,P3), *A. trivalis* (Dahlbom) (P1,P2), *Evagetes crassicornis* (Shuckard) (P1,P2), *Ceropales maculata* (Fab.) (P1).
EUMENINAE: *Odynerus spinipes* (Linn.) (P2,P3), *Ancistrocerus parietinus* (Linn.) (P1,P2), *A. parietum* (Linn.) (P1,P2), *A. trifasciatus* (Müller) (P1,P2,P3), *Symmorphus bifasciatus* (Linn.) (P1,P2,P3), *S. crassicornis* (Panzer) (P1), *S. gracilis* (Brullé) (P1).
VESPINAE: *Dolichovespula media* (Retzius) (P3), *D. norwegica* (Fab.) (P3), *D. sylvestris* (Scopoli) (P2,P3), *Vespula germanica* (Fab.) (P1,P3), *V. rufa* (Linn.) (P1,P2,P3), *V. vulgaris* (Linn.) (P2,P3).
SPHECIDAE: *Ammophila sabulosa* (Linn.) (P1,P2,P3).
CRABRONIDAE: *Dryudella pinguis* (Dahlbom) P1,P2), *Tachysphex pompiliformis* (Panzer) (P1,P2,P3), *Trypoxylon attenuatum* Smith (P1), *T. clavicerum* Lepeletier & Serville (P1), *T. figulus* (Linn.) (P1), *Crabro cribrarius* (Linn.) (P1,P2,P3), *C. peltarius* (Schreber) (P1,P2,P3), *Crossocerus capitosus* (Shuckard) (P1), *C. cetratus* (Shuckard) (P1,P3), *C. dimidiatus* (Fab.) (P1), *C. elongatulus* (Van der Linden) (P1), *C. megacephalus* (Rossi) (P1), *C. nigritus* (Lepeletier & Brullé) (P1,P3), *C. ovalis* Lepeletier & Brullé (P1,P2,P3), *C. podagricus* (Van der Linden) (P1,P3), *C. pusillus* Lepeletier & Brullé (P1,P2,P3), *C. quadrimaculatus* (Fab.) (P1,P2,P3), *C. tarsatus* (Shuckard) (P1,P2), *C. wesmaeli* (Van der Linden) (P1,P2,P3), *Ectemnius cavifrons* (Thomson) (P2), *E. continuus* (Fab.) (P1,P2,P3), *E. lapidarius* (Panzer) (P1), *E. ruficornis* (Zetterstedt) (P3), *Lindenius albilabris* (Fab.) (P2,P3), *Rhopalum clavipes* (Linn.) (P1), *R. coarctatum* (Scopoli) (P2), *Oxybelus uniglumis* (Linn.) (P1,P2,P3), *Mimumesa dahlbomi* (Wesmael) (P1,P3), *Mimesa equestris* (Fab.) (P1,P2,P3), *M. lutaria* (Fab.) (P3), *Psenulus pallipes* (Panzer) (P1), *Pemphredon inornata* Say (P3), *P. lethifer* (Shuckard) (P1,P3), *P. lugubris* (Fab.) (P1,P2), *Diodontus minutus* (Fab.) (P1,P2), *D. tristis* (Van der Linden) (P1,P2), *Passaloecus insignis* (Van der Linden) (P1), *P. singularis* Dahlbom (P1), *Mellinus arvensis* (Linn.) (P1,P2,P3), *M. crabroneus* (Thunberg) (P1), *Nysson spinosus* (Forster) (P1,P2,P3), *Gorytes quadrifasciatus* (Fab.) (P2,P3), *Harpactus tumidus* (Panzer) (P1,P3), *Argogorytes mystaceus* (Linn.) (P1,P2,P3), *Cerceris arenaria* (Linn.) (P3).
COLLETIDAE: *Colletes daviesanus* Smith (P1,P2,P3), *C. fodiens* (Geoffroy *in* Fourcroy) (P1), *C. succinctus* (Linn.) (P1,P2,P3), *Hylaeus brevicornis* Nylander (P1,P3), *H. communis* Nylander (P1,P3), *H. confusus* Nylander (P3).
ANDRENIDAE: *Andrena angustior* (Kirby) (P1), *A. barbilabris* (Kirby) (P1,P2,P3), *A. bicolor* Fab. (P1), *A. chrysosceles* (Kirby) (P1,P2), *A. cineraria* (Linn.) (P2,P3), *A. clarkella* (Kirby) (P1,P2,P3), *A. coitana* (Kirby) (P1), *A. denticulata* (Kirby) (P1,P2,P3), *A. fucata* Smith (P1,P2,P3), *A. fulva* (Müller *in* Allioni) (P3), *A. fuscipes* (Kirby) (P1,P2), *A. haemorrhoa* (Fab,) (P1,P2,P3), *A. helvola* (Linn.) (P1), *A. humilis* Imhoff (P3), *A. lapponica* Zetterstedt (P1), *A. minutula* (Kirby) (P2), *A. nigriceps* (Kirby) (P1), *A. nigroaenea* (Kirby) (P1,P2,P3), *A. praecox* (Scopoli) (P1), *A. ruficrus* Nylander (P1,P2,P3), *A. semilaevis* Pérez (P1,P2,P3), *A. scotica* Perkins (P1,P2,P3), *A. subopaca* Nylander (P1,P2,P3), *A. tarsata* Nylander (P1,P2,P3), *A. wilkella* (Kirby) (P1,P2,P3).
HALICTIDAE: *Halictus rubicundus* (Christ) (P1,P2,P3), *H. tumulorum* (Linn.) (P1,P3), *Lasioglossum albipes* (Fab.) (P1,P2,P3), *L. calceatum* (Scopoli) (P1,P2,P3), *L. cupromicans* (Pérez) (P1), *L. fratellum* (Pérez) (P1,P2,P3), *L. lativentre* (Schenck) (P1), *L. leucopus* (Kirby) (P1,P3), *L. leucozonium* (Schrank) (P3), *L. morio* (Fab.) (P3), *L. punctatissimum* (Schenck) (P1,P2,P3), *L quadrinotatum* (Kirby) (P1), *L. rufitarse* (Zetterstedt) (P1,P2,P3), *L. villosulum* (Kirby) (P2,P3), *Sphecodes crassus* Thomson (P3), *S. ephippius* (Linn.) (P3),

S. ferruginatus von Hagens (P1), *S. geoffrellus* (Kirby) (P1,P2,P3), *S. gibbus* (Linn.) (P1,P2,P3), *S. hyalinatus* von Hagens (P1,P2), *S. monilicornis* (Kirby) (P1,P2,P3), *S. pellucidus* Smith (P1,P2,P3), *S. puncticeps* Thomson (P3), *S. reticulatus* Thomson (P3).
MEGACHILIDAE: *Osmia leaiana* (Kirby) (P1), *Megachile centuncularis* (Linn.) (P1), *M. circumcincta* (Kirby) (P1), *M. ligniseca* (Kirby) (P1), *M. versicolor* Smith (P2,P3), *M. willughbiella* (Kirby) (P1,P2,P3), *Coelioxys elongata* Lepeletier (P1,P2), *C. inermis* (Kirby) (P1), *C. quadridentata* (Linn.) (P1), *C. rufescens* Lepeletier & Serville (P1).
APIDAE (Solitary): *Nomada fabriciana* (Linn.) (P1), *N. flava* Panzer (P3), *N. flavoguttata* (Kirby) (P3), *N. goodeniana* (Kirby) (P2), *N. lathburiana* (Kirby) (P3), *N. leucophthalma* (Kirby) (P1,P2,P3), *N. marshamella* (Kirby) (P1,P2,P3), *N. panzeri* Lepeletier (P1,P2,P3), *N. roberjeotiana* Panzer (P1,P2), *N. ruficornis* (Linn.) (P1,P3), *N. rufipes* Fab. (P1,P2,P3), *N. striata* Fab. (P1,P2,P3), *Epeolus cruciger* (Panzer) (P1,P2,P3), *E. variegatus* (Linn.) (P1), *Anthophora furcata* (Panzer) (P1,P3).
APIDAE (Social): *Bombus distinguendus* Morawitz (P1), *B. hortorum* (Linn.) (P1,P2,P3), *B. humilis* Illiger (P1), *B. jonellus* (Kirby) (P3), *B. lapidarius* (Linn.) (P1,P2,P3), *B. lucorum* (Linn.) (P1,P2,P3), *B. muscorum* (Linn.) (P1,P2), *B. pascuorum* (Scopoli) (P1,P2,P3), *B. pratorum* (Linn.) (P1,P2,P3), *B. terrestris* (Linn.) (P1,P2,P3), *B. barbutellus* (Kirby) (P1), *B. bohemicus* (Seidl) (P1,P2,P3), *B. campestris* (Panzer) (P3), *B. rupestris* (Fab.) P1,P3), *B. sylvestris* (Lepeletier) (P2,P3), *B. vestalis* (Geoffroy *in* Fourcroy) (P2,P3), *Apis mellifera* Linn. (P2,P3).