THE ACULEATE WASPS AND BEES (HYMENOPTERA: ACULEATA) OF TWO CALCAREOUS LOCALITIES IN WATSONIAN YORKSHIRE: BURTON LEONARD LIME QUARRIES AND CAVE WOLD

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Burton Leonard Lime Quarries and Cave Wold are good localities for aculeate wasps and bees. Burton Leonard has 75 recorded species with three species of national importance, and two species of regional importance. Cave Wold has 79 recorded species, with one species of regional importance.

Burton Leonard Lime Quarries (SE36, VC64) is an area of about 22 ha., about one km. south of the village of Burton Leonard, and about eight km. south of Ripon. It mainly consists of two abandoned quarries on the Magnesium limestone hills, last worked in the late 1940s. It has a rich calcareous flora including flowering shrubs, e.g. hawthorn, and a developing ash woodland.

Cave Wold (SE93, VC61) is a linear locality of about 40 ha., about three km. north-east of South Cave. It mainly consists of a disused railway line with steep-sloping embankments, foot paths, and the calcareous grassland of the Yorkshire Wolds. It is rich in flowering herbs and flowering shrubs, e.g. hawthorn.

During 1978, and between 1987 and 1994, 16 visits were made to Burton Leonard throughout the year as follows: April (2 visits), May (4), June (3), July (3), August (3) and September (1). Records also are available from K. G. Payne and A. Godfrey (one visit, July 1990), from which nine species were determined.

Between 1986 and 1994, I made 16 visits to Cave Wold, throughout the year as follows: April (1 visit), May (3), June (3), July (5) and August (4). Two of the visits during July and one visit during August were unsuitable for surveying because of poor weather conditions. Records available from W. D. Roebuck (one visit, 1907), D. H. Smith (one visit, August 1957) and A. Norris (one visit, August 1976). I determined the specimens of D. H. Smith (one species) and A. Norris (one species) but the three species of W. D. Roebuck are known from Butterfield and Fordham (1930).

My visits lasted approximately three hours when all species of aculeate wasps and bees were recorded and usually collected with a hand net for identification.

In the following account, biological names are according to Kloet and Hincks (1978).

Species Present

At the family level, Table 1 shows the taxonomic distribution of species and records at Burton Leonard and Cave Wold. A record represents a specimen differing in one of the following three variables: name, sex, and day of visit. At both Burton Leonard and Cave Wold the dominant solitary wasp family is the Sphecidae and the dominant bee family is the Halictidae. The number of records of Eumenidae (e.g. *Ancistrocerus trifasciatus,* Table 2) and Andrenidae from Burton Leonard, and Pompilidae (e.g. *Priocnemis perburbator,* Table 3) and Andrenidae from Cave Wold also are noticeable.

The social wasps recorded at both Burton Leonard and Cave Wold were: *Dolichovespula sylvestris, Vespula rufa, Paravespula germanica,* and *P. vularis;* the social bees were: *Bombus lucorum, B. terrestris, B. lapidarius, B. pratorum, B. hortorum, B. pascuorum, Psithyrus bohemicus, P. sylvestris, P. vestalis* and *Apis mellifera.* In addition *Psithyrus barbutellus* was recorded at Cave Wold.

Tables 2 and 3 show the number of days on which each species of solitary wasp and bee were recorded. For Burton Leonard, 42 species (68.9%) were recorded on one, two or three days (unusual species) and 19 species (31.1%) on from four to 13 days (common species). For Cave Wold, 40 species (62.5%) were recorded on one, two or three days and 24 species (37.5%) on from four to 14 days. The solitary wasp species were more likely to be the

unusual species (24 at Burton Leonard, 26 at Cave Wold) rather than common species (six at Burton Leonard, four at Cave Wold). The reverse is more likely for the solitary bee species (Common species: Burton Leonard, 18 species; Cave Wold, 14 species. Unusual species: Burton Leonard, 13 species; Cave Wold, 20 species).

TABLE 1
The number of species and records of aculeate wasps and bees recorded from Burton Leonard Lime Quarries (BL) and Cave Wold (CW).

	No. species		No. records	
	BL	CW	BL	CW
Solitary wasps				
Chysididae	3	3	10	5
Mutillidae	1	0	4	0
Sapygidae	1	0	2	0
Pompilidae	3	7	10	22
Eumenidae	6	5	20	7
Sphecidae	16	15	29	27
Total Solitary wasps	30	30	75	61
Solitary bees				
Colletidae	1	2	2	4
Andrenidae	10	10	43	64
Halictidae	14	15	82	84
Megachilidae	1	1	2	1
Anthophoridae	5	6	12	20
Total solitary bees	31	34	141	173
Total solitary wasps & bees	61	64	216	234
Social wasps and bees				
Vespidae	4	4	–	–
Apidae	10	11	–	–
Total social wasps & bees	14	15	–	–
Total aculeate wasps & bees	75	79	–	–

Seasonal Progression of the Solitary Species (Table 4)

For the number of solitary wasp species, June and July were the most productive months at both Burton Leonard and Cave Wold. For the number of new species June, followed by July, were the most productive months for Burton Leonard, and July, followed by June, for Cave Wold. Except for four spider-hunting wasps, the solitary wasps did not appear until June, and can be considered summer species. Of the four spider-hunting wasps, only *Priocnemis perburbator* is a spring species while the other three are summer species, although they might first appear in late spring (Fig. 1).

For the number of solitary bee species the most productive months at Burton Leonard are May and June, and at Cave Wold June. For the new species April and May are the most productive months for both localities. The lack of agreement between the most productive months for the number of species and new species is because the bee fauna is dominated by spring bees and spring and summer bees, with very few summer bees (e.g. *Anthophora furcata*) (Archer, 1966a).

Comparison of the Two Localities

Of the 87 solitary species recorded from the two localities, 38 were recorded from both localities, 23 only from Burton Leonard, and 26 only from Cave Wold.

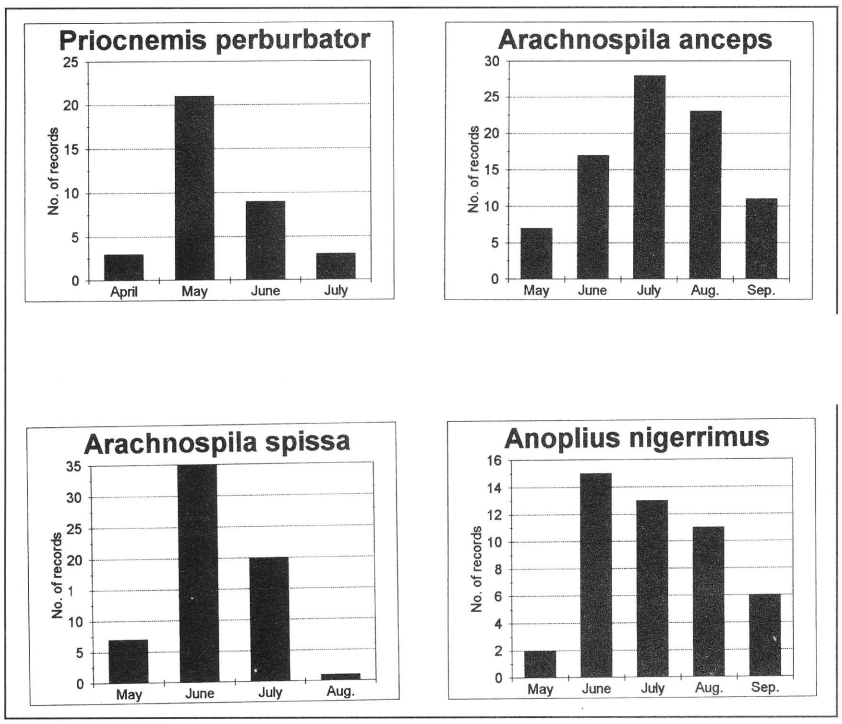

FIGURE 1
The seasonal distribution of four species of spider-hunting wasps (Pompilidae) using all available data from Watsonian Yorkshire.

These data can be compared by calculating similarity indices. Using the simple Jaccard index (Ludwig & Reynolds, 1988), which depends on the presence or absence of species, gives an index of 43.7%. For the solitary bee species, the Jaccard index is higher (62.5%) than for the solitary wasp species (27.7%). This variation of similarities can be related to the number of days each solitary species was recorded (Tables 1, 2). The mean number of records per solitary bee species (4.8 records) was greater than the mean number per solitary wasp species (2.3 records). It is therefore about twice as likely to record a particular bee species as a wasp species, although, overall, more solitary wasp species (47) were recorded than solitary bee species (40).

The Morisita-Horn index, which uses quantitative information on the relative abundance of species, is relatively independent of sample size but gives more importance to the more abundantly-occurring species (Magurran, 1988). Abundance was determined from the number of days on which each species was recorded. The Morisita-Horn index for the solitary species is 77.8% which is higher than the Jaccard index. This indicates that the two localities are more similar to one another in terms of common species. Of the 49 species found in only one of the localities, only seven (14.3%) were common species, found on more than three days. In contrast, of the species found at both localities, 23 (60.5%) were common, at least at one of the localities.

QUALITY ASSESSMENT OF THE SOLITARY SPECIES

Three species from Burton Leonard are nationally scarce species (Falk, 1991), with *Sapyga clavicornis* and *Shecodes crassus* at the northern edge of their range in England, and *Priocnemis schioedtei* widely distributed throughout Britain. Regionally (Archer, 1993a), *S. clavicornis* and *S. crassus* are rare species while *P. schioedtei* is a common species. Regionally *Sphecodes puncticeps* from Cave Wold is a rare species.

TABLE 2
The number of days on which each species of solitary wasp and bee species was recorded at Burton Leonard Lime Quarries.

No. records	No. days	Species	No. species
14	1	*Symmorphus gracilis, Trypoxylon figulus, Crossocerus elongatulus, C. dimidiatus, Psen dahlbomi, Psenulus concolor Pemphredon lugubris, Passaloecus insignis, Andrena clarkella, A. fucata, A. helvola, Lasioglossum morio, Sphecodes crassus, Anthophora furcata.*	14
36	2	*Chrysis angustula, Sapyga clavicornis, Priocnemis schioedtei, Odynerus spinipes, Ancistrocerus gazella, A. oviventris, Trypoxylon clavicerum, Crossocerus tarsatus, C. pusillus (=varus), C. podagricus, Pemphredon inornatus, Passaloecus singularis, Hylaeus communis, Andrena fulva, Lasioglossum villosulum, L. lucopum, Chelostoma florisomne, Nomada goodeniana.*	18
30	3	*Arachnospila anceps, Ancistrocerus parietinus, Ectemnius cavifrons, Rhopalum coarctatum, Andrena chrysosceles, Lasioglossum rufitarse, Sphecodes hyalinatus, Nomada flavoguttata, N. marshamella, N. ruficornis.*	10
20	4	*Chrysis impressa, Trichrysis cyanea, Myrmosa atra, Crossocerus ovalis, Andrena nigroaenea.*	5
15	5	*Arachnospila spissa, Lasioglossum albipes, Sphecodes monilicornis.*	3
18	6	*Andrena bicolor, A. scotica, Halictus rubicundus.*	3
8	8	*Andrena saundersella.*	1
18	9	*Halictus tumulorum, Sphecodes fasciatus.*	2
10	10	*Ancistrocerus trifasciatus*	1
22	11	*Andrena haemorrhoa, Lasiolglossum fratellum*	2
12	12	*Lasioglossum calceatum*	1
13	13	*Lasioglossum fulvicorne*	1

Five species have a local distribution in a regional context (Archer, 1994): *Andrena clarkella* from Burton Leonard, and *Chrysis ruddii, Tachysphex pompiliformis, Oxybelus uniglumis* and *Mellinus arvensis* from Cave Wold.

By giving each solitary species a regional status (Archer, 1993a) Burton Leonard would have a regional quality score of 143 and a species regional score of 2.3 (143/61 species). Cave Wold would have a quality score of 108 and a species quality score of 1.7 (108/64 species) (Table 5).

Using a national status for each species (Archer, 1995), Burton Leonard would have a national quality score of 98 and a national species quality score of 1.6 (98/61), and Cave Wold would have a quality score of 76 and a species quality score of 1.2 (76/64) (Table 6).

TABLE 3
The number of days on which each species of solitary wasp and bee species was recorded at Cave Wold.

No. records	No. days	Species	No. species
21	1	*Chrysis impressa, C. ruddii, Dipogon subintermedius (= nitidus), Evagetes crassicornis, Ancistrocerus parietinus, A. trifasciatus, Symmorphus mutinensis, Crossocerus annulipes, C. dimidiatus, Oxybelus uniglumis, Pemphredon lethifer, P. lugubris, Mellinus arvensis, Nysson spinosus, Argogorytes mystaceous, Hylaeus communis, Andrena fucata, A. minutula, Sphecodes gibbus, S. puncticeps, Megachile willughbiella.*	21
24	2	*Dipogon variegatus, Anoplius nigerrimus, Odynerus spinipes Ancistrocerus parietum, Crossocerus tarsatus, Ectemnius cavifrons, Entomognathus brevis, Pemphredon inornatus, Lasioglossum albipes, L. rufitarse, L. leucopum, Nomada fabriciana.*	12
21	3	*Chrysis angustula, Trypoxylon attenuatum, C. pusillus (= varus), Hylaeus hyalinatus, Andrena fulva, Nomada flavoguttata, N. panzeri.*	7
16	4	*Arachnospila spissa, Nomada goodeniana, N. marshamella, N. ruficornis.*	4
20	5	*Arachnospila anceps, Tachysphex pompiliformis, Andrena saundersella, Lasioglossum villosulum.*	4
30	6	*Andrena subopaca, Lasioglossum cupromicans, Sphecodes fasciatus, S. hyalinatus, S. monilicornis.*	5
14	7	*Priocnemis perburbator, Andrena nigroaenea.*	2
8	8	*Lasioglossum calceatum*	1
45	9	*Andrena chrysosceles, A. haemorrhoa, A. scotica, Halictus rubicundus, H. tumulorum.*	5
10	10	*Lasioglossum fulvicorne*	1
11	11	*Lasioglossum fratellum*	1
14	14	*Andrena bicolor*	1

The size of the quality scores is of a magnitude expected from the areas of the localities (Archer, 1995). This relationship is a reflection of a species-area relationship, where the larger the area of the locality the more species are present, including an increased chance of nationally scarce and rare species being found.

Because the quality scores are so related to the areas of the localities, two further comments can be made. Firstly, the species list for each locality is probably more-or-less complete (Archer, 1996b). Secondly, species diversity, or the number of species, of the two calcareous localities, are comparable to the species diversity of sandy localities (Archer, 1995). Traditionally sandy localities have been considered to have a higher species diversity than calcareous localities. The evidence from Burton Leonard and Cave Wold would indicate this traditional expectation may not be correct. However species lists from larger calcareous localities and from southern parts of England and Wales are required to investigate the validity of this traditional expectation further.

There is some evidence (Archer, 1996c) that species quality scores, unlike quality scores, are independent of the areas of localities so allowing direct comparisons between localities of different areas. As such, the species quality scores of Burton Leonard are similar to those of Skipwith Common (Archer, 1995). The species quality scores of Cave Wold are the

lowest scores so far published, but are similar to those of Askham Bog (based on Archer, 1987; regional species quality score = 1.7; national species quality score = 1.3).

TABLE 4
The number species and new species of solitary wasps and bees recorded per month at Burton Leonard Lime Quarries (BL) and Cave Wold (CW).

	April		May		June		July		Aug.		Sep.	
	BL	CW	BL	CW	BL	CW	BL	CW	BL	CW	BL	CW
No. species												
Solitary wasps	0	1	1	4	19	14	21	18	7	7	0	–
Solitary bees	11	9	20	17	19	25	13	18	11	16	3	–
No. new species												
Solitary wasps	0	1	1	3	18	11	10	14	1	1	0	–
Solitary bees	11	9	12	10	7	8	0	5	1	2	0	–

TABLE 5
The regional quality scores of the species of solitary wasps and bees recorded at Burton Leonard Lime Quarries (BL) and Cave Wold (CW).

Status	Status value (A)	No. species BL(B)	No. species CW(B)	Quality score BL(AxB)	Quality score CW(AxB)
Common	1	37	38	37	38
Frequent	2	13	19	26	38
Occasional	4	8	6	32	24
Rare	8	0	1	0	8
Nationally scarce	16	3	0	48	0

TABLE 6
The Archer national quality score of the species of solitary wasps and bees recorded at Burton Leonard Lime Quarries (BL) and Cave Wold (CW).

Status	Status value (A)	No. species BL(B)	No. species CW(B)	Quality score BL(AxB)	Quality score CW(AxB)
Universal	1	42	52	42	52
Widespread	2	16	12	32	24
Restricted	4	0	0	0	0
Scarce B	8	3	0	24	0

Cleptoparasitic Load

The cleptoparasitic load (CL) is the percentage of aculeate species that are cleptoparasites (or parasitoids) on other host aculeates. A more-or-less complete list of species in a locality should be made before the CL is calculated in order to avoid bias towards either host or cleptoparasitic species. Since the species lists for Burton Leonard and Cave Wold probably are more-or-less complete, CLs can be calculated. The CLs for the species of solitary bees are higher than the CLs for the species of solitary wasps (Table 7). These CLs are similar to values from other localities (Archer, 1996d).

Aerial Nester Frequency

The aerial nester frequency (AF) is the percentage of host aculeate species that have aerial nest sites. Again a more-or-less complete list of species in a locality should be made before the AF is calculated to avoid possible bias towards either aerial or subterranean nesters.

TABLE 7
The relative frequency of the cleptoparasitic species among the solitary wasps and bees from Burton Leonard Lime Quarries (BL) and Cave Wold (CW).

	No. hosts (H)		No. cleptoparasites (C)		Cleptoparasitic load CL=100xC/(H+C)	
	BL	CW	BL	CW	BL	CW
Solitary wasps	25	25	5	5	16.7	16.7
Solitary bees	23	23	8	11	25.8	32.4

At Burton Leonard, underground nest sites are associated with bare patches in the grassland, bare banks at the sides of paths, and on cliff exposures and path surfaces. Some of the path surfaces were the relicts of motor-cycle activity. At Cave Wold there are many bare banks in sunny situations, but the most important is the steep south-facing bank of the railway cutting. At the top of this bank the soil is particularly friable and easy to excavate.

The aerial nest sites are associated with dead plant stems, e.g. bramble, at both localities. At Burton Leonard remains of dead tree stumps in sunny situations also were used. At Cave Wold the dead wood remains from old posts and fencing in sunny situations was valuable.

The AFs for the species of solitary wasps are higher than the AFs for the species of solitary bees (Table 8). The AFs for the solitary bees from both localities are very similar to the British Isles value of 19.0%.

TABLE 8
The relative frequency of the cleptoparasitic species among the solitary wasps and bees from Burton Leonard Lime Quarries (BL) and Cave Wold (CW).

	No. aerial nesters (A)		No. subterranean nesters (S)		Aerial nester frequency AF=100xA/(A+S)	
	BL	CW	BL	CW	BL	CW
Solitary wasps	17	14	8	11	68.0	56.0
Solitary bees	3	3	20	20	13.0	13.0

The AF for the solitary wasps from Burton Leonard is much higher than the British Isles value of 44.9%. This high value probably is a consequence of the relative lack of friable soils which is also the case at Duncombe Park (Archer, 1993b). The AF for the solitary wasps from Cave Wold is more similar to the British Isles value and is nearly the same as that from the sandy locality of Shipley Glen (value should be 56.6%, not 44.4% as printed; Archer, 1996a). The friable soil of the steep south-facing bank at Cave Wold must account for the relatively increased number of subterranean nesters.

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CORRECTION

Regrettably the photographic plate of the snipe which appeared in *The Naturalist* **122**: 32 (1997) was attributed to J. Vaughan, but I am sure readers will have recognised it as the work of Richard Vaughan, a regular contributor of superb photographs of bird studies.

Editor