THE WASPS AND BEES (HYM., ACULEATA) OF CANNOCK CHASE COUNTRY PARK WITH HEDNESFORD HILLS IN WATSONIAN STAFFORDSHIRE

BY MICHAEL ARCHER

Cannock Chase, in Staffordshire, was declared a royal hunting forest by William the Conqueror in 1086. In 1958 an area of approximately 67,350ha was designated an Area of Outstanding Natural Beauty. The study area of c.1,250ha includes Cannock Chase Country Park (c.1,214ha) together with Hednesford Hills, and includes land to an altitude of c.200m. The Country Park consists of heathland and dry acid grassland on sandy soils (with heather, bilberry, tormentil and bird's-foot-trefoil); *Sphagnum* bog, peaty and waterlogged areas in the stream valleys (with cross-leaved heath and marsh marigold); planted woodland (beech, sweet chestnut, sycamore, oak, Douglas fir, spruce and larch) and forestry plantations (Scots pine, spruce and larch). In the wetter areas alder is present and birch and scattered oaks occur in the drier areas. Sand and gravel extraction in the past has resulted in derelict quarries. These varied biotopes provide nesting sites and food resources for aculeate wasps and bees. With 122 recorded species and seven species of national importance, Cannock Chase Country Park has been a rewarding area to study.

SAMPLING METHODS

Between 1967 and 2009, 43 site visits were made to Cannock Chase, as follows: April (2 visits), May (15), June (8), July (10) and August (8). Nine sites were visited: Brocton Field (SJ9817), Castle Rings (SK0412), Gentleshaw Common (SK0511), Hednesford Hills (SK0012), Milford Quarry (SJ9719), Moor's Gorse (SK0215), Pentridge Bank (SK0017), Shaol Hill (SJ9611) and Seven Springs (SK0020). Sites most frequently visited were Gentleshaw Common (10), Milford Quarry (8), Hednesford Hills (5) and Shaol Hill (5). Six visits were made during the 1960s, 1970s and 1980s when site details were not recorded. During each visit, usually from one to three hours duration, all observed species of aculeate wasps and bees were identified and recorded, using a hand net for collection where necessary. Records from these visits represent the Archer sample. The number of visits to each site depended upon its relative importance in providing records and the length of each visit depended on the amount of time needed to gain a representative sample of the species present.

In addition to the Archer sample, Falk made available a report of five visits to Gentleshaw Common during 1994–1995 (Falk *et al.*, 1996) and J. Webb made available reports from nine sites during 1999–2001, in particular from Milford Quarry, Bevins Birches (SK0118) and Sherbrook and Oldacre Valleys (SJ9718). The combined records of Archer, Falk and Webb are referred to as the Composite sample. These visits also followed the procedure of Archer.

In the following account, the nomenclature can be related to that given by Kloet and Hincks (1978). An up-to-date check list can be found on the Bees, Wasps and Ants Recording Society (BWARS) web pages at http://www.bwars.com

SPECIES PRESENT AND SEASONAL PROGRESSION OF SPECIES

A full list of the species recorded is given in the Appendix. Table 1 shows the number of species and records for each family. A record represents a specimen differing in one of the following three variables: species name, sex and day of visit. The solitary wasp family Crabronidae, and the solitary bee families, Andrenidae, Halictidae and Apidae, are the dominant families in terms of number of species and records.

The Falk and Webb samples added the following 22 species to the Archer sample: *Dipogon subintermedius*, *Anoplius concinnus*, *A. nigerrimus*, *Arachnospila anceps*, *Evagetes crassicornis*, *Ancistrocerus trifasciatus*, *Dryudella pinguis*, *Crossocerus cetratus*, *C. wesmaeli*, *Ectemnius cavifrons*, *Cerceris rybyensis*, *Andrena clarkella*, *A. coitana*, *A. denticulata*, *A. synadelpha*, *Lasioglossum smeathmanellum*, *L. fulvicorne*, *Hoplitis claviventris*, *Megachile willughbiella*, *Epeolus cruciger*, *Bombus monticola* and *B. campestris*.

For the Archer sample July and August were the peak months for recording solitary wasp species (Table 2), with most first records of a species occuring in July. The species most evident were those hunting flies (*Lindenius albilabris*, *Oxybelus uniglumis*, *Crabro peltarius*, *Crossocerus quadrimaculatus*), caterpillars (*Ammophila sabulosa*), and homopteran bugs (*Mimesa equestris*). All these species are subterranean nesters.

Peak months for recording solitary bees in the Archer sample were May, June and July (Table 2), with most first records of a species occuring during May. The species most evident, which again are all subterranean nesters or cleptoparasites of subterranean nesters, were: *Andrena nigroaenea* with *Nomada goodeniana*, *A. cineraria* with *N. lathburiana*, *A. haemorrhoa*, *A. humilis*, *Lasioglossum leucozonium* with *Sphecodes ephippius*, *L. rufitarse* and *Nomada flava*. The cleptoparasites of *Andrena humilis* (*Nomada integra*) and *A. haemorrhoa* (*N. ruficornis*) and possible hosts of *Nomada flava* (*Andrena fulva* besides *A. scotica*) were also recorded.

From the Archer sample, the average number of solitary wasp and bee species recorded per visit for each month was 4.5 (range 2–7) in April, 6.5 (1–13) in May, 6.9 (3–14) in June, 5.0 (1–11) in July and 6.0 (1–14) in August.

SPECIES QUALITY

In the Composite sample three Red Data Book species (Shirt, 1987) have been recorded: *Philanthus triangulum*, *N. lathburiana* and *N. signata*. Falk (1991) suggested that the following four species should be given

national scarce status: *Methocha articulata* (Nb), *Andrena humilis* (Nb),

TABLE 1. — THE NUMBER OF SPECIES AND RECORDS (ARCHER SAMPLE) AND SPECIES (COMPOSITE SAMPLE) OF ACULEATE WASPS AND BEES RECORDED FROM CANNOCK CHASE

	Archer sample		Composite sample
	No. species	No Records	No. species
Solitary wasp species			
Chrysididae	3	4	3
Tiphiidae	1	1	1
Mutillidae	1	3	1
Pompilidae	6	6	11
Eumeninae	0	0	1
Sphecidae	1	5	1
Crabronidae	19	57	24
Total	31	76	42
Solitary bee species			
Colletidae	3	5	3
Andrenidae	17	59	21
Halictidae	18	78	20
Megachilidae	2	3	4
Apidae	13	52	14
Total	53	197	62
Total solitary wasps and bees	84	273	104
Social wasp and bee species			
Vespinae	5		5
Apidae	11		13
Total	16		18
Total wasp and bee species	100		122

TABLE 2. — THE NUMBER OF SPECIES AND FIRST RECORDS OF SPECIES OF SOLITARY WASPS AND BEES RECORDED PER MONTH AT CANNOCK CHASE (ARCHER SAMPLE)

	Apr	May	Jun	Jul	Aug
Solitary wasps					
First records	0	8	8	11	4
Recorded	0	8	8	19	11
Solitary Bees					
First records	8	29	7	5	4
Recorded	8	37	20	20	13

Sphecodes crassus (Nb) and *Nomada integra* (Na).

Recent work carried out by the Bees, Wasps and Ants Recording Society indicates that two species (*Philanthus triangulum* and *Nomada lathburiana*) should lose their national status and a further two species should be given a national status (*Priocnemis susterai* and *Anoplius*

TABLE 3. — THE ARCHER NATIONAL QUALITY SCORES FOR SPECIES OF SOLITARY WASPS AND BEES RECORDED PER MONTH AT CANNOCK CHASE (COMPOSITE SAMPLE)

National status	Status value (A)	No. species (B)	Quality scores (A × B)
Universal	1	62	62
Widespread	2	35	70
Scarce	8	5	40
Rare	16	1	16
Very rare	32	1	32
Total		104	220

Species Quality Score (SQS) Composite 220/104 = 2.1

concinnus).

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. According to this national system the Composite sample has one very rare status species (*Nomada signata*), one rare status species (*Nomada integra*) and five scarce status species (*Methocha articulata*, *Priocnemis susterai*, *Anoplius concinnus*, *Andrena humilis* and *Sphecodes crassus*).

By giving each of the 104 solitary wasp and bee species from the Composite sample an Archer national status, a national quality score of 220 can be calculated (Table 3) with national species quality score (SQS) of 2.1 (220 divided by the 104 solitary species).

How do these quality scores compare with other similar English sites? Two similar sites are available for comparison: Charnwood Forest in Leicestershire and Lydford Moorland in Devon (Archer, 1992). Charnwood Forest extends to an altitude of 278m and Lydford Moorland is above 300m. Archer national statuses were not used in this previous study but can be readily calculated. From Lydford Moorland 132 solitary species, with 20 high quality species, were recorded, giving a quality score of 423 and a species quality score of 3.2. From Charnwood Forest 147 solitary species, with 13 high quality species, were recorded, giving a quality score of 347 and a species quality score of 2.4. Compared with Cannock Chase recording from the other two sites was partially or wholly from an earlier period when conditions could have been more favourable; Charnwood Forest from at least the early twentieth century and Lydford Moorland from the 1940s and earlier. However, except for the presence of *Ancistrocerus quadratus* (Panzer), all the species could still be present. The Species Quality Scores are also in accord with their geography, as the scores increase in value from northern to southern England (Archer, 1996).

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 may be present but as yet unrecorded. There are several non-parametric statistical methods which offer a way of estimating species richness. The Chao presence/absence estimator (in Colwell and Coddington, 1994) is based on the number of species that are observed in one (singletons) or two (doubletons) samples or visits. The First Order Jackknife estimator depends only on the singletons and the Bootstrap estimator is based on the proportion of samples containing each species. Because some aculeate species are only active in the spring or summer it is advisable that samples be taken throughout the months of adult activity. The software used to carry out the statistical analysis was provided by Pisces Conservation Ltd.

The statistical procedure was run 100 times for the Archer Sample. The software takes 1, 2, 3, etc. random visit-samples 100 times, each time calculating a mean estimate of species diversity. With a small number of visit-samples the estimates are erratic, but as more visit-samples are added the estimates may stabilise, giving increased confidence. In this case the estimates for all three methods stabilise (Fig. 1), and when all visit-samples are considered, result in a mean value of 106 species (79.3% of species recorded; an average 22 species still to be found) (Table 4). Although these results were reasonable, they should be viewed with caution due to the small number of species recorded on some visits. The analysis was continued by adding further data from Falk and Webb. Table 4 shows that as the number of visit-samples increases, so does the estimated number of species and the percentage of recorded species. At the 54 and 58 sample stages the average percentage of recorded species is the same (86.2%) indicating that, on average, another 16 species remain

TABLE 4. — NON-PARAMETRIC ESTIMATES OF SPECIES RICHNESS OF SOLITARY WASPS AND BEES FROM CANNOCK CHASE USING THE PRESENCE/ABSENCE CHAO, JACKKNIFE AND BOOTSTRAP PROCEDURES WITH THE ARCHER (A), FALK (F) AND WEBB (W) SAMPLES

	A	A+F	A+F+W	A+F+W	A+F+W
No. Samples	40	45	50	54	58
No. Spp. recorded	84	90	96	99	101
Chao					
Estimate no. spp.	108	110	116	112	115
% spp. recorded	77.8	81.8	82.8	88.4	87.8
Jackknife					
Estimate	113	116	123	122	124
% spp. recorded	74.3	77.6	78.0	81.1	81.5
Bootstrap					
Estimate	98	103	109	111	113
% spp. recorded	85.7	87.4	88.1	89.2	89.4

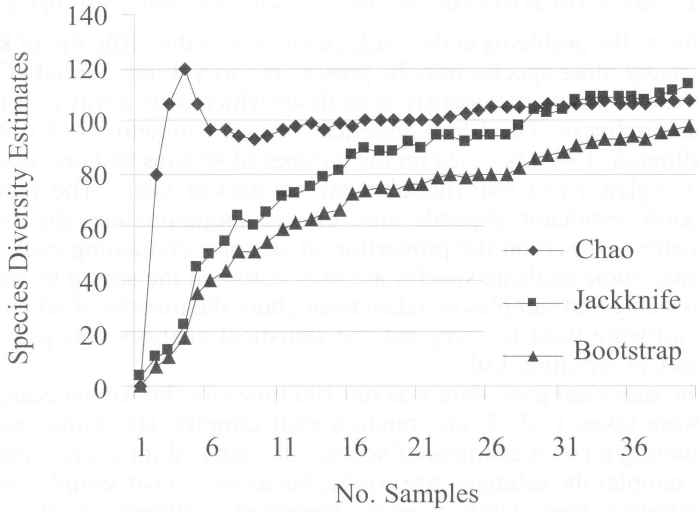

Fig. 1. — The Chao Presence/Absence, First Order Jackknife and Bootstrap estimates of solitary species richness of the Archer sample from Cannock Chase.

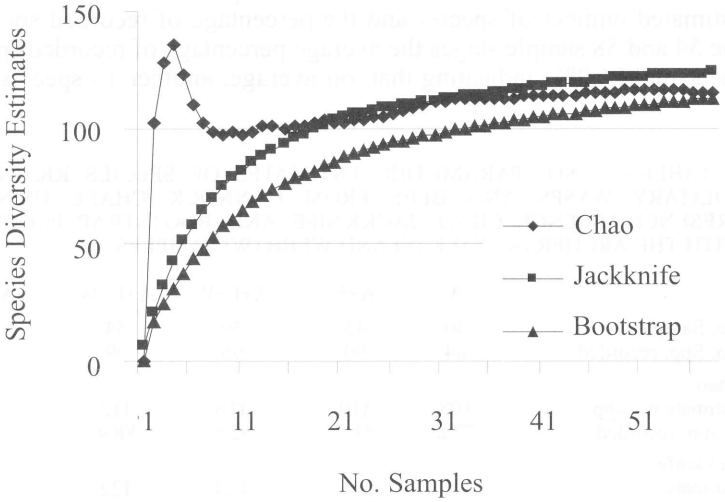

Fig. 2. — The Chao Presence/Absence, First Order Jackknife and Bootstrap estimates of solitary species richness of the Archer, Falk and three Webb sites from Cannock Chase.

to be found. Fig. 2 shows that the estimates of species diversity stabilize at 58 visit-samples for the three procedures.

The social species recorded are all common and widespread species except for *Bombus monticola* (from the Composite sample) and *B. jonellus*, which are both more locally distributed, being particularly associated with heathland.

Cleptoparasitic Load

The cleptoparasitic load (CL) is the percentage of aculeate species that are cleptoparasitic (or parasitoids) on other host aculeates. Wcislo (1987) showed that parasite behaviour among aculeate Hymenoptera correlated with geographical latitude. Thus 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 desert regions where the occurrence of rainfall would tend to synchronise life history characteristics. From a review of the literature Wcislo found that the CLs for bees varied between 16% and 33%, with a range of 17%. The CL from the Composite sample (Table 5) is similar to, and thus supports, Wcisclo's data. The CL will vary from site to site for various reasons, e.g. a low value of 17.2% from Duncombe Park (Archer, 1993) was due to the absence of cleptoparasites of the genus *Sphecodes*, probably because their host populations were not large enough to support them.

Wcislo gave no CLs for solitary wasps but from 27 Yorkshire sites, CLs vary from 10.3%–25.0%, a range of 14.7% (Archer, unpublished). The CL from the Composite sample (Table 5) falls within this Yorkshire range. The lower range of values for the solitary wasps compared with the solitary bees is probably a consequence of food-chain relationships. The cleptoparasites of solitary bees are second order consumers while those of solitary wasps are third order consumers. The host of solitary wasp cleptoparasites being higher in the food chain could result in reduced population numbers so supporting fewer cleptoparasitic species.

All the social species are non-parasitic species except for *Bombus bohemicus*, *B. campestris*, *B. sylvestris* and *B. vestalis* which are social parasites on other species of *Bombus*.

TABLE 5. — THE RELATIVE FREQUENCY OF THE CLEPTOPARASITIC (OR PARASITOID) SPECIES AMONG THE SOLITARY WASP AND BEE SPECIES RECORDED FROM CANNOCK CHASE (COMPOSITE SAMPLE)

	No. hosts (H)	No. cleptoparasites (C)	Cleptoparasitic Load CL = 100 × C/(H+C)
Solitary wasps	35	6*	14.6%
Solitary bees	41	21	33.9%

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

TABLE 6. — THE NESTING HABITS OF THE HOST SPECIES OF SOLITARY WASPS AND BEES RECORDED FROM CANNOCK CHASE (COMPOSITE SAMPLE)

	No. subterranean nesters (A)	No. aerial nesters (S)	Aerial Nester Frequency AF = 100 × A/(A+S)
Solitary wasps	27	8	22.9%
Solitary bees	35	6	14.6%

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, crevices in cob walls and old mortar, or nests are exposed on the surface of rock or other hard material. Subterranean nesters nest in the soil, usually in burrows which they dig themselves, but sometimes by modifying existing holes and crevices.

The AFs for the solitary species are given in Table 6. The AFs for all the British species of solitary wasps is 46.2% and solitary bees is 17.9%. For the Composite samples there is a similar value for the solitary bees while for the solitary wasps the value is lower. This observation for the solitary wasps possibly indicates that suitable aerial nesting sites are lacking.

Of the social species, the host species of *Bombus* are generally either subterranean nesters, usually in small mammal burrows, or nest at ground level under leaf litter and tussocky grass, although *B. pratorum* has been found nesting in aerial situations such as old birds' nests. The social wasps are usually subterranean nesters except for *Dolichovespula norwegica*, which is an aerial nester, and *D. sylvestris* which can be either a subterranean nester, usually in a shallow cavity, or an aerial nester.

CONCLUSIONS

1. With 122 recorded species of aculeate wasps and bees and seven, possibly nine, species of national importance, Cannock Chase is an important site within the West Midlands.
2. The species quality score of 2.1 indicates that the conservation value of Cannock Chase compares favourably with other similar sites such as Charnwood Forest in Leicestershire.
3. It is estimated that 86% of the solitary wasp and bee fauna has been recorded, with an average of about 16 species remaining to be found. However, with 23 species only found on one occasion, the confidence of this statement may not stand.
4. It is suggested that nesting sites for aerial nesters are lacking, so indicating that some habitat management may be needed.

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APPENDIX
SPECIES RECORDED IN THE ARCHER SAMPLE

CHRYSIDIDAE: *Elampus panzeri* (F.), *Hedychridium ardens* (Latreille *in* Coquebert), *Trichrysis cyanea* (L.).

TIPHIIDAE: *Methocha articulata* Latreille.

MUTILLIDAE: *Myrmosa atra* Panzer.

POMPILIDAE: *Priocnemis parvula* Dahlbom, *P. perturbator* (Harris), *P. susterai* Haupt, *Dipogon variegatus* (L.), *Pompilus cinereus* (F.), *Arachnospila spissa* (Schiødte).

VESPINAE: *Dolichovespula norwegica* (F.), *D. sylvestris* (Scopoli), *Vespula germanica* (F.), *V. rufa* (L.), *V. vulgaris* (L.).

SPHECIDAE: *Ammophila sabulosa* (L.).

CRABRONIDAE: *Tachysphex pompiliformis* (Panzer), *Trypoxylon clavicerum* Lepeletier & Serville, *Crabro cribrarius* (L.), *C. peltarius* (Schreber), *Crossocerus elongatulus* (Van der Linden), *C. ovalis* Lepeletier & Brullé, *C. pusillus* Lepeletier & Brullé, *C. quadrimaculatus* (F.), *C. tarsatus* (Shuckard), *Ectemnius continuus* (F.), *Lindenius albilabris* (F.), *Oxybelus uniglumis* (L.), *Mimesa equestris* (F.), *M. lutaria* (F.), *Pemphredon lugubris* (F.), *Mellinus arvensis* (L.), *Nysson spinosus* (Forster), *Argogorytes mystaceus* (L.), *Philanthus triangulum* (F.).

COLLETIDAE: *Colletes succinctus* (L.), *Hylaeus brevicornis* Nylander, *H. hyalinatus* Smith.

ANDRENIDAE: *Andrena angustior* (Kirby), *A. barbilabris* (Kirby), *A. bicolor* F., *A. chrysosceles* (Kirby), *A. cineraria* (L.), *A. fucata* Smith, *A. fulva* (Müller *in* Allioni), *A. fuscipes* (Kirby), *A. haemorrhoa* (F.), *A. humilis* Imhoff, *A. lapponica* Zetterstedt, *A. nigroaenea* (Kirby), *A. scotica* Perkins, *A. semilaevis* Pérez, *A. similis* Smith, *A. subopaca* Nylander, *A. wilkella* (Kirby).

HALICTIDAE: *Halictus rubicundus* (Christ), *H. tumulorum* (L.), *Lasioglossum albipes* (F.), *L. calceatum* (Scopoli), *L. cupromicans* (Pérez). *L. fratellum* (Pérez), *L. leucopus* (Kirby), *L leucozonium* (Schrank), *L. punctatissimum* (Schenck), *L. rufitarse* (Zetterstedt). *L. villosulum* (Kirby), *Sphecodes crassus* Thomson, *S. ephippius* (L.), *S. geoffrellus* (Kirby), *S. gibbus* (L.), *S. hyalinatus* von Hagens, *S. pellucidus* Smith, *S. puncticeps* Thomson.

MEGACHILIDAE: *Osmia rufa* (L.), *Megachile versicolor* Smith.

APIDAE: *Nomada fabriciana* (L.), *N. flava* Panzer, *N. flavoguttata* (Kirby), *N. goodeniana* (Kirby), *N. integra* Brullé, *N. lathburiana* (Kirby), *N. leucophthalma* (Kirby), *N. marshamella* (Kirby), *N. panzeri* Lepeletier, *N. ruficornis* (L.), *N. rufipes* F., *N. signata* Jurine, *N. striata* F., *Bombus hortorum* (L.), *B. jonellus* (Kirby), *B. lapidarius* (L.), *B. lucorum* (L.), *B. pascuorum* (Scopoli), *B. pratorum* (L.), *B. terrestris* (L.), *B. bohemicus* (Seidl), *B. sylvestris* (Lepeletier), *B. vestalis* (Geoffroy *in* Fourcroy), *Apis mellifera* L.