
The Wasps and Bees (Hymenoptera: Aculeata) of North Walney National Nature Reserve

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North Walney NNR has been found to have 51 species of aculeate wasps and bees, of which six are of national importance. North Walney is located at the north end of Walney Island on the south side of the mouth of the Duddon Estuary (SD1772) in the West Cumbria Coastal Plain Natural Area. The site is leased to English Nature from Vickers Shipbuilding and Engineering Ltd and Broughton Estates and is managed by Cumbria Wildlife Trust. Radley (1994) considered that North Walney had been formed on an open coast to form a sandy promontory at the mouth of an estuary. The reserve has an area of 144ha and consists of sand dunes and dune slacks on the north and west sides, saltmarsh on the east side and dune heath with shrubs and pools in the centre. It is surrounded by mudflats, and sandy and shingle beaches. This study was mainly confined to the 68ha of the dunes and dune slacks. Some species of aculeate wasps and bees were found nesting in the bare stable sandy areas, usually on slopes but also on level ground. The flowers of Sea-holly (*Eryngium maritimum*) and other umbellifers, spurges (*Euphorbia* spp.), stonecrops (*Sedum* spp.) and Bird's-foot Trefoil (*Lotus corniculatus*) were important food sources for these insects.

Methods

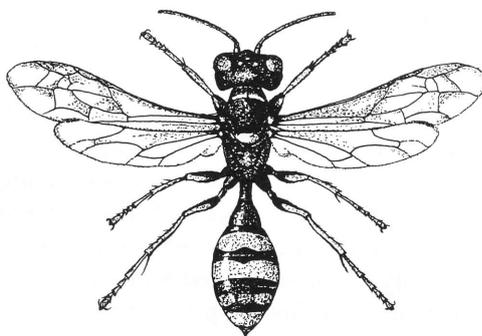
Between 1993 and 2003, the author made nine visits distributed throughout the year as follows: May (1 visit), June (3), July (3) and August (2). During each visit, which lasted about four to five hours, all species of aculeate wasps and bees were recorded and usually collected with a hand net for identification. N.A. Robinson (personal communication) made available additional information, particularly of his visit on 21st July 1996. Further records were found in Dean (1990). In the following account the nomenclature can be related to Kloet & Hincks (1978). An up-to-date checklist can be found on the Bees, Wasps and Ants Recording Society (BWARS) web pages at www.bwars.com.

Species present and the seasonal progression of species

A full list of recorded species is given in the Appendix. Table 1 shows the taxonomic distribution of species and records deriving from the author [Archer

sample’], and these in combination with Neil Robinson’s data [‘Archer+Robinson sample’]. (Robinson listed nine species of which *Crossocerus tarsatus* and *Nomada rufipes* were new to the Archer sample.) A ‘record’ here represents a specimen differing in one of the following three variables: name, sex and day of visit. Insufficient information is provided in Dean (1990) for inclusion in Table 1, and none of the species he listed were new to the Archer+Robinson sample except for *Lasioglossum laevigatum* (Kirby) – recorded during 1986. At present the breeding range of *L. laevigatum* is from Cornwall to Kent and north to Hereford and Worcester and Suffolk. This record, if confirmed, would be regarded as a vagrant species in Cumbria. Archer (2002) also recorded a vagrant specimen of *L. laevigatum* from Yorkshire. This species is not considered further in the analysis of the records.

There are about twice the number of species and records of solitary bees compared with solitary wasps. The family Sphecidae is the dominant taxonomic group among the solitary wasps, both in terms of number of species and records, although the Pompilidae are well represented in terms of records. No one solitary bee subfamily is dominant in terms of number of species but the Megachilinae are dominant in terms of number of records.



Mellinus arvensis, one of the 22 species of solitary wasp recorded at Walney

Based on the Archer sample, Table 2 shows the number of species recorded and when species were first recorded for each month. The most productive months for solitary wasp species were June, July and August, with June the most productive month for the first recording of species. The most frequently encountered species of solitary wasp were: *Crossocerus wesmaeli*; *Pompilus cinereus*, *Episyron rufipes* and *Oxybelus argentatus* as nesting aggregations on slopes of bare sand; *Crabro cribrarius* (usually on flowers of umbellifers), *Anoplius concinnus* and *Ancistrocerus scoticus*. All these species are subterranean nesters.

The most productive months for solitary bee species were June and July, with May and July the most productive months for the first recording of species. The most frequently encountered species were *Hoplitis claviventris* and *Osmia aurulenta* (usually on flowers of Bird’s-foot Trefoil); *Sphecodes pellucidus* searching for the nesting aggregations of its host *Andrena barbilabris*; *Megachile circumcincta* with its cleptoparasite *Coelioxys elongata*; *Epeolus variegatus* searching for the

burrows of its host *Colletes fodiens*, and *Hylaeus brevicornis*. These species are subterranean nesters except for *O. aurulenta*, which nests in empty snail shells, and *H. claviventris* and *Hylaeus brevicornis*, which nest inside dead stems such as Bramble (*Rubus* sp.).

The numbers of species of solitary wasps and bees found per visit were: May: 16, June: 8, 13, 15; July: 12, 14, 18; August: 12, 12.

Estimating the potential number of solitary wasp and bee species

One of the problems in the study of any site is the difficulty of not knowing how many more species are present, but as yet unrecorded. Recent advances in non-parametric statistical procedures offer a way of addressing this problem. Chao and Bootstrap estimates (in Colwell & Coddington, 1994) and Jackknife estimates (Heltshel & Forrester, 1983) describe procedures to estimate the potential number of species (species-richness) likely to be found on a site after a number of samples have been taken. The presence/absence quantitative estimate of Chao is based on the number of species that are recorded in just one ('unique species') or two samples in the survey. The Jackknife procedure is based on the unique species only, while the Bootstrap procedure is based on the relative abundance of each species. Because some aculeate species are only active in the spring or summer it is advisable that samples be distributed throughout the months of adult activity. The software to carry out these statistical procedures was provided by Pisces Conservation Ltd. In practice the software takes one, two, etc samples at random, each time calculating a mean estimate of species-richness. The procedure is continuously repeated dependent on the number of samples. With a small number of samples the estimates are highly variable, but as more samples are selected these may stabilize, giving confidence in them.

The estimates based on the Archer+Robinson sample at different sample sizes are given in Figs 1, 2 and 3. The estimates are tending to stabilise. Table 3 shows the three species-diversity estimates after all samples have been considered, with 95% confidence limits (except for the Bootstrap estimate). The final species-diversity estimates are between 48 and 54 species, of which 79%–88% have actually been recorded.

Recorded species at any site could be resident, tourist or vagrant species. Resident species obtain all their resources, mainly nesting sites and food, from the site under study while tourist species, although living in the geographical area of the site, do not normally obtain their resources from the site. Vagrant species, normally occurring away from the geographical area of the site, were not found at North Walney, except for *Lasioglossum laevigatum*, if it is confirmed. It is often

Figure 1: the Chao presence/absence estimate of species richness for N. Walney

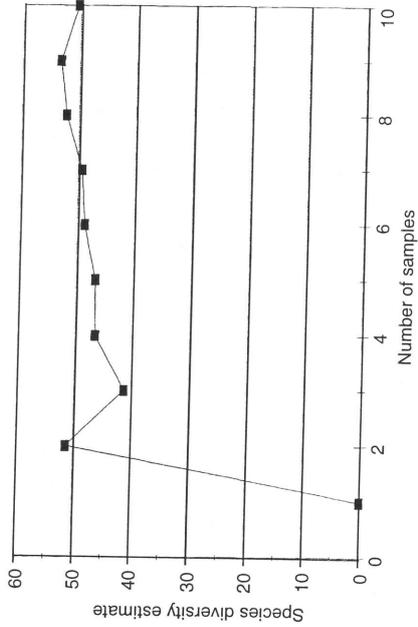


Figure 2: the Jackknife estimate of species richness for North Walney

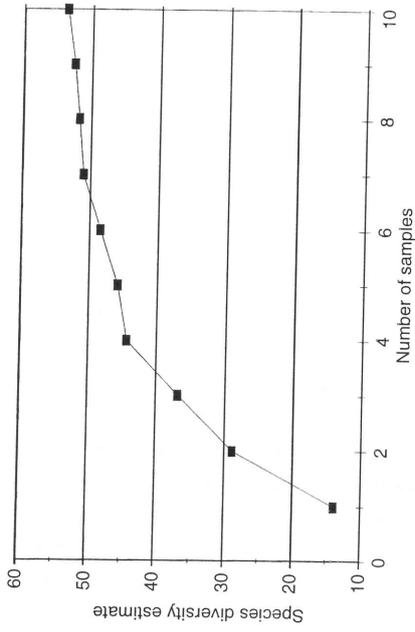


Figure 3: the Bootstrap estimate of species richness for North Walney

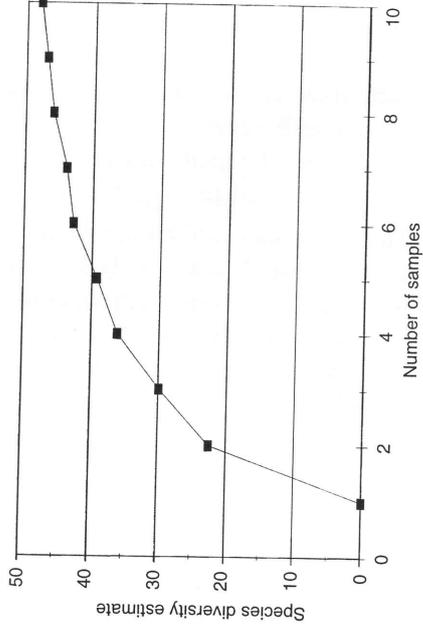
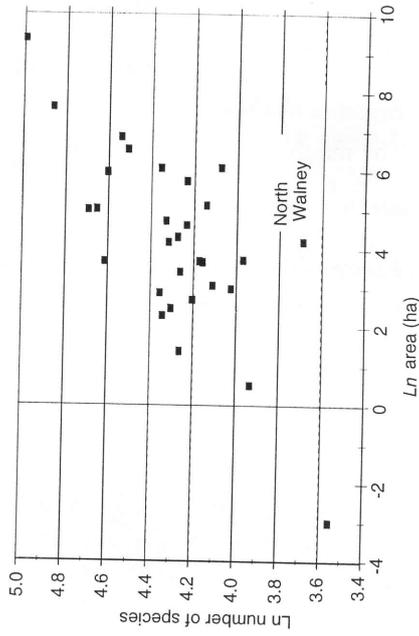


Figure 4: A species-area relationship of 30 sites from the north and north Midlands of England



difficult to separate resident and tourist species. Probably tourist species will tend to be unique [i.e. single record] species, or found on few occasions, as only small numbers would be expected to be present on the site and hence unlikely to be found. Unfortunately unique species could also be rare resident species, which have small numbers on site and are hence again unlikely to be found. It is therefore necessary to generate more specific arguments to begin to separate the rare resident and tourist species. No specific arguments seem possible to separate resident and tourist species at North Walney so the estimates of 48-54 species can be accepted. Thus, on average, 6-12 more solitary species are predicted to be present at North Walney.

Species-area relationship

Another problem in the study of any site is the difficulty of knowing when the species list is sufficiently complete to enable reasonable comparison with other sites. The list from North Walney can be considered reasonably complete from the species-diversity analysis. As such, it would be interesting to compare the species-area relationship for North Walney with other sites from the north and north Midlands of England. Fig 4 compares North Walney with 29 other northern sites, and shows that it lies well outside the 'normal' range. The regression equation for the northern sites is: $\ln \text{ no. spp.} = 3.92 + (0.095 \times \ln \text{ area})$. Inserting the figure for Walney into this reveals that it would need to have some 75 species in order to approximate to the average of the other sites. This observation indicates the relatively unfavourable nature of North Walney, probably climatic, for aculeate wasps and bees. Archer (1990) showed that solitary wasps were more sensitive to summer weather than solitary bees. This may, at least in part, explain the relatively low proportion of solitary wasps on North Walney.

Quality assessment of the solitary species

According to Shirt (1987) *Colletes cunicularius* is a Red Data Book species and according to Falk (1991) *Oxybelus argentatus* and *O. mandibularis* are nationally notable species. Recent work by BWARS indicates that *Anoplius concinnus*, *Ceropales maculata* and *Tachysphex unicolor* are also of national importance.

Each of the 40 solitary species of the Archer sample can be given an Archer national status (Archer, 1999, 2002). Under the Archer scheme *C. cunicularius* is a very rare species, *C. maculata* a rare species and *A. concinnus*, *T. unicolor*, *O. argentatus* and *O. mandibularis* scarce species. With this information a national quality score of 128 and a species quality score (SQS) of 3.2 can be calculated

(Table 4). The species quality score is a measure of the relative number of rare and scarce species present and is thus an indicator of the conservation value of a site.

Archer (1999) found that quality scores are influenced by the area of a site, while SQSs are relatively independent of site area, and so can be used to compare sites. How does the SQS compare with other northern sand dune sites? SQSs from the east coast sites are: Gibraltar Point 1.7 (Archer, 2003), Saltfleetby-Theddlethorpe NNR 1.8 (Archer, 2000), Spurn Point 2.3 (Archer, unpublished) and Lindisfarne NNR 1.6 (Archer, unpublished) and for the west coast are: Ainsdale-Formby 3.8 (Archer, 1999) and North Walney NNR 3.2. The west coast sites have higher SQSs than the east coast sites, probably reflecting the warmer climate of the west coast.

Cleptoparasitic load

The cleptoparasitic load (CL) is the percentage of aculeate species that are cleptoparasites (or parasitoids) on other host aculeates. Wcislo (1987) showed that parasite behaviour among aculeate Hymenoptera correlated with geographical latitude. Thus the parasite rates are higher in temperate regions as host populations are more synchronized in their life-history characteristics, except in hot deserts where the infrequent occurrence of rainfall would tend to synchronise life-history characteristics. From a review of the literature Wcislo (1987) found that the CLs for bees in Europe varied between 16% and 33%, a range of 17%. As such, CLs for sites in Britain should have similar values. For the north Midlands and north England, the CLs for species of solitary bees vary from 21.7%-36.6% (range 14.9%) (Archer, 1999). The CL for North Walney (Table 5) falls within this range and therefore supports Wcislo's hypothesis.

Wcislo (1987) gives no CLs for wasps, but Archer (1999) found that CLs of solitary wasps for sites from north Midlands and north England varied between 10.3%-22.2%. The CL for North Walney (Table 5) falls within this range. Wcislo's hypothesis can therefore be applied to the solitary wasps.

Aerial nester frequency

The aerial-nester frequency (AF) is the percentage of host aculeate species that have aerial nest sites. Aerial nesters use old beetle burrows in dead wood, central plant stem cavities (e.g. bramble), old snail shells, or crevices in old mortar or exposed on the surface of rock or other hard material. Subterranean nesters nest in the soil, usually in burrows dug by themselves, but sometimes holes and crevices

are used after being altered. The aerial nesters at North Walney are all stem nesters except for *Osmia aurulenta*, which uses empty snail shells.

The AFs for the solitary wasp and bee species are given in Table 6. The AF for all the British species of solitary wasps is 46.2% and for solitary bees is 17.9%. The AF for the solitary wasps is much lower than the British AF, while the AF of the solitary bees is much higher than the British AF. Since North Walney is relatively unfavourable for solitary wasps and bees it would be expected that the AFs would be higher than the British AFs. This is because aerial sites are likely to benefit more from the relatively less warmth available both daily and seasonally than subterranean sites. Why then should the solitary wasp AF be so low? Perhaps the stem-nesting species of solitary wasps are yet to be found. Certainly the number of recorded aerial nesting wasps (Table 6) is very small and the discovery of four more species would make a large difference to the AF.

Summary

North Walney:

1. has 51 recorded species of aculeate wasps and bees with six species of national importance;
2. is predicted to have a species-diversity of about 48-54 solitary species of which, on average, about 6-12 species remain to be found. These species could be mainly aerial-nesting solitary wasps;
3. is relatively unfavourable for solitary wasps and bees compared with other northern English sites since it holds fewer species relative to its area;
4. has a higher species quality score than sand dune sites in northeast England;
5. has solitary wasps and bee cleptoparasitic loads similar to those from other sites as predicted by Wcislo (1987); and
6. has a higher aerial nester frequency for solitary bees and a lower aerial nester frequency for solitary wasps compared with British data.

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Illustration (p. 22): David Clarke

Appendix: species recorded

- Chrysididae: *Hedychridium ardens* (Latreille in Coquebert), *Chrysis ignita* (L.).
- Pompilidae: *Pompilus cinereus* (Fab.), *Episyron rufipes* (L.), *Anoplius concinnus* (Dahlbom), *Arachnospila anceps* (Wesmael), *Evagetes crassicornis* (Shuckard), *Ceropales maculata* (Fab.).
- Eumeninae: *Ancistrocerus oviventris* (Wesmael), *A. scoticus* (Curtis).
- Vespinae: *Dolichovespula sylvestris* (Scopoli).
- Sphecidae: *Tachysphex pompiliformis* (Panzer), *T. unicolor* (Panzer), *Crabro cribrarius* (L.), *Crabro peltarius* (Schreber), *Crossocerus elongatulus* (Vander Linden), *C. wesmaeli* (Vander Linden), *Oxybelus argentatus* Curtis, *O. mandibularis* Dahlbom, *O. uniglumis* (L.), *Pemphredon lethifera* (Shuckard), *Mellinus arvensis* (L.).
- Colletinae: *Colletes fodiens* (Geoffroy in Fourcroy), *C. succinctus* (L.), *C. cunicularius* (L.), *Hylaeus brevicornis* Nylander, *H. hyalinatus* Smith.
- Andreninae: *Andrena haemorrhoea* (Fab.), *A. tarsata* Nylander, *A. barbilabris* (Kirby).
- Halictinae: *Lasioglossum leucozonium* (Schrank), *L. villosulum* (Kirby), *Sphecodes pellucidus* Smith, *S. puncticeps* Thomson.
- Megachilinae: *Osmia aurulenta* (Panzer), *Hoplitis claviventris* (Thomson), *Megachile circumcincta* (Kirby), *Coelioxys elongata* Lepeletier.
- Anthophorinae: *Epeolus cruciger* (Panzer), *E. variegatus* (L.), *Anthophora furcata* (Panzer).
- Apinae: *Bombus lucorum* (L.), *B. terrestris* (L.), *B. hortorum* (L.), *B. lapidarius* (L.), *Bombus pascuorum* (Scopoli), *B. bohemicus* (Seidl), *B. sylvestris* (Lepeletier), *Apis mellifera* L.

Table 1
Number of species and records from North Walney NNR
based on the Archer and Robinson samples

	Species (Archer)	Species (Archer + Robinson)	Records (Archer)	Records (Archer + Robinson)
<i>Solitary wasps</i>				
Chrysididae	2	2	2	2
Pompilidae	6	6	26	29
Eumeninae	2	2	7	7
Sphecidae	11	12	36	40
Total solitary wasps	21	22	71	78
<i>Solitary bees</i>				
Colletinae	5	5	18	19
Andreninae	3	3	8	8
Halictinae	4	4	13	13
Megachilinae	4	4	30	31
Anthophorinae	3	4	7	8
Total solitary bees	19	20	76	79
Total solitary species	40	42	147	157
<i>Social wasps & bees</i>				
Vespinae	1	1		
Apinae	8	8		
Total social species	9	9		
Total wasps & bees	49	51		

Table 2

Number of solitary species and months when species were first recorded at North Walney NNR based on the Archer sample

	May	June	July	August
Number of species				
Wasps	7	14	13	12
Bees	9	11	14	7
Number of species first recorded				
Wasps	7	10	2	2
Bees	9	3	6	1

Table 3

Non-parametric estimates of species richness at North Walney NNR based on the Archer+Robinson sample

	Chao estimate	Jack-knife estimate	Bootstrap estimate
No. species recorded	42	42	42
No. species estimated	50	54	48
95% confidence limits	39-62	48-60	—
% of estimated spp. found	84.0	77.8	87.5

Table 4

The Archer national quality scores of the solitary species recorded from North Walney NNR based on the Archer sample

National Status	Status Value (A)	No. Species (B)	Quality Scores (A × B)
Universal	1	20	20
Widespread	2	14	28
Restricted	4	0	0
Scarce	8	4	32
Rare	16	1	16
Very rare	32	1	32
Total		40	128

Species Quality Score (SQS) = 128/40 = 3.2

Table 5

The relative frequency of the cleptoparasitic (or parasitoid) species among the solitary species recorded from North Walney based on the Archer sample

	No. hosts (H)	No. cleptoparasites (C)	Cleptoparasitic Load $CL = 100 \times C/(H+C)$
Solitary wasps	17	4	19.0
Solitary bees	14	5	26.3

Table 6

The nesting habits of the solitary species from North Walney NNR based on the Archer sample

	No. aerial nesters (A)	No. subterranean nesters (S)	Aerial nester frequency $AF = 100 \times A/(A+S)$
Solitary wasps	2	15	11.8
Solitary bees	5	9	35.7