THE WASPS AND BEES (HYMENOPTERA: ACULEATA) OF THE SAND DUNES OF BAMBURGH, NORTHUMBRIA AND SANDSCALE HAWS, CUMBRIA

BY MICHAEL E. ARCHER

Bamburgh dunes (NU1834) are located about five miles east of Belford and about 16 miles south of Berwick-upon-Tweed. Sandscale Haws (SD1975) is located about three miles north of Barrow-in-Furness, and is a nature reserve of the National Trust, to whom I am grateful for being allowed access for recording purposes.

Bamburgh dunes consist of two ridges with a hummocky low area in between. The coastal ridge mainly consists of marram grass over shifting sands with bare areas caused by erosion, particularly by humans, and occasional areas of grey dunes. The inland ridge is stable grassland with bare erosion areas caused by rabbits and humans, ivy-covered areas and a mature plantation. The area between the ridges consists of grey dunes, drying marsh and thin grassland. Patches of bramble, ivy and sycamore flowers provided important food resources and probably mating areas while the bare banks were used by the subterranean nesters. Solitary wasps and bees were scarce with, perhaps, an additional species or group of specimens being found, on average, about every 15 minutes. The recording area was on the south side of Bamburgh Castle in an area of about 56ha.

Sandscale Haws consists of several ridges with slacks between the ridges and an inland stable grassland area grazed by stock. Rest harrow, bird's foot trefoil and sea-holly were important food resources while hawthorn and sycamore, besides also providing food resources, were mating areas. Many flat or sloping bare areas were used by the subterranean nesters. Solitary wasps and bees, at least locally, were plentiful. The recording area was restricted to the dune ridges and slacks, an area of about 70ha.

METHODS

Between 1997 and 2005, the author made eleven visits to Bamburgh dunes distributed throughout the year as follows: May (1 visit), June (3), July (5) and August (2). Each visit lasted about three hours. Further records, made during May to July 1990, were found in Drake & Denman (1993).

Between 1993 and 2003, the author made nine visits to Sandscale Haws distributed throughout the year as follows: May (1 visit), June (3), July (3) and August (2). Each visit could last up to six hours. Additional records were found in Nelson (1975) and supplied by N.A. Robinson (pers. comm.) consisting of records made by N.L. Birkill, N.G. Bloxham, S.M. Hewitt and N.A. Robinson. In addition, a specimen of a male *Astata*

TABLE 1 — THE NUMBER OF SPECIES AND RECORDS OF ACULEATE WASPS AND BEES RECORDED FROM BAMBURGH DUNES (Archer sample, AS; Archer, Drake & Denman sample, ADD).

	Species (AS)	Records (AS)	Species (ADD)
Solitary wasps			
Chrysididae	1	1	1
Pompilidae	4	7	4
Eumeninae	1	2	1
Crabronidae	8	48	9
Total solitary wasps	14	58	15
Solitary bees			
Andreninae	4	4	4
Halictinae	2	3	2
Megachilinae	4	9	4
Total solitary bees	10	16	10
Total solitary species	24	74	25
Social species			
Vespinae	3		
Apinae	11		
Total social species	14		
Total wasps and bees	38		

TABLE 2 — THE NUMBER OF SPECIES AND RECORDS OF ACULEATE WASPS AND BEES RECORDED FROM SANDSCALE HAWS (Archer sample, AS; Archer, Nelson & Robinson sample, ANR).

	Species (AS)	Records (AS)	Species (ANR)
Solitary wasps			
Chrysididae	4	6	4
Pompilidae	4	17	5
Crabronidae	13	55	15
Total solitary wasps	21	78	24
Solitary bees			
Colletinae	5	13	5
Andreninae	4	9	4
Halictinae	9	20	9
Megachilinae	6	30	6
Anthophorinae	2	5	2
Total solitary bees	26	77	26
Total solitary species	47	155	50
Social species			
Vespinae	4		
Apinae	9		
Total social species	13		
Total wasps and bees	60		

pinguis dated 15 June 1994 was found in Leicester Natural History Museum, having been found during a Diptera field meeting.

During the author's visits all species of aculeate wasps and bees were recorded and usually collected with a hand net for identification. In the following account the nomenclature can be related to Kloet & Hincks (1978). An up-to-date checklist can be found on Bees, Wasps and Ants Recording Society (BWARS) web pages at http://www.bwars.com and in Archer (2004a).

SPECIES PRESENT AND 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 from Bamburgh dunes of the author (Archer sample) and for species only of the author together with Drake & Denman (1993) (Archer, Drake & Denman sample). The solitary wasp, *Harpactus tumidus*, was the only species added by Drake and Denman (1993).

Table 2 shows the taxonomic distribution of species and records from Sandscale Haws of the author (Archer sample) and for species of the author together with those of Nelson (1975) and Robinson (Archer, Nelson and Robinson sample). Compared with the Archer sample, Robinson added no new species but the Nelson sample added three new species: *Arachnospila spissa*, *Pemphredon lethifera* and *Mimesa littoralis*.

Compared with Bamburgh dunes, Sandscale has 60% more solitary wasp species and 160% more solitary bee species, although the number of social species are almost equal.

Based on the Archer sample, Table 3 shows the number of species and when species were first recorded for each month. For the solitary wasps, June was the best month for the first recording of species from Bamburgh dunes and May, June and July for Sandscale Haws. June and July were the best months for recording species from both sites. The species most recorded from Bamburgh dunes were the spider hunter, *Pompilus cinereus*, and fly hunters, *Crabro cribrarius*, *C. peltarius*, *Crossocerus pusillus* and *Mellinus arvensis* and from Sandscale Haws were the spider hunter, *Pompilus cinereus*, and the fly hunters, *Crabro peltarius*, *Crossocerus wesmaeli*, *Oxybelus uniglumis* and *Mellinus arvensis*. All these species are subterranean nesters.

For the solitary bees, June was the best month for the first recording of species from Bamburgh dunes and particularly May, with June and July for Sandscale Haws. June and July were the best months for recording species from Bamburgh dunes and May, June and July from Sandscale Haws. The species most recorded from Bamburgh dunes was the crevice nester, (usually in an aerial situation) *Megachile willughbiella* and from Sandscale Haws the subterranean nester, *Megachile circumcincta* with its cleptoparasite *Coelioxys elongata*, and *Osmia aurulenta* which nests in empty snail shells.

The mean number of solitary species recorded during each visit to Bamburgh dunes was: May (1 species), June (7), July (5) and August (5), and to Sandscale Haws was: May (18), June (13), July (17) and August (10).

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 at the site, but as yet unrecorded. Recent advances in non-parametric statistical procedures offer a way of addressing this problem. Chao (in Colwell & Coddington, 1994) and Heltshe & 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 one (singletons) or two (doubletons) samples. The Jackknife estimate of Heltshe & Forrester is based only on singletons. A parametric statistical procedure, Michaelis-Menten (Raaijmakers, 1987) is also used for Bamburgh dunes. The Michaelis-Menten procedure assumes that the probability that the next individual recorded will be a new species declines linearly as species number increases. The statistical procedures were run with the samples, or visits. In practice the software takes 1, 2, etc. samples at random, each time calculating a mean estimate of species richness. The procedures were repeated 50 times (which is sufficient to obtain reliable 95% confidence limits). With a small number of samples the estimates are erratic or variable, but as more samples are selected these may stabilise, giving confidence in them. Because some aculeate species are only active in the spring or summer it is advisable that sampling is distributed throughout the months of adult activity. The software to carry out these statistical procedures was provided by Pisces Conservation Ltd.

The estimates based on different sample sizes for Bamburgh dunes are given in Fig. 1. The species diversity estimates do not stabilize for the Jackknife and Michaelis-Menten procedures and possibly stabilize for the Chao procedure. Table 4 shows the species diversity estimates with their 95% confidence limits after all the samples have been considered. The species diversity estimates of the Michaelis-Menten and Jackknife procedures are similar to each other but these widely differ from the Chao estimate. Confidence in these species diversity estimates is not strong. How can the confidence be increased?

The recorded species at any site could be resident, tourist or vagrant species. Resident species obtain their resources, mainly nesting sites and food, from the site under study while tourist species, although living in the geographical area next to the site under study, do not normally obtain their resources from the site. Vagrant species occur far away from the geographical area of the site, often from another country. It is often

TABLE 3 — THE NUMBER OF SPECIES AND FIRST RECORDS OF SPECIES OF SOLITARY WASPS AND BEES RECORDED PER MONTH FROM THE ARCHER SAMPLE FOR BAMBURGH DUNES AND SANDSCALE HAWS

	May	Jun	Jul	Aug
BAMBURGH DUNES				
Number of species				
Wasps	0	10	8	6
Bees	1	6	5	1
Number of species first recorded				
Wasps	0	10	3	1
Bees	1	6	3	0
SANDSCALE HAWS				
Number of species				
Wasps	7	12	16	7
Bees	11	12	14	8
Number of species first recorded				
Wasps	7	7	6	1
Bees	11	6	6	3

TABLE 4 — SPECIES DIVERSITY ESTIMATES FOR BAMBURGH DUNES AND SANDSCALE HAWS BASED ON THE ARCHER SAMPLE

	Chao	Jackknife	Michaelis-Menten
BAMBURGH DUNES			
All species			
No. species recorded	24	24	24
No. species estimated	52	36	36
95% confidence limits	16–88	27–45	–
% estimated species recorded	46.2	66.7	66.7
Tourist species removed			
No. species recorded	15	15	15
No. species estimated	33	20	21
95% confidence limits	0–67	14–26	–
% estimated species recorded	45.5	75.0	71.4
SANDSCALE HAWS			
All species			
No. species recorded	47	47	
No. species estimated	82	67	
95% confidence limits	47–116	57–77	
% estimated species recorded	57.3	70.1	
Tourist species removed			
No. species recorded	37	37	
No. species estimated	47	48	
95% confidence limits	33–62	41–54	
% estimated species recorded	78.7	77.1	

difficult to separate resident from tourist species. Probably tourist species will tend to be found on one or a few visits, as only small numbers would be expected to be present on the site and hence less likely to be found. Unfortunately, species found on one or a few visits could also be rare resident species which again have small numbers on site and are less likely to be found. It is, therefore, necessary to develop other criteria to separate resident from tourist species. No vagrant species were found at Bamburgh dunes or Sandscale Haws.

The recorded solitary species from Bamburgh dunes can be divided into two groups. The first group consists of subterranean nesting species that were found on three or more visits, are known to be associated with sandy habitats and sometimes their nesting sites were found, e.g., *Pompilus cinereus*, *Mellinus arvensis* and *Megachile circumcincta* with its cleptoparasite *Coelioxys elongata*. These species can be considered resident species. The second group consists of common and widespread species which, if resident species, should have been found on more than one visit, e.g. *Andrena haemorrhoa*, *A. nigroaenea* and *Crossocerus elongatulus*, or are cleptoparasites on common and widespread hosts which were not recorded, e.g. *Sphecodes monilicornis*. These species can be considered tourist species.

Removing the nine tourist species, the three statistical procedures were re-run (Fig. 2). The Chao does not stabilize, the Jackknife procedure is beginning to stabilize while the Michaelis-Menten procedure again stabilizes. Table 4 shows the outcomes after all the samples were considered. Again the species diversity estimates of the Jackknife and Michaelis-Menten procedures are similar but differ from the Chao species diversity estimate. In summary, the best species diversity estimate for Bamburgh dunes is about 20 resident species with nine or more tourist species. Further sampling may help in a firmer determination of the potential number of resident species while discovery of nesting sites would also be helpful.

The Chao and Jackknife procedures were repeated for Sandscale Haws (Fig. 3). The species diversity estimates do not stabilize. Also, after all the samples have been considered, the species diversity estimates widely differ (Table 4). Again, it is possible to identify ten tourist species. A re-run of the two statistical procedures with the tourist species removed results in the stabilization of the species diversity estimates (Fig. 4) and the species diversity estimates, after all the samples have been considered, are very similar (Table 4).

For Sandscale Haws three further samples could be obtained from the Nelson and Robinson records: Robinson for April (4 species), Nelson for May (10 species) and Nelson for June (6 species). The Chao and Jackknife procedures were re-run for the Archer, Nelson and Robinson samples, again with the tourist species removed. The species diversity estimates for both statistical procedures stabilized and, after all the samples had been considered, the species diversity estimate from the Chao procedure was 47

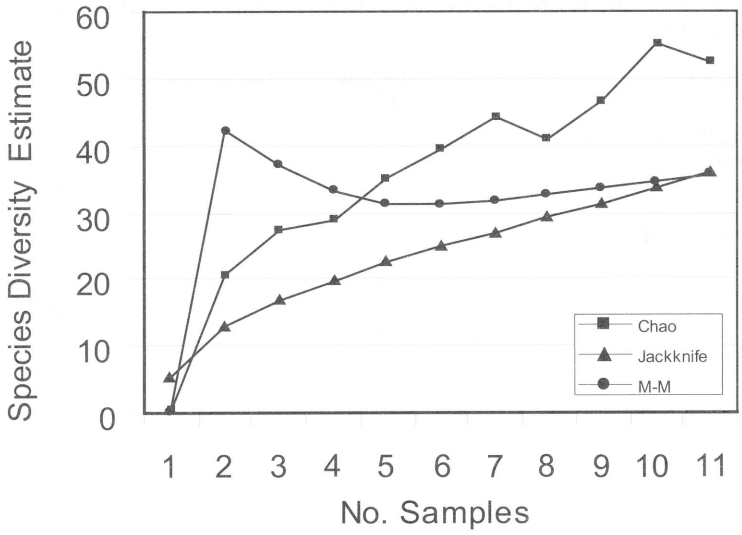

Fig. 1 — Chao presence/absence, Jackknife and Michaelis-Menten estimates of species diversity for all species from the Archer sample recorded from Bamburgh dunes

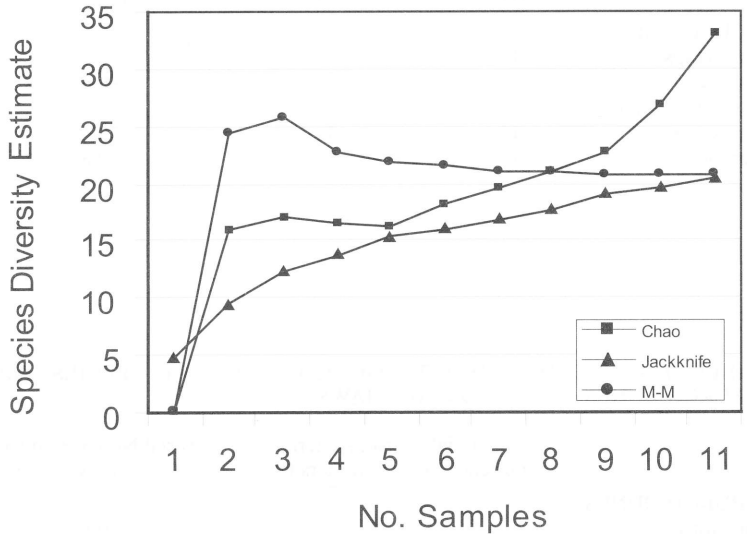

Fig. 2 — Chao presence/absence, Jackknife and Michaelis-Menten estimates of species diversity with tourist species removed from the Archer sample recorded from Bamburgh dunes

TABLE 5 — ARCHER NATIONAL QUALITY SCORES FOR BAMBURGH DUNES AND SANDSCALE HAWS

National status	Status value (A)	No. species (B)	Quality scores (A x B)
BAMBURGH DUNES			
Universal	1	24	24
Scarce	8	1	8
Total		25	32
SANDSCALE HAWS			
Universal	1	27	27
Widespread	2	13	26
Scarce	8	6	48
Rare	16	1	16
Very rare	32	3	96
Total		50	213

TABLE 6 — RELATIVE FREQUENCY OF THE CLEPTOPARASITIC (OR PARASITOID) SPECIES AMONG THE SOLITARY SPECIES RECORDED FROM BAMBURGH DUNES AND SANDSCALE HAWS

	No. hosts (H)	No. cleptoparasites (C)	Cleptoparasitic Load CL = 100 x C/(H+C)
BAMBURGH DUNES			
Solitary wasps	13	2	13.3%
Solitary bees	8	2	20.0%
SANDSCALE HAWS			
Solitary wasps	19	5	20.8%
Solitary bees	18	8	30.8%

TABLE 7 — NESTING HABITS OF THE SOLITARY SPECIES FROM BAMBURGH DUNES AND SANDSCALE HAWS

	No. aerial nesters (A)	No. subterranean nesters (S)	Aerial Nester Frequency AF = 100 x A/(A+S)
BAMBURGH DUNES			
Solitary wasps	4	9	30.8%
Solitary bees	2	6	25.0%
SANDSCALE HAWS			
Solitary wasps	2	17	10.5%
Solitary bees	4	14	22.2%

species and from the first order Jackknife procedure was 49 species. These estimates are similar to each other and to the estimates based only on the Archer samples (Table 4) so giving further confidence in these species diversity estimates. In summary, it is estimated that there are 47–49 resident species at Sandscale Haws with ten or more tourist species.

QUALITY ASSESSMENT OF THE SOLITARY SPECIES

For Sandscale Haws, according to Shirt (1987), *Cleptes nitidulus*, *Mimumesa littoralis* and *Colletes cunicularius* are Red Data Book species. Falk (1991) indicated that *Colletes floralis* should have Red Data Book status and the status of *Cleptes nitidulus* should be downgraded to National Scarce List A status (Na). Falk (1991) further indicated that *Oxybelus argentatus* and *O. mandibularis* should have Na status and *Hedychridium cupreum* National Scarce List B status (Nb). Recent work by the Bees, Wasps and Ants Recording Society (BWARS) indicates that *Ceropales maculata*, *Tachysphex nitidus* and *Megachile circumcincta* are also of national importance. *Megachile circumcincta* is the only species of national importance that has been recorded from Bamburgh dunes.

To take account of these changes and to give a national status to all solitary species, Archer (1999, 2002b) developed a national quality scoring system of high and low quality species. High quality species have a scarce (≡ Nb), rare (≡ Na) or very rare (≡ RDB) status while low quality species have a universal, widespread or restricted status. With the Archer national scheme *Mimumesa littoralis*, *Colletes floralis* and *C. cunicularius* have a Very Rare status, *Ceropales maculatus* a Rare status, and *Cleptes nitidulus*, *Hedychridium cupreum*, *Tachysphex nitidus*, *Oxybelus argentatus*, *O. mandibularis* and *Megachile circumcincta* a Scarce status.

Each of the 25 solitary species from Bamburgh dunes and 50 solitary species from Sandscale Haws can be given an Archer national status (Table 5). With this information a national quality score of 32 for Bamburgh dunes and 213 for Sandscale Haws can be calculated (Table 5). The species quality (SQS) is calculated by dividing the quality score by the number of species: 1.3 for Bamburgh dunes and 4.3 for Sandscale Haws.

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 compared with tropical regions as host populations are more synchronized in their life-history characteristics. This finding probably does not hold for desert climates where the occurrence of rainfall would tend to synchronize life-history characteristics.

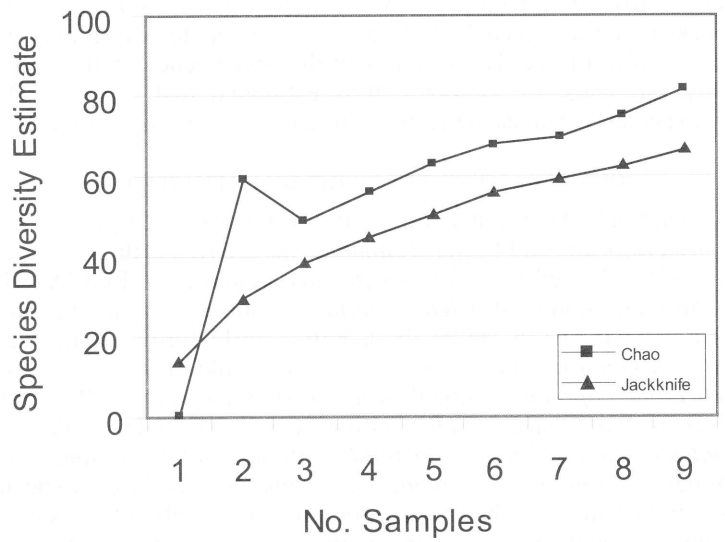

Fig. 3 — Chao presence/absence and Jackknife estimates of species diversity for all species from the Archer sample recorded from Sandscale Haws

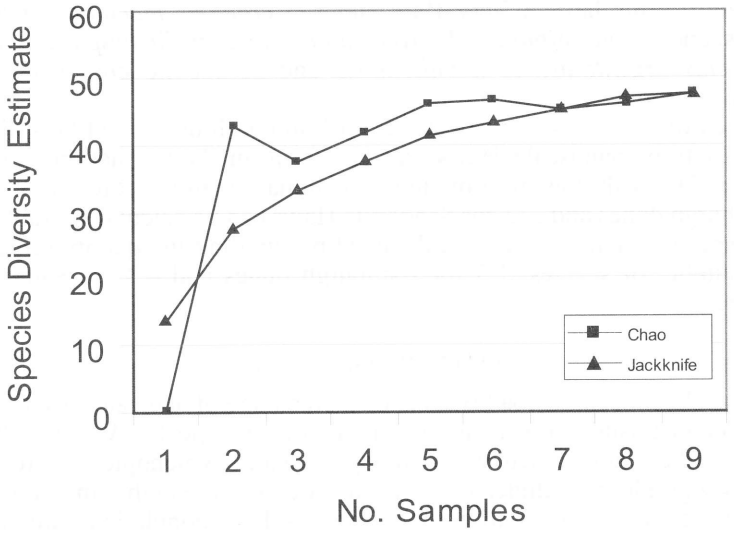

Fig. 4 — Chao presence/absence and Jackknife estimates of species diversity with tourist species removed from the Archer sample recorded from Sandscale Haws

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%. Therefore, CLs for sites in Britain should have similar values. From 27 English sites from Cumbria to Sussex, the CLs for species of solitary bees vary from 22.4–40.0% (range 17.6%) (Archer, this paper). The CL for Sandscale Haws falls within this range, but for Bamburgh dunes falls just below this range (Table 6). The low CL for Bamburgh dunes is probably due to the absence of cleptoparasitic species of some *Andrena* species which were considered tourist species. Cleptoparasites are usually observed near the nest sites of their hosts, so their absence gives further confidence in considering some *Andrena* species tourist species.

Wcislo (1987) gives no CLs for wasps, but from English sites the CLs of solitary wasps vary from 10.3–25.0%, a range of 14.7% (Archer, this paper). The CLs for Bamburgh dunes and Sandscale Haws fall within this range implying that Wcislo's hypothesis can also 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, or sometimes holes and crevices are used after being altered.

The AFs for the solitary species are given in Table 7. The AFs for all the British species of solitary wasps is 46.2% and for solitary bees is 17.9%. The AFs for the solitary wasps for both sites, particularly for Sandscale Haws, are lower than the national AF. The AFs for the solitary bees are a little higher than the national AF for both sites.

The low AF for the solitary wasp species is as expected for sand dune biotope where nesting sites will be mainly subterranean. Such an inference raises a problem of the high AF for the solitary bees. The high AF of the solitary bees is a consequence of tourist species which are aerial nesters.

DISCUSSION

To make comparisons between Cumbrian and Northumbrian sand dunes sites reference will also be made to the Cumbrian site of North Walney NNR (Archer, 2004b) and the Northumbrian site of Lindisfarne NNR (Archer, in press). For convenience, the appendix also lists the species recorded from North Walney NNR and Lindisfarne NNR.

The numbers of solitary species recorded from Northumbrian sites are smaller than from Cumbrian sites (Table 8). The number of recorded species could be influenced by site area of study and number of visits. However, more visits were made to the Northumbrian sites and Lindisfarne NNR is much larger than all the other sites. The number of

solitary species recorded during each visit is also higher for the Cumbrian sites (Table 8). Further, the estimated number of resident solitary species likely to be found at each site is higher for the Cumbrian sites (Table 8).

The number of solitary species of Cumbrian and Northumbrian sand dune sites are also smaller than sand dunes sites in other north English and North Midland sites: Ainsdale-Formby, Lancashire, 94 species (Archer, 1999), Gibraltar Point NNR, Lincolnshire, 73 species (Archer, 1998, 2003), Saltfleetby-Theddlethorpe NNR, 63 species (Archer, 2000a) and Spurn Point, Yorkshire, 72 species (Archer, unpublished). Again these differences could be a consequence of site area of study, but use of a species-area relationship shows this is unlikely. The regression equation of number of the solitary species on site area for 33 sandy northern England and East Midlands sites is: ln. no. spp. = 3.88 + (0.097 * ln. area (ha.)) (Archer, in press). Using this regression equation it can be shown that 33 extra species would be needed to reach the regression line for North Walney NNR, 26 species for Sandscale Haws, 55 species for Lindisfarne NNR and 48 species for Bamburgh dunes. The smaller number of species recorded from the Cumbrian, and particularly the Northumbrian, sites is probably a function of cooler climate.

Both the quality and species quality scores (SQS) are lower for the Northumbrian sites compared with the Cumbrian sites (Table 8). The quality score is likely to be influenced by site area (but not for the current four sites) while the SQSs are relatively independent of area and so are more appropriate to use for comparison between sites (Archer, 1999). The SQSs of the Northumbrian sites are the lowest yet recorded while the SQSs of the Cumbrian sites are similar to those of West Midlands and East Anglian sandy sites (Archer, 2007).

TABLE 8 — COMPARISON OF THE SOLITARY WASP AND BEE SPECIES OF THE CUMBRIAN (NORTH WALNEY NNR AND SANDSCALE HAWS) AND NORTHUMBRIAN (LINDISFARNE NNR AND BAMBURGH DUNES) COAST

	North Walney	Sandscale Haws	Lindisfarne	Bamburgh
Area (ha.)	68	70	240	56
No. spp.	42	50	27	25
No. visits*	9	9	10	11
Spp./ visit*	13.3	14.1	6.0	5.5
(range)	(8–18)	(8–20)	(1–12)	(1–10)
Potential no. spp.*	48–54	47–48	27–31	20–21
No. tourists spp. recorded*	None	10	8	9
Quality score	128	213	42	32
Species quality score	3.2	4.3	1.6	1.3

* based on the Archer samples

SUMMARY

1. With visual recording, Bamburgh dunes have 39 recorded species with one species of national importance and Sandscale Haws has 63 recorded species with ten species of national importance.

2. The Cumbrian sand dunes sites (North Walney NNR, Sandscale Haws) have higher species diversities and Species Quality Scores than Northumbrian sites (Lindisfarne NNR, Bamburgh dunes).
3. The species diversities of the Cumbrian and Northumbrian sites are lower than other sand dune sites from north England and North Midlands.
4. The Species Quality Scores for the Northumbrian sites are the lowest so far recorded for England while the Species Quality Scores for the Cumbrian sites are similar to sites in the West Midlands and East Anglia.
5. Tourist species were detected at both Bamburgh dunes and Sandscale Haws and their presence is used in the interpretation of the low Cleptoparasitic Load for the solitary bees of Bamburgh dunes and the high Aerial Nester Frequencies of the solitary bees of Bamburgh dunes and Sandscale Haws.

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APPENDIX – LIST OF RECORDED SPECIES FROM NORTH WALNEY NNR (NW), SANDSCALE HAWS (SH), LINDISFARNE NNR (L) AND BAMBURGH DUNES (BD)

CHRYSIDIDAE: *Cleptes nitidulus* (Fab.) (SH), *Hedychridium ardens* Latreille *in* Coquebert) (NW, SH, L, BD), *H. cupreum* (Dahlbom) (SH), *Chrysis ignita* (L.) (NW, SH), *C. impressa* Schenck (L.).

POMPILIDAE: *Pompilus cinereus* (Fab.) (NW, SH, L, BD), *Episyron rufipes* (L.) (NW, SH), *Anoplius concinnus* (Dahlbom) (NW), *Arachnospila anceps* (Wesmael) (NW, L, BD), *A. minutula* (Dahlbom) (L) *A. spissa* (Schiødte) (SH, BD), *A. trivialis* (Dahlbom) (SH), *Evagetes crassicornis* (Shuckard) (NW, L, BD), *Ceropales maculata* (Fab.) (NW, SH).

EUMENINAE: *Ancistrocerus oviventris* (Wesmael) (NW), *A. parietum* (L.) (BD), *A. scoticus* (Curtis) (NW, L).

VESPINAE: *Dolichovespula sylvestris* (Scopoli) (NW, SH, L, BD), *Vespula rufa* (L.) (SH, L, BD), *V. germanica* (Fab.) (SH), *V. vulgaris* (L.) (SH, BD).

CRABRONIDAE: *Dryudella pinguis* (Dahlbom) (SH, L), *Tachysphex pompiliformis* (Panzer) (NW, SH, L), *T. nitidus* (Spinola) (NW, SH), *Crabro cribrarius* (L.) (NW, SH, L, BD), *C. peltarius* (Schreber) (NW, SH, BD), *Crossocerus dimidiatus* (Fab.) (L, BD), *C. tarsatus* (Shuckard) (NW, SH, L, BD), *C. elongatulus* (Vander Linden) (NW, BD), *C. megacephalus* (Rossi) (BD), *C. pusillus* Lepeletier & Brullé (BD), *C. wesmaeli* (Vander Linden) (NW, SH), *Ectemnius continuus* (Fab.) (SH), *Oxybelus argentatus* Curtis (NW, SH), *O. mandibularis* Dahlbom (NW, SH), *O. uniglumis* (L.) (NW, SH, L), *Mimumesa littoralis* (Bondroit) (SH), *Pemphredon lethifera* (Shuckard) (NW, SH, L), *Mellinus arvensis* (L.) (NW, SH, L, BD), *Harpactus tumidus* (Panzer) (SH, BD).

COLLETINAE: *Colletes cunicularius* (L.) (NW, SH), *C. floralis* Eversmann (SH), *C. fodiens* (Geoffroy *in* Fourcroy) (NW, SH), *C. succinctus* (L.) (NW, SH), *Hylaeus brevicornis* Nylander (NW, SH), *H. hyalinatus* Smith (NW).

ANDRENINAE: *Andrena barbilabris* (Kirby) (NW, SH, L, BD), *A. fulva* (Müller *in* Allioni) (SH), *A. haemorrhoa* (Fab.) (NW, SH, BD), *A. nigroaenea* (Kirby) (L, BD), *A. scotica* Perkins (SH, L), *A. tarsata* Nylander (NW), *A. wilkella* (Kirby) (BD).

HALICTINAE: *Halictus rubicundus* (Christ) (L), *Lasioglossum calceatum* (Scopoli) (SH), *L. cupromicans* (Pérez) (L, BD), *L. leucozonium* (Schrank) (NW, SH), *L. nitidiusculum* (Kirby) (L), *L. punctatissimum* (Schenck) (SH), *L. villosulum* (Kirby) (NW, SH), *Sphecodes geoffrellus* (Kirby) (SH), *S. gibbus* (L.) (SH), *S. monilicornis* (Kirby) (SH, L, BD), *S. pellucidus* Smith (NW, SH), *S. puncticeps* Thomson (NW, SH).

MELITTINAE: *Melitta haemorrhoidalis* (Fab.) (L).

MEGACHILINAE: *Osmia aurulenta* (Panzer) (NW, SH), *Hoplitis claviventris* (Thomson) (NW, SH), *Megachile centuncularis* (L.) (SH, BD), *M. circumcincta* (Kirby) (NW, SH, L, BD), *M. willughbiella* (Kirby) (SH, L, BD), *Coelioxys elongata* Lepeletier (NW, SH, BD).

ANTHOPHORINAE: *Nomada panzeri* Lepeletier (L), *N. rufipes* Fab. (NW), *Epeolus cruciger* (Panzer) (NW, SH), *E. variegatus* (L.) (NW, SH), *Anthophora furcata* (Panzer) (NW, L).

APINAE: *Bombus hortorum* (L.) (NW, SH, L, BD), *B. jonellus* (Kirby) (BD), *B. lapidarius* (L.) (NW, SH, L, BD), *B. lucorum* (L.) (NW, SH, L, BD), *B. muscorum* (L.) (L), *B. pascuorum* (Scopoli) (NW, SH, L, BD), *B. pratorum* (L.) (SH, L, BD), *B. terrestris* (L.) (NW, SH, L, BD), *B. barbutellus* (Kirby) (L), *B. bohemicus* (Seidl) (NW, L, BD), *B. campestris* (Panzer) (L), *B. sylvestris* (Lepeletier) (SH, BD), *B. vestalis* (Geoffroy *in* Fourcroy) (SH, BD), *Apis mellifera* L. (NW, SH, L, BD).