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THE WASPS AND BEES (HYMENOPTERA: ACULEATA) OF LINDISFARNE NATIONAL NATURE RESERVE

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SUMMARY

The sand dunes and dune slacks of Cheswick and Holy Island have forty recorded species of aculeate wasps and bees with two, possibly three, species of national importance (*Arachnospila minutula*, *Melitta haemorrhoidalis*, *Bombus muscorum*). The two sites are relatively unfavourable for solitary wasps and bees compared with other northern English sites since they have fewer species relative to their combined areas, and are tentatively predicted to have a resident species-diversity of about 29-31 solitary species. The two sites have a species quality score more similar to other east coast, rather than west coast, sites.

INTRODUCTION

Lindisfarne National Nature Reserve (NNR) is situated between Bamburgh and Berwick-upon-Tweed on the Northumberland coast. The NNR covers an area of 3,278ha extending from Budle Point to Cheswick Rocks and including Holy Island. The NNR consists of sand dunes, dune slacks, coastal grassland, heath, saltmarsh and tidal mud-flats. Only the sand dunes and dune slacks of Cheswick, Holy Island and Ross were visited. The sand dunes of Cheswick and Holy Island are lime-rich while those of Ross are more acidic. On the lime-rich dunes a range of herbs, *e.g.* Viper's Bugloss and Vetch, and shrubs, *e.g.* Creeping Willow, are important food sources for the aculeate species. At the back of the dunes and around a cottage, 'The Snook', on Holy Island, are shrubs and trees which provide sheltered areas for mating and probably nesting sites for the aerial nesters. Although Ross dunes were visited, the main investigations were of the dunes of Cheswick and Holy Island which have an area of about 240ha.

METHODS

Between 1997 and 2004, ten visits were made to Cheswick and Holy Island sand dunes distributed throughout the year as follows: May (one visit), June (three), July (four) and August (two). During each visit, which lasted about one and a half hours for Cheswick dunes and four to five hours for Holy Island, all species of aculeate wasps and bees were recorded and usually collected with a hand net for later identification. The weather on one July visit was so cold that only the social species could be recorded.

Four visits were made to Ross dunes and the area behind the dunes between 1997 and 1999 as follows: June (one visit), July (two) and August (one). The records for these visits will not be used in further analysis although they will be referred to where relevant.

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

Species present and the seasonal progression of species

A full list of recorded species, with their authorities, is given in the Appendix. Table 1 shows the taxonomic distribution of species recorded from Cheswick and Holy Island dunes. A record represents a specimen differing in one of the following three variables: name, sex and day of visit. The three groups of social, solitary wasp and bee species have a similar number of species. There are about twice the number of records of solitary wasps compared with solitary bees. The number of records of social species slightly exceeds those of the solitary species.

No additional species were recorded from Ross sand dunes by the author or as given by Eales (1998), although further additional species were found behind Ross dunes: *Crossocerus elongatulus*, *Ectemnius sexcinctus*, *Andrena haemorrhoa*, *Lasioglossum rufitarse* and *Sphecodes gibbus* (Table 1).

Table 1 Number of species and records from Lindisfarne NNR sand dunes (including the region behind Ross dunes).

	Cheswick & Holy Island		Cheswick, Holy Island & Ross	
	Species	Records	Species	Records
Solitary wasps				
Chrysididae	2	5	2	5
Pompilidae	4	9	4	12
Eumeninae	1	7	1	7
Carbronidae	8	37	10	48
Total solitary wasps	**15**	**58**	**17**	**72**
Solitary bees				
Andreninae	3	4	4	8
Halictinae	4	4	6	10
Melittinae	1	1	1	1
Megachilinae	2	12	2	13
Anthophorinae	2	2	2	2
Total solitary bees	**12**	**23**	**15**	**34**
Total solitary species	***27***	***81***	***32***	***106***
Social wasps & bees				
Vespinae	2	2	3	5
Apinae	11	88	11	102
Total social species	***13***	***90***	***14***	***107***
Total wasps & bees	**40**	**171**	**46**	**213**

Of the twenty-seven solitary species recorded from Cheswick and Holy Island dunes one species was first found during May, seventeen species during June, six species during July and three species during August. The number of solitary species found per visit was during May (one species), June (six, twelve, eight), July (six, eight, four, zero) and August (six, three). Although only a single visit was made in May to record solitary species, August, June and July would seem to be the best months for recording them.

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 and first and second-order Jackknife procedures are three statistical methods of estimating the potential number of species (species richness) likely to be found on a site after a number of samples have been taken (Magurran, 2004). The presence/absence quantitative estimate of Chao and the second order Jackknife procedure are based on the number of species that are recorded in one ('singletons') or two ('doubletons') samples while the first order Jackknife procedure is based only on the singletons. 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. Each procedure was repeated thirty times. With a small number of samples the estimates are highly variable, but as more samples are selected these may stabilise, giving confidence in them.

The estimates based on different sample sizes are given in Figures 1, 2 and 3. Except for the Chao estimate, the estimates do not stabilize. Table 2 shows the three species-diversity estimates after all samples have been considered, with their 95% confidence limits except for the second order Jackknife. The species-diversity estimates differ widely from each other and no confidence can be placed in them.

The 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 under study, do not normally obtain their resources from the site. Vagrant species normally occur away from the geographical area of the site. It is often 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 are 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. No vagrant species were found at Lindisfarne.

The recorded solitary species can be divided into three groups. The first group consists of species with their cleptoparasites that are known to be subterranean nesters in sandy soils. These species were usually found on two or more visits and often their nesting sites were found, *e.g. Pompilus cinereus*, *Tachysphex pompiliformis* with its cleptoparasite *Hedychridium ardens*, *Crabro cribarius*, *Crossocerus tarsatus*, *Mellinus arvensis* and *Megachile circumcincta*. This first group can be considered resident species. The second group consists of aerial nesters with their cleptoparasites which use cavities in dead plant stems or dead wood or their mud nests are attached to a firm substrate, *e.g. Ancistrocerus scoticus* with its possible parasite *Chrysis impressa*, *Pemphredon lethifera* and *Megachile willughbiella*. This second group can be considered resident species because of the presence of dead herbaceous and shrubby stems. *Ancistrocerus scoticus* was found plastering its nests onto medieval masonry in a dune slack on Holy Island. The third group consists of subterranean nesters with their cleptoparasites which nest in a wide variety of soils. This third group also consists of species which are common and widespread and would have been expected to be recorded on several visits if they were nesting among the sand dunes. These species included *Andrena scotica*, *Lasioglossum cupromicans* and *Halictus*

rubicundus with its cleptoparasite Sphecodes *monilicornis*. Such species were also found behind the Ross dunes and may be considered tourist species.

Removing the tourist species, the non-parametric statistical procedures were re-run with the results given in Table 2 and Figures 1, 2 and 3. The final potential species-diversity estimates are now very close together varying between 29-31 species and the figures show an improvement in the stabilization of these species estimates. Some reservation still remains about these estimates as they are based on a rather small number of species and samples.

Table 2 Non-parametric estimates of species richness from Lindisfarne NNR using the Cheswick and Holy Island samples.

All species	Chao estimate	First order Jackknife estimate	Second order Jackknife estimate
No. species recorded	27	27	27
No. species estimated	63	42	53
95% confidence limits	21-105	34-50	-
% of estimated spp. found	**42.9**	**64.2**	**50.9**
Tourist species removed			
No. species recorded	19	19	19
No. species estimated	29	27	31
95% confidence limits	13-46	19-35	-
% of estimated spp. found	**65.5**	**70.4**	**61.3**

Compared with other northern sand dune sites (North Walney NNR, Cumbria, forty species (Archer, 2004); Ainsdale-Formby, Lancashire, ninety-four species (Archer, 1999); Gibraltar Point, Lincolnshire, seventy-three species (Archer, 1998); Saltfleetby-Theddlethorpe NNR, Lincolnshire, sixty-three species (Archer, 2000); and Spurn Point, seventy-two species (Archer, unpublished)) the number of solitary species recorded from Lindisfarne (twenty-seven species) is the smallest.

The unfavourable site of Lindisfarne NNR for solitary species of wasps and bees can also be shown in a species-area relationship figure by comparison with thirty-three other northern and east Midland English sites (Figure 4). The dot for Lindisfarne falls below and outside the range of the other sites. The regression equation for the thirty-three sites is ln no. spp. = 3.88 + (0.097 x ln area (ha)). Inserting the area of the sand dunes of Cheswick and Holy Island into this equation reveals that Lindisfarne NNR would need a further fifty-five species to approximate to the average of the other sites.

This unfavourable nature of Lindisfarne for solitary wasp and bee species is probably a consequence of a more unfavourable climate due to its position on the eastern side of England and its more northerly location (55°40 N).

QUALITY ASSESSMENT

According to Falk (1991), *Arachnospila minutula* is the only species of national importance having a nationally notable list B status. Recent work by the BWARS indicates that *Melitta haemorrhoidalis* is also of national importance. Using the latest information from the BWARS, each of the twenty-seven solitary species can be given an Archer national

Figure 1 The Chao presence/absence of species richness for Lindisfarne sand dunes.

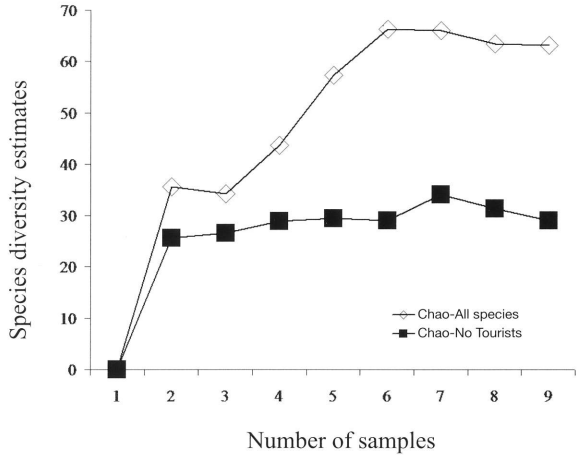


Figure 2 The first order Jackknife estimate of species richness for Lindisfarne sand dunes.

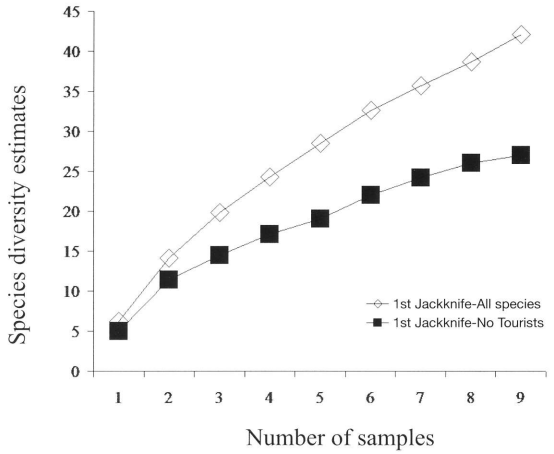


Figure 3 The second order Jackknife estimate of species richness for Lindisfarne sand dunes.

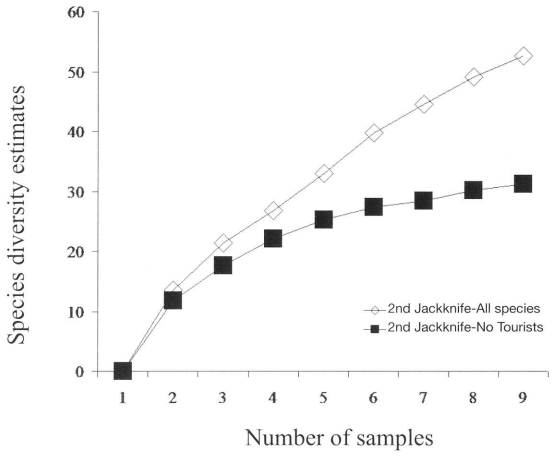
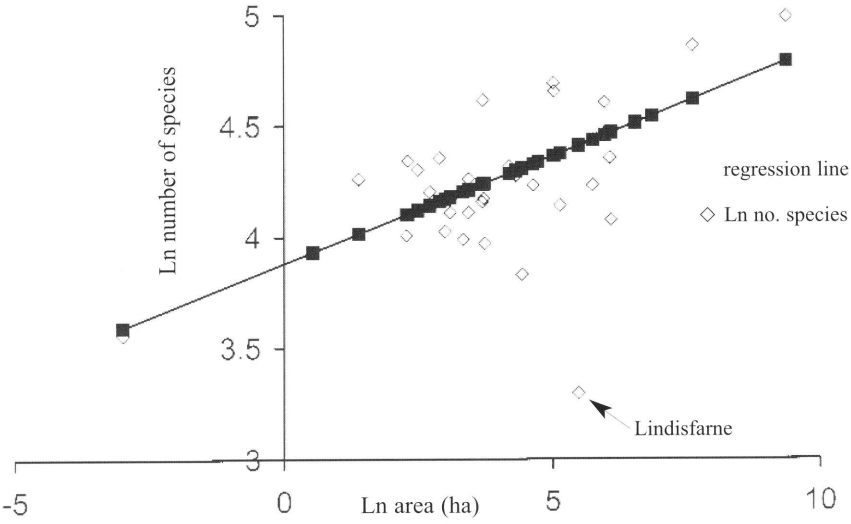


Figure 4 A species-area relationship of sites from the north and north Midlands of England.



status (Archer, 1999, 2002). Under the Archer scheme *A. minutula* and *M. haemorrhoidalis* has 'scarce' status; *Anthophora fucata* has 'widespread' status while the rest of the species have 'universal' status. With this information a national quality score of forty-two and a species quality score (SQS) of 1.6 can be calculated (Table 3).

Table 3 The Archer national quality scores of the solitary species recorded from the Cheswick and Holy Island samples.

National Status	Status Value (A)	No. Species (B)	Quality Scores (AxB)
Universal	1	24	24
Widespread	2	1	2
Restricted	4	0	0
Scarce	8	2	16
Total		**27**	**42**

Species Quality Score (SQS): 42/27 = 1.6

Southern widespread species occur in about three-quarters of England, lowland Wales and south-west Scotland but not north-east England including Northumberland. Northern widespread species occur north of a line from the Wash to the mouth of the Severn. *Sphecodes gibbus* recorded from behind Ross dunes and *Anthophora furcata* currently have a southern widespread status and perhaps should have their status changed to 'universal'. However, the Northumberland record for both species is an outlying record so, for the present, they can retain southern widespread status. *Lasioglossum rufitarse* recorded from behind Ross dunes is a northern widespread species.

Archer (1999) found that although quality scores are influenced by the area of a site, SQSs are relatively independent of site area 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) and Spurn Point 2.3 (Archer, unpublished) and for the west coast are Ainsdale-Formby 3.8 (Archer, 1999) and North Walney NNR 3.2 (Archer, 2004). The SQS for Lindisfarne NNR (1.6)

places it with other east coast sites which have lower SQSs than west coast sites, probably reflecting the warmer climate of the west coast.

None of the social wasp and bee species is of national importance except possibly *Bombus muscorum* which shows signs of recent severe decline especially in inland areas (Edwards, 2005).

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APPENDIX

Species recorded from Cheswick (C), Holy Island (H) and Ross (R) sand dunes and behind Ross dunes (BR).

Chrysididae: *Hedychridium ardens* (Latreille in Coquebert) (C), *Chrysis impressa* Schenck (H).

Pompilidae: *Pompilus cinereus* (Fab.) (C, H, R), *Arachnospila anceps* (Wesmael) (C), *A. minutula* (Dahlbom) (C), *Evagetes crassicornis* (Shuckard) (H, R).

Eumeninae: *Ancistrocerus scoticus* (Curtis) (C, H).

Vespinae: *Dolichovespula norwegica* (Fab) (BR), *D. sylvestris* (Scopoli) (H, R), *Vespula rufa* (L.) (H, R).

Crabronidae: *Dryudella pinguis* (Dahlbom) (H), *Tachysphex pompiliformis* (Panzer) (C), *Crabro cribrarius* (L.) (C, H, R), *Crossocerus elongatulus* (Vander Linden) (BR), *C. tarsatus* (Shuckard) (H), *C. dimidiatus* (Fab.) (H, R), *Ectemnius sexcinctus* (Fab.) (BR), *Oxybelus uniglumis* (L.) (H), *Pemphredon lethifera* (Shuckard) (H), *Mellinus arvensis* (L.) (C, H, R).

Andreninae: *Andrena scotica Perkins* (C, R), *A. nigroaenea* (Kirby) (H), *A. haemorrhoa* (Fab.) (BR), *A. barbilabris* (Kirby) (H).

Halictinae: *Halictus rubicundus* (Christ) (C), *Lasioglossum nitidiusculum* (Kirby) (H), *L rufitarse* (Zetterstedt) (BR), *L. cupromicans* (Pérez) (H, R), *Sphecodes gibbus* (L.) (BR), *S. monilicornis* (Kirby) (C, R).

Melittinae: *Melitta haemorrhoidalis* (Fab.) (C).

Megachilinae: *Megachile willughbiella* (Kirby) (H), *M. circumcincta* (Kirby) (C, H, R).

Anthophorinae: *Nomada panzeri* Lepeletier (H), *Anthophora furcata* (Panzer) (H).

Apinae: *Bombus lucorum* (L.) (C, H, R), *B. terrestris* (L.) (C, H), *B. hortorum* (L.) (C, H), *B. lapidarius* (L.) (C, H, R), *B. pratorum* (L.) (C, H, R), *B. muscorum* (L.) (H), *B. pascuorum* (Scopoli) (C, H, R), *B. barbutellus* (Kirby) (C, H), *B. bohemicus* (Seidl) (C, H), *B. campestris* (Panzer) (C, H), *Apis mellifera* (L.) (C, R).