REVISITING THE SOLITARY WASPS AND BEES (*HYMENOPTERA: ACULEATA*) OF BRIMHAM ROCKS IN WATSONIAN YORKSHIRE

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A study of the aculeate wasps and bees of Brimham Rocks has been published (Archer, 2001). This study indicated that more recording was required to obtain a stable estimate of the number of solitary species. Therefore, the first aim of this paper is to report on further visits to obtain a stable estimate. With the first aim achieved, the second aim of further analysis of the data becomes possible.

Description of Brimham Rocks and sampling methods are given in Archer (2001). No noticeable changes have been found between the earlier visits (1974-1998) and the current visits (2001-2003). Seven current visits (28 Aug. 2001, 25 Apr. 2002, 2 June 2002, 23 June 2002, 29 July 2002, 28 May 2003, 24 June 2003) have been made. A further five solitary species were recorded (*Myrmosa atra* Panzer, 29 July 2002; *Andrena fulva* (Müller *in* Allioni), 25 Apr. 2002, 28 May 2003; *Lasioglossum smeathmanellum* (Kirby), 24 June 2003; *Sphecodes crassus* Thomson, 28 Aug. 2001; and *Epeolus cruciger* (Panzer), 28 Aug. 2001) now giving a total of 45 solitary species. With the 17 social wasps and bees previously recorded, the total of 62 species indicates that Brimham Rocks is a good site for conservation purposes within a Watsonian Yorkshire context.

The daily rate of recording species per month is shown in Table 1. The month with the highest mean number of species is July although on a good day during June and August a similar number of species might be found. Weather conditions can be very variable which accounts for the variability of the number of species recorded during June and August.

From the regression equation of the species-area relationship for 32 lowland sites from the north and north Midlands of England (Archer, 2006), it can be calculated that if Brimham Rocks was equally favourable for solitary species, on average, 80 species would be present. The lower number of species (45) is probably a consequence of the higher altitude of Brimham Rocks at about 260m. with its less favourable climate.

TABLE 1
Mean number and range of species of solitary wasps and bees recorded per month at Brimham Rocks

April	May	June	July	August	September
4.0 2-6	3.3 1-5	5.3 1-10	9.5 7-11	5.8 2-9	4.0 4

Estimating the Potential Number of Solitary Species

The non-parametric statistical procedures used were the presence/absence Chao (in Colwell & Coddington, 1994) and the first order Jackknife (Heltshe & Forrester, 1983) procedures 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 and Forrester is based only on singletons only. 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. 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. With a small number of samples the estimates are erratic, but as more samples are selected these may stabilise, giving confidence in them.

The diversity estimates for the two statistical procedures for the 26 visits are shown in Figs 1, 2 and the final species diversity estimates from Archer (2001, 19 visits) and after the 26 visits in Table 2. After the 26 visits the species diversity stabilizes and the final estimates from the two statistical procedures are similar to each other. With this information, a decision could now be taken to cease further recording. However, with an estimated 71-75% of potential species recorded there is still an opportunity of finding new species.

Species Quality

Using the Archer national quality scoring system (Archer, 1999, 2002), Brimham Rocks has a Quality Score of 64 and a Species Quality Score (SQS.) of 1.4 (Table 3). Archer

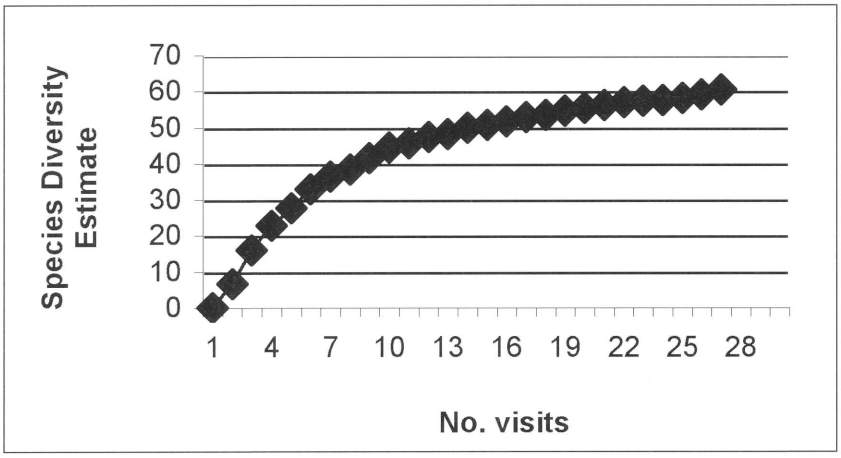

Figure 1.
The 1st order Jackknife estimate of species richness for Brimham Rocks.

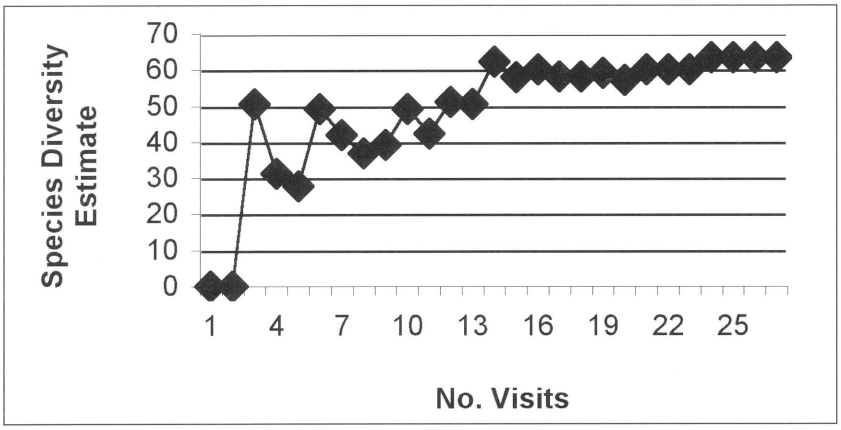

Figure 2.
The Chao presence/absence estimate of species richness for Brimham Rocks.

TABLE 2
Non-parametric estimates of species richness at Brimham Rocks

From Archer (2001)	Chao estimate	Jackknife estimate
No. species recorded	40	40
No. species estimated	70	58
95% confidence limits	40-100	48-68
% of estimated spp. found	57	69
Current paper	**Chao estimate**	**Jackknife estimate**
No. species recorded	45	45
No. species estimated	63	60
95% confidence limits	43-83	52-69
% of estimated spp. found	71	75

TABLE 3
The Archer national quality scores of the solitary species recorded from Brimham Rocks

National Status	Status Value (A)	No. Species (B)	Quality Scores (A x B)
Universal	1	32	32
Widespread	2	12	24
Scarce	8	1	8
Total		45	64
Species Quality Score (SQS) 64/45 = 1.4			

(1999) showed that although quality scores are influenced by the area of sites, the SQSs are relatively independent of site areas so SQSs can be used to compare sites without regard to site areas. Archer (2003) on the basis of their SQS divided Watsonian Yorkshire sites into first class (SQS 2.4-2.9), second class (SQS 1.8-2.3) and third class (SQS 1.2-1.7) sites. Brimham Rocks is a third class site with one nationally Scarce species, *Sphecodes crassus*.

Cleptoparasitic Load

The cleptoparasitic load (CL) is the percentage of aculeate species that are cleptoparasitic (or parasitoids) on other host aculeates, e.g. *Epeolus cruciger* on *Colletes succinctus* (Linn.), *Nomada lathburiana* (Kirby) on *Andrena cineraria* (Linn.), *N. marshamella* (Kirby) on *A. scotica* Perkins and *N. rufipes* Fab. on *A. fuscipes* (Kirby). Although *Argogorytes mystaceus* (Linn.) was found, its cleptoparasite, *Nysson spinosus* (Forster) was not found.

Wcislo (1987) showed that parasite behaviour among aculeate Hymenoptera correlated with geographical latitude. Thus the 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 in Europe varied between 16% and 33%, a range of 17%.

For 27 Yorkshire sites, the author found that CLs for solitary bees vary from 25.6%-40.0% giving a range of 14.4%, which is close to the range found by Wcislo. The CL value for the solitary bees (Table 4) falls within this range. Wcislo gave no CLs for solitary wasps but from 27 Yorkshire sites CLs vary from 10.3%-25.0% giving a range of 14.7%. The CL value for the solitary wasps (Table 4) falls within this range, and supports Wcislo's hypothesis.

TABLE 4
The relative frequency of the cleptoparasitic (or parasitoid) species among the solitary species recorded from Brimham Rocks

	No. hosts (H)	No. cleptoparasites (C)	Cleptoparasitic Load CL = 100 x C/(H+C)
Solitary wasps	13	2	13.3
Solitary bees	19	11	36.7

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 stem cavities (e.g. bramble), crevices in old walls 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 AFs for the solitary species are given in Table 5. The AFs for all the British species of solitary wasps is 46.2% and solitary bees is 17.9%. From 30 Yorkshire sites (Archer, 2006), the AFs for solitary wasp varies between 0%-90% and for solitary bees between 6.7%-40.0%. The AFs for the solitary species from Brimham Rocks are well below the British AFs and the AF for the solitary bees is the lowest value for a Yorkshire site.

TABLE 5
The nesting habits of the solitary species from Brimham Rocks

	No. aerial Nesters (A)	No. subterranean Nesters (S)	Aerial nester frequency AF = 100 x A/(A+S)
Solitary wasps	3	10	23.1
Solitary bees	0	19	0.0

Summary About Brimham Rocks

1. With 62 species of social and solitary species recorded it is a good site in a Yorkshire context.
2. It has fewer solitary species than expected for its area probably due to its higher altitude with less favourable climate.
3. The two estimates of potential species richness are stable and closely agree with each other indicating that about 60-63 solitary species could be present.
4. It is a third class conservation site with one species of national importance.
5. All recorded solitary bee and about 75% of solitary wasps are subterranean nesters.

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REMARKS ON THE IDENTITY OF THE SUBAERIAL GREEN ALGA *CEPHALEUROS ENDOPHYTICUS* (F. E. FRITSCH) PRINTZ AND A NEW RECORD OF THE SPECIES FROM NORTHERN ENGLAND

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Introduction

Green algae belonging to the order Trentepohliales are responsible for much of the superficial brown and orange colour of sheltered rocks and tree trunks throughout the country. Several common species of *Trentepohlia* produce these colorations, but a smaller group of more specialised subaerial algae, belonging to two genera, *Phycopeltis* and *Cephaleuros*, also occur in these islands. Both are common in the tropics and usually found growing on the evergreen leaves of ferns, shrubs and trees and they have occasionally been reported in the British Isles in humid valleys, particularly near the western coast. *Phycopeltis* occurs as small green or brown discs a few millimetres across on the leaves of ivy, rhododendron and conifer needles (Scannell, 1965). The two species *P. arundinacea* and *P. epiphyton* are widely distributed and are probably often overlooked (John, 2000). *Cephaleuros* was first reported and described in Britain by Fritsch (1942) as *Chrooderma endophytica* Fritsch from material sent to him by the Rev. P. G. M. Rhodes. It was collected in April 1932 from the Bonython Plantations, Bochym, near Penzance, Cornwall on stems of *Rubus fruticosus* agg. A recent visit to the Natural History Museum revealed no British material of *Cephaleuros*, but in the *Phycopeltis* folder, the original Cornish material was discovered under the name of *P. epiphylla* 'No. 5127'. This was no doubt an error for *P. epiphyton*, mentioned above. Although Fritsch described the material as damaged, the herbarium material appeared to be in good condition, although sporangiophores were little developed. Fritsch provided a detailed and illustrated description of the Cornish plant. Although it strongly resembled a *Phycopeltis*, on closer examination he discovered that the plant was partially endophytic and consisted of multiple layers of cells. In *Phycopeltis* the cells are entirely epiphytic, and there are few taxa with multilayered cells. He placed the alga in a new genus *Chrooderma*. It was later recognised as belonging to the predominantly tropical genus *Cephaleuros* by Printz and was synonomised with *C. virescens* by Thompson and Wujek (1997).

The genus *Cephaleuros* was first described by Kunze in 1827 and is widely distributed in the warmer regions of the world. It currently contains twelve species, nine of which have been described from Java and tropical America. *Cephaleuros* forms small orange-brown or olive-green rosettes up to c. 5 mm in diameter on bark and leaves in sheltered, humid sites. It is distinguished from *Phycopeltis* by two important features, its predominantly