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The aculeate wasps and bees (Hymenoptera: Aculeata) of Herm and Sark, Channel Islands

MICHAEL E. ARCHER

The University College of Ripon and York St. John, Lord Mayor's Walk, York YO3 7EX

Between 24 July and 6 August 1994 I was able to spend ten days surveying the aculeate wasps and bees on Herm and found 56 species, of which 29 represented first records for Herm and one was new to the Channel Islands. Two visits were also made to Sark (29 July, 3 August) during which 42 species were found, of which 20 represented first records for Sark and one was new to the Channel Islands. This paper reviews the aculeate wasp and bee species known from Herm and Sark and considers the completeness of the respective lists in terms of the species-area relationship for the Channel Islands.

Luff (1905, 1907) listed the species of aculeate wasps and bees on Herm and Sark. Richards (1978) summarized information on the species of aculeate Hymenoptera found on the Channel Islands. Archer (1994) added 20 species to the Herm list and Archer (1993*a*) added six species to the Sark list. C. T. David (1994, pers. comm.) provided an up-to-date, unpublished, listing of the wasp and bee species found on Guernsey, Alderney, Sark and Herm, for which I acknowledge my thanks.

The islands of Herm and Sark lie about 20 miles off the west coast of Normandy, France, and about 80 miles south of the southern coast of England. Herm is about 1.5 miles long and about 0.5 miles at its widest point. Sark is about 3 miles long and 1.25 miles at its widest point. Both islands consist of igneous rocks, mainly granite, which produce an acid sandy soil.

The northern end of Herm, which is covered by wind-blown calcareous sands, consists of a low-lying plain with mobile dunes at the coast and some recent 'blow-out' areas. The centre of Herm is cultivated but the cliffs at the southern end are covered by heathers, bracken and brambles besides having more open sandy areas. Small hills, woodland and hedges are also present.

The centre of Sark is cultivated but is entirely surrounded by cliffs, with extensive areas of cliff tops which are covered by natural vegetation including heathland. Sark has woodland, hedges and many banks at the sides of the roads and lanes, often in sunny sheltered situations. The varied habitats of Herm and Sark provide many suitable nest sites and foraging areas for aculeate wasps and bees.

During each survey period, all species of aculeate wasps and bees were recorded, except for the Apidae, to which less attention was paid. Each specimen was collected with a hand net or specimen tube for later identification.

In the following account biological names follow Kloet & Hincks (1978).

Species present

The full listing of the 101 species of aculeate wasp and bee species recorded from Herm and the 89 species from Sark is given in the appendix. The species

recorded in my 1989, 1991 and 1994 visits (Archer sample) are indicated in the appendix. First species records for Herm and Sark from the Archer sample are also shown in the appendix.

The taxonomic distribution of species at the family level is given in Table 1. The number of species of solitary bees is greater than the number of species of solitary wasps with the ratio of 1 bee : 0.6 wasp for Herm and 1 bee : 0.5 wasp for Sark. The solitary wasp species are dominated by the sphecids, and the solitary bee species by the andrenids and halictids on both islands.

Table 1. The number of species of aculeate wasps and bees recorded from Herm and Sark.

	Herm	Sark
Chrysididae	1	2
Tiphiidae	0	1
Mutillidae	1	0
Pompilidae	5	7
Eumenidae	5	3
Sphecidae	21	12
Solitary wasps	33	25
Colletidae	5	6
Andrenidae	18	20
Halictidae	19	13
Melittidae	1	0
Megachilidae	5	4
Anthophoridae	8	11
Solitary bees	56	54
Vespidae	2	3
Apidae	10	7
Social wasps & bees	12	10
Total wasps & bees	101	89

The new species records for the Channel Islands are *Sphecodes niger* von Hagens from Herm, and *Andrena alfkenella* Perkins from Sark. *S. niger* is widely distributed in central and southern Europe, but is rare in southern England. It is probably a cleptoparasite on *Lasioglossum morio* (F.), a species which has been found on Herm. *A. alfkenella* is a mining bee which is scarce in western and central Europe and is a rare and very local species in southern England, where it has declined in distribution since 1970.

Two species from Herm, *Colletes hederae* Schmidt & Westrich and *Sphecodes marginatus* von Hagens, and three species from Sark, *Evagetes siculus* (Lepeletier), *C. hederae* and *Halictus scabiosae* (Rossi), have never been found on mainland Britain. *Tachysphex obscuripennis* (Schenck) from Herm and *Odynerus reniformis* (Gmelin) (which has not been recorded from the Channel Islands since 1934) from Sark, are now considered extinct on mainland Britain.

A further 27 species, 19 on Herm and 15 on Sark, would have Red Data Book (RDB) or Notable (N) status (Falk, 1991) in a Great Britain context. These species are indicated in the appendix. However, the Great Britain status of these

species is not a good guide to the rarity status of these species on Herm or Sark or the Channel Islands generally. Herm and Sark are well worth visiting to observe aculeate wasps and bees which are impossible or difficult to find in Great Britain.

How complete are the aculeate wasp and bee lists from Herm and Sark?

The aculeate wasps and bees from Jersey, Guernsey and Alderney have been recorded from the end of the nineteenth century and, although new species will still be found (Richards, 1978), it is probable that the species lists are more or less complete. One way of testing the completeness of the species lists, including those of Herm and Sark, would be to determine the species-area relationship (Usher, 1986). The relationship between the number of species and area size is well established, so that as area increases so does the number of species. An equation that is frequently used to show this relationship is: $\ln S = \ln C + z \ln A$, where $\ln S$ is the natural logarithm of the number of species, $\ln A$ the natural logarithm of the area, $\ln C$ the interception on the Y-axis and z the slope or regression coefficient of the relationship. If the plot of $\ln S$ against $\ln A$ shows a straight-line relationship then it may be assumed that the species lists are more or less complete. Fig. 1 shows the plot for Jersey, Guernsey, Alderney, Herm and Sark. Herm would seem to coincide with an approximate straight-line relationship with Jersey, Guernsey and Alderney, indicating that its species list is more

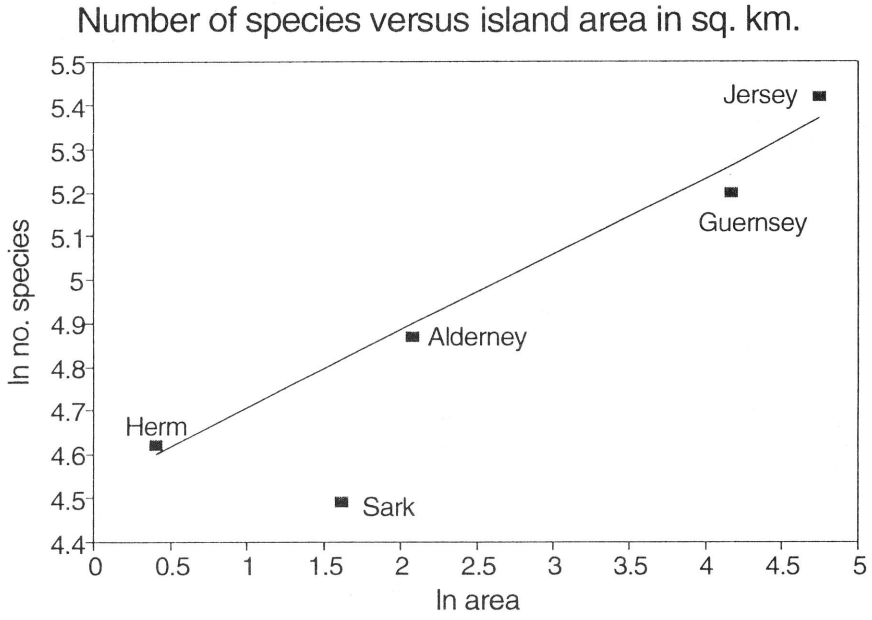

Fig. 1. The species-area relationship of the aculeate wasps and bees on the Channel Islands (best straight-line relationship fitted for Jersey, Guernsey, Alderney and Herm).

or less complete. Sark, however, falls below this straight-line relationship, indicating that its species list is not yet complete. The correlation coefficient for Jersey, Guernsey, Alderney and Herm of 0.99 indicates a very close positive relationship between the number of species and the area.

Despite the small sample size the probability of getting this result by chance is 0.01, so the relationship is statistically significant. The regression equation for the species-area relationship can be written as: $\ln S = 4.53 + 0.176 \ln A$. Using this equation it can be calculated that, for the land area of Sark, about 123 species of aculeate wasps and bees can be expected to be present. Thus it can be predicted that about another 35 species of aculeate wasps and bees will be found on Sark before its species list is almost complete.

The regression coefficient can be used to indicate how fast new species are added as the area increases (Usher, 1986). The rather low value of the regression coefficient of 0.169, which produces a flat slope (Fig. 1), indicates that about a 50-fold increase of area is needed to double the number of species.

Cleptoparasitic load

The cleptoparasitic load (CL) is the percentage of aculeate species that are cleptoparasites (or parasitoids) on other host aculeates. A more or less complete list of species in a locality should be made before the CL is calculated in order to avoid possible bias of either host or cleptoparasitic species. As the species list from Sark is not complete, only the CLs for Herm have been calculated (Table 2). The CL for the species of solitary bees is higher than the CL of the solitary wasps.

Table 2. The relative frequency of the cleptoparasitic species among the solitary wasps and bees on Herm.

	No. hosts (H)	No. cleptoparasites (C)	Cleptoparasitic load CL = 100*C/(H+C)
Solitary wasps	29	4	12.1
Solitary bees	42	14	25.0

Wcislo (1987) showed that the amount of parasitic behaviour among aculeate Hymenoptera is correlated with geographical latitude, being higher in the temperate compared with the tropical regions. If this is the case, since England and Wales with the Channel Islands occupy less than 7° of latitude then the CLs for localities in England, Wales and the Channel Islands should have similar values. For 11 data sets from England (Archer, in press) the CLs for the solitary wasp species (range 13.2–20.0%) and solitary bee species (range 25.0–36.6%) are similar. The CLs for Herm, as well as the CLs for Jersey, Guernsey and Alderney (Table 4), fall within or near the English ranges.

The higher CLs for the solitary bee species versus the solitary wasp species are a function of the British fauna (CL solitary wasps 17.8%, solitary bees 26.0%) and is probably a consequence of food-chain relationships. Host solitary wasp

species are the less numerous secondary consumers, and thus less likely to support cleptoparasitic species. The host-solitary bee species are the more numerous primary consumers and thus more likely to support cleptoparasitic species.

Aerial nester-frequency

The aerial-nester frequency (AF) is the percentage of host-aculeate species that have aerial nests. Aerial nests are often in old beetle burrows in dead wood, or the central cavities of stems such as those of bramble. Subterranean nesters nest in the soil, usually in burrows dug by themselves, but sometimes in crevices or preformed burrows. Again a more or less complete list of species in a locality should be made before the AF is calculated in order to avoid possible bias of either aerial or subterranean nesters, so only the AFs of Herm have been calculated (Table 3). The AF for the species of solitary wasps is higher than the AF of the solitary bees.

Table 3. The nesting habits of the host-solitary wasp and bee species on Herm.

	No. aerial nesters (A)	No. subterranean nesters (S)	Aerial nester frequency AF = 100*A/(A+S)
Solitary wasps	8	21	27.6
Solitary bees	1	41	2.4

Table 4. The cleptoparasitic loads and aerial nesters frequencies of the aculeate wasps and bees on Jersey, Guernsey and Alderney.

	Cleptoparasitic load		Aerial nester frequency	
	Solitary wasps	Solitary bees	Solitary wasps	Solitary bees
Jersey	20.0	31.0	23.7	10.0
Guernsey	22.4	27.4	23.1	8.7
Alderney	21.3	26.1	35.1	5.9

The AFs for Jersey, Guernsey and Alderney are given in Table 4. The AFs for the 11 English data sets (Archer, in press) give a range of 0.0–71.2% for solitary wasp species and 0.0–30.0% for solitary bee species. Much of this variation is dependent on the availability of aerial and subterranean nesting sites (Archer, 1993*b*). Within a Channel Islands context the higher AF for solitary wasp species on Alderney is probably due to a lack of sandy subterranean nesting sites.

The higher AFs achieved by the solitary wasp species versus the solitary bee species is a function of the British fauna (AF solitary wasps 44.9%, solitary bees 19.0%) and probably a consequence of the cooler British climate. Under such weather conditions, aerial nesting sites are likely to warm up more quickly and be warm for a longer time than subterranean nesting sites. Archer (1990) showed the activity of solitary wasps compared to the activity of solitary bees in England is more affected by poor weather conditions.

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Appendix

The species list of the aculeate wasps and bees recorded from Herm (H) and Sark (S). 9, 1, 4 = Archer sample for years 1989, 1991, 1994; * = first record of Archer sample; R1, R2, R3 = Red Data Book 1, 2, 3 species; Na, Nb = Notable a, b species.

Chrysididae. *Chrysis ignita* (L.) (H-4*, S), *C. viridula* L. (S-4).

Tiphiidae. *Tiphia femorata* F. (S-4).

Mutillidae. *Smicromyrme rufipes* (F.) (H-4*, Nb).

Pompilidae. *Auplopus carbonarius* (Scopoli) (S-4*, Nb), *Priocnemis agilis* (Shuchard) (S, Nb), *Pompilus cinereus* (F.) (H-1, 4), *Agenioideus cinctellus* (Spinola) (S-4*), *Archnospila anceps* (Wesmael) (H-1*, 4, S-4*), *Evagetes crassicornis* (Shuckard) (H-4*), *E. siculus* (Lepeletier) (S-4*), *Anoplius nigerrimus* (Scopoli) (S-4*), *Episyron rufipes* (L.) (H-1*, 4), *Aporus unicolor* Spinola (H-1*, 4, S-9, 4, Na).

Eumenidae. *Odynerus spinipes* (L.) (H), *O. reniformis* (Gmelin) (S, R1), *Ancistrocerus gazella* (Panzer) (H-4*, S), *A. oviventris* (Wesmael) (H, S), *A. parietinus* (L.) (H), *A. trifasciatus* (Müller) (H-1*, 4).

Vespidae. *Dolichovespula sylvestris* (Scopoli) (H-4, S-4), *Vespula rufa* (L.) (S-9*, 4), *V. vulgaris* (L.) (H-4*, S-4).

Sphecidae. *Astata boops* (Schrank) (H-4*, S), *A. pinguis* (Dahlbom) (H-4*), *Tachysphex pompiliformis* (Panzer) (S-9*), *T. obscuripennis* (Schenck) (H-1*, 4, R1), *T. unicolor* (Panzer) (H-1*), *Crabro cribrarius* (L.) (H-4*), *Crossocerus elongatulus* (Van der Linden) (H-1*, 4, S-9*, 4), *C. tarsatus* (Shuckard) (S-4*), *C. megacephalus* Van der Linden (H-1*, 4), *C. quadrimaculatus* (F.) (H-1*, 4, S-4*), *Ectemnius ruficornis* (Zetterstedt) (H-4*, Nb), *E. cephalotes* (Olivier) (H4*, S-4*), *Lindenius albilabris* (F.) (S), *Oxybelus uniglumis* (L.) (H-1*, 4), *Pemphredon lethifer* (Shuckard) (H-1*), *Diodontus insidiosus* Spooner (H-4*, R3), *D. tristis* (Van der Linden) (H-4*),

Ammophila sabulosa (L.) (H-1*, 4, S-9, 4), *Podalonia affinis* (Kirby) (H, R3), *Mellinus arvensis* (L.) (H-1, 4, S-4*), *Nysson interruptus* (F.) (S, R2), *N. trimaculatus* (Rossius) (H-4*, Nb), *Gorytes laticinctus* (F.) (H-4*, R3), *Philanthus triangulum* (F.) (H-1*, 4, S-9, R2), *Cerceris arenaria* (L.) (H), *C. rybyensis* (L.) (S-4).

Colletidae. *Colletes daviesanus* Smith (S), *C. fodiens* (Geoffroy) (H-1*, 4, S-4*), *C. hederae* Schmidt & Westrich (H, S), *C. succinctus* (L.) (H, S), *Hylaeus brevicornis* Nylander (H-1, S-4*), *H. hyalinatus* Smith (H-1, 4, S).

Andrenidae. *Andrena apicata* Smith (H, Nb), *A. fulva* (Müller) (H, S), *A. varians* (Rossi) (S, Nb), *A. scotica* Perkins (H, S), *A. trimmerana* (Kirby) (H, S, Nb), *A. bicolor* Smith (H-1, 4, S-4), *A. angustior* (Kirby) (H, S), *A. cineraria* (L.) (H, S), *A. nigroaenea* (Kirby) (H, S), *A. thoracica* (F.) (H-1, 4, S-4), *A. nigriceps* (Kirby) (H-1, 4, S-4, Nb), *A. pilipes* F. (H-4, S-4*, Nb), *A. flavipes* Panzer (H-1, 4, S-9, 4), *A. humilis* Imhoff (S), *A. labiata* F. (S, Na), *A. labialis* (Kirby) (S), *A. alfkenella* Perkins (S-4*, R3), *A. minutula* (Kirby) (H), *A. saundersella* Perkins (H), *A. dorsata* (Kirby) (H-1*), *A. ovatula* (Kirby) (H-1*, 4, S-9), *A. wilkella* (Kirby) (H, S), *Panurgus calcaratus* (Scopoli) (S-4*), *P. banksianus* (Kirby) (H-4*, S-4).

Halictidae. *Halictus rubicundus* (Christ) (H-4), *H. scabiosae* (Rossi) (S), *H. tumulorum* (L.) (H-1, S), *Lasioglossum leucozonium* (Schrank) (H-4*, S-4), *L. albipes* (F.) (S-4), *L. brevicorne* (Schenck) (H-4*), *L. calceatum* (Scopoli) (H-4, S-9, 4), *L. minutissimum* (Kirby) (H-4*, S-4*), *L. nitidiusculum* (Kirby) (H, S-4), *L. parvulum* (Schranck) (H-4*, S-4*), *L. punctatissimum* (Kirby) (H-4*, S), *L. villosulum* (Kirby) (H-1*, 4), *L. morio* (F.) (H-1, 4, S-9, 4), L. *smeathmanellum* (Kirby) (H-4*, S-9, 4), *Sphecodes crassus* Thomson (H-4*, Nb), *S. ephippius* (L.) (H-4, S-4), *S. fasciatus* von Hagens (H-4*), *S. gibbus* (L.) (H-4*), *S. marginatus* von Hagens (H-4*), *S. monilicornis* (Kirby) (H-4*, S-4*), *S. niger* Sichel (H-4*, R2).

Melittidae. *Dasypoda altercator* (Harris) (H-4*).

Megachilidae. *Anthidium manicatum* (L.) (H-4, S-4), *Osmia rufa* (Linnaeus) (H), *O. aurulenta* (Panzer) (H-1, 4, S), *Megachile maritima* (Kirby) (H-1, 4, S), *Coelioxys rufescens* Lepeletier & Brullé (S-9*), *C. vectis* Curtis (H-4*).

Anthophoridae. *Nomada fabriciana* (L.) (H, S), *N. fucata* Panzer (H-1*, 4, S-4*, Na), *N. fulvicornis* F. (H-1, 4, S-4*, R3), *N. goodeniana* (Kirby) (H-1, 4, S), *N. panzeri* Lepeletier (H, S), *N. pleurostricta* Herrich-Schäffer (S, Na), *N. rufipes* F. (H-1*, 4, S-9*), *N. signata* Jurine (S, R2), *Epeolus variegatus* (L.) (S-4*), *Anthophora quadrimaculata* (L.) (H-4, S-9*, Nb), *A. retusa* (L.) (H, S, R1).

Apidae. *Bombus terrestris* (L.) (H-4, S), *B. lapidarius* (L.) (H, S), *B. hortorum* (L.) (H, S), *B. muscorum* (L.) (H-4, S), *B. pascuorum* (Scopoli) (H, S), *B. ruderarius* (Müller) (H), *Psithyrus campestris* (Panzer) (H, S), *P. rupestris* (F.) (H, Nb), *P. vestalis* (Geoffroy) (H), *Apis mellifera* L. (H, S).