Hymettus

Investigation of the autecology of the bee *Anthophora retusa* (Hymenoptera: Apidae) part 2

Mike Edwards and Martin Jenner

2009

Hymettus Ltd.
Lea-Side, Carron Lane
MIDHURST
West Sussex GU29 9LB
Registered in England No. 5761114
Registered Charity No. 1124636

people's trust for endangered species

Cover photograph:
Anthophora retusa male by Mike Edwards

1. Introduction

1.1 This report forms the second part of work initiated in 2008 and reported separately as '*Investigation of the autecology of the bee* ***Anthophora retusa*** *(Hymenoptera: Apidae) in 2008.M. Edwards and M. Jenner.'* Hymettus Research Report for 2008. The background to this work should be sought in this earlier report.

1.2 At the end of the 2008 research we had been unable to identify any pollen sources for female *Anthophora retusa* at the Seaford Head site. Neither female bees visiting flowers, or returning to nest burrows had any discernible pollen on their pollen brushes. Female bees did return to their nest burrows at regular intervals and spend considerable periods in these before flying off again, but only once did we find a bee with any trace of pollen on its legs.

1.3 This lack of pollen collection led us to conjecture that the females could be spending their time underground preparing nest cells and that they had to leave at intervals to source materials, most likely liquids to work the mud lining, for this. We wondered whether this liquid could be nectar, as we had no observations of *Anthophora* females at water sources, which were very limited in the vicinity of the nest in any case. We also knew that females were not bringing wet mud into the nest. Paul Westrich confirmed that he knew of direct collection of water by female bees in only one species and no instances where they were known to collect mud.

1.4 For the second part of this project we proposed that we should repeat the investigations of foraging and returning bees in order to attempt to collect pollen samples directly from the legs, only this time we would collect the bee and send the dead specimen for analysis. Our investigations during 2008 had shown that the local population would easily stand the loss of up to ten individuals for this purpose and doing so would ensure that any pollen sample was sufficient to give a robust output regarding the plants visited. In the 2008 work the only sample we had taken (by temporarily holding the bee in a tube) proved to be too small to allow identification of the pollen with any confidence.

1.5 We would also attempt to excavate a few nests in the cliff where we had worked the previous year, with the intention of obtaining cells linings from incomplete nests to check if these contained free sugars (i.e. had been worked directly with nectar) and pollen loaves from completed cells. We could do this as a small area of this cliff looked to be accessible from an extended ladder placed at the foot of the cliff.

1.6 During the intervening period further searches of the literature and enquiries of other aculeate workers produced one reference to cell-lining manufacture in Anthophorine bees (Batra, S.W.T. & and B.B. Norden. 1996. 'Fatty food for their brood: How *Anthophora* bees make and provision their cells. *Memoirs of the Entomological Society of Washington* **17**: 36-44). This stated that the lining was made by mixing the mud around the cavity with glycerides secreted by the female bee. Thus, although the use of nectar is one step removed, this could still explain the need for female bees to leave the nest at intervals for new food supplies.

1.7 Should we manage to obtain any suitable cell linings we arranged with Dr Rob Paxton of Queens University Belfast to get an analysis for sugars undertaken. Dr Judy Webb of Oxford agreed to undertake any pollen analysis required.

2. The 2009 research.

2.1 Having obtained the necessary permits to excavate nests on the SSSI and improved access arrangements to allow us to take the ladders right down to the site (our thanks to Jon Curson of Natural England and Alex Stephens (South Downs Joint Committee), we made visits on 25/5/2009, 31/5/2009, 7/6/2009 and, MJ only, 21/6/2009. These were deliberately later in the flight period than the first visits in 2008 as we were concerned that nest establishment should be well underway. On all three joint visits we were helped by Rowan Edwards.

2.2 On each occasion the first thing we did was to set up the ladder (photo 1) and one of us, usually ME, stayed here for the majority of the day, unlike in 2008 when we moved about more during each visit. This was to check that we were not missing any activity through being absent on the nest site at the critical time. The visits were also closer together than in 2008.

2.3 Although the ladder certainly improved access and general safety considerably, it was still difficult to reach specific nests. In order to excavate a nest area it was necessary to have two people by the nest, one doing the cutting out from the cliff whilst standing on the ladder, and the other holding a tray to collect the undercut material as it fell out of the cliff. This second person had to balance off the sides of the steps to the beach.

2.4 In the event we managed to successfully excavate three nest areas and failed on several more. Each time a block the size of a house brick was undercut and then freed from the surrounding cliff face (photo 2).

Photo 1. The nest site at Seaford Head.

Photo 2. Excavating the nest was by means of removing a brick-sized block form the cliff face, through undermining and then prizing the block out.

Photo 3. The block held mining bee cells, complete with pollen loaves, larvae and nectar stores, but it was not clear how the cells related to the burrow we were attempting to follow.

2.5 However, the results were not as clear-cut as would have been desirable. Once under the immediate surface of the cliff it was clear that nest tunnels ran in all directions. We attempted to mark out specific tunnels where females had entered, by squirting weak plaster of Paris down them, a technique I had used successfully before. This worked for the first few centimetres but became too faint to follow just as things got really confused.

2.6 This confusion was exacerbated by the fact that the blocks refused to come out of the cliff in a few large pieces, which we had hoped we then would be able to dismantle carefully, but fell out in a random jumble of pieces, including cells. We did retrieve the female we had been following in two of the excavations, but it was impossible to tell which set of cells she was associated with. Likewise, cells, which were clearly full of nectar, broke, their contents rapidly seeping into all adjacent material. Checking for sugars in any lining was clearly a non-starter.

2.7 We did get a number of cells which held larvae and a pollen ball, which was swimming in nectar (photo 3), but there were several large *Andrena* species also present, so there was no guarantee that these were not from these bees as much as the target *Anthophora*. The only good thing was that there were no *A. plumipes* active and it would have been unlikely that cells of this species would still be at an early stage of development at the end of May.

2.8 The cells with larvae were taken home and more carefully dissected. Alarm bells sounded when I discovered that one of the connected but unopened cells had what looked like an *Andrena* pupa in it. Eventually this developed enough to confirm its identity. Furthermore the pollen loads looked too small and too discrete to be *Anthophora*, which, we understand, tends to mix pollen and nectar into a fairly even goo (P. Westrich, pers comm.). Nevertheless, the pollen loaves were sent off to Judy Webb and the larvae consigned to alcohol.

2.9 When the results came back from Judy the pollen balls all contained large amounts of *Acer* pollen. We knew that this plant genus was not present within 0.5km of the nest site as one of the first tasks undertaken on the first day was to make a list of all plants flowering within a radius of 0.5km of the site and to take check samples to match the pollen against.

2.10 I searched for descriptions of Andrenid and Anthophorine larvae so that I could confirm the identity of the larvae I have removed from the pollen balls, but was unable to find anything.

2.11 If the outcome of the nest work was, to say the least, inconclusive, we were much more successful with the observations of foraging female bees. During the time ME was trying to excavate next cells at the cliff MJ was looking over the site for foraging female bees. At the cliff RE and I kept an eye open for returning females with pollen on their legs.

2.12 A total of five females with pollen on their legs were taken over the entire period. One of these was taken at the cliff (25/05/2009), the rest whilst foraging at flowers. All were kept in separate tubes, killed in the freezer and then sent on to Judy to remove a sample from the legs for analysis.

2.13 Judy made a report on all the pollen which is appended to this one. The pollen from the female bees did not agree at all with the pollen samples from the cells, another

indication that these wee from two different bee species, as each set was reasonably internally consistent.

2.14 Pollen from *Anthophora* females was from mixed flower species, but in four of the specimens legume pollen was commonest (*Vicia, Trifolium* and *Lotus*). The fifth had an *Echium* type predominating (probably Vipers Bugloss *Echium vulgare*). What was interesting was the wide range of the other pollens, including Yellow Horned-poppy *Glaucium flavum*.

2.15 At the end of each day's cliff-based observations we all searched for flower-visiting *Anthophora* females. In this way we discovered a female working the deep tubular flowers of Honeysuckle (several times) by the coastguard cottages on the first visit. This female was only taking nectar, but clearly being well-rewarded.

2.16 In the afternoon of the second day we explored the eastward extension of the cliffs at the start of the Seven Sisters. Despite walking for over a kilometre here (furthest point TV530972), we found no signs of foraging *Anthophora* bees of either sex, although they were still fairly frequent on the Seaford Head side. The flora here, once the slope immediately adjacent to Cuckmere Haven had been left behind was far less floriferous, although there were occasional stands of Hound's Tongue *Cynoglossum officinale*, a plant which was a very strong attractant at Seaford Head.

2.17. In the past MJ recalls the slope going away from Cuckmere Haven as having a lot of Horse-shoe Vetch *Hippocrepis comosa* and that this plant here and at Seaford Head, was being visited by *Anthophora*. We had been unable to find any sign of the plant at Seaford, but there were small patches at the start of the Seven Sisters. No *Anthophora* were visiting these.

2.18 On our return to flatter ground we decided to take a good look at the small field on the east side of the river, immediately behind the shingle bar at Cuckmere Haven. Unlike most other fields up the valley, this one was not being hard grazed by cattle and had large stands of flowering Red Clover *Trifolium pratense*, Bird's Foot Trefoil *Lotus corniculatus* and Common Vetch *Vicia sativa.*

2.19 We were soon rewarded with the sight of a foraging female *Anthophora*, in total a walk of less than half an hour by three of us returned over ten sightings of female bees, one of these with pollen on her legs (31.5.2009 in Pollen Report). This was more bees visiting flowers than had been seen in all the other time spent looking around the nest site that day. Again, the majority of bees appeared to be gathering nectar only. Clearly this meadow area is an important foraging resource.

2.20 We extended the search into the other fields adjacent to this one. As they had been grazed more recently than the first one there was less flower around, but those areas furthest from the access points seemed to have been less fertilised and to support a similar flora to the first field. Indeed, we did see another female *Anthophora* in this area.

2.21 MJ Returned to this area on 21/6/2009 and found bees still foraging in this area, including two with pollen on their legs which he took for pollen analysis.

3. Conclusions

3.1 The results of the pollen gathered from the legs of *Anthophora retusa* in the field show this be to be associated with a range of flower species typical of mesotrophic meadows. Therefore, *Anthophora retusa* cannot be described as broadly oligotrophic (associated with the pollen of just one plant family).

3.2 Although many modern records associate this bee with the flowers of Ground Ivy *Glechoma hederacea,* pollen from this flower is not a major component of forage, despite the high frequency of plants on the site.

3.3 There does seem, however, to be a strong need for flowers with a high nectar content and Ground Ivy, being a labiate, satisfies this need very well. However, so do the flowers of the typical legumes visited by the bees.

3.4 Overall, it is the density of the suitable species in flower, both for pollen and nectar, which appears to be the critical resource for this species. The probable factor behind its modern decline is the loss of mesotrophic meadows with a high diversity and population of suitable nectar and pollen forage plants; the case made by Hymettus when putting this species forward for the BAP review.

3.5 Having suitable nesting resources is also essential, but the spread of earlier records in a variety of habitats suggests that this was originally less restricting. It may well be that, in a modern context, the juxtaposition of both flower resource and nesting resource is extremely limiting, notwithstanding the relatively high foraging distances travelled by the bees in the current study.

3.6 It is considered that all three modern areas which hold populations of this bee (Seaford Head; East coast of the Isle of Wight; Purbeck Peninsula) do meet these conditions, albeit for a variety of individual reasons.

4. Habitat management implications.

4.1 Habitat management for this bee should, therefore, aim to provide a high level of suitable flower species, flowering at the appropriate time. As management to provide this over longer timescales may well require that the bee forage areas are sometimes grazed at the time of flowering, it is important that forage resources are considered over a landscape scale, with only part of the area being in good condition during the flight period in any one year.

4.2 Nesting resources should be maintained in an open, sunny position. These do not necessarily need to be particularly close to the foraging resource, but should be within 1km range, preferably not more than 0.5km.

5. Specific considerations for Seaford Head.

5.1 It is proposed to let the sea-barrier at the end of the Cuckmere River fail as part of managed retreat in this area. The consequences of this, in terms of retention of the preferred foraging habitat for *Anthophora retusa,* are likely to be serious under the current management system for the fields in the valley.

5.2 The fields are currently, with the exception of the most sea-ward one, hard grazed by sheep and cattle in May and June. This regime removes all flowering parts of the sward, further exacerbating the losses in floral diversity through past fertilisation of the area as part of commercial farm management. Never-the-less MJ has seen these fields with good stands of the desired flowers in the recent past when, for some reason or other, the livestock were not present during the May-June period.

5.3 It is strongly recommended that the management plan being developed as part of the managed retreat programme recognises the need for the provision of alternative foraging areas within suitable flight distance of the nesting area of *Anthophora retusa*. Under such a plan, one field should not be grazed during the flight period of *Anthophora retusa*. Rotating the ungrazed meadow between two or more sections of the seaward end of the eventual field system on a year-by-year basis would probably be a better strategy than keeping one field permanently under a late-graze system. The resulting variation in ecological stress through grazing would provide more overall niches for plant establishment than a constant stress environment.

5.4 This management system would also benefit the population of the BAP bumblebees *Bombus humilis* and *Bombus muscorum,* both if which were found in the area during the two-year study period, of which *B. humilis* was by far the more frequent one.

Appendix: Pollen analysis carried out by Judy Webb.

Identification of pollen loads on *Anthophora retusa* female bees and the pollen composition of pollen balls from possible *Anthophora retusa* nest holes

Introduction

Mounted, dry female *Anthophora retusa* specimens and pollen balls excavated from possible *A. retusa* nest sites were supplied to me by post by Mike Edwards.

Methods

Pollen was gently brushed from the body of each mounted bee into a drop of water on a glass slide. This was stirred up and left to rehydrate for 10 minutes before the cover slip was placed on. The pollen grains were then examined under a Leica light microscope at x400 and x1000 magnification, with the use of phase contrast illumination for study of the fine sculpturing on the grains.

For the pollen balls, scrapings from the outer layer of each ball were removed with a clean scalpel and placed in water drops on slides, then treated as described above. Scrapings from the innermost layers of each ball were examined as well, to check that the composition of each ball was similar in the centre to that in the outer layers. In every case the centre had approximately the same composition as the outer layers.

Pollen grains encountered were identified by comparison with my reference collection of prepared pollen slides and with fresh dried flower material supplied along with the bees and pollen balls. The pollen from the fresh, dried flowers was soaked in a drop of water for 10 minutes before examination to ensure comparability with the samples removed from the bees and from the pollen balls.

Results

First Delivery

Female bee Description: 'M Jenner, 25.05.2009, Hope Gap, Seaford Head'
Pollen brushed from back legs and the loose pollen fallen off in the tube supplied with the bee

Predominantly a large *Trifolium*-type, most likely to be *Trifolium pratense* (Red Clover)
Smaller amounts of *Prunella*- type (most likely *Glechoma* (Ground Ivy))
Ranunculus type (buttercups)
Vicia - type (vetches)
Rare grains of Asteraceae fenestrate (dandelions, hawkweeds, etc)

****

Second Delivery,
Female Bee description: 'Cuckmere Haven, At *Vicia*, col 31.05.2009'
A variety of pollen types, good proportion of Fabaceae and buttercups:
Trifolium-type, large (probably Red Clover *T pratense*)

Vicia-type, small grains - few (vetches)
Ranunculus - type (buttercups)
Few *Anthyllis* (kidney vetch)
Few *Prunella* -type (probably *Glechoma* (Ground Ivy))
Rare grains of Rosaceae indet. (striate grains, could be *Rosa, Rubus, Crataegus, Sorbus, Malus, Pyrus*… NOT *Prunus avium, P. spinosa* or *P padus*)

Tube 1 pollen ball
Overwhelmingly *Acer* (sycamore, field maple, norway maple or other cultivated maples) 90%+
Few small Apiaceae grains (resembled *Anthriscus*, but could be species)
Few *Sanguisorba minor* (salad burnet)
Few *Ranunculus* type (buttercups)
Few small Brassicaceae (many species possibly including the Hoary Cress supplied with the bees)
Few *Urtica* (nettles)

Tube 2 pollen ball
Mostly *Acer* (sycamore, field maple, norway maple or other cultivated maples) 60%+
The majority of the rest of the pollen is *Aster* type of two sorts:
Aster/Bellis type small grains (many species)
Aster/Bellis type large grains (may be several species)
A few grains of Rosaceae indet. (striate grains, could be *Rosa, Rubus, Crataegus*, *Sorbus, Malus, Pyrus*… NOT *Prunus avium, P. spinosa* or *P padus*)
Ranunculus type (buttercups)
Few small Apiaceae grains (cf. *Anthriscus*, but could be other species)

Tube 3 pollen ball
Overwhelmingly *Acer* (sycamore, field maple, norway maple or other cultivated maples) 90%+
Rosaceae indet. (striate grains, could be *Rosa, Rubus, Crataegus, Sorbus, Malus*, *Pyrus*… NOT *Prunus avium, P. spinosa* or *P padus*)
A few small Apiaceae grains (cf. *Anthriscus*, but could be other species)

Tube 4 pollen ball
Overwhelmingly *Acer* (sycamore, field maple, norway maple or other cultivated maples) 90%+
Few Rosaceae indet. (finely striate grains, could be *Rosa, Rubus, Crataegus, Sorbus*, *Malus, Pyrus*…NOT *Prunus avium, P. spinosa* or *P padus*)
****

Third Delivery

Female Bee labelled ‘ 1’ description: ‘M Jenner Cuckmere Haven, 21.06.2009’ results combined with pollen residue in tube labelled ‘1’

Mostly *Echium* type (Viper’s Bugloss) smaller amounts of:
Prunella type (probably *Glechoma* (Ground Ivy))
Large monocolpate, reticulate grains most likely *Iris*-type (Flag Iris or Gladdon or German Iris from garden)
Glaucium (yellow horned poppy)
Rare grains of Asteraceae fenestrate (dandelions, hawkweeds, etc)
Rare grain of cf. *Spergula* (spurreys)

Female Bee description: ‘Cuckmere Haven, *Vicia*, 07.06.2009’

Mostly Fabaceae, large *Trifolium*- type, most likely to be *Trifolium pratense* (Red Clover)
Ranunculus - type (buttercups)
Gladiolus- type (probably Gladiolus from garden)
Rare *Lotus*- type (Bird’s-foot Trefoil probably)

Female Bee labelled ‘2’ description: ‘M Jenner, Cuckmere Haven, 21.06.2009’

Pollen very sparse
Mostly *Echium* (Viper’s Bugloss) and
Large monocolpate, reticulate grains most likely *Iris*-type (Flag Iris or Gladdon or German Iris from garden)
Rare *Glaucium* (yellow horned poppy)

Female Bee description ’07.06.2009’ rest of label indecipherable

Pollen very sparse overall
Vicia-type (vetches) – pollen of two sizes, the smaller rarer than the larger type
Large monocolpate, reticulate grains most likely *Iris*-type (Flag Iris or Gladdon or German Iris from garden)
Trifolium-type, large (probably Red Clover *Trifolium pratense*)

Pollen ball A

Overwhelmingly *Acer* (sycamore, field maple, norway maple or other cultivated maples)

Pollen Ball B

Overwhelmingly *Acer* (sycamore, field maple, norway maple or other cultivated maples)
Few Rosaceae indet. (finely striate grains, could be *Rosa, Rubus, Crataegus, Sorbus*, *Malus, Pyrus*…NOT *Prunus avium, P. spinosa* or *P padus*)

Pollen Ball C

Equally abundant amounts of *Acer* (sycamore, field maple, norway maple or other cultivated maples) and Rosaceae indet. (finely striate grains, could be *Rosa, Rubus, Crataegus, Sorbus, Malus, Pyrus*…NOT *Prunus avium, P. spinosa* or *P padus*)
Small amounts of small Brassicaceae pollen grains. In the context of the dried flowers sent to me, could be Seakale, or Hoary Cress but not Charlock.