SEM Diaries -11

My foot fetish, and my first published micrograph

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Fig. 1: My first decent micrograph of a tarsal claw. The species is *Labulla thoracica*, a Linythiid, I made the image in March 2016.

One of the justifications to myself for buying an SEM was to enable me to image key parts of the anatomy of as many species of British spiders as I could lay my hands on. In particular, I wanted to capture micrographs of the male and female sex organs, which are key features used to identify a spider to species level.

In pursuing this aim I constructed some special stubs that permitted me to orientate the male sex organs (called pedipalps) to precisely the same angle as they are illustrated in the reference books. I first described these in SEM Diaries - 4, and enlarged upon my technique in SEM Diaries - 7. I encountered two major problems that meant that this technique was

Fig. 2: Tarsus of *Zygiella x-notata, showing central hooked claw and serrated bristles associated with web dwelling spiders*

unlikely to work for any but the largest species of spider. The first was that the pedipalps were just too small to manhandle into the aluminium rods used to hold them on the special stubs. The second was that the area of interest on the palps tended to curl back against the part of the "leg" that I wanted to insert into the hole in the end of those rods. However, these stubs were suitable for mounting and orientating legs, and I discovered early on that these too can be most interesting to image, especially at the "foot", or more specifically the tarsus, end (Figure 1).

Spiders are traditionally thought of as being web-dwellers, or at least to rely on webs to catch their food. One only has to think of the common garden spider (*Araneus diadematus*) seen commonly in the late summer in their large webs suspended on garden plants, or the even more common *Zygiella x-notata*, which attaches its web to window frames. So, how are these spiders able to hold onto and move over their webs?

Figure 2 illustrates one of the tarsi of a *Zygiella x-notata*. Among the features that can be seen are two large combed claws, and in between these there is a third, hooked, claw that does not posses a comb. Just below the hooked claw can be seen a bristle with a large number

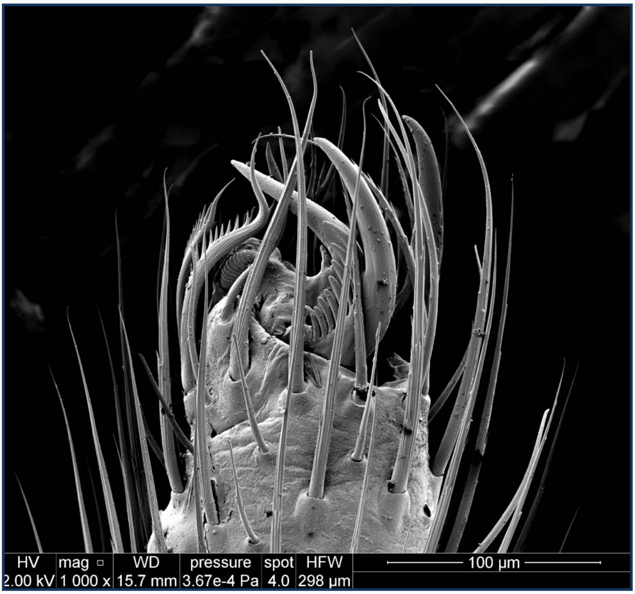

Fig. 3: Tarsus of an un-identified Linyphiid, (also a web feeder) showing a similar construction to that of *Zygiella x-notata.*

of serrations on it, and other similar bristles can just be made out in the micrograph. Rather than use the combed claws to walk on the web the spider actually uses the hooked claw to trap a strand of web and hold it against the serrated bristles. When the spider releases the hook, the web simply springs away from the serrations on the bristles. Figure 3 illustrates the tarsus of a spider of the family Linythiidae. These also rely on webs to catch their prey, although in this case the webs are more like horizontal sheets of material than the intricate orb webs of the Araneidae.

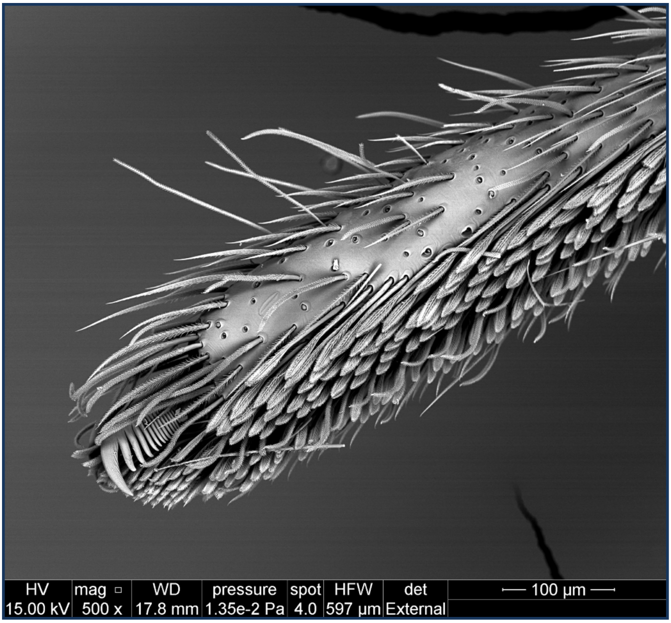

Fig. 5: Tarsus and part of metatarsus of *Clubiona terrestris* (Clubionidae) showing how the scopulae extend up the leg on this species.

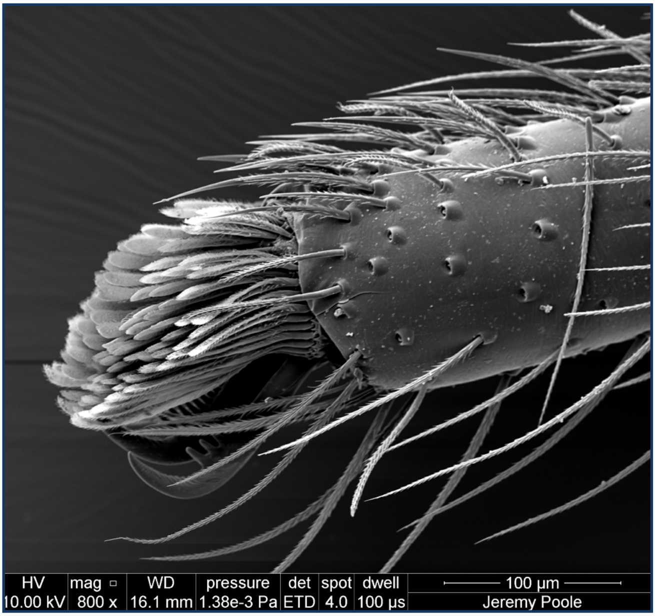

Fig. 4: Tarsus of *Salticus scenicus*, showing the bunch of scopulae (above the combed claws in this orientation).

By no means all spiders are web dwellers or feeders. For example, the hunting spiders (Lycosidae) or jumping spiders (Saltici-dae) pursue their prey in different ways. Thus, these spiders have no need for the central claw or serrated bristles. Instead, these families (among others) have just the two combed claws and a bed of fine branching hairs, known as scopulae (Figures 4 and 5). These hairs are not unlike the pads on the feet of crea-tures such as geckos, and permit these families of spider to walk up vertical surfaces or even hang from the ceiling.

Now, we all know that a

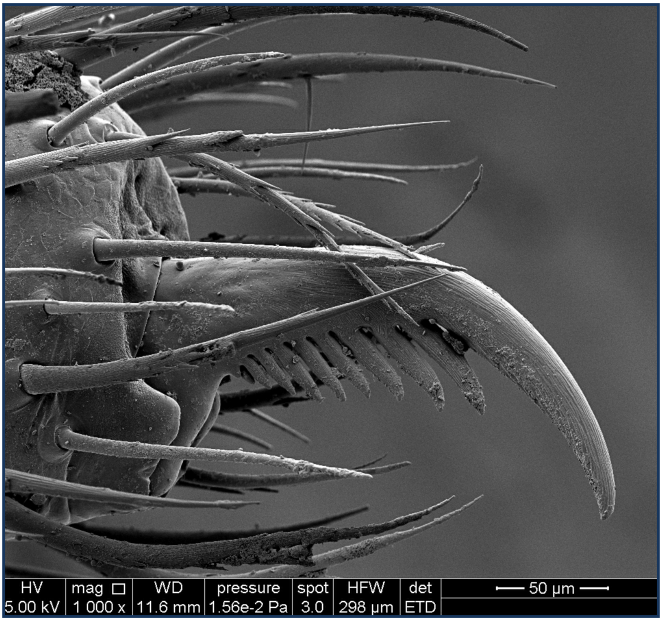

Fig. 6: Tarsal claw on pedipalp of a female *Araneus quadratus*.

spider has eight legs, but if you ask a child to count the legs on a spider he or she might well come up with the answer "10". This is because arachnids and other chelicerates have a pair of appendages, called pedipalps, between their front walking legs and their chelicerae. As mentioned at the start of this article, the pedipalps of a male have a reproductive function. The pedipalps of both sexes also have a range of other functions, such as food manipulation, sensing or defence. Given the intricacy of the pedipalps of male spiders compared with those of females, little is written about the structure of the latter. However, I decided to "take a look" at one of these and was most surprised to discover that, at least for the species I studied, the female pedipalp contains a single, centrally placed, combed claw (Figure 6). Although I could find no reference to the precise function of this claw one can imagine it could come in handy for food manipulation and defence, at least.

For comparison purposes, Figure 7 illustrates the pedipalp of a male *Erigone atra*. This is one of the 250 or so species of money spiders.

In order to reproduce, the male spider will spin a small web and deposit sperm on this from an insignificant opening on his abdomen. He will then place his pedipalps in the sperm and "charge" a

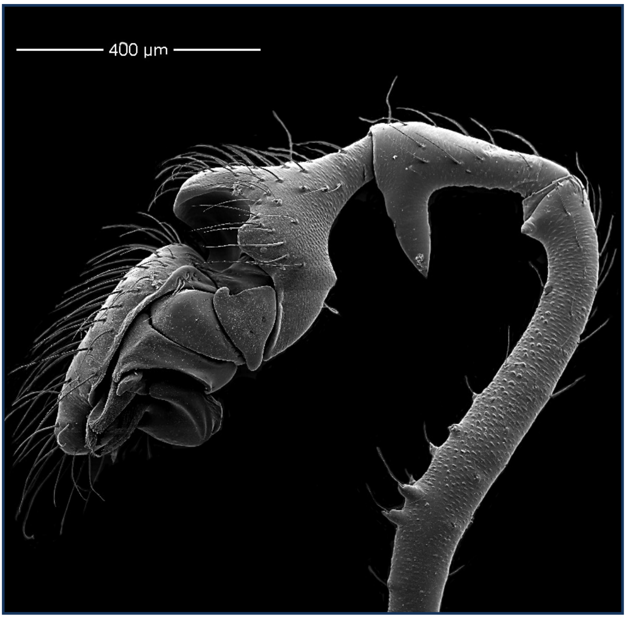

Fig. 7: Pedipalp of a male *Erigone atra*.

chamber in the pedipalps with some semen. During mating the male will insert his “spermophor” (a narrow tube in the palp) into the epigyne of the female and expel some sperm into her seminal receptacles.

I mentioned earlier that the appearance of the male pedipalp is used to identify spiders down to species level. The two illustrations on this page and also Figure 7 illustrate the wide variation of appearance between families of spider. Within a family the differences between species are usually significantly more subtle, but generally permit unambiguous identification to the experienced arachnologist.

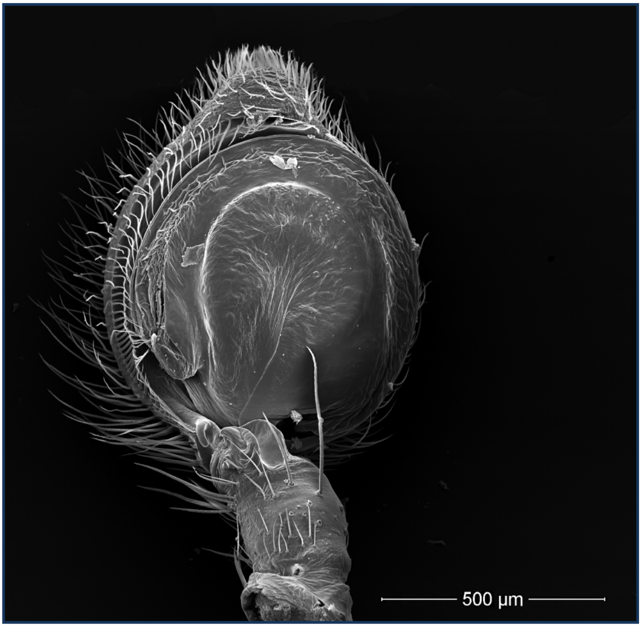

Fig. 9: Male pedipalp of *Philodromus dispar* (Thomisidae)

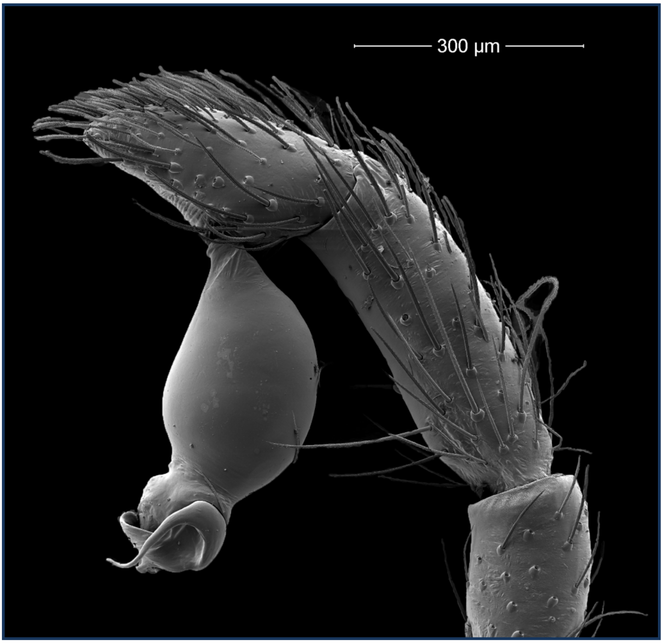

Fig. 8: Male pediplap of the primitive *Harpactea hombergi* (Dysderidae)

You may have noticed the variation in the backgrounds between the various micrographs in this article, with some being mottled and grey in appearance while others have a fully black background. Normally, to obtain a black background, it is necessary to mask the subject matter in Adobe Photoshop® and “paint out” the un-masked area with black. Unfortunately, masking the subject matter can be a difficult and time-consuming operation, particularly with hairy subjects. I have recently started using the “Select and Mask” function of Photoshop CC (previously called “Refine Edge”), and this provides a tool that automatically senses the presence of hairs and selects them accordingly. My explanation is more simplistic than the algorithms involved, I am sure!

A good mastery of selection is also essential if one wishes to colour-in electron micrographs, and it was during the course I attended on that subject, in September 2016, that course members were encouraged to submit their coloured micrographs to the Royal Microscopical Society for consideration for inclusion in their annual calendar, sent out to all members at Christmas. Well, my colouring of micrographs has got off to rather a slow start but I did submit one of my monochrome images this year, which had been subject to copious use of the "select and mask" tool. To my delight, this was selected to represent July in the 2018 calendar. Sadly, apart from the feel-good factor of having been selected, I received no other reward for this achievement!

The calendar image, reproduced below, shows the eight eyes of *Salticus scenicus* (the most common of the jumping spiders). Unusually for a spider, these eyes are in a single row, wrapped around the head. This spider will normally first detect its prey using the small eyes to the side of its head, which have a wide field of view, to sense movement. It will then jump to face the direction of the prey and home in on it with its front eyes, which have high definition but a narrow field of view.

This image was taken using the backscattered electron detector described in SEM Diaries - 9.