parasitiform mites, closely related to opilioacarids and thriving in the coal swamps.

However, a number of serious objections could be raised against this proposal, mostly relating to ventral morphology. The coxo-sternal regions of phalangiotarbids and opilioacarids are very different with the ventral opisthosoma projecting well between the small coxae in opilioacarids, rather than there being large, triangular coxae surrounding a subdivided sternum as in phalangiotarbids. Also the phalangiotarbid mouthparts are currently not known in sufficient detail for direct comparison with opilioacarids. Phalangiotarbids are an order of magnitude larger than opilioacarids. In particular, one characteristic of opilioacarids is the possession of dorsal opisthosomal spiracles set in slightly raised tubercles among the anterior segments of the opisthosoma (Bernini (1986) see also Fig. 2). Examination of the phalangiotarbid *Goniotarbus tuberculatus* in the British Museum (Natural History) (BMNH In 31263) revealed a series of six pairs of raised tubercles at the posterior margins of the anterior tergites (Fig. 1). Were these spiracles? It is virtually impossible to prove, but again the observation is interesting.

In summary, this present account reports preliminary observations and should not be taken to imply that phalangiotarbids are definitely opilioacarids. Distinct synapomorphies of these two taxa have not been explicitly identified and I have made no attempt here to include comparisons with other arachnid groups. Instead I hope to point out some interesting gross morphological similarities between phalangiotarbids and opilioacarids. I would suggest that the possibility that Phalangiotarbida is a subgroup of the Opilioacarida and/or that the two are sister taxa within the Acari, should be considered in compiling future phylogenetic models of the Arachnida. Only with a detailed morphological study of the Phalangiotarbida can this problem be resolved.

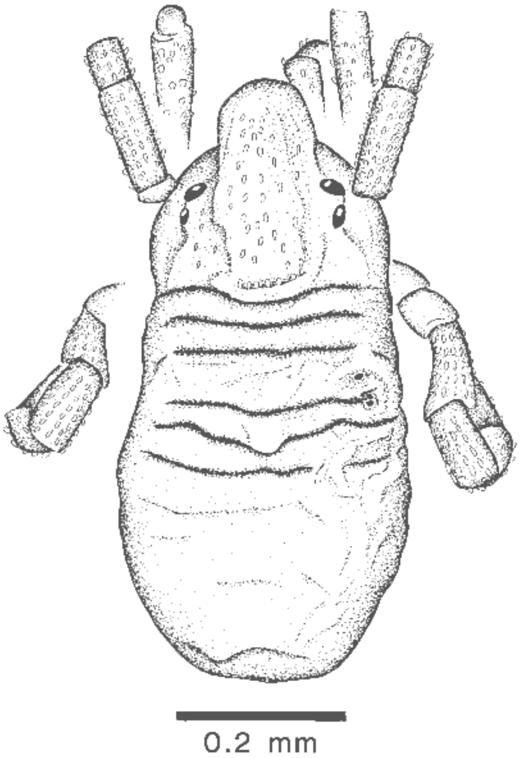

Figure 2. *Drawing of the dorsal surface of* ***Opilioacarus italicus*** *made from a photomicrograph by Bernini (1986, fig. 7A) for comparison with Figure 1.*

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Coiling of the Spirals in the Orb Web of *Araneus diadematus* Clerck

by Samuel Zschokke

Which way round do spiders build their orb webs: clockwise or anticlockwise? This is a question one regularly hears from interested lay persons. There is of course no simple answer, because it depends which side you observe web construction from. Preliminary studies (unpublished) using a standardised side of observation revealed no preference for building the capture spiral clockwise or anticlockwise. Here I try to answer the question: when and how is the direction of the spiral coiling in the webs of *Araneus diadematus* Clerck determined?

Zschokke (1993) showed that the coiling of the capture spiral in the webs of *Araneus diadematus* is determined by the coiling of the auxiliary spiral. But this does not answer the original question, it simply changes it to: which way round does *Araneus diadematus* build the auxiliary spiral? Since the auxiliary spiral is usually built without U-turns (or reverses), we have to focus on the very beginning of the auxiliary spiral construction, namely hub construction and construction of the last radii. There is no information on this in the literature, but a number of authors have attempted to answer the related question: in which order do the spiders build the radii? McCook (1889) described it as alternating from one side to the other. Peters (1937, 1939) confirmed this, but added that there are exceptions to this rule.

Let us consider how *Araneus diadematus* builds the last few radii. When it has almost finished the construction of the radii, it circles the hub to find a gap between two radii where an additional radius is required (Peters, 1937). When it has found such a gap, it walks out along the upper existing radius (the exit radius) to the frame, attaches its dragline to the frame below the exit radius and returns to the hub, laying the definitive radius. As soon as it reaches the hub, it attaches the definitive radius and continues circling the hub to find another gap requiring a radius. When the radii are complete, the hub is usually circled a few more times and then, without interruption, the auxiliary spiral is started by widening the distance to the previously laid thread. The coiling of the auxiliary spiral therefore depends on the direction the hub is circled after the construction of the last radius.

We have now again successfully shifted the question: which way does the spider circle the hub after the construction of a radius? To try to answer this question the construction of 104 webs built by 14 spiders (between 2 and 21 webs per spider) was observed. The methods used (Zschokke, 1994) allowed the moves of each spider to be analysed in detail. The side of the construction (left or right) of the last six radii and the subsequent coiling around the hub was noted. Radii were classified as on the left or right hand side, according to the relative positions of the exit radius and the newly laid radius: if the radius was shifted clockwise compared to the exit radius, then this radius was classified as on the right hand side of the web; if shifted anticlockwise from the exit radius, then it was classified as on the left hand side of the web. This classification corresponds to their real position in the web, except for radii at the top or bottom of the web.

Comparisons were made as follows: the side of a radius with the subsequent coiling around the hub; the side of a radius with the side of the subsequent radius; the coiling around the hub with the side of the subsequent radius; and the coiling around the hub with the coiling around the hub after placement of an intervening radius.

The strongest correlation exists between the side of the radius and subsequent coiling: after a radius constructed on the left hand side, the spider will walk around the hub anticlockwise and, after a radius constructed on the right hand side, the spider will circle the hub clockwise (in 424 (69.3 per cent) of 612 cases, $p<0.0001$, binomial test). Weaker correlations exist between subsequent coilings (same coiling in 293 (58.5 per cent) of 501 cases, $p=0.0002$) and between subsequent sides of the radii (different sides in 305 (58.7 per cent of 520 cases, $p=0.0001$). No correlation can be found between the coiling and the side of the following radius ($p=0.51$) nor could any significant individual differences be found. Note that all these comparisons do not depend on the side from which the construction is observed. If you switch the observation side, left becomes right and clockwise becomes anticlockwise and vice versa.

During the analysis of the moves of the spider, it was also noted that the coiling of the hub after the placement of the last radius is not always the same as the coiling of the auxiliary spiral: there was a U-turn in the hub on three occasions out of 104 webs.

Now we have again shifted the question back by one stage, at least partially, since the position of the last radius only determines the coiling of the auxiliary spiral with a certainty of about 70 per cent. We can say that the coiling of the auxiliary spiral is influenced by the position of the last radius, but other factors also seem to play a role.

The question that we have to answer now is: on which side (left or right) does the spider place the ultimate radius. That is where I give up. I think that this is unpredictable, at least as long as we do not understand the **exact** mechanisms involved in determining the order of the radii placement.

The conclusions we can draw from the results are that the coiling of the auxiliary spiral is only determined at the very end of the construction of the radii and that it is therefore generally unpredictable. This implies that it is unlikely for the spider to have a preferred coiling, or a handedness in this respect.

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No Tuning-fork? Try Forceps!

by David Penney

It is well known that a tuning-fork when struck and held to a spider's web often causes vibrations which entice the spider from its retreat. If the pointed end of a pair of forceps are held together and then released quickly, both halves of the forceps vibrate. Smaller forceps vibrate at a higher frequency than larger ones and these were found to be more successful in the small number of field trials carried out. Only the families Amaurobiidae, Tetragnathidae, Linyphiidae and Agelenidae were tested and responded favourably in that order, that is, the Amaurobiidae were fooled every time, the Agelenidae were tempted but did not actually come out of their retreat, and the other two families were fooled most of the time. It would seem that forceps can function as a useful alternative to a tuning-fork in this respect.

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Techniques for Excising and Storing Spider Genitalia

by Dick Jones

Levi (1965) described techniques for the examination of spider genitalia, parts of which are repeated here with additional notes and alternative techniques. Section 6.2 of the *B.A.S. Members' Handbook* has more information on the storage of specimens.

To examine the dorsal side of an epigyne, the area needs to be lifted or removed, and to be cleared of the surrounding tissue. The tools needed are a sharp needle mounted on a probe, fine forceps and a clearing agent. Some distortion may take place using the following techniques, and so with potentially new species it is essential to draw the epigyne before carrying out any surgery, especially if it is cleared by the method described below.

Small entomological pins can be mounted on a wooden holder made from a short length of 4–5 mm diameter hardwood, but this will absorb alcohol if immersed, unless varnished. Alternatively, various types