Some Cuticular and Surface Structures of *Lyniphia triangularis* (Clerck) revealed by the Scanning Electron Microscope

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Introduction.

The scanning electron microscope has enabled studies to be made of arthropod cuticles and other surface structures without the need for the usual lengthy and tedious techniques for preparing such material for sectioning or replication.

Only minimal preparation is needed before a specimen may be observed in the scanning microscope. The specimen is mounted on a metal stub and placed in a vacuum coating unit where the surface of the specimen is overlain by an ultra thin film of, firstly carbon, and secondly, gold palladium alloy. Either whole specimens (as in this study) or any part of a specimen may be used. The whole of the preparative phase in the present case took only 20 minutes, a period of time not much longer than that required in preparing specimens for conventional study.

Examination by the scanning electron microscope has other advantages. Much higher magnifications (over 6000 times) can be obtained than by light microscopy. The best resolution is of the order of 150Å (Hale and Smith, 1966). Furthermore, even at higher magnification a stereoscopic effect is obtained and at lower powers (40 to 50 magnifications) the effect produced by the great focal depth of the system is quite remarkable and far beyond anything remotely attainable by binocular optical microscopy.

The present paper is a preliminary report arising from work we are engaged in on respiratory processes and cuticular transpiration in linyphiid spiders. We hope this report will show how powerful a technique is available in the stereoscan instrument, since, as far as we are aware no stereoscan pictures of spider cuticle have been published.

Results and Discussion

Appendages.

Figs. 1–7 show the facility of the instrument in ranging from low power views (Figs. 1,6) to those at high power (Figs. 4,5) yet retaining full clarity and depth of form. Fig. 1 shows a general view of the chelicerae and palps of *Linyphia triangularis.* Fig. 2 is a higher power view of the palpal tip showing the socketing of the palpal setae. Fig. 3 shows the articulation between the tarsal and tibial segments of the palp in which the "barbing" of the setae can be clearly seen. This is a form of sculpturing (found very prominently on all the appendages). Differences in articulation of the smaller and larger setae are apparent. That of the larger hairs being more obviously complex in having control placed on possible directions of deflection by the socket rim which allows the hair to be deflected proximally or latero-proximally, but prevents the hair passing through the vertical plane to a more distal position. This may have some importance in mechanoreception, and the arrangement of hairs and spines over the whole leg might well be worth investigation. Another feature is that the lower of the two small hairs in the figure is jointed. The lipped structure below these two hairs is of unknown significance. The structure suggests a sense organ or perhaps a glandular structure of some kind (involved in wax secretion?) Fig. 4 shows the basal articulation of a small hair, revealing a sculpturing of ridges on both the articular base and the setal shaft. The rim of the socket is raised in part and this again may be a mechanism for stopping the hair from moving beyond the vertical plane. The small deposits near the hair are bowl shaped (2μ diameter) and seem to be some kind of surface secretion consisting of aggregated granules (0.7μ diameter), possibly wax. The larger deposits are contaminants.

Fig. 6 shows prolateral surface of the first leg. The scaling of the wax on the leg surface shows up even in the lower power picture, but is much more convincingly shown in Fig. 7. The water run-off from this type of surface should be efficient because of the tile-like arrangements of the scales. The small bowl-like wax deposits mentioned earlier could also play a part in keeping the cuticular surface dry, since the hydrophobe properties of the wax would cause water films on the cuticular surface to form into minute droplets, producing a detergent-like removal action. Such features of the cuticle would have survival-value, especially for smaller spiders which would otherwise be in great danger of water-logging from the surface tension effects of water masses in their habitat. The "barbing" of the hairs is another example of wax sealing. A hair has a large surface area in relation to volume and therefore provides a possible region of excessive transpiration. The pressure of the loose-flaking wax scales on the hairs could be a mechanism for keeping evaporation within tolerable limits. Apart from the ratio of area to volume, the hair may allow greater transpiration than other parts of the cuticle since the cuticle in the hair is thinner than elsewhere. The need for extra water-proofing becomes even greater as a result. Wax laid down in a series of scales gives a thicker covering than would be possible if the wax were laid down as a uniform sheet. The barbing of the surface by the free ends of the scales produces a kind of insulating region between the hair surface and the atmosphere in which air movement would be reduced and in which a protected saturated atmosphere could be produced thus reducing transpiration losses.

Ventral Surface of the Abdomen.

Fig. 8 shows the ventral surface of the abdomen with the epigyne, epigastric furrow and the sclerotised power views of the entrance to the epigyne showing the interior surface very clearly. It would be impossible to study the interior surface at this level of magnification in any other way with such ease. The thickenings in the vulva are strikingly shown in this view.

Eggs and Cocoon.

Fig. 11 is a low power view of the cocoon, cut away to reveal the eggs. Under high power investigation (Fig. 12) the egg surface is seen to be made up of a series of tubercles about 8.0μ in diameter, consisting of spheres split across their diameter or subdivided in a triradiate fashion. The split spheres themselves are often arranged in groups of two or three. The egg surface between the exfoliated structures has a rough irregular appearance. These features are similar to those described in insect eggs by Hinton (1963).

Figs. 13, 14 show increasingly fine detail of the cocoon threads. Single threads are some 2.3μ in diameter. The arrangement of the threads is not definite: there is no defined warp and woof. One obvious feature, however, is the way in which single threads are frequently combined together to run in parallel thereby producing thicker strands. These may provide a strengthening substructure for the cocoon. Linkage of these strands is obtained by what may be described as welds between separate strands at irregular intervals produced by fusion of spherical or sub-spherical structures exactly like thoseron the egg surface. The similarity is such that is would be unlikely that there is no connection between these structures and it may be one of the purposes of the tubercles to link up the threads. There is no twisting or plaiting of the threads to give a rope-like structure. Further stability may be obtained by the cross-linking of these conjoined fibres to other threads (Fig. 14) by the same welding process.

Conclusion.

Even at this early stage in the work it is obvious that the stereoscan has thrown up a number of very interesting points regarding the surface structure of spider cuticle. The stereoscan microscope will undoubtedly prove to be an invaluable instrument in the

PLATE 1. LEGEND TO FIGS. 1 – 7.

Fig. 1. General view of anterior showing chelicerae and palps. x 100.

Fig. 2. Palpal tip showing arrangement of setae. x 2000.

Fig. 3. Articulation between tarsal and tibial segments of the palp x 1030.

Fig. 4. View of a hair on the palp showing basal socketing. x 4000.

Fig. 5. Cup like structure on palp surface possibly a wax secretion. x 20,000

Fig. 6. General view of prolateral surface of 1st leg x 100.

Fig. 7. Higher power view of leg showing scale-like arrangement of cuticle. x 1000

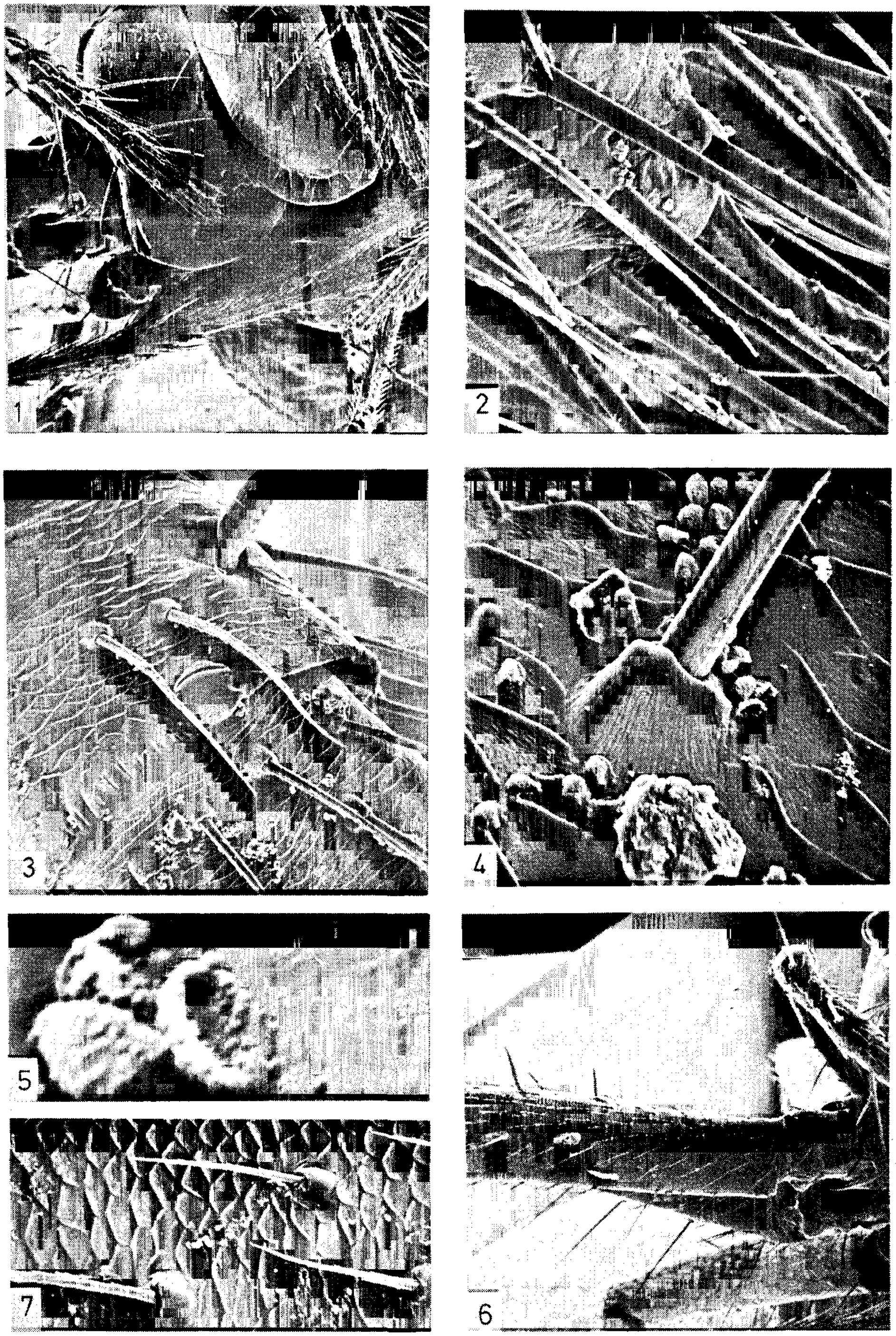

PLATE I

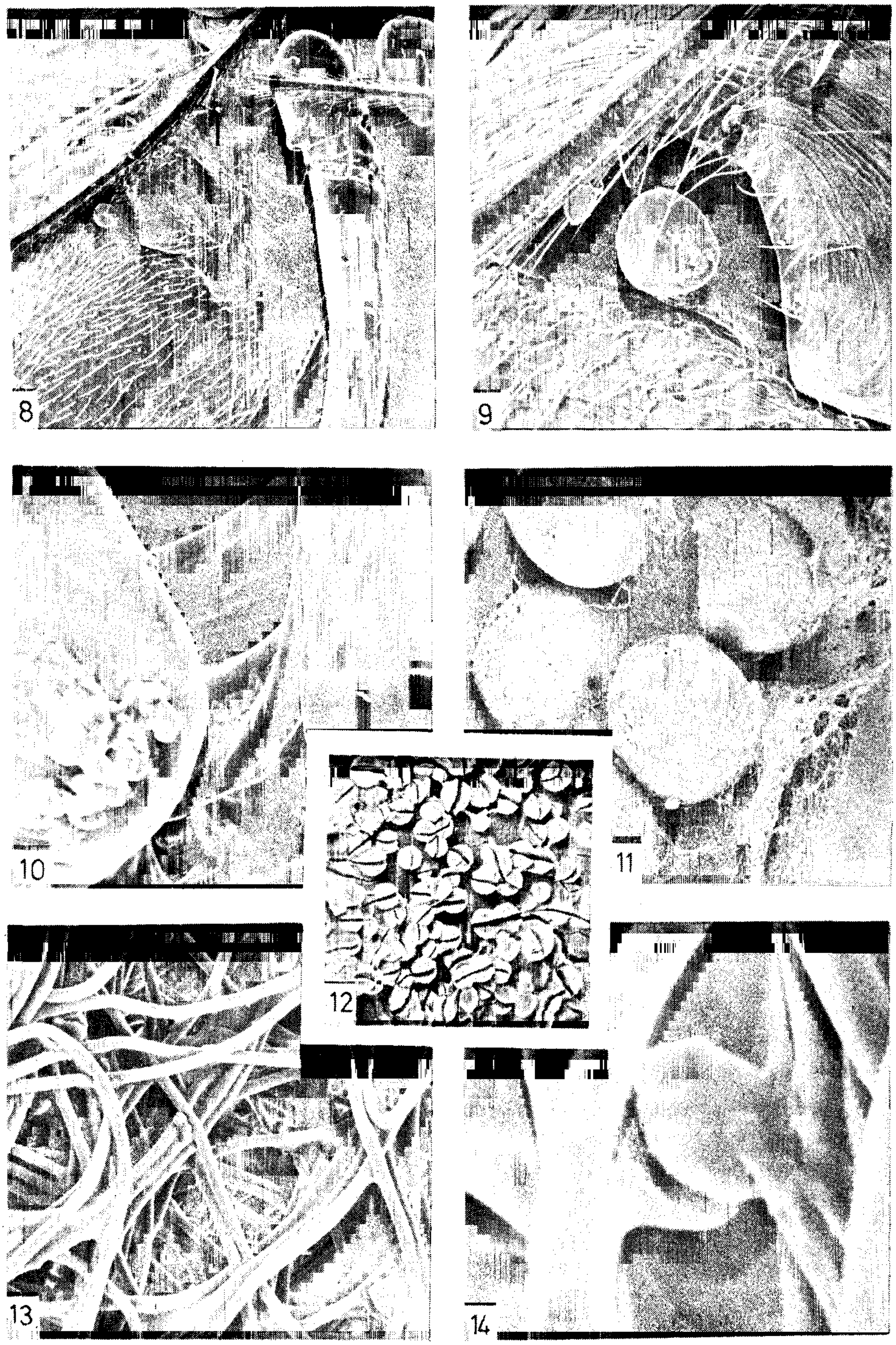

PLATE II

investigation of fine details of surface features in spiders. Surface features include not only details of the external structure, but also, after suitable treatment, details of such internal structures as lung books, genitalia, gut lumen and even individual cells since haemolymph smears, for example, could be examined in this way. Such studies will obviously lead to better understanding of physiological processes and morphological arrangements which are obscure at the moment. The instrument could also play a part in the elucidation of structural detail of taxonomic importance, particularly in smaller species of spider and other arachnids such as mites or pseudoscorpions.

Acknowledgements.

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PLATE 2. LEGEND TO FIGS. 8 – 14.

Fig. 8. General view of ventral surface of abdomen. x 100

Fig. 9. Epigyne at higher power. x 300

Fig. 10. Vulva showing details of interior structure. x 1500

Fig. 11. Cocoon cut away to show eggs. x 85.

Fig. 12. Egg surface at higher power showing types of projections. x 1800

Fig. 13. Arrangement of cocoon threads. x 365.

Fig. 14. Detailed view of a "weld" between two silk threads. x 8830.

A Spider regular in its habits!

Jacques Denis

Have you ever heard of a spider, the males of which appear only once a year, and every time at the same date? If not, please read on!

Spermophora senoculata (Dugés) is a small Pholcid which is not infrequent indoors or in outbuildings over the greater part of the Mediterranean Region; like many other species with similar distribution, beyond a wide gap from the Languedoe and Roussillon, it is established in the Vendée. Here it has been found in at least two houses in Longeville, about 2 – 5 miles from one another. The spider hides away in very concealed places and is much more secretive than its bigger and more common relation *Pholcus phalangioides* (Fuessli). I have caught only a few females in open situations such as corners of ceilings or glass windows, and several more behind furniture when this has been moved for cleaning or painting walls.

I have met with but three males. The first one was wandering on my desk on the 28th July 1962. The next year, another was found in a stone sink, also on the 28th July. The last one sat motionless in the corner of a ceiling near a female, which bore its egg-cocoon; this was in 1964, and again on the 28th July. No other specimen has ever come under my notice.

Should I conclude that the male of *Spermophora senoculata* is only to be found every year on the 28th July, at least in the Vendée; you would smile gently at this nonsense, and of course you would be right. Such a conjuncture is rather unusual, yet it is worth noting, as a lesson is implied in it. Coincidences are not often so conspicuous as this; but observations might occur which do not appear at first to be incomplete, and may seem sufficient enough for drawing a hasty conclusion which may well turn out later to be incorrect. So, odd as it is, perhaps this short account might be of some value if it has shown to a beginner the need for avoiding untimely inferences so far as biology is concerned.