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With thanks and kind regards!
H.M.Pe.

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On the burrowing behaviour and the production and use of silk in *Seothyra*, a sand-inhabiting spider from the Namib Desert (Arachnida, Araneae, Eresidae)

By
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With 12 Figures

Abstract: The *Seothyra* sp. dealt with in this paper burrows into loose dune sand. The burrows consist of a chamber constructed of sand at the surface and a tube of sand that leads vertically downward. The anterior spinnerets play a dominant role in producing these constructions. They are most important for binding sand grains together. This was directly observed when the spider began to construct a chamber. Later, while the tube was being constructed, the activity of the anterior spinnerets could not be directly observed. Therefore, the morphological characteristics of these spinnerets, certain properties of their secretions, and the fine structure of the walls of the tubes were studied in detail. These inquiries gave rise to a hypothesis for how *Seothyra* is able to bind sand grains together to form a wall. There is little doubt that *Seothyra* acts like another spider from the Namib Desert, which also burrows into loose sand, but belongs to a different family: this is *Leucorchestris arenicola* (Heteropodidae). In the case of *L. arenicola* the activity of the anterior spinnerets could be directly observed. These spinnerets, which are long and extensible, as in *Seothyra*, are thrust in quick succession into the sand, thus producing rows of small channels directed outward. Obviously, the gluey secretions of these spinnerets are deposited between the sand grains around the channels.

The device used by *Seothyra* for prey capture consists mainly of what I call cribellar tangles in this paper. These are composed of cribellar fibrils and some other fibres. This composition corresponds, in principle, to the capture threads of *Stegodyphus lineatus*, an eresid spider that builds aerial webs. *Seothyra* is unique in that it incorporates the capture silk in tangles instead of spanning it between supporting lines, as *Stegodyphus* does. Supporting lines cannot be produced in an environment of loose sand, since places to which such lines could be fixed are lacking. Thus, *Seothyra* rolls the capture silk up so that it can be attached directly to the roof of the chamber.

A. Introduction

The eresid species dealt with in this paper is *Seothyra henscheli* Dippenaar-Schoeman, 1990. I was introduced to the biology of *Seothyra* by Dr. Henschel when I visited the 'Desert Ecological Research Unit' at Gobabeb, Namibia.

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In the present paper, I describe the structure of *Seothyra* burrows produced in the laboratory, the kinds of silk involved and the function of various parts of the spinning apparatus in burrow construction and in prey capture. I relate these findings to the ecological basis of the behaviour of *Seothyra* described by Henschel and Lubin (personal communication) and, furthermore, compare them with the behaviour of other spiders: (1) *Stegodyphus lineatus* (Latreille, 1817), an eresid that spins an aerial web; (2) *Leucorchestris arenicola* (Lawrence, 1962) (Heteropodidae), another spider that burrows into sand.

Burrows similar to those described in this paper are produced by *Seothyra schreineri* Purcell, 1903, a sand-inhabiting species from the Karoo (South Africa); unfortunately, however, Purcell's description does not allow detailed comparisons.

B. Materials and Methods

About 40 live *Seothyra* specimens of different sizes were sent to me from Namibia. They were kept in the laboratory at room temperature in glass jars filled with sand and were fed flies (*Drosophila* or *Musca*). A fine-grained sand was used ("Vogelsand", available from German pet shops). The grain size distribution of this sand is as follows:

2.0	-	0.63 mm	1.39%
0.63	-	0.2 mm	94.82%
0.2	-	0.063 mm	3.78%

For certain observations sand was stained black with spirit stain (label Clou). After staining, the sand was washed with water and dried. Thin sections of a spider's tube were made after hardening it with Epoxit. For closer examination of the shape of certain parts of the burrows it was found most useful to harden them with paraffin or Clear Varnish.

The spinning apparatus was studied according to methods described by Peters (1980) and Peters & Kovoor (1982). Some kinds of silk were examined with light microscopes (LM), with the transmission electron microscope (TEM) or, after sputtering with gold/palladium, with the scanning electron microscope (SEM).

The study of the fine structure of the cribellar material used by *Seothyra* for prey capture was difficult, since it was not possible to remove these structures undamaged from the substratum. Finally, I found that the spiders readily accepted glass plates instead of sand surfaces to spin a surface mat in just the same way as they do on sand. Sometimes the spiders even deposited their cribellar material upon glass, enabling me to examine these delicate structures in detail.

Acknowledgement

My cordial thanks go to Dr. Henschel for supplying me with live specimens and for continuous discussions.

For technical help I am grateful to the following persons: Horst Hüttemann and Horst Schoppmann (SEM), Antje Rummel (TEM) and Robert Neugebauer (LM). For the thin sections of a *Seothyra* tube I am indebted to Jürgen Mällisch. Dr. Dieter Burger was kind enough to establish the grain size distribution in the sand used in the experiments.

C. Results

I. Architecture of the burrows

A generalized diagram of a burrow, based upon my observations in the laboratory, is shown in Fig. 1. A burrow consists of a chamber and a tube. The chamber is covered with a roof composed of several layers of sand grains bound with silk. The tube, also made of silk-bound sand grains, leads vertically downward, widening slightly towards the bottom.

The floor of the chamber and the walls of the tube are connected to the roof with silk. The outer edges of the roof have fine slits (Fig. 1). These open into small pits at the edges of the chamber. The slits are important for prey capture: at these points, the spider can lift the edge of the chamber and grasp prey that has fallen into the pit. The prey adheres to small balls of cribellar material, or cribellar tangles (described below), that are laid on the roof near the slits.

There is much variation in the shape and size of the chambers, the length of the tubes, the number, location and shape of the pits, and the relative location of the entrance to the tube (centric or eccentric). Many changes can occur in an inhabited burrow. The shape of the burrow appears to be influenced to a large extent by the environment (Henschel and Lubin, personal communication) and its appearance in the laboratory can thus differ from that in the field.

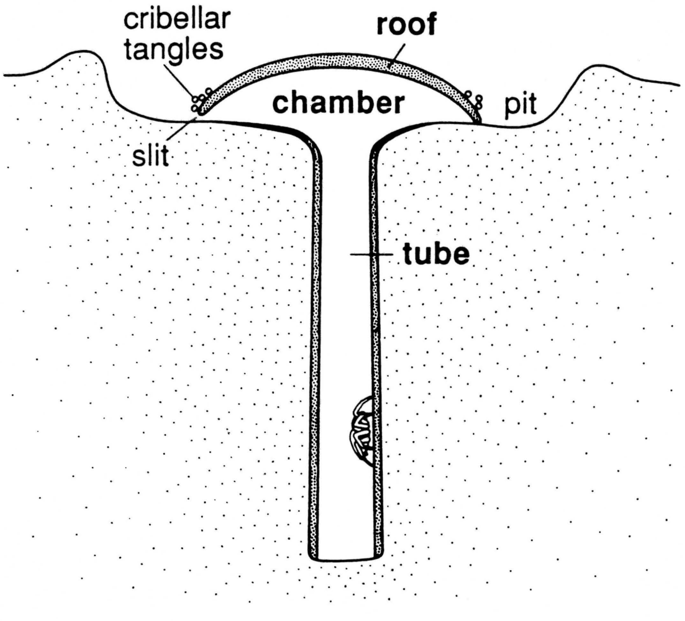


Fig. 1. *Seothyra*, generalized diagram of a burrow. The left slit is slightly open, the right slit closed.

II. Constructing a burrow

1. Chamber

Before *Seothyra* begins to build its burrow, it walks to and fro over short distances. After a while, the spider concentrates on an area more or less circular in shape, often with a diameter about twice the spider's own length. It covers this area with a criss-cross of fine silk (Fig. 2b). During this activity the anterior spinnerets are extended and sweep over the sand. It may be concluded that much of this silk is extruded from the anterior spinnerets (see below).

After having produced a loose sheet in this way, the spider grasps its edge with the front legs and slips, upside down, beneath it (Fig. 2c). The extended anterior spinnerets now collect sand grains and spin them to the sheet above. (Fig. 2d).

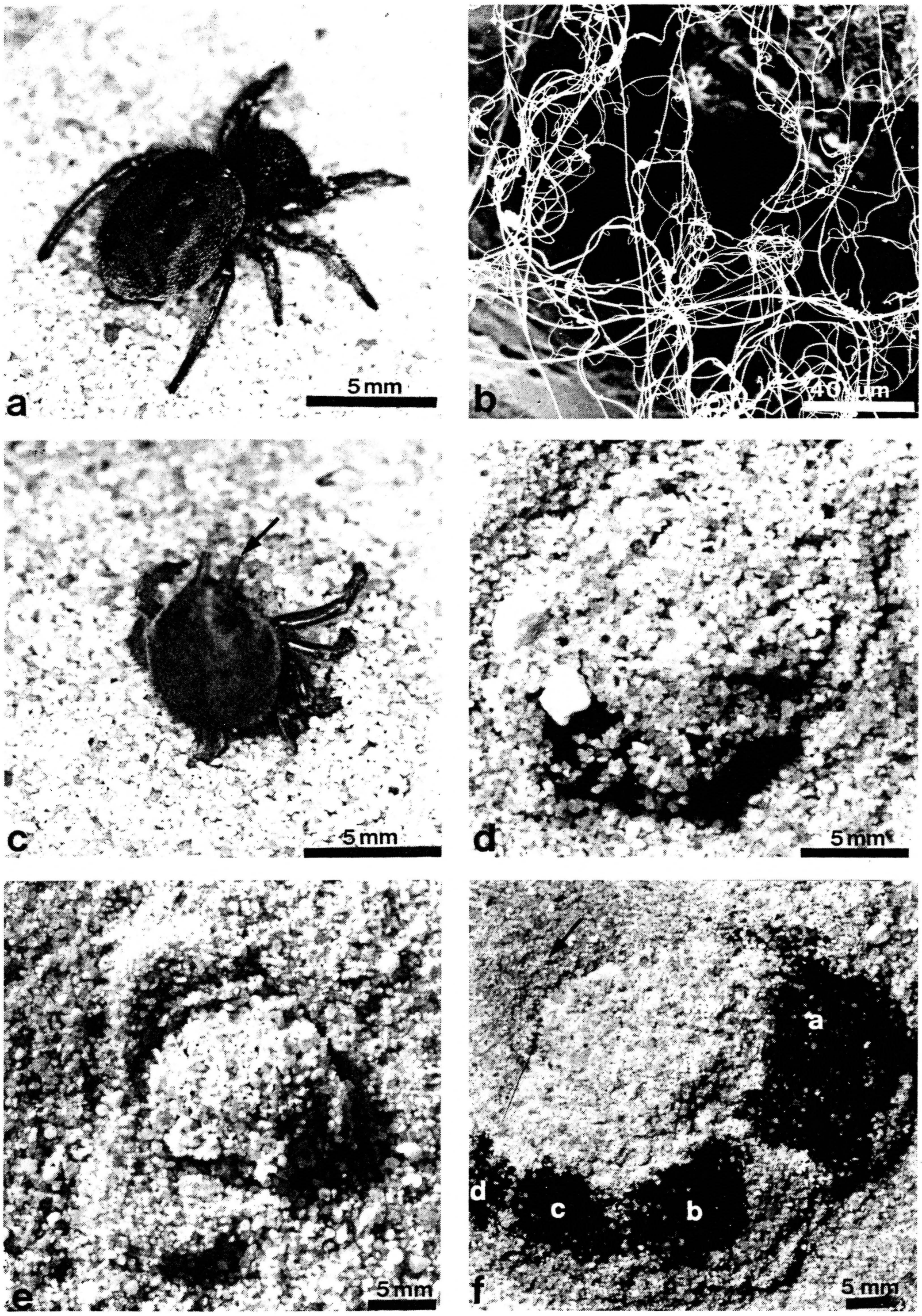
The next steps consist in producing a hollow under the sheet and strengthening this preliminary roof from below with sand. The latter activity cannot be directly observed (see below). The spider usually pushes much of the sand from below the covering outward, thus producing pits (Fig. 2e). Sometimes little or no sand was thrown out at the beginning and pits were produced later or not at all. In such cases the spider produced a hollow under the roof by spinning more sand into the periphery of the roof to raise it and expand it outward.

The production of a chamber is closely connected with the excavation of the tube. This can be experimentally demonstrated. In the experiment documented in Fig. 2f, a layer of normal (pale) sand, 23 mm thick, was placed upon a layer of black sand, 17 mm thick. The spider dug herself in on day 1 (Fig. 2d). On day 2, a flat pit was seen at the left side (Fig. 2f, arrow), and a very small patch of black sand in the roof (indicated with an "a" in Fig. 2f). The latter means that the spider had burrowed to a depth of 23 mm. No changes occurred on day 3, but on day 4, the patch first seen on day 2 was increased (Fig. 2f). Patches b, c and d were not seen until day 5. Closer examination revealed that not all of the black sand was incorporated into the roof, but some of it was laid down upon the chamber floor.

2. Tube

It was not possible to observe how the sand was transported to the surface. I confine myself to a description of the fine structure of the wall of the tube and to a hypothesis for how this structure is produced.

Fig. 2. *Seothyra*, burrowing activity. – (a) Spider still resting on the sand; (b) silk laid down upon the sand (SEM); (c) spider slipping underneath; note the extended anterior spinnerets (arrow); (d) completing the preliminary roof of a chamber; (e) two pits at the edge of a chamber in construction [this picture refers to a different individual than Fig. (d)]; (f) roof of the chamber shown in (d) 4 days later [for explanation see text].


a
5mm
b
40 µm
c
5mm
d
5mm
e
5mm
f
5 mm
a
b
c
d

The tube can be freed from the surrounding sand without damaging it. Although the circular tunnel collapses, the walls keep their coherence (Fig. 3a). The wall consists of several layers of sand grains (Fig. 3b). When the tube is viewed from the outside a characteristic pattern perpendicular to the long axis is noted. This pattern results from rows of crests consisting of sand grain clusters, between which deeper furrows are seen. A comparable pattern can be seen on the inside wall of a tube, but this pattern is much finer (Fig. 3c).

A characteristic of the inner surfaces of the walls is that they are strewn with pores that project outward. These pores are so fine that they can hardly be seen with the naked eye, or even at low magnification (Fig. 3c). They can be seen clearly at higher magnification with the stereomicroscope or with the SEM (Fig. 3d).

III. Spinning apparatus and its functions in relation to the construction of burrows

1. Morphology of the spinning apparatus

I suggested above that there is a close relationship between the structure of the tube and the functional morphology of the spinning apparatus. The spinning apparatus was therefore studied with regard to this expectation.

Little of the spinnerets is visible when they are in the resting position, because they are deeply withdrawn into the opisthosoma and densely covered with hairs (Fig. 4a). When the spinnerets are displayed by extending them artificially, the anterior spinnerets are seen to be by far the largest, the median spinnerets the smallest, and the posterior spinnerets intermediate in size (Fig. 4b). The cribellum is bipartite, as in other Eresidae.

I concentrated on the study of the anterior spinnerets in maximal extension (Fig. 5a), which revealed some of the mechanism of this extension. The spinnerets are placed upon a large, complex membranous structure (Fig. 5a, arrows, bottom; for the median spinnerets see Fig. 4b). These membranes are folded inward in the resting position and become taut in the active phase. Corresponding membranes are placed between the heads of the spinnerets and the basal members (Fig. 5a, arrow, top).

The spigots on the anterior spinnerets are all of the same type, but the outer ones are longer than the rest (Fig. 5b). Most striking are the very long, extremely fine, terminal shafts. These shafts are highly flexible (Fig. 5c). Figure 5c documents an experiment in which a spider about to dig herself in was paraffinized while covering the sand with silk. This confirms the suggestion (see above) that the anterior spinnerets are involved in the activity under scrutiny.

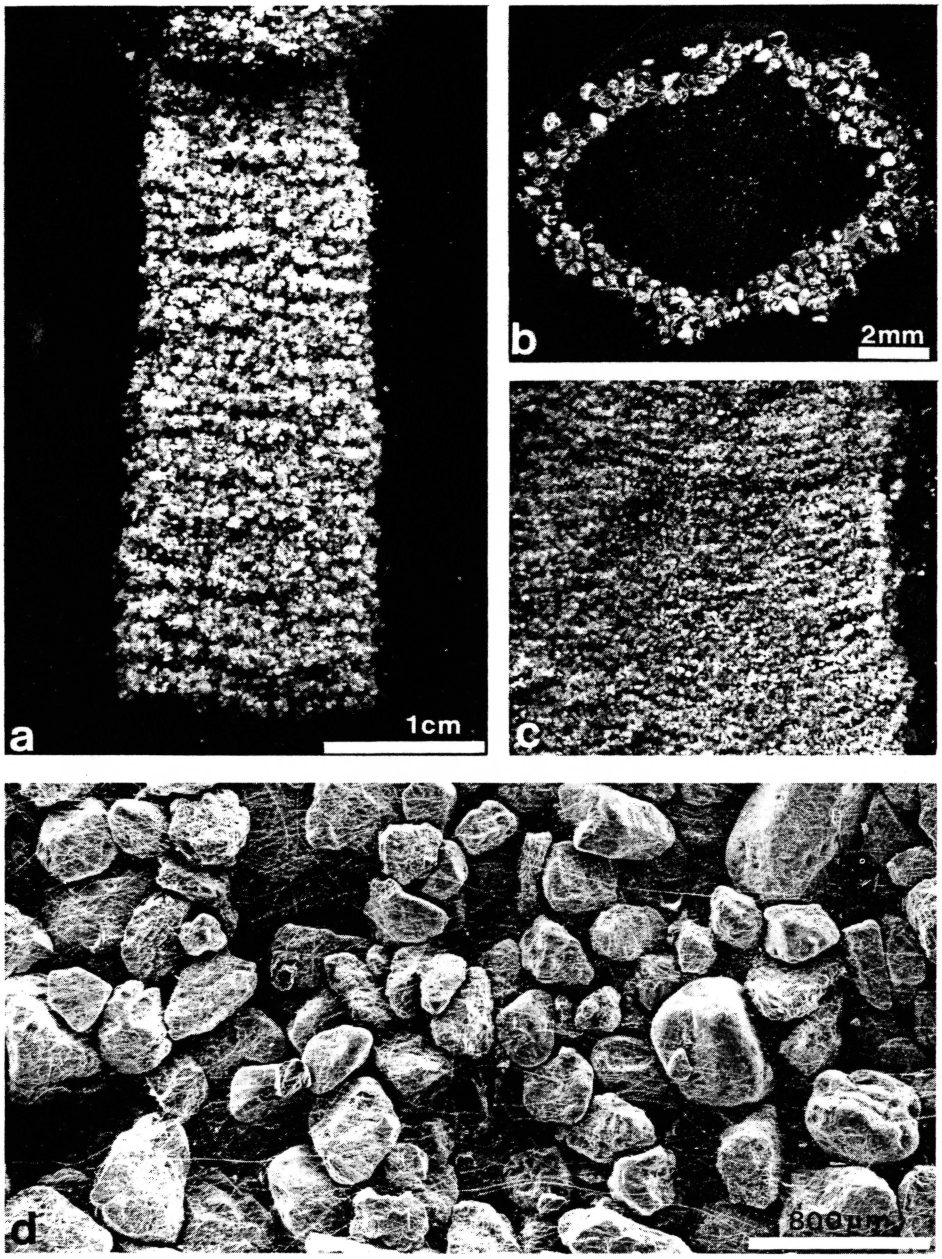


Fig. 3. *Seothyra*, structure of tubes; except in (b), all pictures from the same tube. (a) Tube from outside; (b) cross section; body length of the spider 10 mm (extremities not included); (c) tube from inside, magnification as in (a); (d) two rows of pores on the inside at higher magnification (SEM).

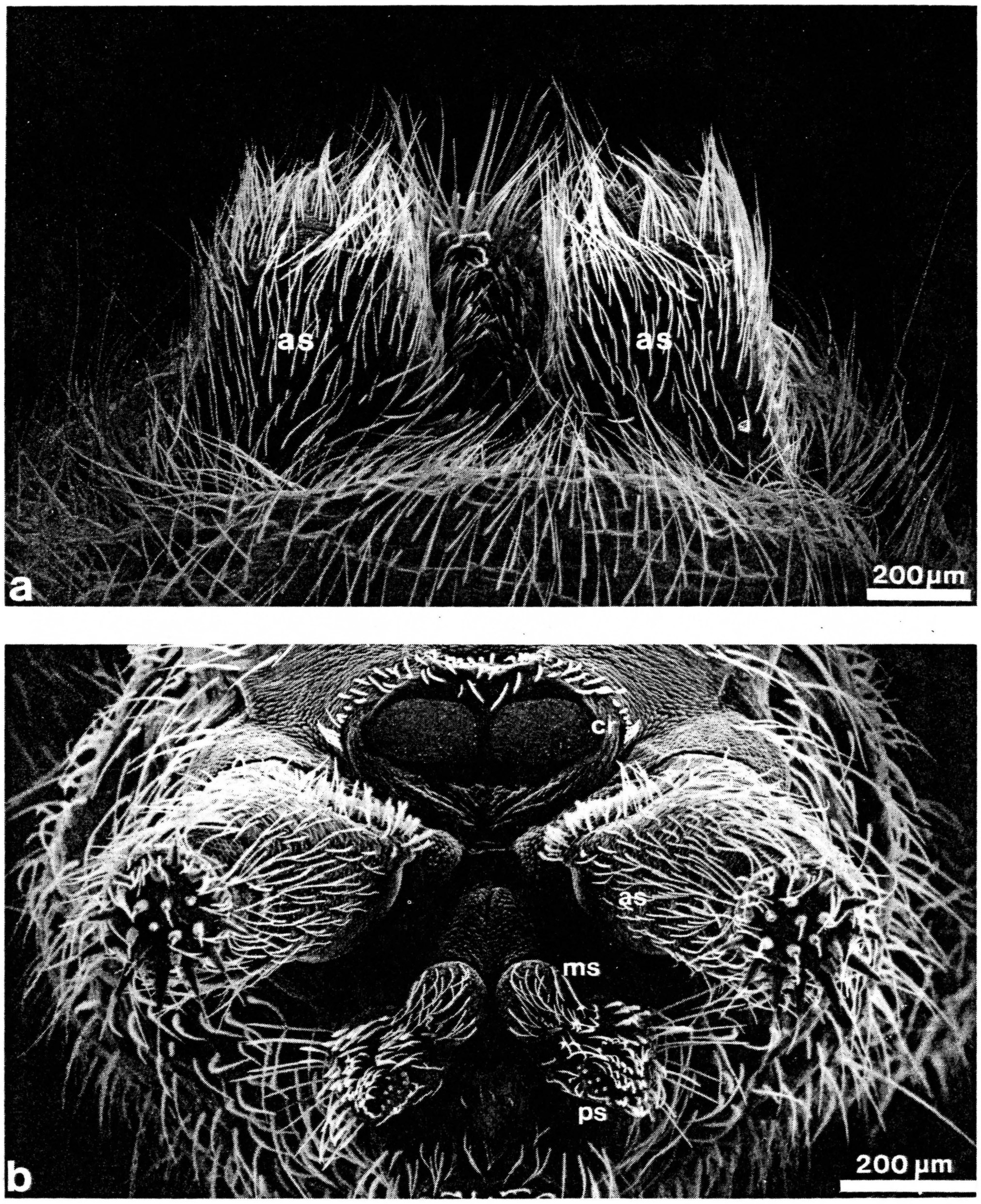


Fig. 4. *Seothyra*, spinning apparatus. – (a) Spinnerets in resting position, viewed from the front; *as* anterior spinnerets; (b) spinnerets artificially displayed [*cr* cribellum, *as* anterior spinnerets, *ms* median spinnerets, *ps* posterior spinnerets] (SEM).

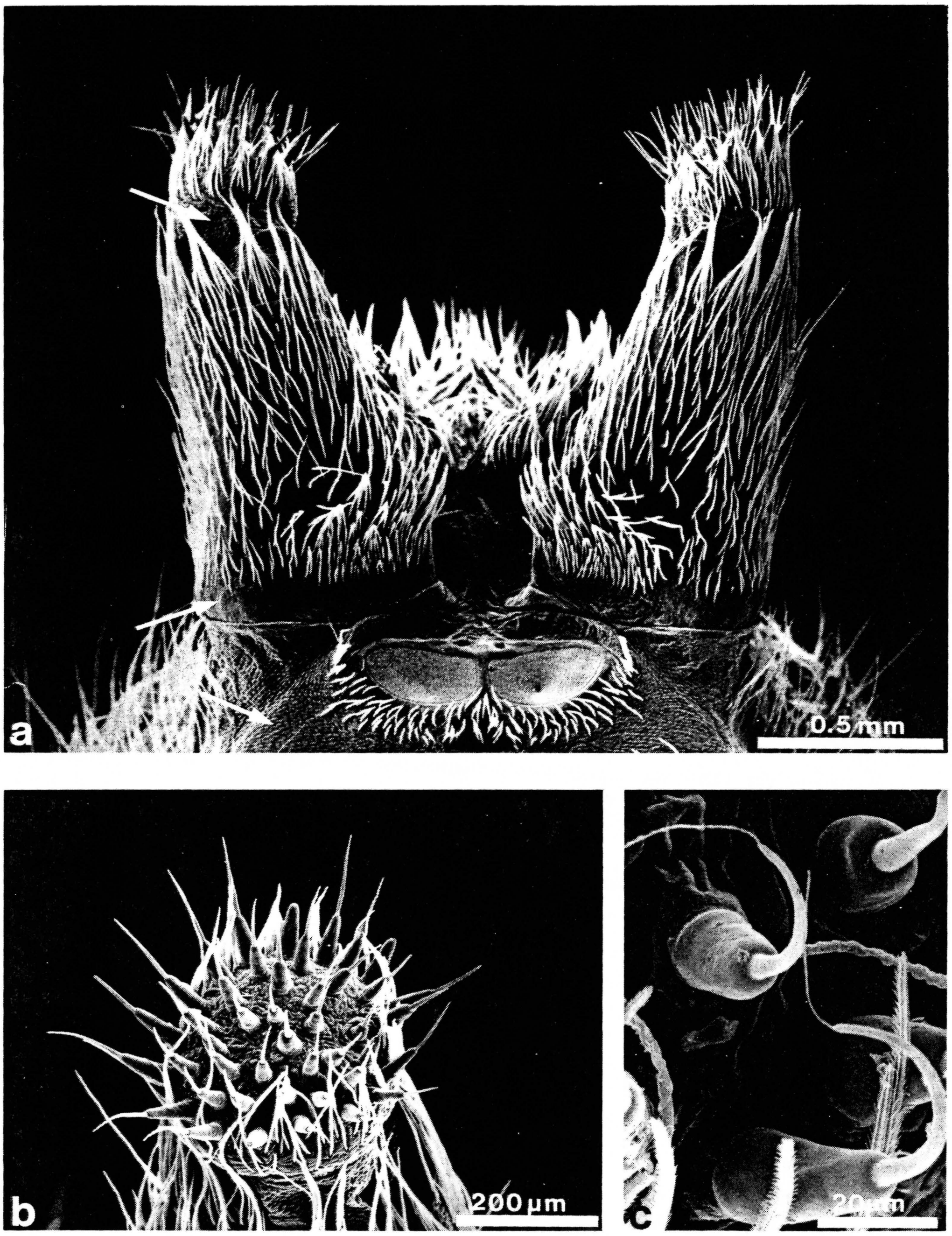


Fig. 5. *Seothyra*, morphology of the anterior spinnerets. – (a) Anterior spinnerets maximally extended, arrows (two at the basis, one near the top) point to the membranous structures explained in the text; (b) spigots on the top viewed from above; (c) two such spigots with adhering fibres (see text). (SEM).

2. Some properties of the silk extruded from the anterior spinnerets

Silk from the anterior spinnerets laid upon glass plates made it possible to study these secretions in more detail. Spiders that were placed on glass produced surface mats as usual, even without the ability to dig themselves in further (Fig. 6a, low magnification; Fig. 6b, higher magnification). Almost all fibres in these webs are of the very fine type. Since they most probably originate from piriform-like glands, I call them p-fibres. The diameters of p-fibres vary somewhat. This is partly because they sometimes combine with each other (Fig. 6b). Other preparations revealed that more than two elementary fibres may adhere to one another. Fibres can also appear swollen in certain places (Fig. 6c, arrow).

Occasionally two kinds of thicker fibres of different diameters were observed (Fig. 6c: a1, a2). Fibres of both kinds can run in pairs, as shown in Fig. 6c for the thinner ones, where the pair was combined with a p-fibre. The glandular origin of these fibres in unknown. They cannot be assigned to the anterior spinnerets, where corresponding spigots are lacking. They are probably secreted from spigots situated on the median and/or posterior spinnerets.

The mechanism by which p-fibres are fixed to the substratum can be seen in Fig. 6d, which shows how a little lump of silk secretion fixes the fibre. The fibres tend to run continuously over long distances. This continuity can be maintained by fixing the fibres with a strip of secretion directly attached to the substrate at intervals (Fig. 6b).

These observations lead to the conclusion that there is no special glue for fixing p-fibres; rather the same secretions that produce the fibres are also used for anchoring them.

3. A hypothesis for tube construction

Taken together, the findings relating to the structure of the tubes, the morphology of the anterior spinnerets, and the properties of the secretions extruded from them lead to a hypothesis for tube construction.

I suggest that the sand grains forming the wall are bound together with secretions from the anterior spinnerets. After a layer of sand has been excavated, the spider pushes the anterior spinnerets into the remaining sand near the bottom of the tube, thus producing a series of small channels. The openings of these channels are seen as pores along the fine furrows on the inner surfaces of the tubes. These channels lead outward and the output accumulates, forming the characteristic crests that project into the surrounding sand.

While the spinnerets are thrust into the pores, silk is secreted from the long spigot shafts and placed on and between the surrounding sand grains. At least some of the secretions become transformed into fibres, and corresponding fibres can be seen outside (Fig. 7c). It is, however, quite possible that sand grains can also adhere directly to one another without being bound with fibres.

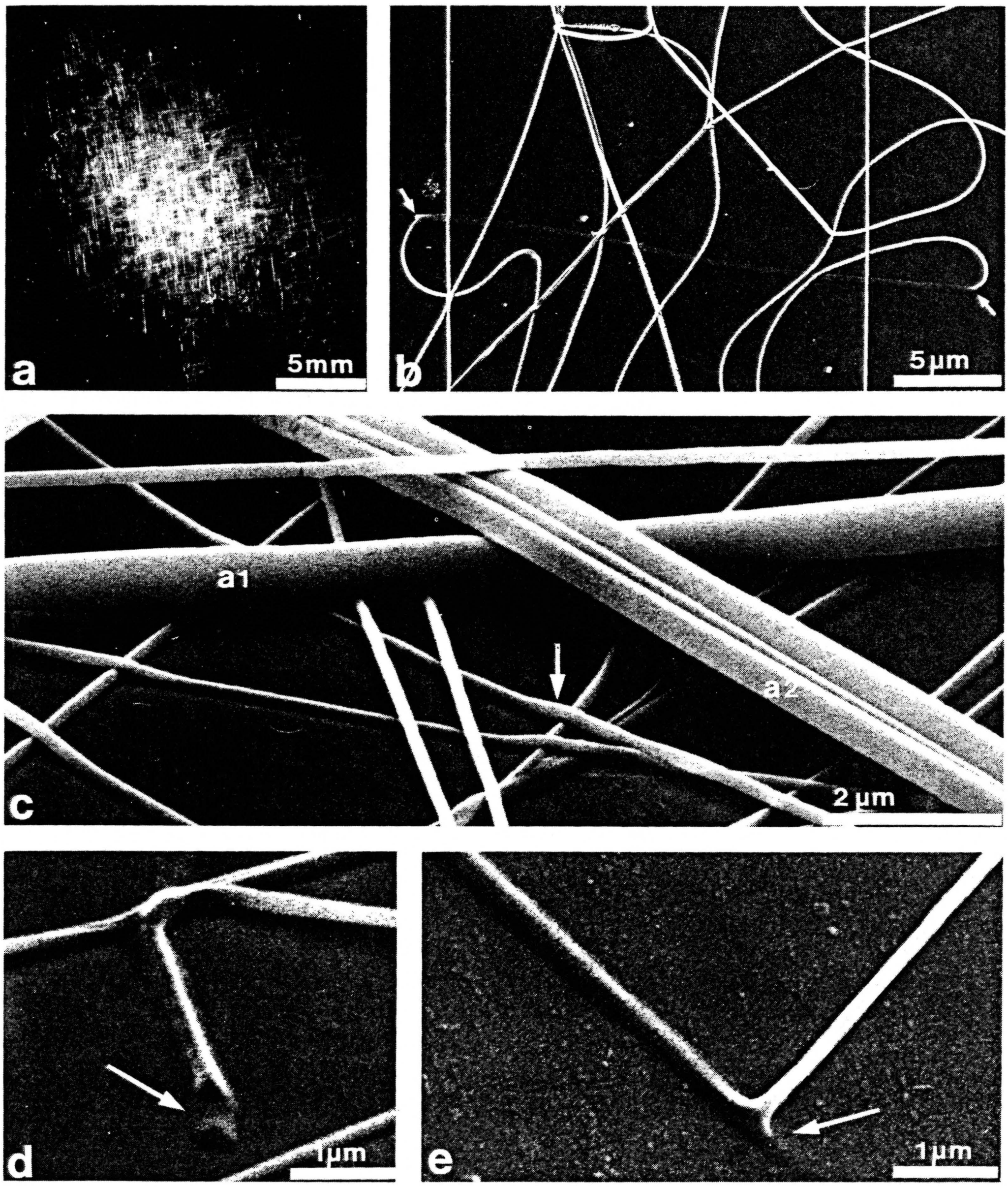


Fig. 6. *Seothyra*, silk on glass plates, like that produced by the spider before slipping into the sand. – (a) Such a web at low magnification; (b) fibres from the anterior spinnerets (p-fibres), between the two arrows a cord of secretion is directly attached to the glass; (c) in addition to p-fibres two kinds of thicker fibres are represented (a1, a2), [arrow points to a place where p-fibres appear swollen]; (d) p-fibre starting from a little knob of secretion attached to the glass (*arrow*); (e) p-fibre starting from a cord of secretion attached to the glass [arrow points to the place where the fibre bends]. (SEM).

The hypothesis proposed here cannot explain how the spider constructs the chamber roof. In this case sand has to be tied from below to a sheet already present above. I assume that the spider collects sand grains from the floor with the anterior spinnerets to which they adhere and then fits them into the roof. It may be added that, occasionally, pores similar to those in the tubes have been seen in roofs (Fig. 7a). Thus, the technique described for the tubes seems also to be employed in construction of the roofs.

4. Lining the burrows with silk

I suggest that the techniques so far described or assumed have only a preliminary function with respect to the production of stable burrows. The inner surfaces of the burrows are covered with a silken sheet, also covering the pores (Fig. 7a, b). This lining seems to become progressively denser with time, and it seems most likely that it contributes much to the stability of the whole construction.

In older burrows thick strands of many fibres were seen freely passing through chamber and tube (Fig. 7b). These fibres might originate as drag-lines drawn out by the spider while moving within the burrow; it seems likely that the strands are of use as signal threads.

The glandular origin of the sheet and of the strands inside the burrows is unknown. There is little doubt that secretions from the median and/or posterior spinnerets are important in this respect.

IV. Device used for prey capture

Most of the silk used by *Seothyra* for prey capture is incorporated in what I call cribellar tangles. They are attached to the roof of the chambers above the slits. I do not believe that they also occur elsewhere in the vicinity, but it has to be taken into account that the tangles are extremely difficult to see, since they are transparent and very small. I could not see them with the naked eye. Figure 8a gives an impression of how a group of tangles looks when viewed with a stereomicroscope. Only strongly curled fibres can be seen. Figure 8b shows a tangle in polarized light. It consists of highly curled, relatively thick fibres and of light flocks inbetween. The latter are masses of cribellar fibrils that are not optically resolved at this magnification. Each loop is composed of a strong fibre surrounded by a highly undulated thinner one and, again, by cribellar fibrils (Fig. 8c).

Many tangles are interconnected with fine strands (Fig. 8d, e). This interconnection means that generally two such strands can be seen at the edge of a tangle, one going in and the other out. These strands correspond to what I have called calamistrated strands with reference to other cribellate spiders (e.g. Peters 1987). Corresponding to capture threads of other cribellate spiders, the straight fibres are called axial fibres (a-fibres) and the others undulated fibres (u-fibres). There are cribellate spiders in

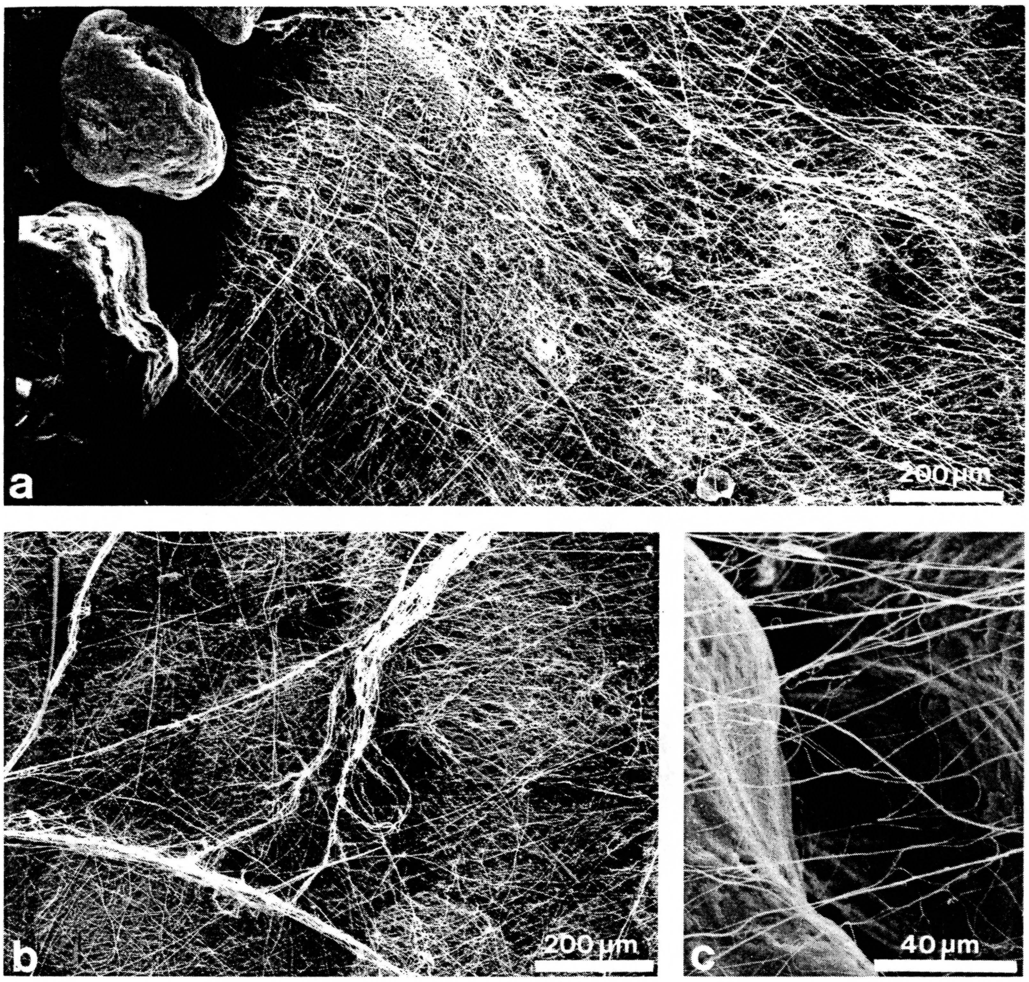


Fig. 7. *Seothyra*, silk used for various purposes. – (a) Section of a chamber roof viewed from inside; (b) section of a tube from inside; note strands of fibres passing freely through the lumen [for explanation see text]; (c) place where fibres are seen at the outer surface of a tube. (SEM).

which the two halves of a capture thread combine to form one single thread. In *Seothyra*, they remain relatively independent of one another, running close together in some parts while remaining separate in others (Fig. 8d, e).

It becomes clear that a cribellar tangle is a complex of two calamistrated half-strands. This statement is in accordance with observations on spiders producing cribellar tangles. Such spiders spend a long time (e.g. 40 s) at the same place continuously reeling off silk. After having laid down a cribellar tangle upon the substrate the spider moves to another site, drawing a connecting thread behind itself.

To complete the description, attention is drawn to Fig. 8 f. This TEM picture gives a more realistic impression of the diameter of an a-fibre in relation to that of an u-fibre.

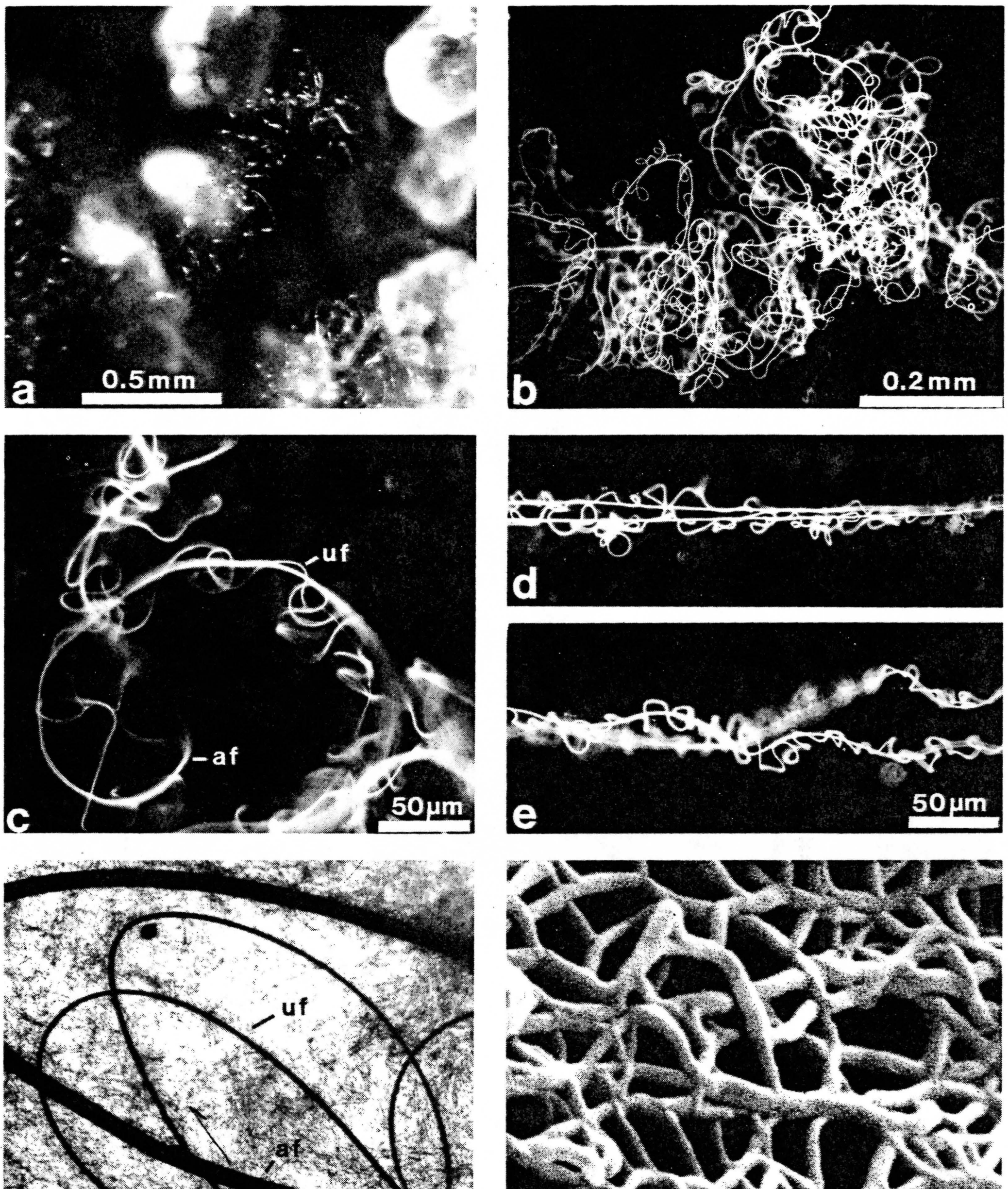


Fig. 8. *Seothyra*, the device used for prey capture. – (a) Cribellar tangles above a slit, viewed with the stereomicroscope; (b) cribellar tangle viewed in polarized light; (c) individual loop of the tangle shown in (b) but at higher magnification; the axial fibre (*af*) is surrounded by an undulated fibre (*uf*); the cribellar material (*light*) is not optically resolved at this magnification; (d, e) connecting strands, viewed in polarized light at the same magnification [for explanation see text]; (f) section of a tangle viewed with the TEM [*af* axial fibre, *uf* undulated fibre, in between cribellar fibrils]; (g) cribellar fibrils at much higher magnification (SEM) [for explanation see text].

Figure 8g shows a small section of the cribellar mass at very high magnification. The striking differences in the diameters of the fibrils and many of the numerous interconnections are most probably artefacts of the SEM preparation. This can be concluded from comparison with TEM pictures.

Prey capture

Insect prey coming into contact with the cribellar material immediately adhere to it because of the extremely strong adhesion of the cribellar fibrils. The more a captured insect struggles, the more tangles and connecting threads it tears off the roof. These loose tangles then adhere to other parts of the insect and soon bind it securely (Fig. 9). Very soon it is incapable of escaping. The spider then grasps the bound prey through the slit and pulls it into the burrow.

The capture device is now destroyed, but the spider replaces it sooner or later.

V. Comparisons with two other spiders

1. Comparison within the family Eresidae

The capture devices are well enough known for another eresid spider, *Stegodyphus lineatus*, to enable comparison with *Seothyra*. *Stegodyphus lineatus* lives in silken retreats spun in vegetation above the ground. From there, strong lines radiate outward to which the capture threads are attached (Fig. 10a). Each of these capture threads also

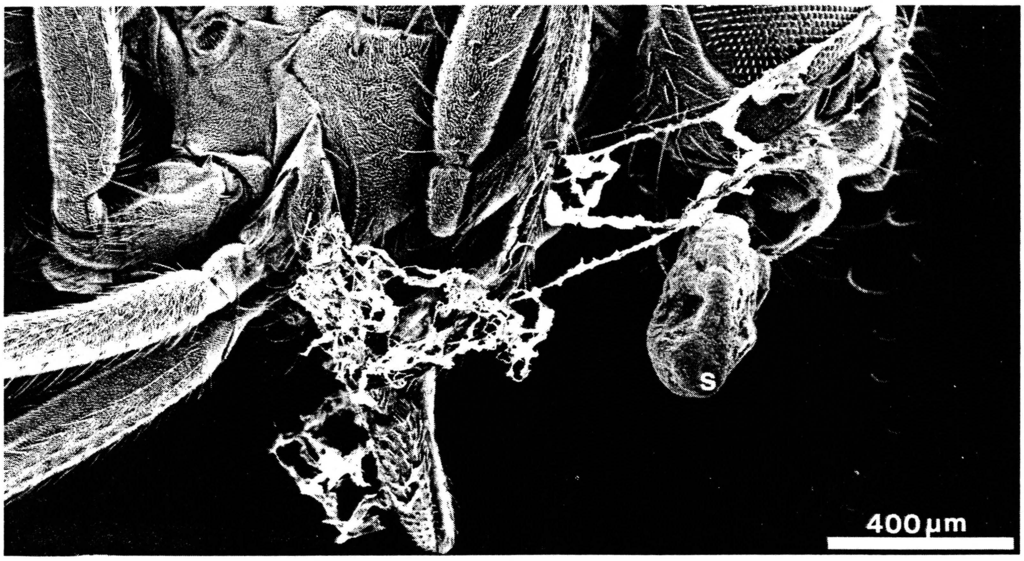


Fig. 9. A *Drosophila* covered with cribellar material after having touched some tangles; *s* sand grain. (SEM).

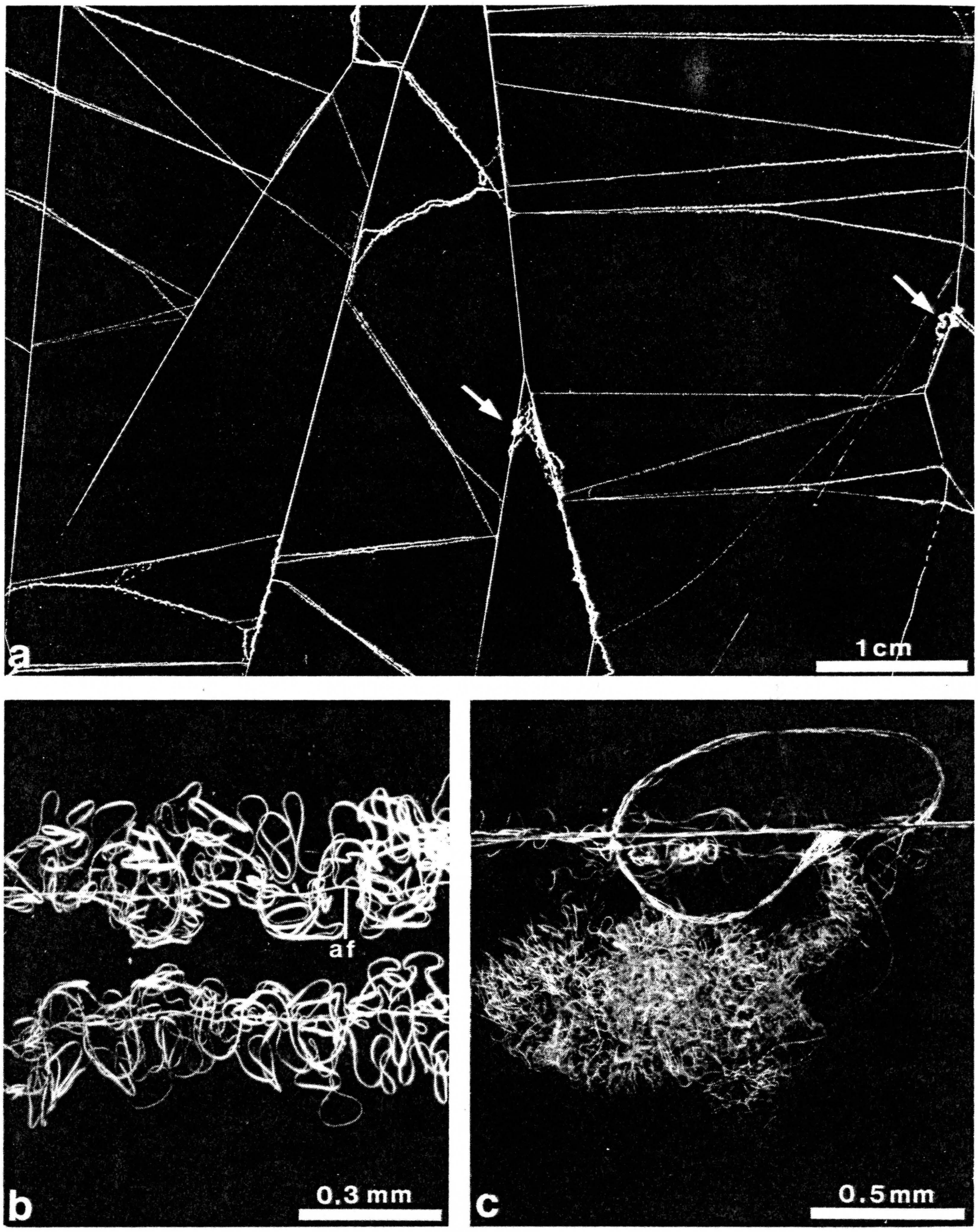


Fig. 10. *Stegodyphus lineatus*, ad. ♀♀. – (a) Section of a web, the arrows pointing to loose cribellar strands; (b) section of a capture thread (polarized light); (c) cribellar strands incorporated in a tangle (dark field).

consists of two calamistrated half-strands, each of a similar composition to the half-strands in *Seothyra* (Fig. 10b). The compositions differ mainly in the number of u-fibres combined with the axial fibres; in *Seothyra* there is only one, compared with three in *Stegodyphus*. This number cannot be inferred from Fig. 10b: I established it by special preparation.

A striking difference between the capture devices of the two spiders lies in the fact that in *Seothyra* most of the strands are incorporated in tangles, whereas in *Stegodyphus* they are freely spanned between supporting lines (Fig. 10a). This does not exclude the possibility that some of the cribellar material remains loosely attached to those lines (Fig. 10a, arrows). Occasionally the two cribellar half-strands are rolled up to form tangles closely resembling those of *Seothyra* (Fig. 10c).

2. Comparison with an heteropodid spider burrowing in loose dune sand

Another spider species burrowing in the dune sand of the Namib Desert is *Leucorchestris arenicola* (Heteropodidae). The ecology and behaviour of this spider was studied by Henschel (in press). I confine myself to some brief notes on the spinning apparatus in relation to the construction of the burrows.

The burrows consist of tubes excavated in the sand, each covered with a lid. The axis leads obliquely downward. These spiders are much larger than *Seothyra* and build correspondingly wider tubes. *Leucorchestris* can be observed producing the wall of a tube by watching it working along the wall of a glass jar. The excavated sand is brushed out of the tube. Having taken off a portion of sand at the bottom of the tube, the spider pushes the anterior spinnerets deep into the sand around the roof of the hollow in quick sequences. On the inside this produces series of pores (Fig. 11a). The structures that are produced by this activity of the spider very closely resemble those described for *Seothyra* (Fig. 11c, d).

As may be expected from this, the spinning apparatus of *Leucorchestris* has much in common with that of *Seothyra*. In their resting position, the spinnerets of *Leucorchestris* (Fig. 12a) can be withdrawn even further into the opisthosoma than in *Seothyra*. The anterior spinnerets can also be extended a very long way (Fig. 12b), which is similarly made possible by membranous connections (Fig. 12b, arrow). The anterior spinnerets bear spigots with very long, fine shafts. There is no evidence of spigots of ampullate glands on the anterior spinnerets.

D. Discussion

The family Eresidae is estimated to comprise about 96 nominal species in 10 genera (Platnick 1989). Since little is known of the life strategies of most of these spiders the possibility of comparisons is very limited.

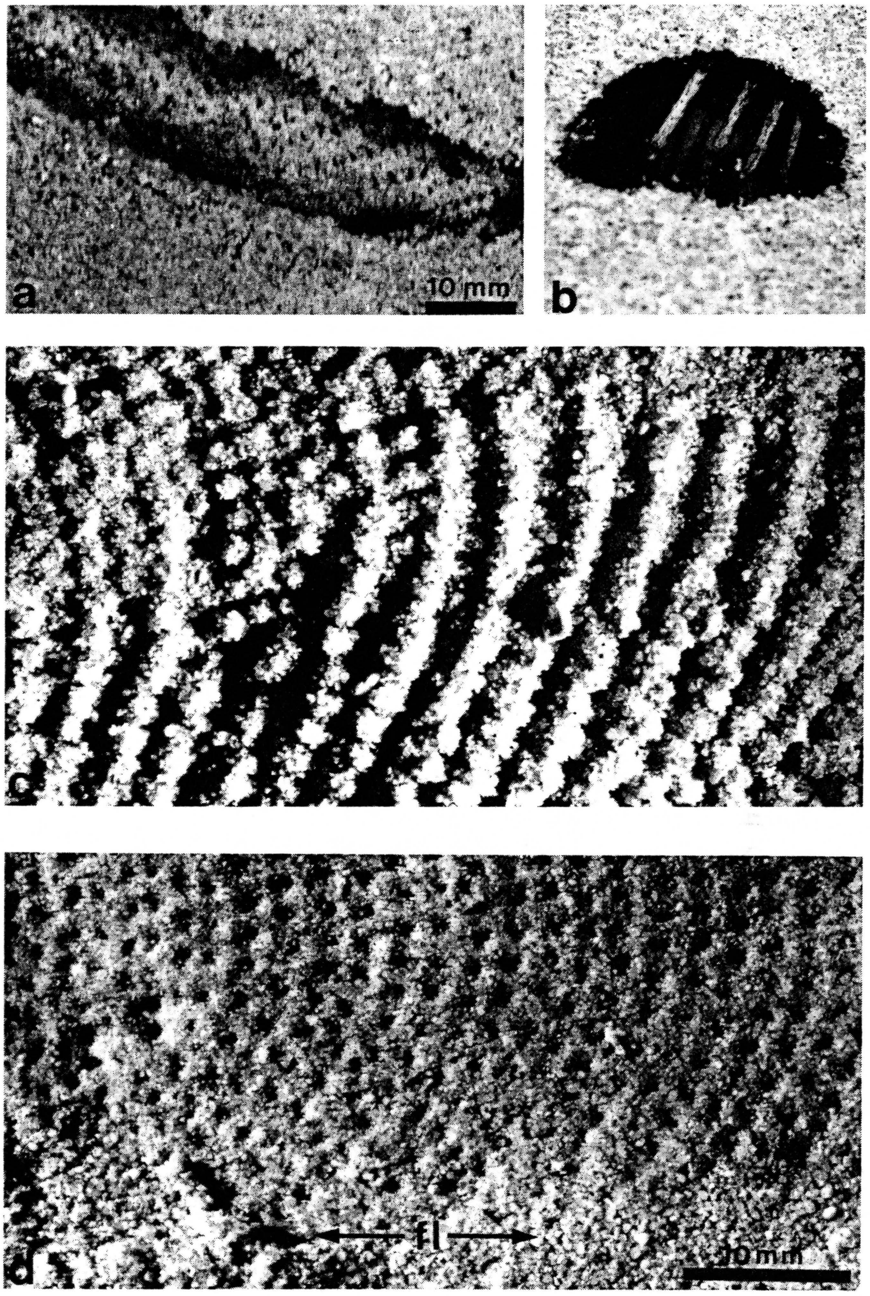


Fig. 11. *Leucorchestris arenicola*, tube construction. – (a) Section of a tube built along a glass wall; (b) tube ending at a glass wall; the spider is seen from the side in its typical position hanging at the roof [approximately same magnification as in (a)]; (c) section of a wall at higher magnification viewed from outside; (d) same section viewed from inside [*fl* floor of the tube], same magnification. – The direction of the structures in (c) and (d) does not correspond to their natural orientation in relation to the *vertical line* [see (a)].

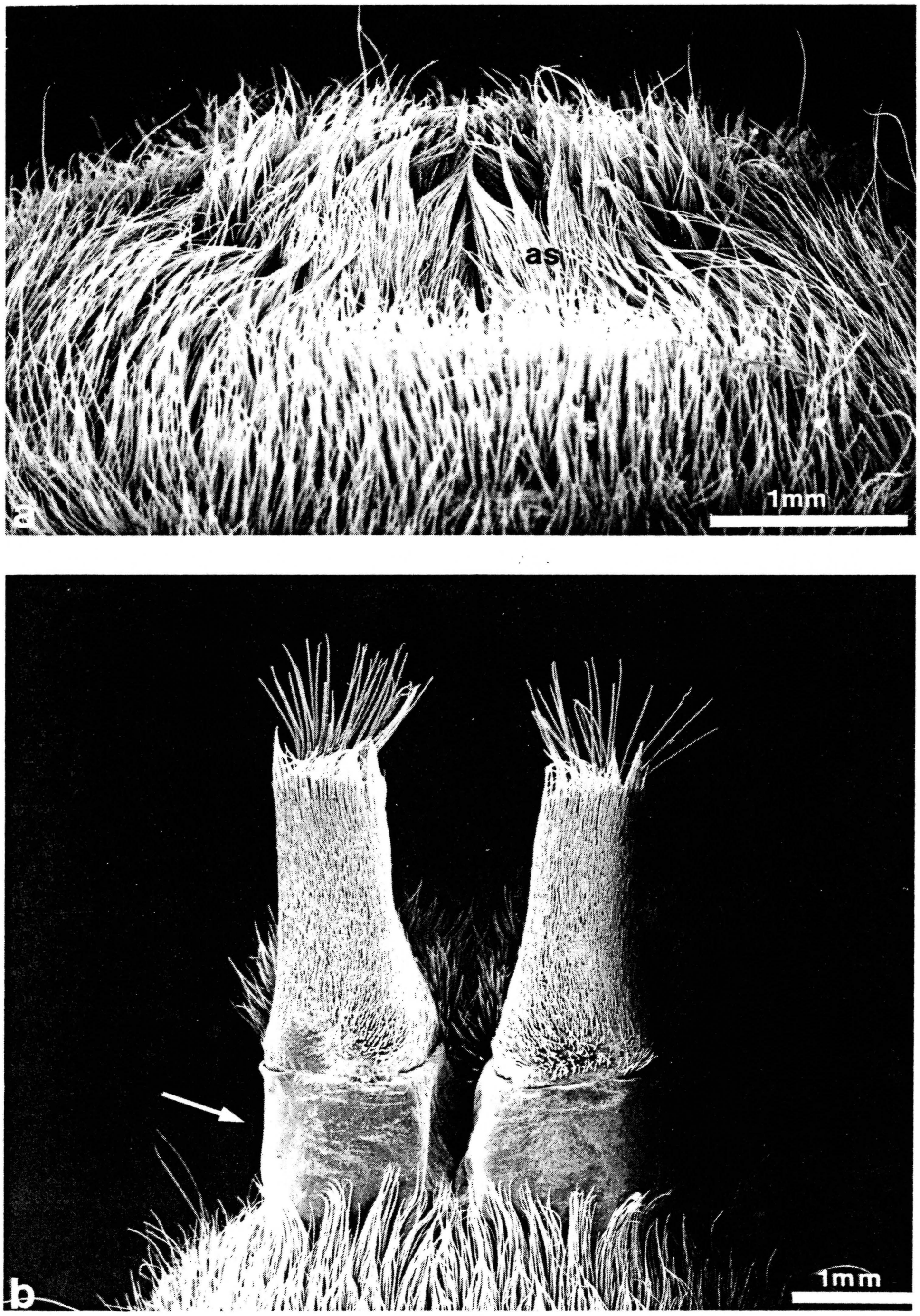


Fig. 12. *Leucorchestris arenicola*, spinning apparatus. – (a) Spinnerets in resting position, viewed from the front, *as* anterior spinnerets; (b) anterior spinnerets extended, viewed from the front [*arrow* points to the membranous structure at the base]. (SEM).

Eresidae in general seem to live in self-made homes consisting of silk-lined retreats, each with a capture web attached to the opening of this hiding place.

The design of these homes is deeply influenced by the conditions of the habitats. With regard to their different life histories, SIMON (1892) has divided the eresid species into "les espèces phytophiles" and "les espèces terricoles". In such a grouping *Stegodyphus lineatus* and *Seothyra* hold extreme positions. Members of both these genera live in silken retreats, but, in the case of *Stegodyphus lineatus* these retreats are spun in bushes above the ground, whereas in the case of *Seothyra* they are placed in loose sand.

These different environmental conditions characteristically reflect on the patterns of the capture webs. In the case of *Stegodyphus*, from the retreats lines radiate outward, to which capture threads are attached. These spiders have no problem in finding attachment points for the supporting lines in the vicinity. This is impossible for a spider like *Seothyra*, however, whose retreat is surrounded by loose sand. Instead of spanning the capture silk out *Seothyra* rolls it up, so that it can be fixed to the small places available on the chamber roof.

The design of the anterior spinnerets of the two spiders is in accordance with these behaviours. Supporting lines generally originate from ampullate glands whose spigots lie on the anterior spinnerets. Corresponding spigots are present in *Stegodyphus* but lacking in *Seothyra*.

Terricolous eresids excavate tubes in the soil and line them with silk. *Eresus niger* offers an example of this (Nørgaard 1941). It cannot be inferred from Nørgaard's description whether *Eresus* fixes the soil particles forming the wall before the spider lines the wall with silk. The necessity of such a fixing depends on the consistency of the soil, but nothing is known about this. At any rate, a spider like *Seothyra*, which burrows into loose sand, is forced to fix the loose particles before the wall can be covered with a silken sheet. I have hypothetically described in this paper how *Seothyra* binds sand grains together. This technique can be regarded as a specialization of a method quite commonly used by spiders. Generally spiders, including *Stegodyphus*, use the anterior spinnerets for tying fibres to one another or to a substrate. This is done by laying these spinnerets on the point of attachment, extruding a drop of secretion and then withdrawing the spinnerets. *Seothyra*, during tube construction, binds sand grains instead of fibres to one another, and, instead of simply laying the spinnerets on the substrate, the spider pushes them deep down into it. The morphological characteristics of the anterior spinnerets of *Seothyra* are in accordance with this behaviour.

Although the glands from which the secretion used by *Seothyra* originates were not studied, there is no doubt that they are, as in other spiders, piriform, or piriform-like, glands. From the chemical point of view the secretion of these glands is "more a glue than a silk" (ANDERSEN 1970). Nevertheless, this glue can also be drawn out to fibres. This has been demonstrated for Uloboridae and Araneidae (PETERS 1982) and is now shown for *Seothyra*. In this respect *Seothyra* presents nothing more than seems to be common to several families.

It is interesting that a member of the family Heteropodidae, *Leucorchestris arenicola*, which also burrows in loose sand, appears to have developed a technique of binding sand grains together just like that hypothetically proposed in detail for *Seothyra*. My direct observations of the activity of the anterior spinnerets in *Leucorchestris* strongly support the hypothesis of this procedure in *Seothyra*. The striking analogies between *Leucorchestris* and *Seothyra* are certainly a remarkable example of convergent evolution in distantly related taxa - not only with respect to the morphological structures involved, but also with respect to the neurosensory systems that guide these structures.

Seothyra is exposed to extreme daily ranges of temperature (LUBIN & HENSCHEL, in press). Surface temperatures can reach 65-75° C, but the bottom of the tubes is "a relatively constant thermal environment, which rarely exceeds 35° C. By positioning themselves in various sites within the burrow, spiders may choose from a >30 °C range of temperatures at the hottest time of day."

I conclude that the ancestors of the *Seothyra* species under scrutiny, by burrowing in the ground, have fulfilled an essential precondition for immigration to a region as inhospitable as the Namib Desert.

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