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SEM OBSERVATIONS ON TWO LERP-FORMING PSYLLOIDS (HOMOPTERA)

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Abstract

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Lerps and nymphs of *Celtisaspis usubai* occurring in Japan and *Macrohomotoma* sp. from the Philippines were observed mainly in scanning electron microscopy. The lerps of both species are made of an amorphous substance supposedly discharged from the anus with pieces of wax filaments intermingled. *Celtisaspis usubai* has disc pores on the caudal plate ; each pore secretes flattened wax filaments, and these filaments are combined to form a double polygonal tube, which is crushed flat or disjointed into individual filaments and broken into fragments when applied to the lerp under formation. The species of *Macrohomotoma* also secretes wax filaments in the form of tubes, which are, however, round in cross section and discharged from pores occurring in a particular structure on the anal plate ; the lerp is coarse in texture, with tubes depressed and broken or remaining round in cross section and laid disorderly. The lerps of these psylloids and the tests of *Conchaspis* species (Coccoidea) are similar in both external appearance and internal structure, but the wax-secreting organs are utterly different among these insects. It is suggested that wax-secreting organs are useful for phylogenetic study in the Psylloidea, and also that coverings of homopterous insects and their formation are worthy of study from the viewpoint of adaptation and phylogeny.

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Contents. Introduction — Preliminary observations on *Celtisaspis usubai* — Further observations on *Celtisaspis usubai* — Observations on *Macrohomotoma* sp. — Concluding discussions — Acknowledgements — Literature — Plates.

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INTRODUCTION

Not a few species of the superfamily Psylloidea (jumping plant lice) live in their nymphal stage under coverings formed by themselves. These coverings are called 'lerps', originally a native Australian word ('laap') for a kind of manna produced by certain psylloids on *Eucalyptus*. Indeed, lerp-forming psylloids are especially abundant in the Australian Region, where they have long attracted the attention of entomologists as well as of native Australians.

In Japan the occurrence of lerp-forming psylloids has only recently been noticed, and 2 species, *Pachypsylla japonica* and *P. usubai*, were described in 1968 and 1980, respectively, by the junior author. Yang and Li (1982) erected *Celtisaspis* for 5 lerp-forming species occurring in China and referred the Japanese species to the genus. (The name of the genus should correctly be *Celtidaspis*. However, the original spelling is adopted in this paper, because there is no evidence of an inadvertent error in the original publication itself.)

Celtisaspis japonica and *C. usubai* as well as the Chinese species are associated with *Celtis sinensis*, the nymphs forming lerps on the undersurface of the leaves. *C. japonica* has 2 generations a year, whereas the *C. usubai* adults appear in early summer only. *C. japonica* causes a prominent hornlike pouch gall to grow on the upper surface of the leaf opposite to its lerp in the 1st generation. (In the 2nd generation no gall is formed, in spite of the fact that growing leaves are still available in the season.) *C. usubai* induces a shallow pouch gall, which makes a low swelling on the upper surface of the leaf.

The junior author (Miyatake 1980) once has adopted the view that *C. japonica* is immediately ancestral to *C. usubai*. However, Yang and Li (1982) state that three of the Chinese species are similar to *C. japonica* [misspelled '*niponica*' on p. 186] and the other two to *C. usubai*. The Japanese species have been supposed to be allopatric, *C. usubai* occurring east of the range of *C. japonica* (Miyatake 1980). But further records, published and unpublished, suggest that they widely overlap each other in distribution. In fact, the material of *C. usubai* examined in this study was collected in Kyôto, far west of the supposed border line; *C. japonica* has recently been recorded by Usuba (1989) from out of the known range and on another plant, '*Celtis bungeana jessoensis*' (= *C. jessoensis*). Evidently our knowledge of the insects of this peculiar genus is still limited and too insufficient. Furthermore, in lerp-forming psylloids in general, lerp-formation and body structures associated with it have not yet been studied in detail.

The lerps of *Celtisaspis* are very similar in external appearance to the tests of *Conchaspis* (Coccoidea: Conchaspididae) and also to those of certain advanced forms of armoured scale insects (Coccoidea: Diaspididae). The senior author (Takagi 1992), however, has shown that there is a distinct difference in internal structure between the tests of *Conchaspis* and those of armoured scale insects.

In this paper are given results of scanning electron microscopy and of supplementary light microscopy on lerp-formation in *Celtisaspis usubai*. Observations on another lerp-forming psylloid, *Macrohomotoma* sp. from the Philippines, are also given for comparison. Information is given by means of photographs rather than by tedious descriptions.

Material

Leaves of *Celtis sinensis* with lerps of *Celtisaspis usubai* were collected in Kyôto (on the left bank of the Kamogawa) on October 3, 1989, and preserved dry. The leaves showed on the upper surface a low swelling opposite to each lerp formed on the undersurface. The lerps were empty or contained mummified last instar nymphs each with an irregularly shaped hole on the body wall (probably a parasite exit hole). It was assumed that the lerps, when collected, had been formed months before, because this species has 1 generation a year.

Leaves with lerps were put in a humid atmosphere (with creosote in a small open vial) for some days. The lerps were detached from the leaves and some mummies were taken out. Then the lerps and mummies were dehydrated in alcohol, critical point dried, and coated with gold for scanning electron microscopy. Other mummies were prepared for light microscopy.

Completed lerp

A completed lerp is white, nearly circular and gently convex dorsally. The dorsal surface shows several eccentric rings which may correspond to the alterations of instars (Fig. 1). The surface, when highly magnified, is largely made of an amorphous material forming a rugged surface (Fig. 2), with pieces of flat filaments exposed here and there (Fig. 3). The inner surface is a smooth wall, against which long and short pieces of filaments are appressed ; it is noteworthy that not all pieces of filaments are of the same width, some pieces being distinctly narrower (Fig. 4).

The ventral portion of the lerp is formed in a belt along the margin. In Fig. 5 the body of a mummified last instar nymph occupies a large space in the lerp, and the belt is broadest about the place where the posterior end of the body is applied. The belt is made of irregularly tangled lumps of the amorphous material mingled with filaments (Fig. 6).

In cross section the dorsal portion shows a number of filaments embedded in the amorphous material, which are mostly laid horizontally or nearly so (that is, in parallel to the dorsal and ventral surfaces of the lerp) (Figs. 7 and 8). At higher magnifications layers of the amorphous material can be recognized by the occurrence of many irregular horizontal lines or fissures, and filaments are, though often strewn individually, sometimes laid together (this will be shown in Fig. 20 in a growing lerp).

Fifth instar nymph

Mummified bodies of the 5th instar nymph have been observed in scanning electron microscopy and light microscopy. In this insect some apical segments of the abdomen are fused to form a caudal plate dorsally and an anal plate ventrally as usual in psylloids. (But these plates are not separated laterally from each other.) The anus is, however, not ventral on the 'anal plate' but opens at the posterior end of the abdomen, which is produced in the shape of a truncated triangle. There are on the caudal plate, in a broad lateral area on each side, a number of small tubercular processes, of which the top is flattened to make a disc. They are mostly curved to face posteriorly (though some are little or not curved). In scanning electron microscopy there are on the disc 5 fissures around a central one (Figs. 9–11). In light microscopy 5 round openings encircling a central one are observed, all these round openings corresponding to the fissures in the scanning electron microscopy. The processes are called '6-fissural disc pores' hereinafter. (The number of the fissures is somewhat variable, but it seems that normally the disc pores are 6-fissural.)

Formation of lerp

The completed lerp of *Celtisaspis usubai* is similar to the female tests of *Conchaspis* species (*C. garciniae*, *C. vaccinii* and *C. buchananiae*, all examined by Takagi 1992) in both external appearance and internal structure. Apparently the lerp is composed of a substance discharged from the anus and a waxy substance secreted from the 6-fissural disc pores in the form of flat filaments; the insect must move about when discharging the anal substance and secreting wax filaments, and press the lerp under formation on the inner wall. The completed lerp is only somewhat larger than the nymph within it (Fig. 5) in contrast to the *Conchaspis* tests, which are very large in comparison with the insect body. (But this does not necessarily mean that the *Conchaspis* tests are larger in absolute size.) Probably the nymph usually moves in a broad oscillation rather than in a complete rotation when forming the lerp, bringing about an eccentric pattern of growth on the dorsal surface of the lerp (Fig. 1).

In *Conchaspis* the organs secreting wax filaments are situated lateroventrally on the metathorax and some basal segments of the abdomen, whereas in *C. usubai* they are located laterodorsally on the caudal plate. Difference is more remarkable in the secretory organs themselves. In *Conchaspis* the organs are ducts, whereas in *C. usubai* they are elevated disc pores normally with 6 fissures. This difference especially deepens interest in the lerp-formation of *C. usubai*, requiring further study.

FURTHER OBSERVATIONS ON CELTISASPIS USUBAI

Material

Celtisaspis usubai nymphs and their lerps were collected in Kyôto (on the left bank of the Kamogawa and at a few other places) on April 28 (1st instar), June 5 (2nd to 4th instars) and June 14 (5th instar), 1991. They had been preserved in 70% alcohol until they were prepared for scanning electron microscopy.

Lerp in development

The covering made by the 1st instar nymph is an irregular net, which is fairly large in comparison with the insect body (Fig. 12). This net is apparently made of the supposed anal substance. It has not been confirmed whether wax filaments take part in the formation of the net (Fig. 13), though the 1st instar nymph can secrete wax filaments (Fig. 27). Lerps in later stages of formation also have a netlike structure on the top, apparently made during the 1st instar (Figs. 14 and 15).

The external appearance of the lerp is changed in the 2nd instar. The anal substance is now laid not to form a netlike structure but to make irregular masses (Figs. 14 and 16). On the inner wall abundant wax filaments are seen (Figs. 17 and 18). They show a prevailing running direction, suggesting rotative or oscillating movements of the insect body, but partly they are laid rather disorderly. In cross section growing lerps show the same pattern of the internal structure as observed in the completed lerp, with wax filaments embedded in the supposed anal substance (Fig. 19). At high magnification the successive accumulation of the anal substance is traceable by irregular horizontal fissures, and filaments are sometimes laid together somewhat like the sideboards of a crushed box (Fig. 20). Wax filaments are also seen beneath the insect body (Fig. 21).

Nymphs

All the 5 nymphal instars have been recognized in the material. The nymphs are remarkably different between the 1st instar and the succeeding ones in the shape of the body, in the setae of the caudal plate, in the opening of the anus, and in the secretory organs of wax filaments.

The 1st instar nymph is plump and nearly ovoid, with several pairs of prominent setae on the caudal plate (Fig. 22). In the succeeding instars the body is constricted between the thorax and abdomen, with many long setae on the caudal plate (Figs. 23 and 24).

In all the instars the posterior end of the abdomen is produced and the anus opens at its apex. However, in the 1st instar the anus is sclerotized to form a structure shaped like some vessel; the opening is directed dorsally, nearly deltoid, being pointed at the posterior end, and smooth on the margin (Fig. 25). In the succeeding instars the opening of the anus is directed posteriorly and densely fringed with spinous processes (Fig. 26).

In the 1st instar no 6-fissural pores have been recognized; instead, there is a pair of round buttonlike structures submarginally on the base of the caudal plate (Figs. 22 and 27). The 'button' is interpreted as a secretory organ, emitting wax filaments radially from around its margin in 2 stories (Fig. 27).

The 2nd to 5th instar nymphs all agree in having 6-fissural disc pores. These pores and their secretions are shown in Figs. 28-31. As stated in Preliminary observations these pores are normally provided with 5 fissures or secreting apertures occurring around a central one (termed 'surrounding fissures' and 'central fissure'). Each surrounding fissure secretes a flattened wax filament, and the filaments secreted from the surrounding fissures of a pore constitute a polygonal, normally pentagonal, tube. The central fissure also makes secretion, and it seems that it usually secretes a smaller tube composed of narrower filaments (in spite of its appearance of being a single aperture: Fig. 11) within the tube made by the surrounding fissures. The inner tube may be incomplete or even take another shape. In an observed case, for example, the secretion takes the shape of a Y in cross section (Fig. 28); this may be possible by a coalescence of filaments to be formed, normally, into a tube. The disc pores are mostly elevated to face posteriorly, so that the secreted tubes mostly grow posteriorly.

In light microscopy, not fissures but round openings are seen on the disc pores as figured by Yang and Li (1982) for Chinese species. However, the pores secrete flat filaments, which, being impressed on the surface with many fine striae running longitudinally and all in parallel (Fig. 31), appear to have been pressed flat when discharged. The fissures observed in scanning electron microscopy may represent the real state of the secreting apertures, and the round openings in light microscopy are apparently an artifact. If this interpretation is correct, however, the formation of the inner tube is mysterious, because the central fissure appears to be a single aperture. It may be assumed that the central fissure expands to a polygon when secreting filaments (compare Fig. 11 with Fig. 28), but this assumption is to be ascertained by further observations.

Nymphal features which may not be immediately related with lerp formation are excluded from this study. On this occasion, however, some dermal structures should be presented (Figs. 32-39). They may not be unrelated with lerp formation, because it is supposed that the insect, when forming the lerp, presses it on the inner wall probably with the dorsum. In fact, the derm is covered with granules and spinules and these are especially well developed on the dorsum (Figs. 32 and 34-37); the caudal and anal plates are covered with spinules of another type (Figs. 38 and 39).

Observations on *Macrohomotoma* sp.*

Material

Twigs of *Ficus benjamina* with lerps of *Macrohomotoma* sp. were collected in the grounds of the University of the Philippines at Los Baños, Laguna, Luzon Island, on Nov. 24, 1992. The material had been preserved in 75% isopropyl alcohol until lerps and nymphs were prepared for scanning electron microscopy. Some dehydrated nymphs were washed with chloroform in an ultrasonic cleaner before undergoing further treatments. Several nymphs were prepared for light microscopy.

Lerp

Lerps occur on the twig under the stipule, where they are formed one after another, making together a mass, which eventually grows out from under the narrow stipule. It is difficult to separate the mass into individual lerps without breaking them, because, while they are closely appressed together, each lerp is loosely constructed internally as will be shown below. When cut along the twig, the lerps except the anteriormost (formed in the depth of the space under the stipule) are formed obliquely, overlapping one another, with the nymph perching on the dorsal surface of the preceding lerp. Lerps are generally considerably large in comparison with the insect body.

No incipient lerps were available. However, growing lerps are covered with an irregular netlike structure, which is similar to the netlike covering made by the 1st instar nymph of *Celtisaspis usubai* (Fig. 40; compare with Figs. 13 and 15).

Lerps are made of an amorphous material and tubular filaments, the latter being round in cross section (Figs. 41 and 42). The amorphous material is laid in irregular layers, with tubular filaments more or less depressed and broken or remaining round in cross section and scattered here and there or placed together. The internal structure thus appears disorderly and coarse in texture. On the inner wall of the lerp long and short fragments of filaments are observed. The amorphous material

* Systematic and Ecological Surveys on Some Plant-parasitic Microarthropods in Southeast Asia, Scientific Report No. 19. This species could not be identified, because no adult insects were collected together with the lerp and nymph material. According to Mr Mario V. Navasero, University of the Philippines at Los Baños, *Macrohomotoma apsylloides* [=*Pauropsylla apsylloides* Crawford 1919] occurs on *Ficus benjamina* in the grounds of the university (personal communication).

should come from the anus and the tubular filaments should be made of waxy substance secreted by pores of some kind.

Nymphs

Nymphs collected from under the lerps are interpreted to belong to the 3rd to 5th instars. Here photographs of the final instar nymph alone are presented (Figs. 43–51). In this instar a number of remarkable processes are seen on the caudal plate (Fig. 43). However, they are not pores but thickened setae (Fig. 44) and there are no other processes on the dorsal side.

The anal plate bears the anus near the posterior end, and the derm is plicate rather complicatedly around the anus (Figs. 45–47). There is on the anal plate a remarkable structure, which may be identified with the 'circumanal pore ring' occurring in many other psylloids. In this species, however, the 'ring' extends far laterally, forming a pair of aliform fields (Figs. 45 and 48). Each of these fields is composed of a surrounding belt bearing a number of large and small pores and another belt occurring immediately inside the pore belt. There are on the inner belt a number of small spots, which show a ramified pattern inside and are arranged in rows (Figs. 48–50). The pore belts of both the fields are not closed at their mesal ends but connected together by their extended belts, which run anteriorly and posteriorly to the anus; the aliform fields thus form a complete 'circumanal ring' (Figs. 46 and 47). Apparently the pore belt is responsible for the production of tubular filaments; it seems that both large and small pores secrete tubular filaments (Fig. 51). However, no particular structure has been found inside the pore in both scanning electron microscopy and light microscopy. The function of the inner belt is unknown; the spots on it do not appear to be secretory organs.

The central area of the aliform field is wrinkled in a complicated manner (Figs. 48 and 49). It is also noteworthy that the derm of the anal plate makes a fold along the anterior margin of the aliform field (Fig. 48). These structures may have some functions, which are, however, only to be assumed in the present study.

In the supposed 3rd and 4th instar nymphs the abdomen is produced apically, but the anus is situated on the anal plate at some distance from the apex as in the 5th instar nymph. The aliform fields of both sides are not connected together through their pore belts, which are absent around the anus (thus the fields do not constitute a 'circumanal ring'). They are simpler in structure, too, the pores being uniform in size and the 'central area' being absent (in the 3rd instar) or only narrowly developed (in the 4th instar).

Concluding discussions

The primary purpose of this study was to make a comparison between the psylloids and some coccoids, especially of the genus *Conchaspis*, in the formation of their coverings. The lerp of *Celtisaspis usubai* and the tests of *Conchaspis* species are similar in both external appearance and internal structure. In the supposition here adopted they are made of a substance discharged from the anus. Flattened wax filaments are also secreted and 'crushed into fragments to be mingled with the anal substance just like pieces of aggregate mixed with cement to make concrete' (Takagi 1992). In all these respects, there is no essential difference between the

Celtisaspis lerp and the *Conchaspis* tests.

It is quite impressive, therefore, that the organs secreting wax filaments are utterly different between *Celtisaspis* and *Conchaspis*. In *Conchaspis* the organs are ducts situated lateroventrally on the metathorax and basal segments of the abdomen, each of them secreting a single piece of filament. *Celtisaspis usubai* has elevated disc pores on the caudal plate (that is, dorsally), and each pore produces a polygonal (normally pentagonal) tube composed of filaments secreted individually from the 'surrounding fissures'. What seems most surprising is the presence of an inner secretion made usually in the form of a complete or incomplete polygonal tube. It has not been confirmed (owing to the limited material) whether the inner tube is formed along the whole length of the outer or not. In any case, all these outer and inner tubes, when applied to the lerp under formation, are crushed flat or disjointed into individual filaments and broken into fragments. These elaborate tubes are constructed simply to be broken ! In the present state of our knowledge it is difficult to explain from a functional viewpoint why polygonal tubes, and double ones, should be constructed first in forming the lerp.

The meaning of this construction—double compound tubes— may not be functional but phylogenetic. In other words, wax-secreting organs may be useful in working on the phylogeny of the Psylloidea. (There are many psylloids which do not form coverings but secrete waxy filaments.)

This supposition is supported by the observations on the *Macrohomotoma* species. This species also forms a similar lerp, but its wax-secreting organs are quite different again and it seems hardly possible to regard them as homologous with the disc pores of *Celtisaspis usubai*. Indeed, *Celtisaspis* and *Macrohomotoma* belong to different families, the Spondyliaspididae and the Homotomidae, in the current system of classification. It may, therefore, be expected that an extensive study of the wax-secreting organs will eventually support the recent shift of the main groups (subfamilies) of jumping plant lice up to the family rank.

In *Celtisaspis usubai* the disc pores occur on the dorsal side of the body. This is natural for organs responsible for the formation of a dorsal covering. *Macrohomotoma* differs from *Celtisaspis* and agrees with *Conchaspis* in having the wax-secreting organs on the ventral side. It was assumed that *Conchaspis* bends up the abdomen and apply the ventral surface to the test under formation, thus supplying wax filaments to the test (Takagi 1992). Because in *Macrohomotoma* the organs are located near the end of the abdomen, much more posteriorly than in *Conchaspis*, it is less difficult to imagine how wax filaments are supplied to the dorsal covering. It should be added that, in the alcohol-fixed material, nymphs were found perching with their own lerps dorsally.

The lerp of *Macrohomotoma* differs from that of *Celtisaspis* in its texture being rough and coarse. The wax filaments are tubes, and their cross sections in the lerp are often round, thus with no trace of being crushed. The final instar nymph has many strong spinous setae on the caudal plate, but there are no other particular processes dorsally ; the 3rd and 4th instar nymphs also have no processes on the dorsal surface except for scattered setae. On the other hand, the lerp of *Celtisaspis usubai* is fine and compact in texture, requiring pressure from the inside (that is, by the insect body) during its formation, and the nymphs are covered with numerous processes dorsally. The tests of *Conchaspis* also require pressure during their formation, and the insect body is provided with 'dorsal spots', structures particular to the family. In the present state of our knowledge, however, the suggested relation between these dermal structures and the covering-formation is no more than speculation. The aliform fields in the final instar *Macrohomotoma* nymph, with the central areas complicatedly wrinkled and with the anterior margins situated along dermal folds of the anal plate, also may have some behaviour when applying tubular filaments to the lerp.

The coverings of these psylloids and coccoids are similar in their gross external appearance and agree in the use of the supposed anal substance mixed with pieces of wax filaments. This convergence of the coverings among the different homopterous groups with the different wax-secreting organs may well suggest the adaptive significance of this type of covering. Yet these insects form only small minorities in the superfamilies Psylloidea and Coccoidea. The senior author (Takagi 1992) once has asked himself why the Conchaspididae are so poorly represented, and thought that their tests, being made of the amorphous anal substance (mixed with fragments of wax filaments in many species), cannot assume diverse shapes and thus have led the group to a back alley of evolution.

In the Australian Region, however, lerp-forming psylloids are well represented in the family Spondyliaspididae and form a variety of lerps. Some lerps are of latticelike construction; others are lacelike and especially delicate; laminate lerps sometimes bear elaborate ornamentation; basketlike lerps are also variable in shape; corniculate lerps are with or without laciniate margins (Taylor 1962 and 1987). Of what material are these lerps made and in what manner are they formed? Is there any essential difference in lerp-formation between the Australian Spondyliaspididae and the examined *Celtisaspis* and *Macrohomotoma* species?

In this connection it should be mentioned that in *Celtisaspis usubai* the 1st instar nymph differs from the nymphs of the succeeding instars in making a netlike covering and in the anus shaped into a vessel-like structure with the opening directed dorsally. The net it makes is rough and crude and quite different from the delicately constructed lacelike and latticelike lerps of Australian psylloids, but all these lerps, being various types of net, may have some common aspects in their formation.

In conclusion, coverings of homopterous insects and their formation are worthy of detailed study from the viewpoint of adaptation and phylogeny. But any evolutionary explanation would be no more than an *ad hoc* one without extensive inquiries on them.

ACKNOWLEDGEMENTS

The *Macrohomotoma* material was collected by the senior author in the Philippines under the project 'Systematic and Ecological Surveys on Some Plant-parasitic Microarthropods in Southeast Asia'. He takes this opportunity to express his thanks to staff members and students of the Department of Entomology and the Natural History Museum, the University of the Philippines at Los Baños, who cooperated with him and helped him in various ways. He is especially thankful to Dr Venus J. Calilung for her coordination for the surveys, and to Dr Edwino S. Fernando and Dr J. Rojo for their identifying host plants of the *Macrohomotoma* species and many scale insects. Mr Mario V. Navasero gave him information as to the occurrence of *Macrohomotoma apsylloides* in the Philippines.

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PLATES

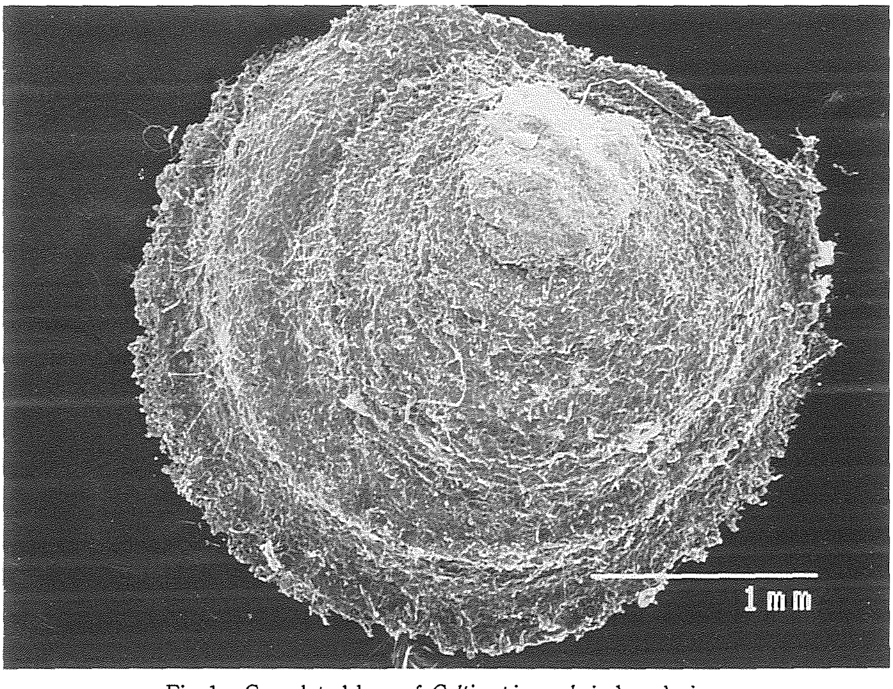

Fig. 1. Completed lerp of *Celtisaspis usubai*, dorsal view.

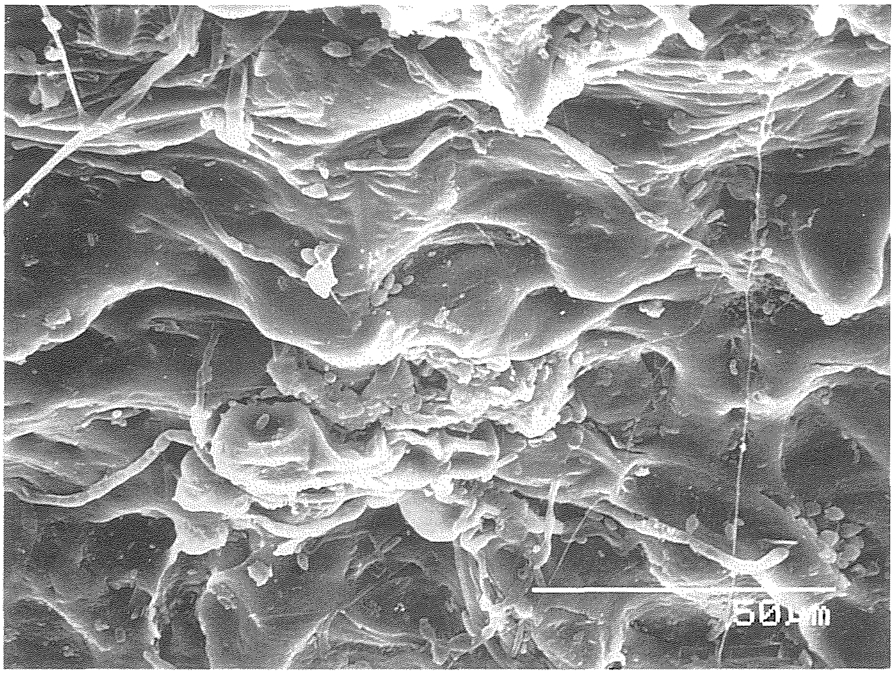

Fig. 2. Part of Fig. 1.

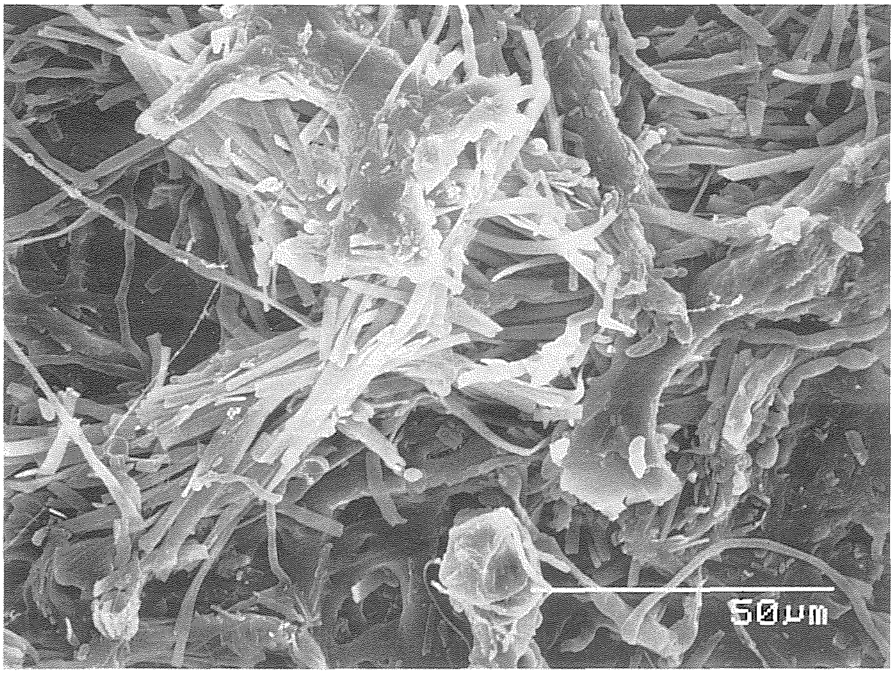

Fig. 3. Part of Fig. 1.

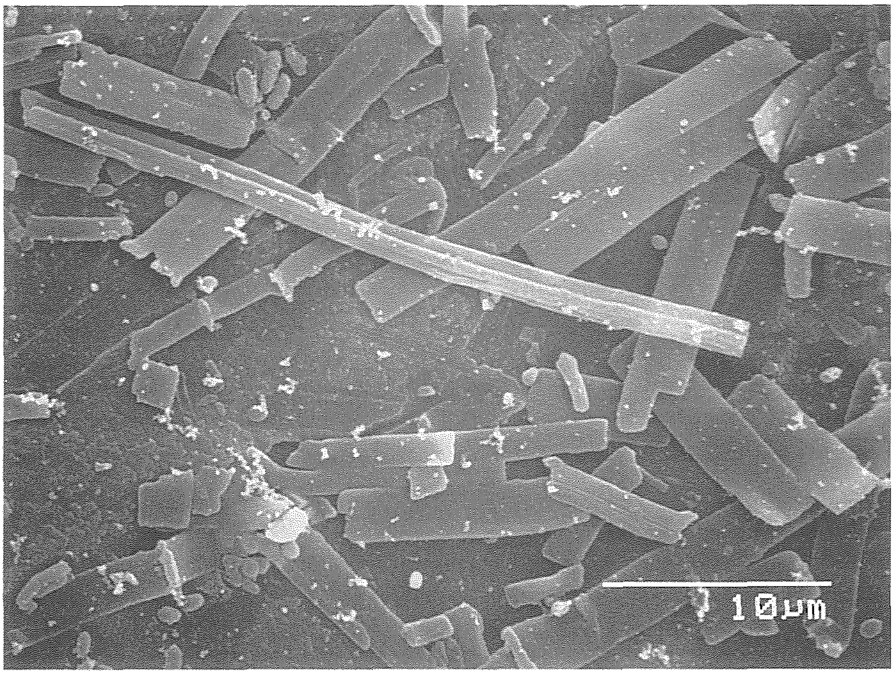

Fig. 4. Lerp of *Celtisaspis usubai*, part of inner surface.

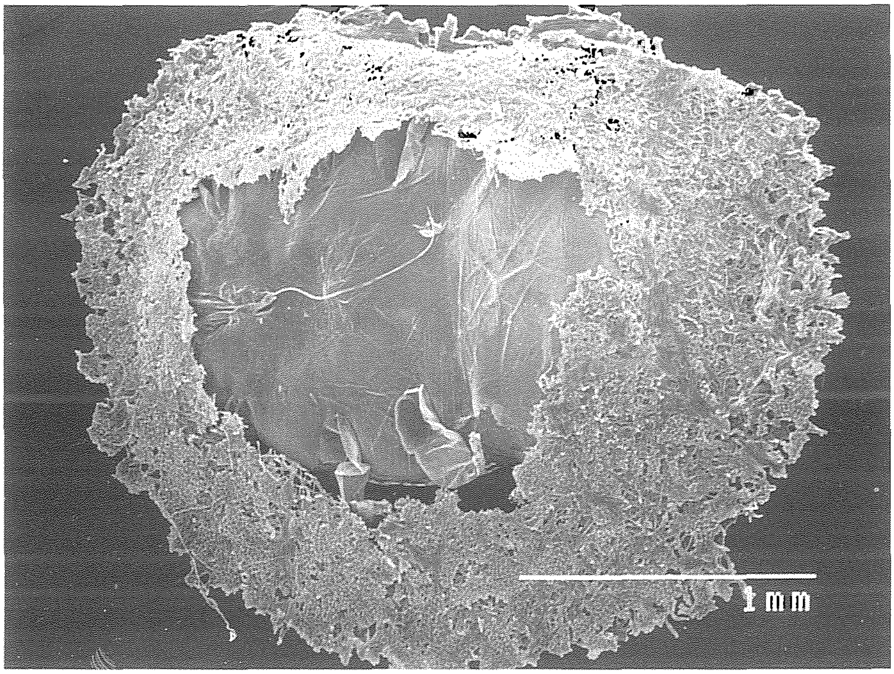

Fig. 5. Lerp of *Celtisaspis usubai*, ventral view, with a mummified nymph of 5th instar.

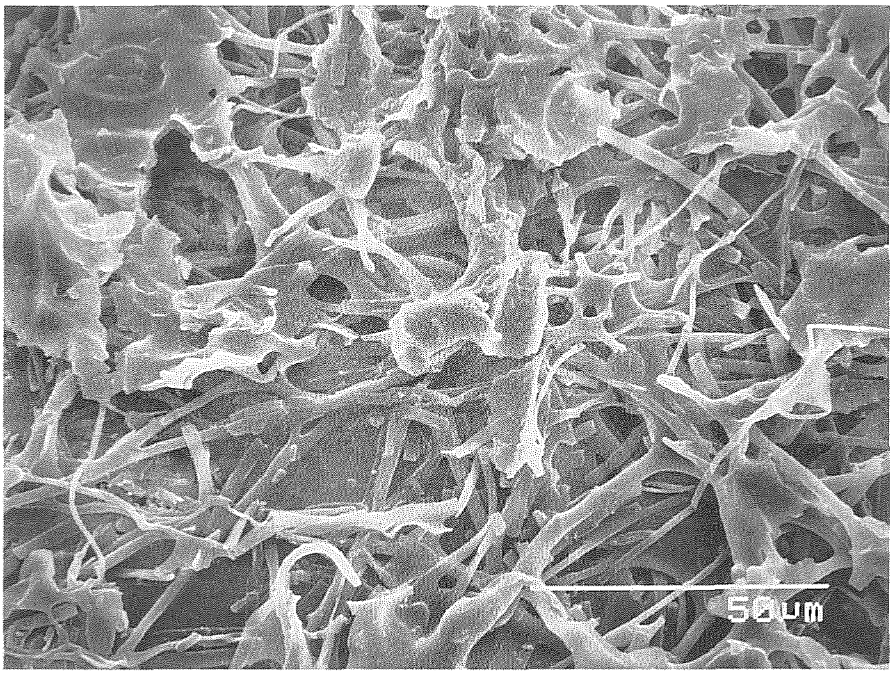

Fig. 6. Lerp of *Celtisaspis usubai*, part of ventral portion.

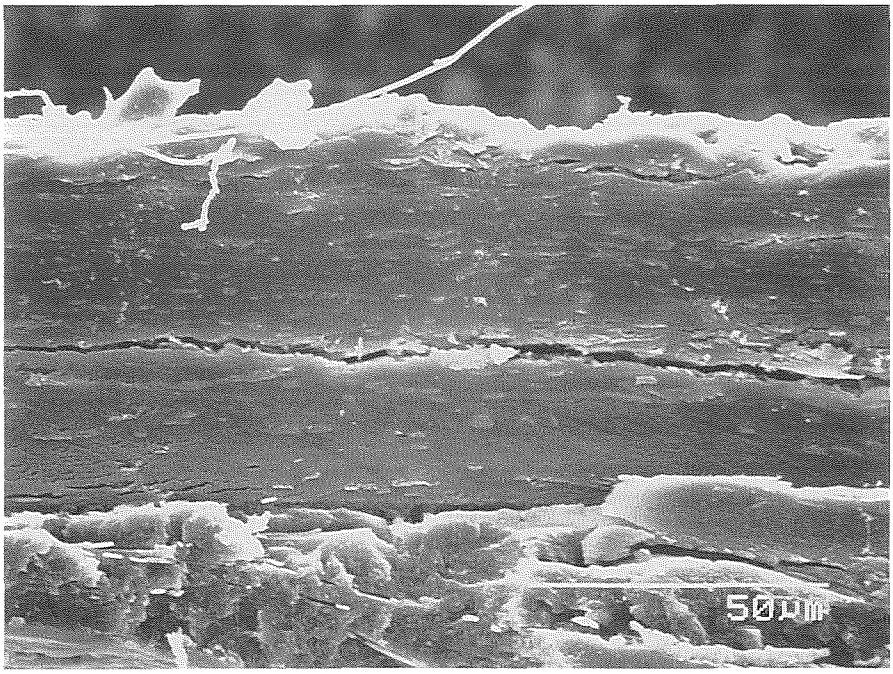

Fig. 7. Lerp of *Celtisaspis usubai*, part of a cross section.

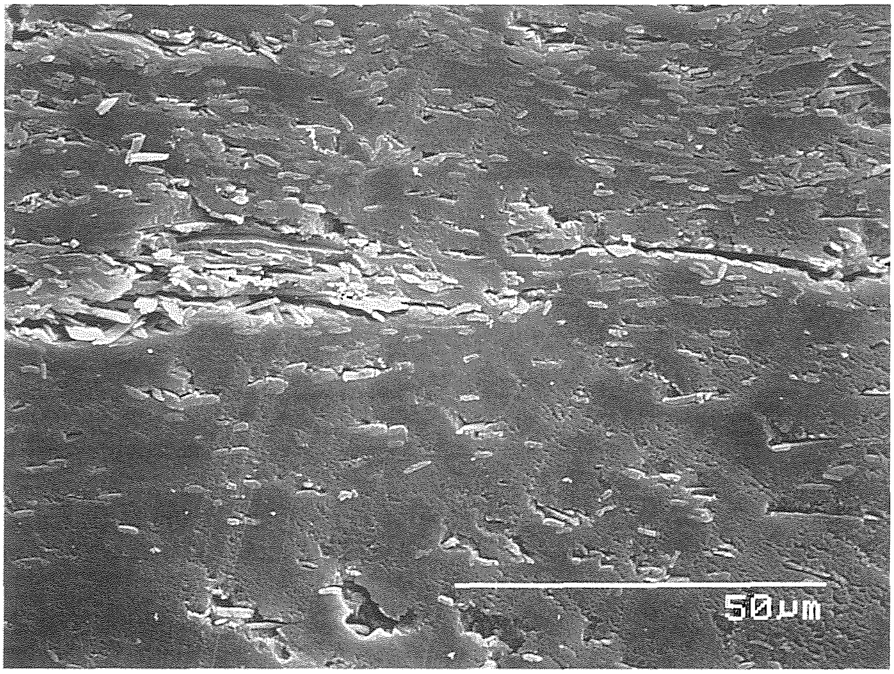

Fig. 8. Same cross section as shown in Fig. 7, another part more magnified.

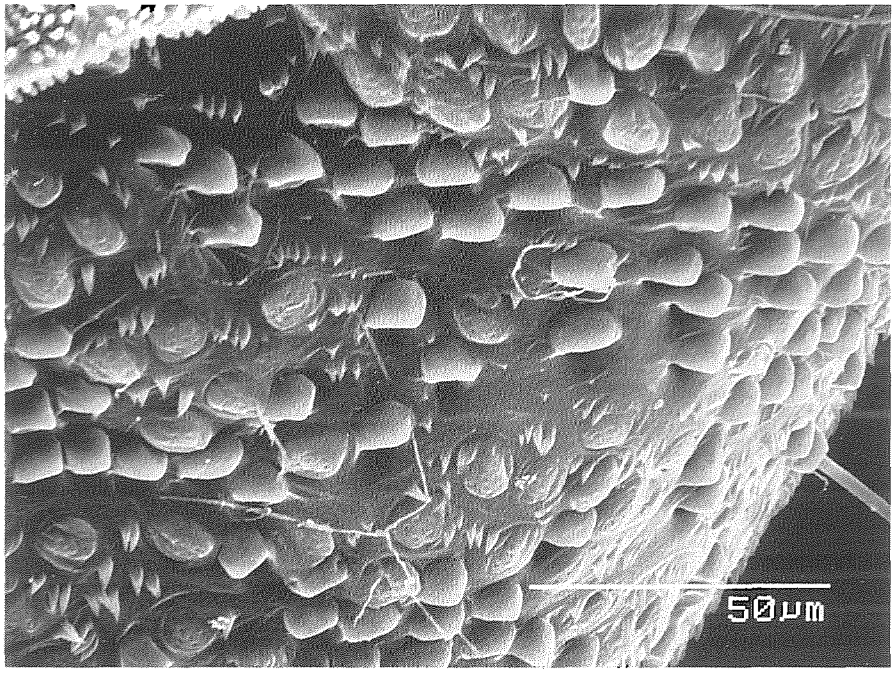

Fig. 9. Mummified nymph of 5th instar of *Celtisaspis usubai*, part of caudal plate, showing 6-fissural disc pores.

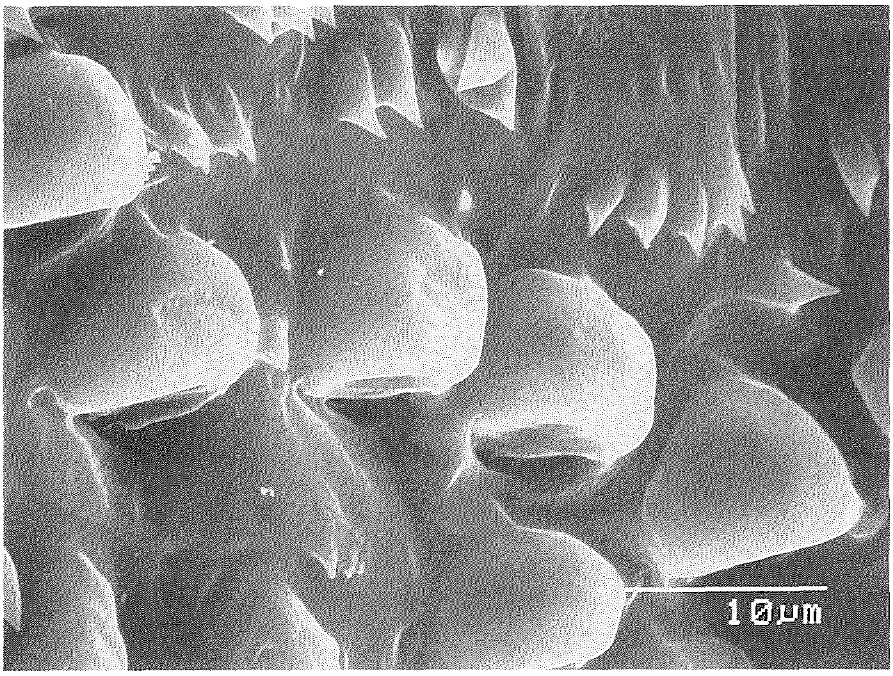

Fig. 10. Part of Fig. 9.

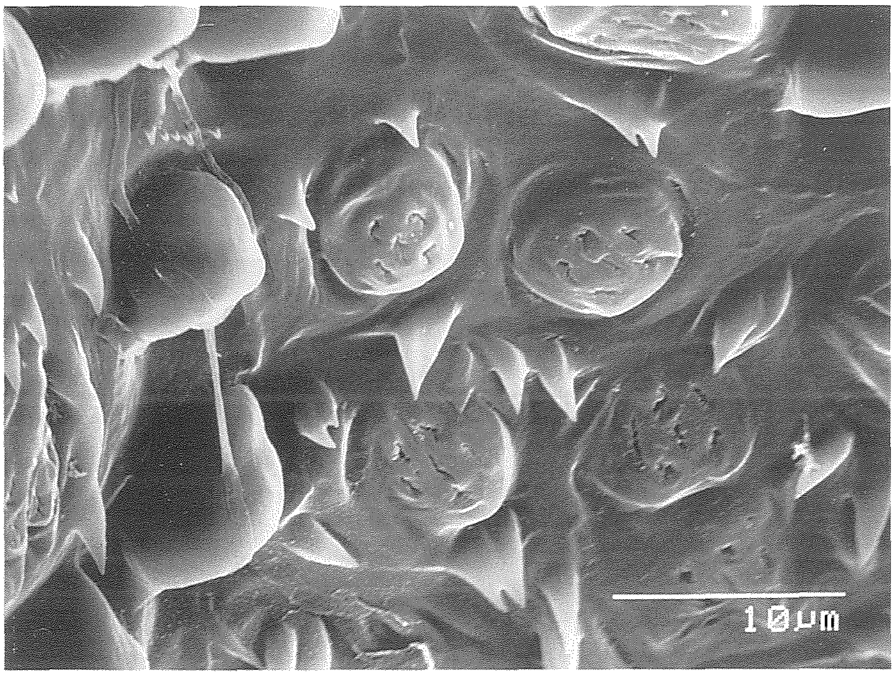

Fig. 11. Part of Fig. 9.

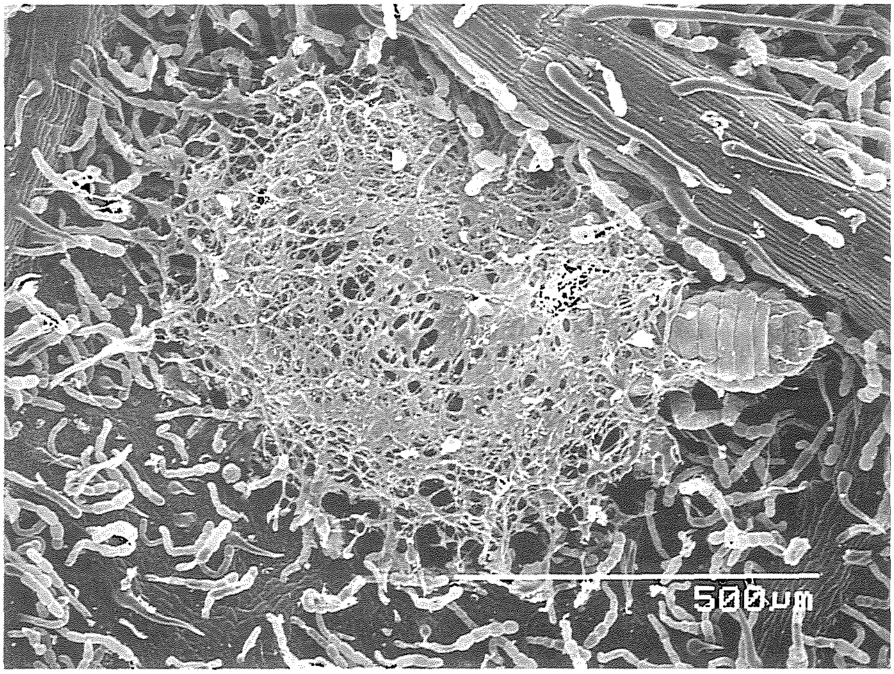

Fig. 12. First instar nymph of *Celtisaspis usubai* and its covering.

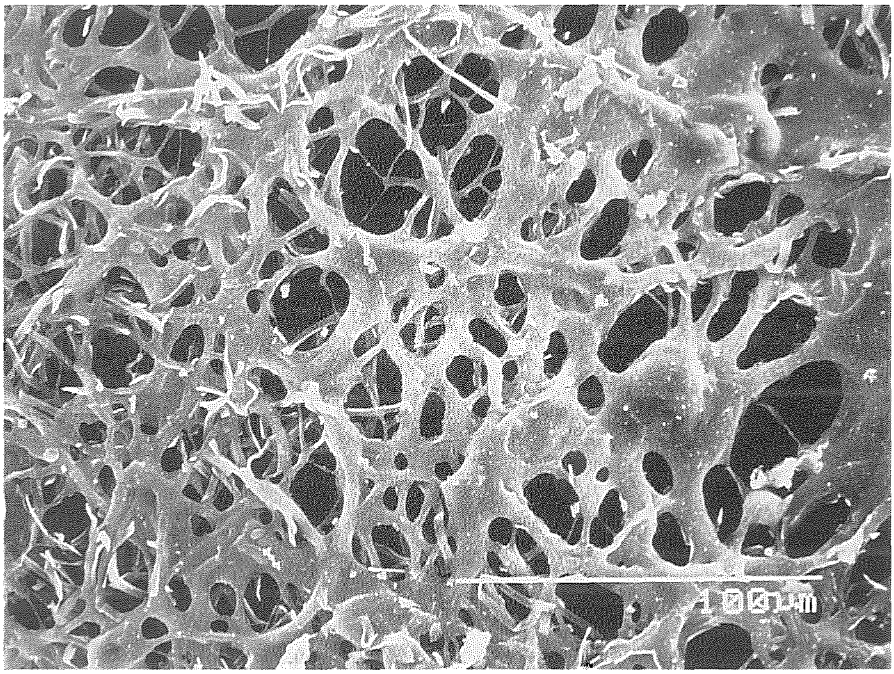

Fig. 13. Part of Fig. 12, showing part of netlike covering.

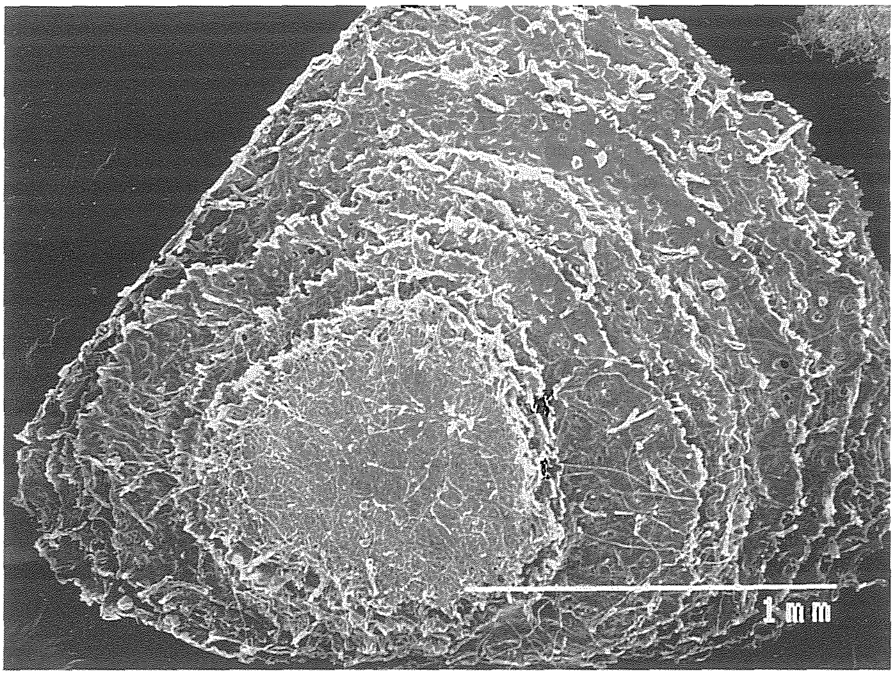

Fig. 14. Lerp of *Celtisaspis usubai* under formation by a 3rd instar nymph.

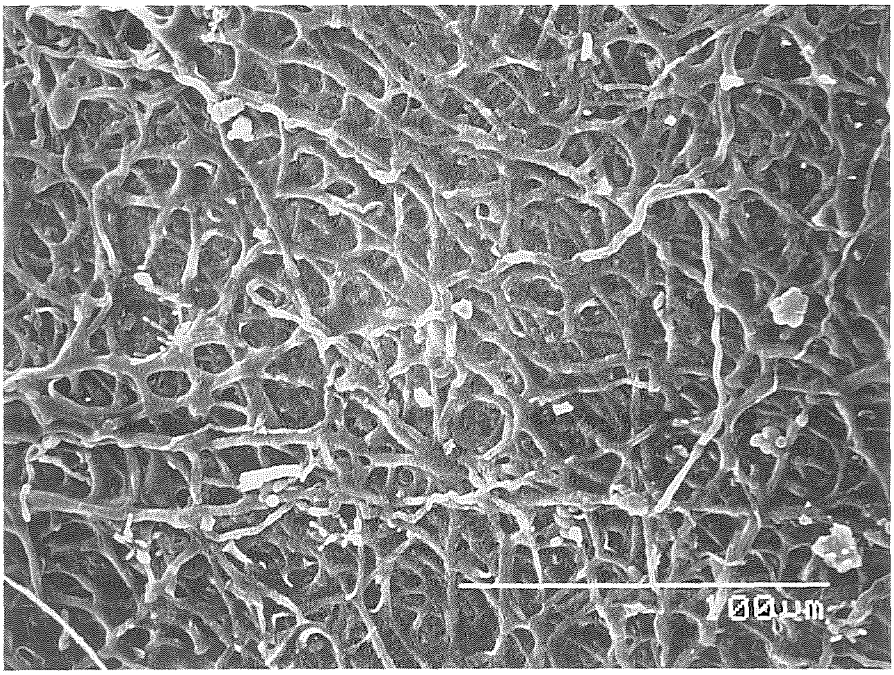

Fig. 15. Part of Fig. 14, showing netlike structure at top of lerp.

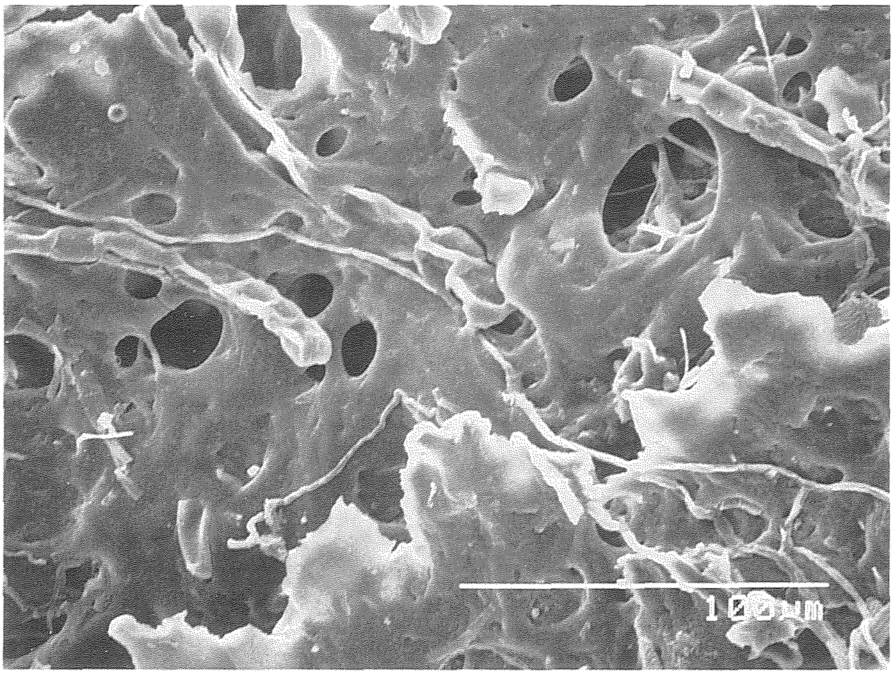

Fig. 16. Part of Fig. 14, showing part of lerp formed during 2nd instar.

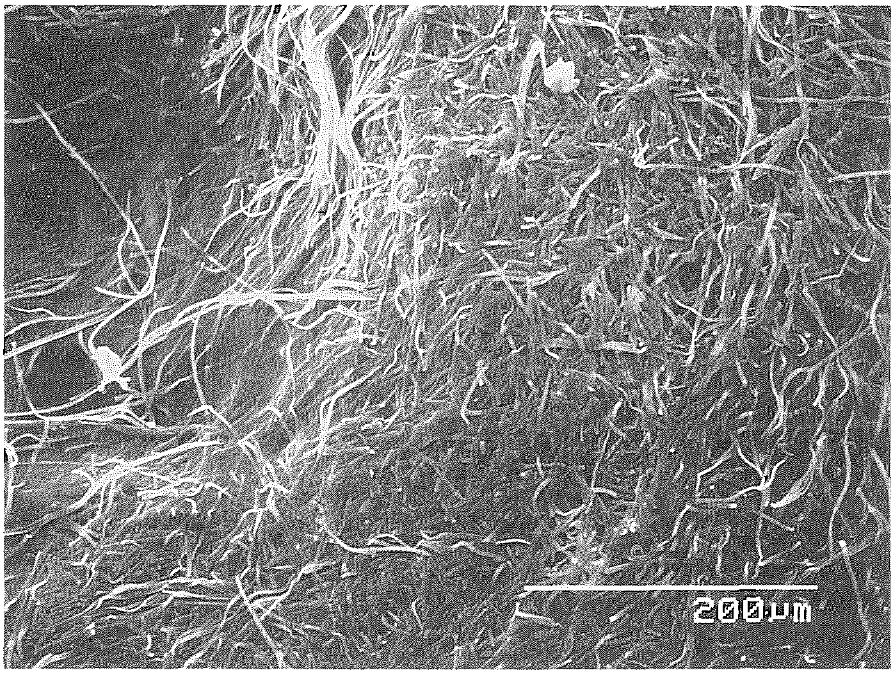

Fig. 17. Lerp of *Celtisaspis usubai* under formation by a 3rd instar nymph, part of inner surface. Top of lerp in left upper corner of picture.

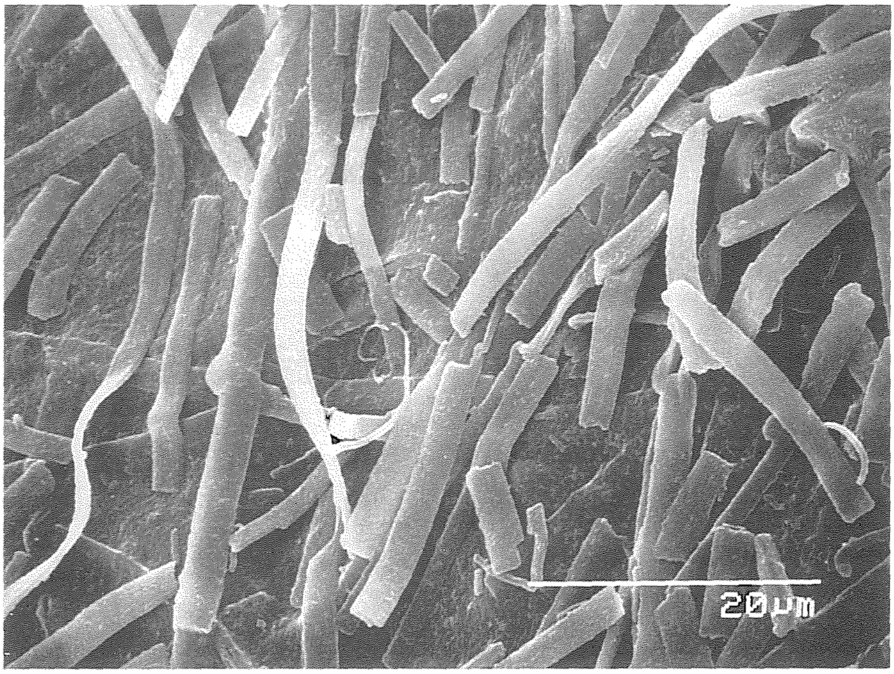

Fig. 18. Same lerp as shown in Fig. 17, part of inner surface, showing pieces of filaments.

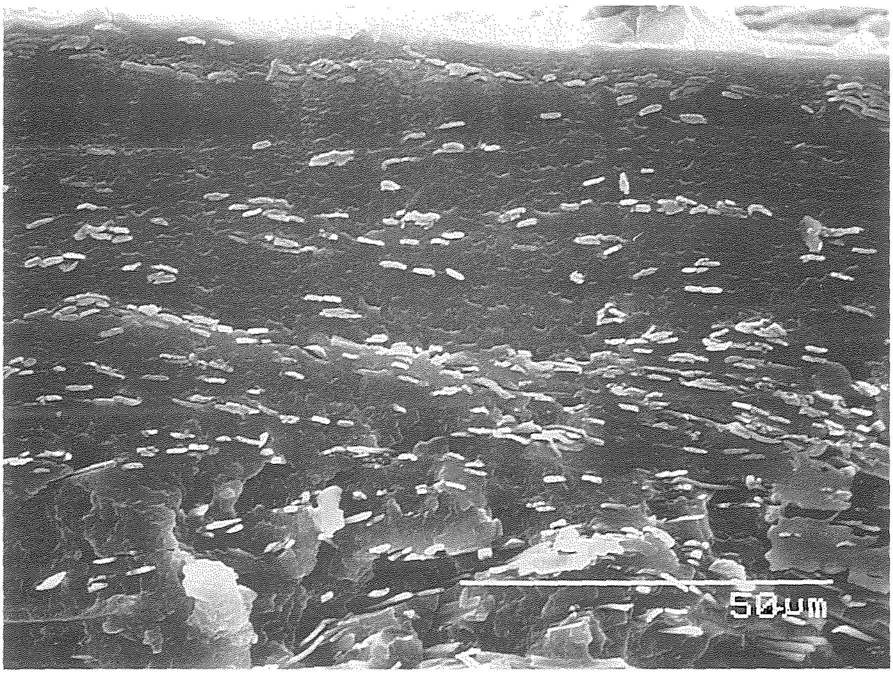

Fig. 19. Lerp of *Celtisaspis usubai* under formation by a 4th instar nymph, part of a cross section.

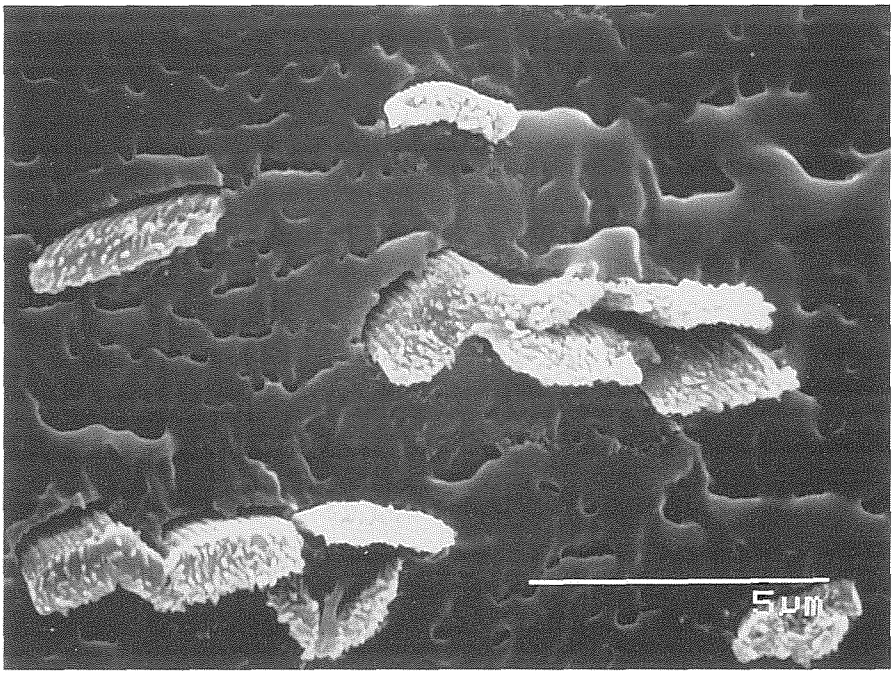

Fig. 20. Part of Fig. 19.

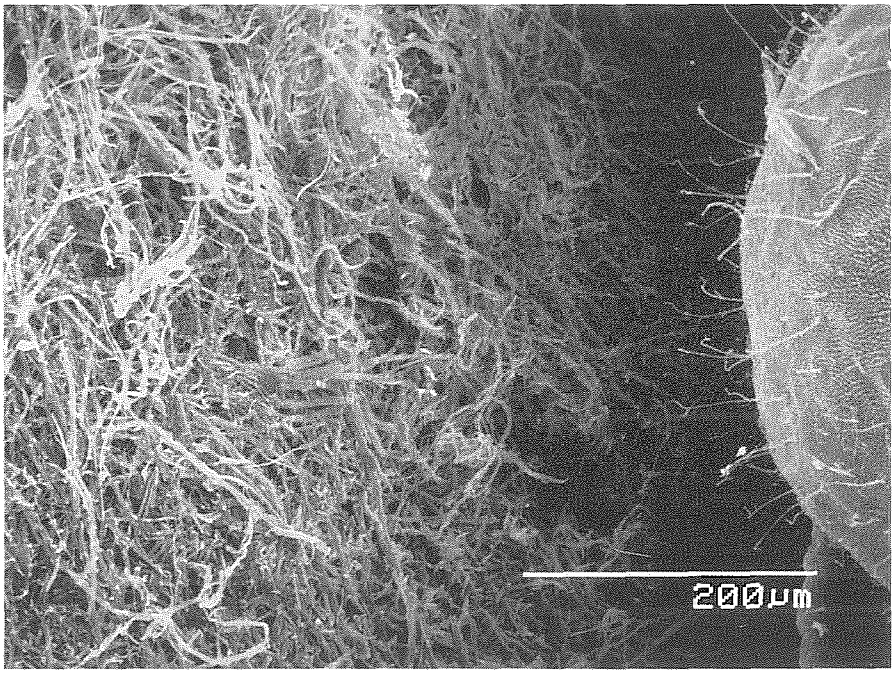

Fig. 21. Long wax filaments laid beneath insect body in a lerp of *Celtisaspis usubai* under formation by a 3rd instar nymph. Head of nymph on right margin of picture.

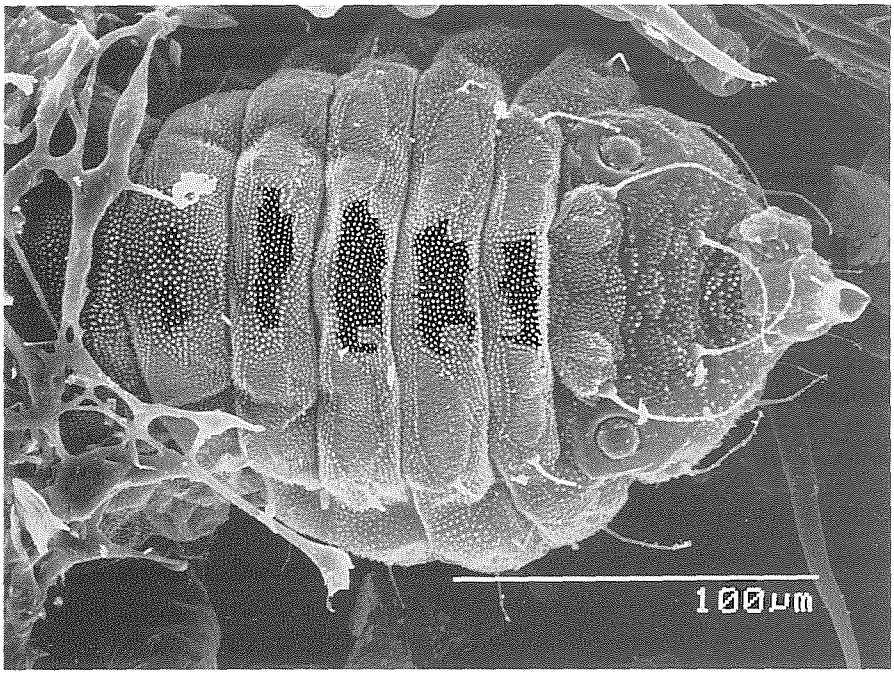

Fig. 22. Part of Fig. 12, showing first instar nymph of *Celtisaspis usubai* in dorsal view.

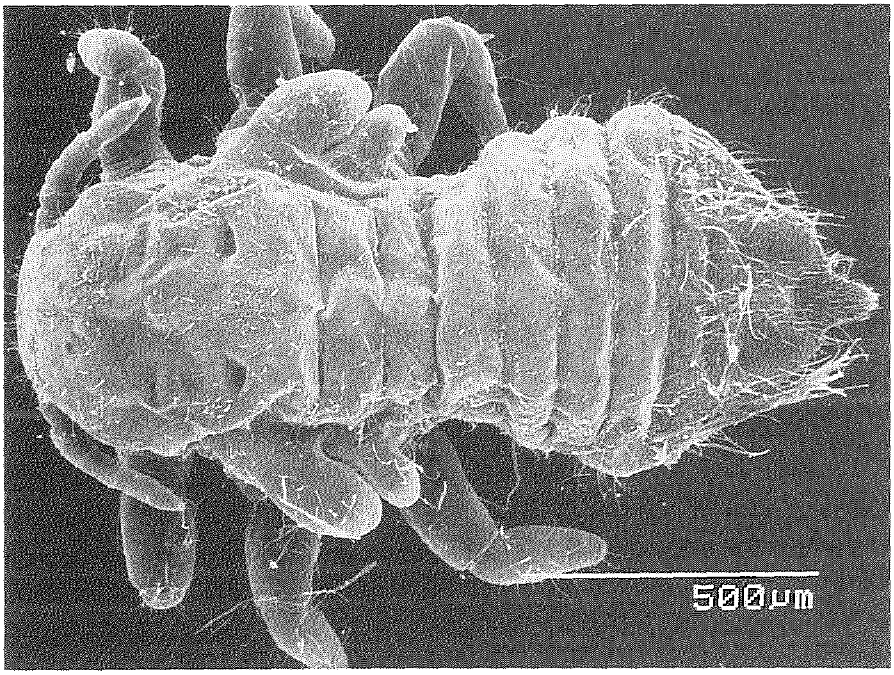

Fig. 23. Third instar nymph of *Celtisaspis usubai*, dorsal view.

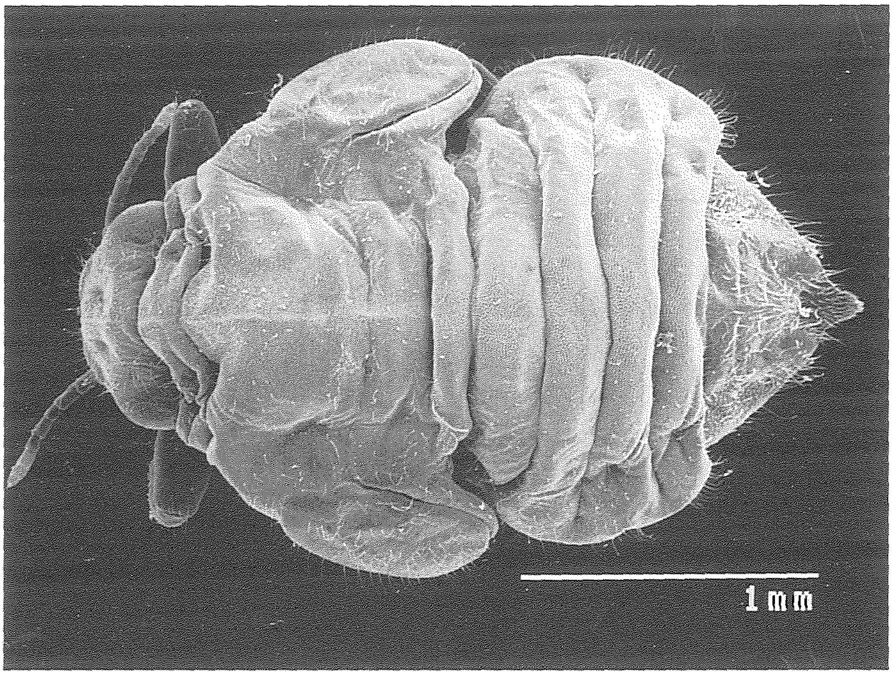

Fig. 24. Fifth instar nymph of *Celtisaspis usubai*, dorsal view.

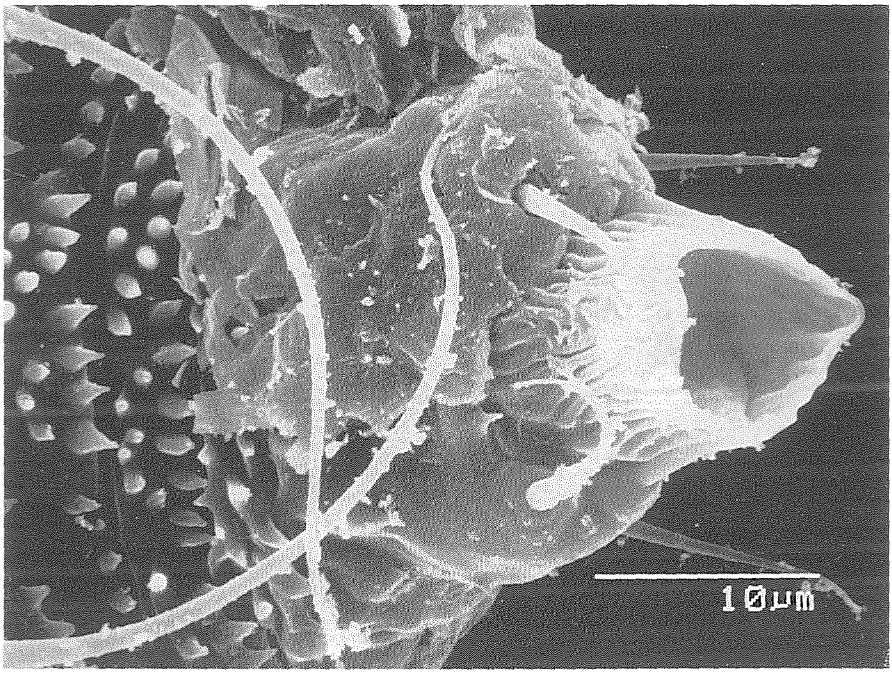

Fig. 25. Part of Fig. 22, showing anus of 1st instar nymph.

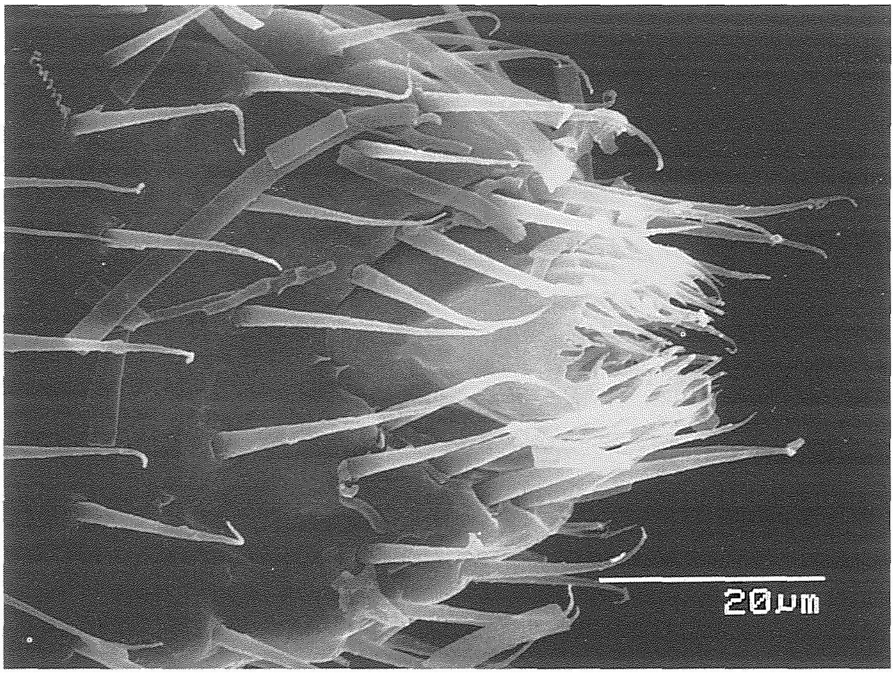

Fig. 26. Part of Fig. 23, showing anus of 3rd instar nymph.

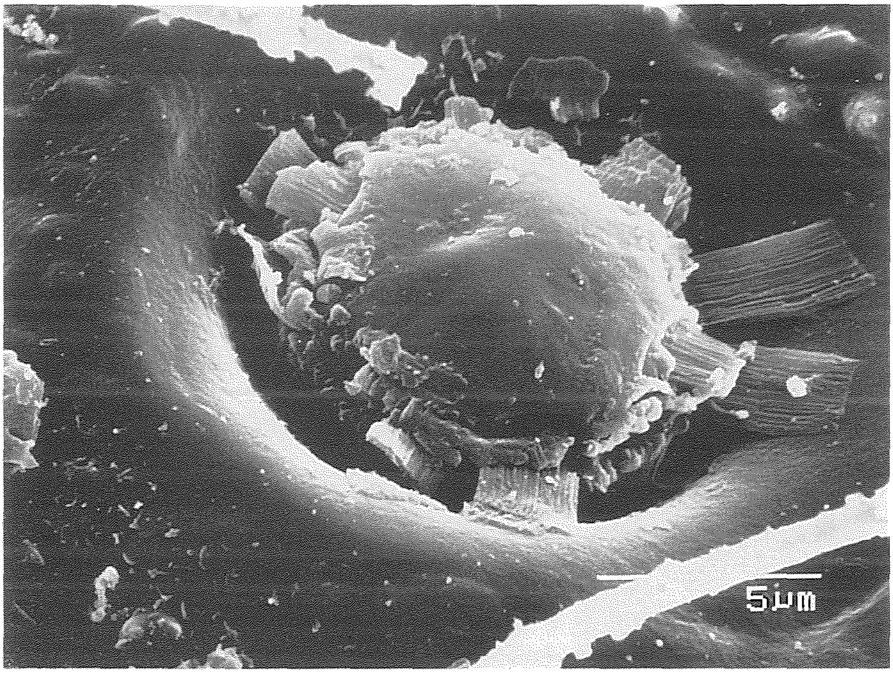

Fig. 27. Part of Fig. 22, showing 'buttonlike structure' of 1st instar nymph.

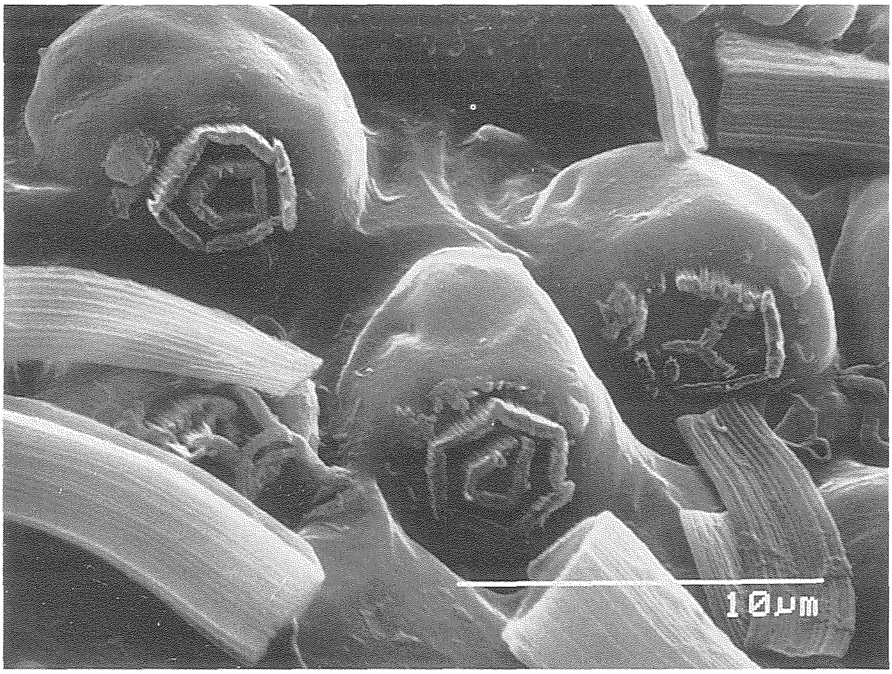

Fig. 28. Part of caudal plate of 4th instar nymph of *Celtisaspis usubai*, showing 6-fissural disc pores secreting outer and inner tubes made of wax filaments.

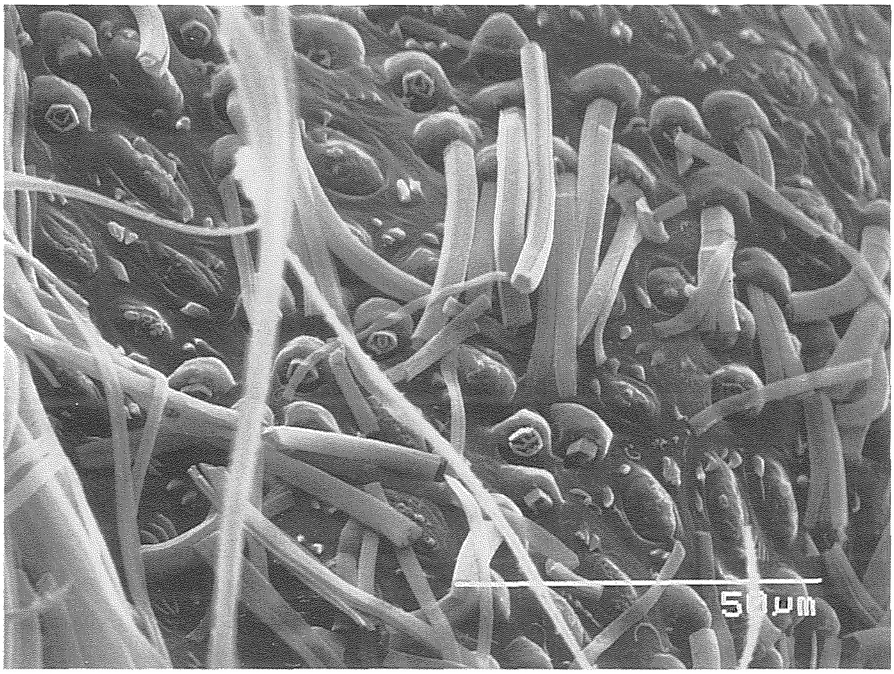

Fig. 29. Same caudal plate as shown in Fig. 28, showing disc pores and wax tubes.

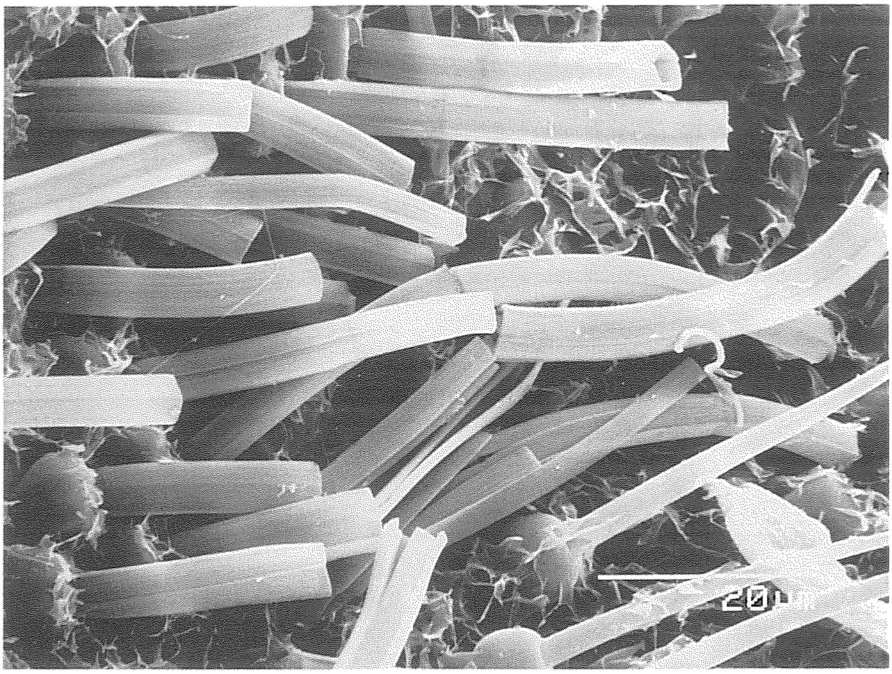

Fig. 30. Part of Fig. 24, showing wax tubes.

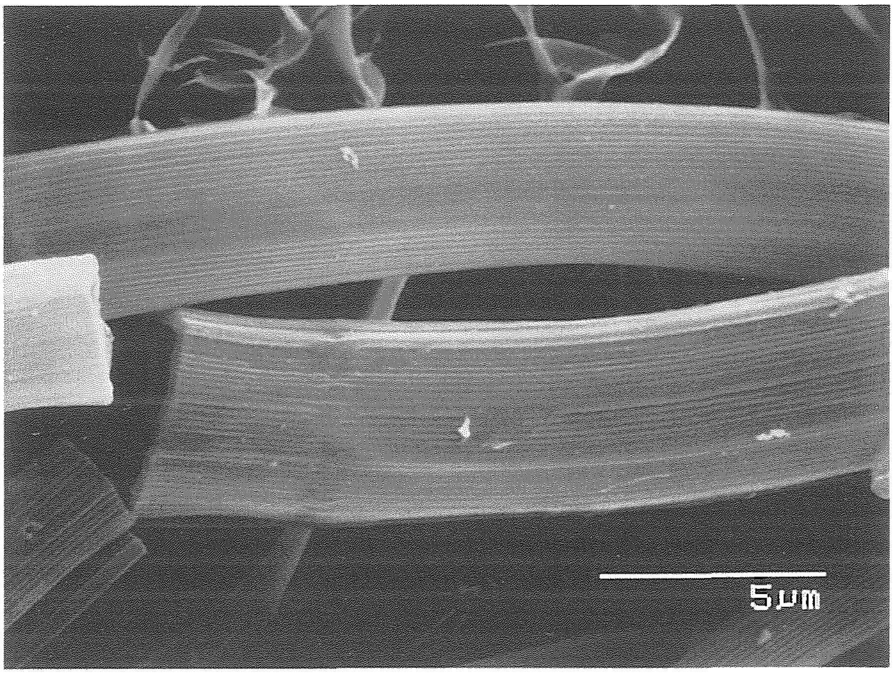

Fig. 31. Part of Fig. 30, showing wax tubes.

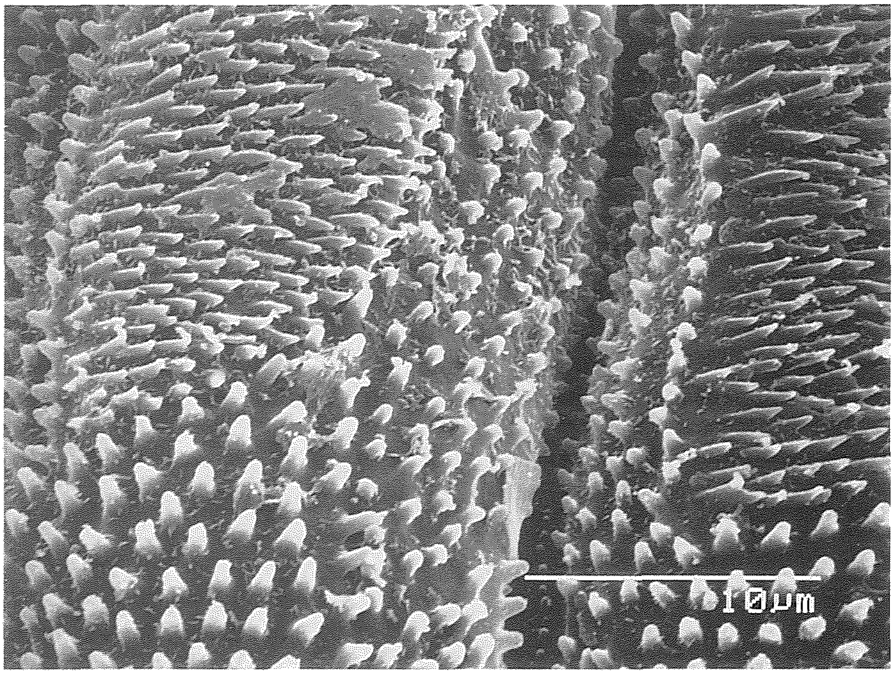

Fig. 32. Part of Fig. 22, showing dorsal processes of 1st instar nymph.

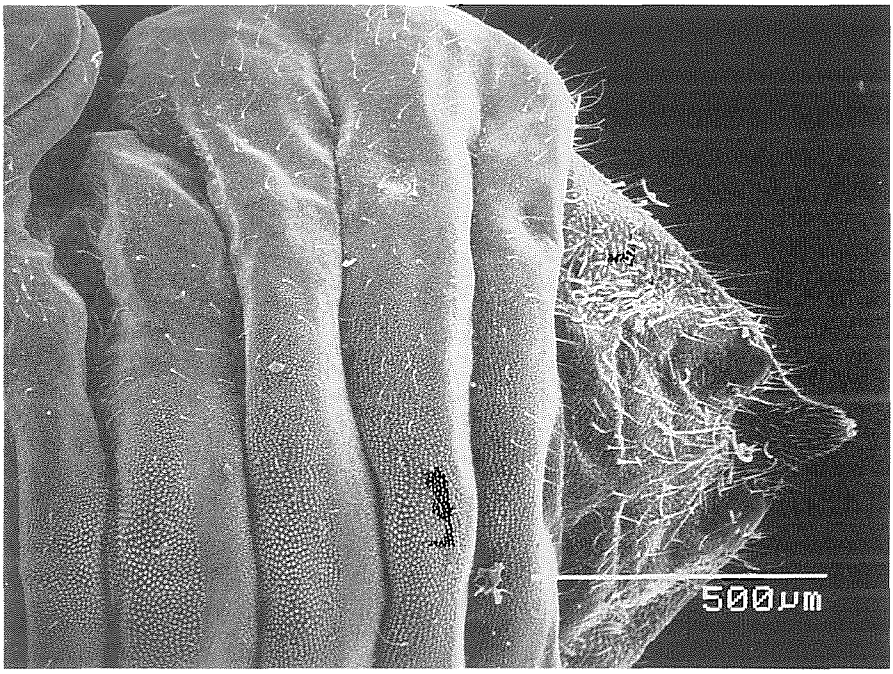

Fig. 33. Part of Fig. 24, showing dorsal surface of abdomen of 5th instar nymph.

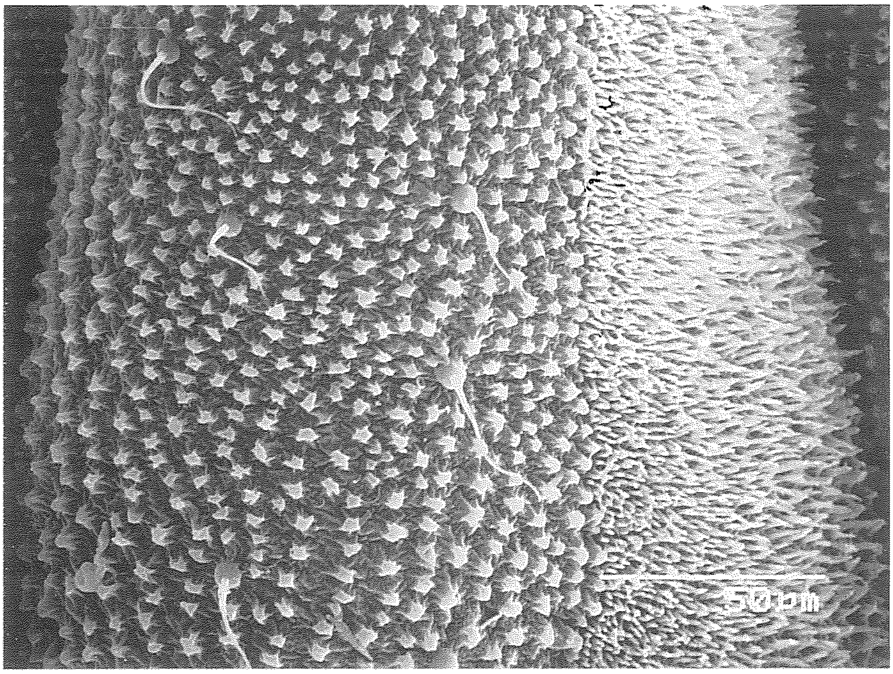

Fig. 34. Part of Fig. 33, showing dorsal processes (granules and spinules) on 3rd abdominal segment.

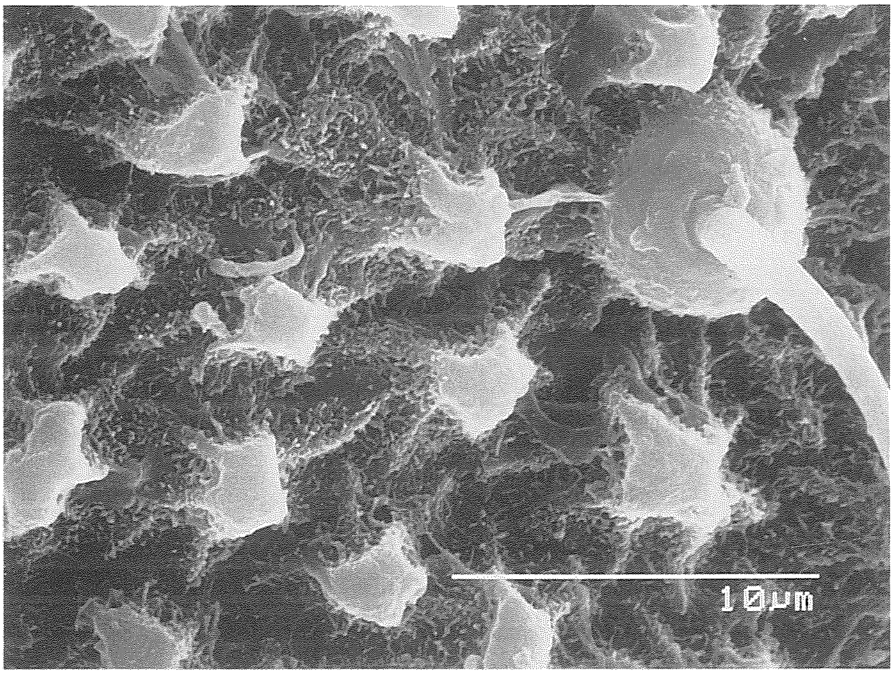

Fig. 35. Part of Fig. 34, showing granules.

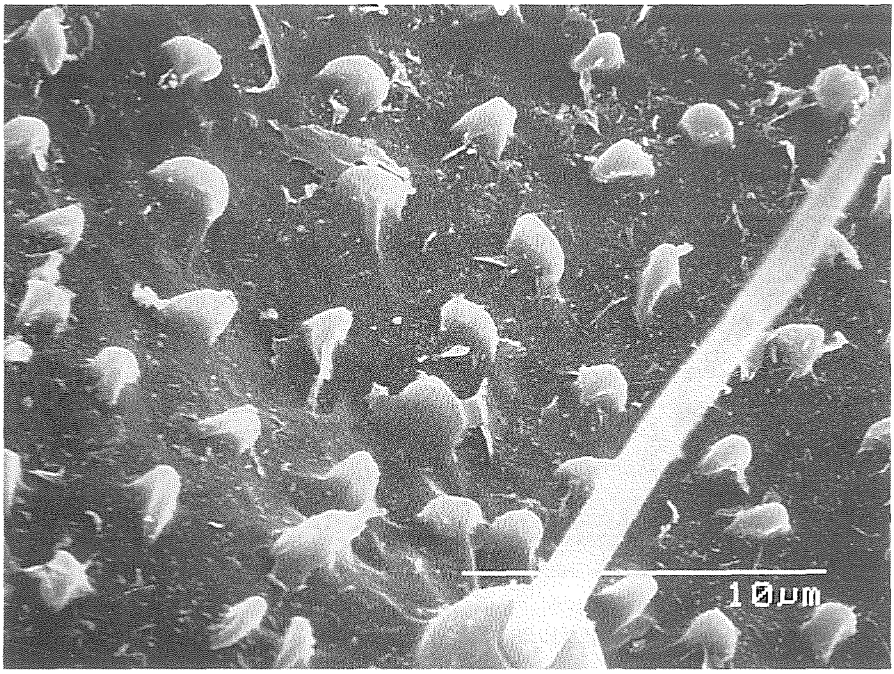

Fig. 36. Part of Fig. 33, showing granules on lateral area of 3rd abdominal segment.

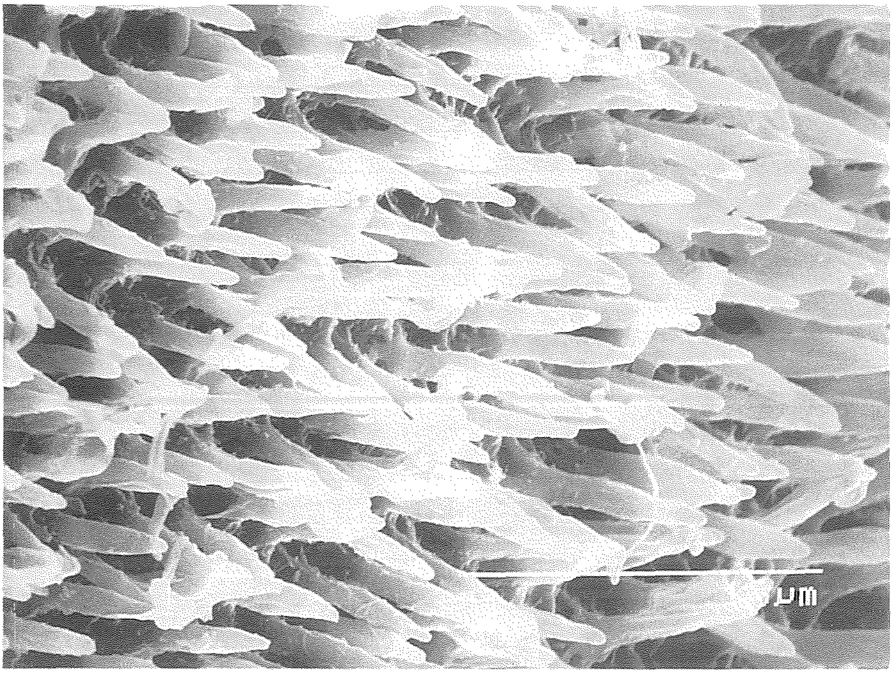

Fig. 37. Part of Fig. 34, showing spinules.

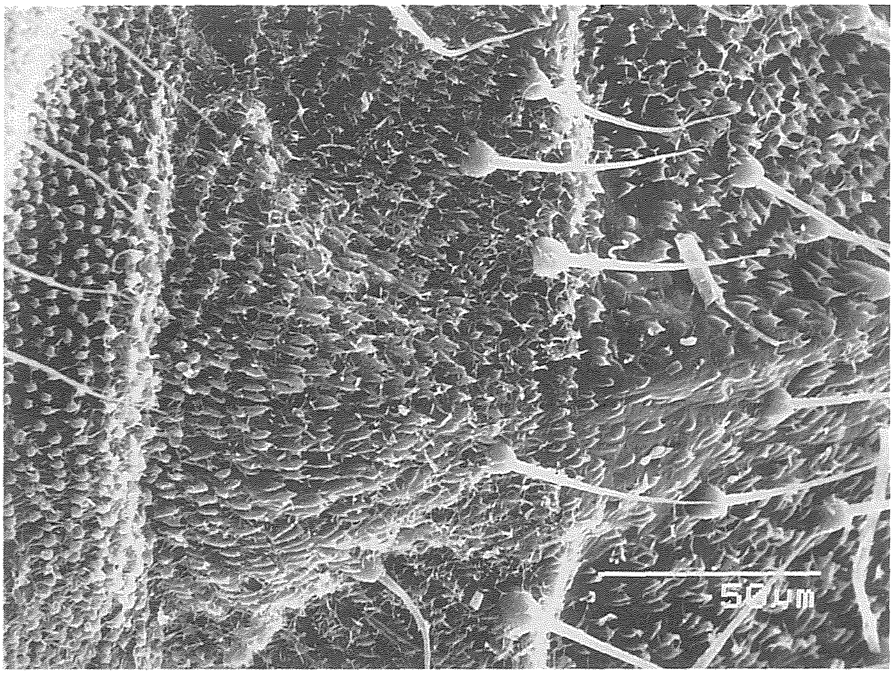

Fig. 38. Part of Fig. 33, showing part of caudal plate.

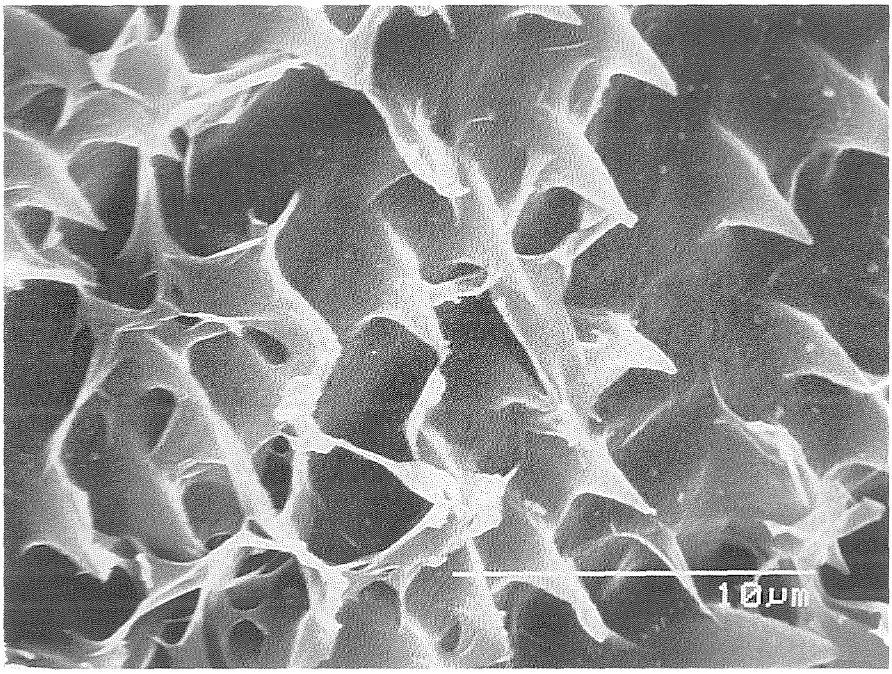

Fig. 39. Part of Fig. 38, showing spinules on caudal plate.

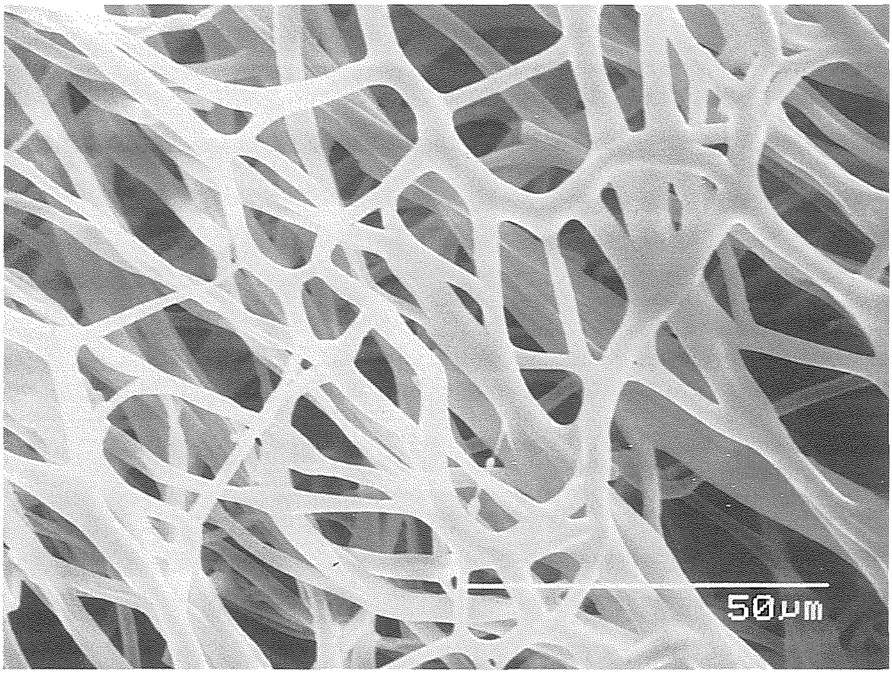

Fig. 40. Lerp of *Macrohomotoma* sp., showing part of netlike structure on dorsal surface.

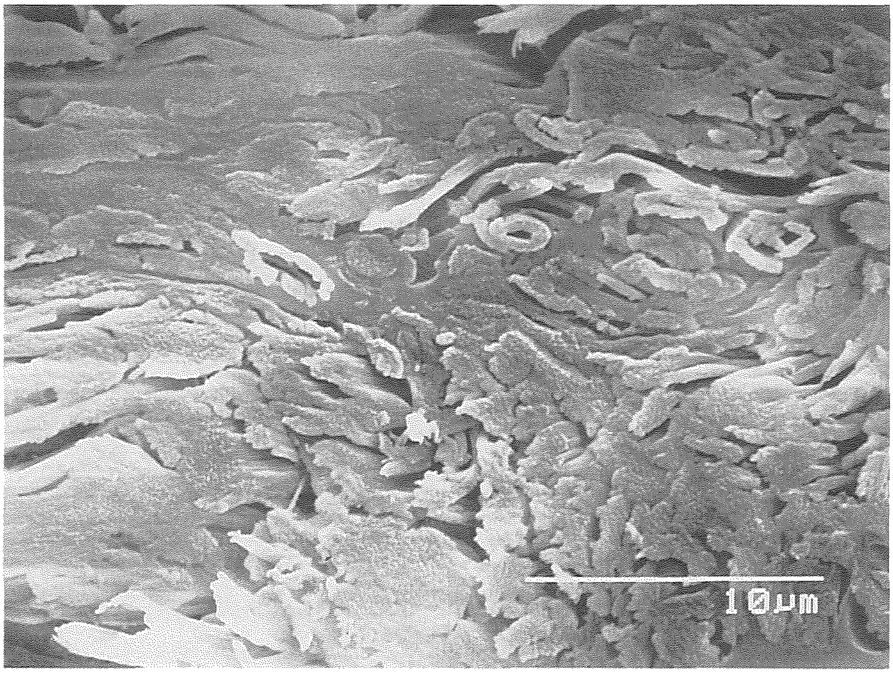

Fig. 41. Lerp of *Macrohomotoma* sp., part of a cross section.

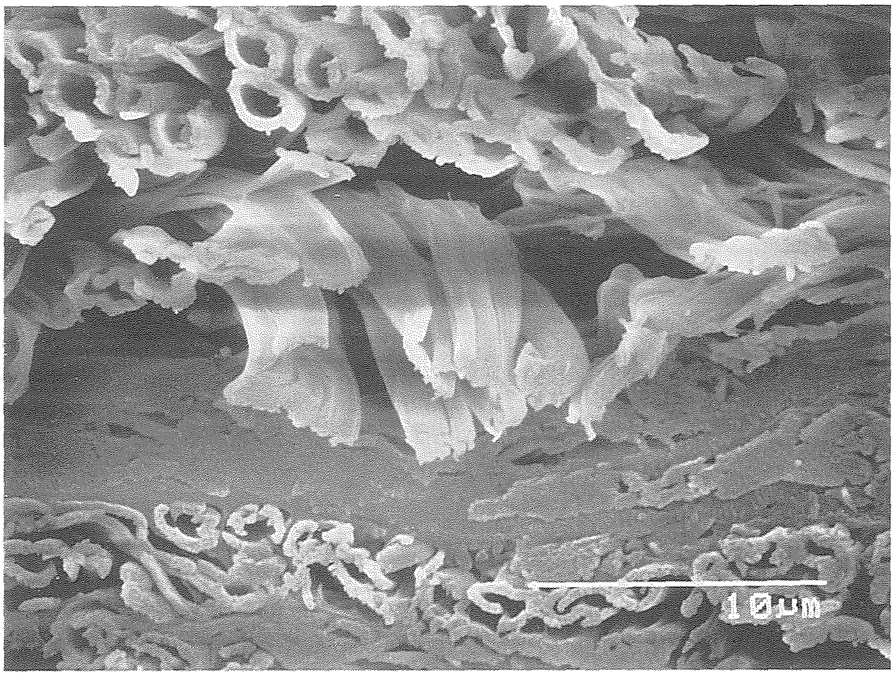

Fig. 42. Lerp of *Macrohomotoma* sp., part of a cross section.

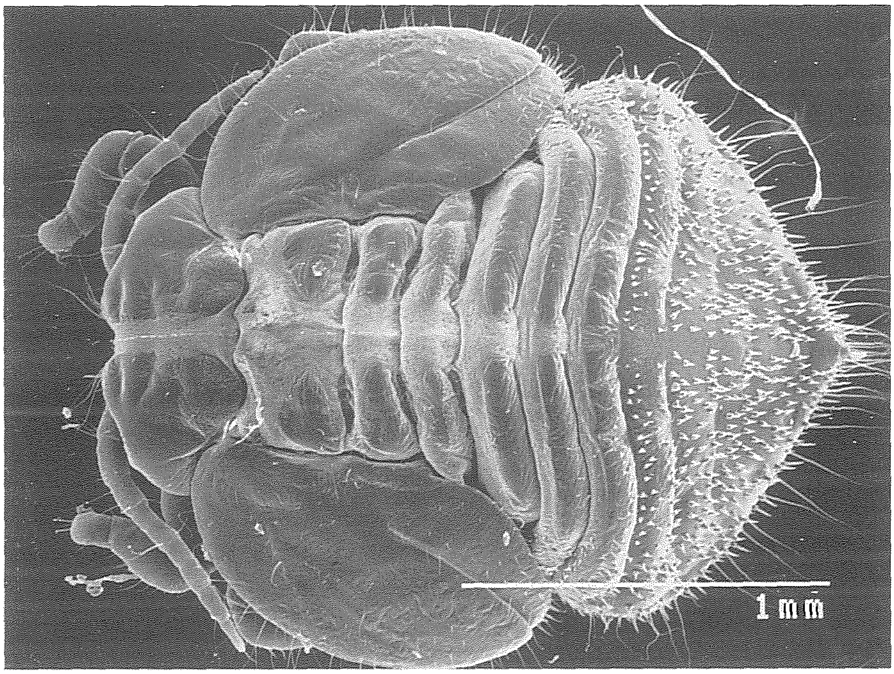

Fig. 43. Fifth instar nymph of *Macrohomotoma* sp., dorsal view.

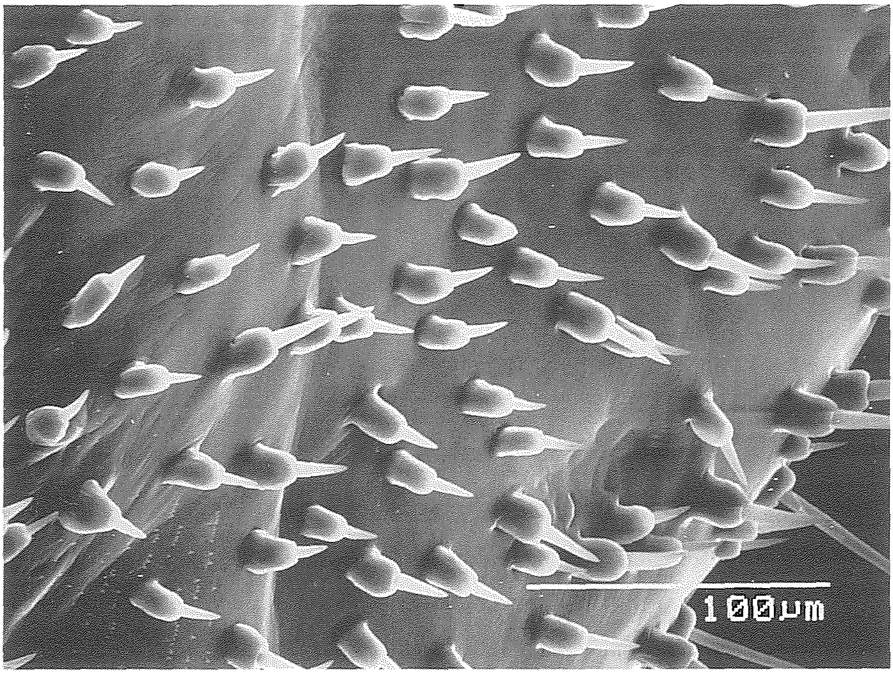

Fig. 44. Part of Fig. 43, showing setae on caudal plate.

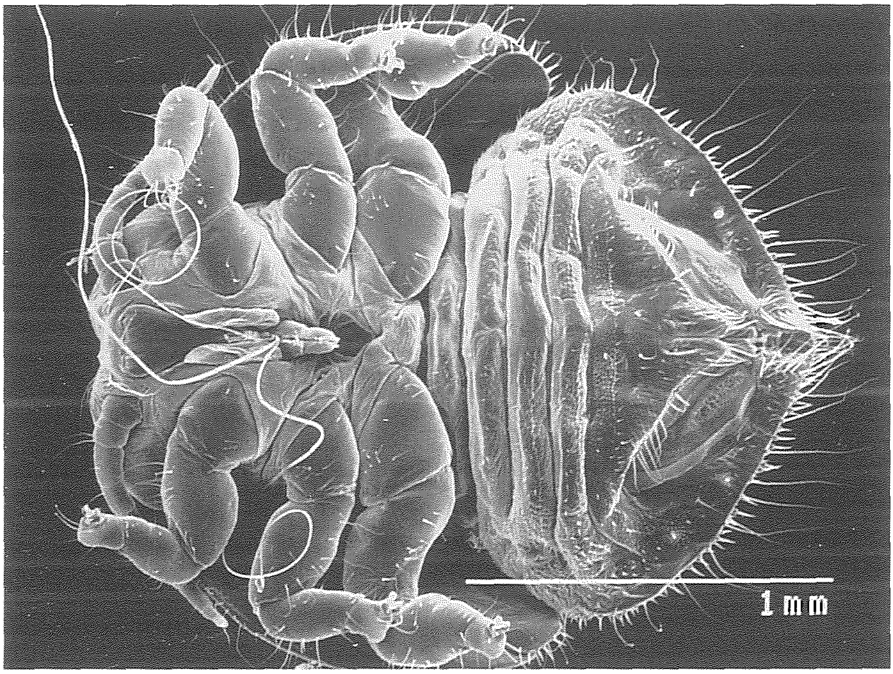

Fig. 45. Fifth instar nymph of *Macrohomotoma* sp., ventral view.

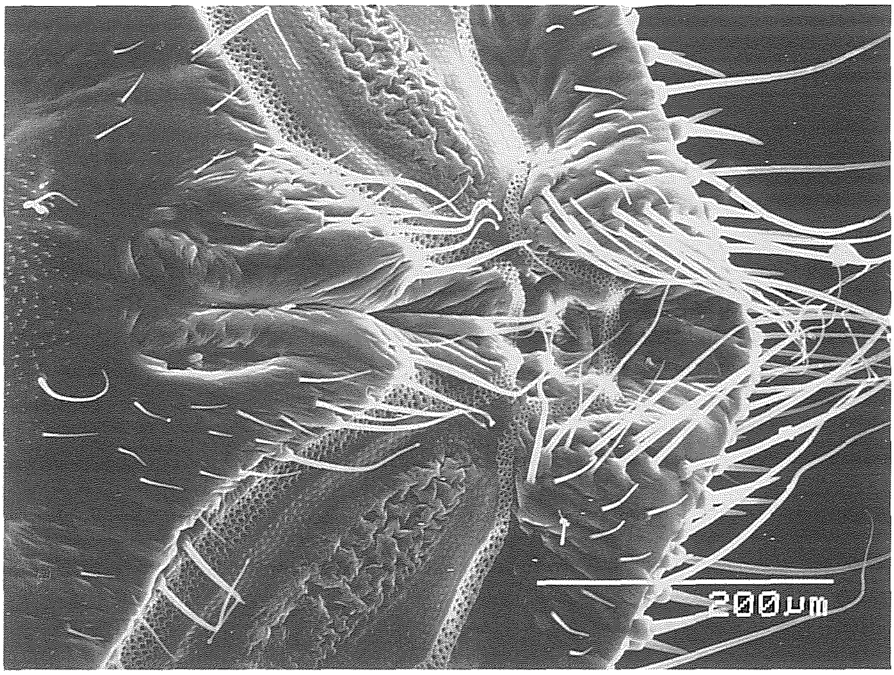

Fig. 46. Part of Fig. 45, showing anal region.

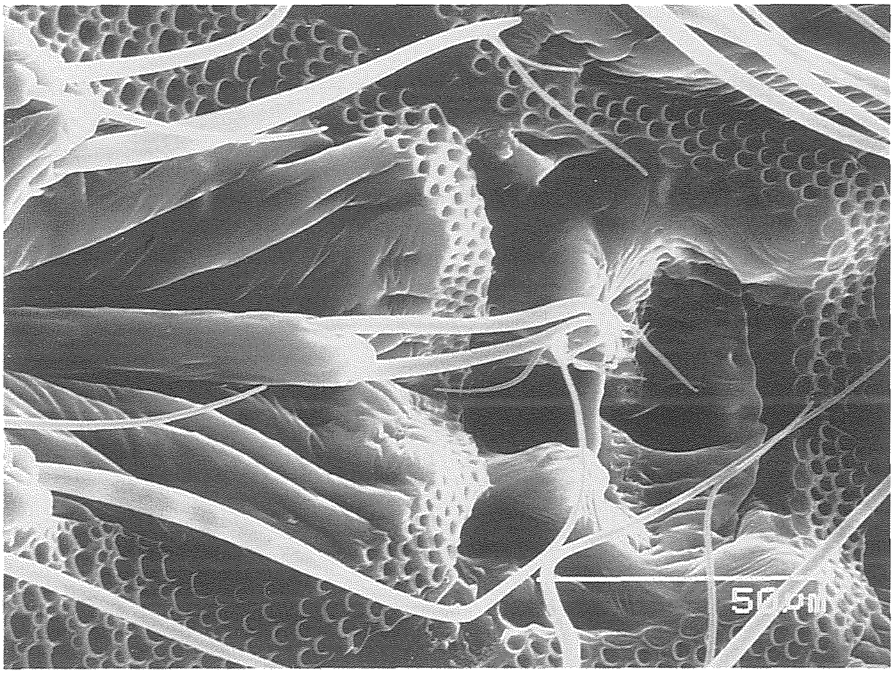

Fig. 47. Part of Fig. 46, showing anal region.

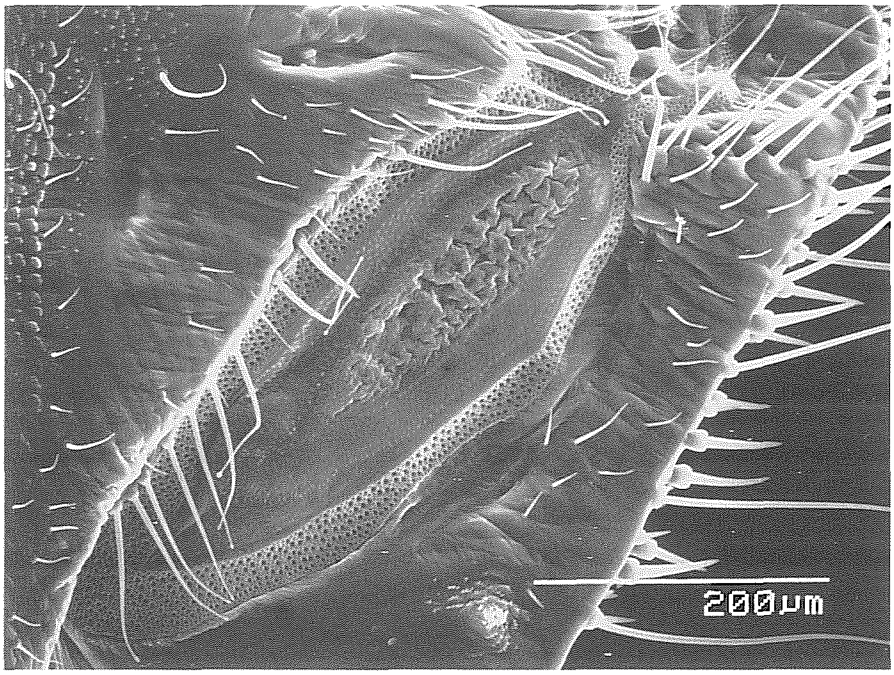

Fig. 48. Part of Fig. 45, showing 'aliform field'.

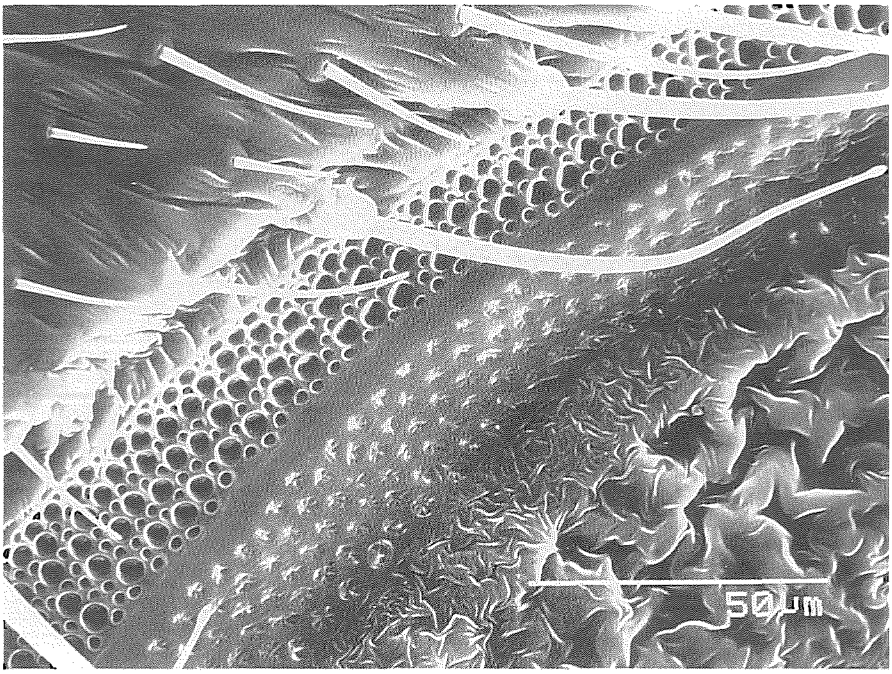

Fig. 49. Part of Fig. 48, showing part of 'aliform field'.

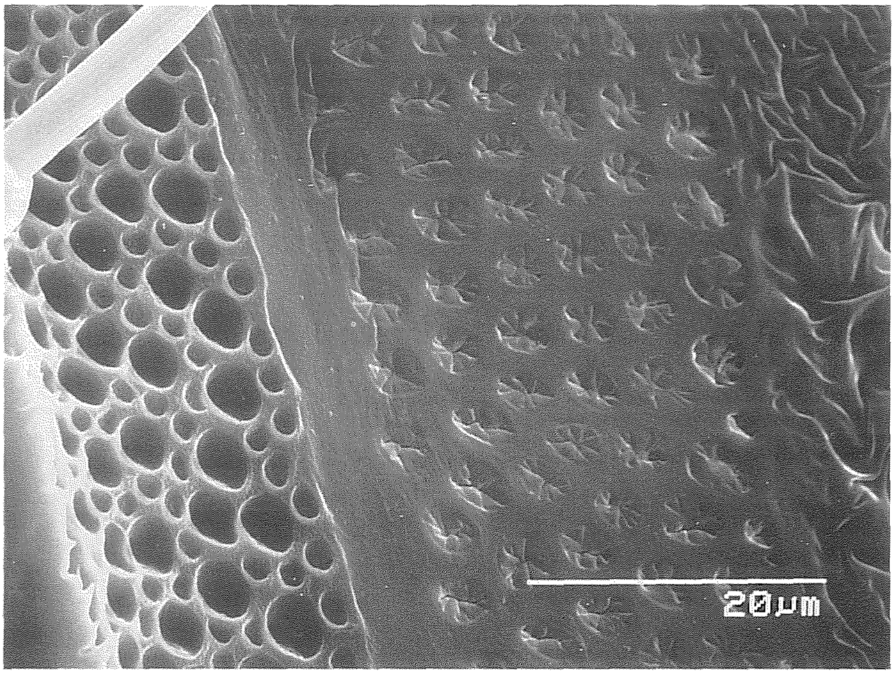

Fig. 50. Part of Fig. 48, showing part of 'aliform field'.

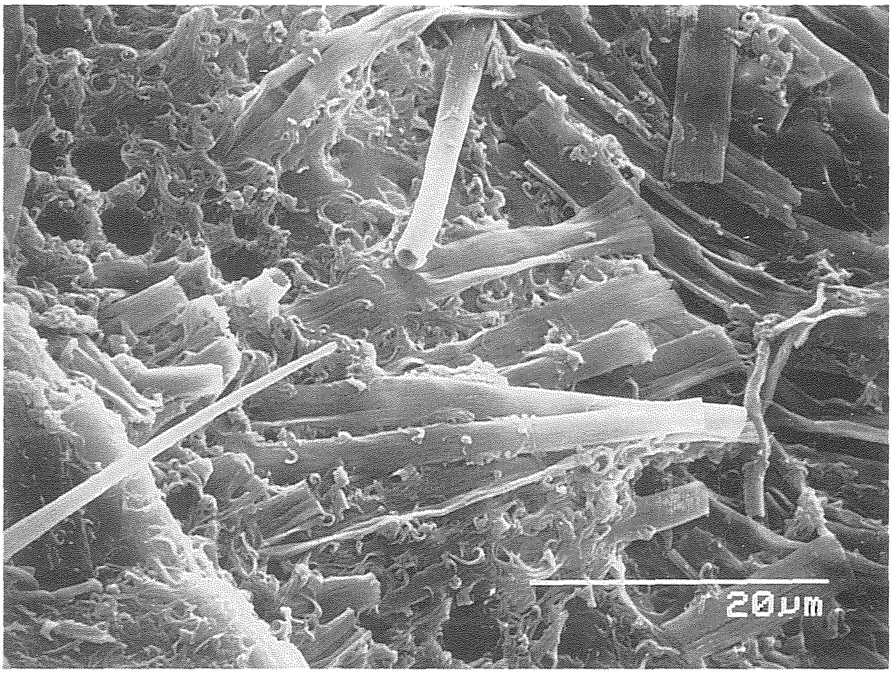

Fig. 51. Fifth instar nymph of *Macrohomotoma* sp., showing part of 'aliform field' secreting tubular filaments.