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Scanning Electron Microscopy on *Ixodes signatus* Nymphs with Particular Reference to Major Physiological Sensory Organs

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Ixodes signatus 若蟲의 生理學的 主要 感覺器官에 對한 走査電子顯微鏡的 觀察

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抄錄 : 제주도 남제주군 성산읍 성산리 성산일출봉 부근에서 생포된 天然記念物 보호조인 흰꼬리수리로 부터 *Ixodes signatus* 약충을 채취하여 生理學的 主要感覺器官에 對한 表面微細構造를 走査電子顯微鏡으로 觀察하였든 바, 映像觀察 및 寫眞分析 結査 얻어진 所見을 要約하면 다음과 같다.

1. 蟲體 背面 및 腹面에 對한 觀察에서 指紋狀의 수많은 表面주름과 多樣한 크기의 剛毛들을 볼 수 있었으며, 特히 口器部에 있어서 크고 잘 發達된 剛毛 또는 剛毛群을 確認할 수 있었다.

2. 腹面下部의 肛門과 肛門주위에 위로부터 아래로 뻗어내린 肛門溝가 뚜렷이 패여져 있었으며 1雙으로된 肛門葉에는 各各 3개씩의 感覺性 剛毛가 位置하고 있음을 確認하였다.

3. 側面에 부착되어 있는 氣門板 觀察에서 中央部에 단추모양의 構造物이 있었으며 邊緣部에는 수많은 氣孔들이 뚫려 있음을 確認하였다.

4. 四肢에 對한 觀察結果, 基節의 外側突起가 특징적으로 觀察되었으며, 各 마디 表面의 많은 剛毛와 第1肢의 跗節에서 化學受容器의 機能을 갖고 있는 홀러씨 기관(Haller's organ)을 觀察하였다.

5. 楕圓型으로 열려있는 홀러씨 기관 주변에서 2種類 크기의 剛毛群을 觀察할 수 있었으며, 器官內部에는 갈쿠리 모양의 突出型 感覺性 간상체 7개가 정렬되어 있음을 確認할 수 있었다.

Introduction

As was reported(Kang *et al.*, 1987) *Ixodes signatus* was firstly recorded to occur on Cheju Island in Korea, and the authors made a proposal for the nomenclature in Korean language as "badasea" tick meaning sea-bird tick according to host parasitized. The host of the tick specimens was confirmed as the white-tailed sea eagle *Haliaeetus pelagicus* in the Family Accipitridae, and the eagle was regarded as a major naturdenumal No. 243 (June 20th 1973) confined by the Cultural Properties Protection Law, No. 961(January 10th 1962) in the Republic of Korea. A total of 8 genera 23 species of ticks including some ambiguous records has been recorded to occur in the nation up to date. On the ticks belonging to the genus *Ixodes*, few reports on the occurrence and identification are available, such as, *I. acuminatus* and *I coreensis* by Kishida (1936), *I. ricinus* by Kishida (1936), Itagaki *et al.*, (1959) and Han *et al.*, (19

66), *I. granulatus* by Arthur(1957) and Noh(1965), *I. turdus*, *I. japonensis*, *I. cavipalpus* and *I. persulcatus* by Noh(1965) and *I. vespertillionis* by Yamaguti *et al.*, (1971). However, it has been reviewed by Kang *et al.*, (1985) that *I. ricinus* in the early literatures is probably the synonym of *I. persulcatus*(Kang *et al.*, 1982, 1984), *I. japonensis* is probably *I. ovatus* and that *I. coreeensis*, *I. acuminatus* and *I. cavipalpus* are not fully agreed doubtful records with no further information available.

In most arthropods there is no absolutely satisfactory distinction between two senses taste and smell. Nerve endings of many kinds are doubtless sensitive to irritant chemical substances(Wigglesworth, 1974). For in insects the chemical senses are served by primary sense cells which may be located in certain parts of the body and distributed in various localities from one species to another. Fine interesting reports on the sensory systems or the sense organs in certain insect species are available(Wensler and Filshie, 1969; Schoonhoven and Henstra, 1972; Backus and McLean, 1982, 1983; Han *et al.*, 1986). For in ixodid ticks the Haller's organ is regarded as a chemoreceptor (Elizarov, 1961), and the studies on the structure and function of the organ are now being concentrated on the understanding of the action and reaction of the organ to the ixodicidal chemicals relevant to the efficacy of the chemicals and the resistance in the ticks(Kang *et al.*, 1986).

In this manuscript, the scanning electron microphotographs of *I. signatus* nymphal specimens were presented for the understanding of ultramicro-structure of the major physiological organs including the Haller's organ as a specific sensory chemoreceptor in the tick.

Materials and Methods

Tick specimens, host and locality: On February 15th 1987, a total of three nymphal specimens was collected from the white-tailed seaeagle, *Haliaeetus pelagicus*, a major naturdenumal caught alive in the vicinity of the "Seongsan Ilchulbong" meaning 'the sun-rising peak' located in Seongsan-Ri, Seongsan-Eup, Namcheju-Kun, Cheju-Do Province. The tick specimens collected were fixed first in 10% formol-saline for 24 hours and then transferred into 70% ethyl alcohol containing 10% glycerine for preservation and observation.

Tick species identification: The tick species were identified as *I. signatus* nymphs sucking the blood on the host. On the basis of the information obtained by the light and scanning electron microscopy the description was made as reported by Kang *et al.*, (1987). The view by Yamaguti *et al.*, (1971) was complete and extremely helpful for the confirmation of species identification.

Scanning electron microscopy: Completing the observation on the light microscope the specimens were then subjected to the preparation for scanning electron microscopy. Without any post-fixation for the specimens, drying was performed directly in a dessicator at 20°C and it was confirmed that the procedure with air drying was sufficient for such kind of chitinous specimens as described by Stendel and Holm(1975). Then the dried specimens were attached on an aluminium stub by means of both-sided serotapes and subjected to evaporation with gold(Au) using an ion-coater(Eiko IB-3). The coated specimens were then observed by a scanning electron microscope (Hitachi S-570) at 20 kilovolts with the range of 30 ×to 10,000×magnifications. The microphotography was done on the Polaroid films type 55 with horizontal to 15° tilted-angle observations.

Results

As shown in Figs. 1, 5, 6, 7 and 10, the numerous finger prints were observed on the surface throughout the body. Variable setae were also observed in many parts of the body, and especially well developed sensory setae were found on the article Ⅳ(Figs. 2, 3 and 4) and on the anal lobes(Fig. 6). In the lateral aspects, a central button-like organelle and numerous small holes were found in the spiracular plate(Figs. 7 and 8). Various types of sensory setae were also found in the legs Ⅰ to Ⅳ thoroughly(Figs. 9 to 12). A pair of claws and pulvillus was well developed at the margin of the tarsus where some sensorv setae identified.

The Haller's organ one of the chemoreceptors as sensory organ of the tick, was observed at the distal

part of the tarsus on the leg I(lower part in Fig. 13) and as fully opened(upper part in Fig. 13). Two types of sensory setae were identified in the vicinity of the Haller's organ(Fig. 14), the shorter ones(a bundle of 5 setae in number) measured 5 to 6μm in length located in front of the organ and the longer ones measured 40 to 60μm in length located in distal front(with a bundle of 6 setae in number) and in near behind(with a bundle of 5 setae in number) of the organ. However, other setae rooted isolately each one another on the surface of the body and legs were also observed without any relation to the Haller's organ. The Haller's organ measured 32 μm longest and 14 μm shortest in diameter, and was constructed with a total of 7 basiconic sensory pegs inside (Fig. 15). The sensory pegs were identified as to be rooted deeply in the Haller's organ, and they were well arranged hook-shapes towarding to the distal direction of the leg(Fig. 16).

Discussion

Although a great deal of work has been done by foreign workers for the importance of ectoparasites in disease transmission and pathoecology with epizootical relation with migrating birds(Hoogstraal, 1956; Emel'yanova and Gordeeva, 1969: Galimov *et al.*, 1971; L'vov 1972; Brocklesby 1978), a few reports are available in Korea, such as, Noh(1965) on the ticks, *I. granulatus*, *I. japonensis* and *I. turdus* from *Erinaceus* species, Kang and Byun(1984) on the lice, *Cuclotogaster heterographus* and *Anaticola anseris* from the white stock *Ciconia boyciana* and Kang *et al.*, (1987) on the tick *I. signatus* from the whitetailed sea eagle *Haliaeetus pelagicus*.

The descriptions and occurrance records of some *Ixodes* species, such as, *I. albignaci* by Uilenberg *et al.*, (1970) *I. berlesei* by Chunikin(1967), *I. domerguei* by Uilenberg and Hoogstraal(1965), *I. eldericus* by Berdyev(1973), *I. himalyanensis* by Dhanda and Kulkarni(1969), *I. hyatti* by Clifford *et al.*, (1971), *I. kaiseri* by Filippova and Uspenskya(1973), *I. mitchelli* by Kohls *et al.*, (1970), *I monospinosus* by Saito(1967), *I. myotomys* by Clifford and Hoogstraal (1970), *I. nipponensis* by Kitaoka and Saito(1967), *I. nuttallianus* by Clifford *et al.*, (1971), *I. persulcatus* by Kang and Jang(1985) and Kang *et al.*, (1985), *I. plumbeus* by Stolbov(1966), *I. ricinus* by Belozerov(1971), *I. sachalinensis* by Filippova(1971), *I. shali* by Clifford *et al.*, (1971) and *I. werneri* by Keirans *et al.*, (1970), were used for the differential diagnosis of the species. *I. signatus* has now been firstly recorded to occur in Korea. Some extraordinary pictures of the species taken by a scanning electron microscope were presented for the understanding of morphology of the major physiological sense organs in this manuscript.

All the sensilla of insects are covered by a continuous cuticular sheath, but in certain of them the cuticle is excessively delicate, and it is natural to regard these as the chemoreceptors reponsible for taste and smell. Organs of taste are associated with the mouth in many insects. In the bee sensory pits at the base of the tongue are perhaps the receptors, for example, while the oral lobes of the proboscis in certain fly bear gustatory hairs along their margins. In a few insects such as ants, bees and wasps, the antennae have been shown to bear organs of taste. The receptors are confined to the distal segments and are perhaps the poreplates. Wigglesworth(1974) has also mentioned that a more frequent site is the tarsus and distal end of the tibia. The studies on the fine structure of the various sensory hairs, setae and pegs in the chemoreceptors of arthropods including ticks would be invaluably helpful for the understanding and advancement of knowledge in ecology and physiology of the arthropods themselves.

Summary

Ixodes signatus nymphs were subjected to the scanning electron microscopy for the observation of the major physiological sense organs including the Haller's organ.

Finger prints and variable sensory setae were found on the body surface, and especially well developed setae were identified on the article Ⅳ and on the anal lobes. A central button-like organelle and numerous small holes were found in the spiracular plate. The Haller's organ was identified at the distal point of the tarsus I and regarded as the major sensory organ, chemoreceptor.

Tow types of sensory setae were observed, the shorter ones in front of the organ and the longer ones in distal front as well as near behind of the organ. The fully opened organ was ellipsoidal and a total of seven basiconic sensory pegs rooted deeply and shaped as well arranged hook-like was found inside the organ.

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Legends for Figures

Ixodes signatus nymphal specimens; SEM Hitachi S~570, 20Kv

Fig. 1. Dorsal view of the capitulum and the scutum showing a pair of cervical grooves and some sensory setae on the surface(110 X).

Fig. 2. Dorsal view of the palps and hypostome(lower part, 290 ×) and the botton-like feature of the hypostome and a dorsointernal on the article Ⅱ (upper part, 2,900 ×).

Fig. 3. Ventral view of the palps showing the articles I to Ⅳ with some sensory setae on the surface (500×).

Fig. 4. Cephaloventral aspect of the article Ⅳ showing a bundle of 15 sensory setae on the surface (2,000×).

Fig. 5. Ventral view of the abdomen and coccygeal part of the body showing the anus and the anal groove rounded anteriorly. Notice the genital groove and the finger prints on the surface(70 ×).

Fig. 6. The anus with anal groove(lower part, 150 ×) and the magnified aspect of the anus showing a pair of anal lobes with three pairs of specified anal setae(upper part, 750 ×).

Fig. 7. Lateral view of the spiracular plate(lower part, 60 ×) and the magnified aspect with a central botton and numerous holes on it. Also notice the finger prints surrounded (upper part, 300 ×).

Fig. 8. The magnified spiracular plate. Notice the arrangement of the holes on the plate(1,500×).

Fig. 9. Dorsal view of the legs Ⅰ and Ⅱ. Notice the hairs of host, sea eagle, on the bottom(100 ×).

Fig. 10. Dorsal view of the legs Ⅲ and Ⅳ with the finger prints on the surface of the body (100 ×).

Fig. 11. Ventral view of the legs Ⅱ and Ⅲ showing the coxa Ⅱ with an external spur, and other parts of the leg (80 ×).

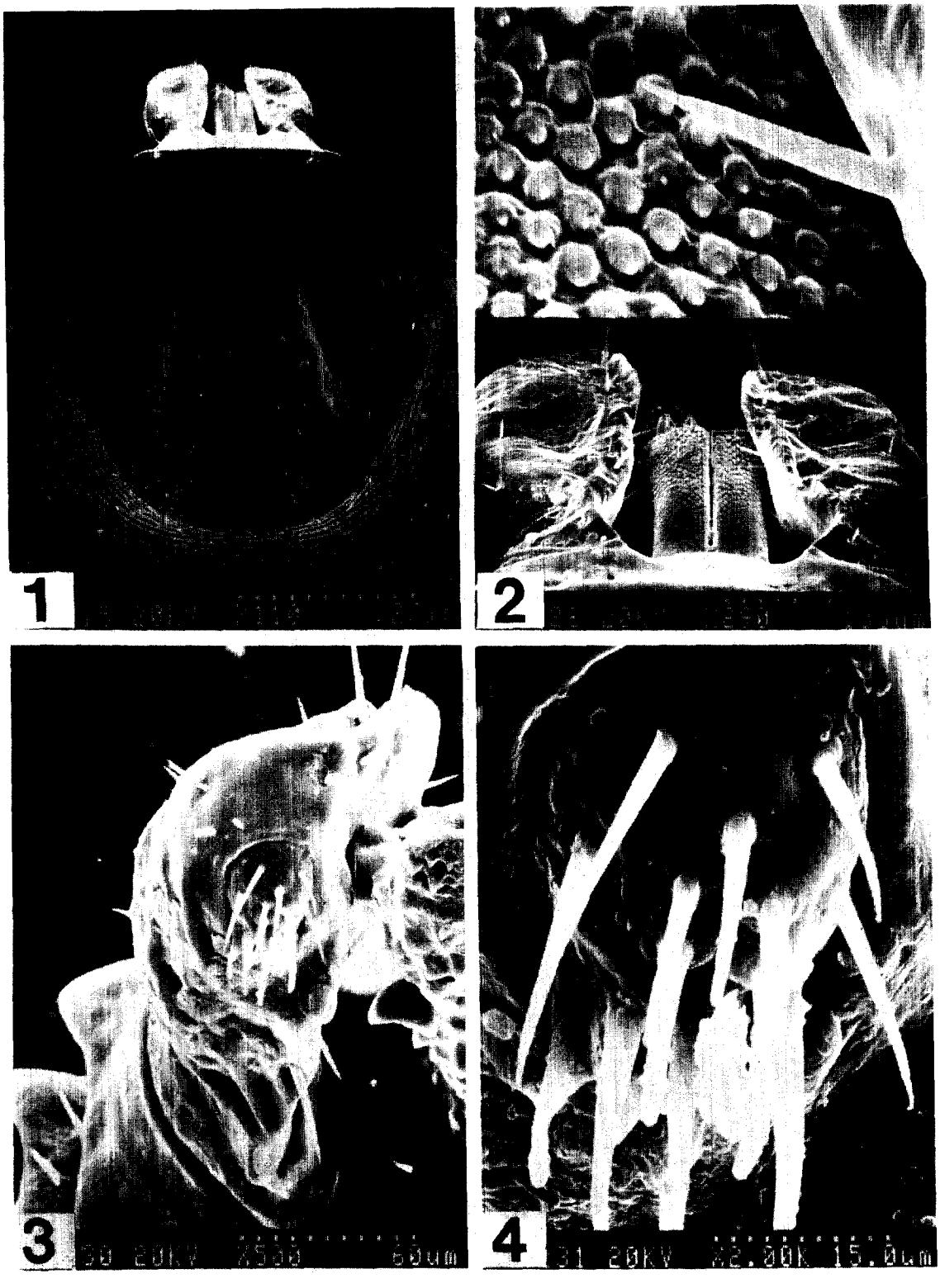
Fig. 12. The pulvillus and claws with some sensory setae on the surface of the distal part of tarsus(60 ×).

Fig. 13. Ventral view showing the capitulum(lower part, 30 ×) and the magnified part of the leg Ⅰ (upper part, 300 ×).

Fig. 14. The Haller's organ with two types of setae(500 ×).

Fig. 15. A bundle of basiconic sensory pegs in the Haller's organ. Notice the hook shapes and seven pegs in number(2,500 ×).

Fig. 16. A higher magnified aspect of a sensory peg in the fully opened Haller's organ(10,000 ×).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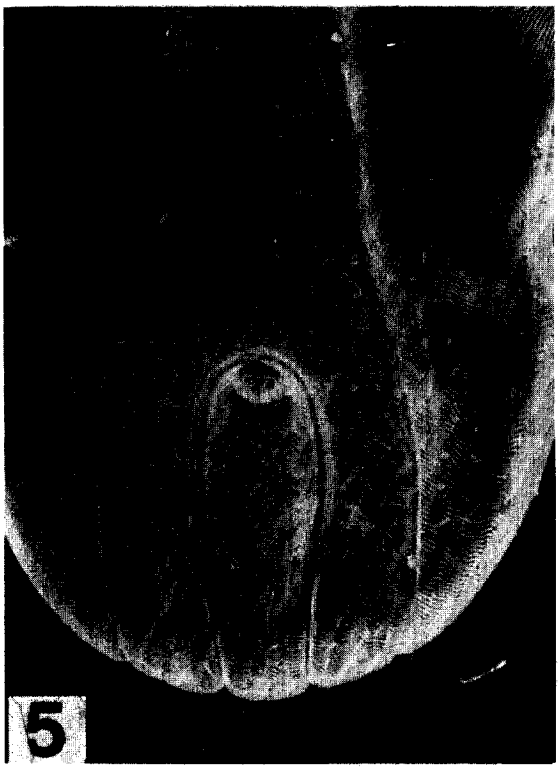
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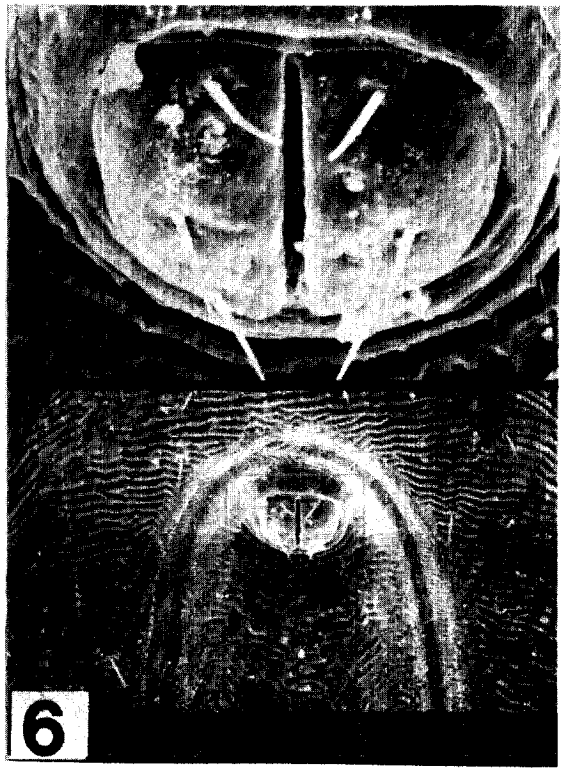
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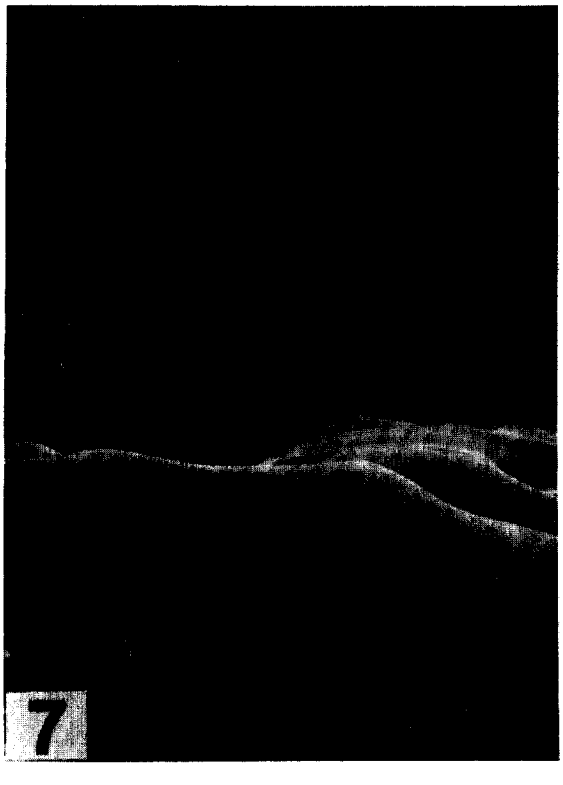
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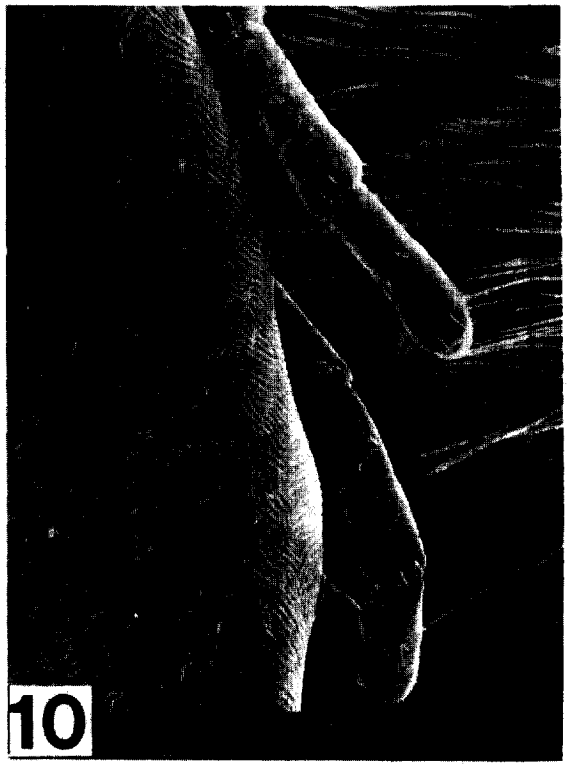

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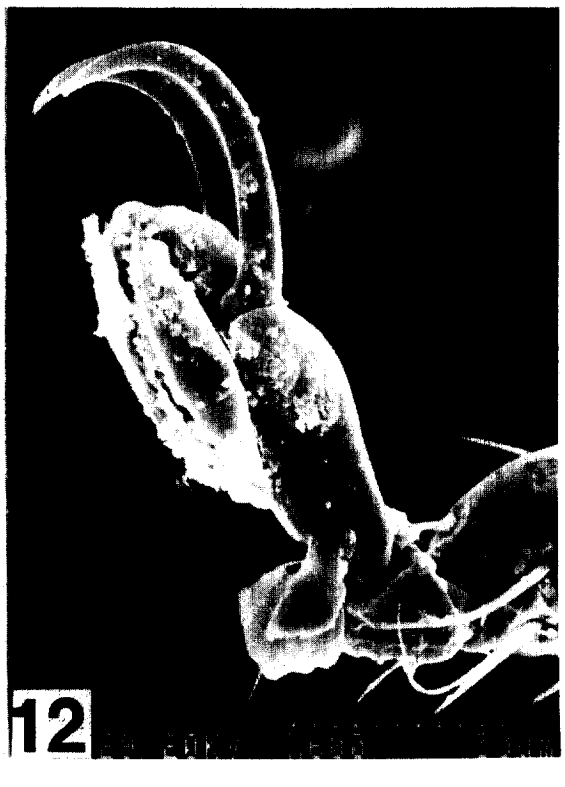

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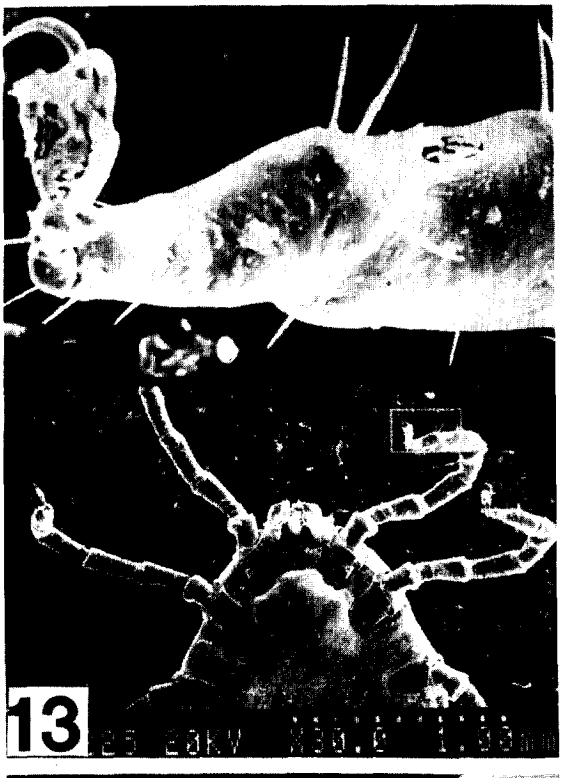
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