ANTENNAL RECEPTORS ULTRASTRUCTURE OF THE RED PALM WEEVIL *RHYNCOPHORUS FERRUGINEUS* (OLIVIER) (COLEOPTERA: CURCULIONIDAE)

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ABSTRACT

The sensilla on the antenna of both male and female of the curculionid red palm weevil Rhyncophorus ferrugineus (Olivier) (Coleoptera) were investigated by using light and scanning electron microscopy. Ten types of antennal sensilla were occur in the antennae of both sexes. The roof- like tip of the terminal segment of the antennae were different in both sexes,being wrinkled in the male and densely hairy in the female.

Keywords: *red palm weevil,(RPW) antenna, sensory organs*

INTRODUCTION

The curculionid red palm weevil (RPW) *R. ferrugineus* (Olivier) is a serious pest of cultivated palms in many countries in southern Asia, North Africa, the Gulf States and the Middle East (Van Der Laan, 1981). It attacks many kinds of palm trees causing enormous damage to infested ones. This pest was discovered in north eastern Egypt in 1992 (Cox, 1993) and now becomes a devastating pest of date palm trees *Phoenix dactylifera* and the canary Island palm *P. canariensis* and other palm trees in Egypt (Alfazairy *et. al.*, 2003).

The aim of this work is to study for the first time the fine structures of the antennal sensory receptors of the RPW. These receptors play an important role in host recognition, as well as in the communication between males and females. This is an attempt to provide a basic information for future electrophysiological work concerned to elucidate different behavioral responses of this pest to various tested biotechnical methods and their evaluation in contribution to development of suitable IPM programs.

MATERIALS AND METHODS

Adults of the red palm weevil *R. ferrugineus* (Coleoptera, Curculionidae) were collected from Antoniades gardens in Alexandria Governorates, Egypt and reared on artificial diet in the laboratory (Alfazairy *et al.*, 2003). The antennae of both sexes were prepared as whole mounts for light microscopic examination by soacking them in 10% NaoH solution for a week then they were rinsed in distilled water several times. The specimens were passed through a series of ethyl alcohol from 50 – 95% for 1 hour for each concentration. The dried specimens were transferred to clover oil for 24 hours for clearing, then mounted on slides in Canada Balsam and then dried in an oven at 40 °C for one week.

For scanning electron microscopy (SEM) antenna of both sexes was dipped in 70% ethyl alcohol for 1 hour, then mounted on a stub by means of a double-sided sticky transparent tap or with carbon. The specimens were coated with gold in (JOEL JFC- 1100 E) high resolution sputter coater for 25 minutes to a thickness of 12 nm. Preparations were examined in a JOEL (JSM- 5300) Scanning Electron Microscopy at the Faculty of Science, Alexandria University. The sensory receptors of antenna of both sexes were described briefly.

RESULTS AND DISCUSSION

General features

The antenna of both sexes of the RPW *R. ferrugineus* is elbowed or geniculate and clubbed (Fig., 1). It consists of an elongate scape with minute spines scattered on its surface (Figure 2), short quadrate pedicle, and 6 flagellar segments. The scape is much longer than wide, about 7 times as long as wide, the pedicle forming the pivot between scape and flagellum. The first flagellar segment is cylindrical, the second and the third ones slightly smaller and relatively similar in size. The next two are enlarged gradually, the terminal segment segment is greatly enlarged, funnel shaped with roof-like tip. There are slightly differences between male and female antenna in the ultrasturcture of the roof-like tip of the terminal segment which is wrinkled in the male but densely hairy in the female (Fig, 3 a & b).

Antennal sensilla

Ten different types of sensilla were distinguished, and all of them were found in both male and female. The terminology of sensills of Schiender, (1964) were followed in the present work.

Sensilla Trichodea (ST):

Sensilla trichodea are thin walled hairs tapering to fine points. They are distinguished by their insertion in sockets serving as articulating membrane. It is relatively great in length and found in the antennae of several insects (Schnieder, 1964). They could be divided into five distinct types on criteria of surface substructure and length.

Sensilla Trichoidea 1 (ST1)

They are found in numerous numbers, clothing the roof-like tip of the terminal segment of female antenna (Figure, 4). They are fine with curved tips.

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The function of these setae are chemoreceptor recognizing the odour of the host plant (Bartlet *et. al.*, 1999).

Sensilla Trichoidea 2 (ST2)

It is about 65 µm in length with 17µm wide at base and with obliquely pointed tip about 4.3 µm in width. They are arranged in diagonal raws on the basal smooth part of the terminal segment. Also, they are found in large numbers in females and males and characterized by slightly swollen base and a single apical pore. Also, it possesses longitudinal cuticular shallow ridges or grooves in addition to slit-like groove (bothria) (Figure, 5).

Sensilla Trichodea 3 (ST3)

These seta are arranged in a circle in large numbers around the basal smooth part of the terminal segment. They are characterized by the presence of whorls of grooves on its base and biforked tip (Figure, 6).

Sensilla Trichodea 4 (ST4)

They are straight setae about 97.8 µm length and slightly wider base about 15.6 µm with a pointed tip. They are distributed between the dense hairs (ST1) of the roof-like part of the female antenna. These setae are characterized by the presence of longitudinal deep groove at its base and with a pointed tip (Figures, 4, 7).

Sensilla Trichodea 5 (ST5)

This type of trichodea sensilla is distributed essentially on the penultimate segment of antenna. They are about 105.6 µm in length, the hair base extends perpendicular to the cuticle surface, then curves towards the apical end of the antenna. Also, it is characterized by the longitudinal groove on its entire length (Figure, 8).

It has been proved by several morphological and electrophysiological studies that sensilla trichodea had characteristic features of insect chemoreceptors sensilla or olfactory sensilla in several coleopterous insects as previously described by several authors (Schneider, 1964; Hatfield *et. al*, 1976; Smith *et. al.*, 1976; Ritcey and Mciver, 1990; Mbata *et. al.* 1997; and Bartlet *et al.*, 1999).

Sensilla chaetica (SC)

This type of setae is straight or gently curved hairs. They are elevated on a specialized and flexable high bulb or collar-like socket at the base. There are two distinct types of sensilla chaetica according to their surface substructure and length:

Sensilla chaetica 1 (SC1)

It is about 23.63 µm in length, arranged in complete raw at the tip of the roof-like part of the terminal segment. These setae are characterized by longitudinal cuticular stria along their entire length and with unipore in its blunt tip (Figure, 9).

Sensilla chaetica 2 (SC2)

A group of chaetica sensilla emerged in the wrinkled part of the roof-like tip of the male terminal segment. These setae are smooth, erected and elevated on a flexable base. They are ranged from 57.7 - 100 µm in length (Figure, 10 a & b).

From the electrophysiological point of view the sensilla chaetica postulate to act as mechanoreceptor sensilla (Schnieder, 1964; Van Der Press and Dan Otter, 1978 and Bartlet *et al.*, 1999). Furthermore, Slifer (1970 & 1979) and Koh *et. al.*,1995 stated that these sense organs serve as both mechanoreceptors and chemoreceptors.

Coeloconic sensilla (C_s):

It is thin walled cone arising from the floor of a relatively wide cuticular pit or depression in the antennal cuticle (pit – peg). They are found in few numbers on the penultimate segment. It is about 2.5 µm in length (Figure, 11).

These sense organs are innervated by four or five nerve fibers ending into the tip of cone (Schneider, 1964). According to Chapman (1975) and Altner and Loftus (1985) the coeloconic sensilla may act as thermo-hygroreceptor sensilla.

Campaniform sensilla:

A group of dome-like campaniform sensilla found in between the scape and the head (Figure, 12). Their location in this place with the greatest muscle loading is an indication of their possibly important role in motor processes (Romoser.1973). They are considered to be mechanoreceptive sensilla and report the antennal position as proprioceptors (Schnieder, 1964).In addition, the campaniform sensilla are sensitive to temperature and humidity (Dietz and Humphery , 1971).

Comb-like sensilla:

Many rows of thin walled comb-like sensilla found on the scape, pedicel and each segment of the flagellum except the clubbed terminal segment. They are about 25 µm in length. These setae may possess 2, 3 or 5 dents (Fig 13 a, b). Ahmed (1995) found these setae on the fore tarsus of *Ectopsocus briggsi* (Psocoptera) and named it as ctenobothria hair. He stated that the comb-like hair may act as chemo- and mechanoreceptors.

The SEM photographs of the terminal segment of the female antennae showed many punctures on the smooth part of this segment more than in the male (Figure 14).

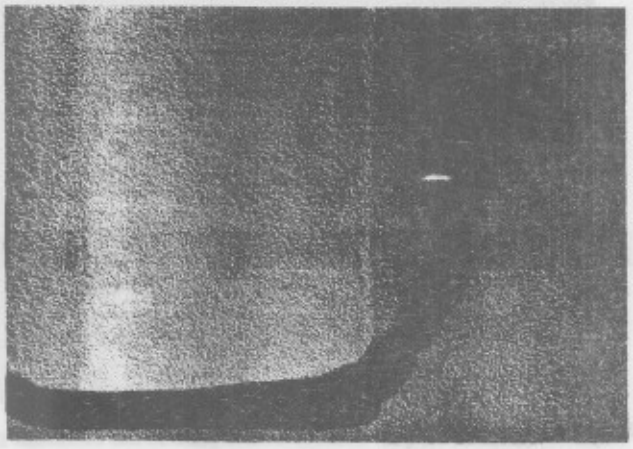


Figure (1): General view of adult *Rhyncophorus ferrugineus* antenna.

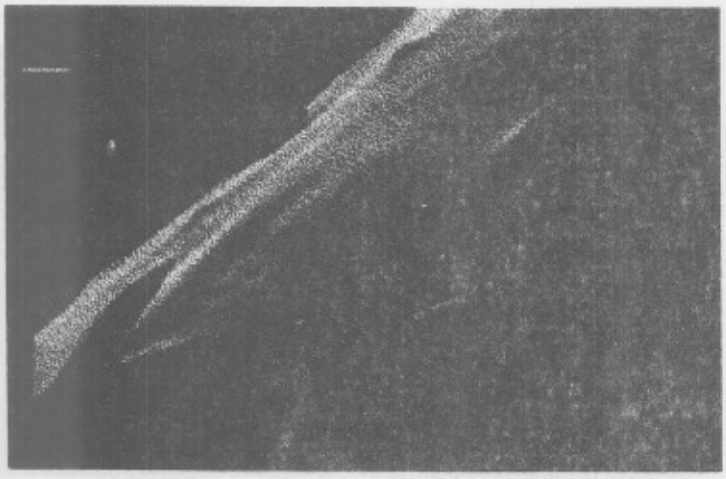
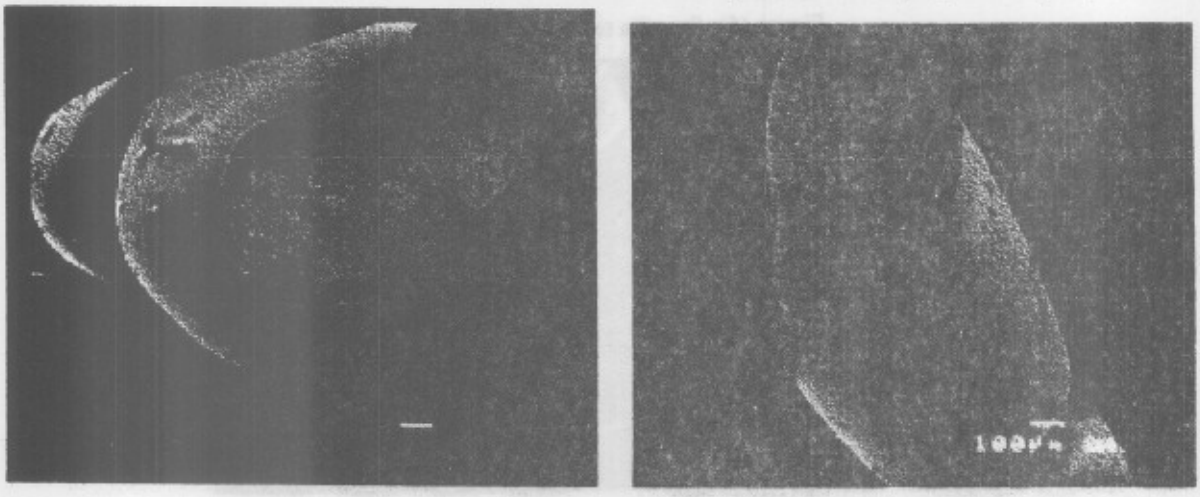


Figure (2): SEM photograph showing the scattered minute spines on the scape (Bar = 10 µm).



(A) (B)

Figure (3) SEM photograph showing the terminal segment of *R. ferrugineus* antenna. A: female , B. Male (Bar = 100 µm).

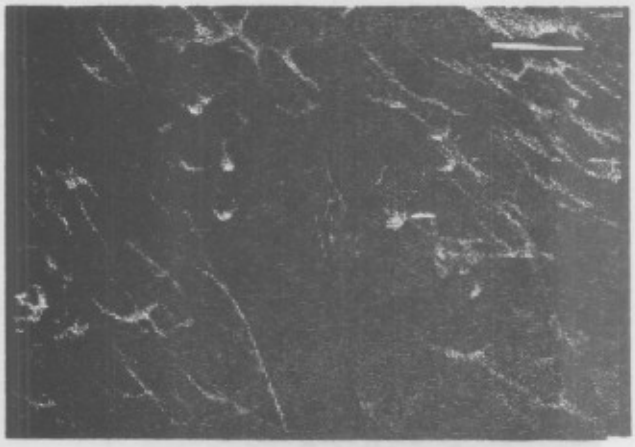


Figure (4): Sensilla trichodea type 1clothing the roof – like part of the terminal segment of female antenna (Bar = 10μm).

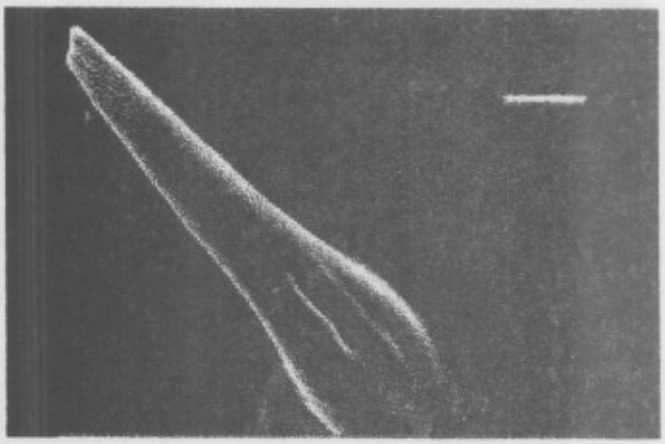


Figure (5): Sensilla trichodea type 2 (Bar = 10μm).

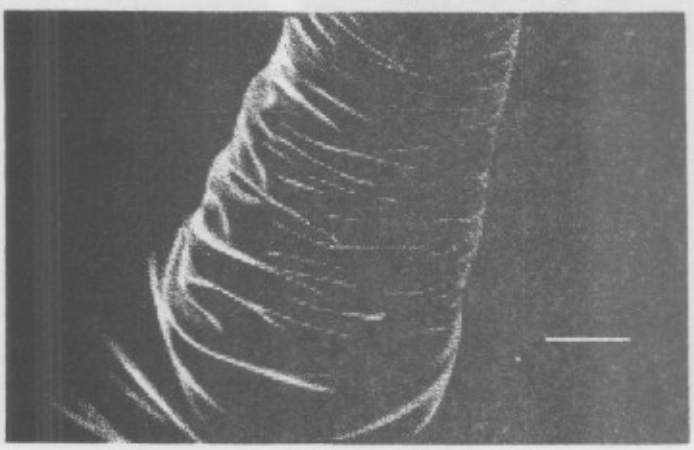


Figure (6): The whorle groove at the base of trichoidea sensilla type 3 (Bar = 5μm)..

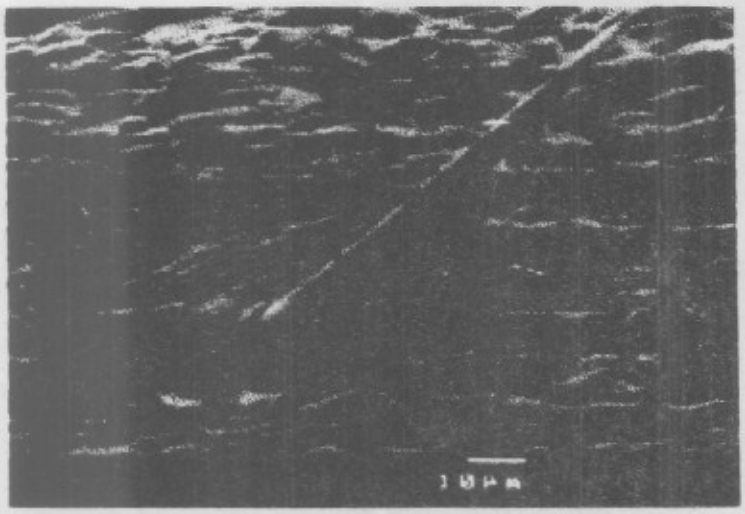


Figure (7): Trichoid sensilla type 4 in the roof – like part of the terminal segment of the female antenna (Bar = 10μm).

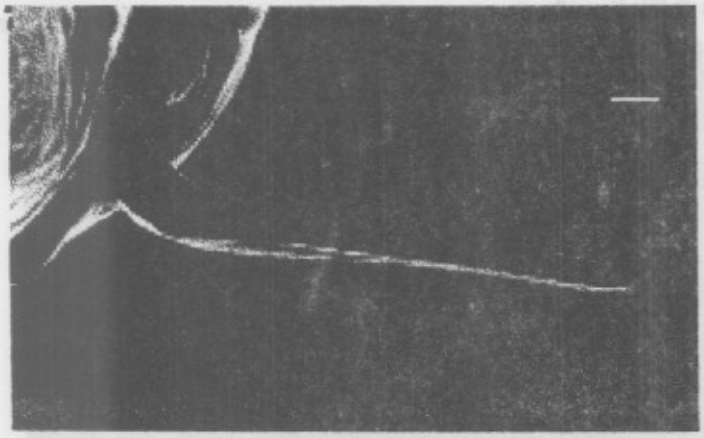


Figure (8): Trichoid sensilla type 5 in the penultimate segment of the antenna showing the longitudinal groove (Bar = 10μm).

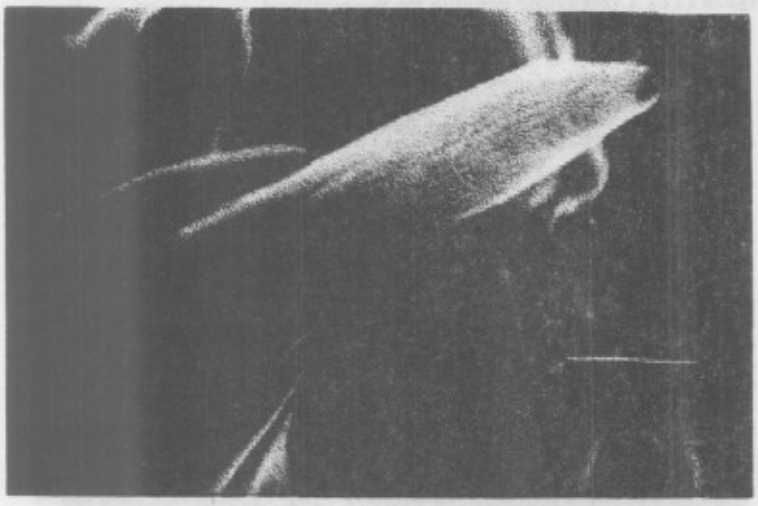
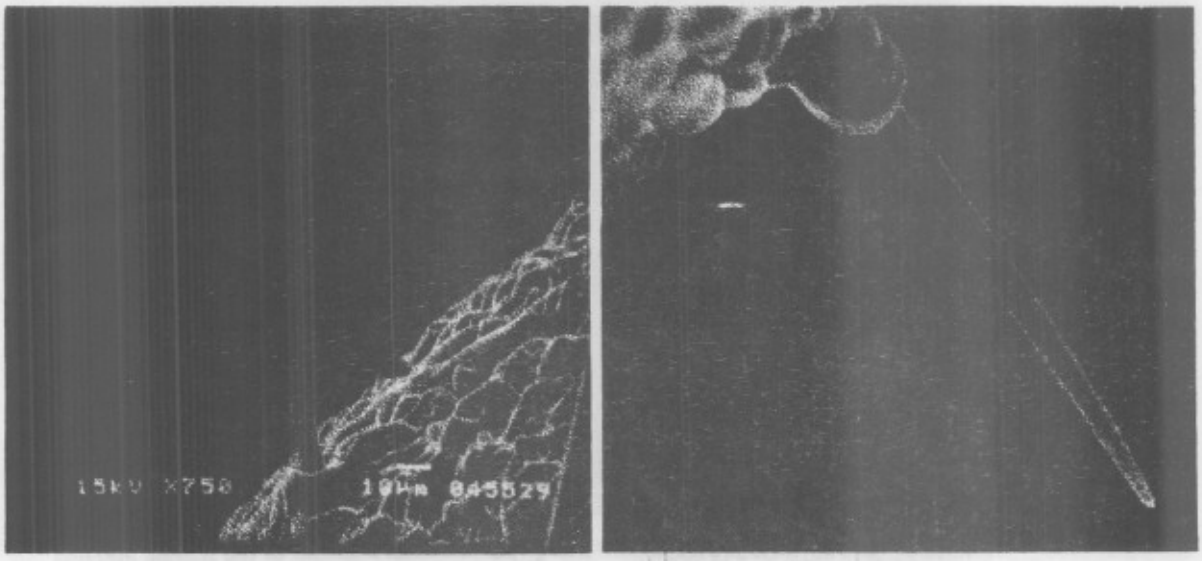


Figure (9): Sensilla chaetica type 1 showing the longitudinal stria and the uniapical pore (Bar = 5μm).



A B

Figure (10A & B): Sensilla chaetica type 2 showing smooth shaft of setae (Bar = 10µm).

Figure (11): Coeloconic sensilla on the terminal segment (Bar = 5µm).

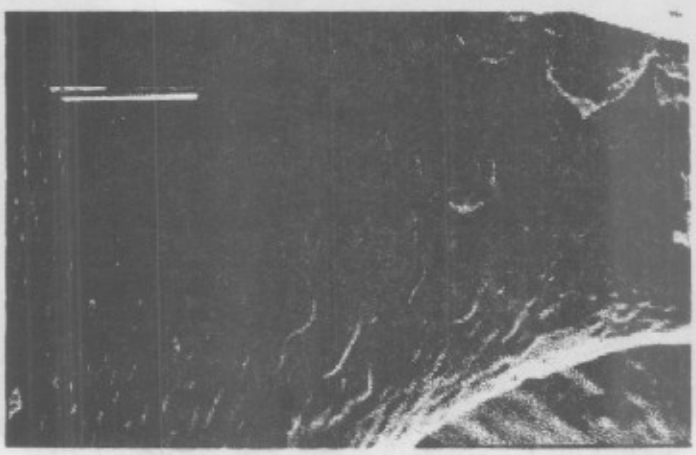


Figure (12): A group of campaniform sensilla on the scape (Bar = 50µm).

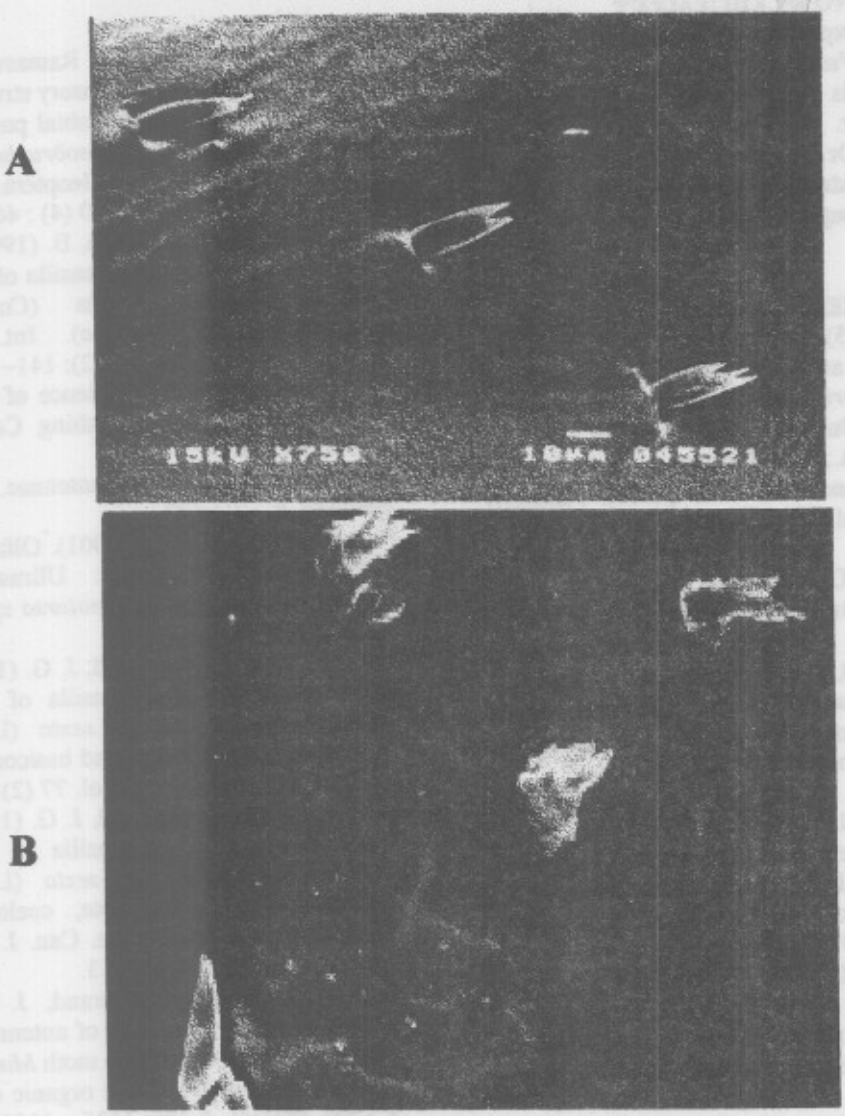


Figure (13 A, B): Comb-like hairs on the antennal segments (Bar = 10µm).

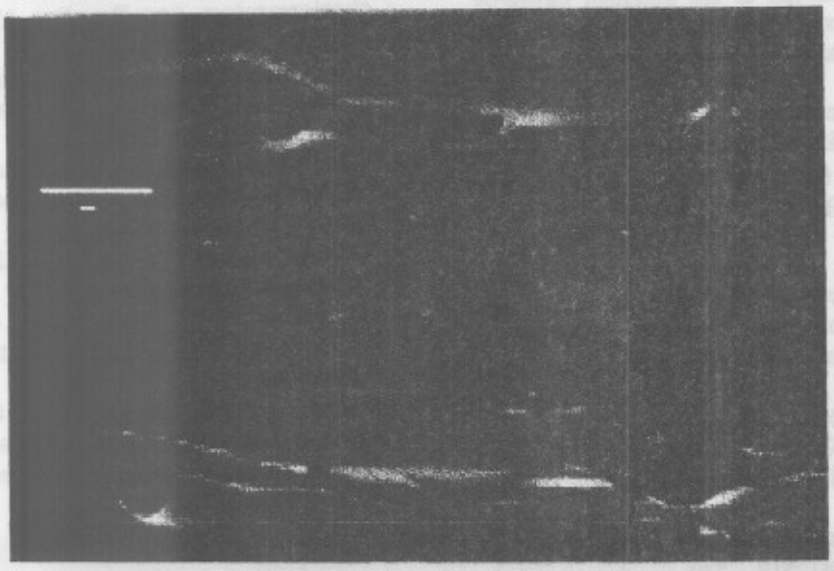


Figure (14): Punctures on the smooth part of the terminal segment of the female antenna (Bar = 5µm).

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الملخص العربى

دراسة التركيب الدقيق للمستقبلات الحسية على قرن استشعار سوسة النخيل الحمراء

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تم فى هذا البحث دراسة المستقبلات الحسية على قرن استشعار ذكر وأنثى سوسة النخيل الحمراء رتبة غمدية الاجنحة والتى تسبب تدمير شامل لنخيل البلح وغيره من انواع النخيل .

وقد تمت فى هذه الدراسة وصف وتوزيع أعضاء الحس بالفحص بالميكروسكوب الالكترونى و الميكروسكوب الضوئى وقد تم حصر عشرة انواع من أعضاء الحس وهى خمسة انواع Trichodea ونوعين Chactica ونوع Coeloconica ونوع Campaniform بالإضافة إلى شعرات مشطية Comb-like hairs . وقد أتضح وجود فرق ظاهرى بين قرن الاستشعار فى الانثى عنه فى الذكر حيث أن قمة العقلة الطرفية فى الانثى تغطى بشعرات قصيرة كثيفة وهذه لاتوجد على قرن استشعار الذكر