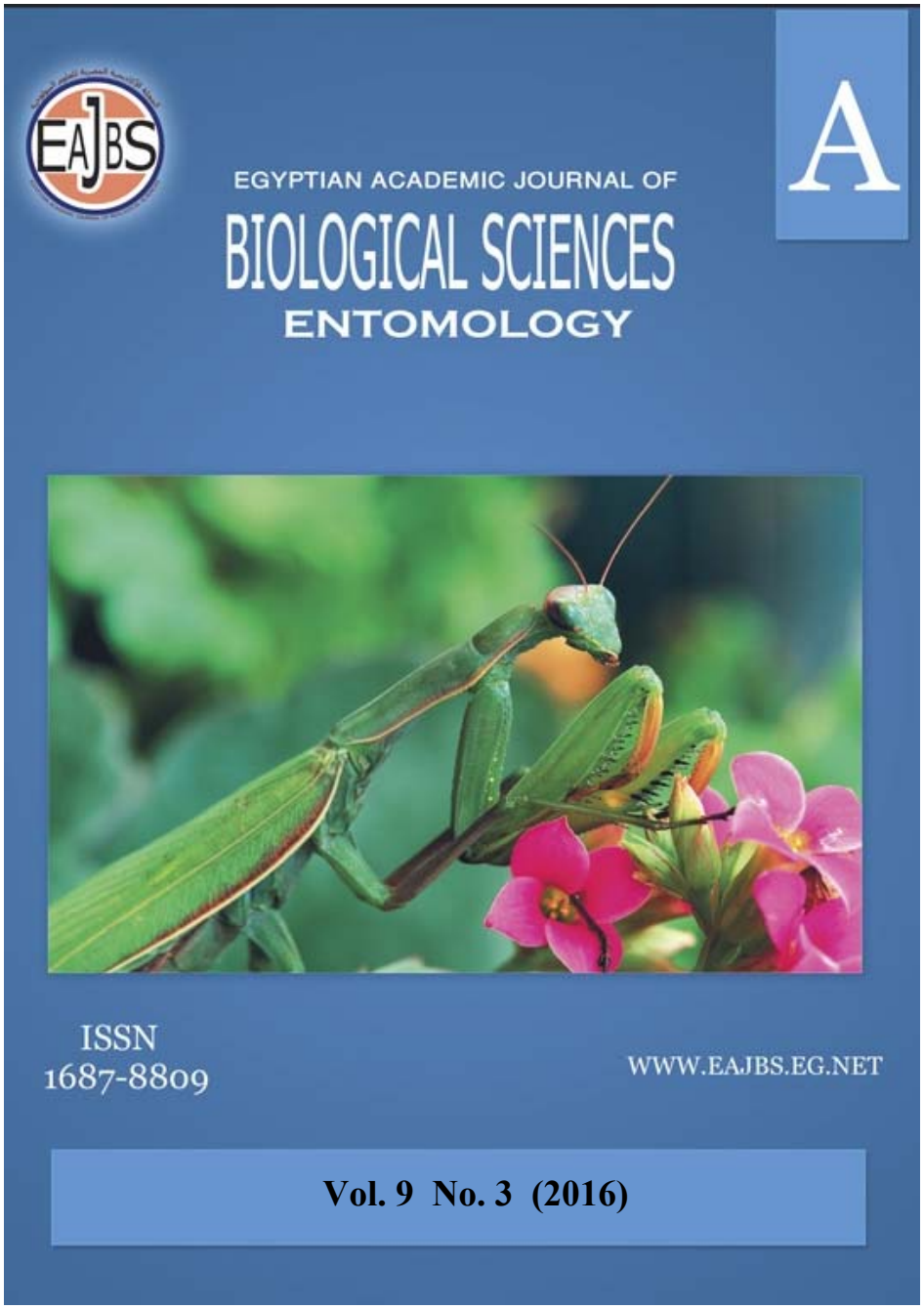

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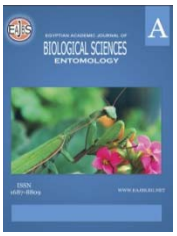

Morphology and Ultrastructure of the Sensilla of Larval Antennae and Mouth Parts of the Mediterranean Flour Mouth, *Ephestia kuehniella*zeller *(*lepidopetra: pyrilidae)

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ABSTRACT

The Mediterranean flour moth, *Ephestia kuehniella* (Lepidoptera: Pyrallidae) is one of the most destructive pests of flour, grains, baked goods and cereal products. The morphology of the larval antennae and mouthparts is described and illustrated with the aid of scanning electron microscopy, with particular focus on the sensilla. The antennae possess three types of sensilla: two sensilla chaetica, six sensilla basiconica, and a sensillum styloconicum. The labrum bears six pairs of sensilla chaetica. Each dentate mandible carries two sensilla chaetica on outer surface and five teeth.On the maxilla, both cardo and stipes carry one sensillum chaeticum. Each galea has three short-sharp sensilla basiconica, two large sensilla styloconica and three sensilla chaetica. The distal segment of the maxillary palp possesses seven sensilla basiconica, and one sensillun styloconicum. Each labial palp bears distally a cone-shaped sensillum chaeticum and an elongate sensillum styloconicum. In addition, the functions of these sensilla are discussed by comparing them with those of other Lepidopteran larvae.

INTRODUCTION

E. kuehniella (Mediterranean flour moth) caterpillars are a common pest, infesting grain, flour, baked goods and cereal products. They cause damage by eating especially the germ and bran from grain, and leaving frass, webbing, and body parts in stored dried foods. They are found in households as well as mills, warehouses, and processing plants. They are prolific spinners of silk which has made them a serious pest in flour mills. If left uncontrolled, the species may reach extreme population densities in suitable locations, such as mills, and the copious webbing which they produce blocks milling machinery, and interferes with production; large clumps of webbed flour also provide harbourage for other insect pests (Rees, 2003). In the Lepidopetra, the sensilla on the antennae and mouthparts have been documented in many pest speices for adult stage, since they are involved in semiochemical reception and are related to food seeking and food acceptance (Zacharuk and Shields, 1991).

The goal of the present study is to investigate the ultrastructure of the sensilla on the antennae and mouthparts of the larvae in *E. kuehniella*.

MATERIAL AND METHODS

The *E. kuehniella* larvae were obtained from infested wheat flour in Zagazig, Sharqia, Egypt. About ten fifth instar larvae were selected for analysis using scanning electron microscopy (SEM) investigation. All larvae were washed several times with distilled water and fixed in 10% formalin for a period of 12 h, dehydrated in various grades of alcohol, cleared in acetone, dried and fixed on metallic stub at different angels. Mouth parts fixed on stub were processed for gold coating and scanned under the Jeol/ EO, Version 1.0 (Instrument JSM-5500) Scanning Electron Microscope (SEM) at the regional center for Mycology and Biotechnology, Al- Azhar University, Egypt.

RESULTS

The head of the *E. kuehniella* mature larvae is strongly sclerotized capsule, oval in shape, and hypognathus, with the mandibulate mouth parts directed downwards. The frontal portion of the head capsule is supplied with the antennae and mouth parts (Fig. 1). The paired antennae are short and arise from a prominent membranous membrane base. The mouth parts are composed of labrum, a pair of mandible, a pair of maxillae, a labium and a hypopharynx. On each side of the head capsule there is a group of six stemmata, which are arranged in a loose circle above and lateral to the antennal base (Fig. 1).

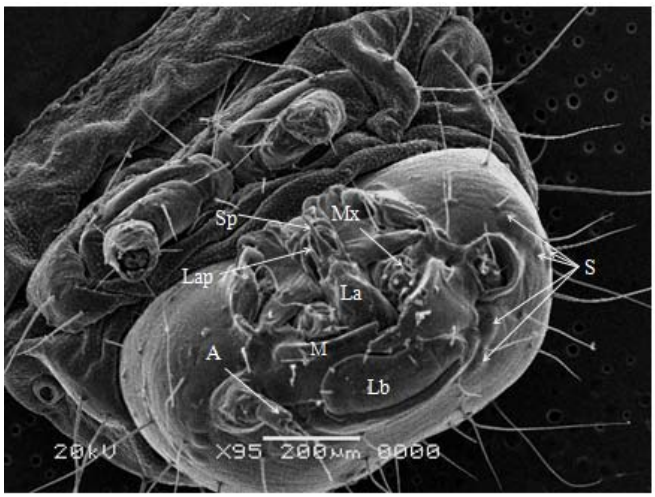

Fig.1: Ventrolateral view of the head of *E. kuehneilla* fifth instar larva. antenna (A); labrum (Lb); mandible (M); maxilla (MX); labium (La); labial palp (Lap); spinneret (Sp); Stemmata (S).

Antennae

The antennae are paired, segmented appendages that articulate with the cranium in the antennal socket (Fig. 2a). Three parts can usually recognized; the basal, or the first segment is the scape; the second segment is the pedicel; and the remaining segment is the flagellum (Fig. 2b). The sensillae are primarily on the tips of pedicel and flagellum. The basal scape is the broadest and longest segment, and devoid of any sensillae. The pedicel is long and carries three sensillae basiconica (B1-B3) and two sensillae chaetica (C1-C2) at its apex. B2 is much shorter than B1 and B3. Both

C1 and C2 are located at the distal margin of the pedicel. The apical flagellum is greatly reduced and borne distally along the dorsal margin of the pedicel. The flagellum bears an elongate sensillum styloconicum and three basiconica (B4-B6) (Fig. 2c).

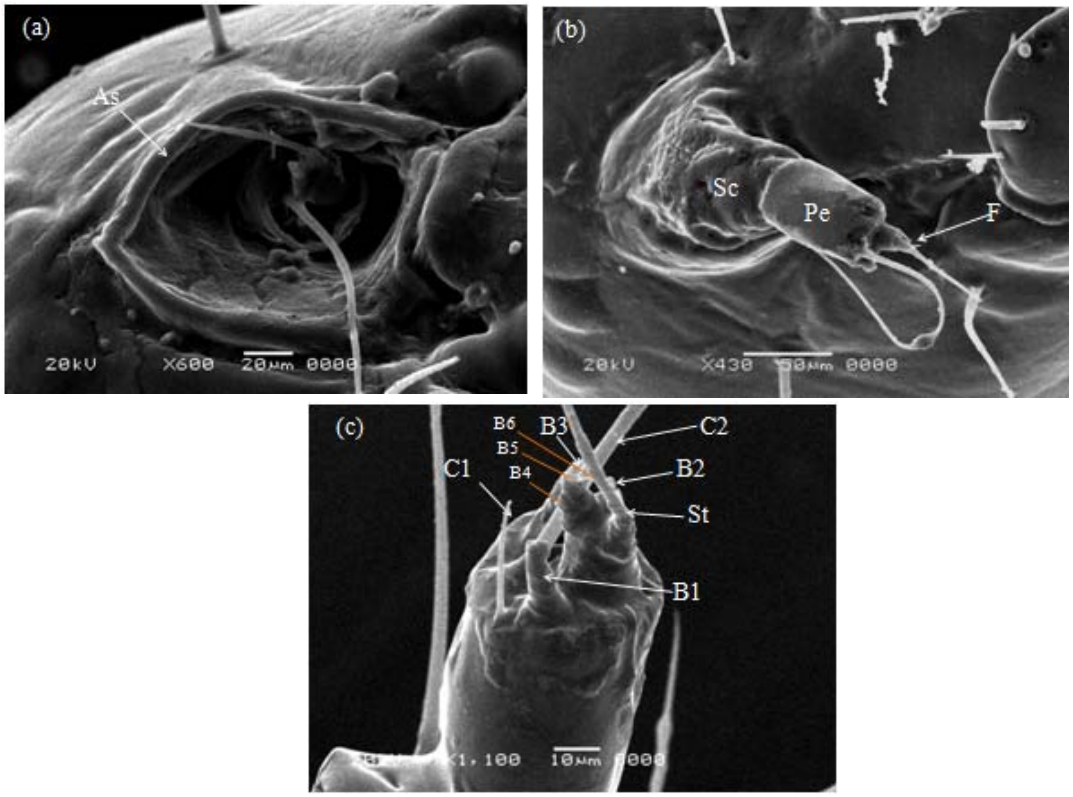

Fig. 2: Morphology and structure of the antenna of *E. kuehneilla*. (a) Antennal socket; (b) Ventral view of three segmented antenna (c) Ventral magnifying view of antenna, antennal socket (As); scape (Sc); pedicle (Pe); flagellum (F); Sensilla chaetica(C1-C2); sensillum styloconicum(St); sensilla basiconica(B1-B6).

Labrum

The labrum is well developed and roughly trapezoid, proximally articulated with the anteclypeus. The ventral margin of the labrum is slightly notched medially with six pairs of sensillaechaetica (C1- C6), (Fig. 3).

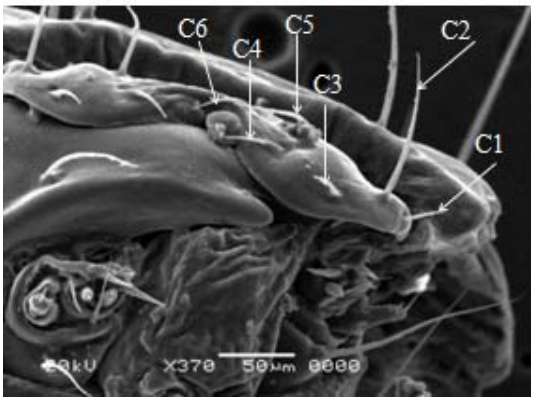

Fig. 3: Labrum of *E. kuehneilla* fifth instar larva. (a) Frontal view of labrum, showing six pairs of sensilla chaetica(C1-C6).

Mandibles

The mandibles are strongly developed and sclerotized, slightly excavated on the inner side and convex on the outer side. The apex of the mandible is strongly dentate, with five prominent incisor cusps (T1-T5).

Each mandible bears long sensilla chaetica (C1- C2) situated on the basal part of the outer surface along the anterior margin (Fig. 4).

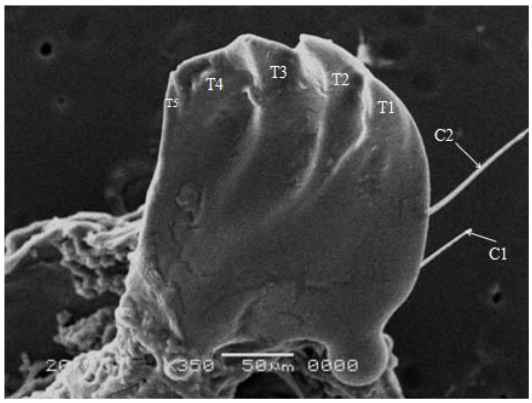

Fig. 4: Mandible of *E. kuehneilla* fifth instar larva. Inner view of mandible, showing five distal teeth (T1-T5) and two sensilla chaetica (C1- C2).

Maxillae

Each maxilla consists of a cardo, stipes, galea, and maxillary palp. The cardo and stipes each bears a sensillum chaeticum (Fig. 5a). The galea and the palp each carry an apical cluster of pegs. The galea carries seven sensilla on its distal surface: Two sensillaechaetica (C1 and C2), three flattened elongated sensilla basiconica (B1-B3), and two sensilla styloconica (St1 and St2) (Fig. 5b). Both of the sensilla styloconica have a small slender peg on the top of an elongate thick base. The maxillary palp is two segmented. The basal segment is long and wide at the base. The distal segment is long and carries eight sensilla on its terminal surface. Seven basiconica (B1- B7) and one styloconicum (St), (Fig. 5c).

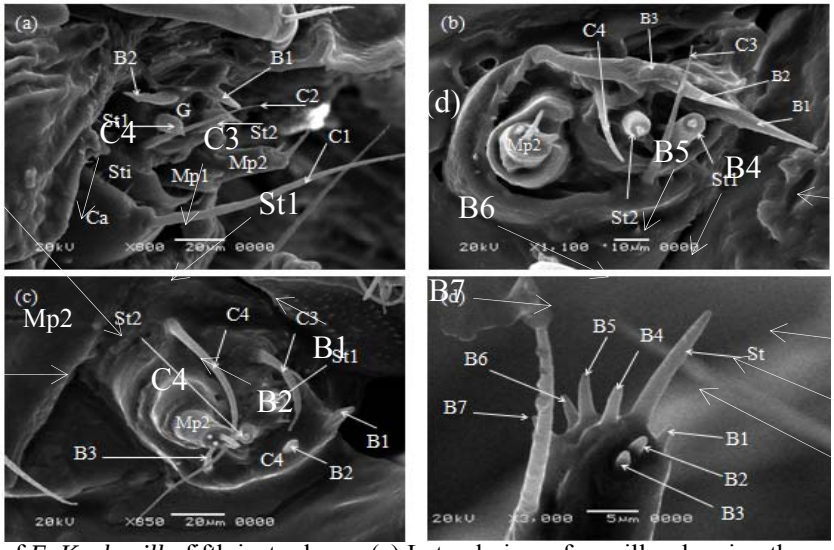

Fig. 5: Maxilla of *E. Kuehneilla* fifth instar larva. (a) Lateral view of maxilla, showing the cardo, (Ca); stipes,(Sti); sensilla chaetica (C1-C4), galea, (G); maxillary palps (Mp1-Mp2). (b& c) maxillary palps Distal view of the galea, showing two sensilla chaetica (C3-C4), three sensilla basiconica (B1-B3) and a two sensilla styloconica (St1-St2). (d) The distal segment of maxillary palp, showing seven sensilla basiconica (B1-B7) and a sensillum styloconicum (St).

Labium

The labium bears a pair of palps and a long tube- like spinneret, from which silk can be secreted by the larvae (Fig. 6a). The labial palp bears a long sensillum styloconicum and a short cone shaped sensillum chaeticum (Fig. 6b).

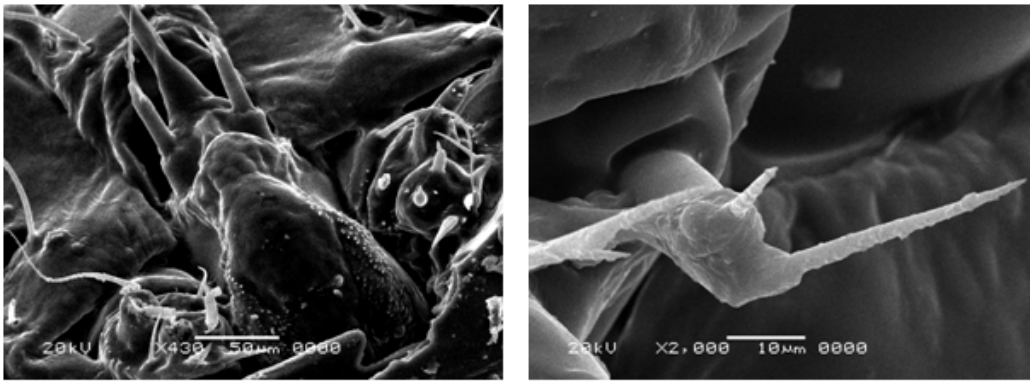

Fig. 6: Labium of *E. kuehneilla* fifth instar larva (a) The dorsal view of labium, showing two labial palps(Lap) and a spinnerete (Sp). (b) The magnifying view of labial palp, showing a sensillum chaeticum, (C) and a sensillum styloconicum, (St).

DISCUSSION

Insect sensilla play an important role in olfactory and gustatory sensation. The main function of antennae is olfactory in Lepidopteran larvae. The mouthpart of Lepidopetra larvae consists of various types of sensilla and play an important role in feeding behaviours during larval life. In this study, sensilla on the larval antenna and mouthparts were examined in *E. kuehniella* with scanning electron microscopy. The types, numbers, and distribution of sensilla were similar to *Grapholita molesta* (Song *et al.*, 2014) and to *Crposina sasakii* (Liu *et al*., 2011).Each antenna possesses three sensilla basiconica and two sensilla chaetica on the pedicle; three sensillabasiconica and one sensillum styloconicum on the distal flagellum. This results similar to *Pentateucha inouei* (Lin, 2002) even the morphological appearances are different. This kind of sensilla is reported to possess olfactory function (Hanson and Dethier,1973 ;Zacharuk, 1985). The sensilla chaetica are involved in tactile stimulus reception (Schoonhoven, 1967; Albert, 1980; Zacharuk, 1985; Baker *et al*., 1986; Faucheux, 1995) and sensilla styloconica are suggested as thermal detectors (Schoonhoven, 1967). We propose that the sensilla on *E.kuehneilla* larvae may also be involved in these functions.

The sensilla on the larval mouth parts of *E. kuehneilla*are partly similar to other lepidopteran insects, but differ somewhat in the sensillum number, distribution, and external morphology in comparison with other Lepidopterans. The most notable variation exists on the maxillae on each maxillary palp,*E. kuehneilla* possesses eight apical sensilla, seven sensilla basiconica and one styloconicum in contrast with eight sensilla basiconica in other Lepidoptera (Grimes and Neunzig, 1986b; Faucheux, 1995). The presence of apical basiconica on the maxillary palp might be playing similar role and function as gustatory. They are probably related to olfactory functions (Schoonhoven, 1972;Devitt and Smith, 1982) and may also have mechanoreceptory functions (Schoonhoven and Dethier, 1966). The sensilla styloconica plays a major rolein food recognition Ishikawa *et al.* (1969) as well as it is gustatory in nature. The sensilla styloconica and sensilla basiconica on the galea have been shown to be important chemosensory function for modifying feeding

behavior (Albert, 1980). The sensilla chaetica of the maxillae are tactile (Schoonhoven and Dethier, 1966; Hanson, 1970). In *E. kuehneilla* larvae, group of microtrichia is present on the maxilla and labium are similar to microtrichia described on the labrum of *Acheta domesticus* (Rohr, 1882).On the labrum, there are six pairs of sensilla chaetica, which are similar to other Lepidoptera and are reported to have mechanical function (Davis *et al*., 2008; Kent and Hildebrand, 1987; Nielsen and Kristensen, 1989).

The two sensilla chaetica on the mandible are mechanoreceptors (Albert, 1980;Kent and Hildebrand, 1987). Each mandible bears five teeth for cutting offpieces of food and crushing them. The two sensilla on labial palps were shown to be mechanoreceptors (Albert, 1980; Devitt and Smith, 1982 and Faucheux, 1995).

The description and illustration of sensilla types in *E. kuehneilla* will consider as abases for future aiming to understand feeding behavior and preferences with a promising to the development of future control method.

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RABIC SUMMERY

الشكل الظاهري والتركيب الدقيق للشعيرات الحسيه في قرون الاستشعار وأجزاء الفم ليرقه فراشه البحرالمتوسط ، *افستياكونيلا*زيلر (حرشفيه الاجنحه : بيراليدي)

كريمة شكرى خاطر
قسم علم الحيوان – كلية العلوم – جامعة الزقازيق

إن فراشه البحر المتوسط (افستياكونيلا) إحدي الافات الضاره للدقيق والحبوب ومنتجات الحبوب. فى هذا البحث تم وصف الشكل الظاهري لقرون الاستشعار واجزاء الفم للعمر اليرقى الخامس لفراشة البحر المتوسط بواسطه الميكرسكوب الماسح مع التركيزعلي الخلايا الحسيه.

من خلال الدراسة وجدت ثلاثة انواع من الشعيرات الحسيه علي قرون الاستشعار: اثنين من الشعيرات الحسيه وسته من الشعيرات الحسيه مخروطيه القاعد هو واحد من الشعيرات الحسيه مخروطيه الساق. ويخرج من الشفه العليا ستهازواجمن الاشواك الحسيه. ولوحظ ان الفك مسننو به خمسه اسنان ويحمل اثنين من الاشواك الحسيه علي السطح الخارجي. ووجد ان كلم نقاعدة الفك (الكاردو) وساق الفك (الاستيبس) في الفك السفلي تحمل شوكه حسيه واحده. ومن جهة اخرى وجد ان كل خوذة (جاليا) بها ثلاثه شعيرات حسيه مخروطيه القاعده مدببه واثنين من الشعيرات الحسيه مخروطيه الساق وثلاثه اشواك حسيه والجزء البعيد من الملماس الفكي به سبعه من الشعيرات الحسيه مخروطيه القاعد هوواحد من الشعيرات الحسيه مخروطيه الساق. وايضا كل ملماسشف ويتخرج من هشوكه تشبه المخروط وشعره حسيه مخروطيه الساق. وقد تمت مناقشة وظائف هذه الشعيرات الحسيه مع الانواع الاخري من يرقات الفراشات.