

## INTERNAL ANATOMY OF DIGESTIVE SYSTEM OF DIFFERENT STAGES OF THE RED PALM WEEVIL, *RHYNCHOPHORUS FERRUGINEUS* (OLIV.) (COLEOPTERA : CURCULIONIDAE).

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(Received: May 20, 2014)

**ABSTRACT:** *The red palm weevil, Rhynchophorus ferrugineus (Oliv.) is a notorious insect pest of palm trees especially date palm, worldwide. The understanding of digestive system anatomy and function is essential for advanced techniques of pest management such as entomopathogenic agents and enzyme inhibitors. Structure of the larval and adult digestive system is described. The crop of adult stage has several spine-like structures on its internal surface. The results of these study revealed that the alimentary canal was structurally adapted to breaking, grinding and digest its food for extracting and obtaining its nutritional requirements.*

**Key words :** *Morphology, digestive system ; Rhynchophorus ferrugineus (Oliv.); dissection; date palm.*

### INTRODUCTION

Digestive system in the living animals is one of the most important systems of the body. The digestive canal of insects is an important natural physical and chemical defense barrier against pathogen invasion. Generally, alimentary canal of insects consists of three parts namely as foregut, midgut and hindgut. These parts have obviously differences among species because of variation of food habits (Chapman, 1985; Levy *et al.*, 2008, and Omotoso, 2013 ). Sánchez *et al.*, (2000) mentioned that the proventriculus of *Rhynchophorus palmarum* (L.) shows numerous cuticular internal projections which close the lumen acting as filter. The crop of *Rhynchophorus phoenicis* Fabricius is big or small and the proventriculus had bristle teeth which the insect used in mechanical breakdown of ingested food. Also, the midgut is the longest part of the alimentary tract (Omotoso, 2013). Red palm weevil is one of the most serious pests which attack palm trees specially date palm. It feeds on trunk of palm causing the breaking of the palm trees. Understanding of digestive system anatomy and function is essential for advanced techniques of pest management such as entomopathogenic agents and enzyme inhibitors. Little Data is known about alimentary canal morphology. The purpose of the present work was to

provide information on morphology of the alimentary tract of larval, pupal and adult stages.

### MATERIALS AND METHODS

This research was carried out at Department of Plant Protection, Faculty of Agriculture, Fayoum University, Egypt. Samples of fifth larval instar, pupae and newly emerged adults of red palm weevil were obtained from infested date palm trees in the field. In the laboratory, each stage was separated in plastic containers and covered with perforated lids. Larval and adult stages were provided with merstemic logs of palm and incubated under laboratory conditions. The alimentary canal of larvae, pupae and adults were prepared according to methods described by Adedire (2002). Insects were anaesthetized in deep freeze at 0.0 °C for 30 minutes to immobilize them before dissecting, then adult wings, legs and antennae were removed with fine scissors.

The insects (larvae, pupae and adults) were carefully dissected in Ringer's solution with aid of a pair of the fine forceps and the digestive system was isolated. Dissecting and examination carried out by using a dissecting stereomicroscope. Isolated samples were fixed in Boun's solution. The guts were stained with Nigrosin stain for one minute and thereafter washed in tap water

for 3 times to remove the excess of stain. The alimentary canal was placed on glass slide and its parts were separated.

To remove the salivary glands, 6<sup>th</sup> instar larvae were obtained from laboratory stock culture and dissected dorsally from the body end and transversally at the neck. Salivary glands were separated by cut the crop and towing the head, and scattered onto glass Petri dish. Photographs of the digestive system parts were took with digital microscope.

## RESULTS AND DISCUSSION

### Morphology of the alimentary canal:

The general structure of the alimentary canal of *Rhynchophorus ferrugineus* larvae and adults are tubular with widened parts which supported with numerous tracheae, tracheoles and aerial sacs. The length of the whole alimentary canal is about two folds that of the insect body (Table 1). The length of foregut midgut and hindgut resembles 17.2, 53.4 and 27.6% of the total length of adult alimentary canal, while it occupies 22.3, 50.1 and 27.5 % for larval alimentary canal, respectively. Results agree with some authors such Wigglesworth, (1972),

Rubio-Gomez *et al.*, (2008) and Sarwade *et al.*, (2013) who mentioned that midgut is the largest and longest division of the alimentary canal. Concerning adult and larval stages, it found that the length of larval alimentary canal is 1.2 folds that of adult weevil (Table 1 and Fig. 1).

The foregut extends from mouth parts to cardiac valve including bucal cavity (Fig.2), pharynx, esophagus. The esophagus is long and terminates with a crop. Crop connects in its base with strong proventriculus where food is pulverized. It found that the shape and size of crop and proventriculus of larvae deferent from those of pupa and adults, where the crop of pupae and adults is smaller than that of larvae. The internal surface of the adult crop shows several yellowish brown spine-like structures which ranged in 8 longitudinal rows and oriented to behind, while the crop of larvae was membranous large sac in which the food is stored. The proventriculus of larvae is very small, while that of adult is enlarging, hardest and sclerotized section of the alimentary canal. The proventriculus is supported by eight sclerotized projections on its internal surface (Figs. 3, 4 ).

**Table (1). Measurements of alimentary canal parts of the red palm weevil larval and adult stages.**

Parameter	Measurements(cm)	
	Mean ± SD	
	(range)	
	Adult	larvae
Foregut	1.2 ± 0.038 (1.00-1.40)	1.88 ± 0.044 (1.70-2.10)
Midgut	3.73 ± 0.13 ( 3.6-4.3 )	4.15 ± 0.042 (4.00-4.30)
Hindgut	1.93 ± 0.67 (1.70-2.10)	2.28 ± 0.064 (2.00-2.60)
Alimentary canal length	6.99 ± 0.017 (6.40-8.00)	8.28 ± 0.079 (7.90-8.70)

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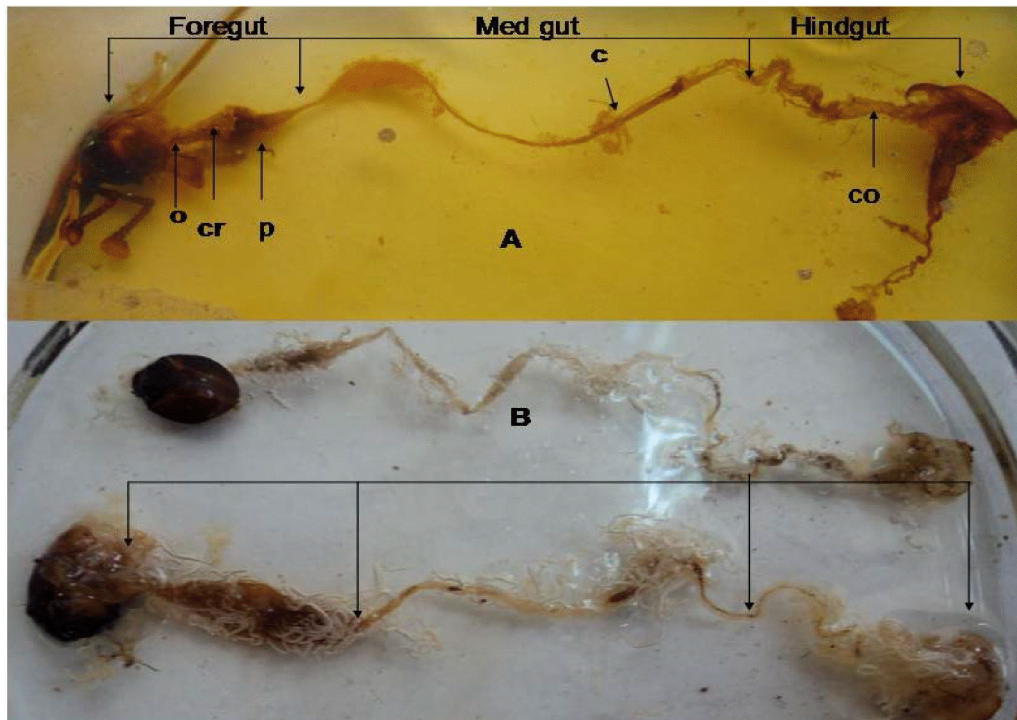


Fig. (1). Morphology of the alimentary canal of larval and adult stages of *R. ferrugineus*:  
 A) Adult stage : (o) esophagus, (cr) crop (p) proventriculus (c) gastric caecum (co) colon.  
 B) larval stage.

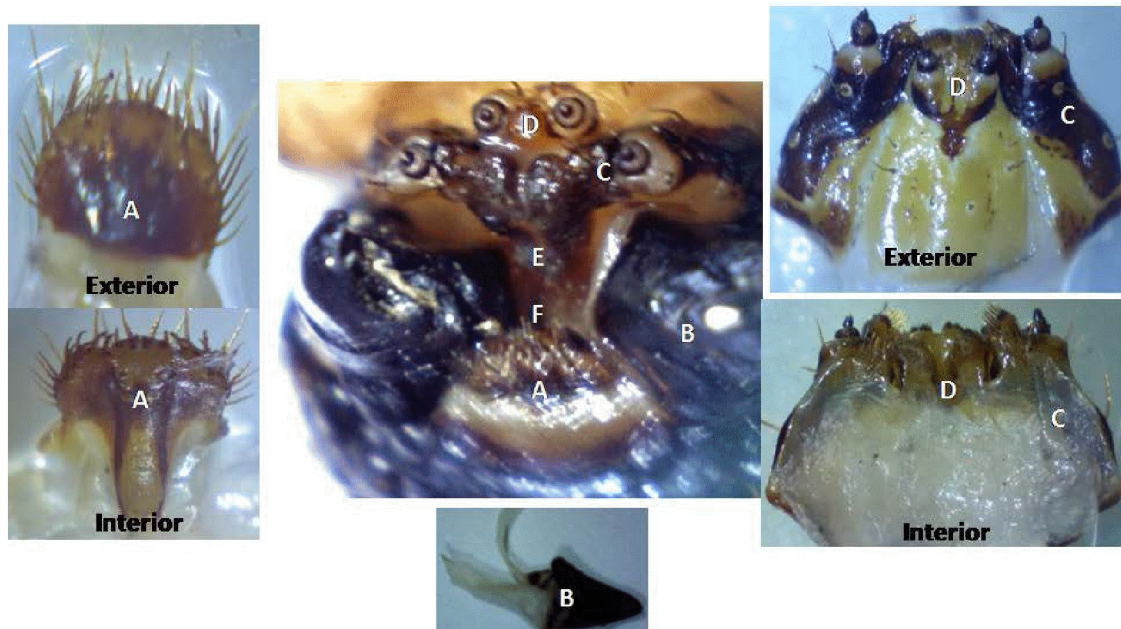


Fig. (2). *R. ferrugineus* mouth parts and bucal cavity:  
 A, labium; B, mandible; C, maxilla; D, labrium; E, epypharynx; F, bucal cavity.



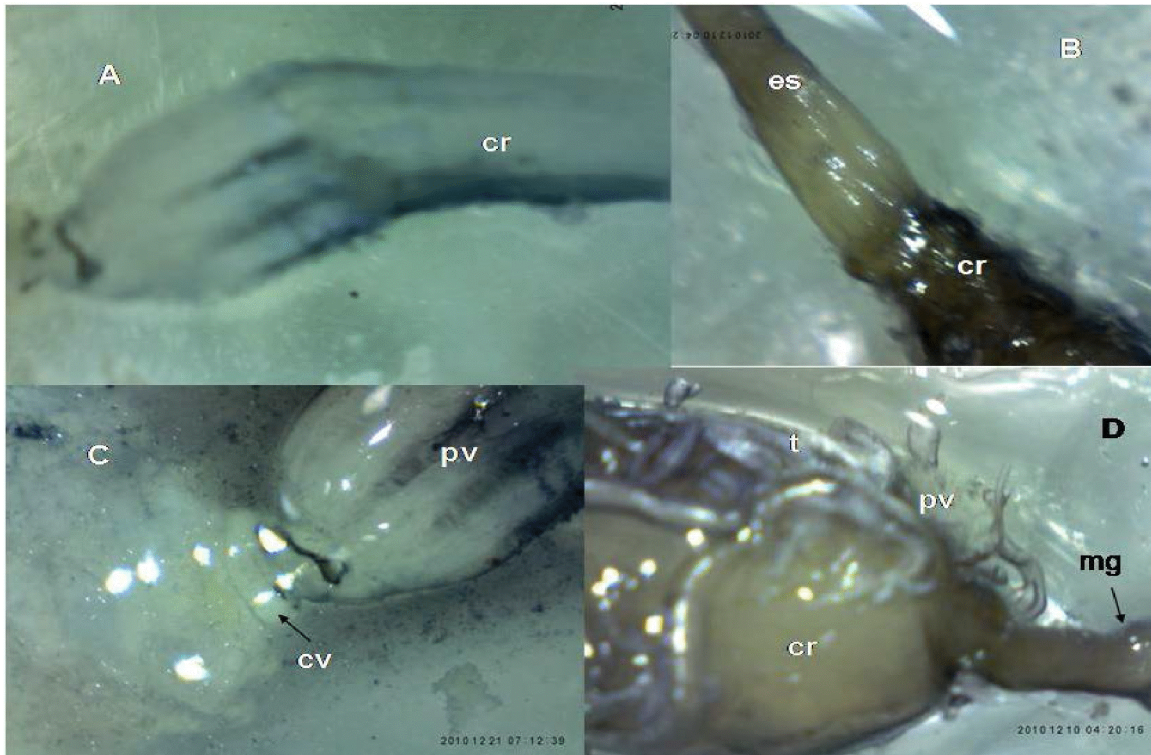


Fig. (3). Morphology of foregut of *R. ferrugineus* A) old pupal stage (cr) crop, B) adult stage; (es) esophagus, (cr) crop, C) pupal stage; (pv) proventriculus, (cv) cardiac valve, D) larval stage; (cr) crop, (pv) proventriculus, (mg) midgut.

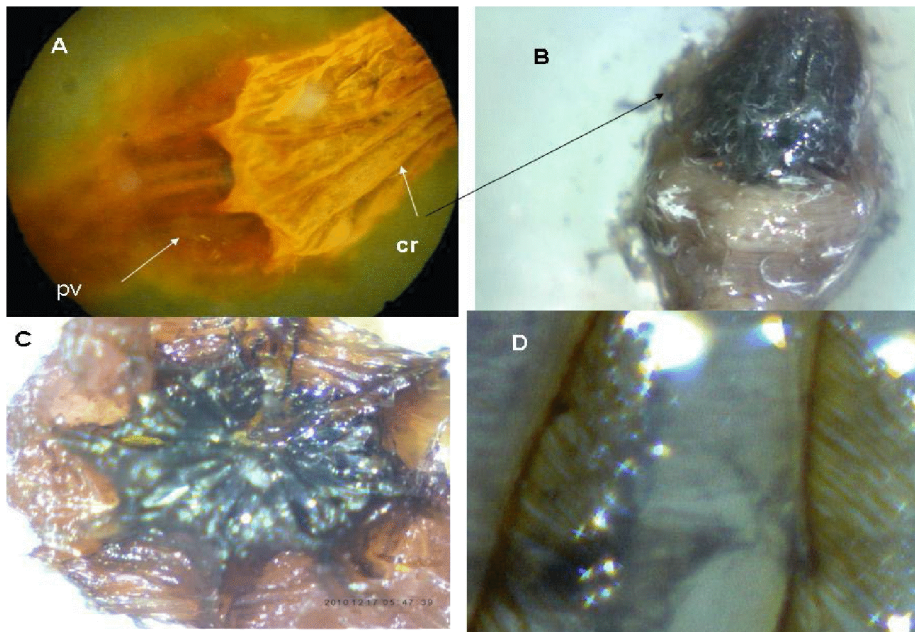


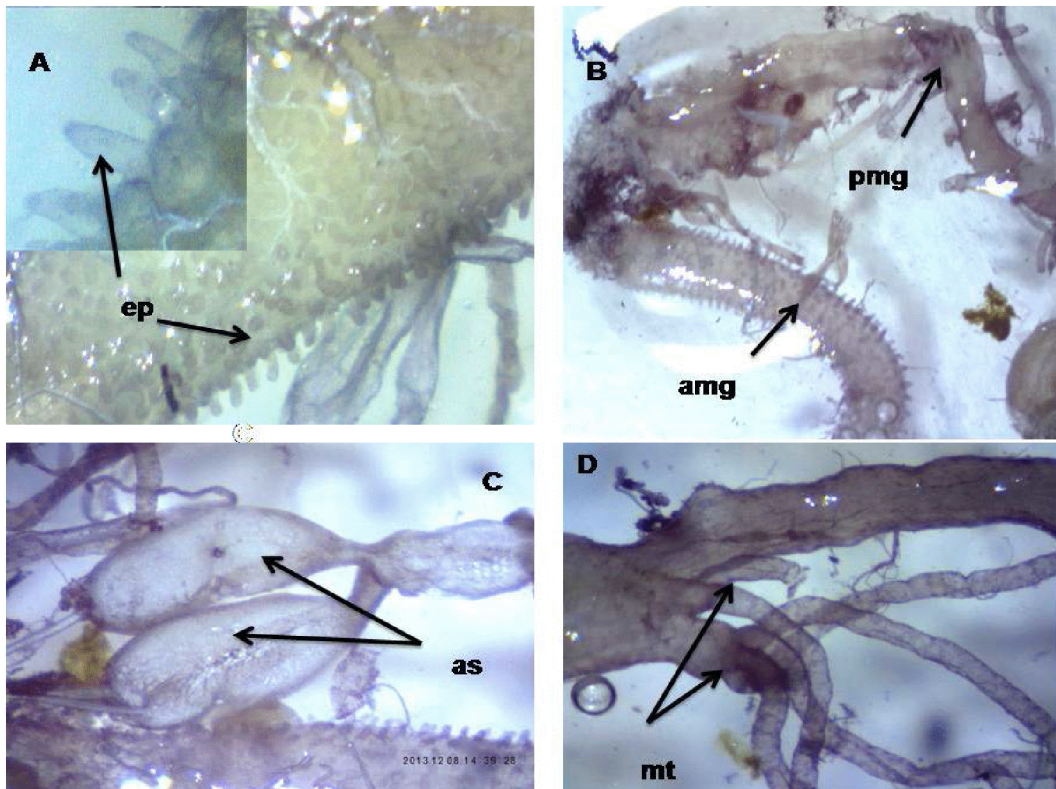
Fig. (4). Crop and proventriculus structure of adult. A and B: lateral view, C: transversal section of proventriculus, D: spine-like projections on internal surface of crop.

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The hindgut starts with the portion of malpighian tubules where the pyloric valve is found. Malpighian tubules consist of six long tubules in two groups; the first contains four and connect with alimentary canal by single and short common duct, while the other two tubules connect directly and separately with the beginning of hind gut (Figs. 5,6). The hind gut consists of two regions, the ileum which starts from pyloric valve and ends with colon. The colon is enlarged and surrounded by a group of muscles that aid in the peristaltic movements. The colon ends with rectum, which more sclerotized section and opens in anus. For larvae, the hindgut consists of ileum and colon. Ileum contains enlarged location filled with food and ends with narrow area where it connects with the second section ( colon ). The colon is enlarged and provided with transversal muscles (Fig. 7).

**Salivary glands :**

Results of anatomy of 6<sup>th</sup> instar larvae under light microscope demonstrated that the salivary glands is almost  $\frac{3}{4}$  length of the alimentary canal where the length is about 6.3 cm. The salivary gland consists of a pair of simple long white opaque tubules situated on either side of the foregut and extended to the posterior midgut region. A thin short and narrow efferent duct emerges from the anterior of each gland and unites together to form a translucent single median common deferent duct, which inserted in the dorsal cephalopharyngeal skeleton (Fig. 8). The glands are bathed in haemolymph and surrounded by fatty bodies. These results agree with that mentioned by Roelfstra *et al.*, (2010) on larval stage of *G. intestinalis* , Abdel-Meguid *et al.*, (2013) on larvae of *Cephalopina titillator*. and Nurul Hidayah *et al.*, (2013) on *R. ferrugineus* who mentioned that the morphology of the gland was found to be a tubular type.



**Fig. (5). Morphology of adult midgut:**

**A) anterior midgut (ep) external projections; B) (amg) anterior midgut (pmg) posterior midgut; C) air sacs supported anterior midgut; D) malpighian tubules (mt).**



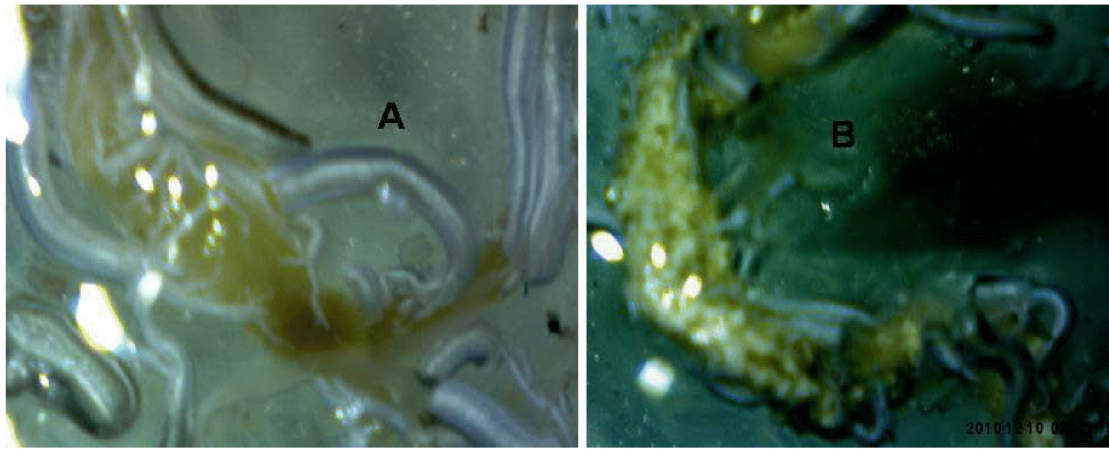


Fig. (6). Morphology of posterior part of larval stage of midgut:  
A & B ) midgut is supported with tracheae and filled with food particles.

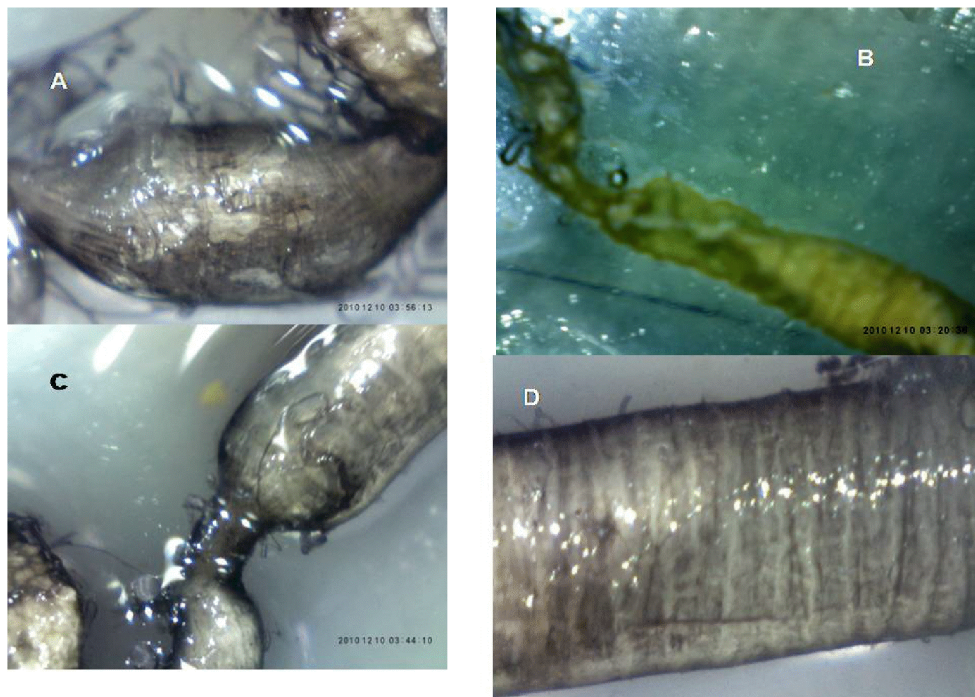


Fig. (7). Morphology of larval and adult stages of hind gut:  
A) enlarged part filled with food  
B) connection portion ileum and colon in larvae  
C) connection portion ileum and colon in adult  
D) lateral view of colon and its circular muscles.

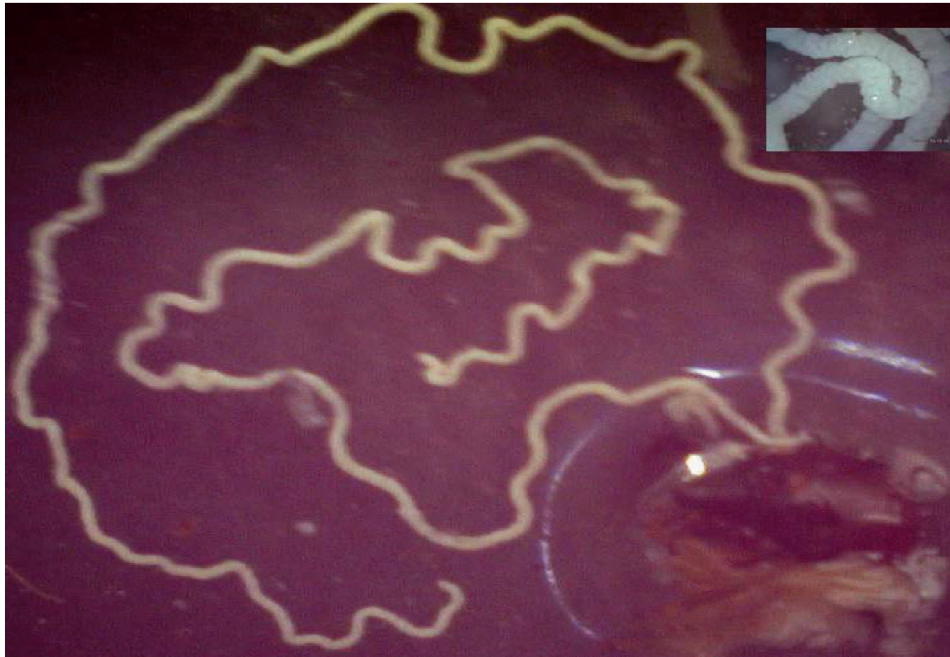


Fig. (8). Salivary glands of 6<sup>th</sup> larval instar of the red palm weevil.

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## التشريح الداخلي للجهاز الهضمي للافطوار المختلفة لسوسة النخيل الحمراء

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### الملخص العربي

تعتبر سوسة النخيل الحمراء (*Rhynchophorus ferrugineus* (Oliv.)) آفة حشرية مشهورة على أشجار النخيل خاصة نخيل البلح على مستوى العالم. من الضروري فهم تشريح الجهاز الهضمي من أجل استخدام التقنيات المتقدمة للمكافحة المتكاملة للآفات مثل المواد الممرضة للحشرات و مثبطات الأنزيمات. وقد تم وصف الجهاز الهضمي لكل من اليرقات و الحشرات الكاملة . تحتوي حوصلة الحشرات الكاملة على تراكيب تشبه الأشواك على السطح الداخلي. وقد اوضحت نتائج هذه الدراسة أن القناة الهضمية تحورت تركيبيا لتقطيع و طحن و هضم الغذاء لإستخلاص و الحصول على احتياجاتها الغذائية.