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Internal Morphology and Comparison between the Reproductive Systems of Solitary Carpenter Moth, *Paropta paradoxa* (Herrich-Schaffer) and Leopard Moth, *Zeuzera pyrina* (L.) (Lepidoptera :Cossidae).

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ABSTRACT

Because of the economic importance of the solitary carpenter moth, *Paropta paradoxa* (Herrich-Schaffer) and leopard moth, *Zeuzera pyrina* (L.) (Lepidoptera: Cossidae) on grapevine, fig, apple, olive, pear trees, the male and female reproductive systems were described and illustrated. They are similar to that of the other lepidopterous insects with a little variation. Accessory glands are longer and its reservoirs are larger compared with several species of Lepidoptera. Concerning *P. paradoxa* and *Z. pyrina* species, the most differences include accessory glands, accessory gland reservoirs, length and shape of male genitalia and aedeagus tips.

Keywords: internal morphology, reproductive system; *Paropta paradoxa*; *Zeuzera pyrina*; accessory glands; ductus ejaculatoris duplex; ductus ejaculatoris simplex.

INTRODUCTION

The solitary carpenter moth, *Paropta paradoxa* (Herrich-Schaffer) (Cossidae) considered a serious damaging borer on apples, grapevine, fig and trees.. After hatching, the newly hatched larvae move on the surface of tree branches searching for suitable sites. The young larvae feed directly under host bark, while the older instars bore into stems causing longitudinal cylindrical tunnels in the main stems and branches (Shehata *et al*., 1999).The leopard moth, *Zeuzera payrina* (L.) attacks many fruit trees such as apple, pear, peach and olive. Recently, it caused serious yield losses in newly established olive orchards in Egypt including the death of young trees (Hegazi *et al*., 2010). Concerning reproductive systems morphology, Arturo and Celina (2015) mentioned that a few differences were found in female reproductive system *Comadia redtenbacheri* (Hammerschmidt) (cossidae) compared with other Lepidoptera.

Knowledge of the internal morphology of the reproductive systems is important to biological and sex pheromone studies. Tell now little studies have been reported on the internal morphology of reproductive organs of Cossidae. In this study, we describe the anatomical morphology and compare between male and female reproductive systems of *P. paradoxa* and *Z. pyrina* to support the researchers in reproduction and biological field with some basic data.

MATERIALS AND METHODS

The larvae and pupae of *paropta paradoxa* and *zeuzera payrina* borers were collected from vine and willow trees during October 2015 from Dar Elramad and Fedemeen villages, Fayoum Governorate. These specimens were kept individually in cylindrical containers (6cm in diameter and 15cm in height) and provided with two of host cuttings (5 cm) as food. The samples were examined every three days to replace the cuttings with new ones and clean the containers until adult emergence.The adult moths were collected and placed in chimney glass cage. Cages were provided with 10 % sugar solution as food. Used Males and females as anatomical material were alive and virgin.

Adults were prepared to dissection by cutting antennae, legs and wings and cleaning the body from scales under tap water. After that they were dissected in Ringer solution (6.5g sodium chloride, 0.14g potassium chloride, 0.12g calcium chloride, 0.2g sodium carbonate, and diluted with1000 distilled water) under stereomicroscope. The reproductive systems were isolated and placed on glass slide. Each specimen was cleaned from fatty bodies and its parts were separated by insulin syringe in sequenced changes of dissecting solution. The isolated organs were stained with Nigrosin or Giemsa stains, measured, described and it's photographed using a computer and video microscope digital.

RESULTS AND DISCUSSION

Female reproductive systems.

The internal structure of *P. paradoxa* and *Z. pyrina* reproductive systems (Figs.1A, 1B and 2 A) are composed of a pair of ovaries,a pair of lateral oviducts, one common oviduct, spermatheca, accessory glands and vagina. Each ovary (ov) consists of four ovarioles (o) arestabilized within the abdomen with fine tracheae and fatty bodies. Also, ovarioles of each ovary hold together with the same manner. The length of overioles ranged from 2.1 to 2.7cm in *P paradoxa* and 2.9 to3.2cmin *Z. pyrina*. Each ovariole composed of thin membranous Tunica propria which contains average of 16 oocytes in *P. paradox* and 27 oocytes in *Z. pyrina*.

The filament (f) and germarium zone (gr) of overioles are opaque white in color while the growth and mature zones (vitillarium) (vt) contain reddish Oocytes (Oo) in *P. paradoxa* and whitish Oocytes in *Z. pyrina*.Ovarioles of each ovary connect to lateral oviduct (lod) in calyx portion. Paired lateral oviduct connects slightly before vagina where the common oviduct (cod) is differentiated. The average lengthsof lateral oviduct were 3 and 2.6 mm, while those of common oviduct were 1.2mm and 1.2 for *P. paradoxa* and *Z. pyrina* respectively (Figs. 1B and 2B).

Spermatheca composed of spermathecal gland, spermathecal chamber and spermathecal duct. Spermathecal gland (spg) is narrow membranous, tubular in shape and opaque white in color. Spermathecal chamber (spc) arises from spermathecal gland as membranous sac

and opens through the spermathecal duct. Spermathecal duct (spd) is a tubular part which attaches sideward with vagina nearby common oviduct and distally connects to spermathecal chamber.

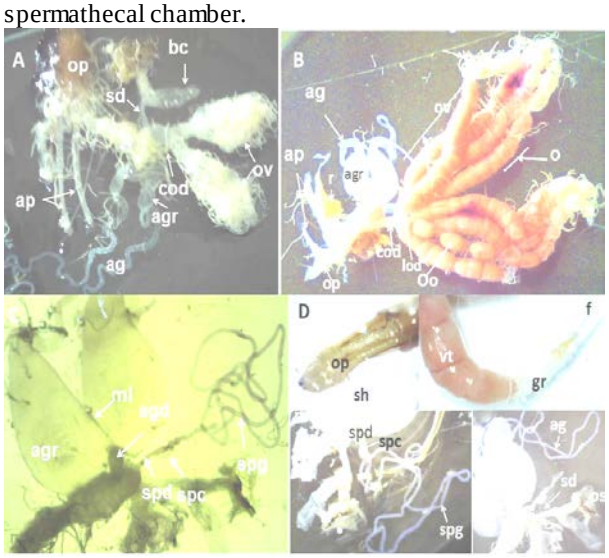

Fig. 1. A, op, ovipositor; ov, ovary;bc, bursae copulatrix ; sd, seminal duct;cod, common oviduct; ag, accessory glands; agr, accessory gland reservoirs; ap, anterior apophyes B) op, ovipositor; ap, anterior apophyes; ag, accessory glands; agr, accessory gland reservoirs; cod, common oviduct; lod, lateral oviduct; Oo, Oocytes; ov, ovary;o, overioles C) spg, spermathecal gland; spc, spermathecal chamber; spd , spermathecal duct; agd, accessory gland duct; agr, accessory gland reservoirs; ml midline D) ov, ovipositor; sh, sensory hairs; vt, vitellarium; gr, germarium; f, filament; sd, seminal duct;os, ostiumbursae; spg, spermathecal gland; spc, spermathecal chamber;spd , spermathecal duct.

Accessory glands: generally, accessory glands in both species composed of three obvious parts. Common accessory glands duct (cagd), accessory glands reservoir (agr) and accessory glands (ag). *P. paradoxa* female has a short Common accessory gland duct which arises directly from its distal end pair of accessory gland reservoirs. Theses reservoirs are membranous swollen, enlarged and fused in the proximal part and separate in the distal part. From the anterior end of each lateral reservoir, one elongate,tubular and opaque white accessory gland arises and is folded together with spermathecal gland several times in vagina and bursa copulatrix location (Fig.1A, 1B, 1C). In *Z. pyrina* reproductive system, the common accessory gland duct attaches to vagina in the same side and below the spermatheca portion and distally expands toform a pair of zigzag lateral accessory gland ducts. Each lateral accessory gland duct swellsforming lateral kidney-shaped and membranous accessory gland reservoir. The distal end of each reservoir connects with a tubular and long accessory gland. On each of accessory glands and nearby their junction with reservoirs, eight short external invaginations were showed(fig. 2C and 2D). The lengths of common accessory gland duct, lateral accessory gland duct, reservoirs, accessory gland were0.9mm, 2.5mm, 6mmand 2.4cm,respectively in *Z. pyrina*.The contraction and dilation of accessory gland reservoirs in *P. paradoxa* depending on sexual maturity of adults. The reservoir is contracted in premature females (Fig. 1A), while it is dilate in mature ones (Fig.1 B and 1C). Arturo and Celina (2015) mentioned the glandular portion of accessory glands is unusually long compared with that of other Lepidoptera.

Bursa copulatrix(bc) is a large and membranous organ. It consists of corpus bursae, bursae duct(bd) and seminal duct (sd). Bursae open externally in the intersegmental membrane through ostium burae (os). Seminal duct arises from the apex of corpus bursae as a whitish tube and attaches to virgin (v) in the reverse side of spermatheca and accessory gland. It has not a bolla seminalis. Wang *et al.*, (2015) stated that no bolla seminals is showed in *Dioryctria rubella* Hampson seminal duct. The length ofseminal duct is 6 and 8 mm for *P. paradoxa* and *Z. pyrina*, respectively (Figs. 1A, 1B and 2B).

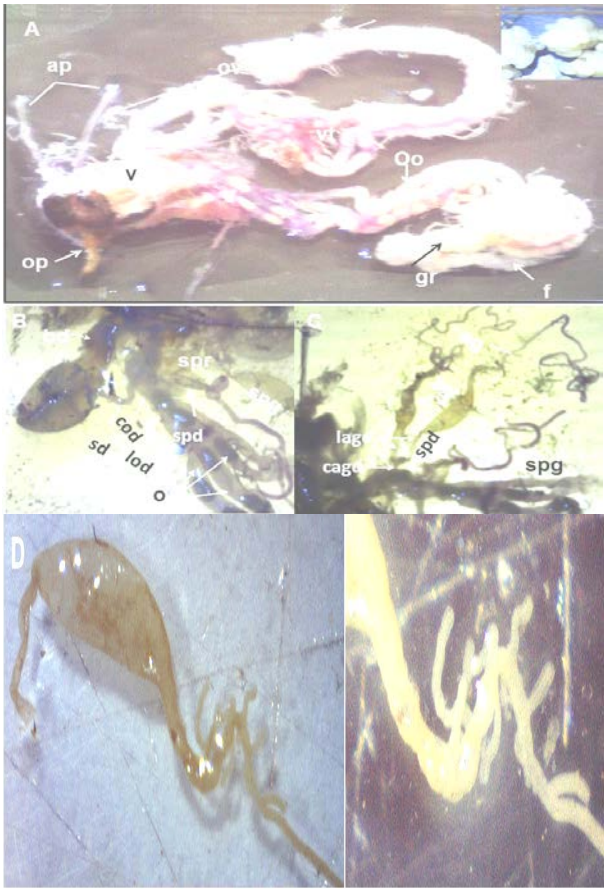

Fig. 2. A, ap, anterior apophyes; ov, ovary; vt, vitillarium; Oo, Oocytes; f, filament; gr, germarium; v, vagina; op, ovipositor B) bc, bursae copulatrix ; bd, bursae duct; sd, seminal duct; cod, common oviduct; lod, lateral oviduct; spr, spermathecal chamber; spd , spermathecal duct; spg, spermathec algland; o, overioles C) ag, accessory glands; agr, accessory gland reservoirs; lagd, lateral duct of accessory glands; cagd, common duct of accessory glands D) accessory gland and its invaginations.

Also, there are pair of sclerites in 8th segment of abdomen, which bear two anterior apophyses (ap). There are several sensory hairs on the terminal part of the ovipositor. In *Z. pyrina* (fig. 3B) the terminal part of the ovipositor is more taper and has more numbers of hairs than that of *P. paradoxa* (Fig. 3A).

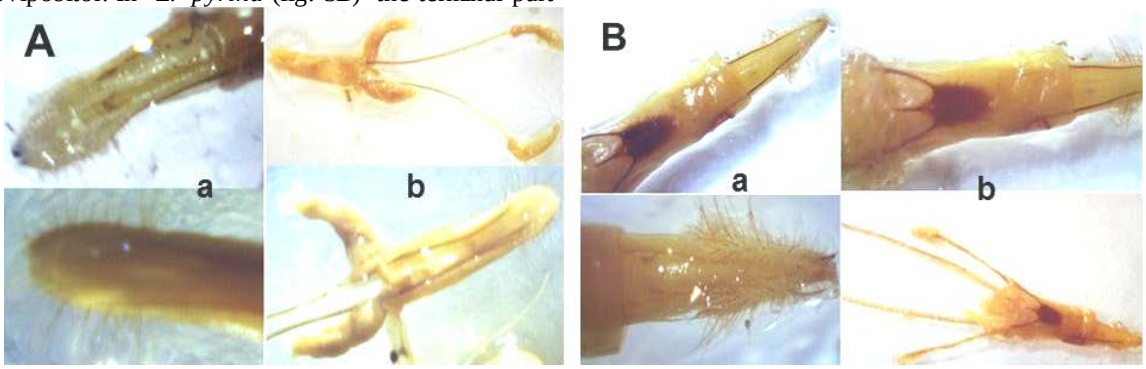

Fig. 3. A, *P. paradoxa* (a, ovipositor; b, apophyses) B) *Z. pyrina* (a, ovipositor; b, apophyses).

Male reproductive systems

Generally, the male reproductive organs of *P. paradoxa* and *Z. pyrina* (Figs. 4A&5A) are similar to that of other Lepidoptera where they composed of a pair accessory glands, a pair vasa deferentia, two testes, ductus ejaculatoris duplex, ductus ejaculatoris simplex and aedeagus. The two fused testes (t) are inclosed in a thin and transarant sheeth(scrotum). Fused testes is distinguished as spherical yelowish body. The most obovious difference presence brown line (ml) dividestestesinto two equal divisionson the dorsal surface of *Z. pyrina* testes, whereas this line is disappered on *P. paradoxa* testes. The vasa deferentia (vd) of *P. paradoxa* (4A and 4B) and *Z. pyrina* (5A and 5C) arise from the ventral surface of testes and join ductus ejaculatoris duplex. Each vas deferens become swollen in certain regions according to insecct species to form seminal vesicle (sv).

The seminal vesicle in *P. paradoxa* appear as slight dilation in in the upper region directly below testes, while it is asignificant dilation in the lower part of vas deferens in *Z. pyrina*. The shape and location of seminal vesicle is one of the significant differnces between male reproductive systems of *P. paradoxa* and *Z. pyrina*. The accessory glands are long, uniform and opaque whitish tubules the lengths of accessory glands range 1.7 to 2.o and 1.5 to 1.9 in *P. paradoxa* and *Z. pyrina* reproductive systems, respectively. They are in close contact throughout the most of their length but not fused (fig.(figs.4A, B and5A).

Ductus ejaculatoris duplex (ded) is the shortest part of the male reproductive tract (Figs.4A, B and 5A, B).It is opaque white in color and average length of 1.6cm in *P. paradoxa*and 1.9cm in *Z. pyrina*. The ductus ejaculaturis duplex extends anteriorly to join with a pair of accessory glands and connected posteriorly with ductus ejaculatoris simplex. In the third part nearby semplex arise a pair of vasa deferentia (fig.5B). the ductus ejaculatoris duplex is considered as reservoir for sperms living the vas deferens and seceration of the accessory glands. Amaldoss, (1989)mentioned that,in *Spodoptera exigua* (Hubner), Duplex region between the accessory glands and vd enterance is shorter in comparion with a longer region between vd enterance and Simplex. Also, Wang *et al*., (2015) stated that in *D. rubella*the junctions of vasa deferentia with Duplex are near accessory glands at the one third of ductus ejaculatoris duplex.

Ductus ejaculatoris simplex: Simplex is a tubular structue which extendes from the ductus ejaculatoris duplex to the phallus. This duct is divided into two distinct morphological regions. The white and more cephalad portion is termed the primary segment and the dark and short cadual portion is termed the cuticular segment th total length of Simplex is 2.9 and 3.2 cm in *P. paradoxa* and *Z. pyrina*, respctively. Callahan (1958) poitend out that in *Heliothis zea* this duct consists of two distinct morphological areas, primary and cuticular segments.Aedeagus and phalls in *P. paradoxa* are longer than those of *Z. pyrina*.Phallus is cylindrical in shape and brown in color while the aedagus is cylindrical and opaque white in color. Aedeagus tip is swollen and slightly cureved in *P. paradoxa*(fig. 6A) and hook shaped in *Z. pyrina* (Fig. 6B).

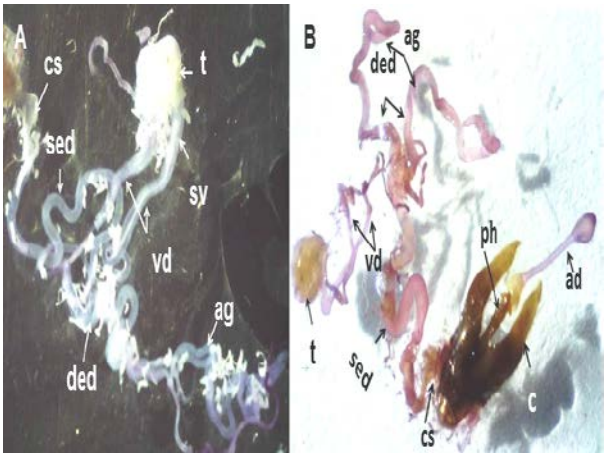

Fig. 4. A cs, cuticular segment; sed, ductus ejaculatoris simplex; t, testes; sv, seminal vesicle, vd vasa deferentia; ded,ductus ejaculatoris duplex; ag, accessory glands B) ag, accessory glands; ded, ductus ejaculatoris duplex; vd, vasa deferentia; t, testes; sed, ductus ejaculatoris simplex; cs, cuticular segment; ph, phallus c, clasper; ad, aedeagus

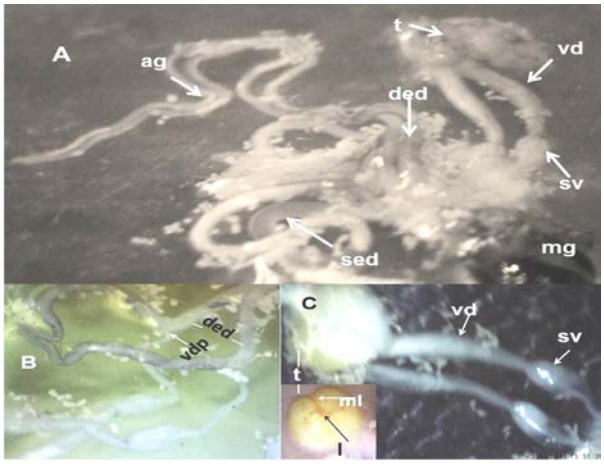

Fig. 5. A, ag, accessory glands;t, testes;vd, vasa deferentia;sv, seminal vesicle; ded, ductus ejaculatoris duplex; sed, ductus ejaculatoris simplex; mg, male genitalia B) ded, ductus ejaculatoris duplex; vdp, vas deferens junction portion C) vd, vasa deferentia; sv, seminal vesicle; t, testes; ml, midline; l, lens.

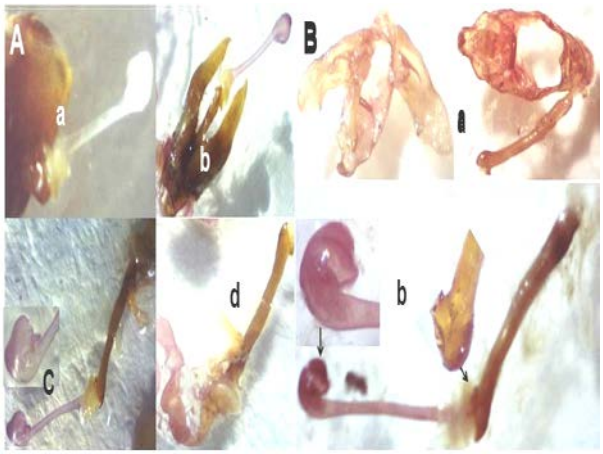

Fig. 6. A, Male genitalia of *P. paradoxa*(a, the terminal abdominal segments; male external genitalia; c, aedeagus; d, phallus B) male genitalia of *Z. pyrina* (a, male external genitalia; b, aedeagus and phallus)

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دراسات مورفولوجية و مقارنة على الأجهزة التناسلية لحشرتي حفار ساق العنب *Paropta paradoxa* و حفار ساق التفاح *Zeuzera pyrina* رتبة حرشفية الأجنحة Lepidoptera عائلة Cossidae

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بسبب الأهمية الإقتصادية لكل من حفار العنب *Paropta paradoxa* و حفار ساق التفاح *Zeuzera pyrina* على أشجار العنب و التفاح و الزيتون و التين و الكمثرى تمت دراسة التشريح الداخلى للأعضاء التناسلية . تم وصف و تصوير و قياس الأعضاء التناسلية لكلا النوعين تحت الدراسة وقد وجد أنها تتشابه مع تلك الخاصة بحشرات حرشفية الأجنحة الأخرى مع بعض الإختلافات المتضمنة حجم و شكل الغدد المساعدة في الإناث و بمقارنة النوعين تحت الدراسة كان أهم الإختلافات في الغدد المساعدة الأنثوية و شكل و الزوائد التناسلية الخارجية و كذلك مقدمة ألة السفاد في الذكور.