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A morphological study of the tree-fungus beetle, *Xylographus bostrichoides* (Coleoptera: Ciidae) from Iran

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ABSTRACT. Previous investigations related to tree-fungus beetle, *Xylographus bostrichoides* (Dufour) (Coleoptera: Tenebrionoidea: Ciidae) have not studied beetle's morphology in detail. This beetle is associated with tree fungi and collected from *Fomes* sp (Polyporales: Fomitopsidaceae). Pregenital ring, and the almond-shaped plates of abdominal terminalia, are useful characters for the species identification. Also, frontoclypeal area, first abdominal sternite, and abdominal terminalia are the important characters for the female and male separation. The larvae and adult specimens of *X. bostrichoides* (Dufour, 1843) studied here were found feeding on the dried fruit body (basidiome) of *Fomes* sp., which had been stored for a long time as a mushroom stored product. The signs and symptoms of the beetle damage (feeding) on the mushroom are also described.

Key words: Ciidae, Fungus beetles, Morphology, Tenebrionoidea, Iran

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Introduction

The fungus beetles *Xylographus* Mellié (Ciidae: Orophini), both larval and adult stages, are associated with fungi's tree, Polyporales and Hymenochaetales, belong to the Basidiomycota group. These fungi grow on the forest tree trunk and are important in decomposing wood of forest trees (Lawrence & Lopes-Andrade, 2010; Lopes-Andrade, 2010; Reibnitz et al., 2013). However, some Ciidae members, such as *Cis chinensis* is a pest of commercial dried fruiting bodies of *Ganoderma lucidum* (Amini et al., 2016; Lopes-Andrade, 2008; Jinachai et al., 2002). Rose (2012) investigated the fauna of Ciidae (Coleoptera, Tenebrionoidea) in France and Corsica and, provided an updated key and notes on the species distribution. The species of *Xylographus* cannot be identified due to the unclear original description, the lack of information on the male genital ring and it is difficult to identify the specimen if it is not compared with the type material (Lopes-Andrade & Zacaro, 2003). According to the studies of Sandoval-Gómez et al. (2014), the type of *Xylographus bostrichoides*, has not studied in detail (J. Reibnitz - personal communication).

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Xylographus, including 36 known species with maximum diversity in tropical and subtropical regions of the world (Lopes-Andrade & Zacaro, 2003; Lawrence & Lopes-Andrade, 2010; Reibnitz et al., 2013; Sandoval-Gómez et al., 2014). This small insect, *X. bostrichoides*, probably originates from Asia (Palearctic species), and has a broad distribution in Europe, Asia and northern Africa (Sandoval-Gómez et al., 2014). Adults and larvae of ciids, minute tree-fungus beetles, are most often associated with xylophagous bracket mushrooms (Polyporales: basidiomycota) (Orledge & Reynolds, 2005). In this paper, we focused on the morphological study (including male and female abdominal terminalia) of *Xylographus bostrichoides*, and also explain its damage on the mushroom.

Material and methods

Description of the *Xylographus bostrichoides* is based on specimens from western part of Iran, found in a package of dried mushrooms collected from *Juglans* sp. and maintained in collections of the Department of Plant Protection in the normal conditions of the laboratory's collection. In these collections, more than 100 specimens of live and dead beetles were collected along with their nutritional effects on the mushroom cap and stored in 75% alcohol. The specimens were in a single packaged dried mushroom, which collected and preserved in the normal conditions of the laboratory's collection, for long time. Morphological terminology mainly follows that related to Ciidae literatures, such as Lawrence (2016, 2019), Lopes-Andrade & Lawrence (2005), Snodgrass (1935) and Vahedi (2002). Male and female were dissected and mounted on slides following the protocol provided by Lopes-Andrade (2011). A numbers of images (including the live photography) were taken using the Blue Light model of the Eyepist (Scaled Loop) and digital camera SSC-DC50AP digital camera, model XTS3022, and Olympus BX microscope 51 with an attached digital Dino eye-piece camera was photographed and recorded. Relevant sources are used for identification, rather than identification by Professor Johannes Reibnitz, who worked with the specific classification group (Ciidae family). Specimens used in this study are deposited in the Laboratory of Plant Protection Department, College of Agriculture, Razi University, Kermanshah, Iran and personal collection of Prof. Johannes Reibnitz, Tamm, Germany.

Results

Xylographus bostrichoides (Dufour, 1843) (Fig. 1)

Cis bostrichoides Dufour, 1843

Cis cribratus Lucas, 1849

Xylographus bostrychoides var. *aubei* Mellié 1849

Material studied: Dried mushrooms, Herbarium fungi collection, plant protection Dept. College of Agriculture, *Juglans* fungus, *Fomes* sp. (Polyporales: Fomitopsidaceae) (Preserving fungi specimens), 15.IV.2017, Shiva Ghanbari, 83/ ad (♀♂), 9.VI.2018, Entomo. Lab., Plant protection Dept.

Diagnosis: Males and females share the following diagnosis characters (Fig. 1): (i) robust convex body; (ii) usually light- to dark-brown in colour; (iii) pronotum and elytra covered with numerous setigerous punctures (pits with hairs), dorsally; (iv) bristle-like seta, decumbent posteriorly (Fig. 3B); (v) 10-segmented antennae, apically with three large club, each club having four large sensillifers, which bearing a sinuous row of 8-11 flashy setae and 8-12 round holes (Fig. 2D, E); (vi) all tibia strongly expanded and with a row of ≥ 12

distinct spine-like teeth on outer edges and apex; the apical spines forming tibial comb-like (Fig. 2A, B, C); and (vii) the last abdominal tergite, which divided into two almond shape plates, medially (Figs. 3C and 4B).

Male diagnosis characters: (i) first abdominal sternite with pubescent fovea (Fig. 4A); (ii) forehead with a concave surface and bearing two distinct protuberance (Fig. 4D); and (iii) 9th segment or pregenital ring showing open ring with elongated hexagon -shape (Fig. 5A).

Female diagnosis characters: (i) Female abdominal terminalia with a long spiculum ventral (longer than ovipositor) (Figs. 5B); (ii) paraprocts with longitudinal baculi (Fig. 5B); (iii) gonocoxites with transverse baculi (Fig. 5B); (iv) Each gonocoxite with disperse seta posteriorly; (v) gonostylus vestigial or absent; if present with no seta, and (vi) proctiger with longitudinal baculi (Fig. 5B).

Body (Fig. 1), 1.89 (1.63–2.23) mm long and 0.98 (0.90–1.17) mm wide; Body robust, convex; surfaces mostly dark brown; both pronotum and elytra bearing abundant punctuation with uniform size and distribution (Fig. 3A); frequency of punctuation on pronotum (15 points per 40 μ m² on central part of pronotum). Each puncture with a decumbent or erect hair, 0.09 (0.05–0.12) mm.

Antenna, mouthparts and tarsi light brown; each antenna with 10 segments (Fig. 2D), first segment stout and spherical, 2nd moderately stout, 3rd segment longer than the fourth; apically with three large segmented club, each club having four large sensillifers, which bearing a sinuous row of 10-12 flashy setae and 8-10 round holes (Fig. 2E).

The convex head is not visible from above and hidden under the pronotum (Fig. 1). Compound eyes prominent (Fig. 4C). Each side of frontoclypeal area in male with a protuberance (Fig. 4D). Pronotum of the dorsal surface and the sides is convex, covered with numerous distinct punctures, each whit hairs, 0.09–0.12 mm long; pronotum approximately as wide as long, narrowing anteriorly; lateral margins completely invisible from above and basal angles rounded. Elytra nearly equal in width to pronotum at base (Fig. 3A); punctuation irregular and disperse. Prosternite distinctly short before the coxae, not reticulate at middle and finely reticulate; prosternal process sharp, beak-like and upheaved under wards; propleuron finely reticulate and very indistinctly punctured. Meso- and meta-sternum coarsely and shallowly punctured and finely reticulate.

Abdominal segments: Visible sternites (ventrite) each with fine puncture; first abdominal sternite of male with a pubescent fovea (Fig. 4A), slightly lengthwise and contains a thick hairpin. These hairs are probably associated with the sex pheromone secretion glands. Tergites more and less membranous uniformly. The last abdominal tergite, split into two typical almond-shaped plates. These paired plates are probably associated with the ovipositor, with unknown function.

All tibia strongly expanded and with a row of ≥ 12 distinct socketed spine-like teeth on outer edges and apex; the spines, often oak-shape, apically (Fig. 2A, B, C). Most thick conical spines with a distinct socket at the apex forming tibial comb-like (Fig. 2B). The shape and distribution of the spines on the tibia is shown in (Fig. 2A, B). Tarsi 4-segmented, 1st and 2nd tarsomeres subconical and well separated. Each compound eye glabrous.



Figure 1. Fungivorous beetle, *Xylographus bostrichoides*, **A.** Dorsal, **B.** Ventral, **C.** Lateral view (Original).

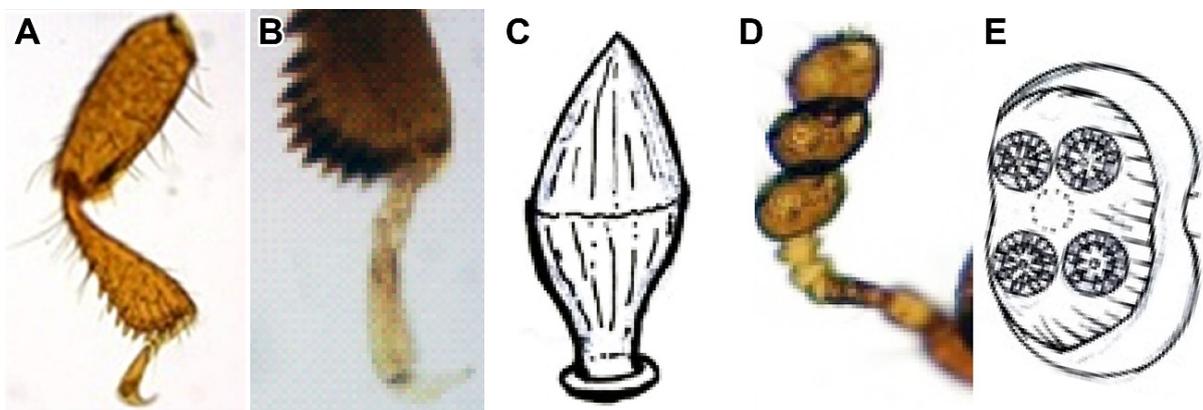


Figure 2. Fungivorous beetle, *Xylographus bostrichoides*, **A.** Front leg, **B.** Tibial apex area (the spines are extend through at least the apical third of tibia), **C.** Magnified oak-shaped tibial spine, **D.** Antennae, **E.** 2nd -antennal club segment details, top view (Original).

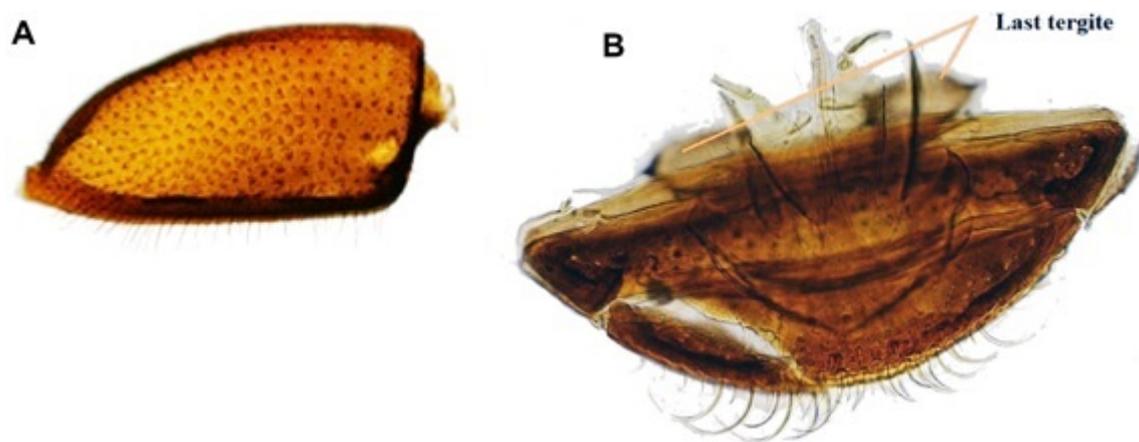


Figure 3. Fungivorous beetle, *Xylographus bostrichoides*, **A.** Elytra, showing setigerous punctures (pits with hairs), **B.** Abdominal terminalia segments, showing ovipositor, dorsal view of last tergite and decumbent bristle-like seta (Original).

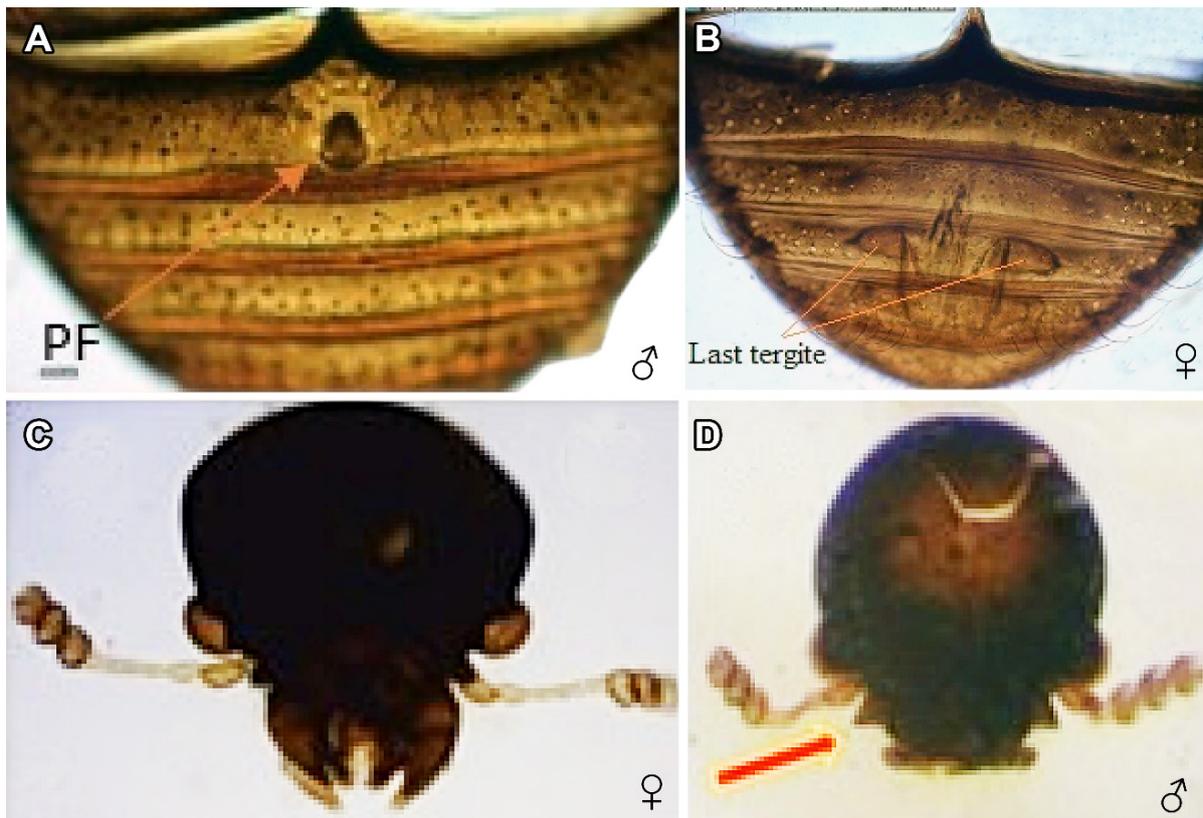


Figure 4. Fungivorous beetle, *Xylographus bostrichoides*, Abdominal sternites. **A.** Male first sternite with pubescent fovea (PF), **B.** Female first sternite without pubescent fovea (PF), posteriorly with enclosed ovipositor and dorsal view of last tergite, divided into two almond shape plates, medially **C.** Female head attachments (antennae; compound eye and mouth-parts), without frontoclypeal protuberance, **D.** Male head attachments (antennae; compound eye and mouth-parts), with frontoclypeal protuberance (red arrow) (Original).

Male genitalia: 8th abdominal sternite (viii) with an elongated median lobe (=penis), anteriorly and with several long hair on each side, posteriorly; median lobe closely attached to lateral lobe (=tegma); 9th segment or pregenital ring (=spiculum gastrale), which showing open ring with hexagonal-shape, becoming narrow gradually towards (Fig. 5A). Pregenital ring (= 9th segment), more and less hardened uniformly. Lateral lobe bending inward on sides excepting the posterior part. Basal piece sub-triangular, less hardened; the basal piece (bp) is partially or completely positioned ventrally to the tegmen.

Host

Xylographus bostrichoides feeds on the interior parts of the mushroom cap, *Fomes* sp. (Polyporales: Fomitopsidaceae) (off Walnut tree, *Jugland* sp.) (Fig. 6A, B) and drain the tissue within the fungus. But the outer envelope of the damaged fungus looks (Fig. 6B). Symptoms of damage of the beetle include perforations on the fungus and a mixture of mushroom powder with beetle stool under the cap. The fecal mass of this insect is seen in the form of fine, oval, and shiny-dark brown granules beneath the fungus (Fig. 6C).

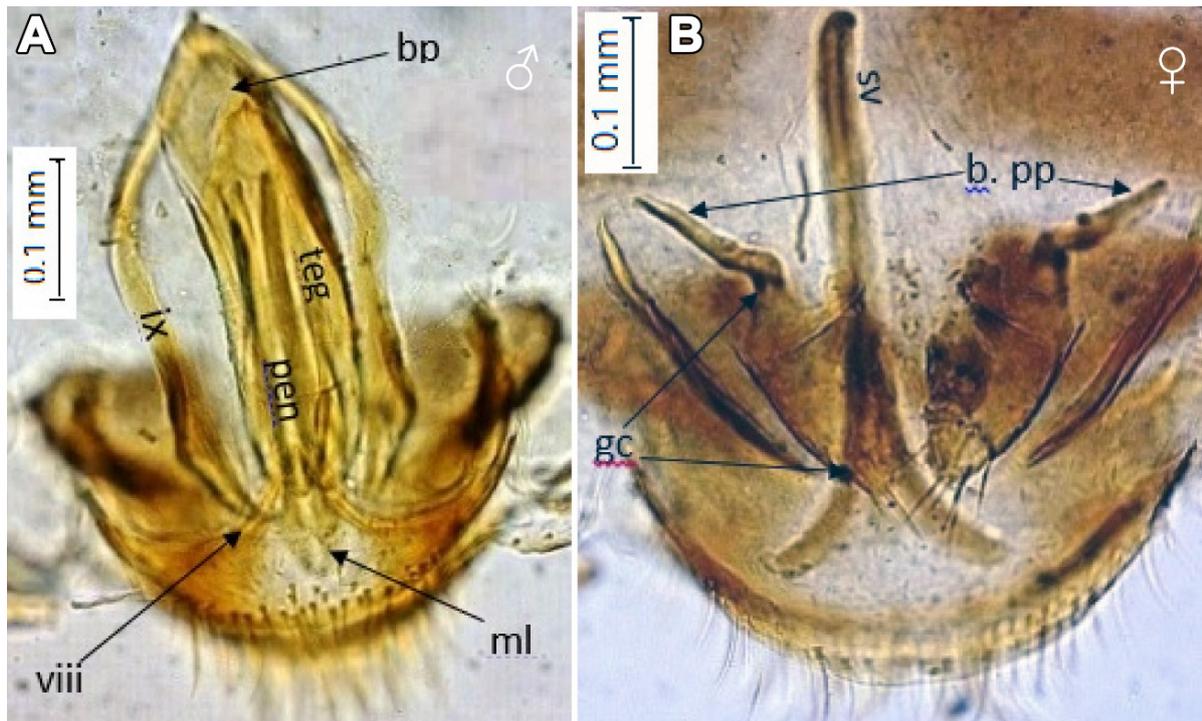


Figure 5. Fungivorous beetle, *Xylographus bostrichoides*. Slide preparations of abdominal terminalia. **A.** Male genitalia. 8th sternite, showing the sclerotized anterior edge bearing a median strut (viii), 9th segment or pregenital ring showing open elongated ring with hexagonal-shape; Basal piece (bp), Median lobe apex (ml), Tegmen (teg) and penis (pen). **B.** Female genitalia. Paraproctal baculi (b.pp), Gonocoxites (gc) and spiculum ventral (sv) (Original).



Figure 6. The tree fungus, *Fomes* sp. (Polyporales: Fomitopsidaceae), **A.** Non-damaged; **B.** Damaged fungi including beetle frasses, **C.** Beetle frasses of *Xylographus bostrichoides* (Original).

Discussion

The tree-fungus beetle, *Xylographus bostrichoides*, has recently been recorded by [Samin et al. \(2018\)](#) from Iran, West Azarbaijan, Oshnavieh, September 1999, but its host was not mentioned. Here we collected it from walnut tree's fungus, *Fomes* sp. (Polyporales: Fomitopsidaceae). [Sandoval-Gómez et al. \(2014\)](#) considered that the original description of

X. bostrichoides, is inadequate for understanding and makes a poor citation as a result. That's why we did a morphological study of the local specimen, *X. bostrichoides*, from west of Iran and compared to the close species *X. globipennis* and *X. lucasi* based on the literatures (Table 1). The pregenital ring performs better in identifying this species than other external morphological features. This idea is based on a comparison of the pregenital ring (=abdominal segment nine (ix)) of *X. bostrichoides* with related images of other *Xylographus* species in published articles such as Sandoval-Gómez et al. (2011) and Lopes-Andrade & Zacaro (2003) (see Fig. 7).

It is here considered, that last abdominal tergite, which split into two typical almond-shaped plates, is not previously recorded in the *Xylographus* Mellié. These two almond-shaped plates are probably associated with the ovipositor, with unknown function.

Table 1. Morphological differences between three close species of *Xylographus* Mellié.

| Morphological features | <i>X. bostrichoides</i> (Current study) | <i>X. globipennis</i> (Sandoval-Gómez et al., 2011) | <i>X. lucasi</i> (Lopes-Andrade & Zacaro, 2003) |
|-------------------------------------|--|--|--|
| Colour: mostly | Dark-brown | Black | Black |
| Body length | 1.93 × | 2 × | 1.83 × |
| Anterior margins of pronotum (male) | curved inward | curved upward | curved inward |
| Frontoclypeal sides (male) | with a large subtriangular protuberance | with a small subtriangular protuberance | Clypeus without tubercles |
| Number of tibial spines | ≥12 | ≤ 12 | ≤ 12 |
| Male genitalia, 9th tergite | elongated hexagonal-shape | V-shaped | V-shaped |

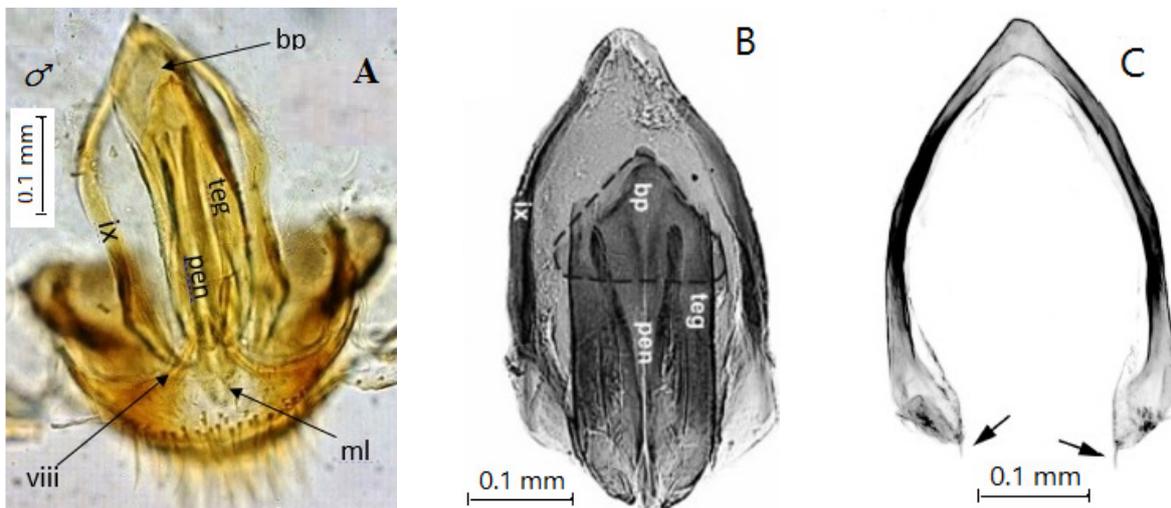


Figure 7. Main differences between male abdominal terminalia of three *Xylographus* Mellié showing in abdominal segment nine (ix) or pregenital ring. **A.** *X. bostrichoides*, with an open, elongated hexagonal-shap, **B.** *X. globipennis*, Inverted V-shaped (Sandoval-Gómez et al., 2011), **C.** *X. lucasi*, Inverted V-shaped (Lopes-Andrade & Zacaro, 2003).

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Conflict of Interests

The authors declare that there is no conflict of interest regarding the publication of this paper.

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مطالعه ریخت‌شناسی سوسک قارچ‌خوار *Xylographus bostrichoides* (Coleoptera: Ciidae) از ایران

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چکیده: در تحقیقات قبلی، ویژگی‌های ریخت‌شناسی سوسک قارچ‌خوار *Xylographus bostrichoides* (Dufour) (Coleoptera: Tenebrionoidea: Ciidae) به طور دقیق بررسی نشده است. این سوسک با قارچ‌های درختی در ارتباط است و از روی گونه *Fomes* (Polyporales: Fomitopsidaceae) sp. جمع‌آوری شد. حلقه ماقبل تناسلی و صفحات بادامی شکل بند انتهای شکم (اسکلریت پشتی)، ویژگی‌های خوبی برای شناسایی گونه‌ها هستند. همچنین ناحیه frontoclypeal، اولین استرنیت شکم و بندهای انتهای شکم (ساختار ژنیتالیا) از ویژگی‌های مهم برای جداسازی نر و ماده هستند. در این تحقیق، لاروها و حشرات بالغ (*X. bostrichoides* (Dufour, 1843)) در حال تغذیه از بازیدیوم خشک قارچ *Fomes* sp. موجود در کلکسیون، جمع‌آوری شد. این قارچ‌ها جهت مقاصد آموزشی برای مدت طولانی در آزمایشگاه نگهداری می‌شد. علائم و آثار خسارت (تغذیه) سوسک بر روی قارچ نیز شرح داده شد.

واژگان کلیدی: Ciidae، سوسک قارچ‌خوار، ریخت‌شناسی، سوسک تاریک‌زی، ایران