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## Identity of *Eumenodora encrypta* Meyrick, a cryptic Australian moth (Lepidoptera: Gelechioidea)

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### Abstract

A hitherto neglected gelechioid moth genus *Eumenodora* Meyrick (Gelechioidea: Elachistidae; Cosmopterigidae; Xyloryctidae) is redescribed. The genus, originally assigned to the Elachistidae and later transferred to the Cosmopterigidae, is monotypic. The single constituent species, *E. encrypta* Meyrick, 1906, has long been known only from the holotype, collected in Brisbane, Queensland (Australia). The specimen lacks its abdomen. The genus is characterized and the single recognized species redescribed based on recently collected adult males and a female. Evidence from morphology, supported by DNA sequences, is provided to support the placement of the taxon in the *Hierodoris* group of the Xyloryctidae, in spite of its atypical external appearance.

**Key words:** systematics, Gelechioidea, Cosmopterigidae, Elachistidae, Xyloryctidae, *Hierodoris* group, re-description

### Introduction

Australia is notorious for harbouring a vast diversity of moths belonging to the superfamily Gelechioidea where it is by far the largest lepidopteran superfamily (Nielsen et al. 1996). While the Oecophoridae is the largest of gelechioid families in Australia, families such as the Gelechiidae, Xyloryctidae, Cosmopterigidae, Elachistidae and Stathmopodidae are also particularly diverse there (Common 1990, Nielsen et al. 1996, Kaila 2011). Among well-defined groups there occurs also a large diversity of species, both described and undescribed, whose systematic position has never been thoroughly scrutinized. For convenience, many of these have been placed in families where they best seem to fit. A family of such a ‘waste-paper basket’ nature for smaller and narrow-winged gelechioids in Australia has traditionally been Cosmopterigidae, part of which will prove when studied to belong to other groups, for example Parametriotinae (Elachistidae s. l.) and Scythirididae (L. Kaila, personal observation; see also Sinev 2002).

One of the Australian taxa that has never received attention is *Eumenodora encrypta* Meyrick, 1906. The genus is monotypic, and was originally described in the Elachistidae. At the time of the description, though, the family concept was different from the current one. The Elachistidae s. *stricto*, equating to the present-day Elachistinae (see e.g. Nielsen & Traugott-Olsen 1977, Kaila 1999, 2004) was first defined by Busck (1909) and Walsingham (1909). Nye & Fletcher (1991) place *Eumenodora* at Cosmopterigidae without comment. Edwards & Nielsen (1996) follow this placement in the check-list of Australian Lepidoptera. Cosmopterigidae and several other groups of Gelechioidea were characterized by, e.g., Hodges (1978) and Koster & Sinev (2003). Apart from Meyrick (1906) and the Australian check-list, the genus seems to have been mentioned only twice in the literature: in the list of generic names of Microlepidoptera by Nye & Fletcher (1991), and by Kaila et al. (2011) where it was included as unassigned in a molecular study of the Gelechioidea. The species has been only known from the holotype, held in the Natural History Museum, London. It lacks the abdomen which hampers its identification. This taxon caught the present author’s interest during revisionary work on Australian Elachistinae (Kaila 2011), due both to its superficial similarity to the Elachistinae, and Meyrick’s initial placement of the taxon in this family. An examination of the holotype (Fig. 1) has permitted the identification of recently collected material as this species (Figs 2, 3). Although the genitalic characters could not be used in the identification of the recently collected specimens, these specimens agree in all other respects with the holotype, and no other closely similar species is known. Based on this material, the species is re-described here, and its systematic position is discussed.

This paper is based on material held in the following collections:

|      |   |
|------|---|
| ANIC | The Australian National Insect Collection, CSIRO, Canberra, Australia (T. Edwards)          |
| BMNH | The Natural History Museum, London, U. K. (K. R. Tuck)                                      |
| MZH  | Finnish Museum of Natural History, Zoology Unit, University of Helsinki, Finland (L. Kaila) |
| ZMUO | Zoological Museum, University of Oulu, Finland (M. Mutanen)                                 |

### *Eumenodora encrypta* Meyrick, 1906

Figs. 1–11

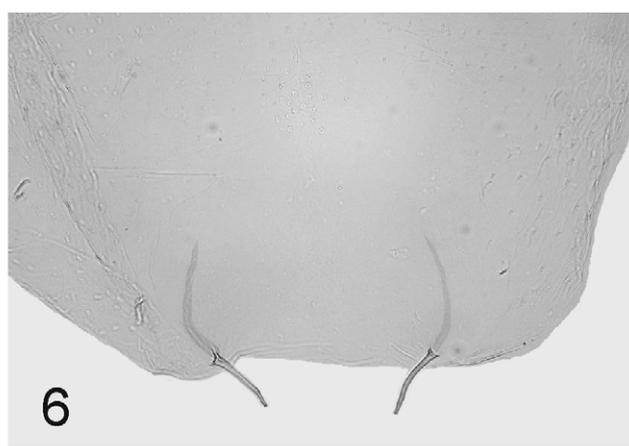
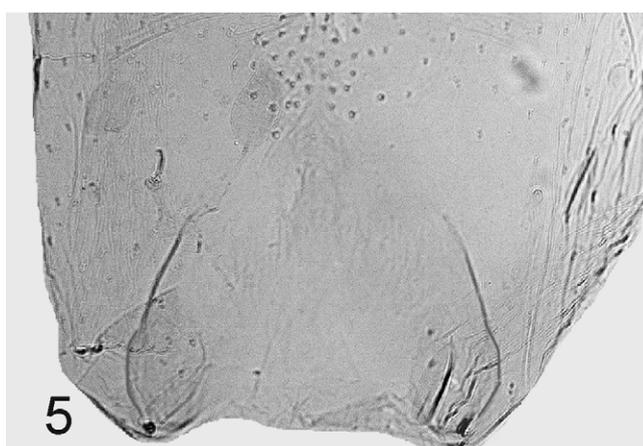
*Eumenodora encrypta* Meyrick, 1906: 55. Type locality: Australia, Queensland, Brisbane. Holotype in BMNH.

**Material studied.** Type material. Holotype ♂ labelled: Holotype [round with red margin]; Brisbane Queensland 16/9/[18]79; *Eumenodora encrypta* 1/1 Meyr. E. Meyrick det. in Meyrick Coll.; Meyrick Coll. BM 1938-290; *encrypta* Meyr.; *Eumenodora* Meyr.; abdomen missing [printed blue label], Coll. BMNH. Other material: **Australia:** The Australian Capital Territory: Black Mt., blended light, 16.XII.1995 2 ♂ 1 ♀ R. J. B. Hoare leg., (ANIC 16033, 16035, in ANIC, L. Kaila prep. 4932, in MZH); 35.16S 149.06E Black Mountain, summit, 14.II.1999 L. Kaila leg. (in ANIC); Queensland: 23.17S 150.31E Parkhurst 26.VIII.1987 2 ♂ I. F. B. Common leg. (ANIC); 23.18S 150.32E 8 km NNE Rockhampton 6.IX.1980 1 ♂ I. F. B. Common leg. (ANIC 16417, in ANIC); 27.33S 151.59E Prince Henry Heights, Toowoomba, 620 m, 26.I.1983 1 ♂ I. F. B. Common leg. (L. Kaila prep. 5677, in MZH). South Australia: 35.59S 137.11E Vivonne Bay, Kangaroo Island, 19.I.2008 1♂ D.A.Young leg.; DNA sample 11121 Lepid. Phyl. (only wings left as vouchers, preserved in DNA collection of ZMUO).

**Diagnosis.** As only the type species is known for the genus *Eumenodora*, this diagnosis does not separate characters of ‘generic’ and ‘specific’ level, but gives a general characterization of the taxon. *Eumenodora encrypta* is a very small species, the wing shape is acute, the hindwing in particular (Figs 1–4). The forewing venation has a distinctive basal forking of 1A+2A, and in the hindwing RS and M<sub>1</sub> are separate (Fig. 4). The species is sombrely-coloured without any distinctive wing markings. Sternum II displays sexual dimorphism, the male having a vestigial, and the female a well-developed apodeme (Figs. 5, 6). The sternal rods are narrow and not distinctive; there is no lateroanteriorly directed sclerotization (presence of it has been considered to characterize ‘tortricid-type’ sternum II (Kyrki 1983)); the male genitalia are peculiar with the uncus forming a pair of large, sclerotized hooks and with the socii formed as large setose lobes (Fig. 7). The juxta bears a pair of long, narrow, distally setose, caudally directed lobes, similar to those of several *Hierodoris* species (Figs 8, 10). The valva is simple, with only one specialized structure: a non-setose lobe near the base of the costa (Fig. 10). The female genitalia are generalized (Fig. 11). The papillae anales are rather weakly sclerotized; segments A8–9 are at most weakly extensile; segment 8 is setose on the caudal margin, S8 has denser groups of setae near the mesial invagination in the posterior margin; the ostium bursae is wide, and no distinct antrum is present; the ductus seminalis is not basally dilated, i.e. the bulla seminalis is absent; the ductus bursae is without scobination, but there is a sclerotized, scobinate plate near the entry point of the ductus seminalis. The signum of the corpus bursae is distinctive being very large and asymmetric; it has a median fold and a distinctly sclerotized band of transverse ridges on one side.

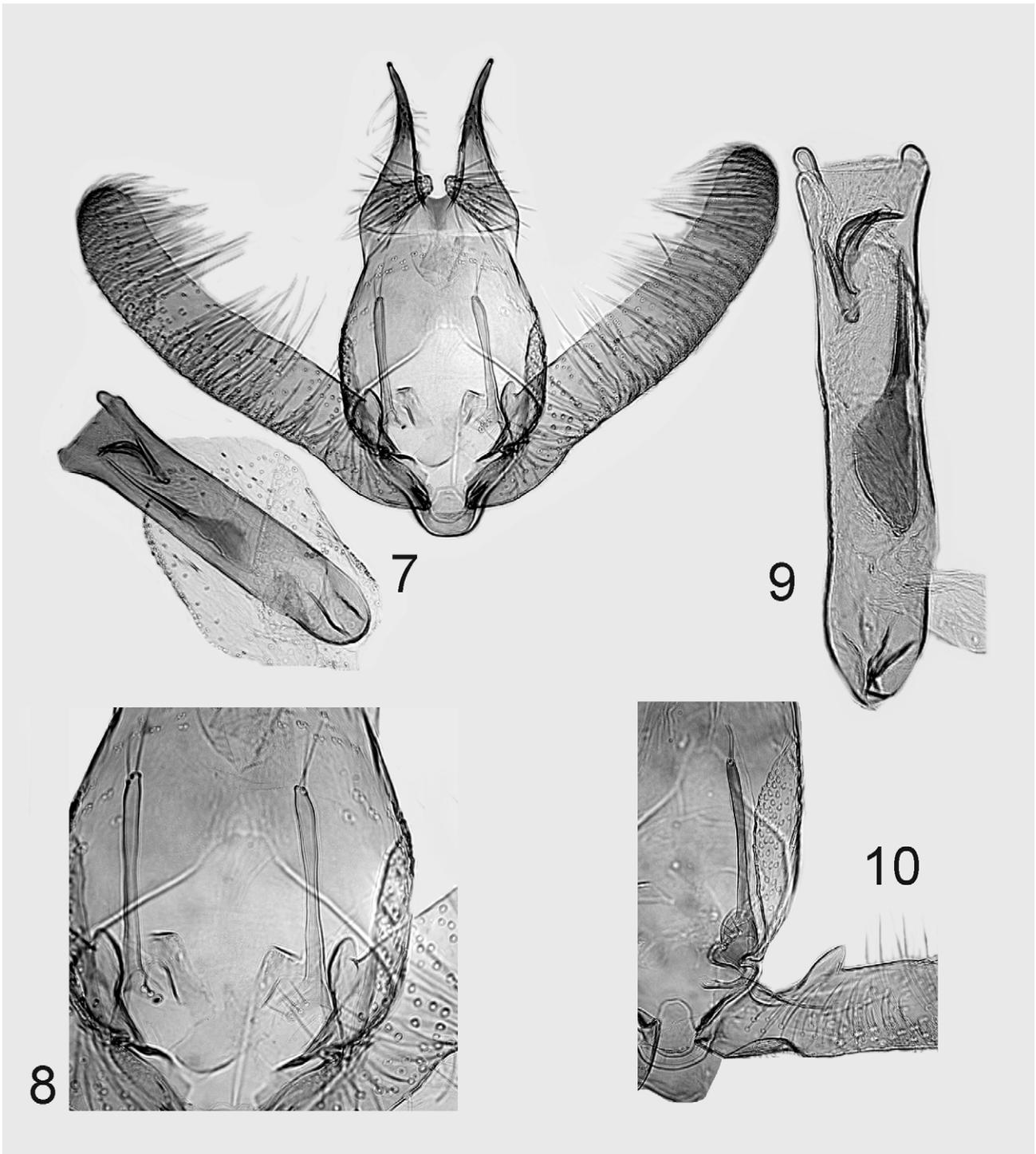


**FIGURES 1–3.** External appearance of *Eumenodora encrypta* Meyrick. Fig. 1: holotype #m (Queensland: Brisbane) (courtesy by CSIRO Division of Ecosystem Sciences). Fig. 2: #m (The Australian Capital Territory, Black Mountain). Fig. 3: #f (The Australian Capital Territory, Black Mountain). Scale bar in Figs 2 and 3 is 2 mm.



**FIGURES 4–6.** Details of denuded specimens of *E. encrypta*. Fig. 4: wing venation (L. Kaila prep. 5677). Fig. 5: Sternum II of male (ANIC slide 16033). Fig. 6: Sternum II of female (ANIC slide 16035).

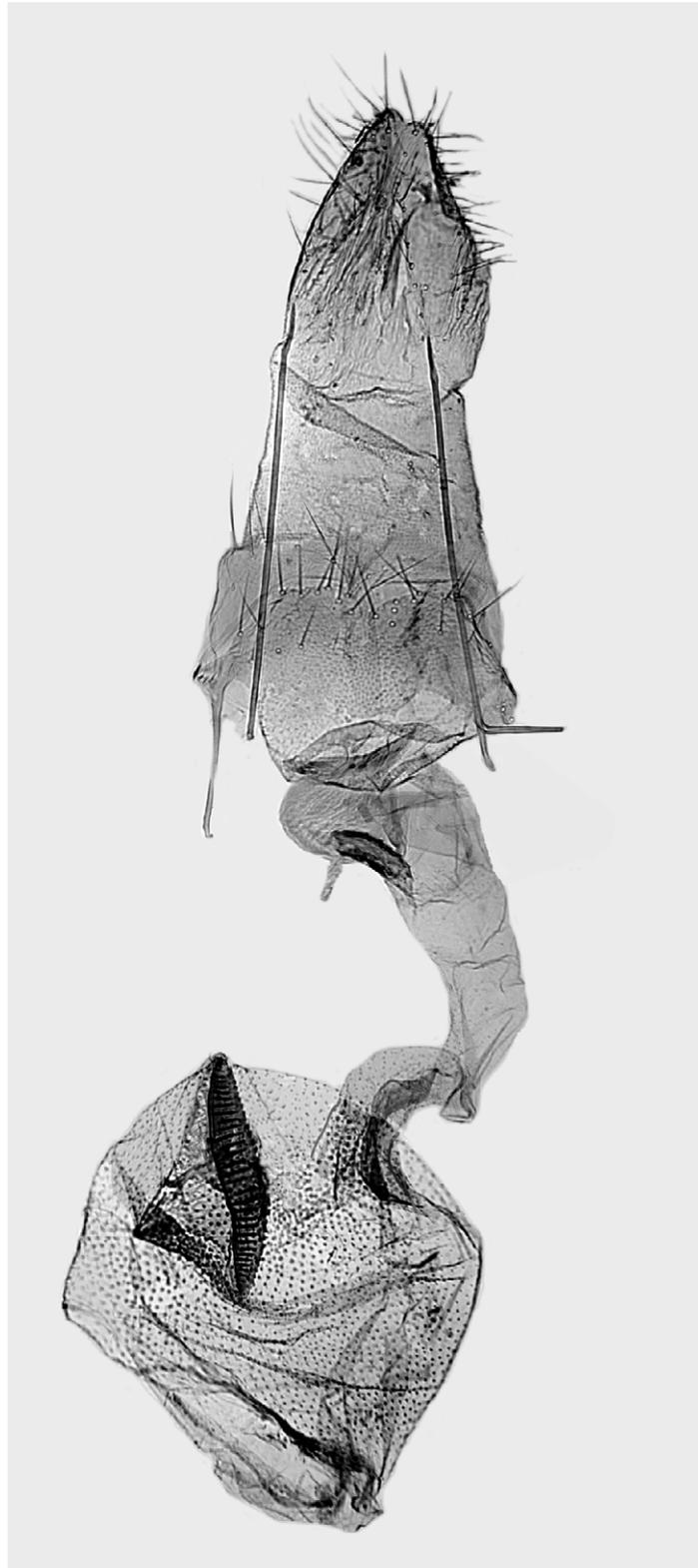
**Description.** Wingspan 6.5–7.5 mm. Labial palpus ascending, length equal to diameter of head, above shiny, creamy white, apex of second and third segment to a varying extent grey; labial palpus variably mottled grey below. Head shiny, creamy white, to a varying extent mottled with dark grey scales with faint bronzy sheen; neck tuft dark grey; antenna dark grey, segments basally annulated with paler rings; serrate in distal half in male; flagellum of male ventrally ciliate, length of cilia 2/3 of diameter of flagellum. Fore leg dark grey, segments and tarsomeres distally and ventrally creamy white; mid and hind leg grey, segments and tarsomeres distally and ventrally pale creamy white. Forewing pterostigma absent; retinaculum of male arising from a spur of Sc; five R-veins present, all directed towards costa; cell closed; no chorda present;  $M_1$ ,  $M_2$ ,  $M_3$ ,  $CuA_1$  and  $CuA_2$  all present, and separate from each other; CuP basally decipherable as a fold, distally entirely absent; 1A+2A with basal fork. Hindwing Sc+R<sub>1</sub> near costa; R and M only distally present; Rs and  $M_1$  separate;  $M_1$  and  $M_2$  basally coalescent; Cu basally well-developed, distally three-branched, the branches presumably  $M_3$ ,  $CuA_1$  and  $CuA_2$ . Forewing ground colour formed of basally pale and distally dark grey scales with faint bronzy sheen; the only markings being variable and indistinct, dark spot in the middle of wing at fold, and another at 2/3 wing at the end of cell; fringe scales concolorous dark grey. Underside of forewing dark grey with concolorous fringe. Both sides of hindwing grey, with concolorous fringe. Abdomen leaden grey. Sternum II without lateroanteriorly directed sclerotization; sternal rods narrow, indistinct; apodemes of male vestigial, well-developed in female.



**FIGURES 7–10.** Male genitalia of *E. encrypta*. Fig. 7: General image of the genitalia with phallus severed, in the same scale (ANIC slide 16417). Fig. 8: Details of juxta and base of valva (ANIC slide 16417). Fig. 9: Phallus enlarged (ANIC slide 16033). Fig. 10: Details of juxta and base of valva (ANIC slide 16033).

Male genitalia. Uncus formed of large, paired, setose hooks that are basally broad, somewhat curved to S-shaped and with narrow pointed apex. Socius a tongue-shaped lobe, densely covered by long setae. Gnathos absent. Valva long and narrow, parallel-sided, with rounded apex; inner surface densely covered with setae. A blunt lobe devoid of setae near base of costa. Juxta weakly sclerotized, with two short distal lobes, mediolaterally with group of a few setae, long, narrow lobe with a few setae apically. Vinculum small, U-shaped. Phallus about 2/3 times as long as valva, straight and broad, parallel-sided; with rounded coecum; distal end clear-cut, with pair of blunt

appendages; vesica with four cornuti: one relatively basally situated, very large, consisting of a broad basal plate and elongate distal horn, length of this cornutus half the length of phallus; three smaller, yet prominent, cornuti in a group near apex of phallus, two curved, one straight. Tubular portion of bulbus ejaculatorius not coiled, shorter than length of phallus.



**FIGURES 11.** Female genitalia of *E. encrypta* (ANIC slide 16035).

Female genitalia. Papillae anales dorsally fused, setose, weakly sclerotized. Segments 8–10 not or weakly extensile; apophyses posteriores very long, straight; apophyses anteriores 1/3 of the length of apophyses posteriores. Caudal part of segment 8 setose, setae densest in two patches in S8; S8 weakly sclerotized, posteriorly somewhat divided mesially. Ostium bursae on intersegmental membrane between S8 and S7, very broad; no antrum present; ductus seminalis not swollen; elongate scobinate sclerotization near its entry point; ductus bursae membranous, gradually narrowed towards corpus bursae, somewhat longer than apophyses posteriores, abruptly meeting the corpus bursae; corpus bursae rounded, internally covered with granules that are largest in the median area, signum large, triangular, partly weakly sclerotized, with longitudinal fold that serves as the margin of a strongly sclerotized, elongate part with dense row of transverse sclerotized ridges.

**Biology.** The immature stages are unknown. Adults are attracted to artificial light at night. The species has been found in semi-open forests. The flight period appears to be very long, from August to February, there are also records from September, December and January. It remains unknown whether more than one generation develops per year.

**Distribution. Australia:** Queensland, Australian Capital Territory, South Australia. The species is widespread in eastern Australia, though currently with very scattered records. It may eventually prove to be a common species that is currently somewhat neglected due to its small size and modest appearance.

## Discussion

The thoraco-abdominal supporting system has long been considered a key character in the placement of taxa within ditrysian Lepidoptera (Kyrki 1983, Minet 1991). Within the Gelechioidea, its significance is, however, ambiguous, and sexual dimorphism as observed in *Eumenodora* is not exceptional. Such dimorphism is known to occur in several groups within the Gelechioidea, notably in Oecophoridae and Xyloryctidae; see Kaila (2004) for discussion, Hoare (2010) for illustrations on the range of variation in *Izatha*, a genus of the *Hierodoris* group of Xyloryctidae sensu Kaila (2004) and Kaila et al. (2011). This trait excludes Elachistinae as a likely placement for *Eumenodora*, as apodemes are never developed in this subfamily. Otherwise the thoraco-abdominal supporting system does not give unambiguous support for the placement of *Eumenodora*.

The wing shape is acute, that of the hindwings in particular, most similar to Elachistinae. In the venation, the presence of a distinctive basal forking of the forewing 1A+2A is unusual in Elachistinae, and the hindwing RS and M1 are separate in *Eumenodora*, a usual condition of Gelechioidea, but never encountered in Elachistinae (Traugott-Olsen & Nielsen 1977, Albrecht & Kaila 1997; Kaila & Sugisima 2011).

The male genitalia of *Eumenodora encrypta* are characteristic with the large, sclerotized uncus and the large socii. There seems to be no other species known whose genitalia would show any superficial resemblance to those of *Eumenodora* (Ted Edwards, personal communication).

The paired, caudally directed, large and sclerotized uncus, and large socii are peculiar. Somewhat similar socii are only known from some Depressariinae (Kaila 2004). The shape of the uncus appears to be nearly unique within the Gelechioidea. Some Cosmopterigidae and Scythrididae also have the uncus formed as paired hooks, but their orientation is different, and the genitalia are otherwise entirely different (Landry 1991, Koster & Sinev 2003). Species of the genus *Batrachedrodes* Zimmerman from Hawai'i and *Duospina* Hodges from the USA (Batrachedridae) have a similar forked uncus, as do some New Zealand batrachedrids referable to the same group (R. Hoare, personal communication). These taxa lack the strongly developed setose socii, and have a well-developed gnathos. The uncus is also paired in Depressariinae, Elachistinae, Agonoxeninae and Parametriotinae, but it is formed of broad, weakly sclerotized lobes in these groups (Kaila (2004). The long and narrow, caudally directed tongue-shaped appendix of the juxta is similar to a structure characterizing the Lypusidae, but it arises from the juxta in *Eumenodora*, and from the transtilla in Lypusidae (Heikkilä & Kaila 2010). In Lypusidae, the female ductus bursae is typically sclerotized, but not in *Eumenodora*, telling against a placement in this family. The shape and position of the male appendix of the juxta is similar to that in some species in *Izatha* and especially *Hierodoris* that belong to the *Hierodoris* group (Hoare 2005, 2010). Although traditionally considered as belonging to Oecophoridae, this group was shown to belong with the Xyloryctidae both in the morphological analysis of Kaila (2004) and a molecular study by Kaila et al. (2011). An appendix near the base of the valval costa appears unique in *Eumenodora*. Some *Izatha* species have a similar, but setose, appendix which may or may not be

homologous with the lobe of *Eumenodora* (cf. Hoare 2010). The tubular portion of bulbus ejaculatorius is not coiled. This condition agrees with the *Hierodoris* group. It is fairly large but not significantly so as in many *Hierodoris* (Hoare 2005) or *Izatha* (Hoare 2010). However, the size of it varies between species also in these genera, in *Izatha* in particular.

When the morphological characters available were coded and analysed together with the dataset of Kaila (2004), *Eumenodora* was placed near *Hierodoris*. A thorough revision of this morphological data is currently underway (M. Heikkilä et al., in preparation), and therefore this result can only be considered preliminary and is not elaborated on here. *Eumenodora* was also included in a study of the molecular interrelationships of Gelechioidea (Kaila et al. 2011), and it was associated with the genera *Hierodoris*, *Gymnobathra* and *Izatha*. This result thus supports the affinity of *Eumenodora* with the *Hierodoris* group in the Xyloryctidae s. l.

*Eumenodora* differs superficially rather drastically from other xyloryctid genera, not only in its very small size—xyloryctids generally have a wing span at least twice, up to ten times larger than *E. encrypta*—but also in its acute hindwing shape. Moreover, the male genitalia have distinctive differences, notably the paired, hook-shaped uncus and the socius forming a large lobe. The valva is devoid of any specialized structures of the sacculus, unlike species in *Izatha* and *Hierodoris*. Whether the basal lobe of the valval costa is homologous with the pulvinus described for *Izatha* by Hoare (2010, see Fig. 124 there) remains to be investigated. On the other hand, the female genitalia seem to be entirely consistent with other recognized taxa of the *Hierodoris* group of Xyloryctidae. To conclude, *Eumenodora encrypta* Meyrick appears to be a derived member of the *Hierodoris* group, considered a part of the gelechioid family Xyloryctidae.

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