

Revision of *Euprotomus* Gill, 1870. 5¹. A third putative hybrid in *Euprotomus* (Gastropoda, Caenogastropoda) with some additional remarks on hybridization in *Euprotomus*

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A putative hybrid *Euprotomus aratum* (Röding, 1798) x *E. bulla* (Röding, 1798) is reported upon. It is compared with the two supposed parental species. Some additional remarks on putative *Euprotomus* hybrids are made.

Key words: *Euprotomus aratum*, *Euprotomus bulla*, hybridization, Indo-Pacific.

¹ For no. 4 in this series see: Kronenberg, G.C. & Harzhauser, M., 2012. *Europrotomus* (Mollusca: Caenogastropoda: Strombidae): a new Middle Miocene European strombid genus. – *Paläontologische Zeitschrift* 86 (2): 147-159.

INTRODUCTION

Putative cases of hybridization in Indo-Pacific strombids have been documented for a large number of cases [for a preliminary overview see Kronenberg (2008b) – but since then more cases have been reported, for an overview see Liverani (2013: 5)]. So far, three putative combinations of parental species forming hybrids have been reported within the genus *Euprotomus* Gill, 1870 (Kronenberg, 2008b). Two of these combinations have been discussed, viz. *E. vomer* (Röding, 1798) x *E. bulla* (Röding, 1798) (erroneously described as *Strombus hirasei* Kuroda, 1942) by Kronenberg (1999; 2002) and Dekkers (2012), and *E. bulla* x

E. chrysostomus Kuroda, 1942, by Liverani (2002). The third combination, *E. bulla* x *E. aratum* has been listed by Kronenberg (2008b: Table 1) as a unique record. This listing was based on a photograph made available by Jean-Pierre Barbier (Cebu, Philippines) of a specimen collected at North Palawan (Coron Island), but that specimen was not discussed in detail. Kronenberg (2008b) however, overlooked the specimen illustrated that same year in Kronenberg (2008a: pl. 230 fig. 6a, b); after re-examination of the image it turned out that this specimen also appears to be a hybrid of *E. aratum* x *E. bulla*. A putative case of hybridization involving a species of *Euprotomus* reported by Thach (2007) has been dismissed by Kronenberg (2008b), who, based on the illustration of the specimen (Thach, 2007: 18, fig. 39), concluded that the specimen was a malformed *E. aratum* (Röding, 1798).

In 2012 Dr. Nguyen Ngoc Thach (Nha Trang City, Vietnam) made some images available of what at first glance seemed to be a specimen of *E. aratum*. Dr. Thach however, already noted that there were some remarkable differences with *E. aratum*. And indeed, upon closer examination of the images, the specimen could not be identified as that species with certainty. Provisionally it was identified as *E. aratum* x *E. bulla*. Subsequently, Dr. Thach made the specimen available for examination. The results are presented below. I also take the opportunity to illustrate for the first time the specimen mentioned in Table 1 by Kronenberg (2008b).

DESCRIPTIVE PART

Class Gastropoda Cuvier, 1795
 Subclass Caenogastropoda Cox, 1960
 Order Littorinimorpha Golikov & Starobogatov, 1975
 Superfamily Stromboidea Rafinesque, 1815
 Family Strombidae Rafinesque, 1815

Euprotomus Gill, 1870*Euprotomus bulla* × *Euprotomus aratrum* (Figs 1-10)

Euprotomus bulla (Röding, 1798) – Kronenberg 2008a: pl. 120 figs 6a-b.

Euprotomus bulla × *E. aratrum* – Kronenberg 2008b: 332 [Table 1].

Diagnosis. — Adult shell with one digit at the adapical part of the outer lip, more or less parallel to the shell's axis, with columellar and parietal callus well developed, slightly thicker at adbasal part of the last whorl, apex and part of the spire covered with a dark brown callus deposit.

Description. — Adult shells with characters typical of species attributed to the genus *Euprotomus* Gill, 1870, measuring about 62-71 mm in length, with about eight teleoconch whorls; the number of nuclear whorls unknown. The first two to five teleoconch whorls more or less extensively covered by the callus, thereby obscuring the sculpture. First teleoconch whorls with fine axial and spiral cords, resulting in a reticulate sculpture. From the third whorl onwards the axial cords gradually develop into ribs, overlaid by the spiral sculpture. Simultaneously a subsutural cord develops, broader than the other spiral cords. On this cord an axially sculpture persists, but in other spiral cords the axials gradually turn obsolete. From the third or fourth whorl onwards a row of knobs on the shoulder develops, gradually increasing in size. Last whorl with an extensive callus on the adapertural side, slightly thicker at the adbasal side, obscuring about 45% of sculpture of the total of the last whorl. On the last whorl there are about 11 knobs; on the ventral side of the shell the knobs are covered by the callus, more or less obscuring their presence. Abapical of this row of knobs spiral cords are present, with two cords being broader, bearing low knobs. A third cord of intermediate broadness may be present (Figs 6-8), but this third cord can also be absent (Figs 2-4). Suture of last whorl acutely curved adapically and crossing the suture of the penultimate whorl.

Outer lip not broadly expanded, with a distinct, deep, stromboid notch and a projection at the adapical part, slightly diverging from the shell's axis, reaching beyond the apex. At early adult stage the rim of the outer lip, abapically of the projection and adapically of the stromboid notch, is slightly curved into adaper-

tural direction. When fully grown, the cavity thus formed is filled with callus and subsequent thin layers of callus cover the rim of the outer lip, resulting in a subangled outer lip with a glaze. Anterior canal rather long, curved addorsally, (almost) perpendicular to the shell axis. Between the thickened outer lip and the projection, a low, very poorly developed secondary notch is present. On the adapertural side of the outer lip, a few poorly developed to very faint plicae are present on the adapical part; at the point of attachment to the spire there is a shallow canal. Adapertural side between strombid notch and anterior canal with a few poorly developed plicae. Colour pattern very variable [see illustrations herein and Kronenberg in Poppe (2008a: pl. 120 fig. 6a-b) and discussion below]. All three specimens share a dark brown callus deposit on the spire, the rim on the outer lip at the digit-like extension, and the part of the outer lip attachment to the spire and near the stromboid notch.

Known records. — So far only three specimens are known, viz. (1) Philippines, near Palawan at about 3 m depth; (2) Philippines, Olango Island at 10 m; and (3) Vietnam, off Nha Trang, at unknown depth. These specimens are kept in the collections of, respectively, Jean-Pierre Barbier (Cebu) and Guido T. Poppe (Cebu), and the author's private collection (no. 6416). The latter specimen will be deposited in Naturalis Biodiversity Center (Leiden) at some point in the future.

DISCUSSION

All three specimens appear to have a mixture of characters of both *E. bulla* and *E. aratrum*, although they differ remarkably from one another. A difference with *E. aratrum* is the extensive callus deposit, reaching the apex and covering a (large) part of the apex and initial post nuclear whorls, which much more resembles *E. bulla*.

The colour of the callus deposits on the ventral side of the shells shows a great variability. The specimen in the Barbier collection is most reminiscent of *E. bulla*. It is white except for (1) a patch with a light orange hue near the adapical part of the columella, and (2) the spire callus, which is dark brown (Figs 1-4). The specimen in the Poppe collection is intermediate in that character (see Kronenberg, 2008a: pl. 230 fig. 6a) and the specimen in the Kronenberg collection (Fig. 5) is much closer to *E. aratrum*. Another difference with *E. aratrum* is the much paler colouration of the extended columellar callus where the outer lip is attached to the columella. This columellar callus is whitish in the Kronenberg specimen, contrary to *E. aratrum* where this patch is always dark, even in the palest specimens. The Barbier and Poppe specimens are less prominently coloured and do not show this

character clearly. The colour of the aperture is much more intense orange as is usually the case in *E. aratrum*, which usually is (much) paler. Only exceptionally the colour of specimens of *E. aratrum* may reach the same intensity. Also the sculpture and colour pattern of the dorsal side of the specimen differ slightly from that in *E. aratrum*.

As far as the colour pattern of the shell is concerned, the pattern of the shell in the collection Kronenberg (Figs. 5-8) is most reminiscent of *E. aratrum*, with the irregular of light brown speckles and mottling on a cream background. The specimen in the Barbier collection is much more like *E. bulla*, especially on the abapertural part of the outer lip, which has some small white spots on a brownish background. The specimen in the Poppe collection is much paler, near white with a few brown blotches (Kronenberg, 2008a: pl. 230 fig. 6b). The dark brown blotch on the centre of the dorsal side of that specimen has never been encountered in *E. aratrum* to my knowledge, but rarely occurs in *E. bulla*, see e.g. Kronenberg (2008a, pl. 230 fig. 2).

The main differences between the putative hybrids and their probable parental species are summarized in Table 1.

Unfortunately, like all other cases of presumed hybridization in Indo-Pacific Strombidae (Kronenberg, 2008b), there is no definite proof of it. The animal of a specimen that was considered to represent a putative case of hybridization in a specimen of *Lambis* comparable to specimens figured in De Turck et al. (1999: pl. 30 fig. 3) and Kronenberg (2008a: pl. 210 figs 1a, 1b) has become available for examination. Preliminary results of the dissection of that specimen showed that its anatomy differs from either of the putative parent species and, surprisingly, not being intermediate (Simone, unpublished data).

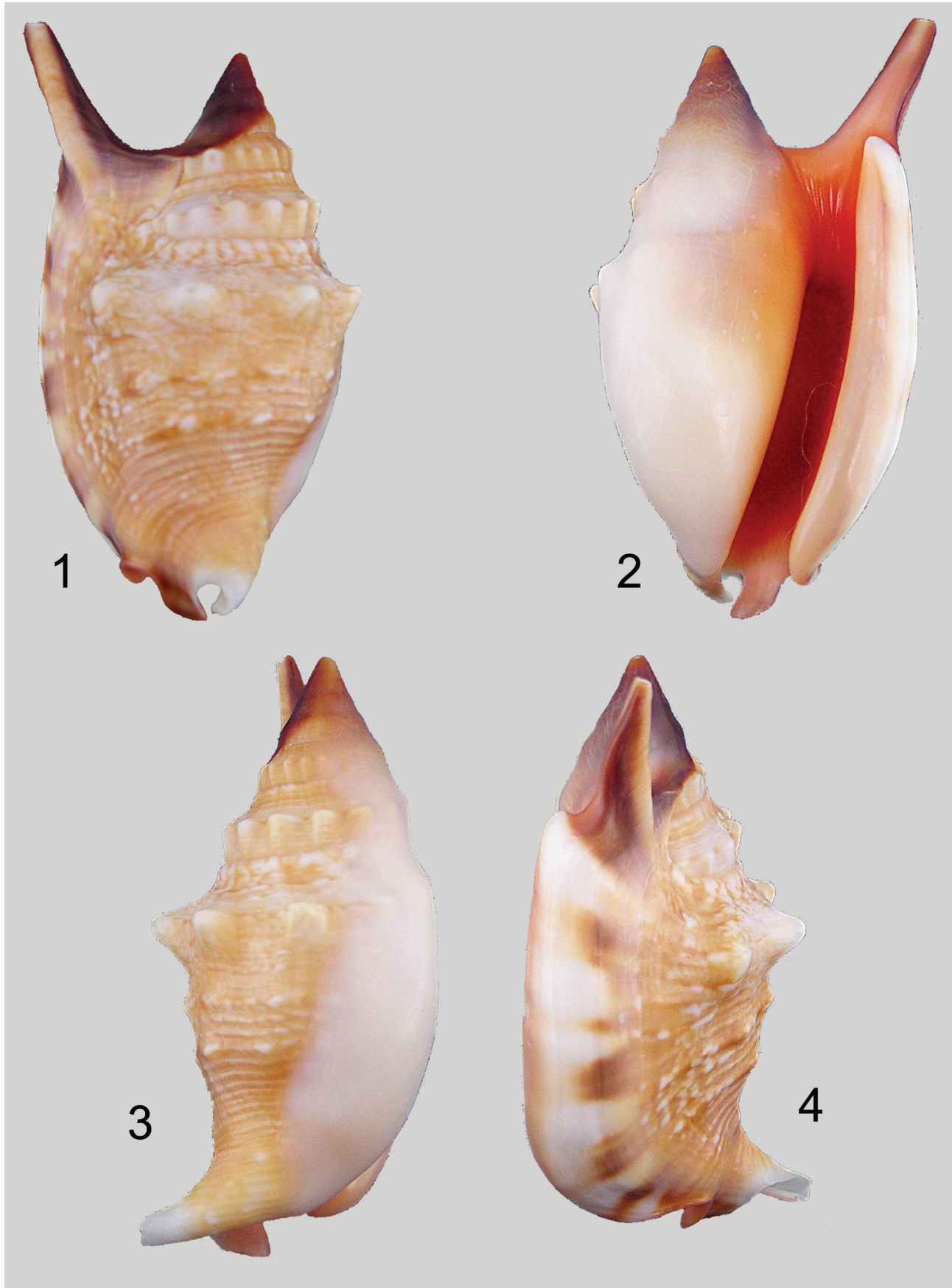
SOME ADDITIONAL REMARKS ON *EUPROTOMUS*
RELATED TO PUTATIVE HYBRIDIZATION

Euprotomus bulla x *E. aurisdiana*

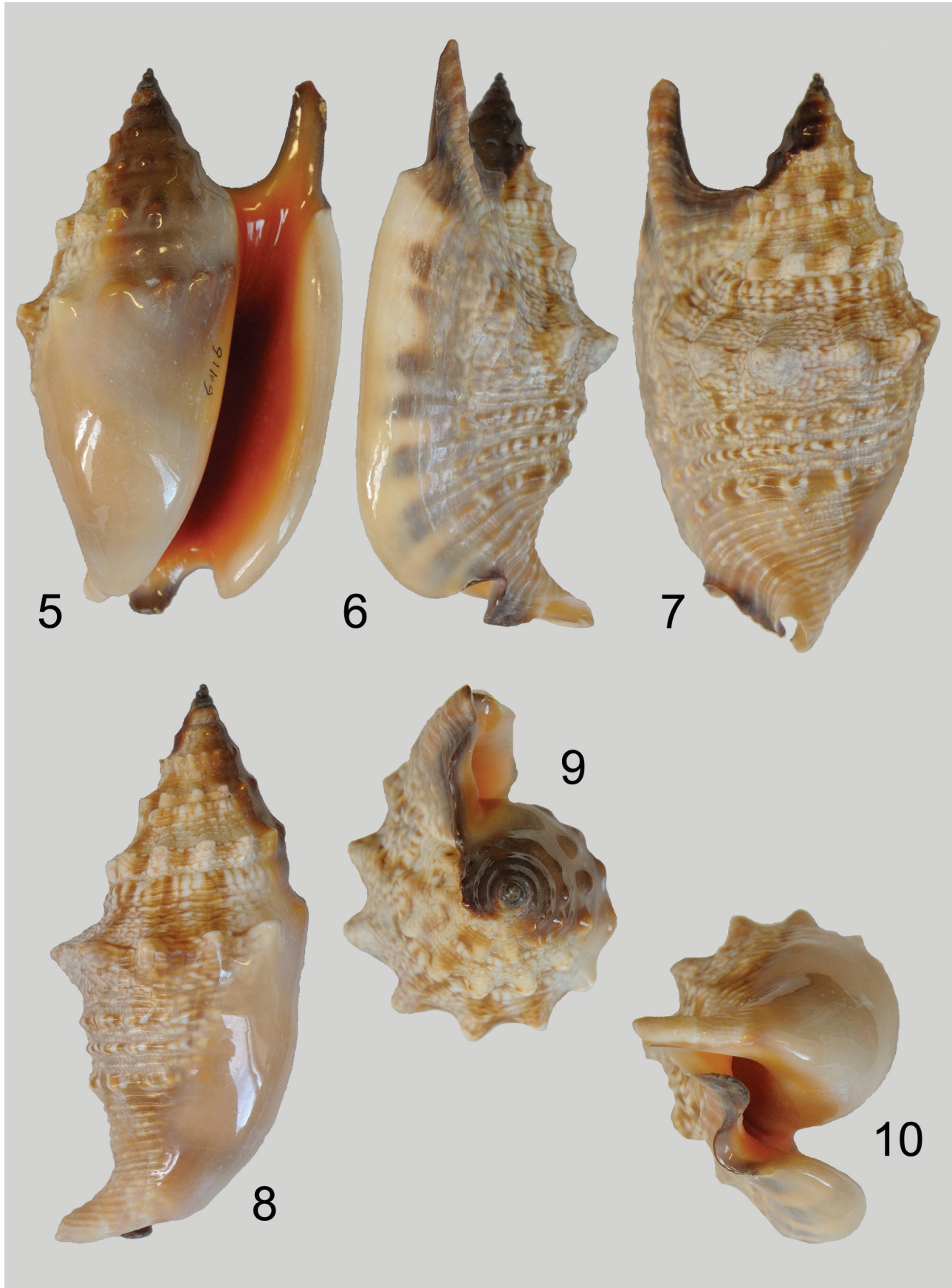
In his description of *E. aurora*, Kronenberg (2002b) already noticed that conchological characters of this species are more or less intermediate between *E. bulla* and *E. aurisdiana*. However, the possibility that *E. aurora* is a hybrid was rejected as none of the supposed parental species lives in the (Western) Indian Ocean. After Kronenberg's (2002b) description, who

Character	<i>Euprotomus aratrum</i>	<i>E. aratrum</i> x <i>E. bulla</i>	<i>Euprotomus bulla</i>
Shell length	58 – 91 mm	62 – 71 mm	50 – 73 mm
Callus on spire	Only small part of the spire covered, near attachment of outer lip, apex and first four to five teleoconch whorls not covered	Dark chocolate brown, reaching and partly covering apex	Reaching and partly covering apex
Colour of callus	Cream via orange to dark chocolate brown, sometimes near black	Cream to dark chocolate brown, with a paler, patch near attachment of outer	White
Colour of aperture	Cream via pale orange to bright orange	Bright orange	Reddish
Colour rim of outer lip near digit and strombid notch	Dark brown to blackish	Dark brown to blackish	White
Dorsal sculpture below shoulder knobs	Coarse spiral sculpture of close set spiral cords, two or rarely three cords broader, usually bearing distinct knobs	Coarse spiral sculpture of close set spiral cords, two cords broader, usually bearing indistinct knobs	Smooth to very low close set spiral cords of nearly equal size
Plicae adapertural side outer lip	Present, strong to moderately strong	Present, moderately strong to weak	Absent

Table 1. Comparison of some of the shell characters of *Euprotomus aratrum*, *E. bulla* and the putative hybrid *E. aratrum* x *E. bulla*. Shell measurements of *E. aratrum* and *E. bulla* round after Abbott (1960).



Figs 1-4. *Euprotomus aratrum* X *E. bulla*: Philippines, North Palawan, Coron Island, by compressor diver, at about 3 meters in sand & seaweed bottom. Actual size: 62.2 mm in length. Coll. Jean-Pierre Barbier, unnumbered. Photographs by Jean-Pierre Barbier.



Figs 5-10. *Euprotomus aratrum* X *E. bulla*: Vietnam, off Nha Trang at unknown depth, by local fishermen. Actual size: 70.3 mm in length. Coll. G.C. Kronenberg, 6416. Photographs by Eelco Kruidenier, Naturalis Biodiversity Center.

excluded the Pacific from the distribution of *E. aurora*, some records from the Pacific of *E. aurora* were published (Monsecour, 2004; Vermeij, 2005 [as *E. bulla*, but subsequently considered as *E. aurora*, Vermeij pers. comm. to present author]; Kronenberg & Dharma, 2005; Kronenberg, 2008a).

Recently *E. aurora* has also been reported from American Samoa (Brown, 2011: 248). There was neither description nor illustration. This record needs confirmation, as it is also possible that this concerns a relatively heavy sculptured form of *E. bulla*. The possibility of this specimen being a hybrid of *E. aurisdianae* x *E. bulla* is provisionally excluded, because to my knowledge *E. aurisdianae* does not live further east than the Solomon Islands, where Abbott (1960: 127, pl. 103) recorded it from Bougainville Island. Note however that Abbott confused *E. aurisdianae* with *E. aurora*. *Euprotomus bulla* is known from Samoa; Abbott (1960: 129-130, pl. 105) recorded it from Tutuila Island.

More recently, Mr. David Monsecour (Aarschot, Belgium) sent me images of a specimen of *Euprotomus* sp. from the Solomon Islands. This appears to be a genuine specimen of *E. aurora*. A discussion of this specimen and a discussion on further records of *E. aurora* from Pacific localities will be published elsewhere (Monsecour & Delsaerdt, in prep.).

So far, no convincing hybrid *E. aurisdianae* x *E. bulla* is known to me.

Euprotomus bulla x *E. chrysostomus*

In the original report on this presumed hybrid (Liverani, 2002) two specimens, both from Sogod (Cebu, Philippines) were illustrated (p. 59, figs 3-4), measuring 74 and 66 mm, respectively. Liverani's fig. 3 was subsequently re-illustrated in Liverani, 2013 (pl. 162 fig. 2a, b). Although the same specimen is photographed, the colour of the dorsum in the images (Liverani, 2002: fig. 3 right; Liverani 2013: fig. 2a) differs remarkably. On Liverani's 2002 fig. 3 the dorsum of the specimen appears to have a greyish pattern on a white background, while in Liverani's 2013 fig. 2a the pattern is brown on a white background.

Both specimens are rather close to *E. chrysostomus* (Kuroda, 1942), especially the specimen re-illustrated in Liverani 2013. Both specimens illustrated by Liverani have a callus deposit on the spire that reaches further to the apex than in *E. chrysostomus*, but do not reach the apex. In the text on *Euprotomus*, Liverani (2002) stated that the interior of the outer lip is a rich orange-red, being paler near the abapertural border. Liverani further noted "A pair of light [sic] lirae are present in the posterior canal." These are not visible on the accompanying images, so they must indeed be very faint.

On <http://www.stromboidea.de/?n=Species.EuprotomusBullaXChrysostomus> the specimens from the Liverani collection are illustrated again, but the measurements are indicated as 73 and 74.5 mm, contrary to the caption on Liverani's 2002 plate. The correct measurements are 73,5 and 65,5 mm (pers. comm. V. Liverani). On this website another putative *E. bulla* x *E. chrysostomus* specimen from Panglao (Bohol, Philippines) from the Börnke collection is illustrated. It measures 65 mm and has the callus on the spire more extended towards the apex –but not reaching it– as in the Liverani specimens, but there are distinct plicae in the adapical part of the adapertural side of the outer lip. Another specimen (not illustrated) is present in the Kronenberg collection. It was collected at Bohol. In this specimen, the callus does reach the apex, but plicae in the adapical part of the adapertural side of the outer lip are not noticeable.

Euprotomus bulla x *E. vomer*

Bozzetti & Sargent (2011) described a new species in *Euprotomus*, viz. *E. kiwi*. In their paper they also referred to *E. hirasei* (= *E. vomer* x *E. bulla*) as being "... the smooth backed form that was described as *Euprotomus hirasei* Kuroda, 1942 [sic!; in the original description by Kuroda it is named *Strombus hirasei*]" (Bozzetti & Sargent, 2011: 24). This observation, however, is not correct; the holotype of *S. hirasei* has a distinct sculpture of spiral cords on the dorsal side; see the description and figures of the holotype by Kuroda (1942: 8, figs 3-4) and Kronenberg (1999: figs 2, 5, 8) and the paratype by Habe (1964 and 1965: pl. 16 fig.1). Note that the paratype illustrated by Habe is not indicated as such in Habe's works, but this information was obtained from Dr. Kazunori Hasegawa and Dr. Hiroshi Saito, both National Science Museum, Tokyo, Japan.

Kronenberg (2002a) subsequently reported on a third specimen from Fiji and both Dekkers (2012) and Liverani (2013: pl. 160 figs 3a-b) recorded a specimen from New Caledonia. Dekkers (2012) discussed his specimen, collected at Balabio Isl., (20°06' S, 164°11' E) at 15-30 m, extensively and noted that there was some variability in the shell characteristics of the putative hybrid specimens known so far: the Fiji specimen being rather close to *E. vomer*, the Japanese specimens intermediate, and the Balabio Isl. specimen closer to *E. bulla*. This agrees with the observations made by Kronenberg on the putative *Lambis* hybrid, generally referred to as *L. arachnoides* (see Kronenberg, 1993).

In conclusion, there are at present three putative combinations of hybrid specimens known within *Euprotomus*, viz. *E. bulla* x *E. aratum* (this paper); *E. bulla* x *E. chrysostomus* (Liverani, 2002; Wieneke et al., 2016);

and *E. bulla* x *E. vomer* (Kronenberg, 1999; 2002a; Dekkers, 2012; Liverani, 2013). It is remarkable that in all these instances one of the supposed parent species is *E. bulla*.

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This paper is dedicated to Mr. Robert G. Moolenbeek on the occasion of his retirement from active duty. Robert was the first to put forward to me that *Lambis wheelwrighti* Greene, 1978, could be a junior synonym of *L. arachnoides* Shikama, 1971, and the possibility of this being a hybrid (see Kronenberg, 1993).

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