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A probable non-annelid origin of pods attached to *Amaeana ellobophora* (Annelida: Polycirridae)

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There is an alternative explanation to the proposal by Nogueira *et al.* (2015) that the polycirrid *Amaeana ellobophora* Nogueira, Carrerette & Hutchings, 2015 is a species which broods eggs in attached cocoons. We suggest that the pods observed fixed to the anterior of one worm are instead highly modified parasitic copepods (Arthropoda: Crustacea: Copepoda: Poecilostomatoida), and thus do not provide any information on the reproductive mode of *Amaeana* Hartman species.

When *Amaeana ellobophora* from Moreton Island, Queensland was newly described by Nogueira *et al.* (2015), the species name, which alludes to pod-bearing, was in reference to "egg cocoons" attached to the prostomium of one paratype. The authors stated that it seems likely that *Amaeana* species "brood their embryos", that an attached cocoon (pod) was "a character which has not been found in any other species examined to date", and that "such [a] brooding method has never been observed in any other species of Terebelliformia" (Nogueira *et al.* 2015: 4, 33).

The brooding of larvae (inside the tube or burrow) in simple gelatinous egg masses or enclosed by fragile capsules secreted by the worms would not be unusual reproductive modes in Terebellidae and relatives (e.g., Thorson 1946; Blake 1991; Wilson 1991), whereas here the pods clearly had a substantial outer "skin", and were attached narrowly at one end to the anterior of the worm itself rather than deposited along the tube/burrow wall. These were the factors that prompted Nogueira *et al.* (2015) to state that the brooding method was novel.

However, there are past reports of uncommon reproductive modes for annelid species that have become embedded in review literature, but have not been confirmed or observed subsequently. For example, the viviparity of the ampharetid *Alkmaria romijni* Horst enigmatically asserted by Wesenberg-Lund (1934), was not confirmed elsewhere (Cazaux 1982), and still lacks subsequent verification (Rouse & Pleijel 2001: 241), but nevertheless has been treated as factual in reviews (e.g., Ostrovsky *et al.* 2015). It is therefore important that new reports of unusual reproductive modes be based on a sound interpretation of the data.

A figure of an apparent cocoon-bearing *Amaeana* was first published in Hutchings & Glasby (1986: 322 Fig.1). They described "a peculiar reproductive structure" present in "a few" *Amaeana trilobata* (Sars) specimens from Queensland (Australian Museum lots AM W.10341 and AM W.7047), in which "two long, cylindrical and transparent egg tubes were attached distally to a larger, thicker walled sac which was in turn attached by a narrow neck to the tentacular membrane. A duct connected this structure with the coelom." They further commented that the "significance of this reproductive adaptation is unclear." The figured specimen (AM W.10341) was collected from Calliope River, Gladstone. However, it was long ago pointed out to one of us (GBR) that the structure appeared to be an attached parasitic copepod. This identification as a copepod was acknowledged as being correct by the original authors in an unrelated article (Hutchings & Glasby 1988: 53), in which they stated that the *Amaeana* copepod had been "wrongly interpreted as an egg sac" in 1986, and is supported by the opinion of an expert copepodologist (G. Boxshall, personal communication, August 2015).

Sac-like copepods are known to parasitize Terebelliformia annelids, including polycirrids, and may have external structures very similar to those reported by Nogueira *et al.* (2015) (e.g., Caullery 1915: 247 Fig. 2; Wesenberg-Lund 1951: 117 Fig. 11). These parasites gain sustenance by maintaining a permanent attachment duct into their host's interior. The anatomy of *Xenocoeloma alleni* (Brumpt), which is one such parasite of a *Polycirrus*, has been studied in detail (Bocquet *et al.* 1970). Additionally, a recent review of annelidicolous copepods lists a number of instances of copepod infestations of *Polycirrus* species, predominately by xenocoelomatids (Conradi *et al.* 2015: 21). Occurrence rates of sac-

like copepod parasites on annelid hosts can range from rare to reasonably common (0.64 % *vide* Bresciani & Lützen 1961; 20% *vide* Bocquet *et al.* 1964). Reduced fecundity of the host has been reported as a consequence of the parasitism (Bocquet *et al.* 1968).

Until now the 1986 observation had not appeared again in the literature, except with corrected identification as seen in Hutchings & Glasby (1988), and it seemed probable that others had readily placed the figured structure as a copepod parasite. However, Nogueira *et al.* (2015) recently cited and repeated the original incorrect interpretation of brooding by an *Amaeana*. While purportedly based on the same Calliope River specimen (AM lot W.10341) assigned in 1986 to *A. trilobata*, surprisingly they showed a different worm (Hutchings & Glasby 1986 Fig. 1 versus Nogueira *et al.* 2015 Fig.1), now included in the newly named *A. ellobophora*. We wish to correct the AM lot number published for the specimen examined and figured in Nogueira *et al.* (2015), as it was actually from lot AM W.7047 from Morton Island (collected East Channel, off Tangalooma Point, December 1972) near the type locality, rather than a previously unknown second AM W.10341 Calliope River specimen.



FIGURE 1. *Amaeana ellobophora* paratype AM W.7047, dorsal view, incomplete, with two large (P) and two small (p) pods attached. Scale bar 0.5 mm.

The incomplete AM W.7047 specimen (Fig. 1 herein) was reported as bearing "four egg cocoons attached to [the] mid-dorsal prostomial process." The "egg cocoons" (pods) in the images are of different sizes, with the two largest pods about 2.8 mm long, and the two smaller pods about 1 mm and 0.4 mm long respectively. The larger pods correspond in size to the single pod figured in Hutchings & Glasby (1986). Specimen AM W.10341 is still present in the collection, together with its parasitic copepod, now detached, but was not re-examined for Nogueira *et al.* (2015). It is therefore lot AM W.7047 that is a paratype of *Amaeana ellobophora*, and not lot AM W.10341.

Identifications of the AM W.7047 specimen structures in Fig. 1 as parasitic copepods are less obvious than for the Hutchings & Glasby (1986) AM W.10341 specimen as there are no trailing ovisacs on the pods, but these will be absent in immature individuals, are fragile (Hutchings & Glasby 1986: 323), and can easily become detached (McIntosh 1885:

477). It seems logically consistent that the same identification of the AM W.7047 pods as copepods applies, as the pods are very similar. The smaller pods when interpreted as parasites would be younger growth stages, whereas it is more difficult to explain, when interpreted as *Amaeana* egg-mass cocoons, why they would be so different in size if generated during spawning. One of us (JMMN), as lead author of Nogueira *et al.* (2015), now accepts the presence of the pods has a simpler explanation as a host/parasite relationship. It is our assessment, supported by the independent opinions of experts given to both of us, that the pod structures shown are sac-like parasitic copepods. This identification could be confirmed in future by molecular analysis (difficult here as both samples were formalin fixed) or by microtomography of internal structures.

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