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COMMENT

On the generic placement of '*Livoneca* sp.': a critique of Colorni et al. (1997)

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It is refreshing and encouraging to see the biology of a cymothoid isopod emphasized in a paper (Colorni et al. 1997). The article is interesting and useful but, reluctantly, we must disagree with the generic placement of the isopod, correct some pertinent literature omissions, and comment on a few other aspects of Colorni et al. (1997).

We recently attempted (Bunkley-Williams & Williams 1998) to clear up old errors and misstatements concerning fish-associated isopods that are found in semi-popular textbooks addressing this topic. Many of these problems were due to the use of outdated or misquoted primary literature, but some were mistakes in the literature itself. Having seen how these mistakes are perpetuated and magnified in the semi-popular literature that reaches the public, we have become concerned about irregularities in the primary literature.

We disagree with the generic placement of '*Livoneca* sp.'. Bruce (1990), overlooked by Colorni et al. (1997), reduced the number of species in the genus *Livoneca* to 2 (we suggest that 3 occur [Williams & Bunkley-Williams 1999]). *Livoneca* appears to be a New World genus. The morphology of the female '*Livoneca* sp.' pictured by Colorni et al. (1997) differs from almost all characters of the generic diagnosis of Bruce (1990) by having: cephalon immersed in pereon, body not twisted to one side, posterior margin of cephalon not trilobed, coxal plates not as long or longer than respective segment, and pleon immersed in pereon. Also, females of the genus *Livoneca* occur in the gill cavity and not on the tongue of fishes.

The *Livoneca* sp. of Colorni et al. (1997) was subsequently described as a new species, *L. paperna* (Trilles et al. 1999). Trilles et al. (1999) cite Bruce (1990), but they place their new species in *Livoneca* as a provisional genus, just the type of confusion that Bruce (1990) attempted to resolve. The genus diagnosis of *Livoneca* by Bruce (1990) could hardly be modified to accommodate the species *L. papernea*.

Stunting or any impairment of the host by the isopod is rejected by Colorni et al. (1997) based on the condition factors of parasitized and non-parasitized fish. Some infected hosts are uniformly or proportionally stunted (slowed growth), and this effect is not evident in simple condition-factor measurements (Romestand & Trilles 1979). Ageing of hosts by otoliths or other methods is necessary to demonstrate proportional stunting. We studied hundreds of doctorfish *Acanthurus chirurgus* (Bloch) in Puerto Rico parasitized by 0 to 7 cymothoid isopods (0 to 4 large female cymothoids per host) (*Anilocra acanthuri* Williams and Williams, 1981 and *Agarna cumulus* [Haller, 1880]). The condition factors of non-parasitized and parasitized doctorfish did not significantly differ, but the most heavily parasitized hosts were clearly proportionally stunted (Bunkley-Williams & Williams unpubl. data). Cero (mackerel) *Scomberomorus regalis* (Bloch) (Scombridae) only show condition-factor differences between parasitized and non-parasitized hosts when a female-male pair of *Livoneca redmanii* (Leach, 1818) occur in each gill cavity, destroy most of the gill filaments, and the host is near death (Williams & Bunkley-Williams 1996). Condition factor is not a very sensitive measurement of isopod impairment in many hosts.

Colorni et al. (1997) reported that juveniles were attached to the host. Juveniles often escape from the brood pouch (see 'burst release' of Williams & Williams 1985) and attach to the host, divers in the water, or any available substrate during capture. The attachments reported may not have occurred until the hosts were collected. Juvenile cymothoids appear to occur rarely on hosts and can be lethal in groups (Williams & Bunkley-Williams 1994).

Colorni et al. (1997) concluded that the presence of a female isopod on the tongue did not affect the feeding of the host. We found that jacks (*Caranx* spp., Carangidae) infected with *Cymothoa oestrum* (Linnaeus, 1793) ate about the same amount of food, but food items differed from those eaten by non-parasitized jacks (Kimmel & Arneson 1978, Bunkley-Williams & Williams 1994). Examination of stomach contents of the fish by Colorni et

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al. (1997) might have been more informative. Although jacks are carnivores and silversides are planktivores, the size or composition of the plankton selected may have differed. No data is presented to support the unusual conclusion of Colorni et al. (1997) that this isopod grips prey items for the host.

That fish erythrocytes are occasionally found in the intestinal lumen of 'adult' isopods is valuable information. Few studies have conclusively determined what parasitic isopods consume from the host. Knowing if the isopods with ingested blood were males, females without oostegites, or females with oostegites would have been even more useful. Brusca (1981) and others have suggested that females with oostegites cannot feed, as the laminae vibrans occlude the buccal opening.

The 2 possible solutions suggested by Colorni et al. (1997) to correlate the length of the female cymothoid with the length of their hosts (slowly growing with the host over the long term, or quickly growing to fill the mouth cavity regardless of the host size) are essentially the same. In either scenario, the female isopod must grow with the host (Williams & Williams 1982) or die quickly (which the long-term associated damage refutes). Female cymothoid isopods in the mouth or gill cavities of fishes always grow quickly to fill the available space. External cymothoid isopods are not space-limited, and their lengths do not always correlate with their host lengths (Williams & Bunkley-Williams unpubl. data). The question of Colorni et al. (1997) is just a matter of which host size range is infected. It is an interesting, if more simple, aspect of this isopod's biology. Female cymothoids alternate between reproductive activity and growth stages and remain associated with the host for a considerable part of its life cycle (Bunkley-Williams & Williams 1998).

Not only is there little sexual dimorphism in this species of isopod, there is little differentiation from juvenile to female. The slender body and large eyes make the female appear morphologically very much like a juvenile cymothoid.

The greater number of reproductive units in larger isopods is valuable information; however, this would have been much stronger if the broods of more than 3 females had been counted. The suggestion by Brusca (1981) that this always occurs should have been mentioned.

Many confusing terms are used in Colorni et al. (1997). The term 'infestation' has been generally replaced by 'infection' for parasites for decades, following a recommendation of the American Society of Parasitologists (as used in Margolis et al. 1982). The male of this hermaphroditic isopod cannot be called an 'adult'. Six different terms are used for the same thing: 'larvae', 'larval stages', 'manca', 'post-larval stages', 'undifferentiated stages', and 'young'. Any of these terms used exclusively might have been acceptable (we prefer the term 'juveniles'), but not such a variety in the same paper. At the bottom of page 67, the term 'male' has been put in place of 'female.'

With the exception of these problems, the paper (Colorni et al. 1997) is an outstanding contribution to science. We only wished to correct these few errors.

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