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Digenea, Plagiorchiida

Bivesiculata Olson et al., 2003 (Suborder): Small, Rare, but Important

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Class Trematoda

Subclass Digenea

Order Plagiorchiida

Suborder Bivesiculata

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Chapter 37

Bivesiculata Olson et al., 2003 (Suborder): Small, Rare, but Important

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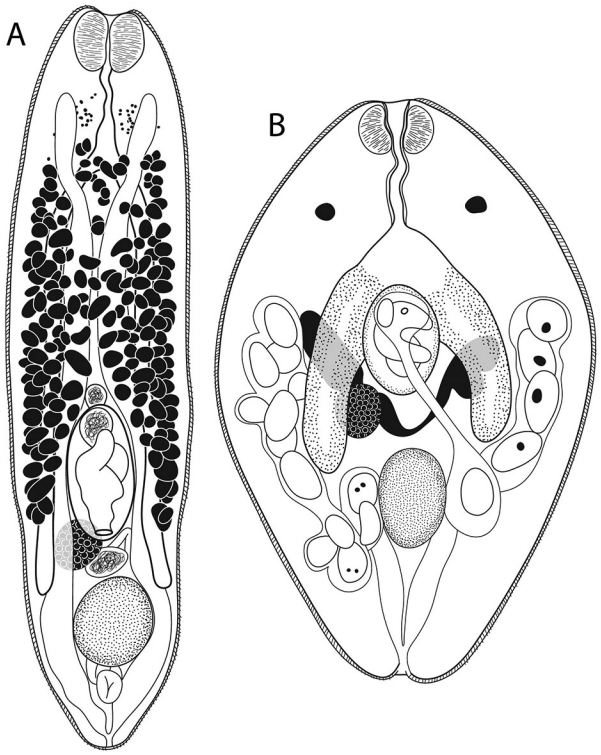

Figure 1. Sexual adult worms of family Bivesiculidae. All species lack oral and ventral suckers but have a well-developed pharynx. Species of the genus *Paucivitellosus* are unique within the family in having a highly reduced vitellarium and eggs that embryonate and grow in utero. A) *Bivesicula claviformis*. B) *Paucivitellosus fragilis*. Source: T. H. Cribb. License: CC BY-NC-SA 4.0.

Introduction

The Bivesiculata Olson et al., 2003 is a suborder of digenean trematodes, the species of which are found in the intestine of marine bony fishes, species of Osteichthyes. The single superfamily and family contain just 5 genera and 29 species (Decock et al., 2013). As none of the species have been reported to have any economic significance, why should we be interested in them? Their greatest significance lies in their evolutionary position and what their morphology and life cycle may therefore imply for the evolution of the Digenea as a whole.

Identifying Bivesiculids

Bivesiculids are small trematodes, the largest reported species (*Bivesicula congeri* Yamaguti, 1970) reaching just barely over 5 mm in length (Yamaguti, 1970) and the smallest (*Paucivitellosus fragilis* Coil, Reid & Kuntz, 1965) maturing at under 0.5 mm in length (Pearson, 1968) (Figure 1). They occur in a wide range of fishes; currently 36 families are known hosts. They are principally recognized by what they lack, namely, oral and ventral suckers. The absence of the ventral sucker is clear and unambiguous; However, the supposed absence of an oral sucker has been contentious because there is one anterior **muscular structure** surrounding the **gut** which sometimes been interpreted as an oral sucker and sometimes as a pharynx. Cribb and Cutmore take the view that it is a **pharynx** as it is well inside the body instead of around the **mouth**. The expression of the absence of oral and ventral suckers is most clear in living worms. They have a distinctive movement marked by pronounced peristaltic contraction of the body; comparable movement in any other trematodes has never been observed.

Beyond the absence of suckers, bivesiculids have few strongly distinguishing characters. They have **cecae**, a single **testis**, a well-developed **cirrus sac**, an **ovary**, extensive **vitelline follicles** (except in species of *Paucivitellosus*), and a deeply V-shaped **excretory bladder** (from which the type-genus *Bivesicula* takes its name).

Life Cycles

The known life cycles of trematodes in the Bivesiculidae are highly distinctive. All known bivesiculid cercariae develop in gastropods of the family Cerithiidae, a massively speciose family of marine snails known generally as sand-creepers. Le Zotte (1954) described 6 distinct bivesiculid cercarial morphotypes from cerithiid snail around Puerto Rico. There are perhaps not quite enough recorded and published data on infections known to be certain, but it seems likely that all bivesiculids infect members of the family Cerithiidae.

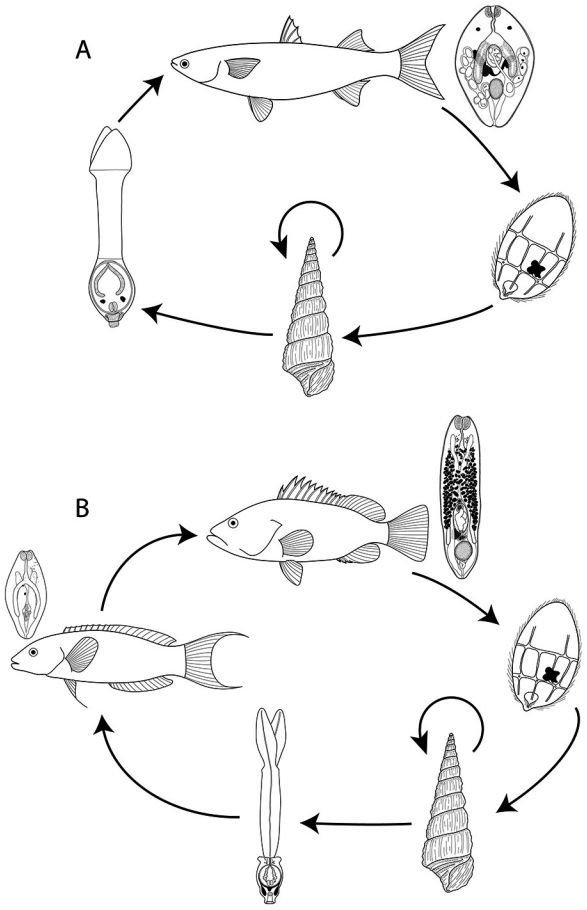

Figure 2. Life cycle of Bivesiculidae. A) *Paucivitellosus fragilis*; cercaria is ingested directly by definitive host. B) *Bivesicula claviformis*; cercaria is ingested by small fish, develops into a juvenile in the gut, and is then ingested with its host by a larger fish-eating grouper. The worms never mature in the small fish. Source: Source: T. H. Cribb. License: CC BY-NC-SA 4.0.

The most complete known life cycle for the family is that of *Paucivitellosus fragilis* as described by Pearson (1968) (Figure 2). A mother-sporocyst generation was not reported for this or any other bivesiculid, but presumably it exists and produces the generation (or generations) of rediae which are known, and which in turn produce cercariae. The cercaria is highly distinctive. It is relatively large (just visible to the naked eye), fork-tailed, and the cercarial body is withdrawn into a chamber at the base of the tail. In this respect it resembles cercariae of the Azygiidae, but the cercarial bodies of azygiids have well-developed oral and ventral suckers. The body withdraws into the base of the tail shortly after the cercaria emerges from the gastropod.

The cercaria is free-swimming and is thought typically to be eaten directly by the definitive host. This is certainly the case for *Paucivitellosus fragilis*, which attaches to the substrate and is then ingested (presumably accidentally) by grazing mullet (Mugilidae) and blennies (Blenniidae) (Pearson, 1968). Some bivesiculids infect planktivorous fishes (for example, Apogonidae, Clupeidae) and it is suspected that their cercariae are eaten directly from the plankton (Trieu et al., 2015). Other bivesiculids infect large predatory fishes, which seems incompatible with what is known of the life cycle of *P. fragilis*. However, Cribb and colleagues (1998) used DNA sequence evidence to show that one of these species, *Bivesicula claviformis* Yamaguti, 1934, frequently occurs as juveniles in the intestines of small fish species in which they are never found as sexual adults. They inferred that the small fish ingest the cercariae and that they are in turn ingested by the definitive hosts (Serranidae or groupers), so that the life cycle was facultatively (perhaps obligatorily) 3-host in at least some species. Such a life cycle probably explains the presence of bivesiculids in fishes such as moray eels (Muraenidae) and scorpionfish (Scorpaenidae).

Bivesiculata in Relation to Others in Their Group

In the molecular phylogenetic analysis of the Trematoda by Olson and colleagues (2003), the Digenea was identified as forming 2 major clades recognized as orders—the Diplostomida (including the blood flukes) and the Plagiorchiida (including such groups as *Fasciola,* the sheep blood fluke, and the human liver flukes, *Clonorchis* and *Opisthorchis*). The Bivesiculidae was resolved as basal, or the sister taxon, to all other Plagiorchiida. It is in this respect that the group is most interesting in its key morphological characters (absence of suckers) and the simple nature of the life cycle of some of its members (2-host with direct ingestion of an unencysted cercaria). The argument with respect to these characters is complicated and not entirely settled because it must take into account the fact that the Bivesiculidae is evidently basal only to the remainder of the Plagiorchiida, not to the Digenea as a whole. It thus remains debatable, for example, as to whether the absence of suckers is plesiomorphic (the basal condition) which implies that they evolved separately in both the Diplostomida and other Plagiorchiida or were secondarily lost in the Bivesiculidae. It seems likely, however, that bivesiculids represent a close approximation of the nature of at least one of the earliest forms of the Digenea.

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