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Platyhelminthes

Transversotrematidae (Family): Ectoparasitic Trematodes

Scott C. Cutmore and Thomas H. Cribb

Phylum Platyhelminthes

Class Trematoda

Subclass Digenea

Order Plagiorchiida

Suborder Transversotremata

Superfamily Transversotrematoidea Witenberg, 1944

Family Transversotrematidae

doi:10.32873/unl.dc.ciap061
2024. *In* S. L. Gardner and S. A. Gardner, eds. Concepts in Animal Parasitology. Zea Books, Lincoln, Nebraska, United States.

Chapter 61

Transversotrematidae (Family): Ectoparasitic Trematodes

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Introduction

The suborder Transversotremata is a small but biologically significant group of plagiorchiid digenean trematodes. There are just 1 superfamily, 1 family (family Transversotrematidae), 4 genera, and about 30 species known at present. It seems likely that the family Transversotrematidae is far richer than presently realized given that only a few workers have looked for them actively. All species are known from marine fishes of the Indo-West Pacific region or from freshwater fishes from the surrounding land masses. They are of particular interest because of the site of infection of the sexually adult worms. Species of this family live under the trailing edge of the scales of a wide range of marine and freshwater bony fishes. They are described as ectoparasites in the title to this chapter, but it is true that, when removed from the fish, they survive better in physiological saline than in either fresh or sea water; thus, they are evidently well sealed off from the external environment. No other trematodes are known to occupy this niche.

Perhaps because of the unusual site of infection, transversotrematids were recognized relatively late. The first described species, *Transversotrema patialense* (Soparkar, 1924), was actually first described as a cercaria. It was not until 1944 that the first sexual adult, *Transversotrema haasi* Witenberg, 1944, was reported and, even then, the host and site of infection was not really known as the specimens were found in basin of preserved fishes. Crusz and his colleagues (Crusz and Sathananthan, 1960; Crusz et al., 1964) first realized that the distinctive cercarial type of *Cercaria patialense* matched with adult worms from the skin of freshwater fishes.

Identifying Transversotrematids

Transversotrematids can perhaps be first suspected as such by the site that they infect. Work in our laboratory suggests that they are most easily detected by simply soaking the body of the dead (potential host) fish in 0.85% saline solution for 30–60 minutes. The worms emerge from under the scales and fall to the bottom of the container where they can be easily collected by inspecting the sediment with a stereo microscope.

All transversotrematids are at least partly transversely elongate (from which the type-genus name is derived) and exceptionally flat and thin, consistent with their subscale niche (Figure 1). The largest known species, *Transversotrema gigantica* Hunter et al., 2010, has been reported as reaching just over 8 mm in width (always greater than length) but most species are closer to 2 mm-wide. Most species lack an oral sucker, but the 2 known species of *Prototransversotrema* Angel, 1969 possess what might be either a true **oral sucker** or an analogous structure (Figure 1C). All species have a **ventral sucker**, a **pharynx**, and a **cyclocoel gut**. The **gonads** (2 **testes** and an **ovary**) are enclosed by the cyclocoel. **Vitelline follicles** are usually extensive but in the single described species of *Crusziella* Cribb, Bray & Barker, 1992 (Figure 1B) they are highly reduced and, in apparent association, the **eggs** embryonate in utero and will hatch to active **miracidia** as soon as they are laid. Importantly, members of the specious genus *Transversotrema* Witenberg, 1944 (Figure 1A) are now considered to be largely morphologically cryptic; although some species of *Transversotrema* are morphologically distinct, most have overlapping metric features and can only be definitively distinguished using genetic data.

Life Cycles and Host Range

The life cycle of transversotrematids is highly distinctive and specialized (Figure 2). Notably, although far more marine than freshwater species are known, all knowledge of the life cycle relates to freshwater species; nothing at all is known with respect to marine life cycles. However, it can be predicted that the life cycle does not vary greatly except perhaps with respect to the gastropod intermediate hosts infected.

Eggs embryonate and hatch as unremarkable miracidia. These actively seek and penetrate gastropod intermediate hosts (families Tateidae and Thiaridae known at present), in which the miracidium develops to a mother sporocyst. This has been described only once (Cribb, 1988) and in that case the sporocyst appears to produce only a single redia which in turn produces another generation of rediae, which then

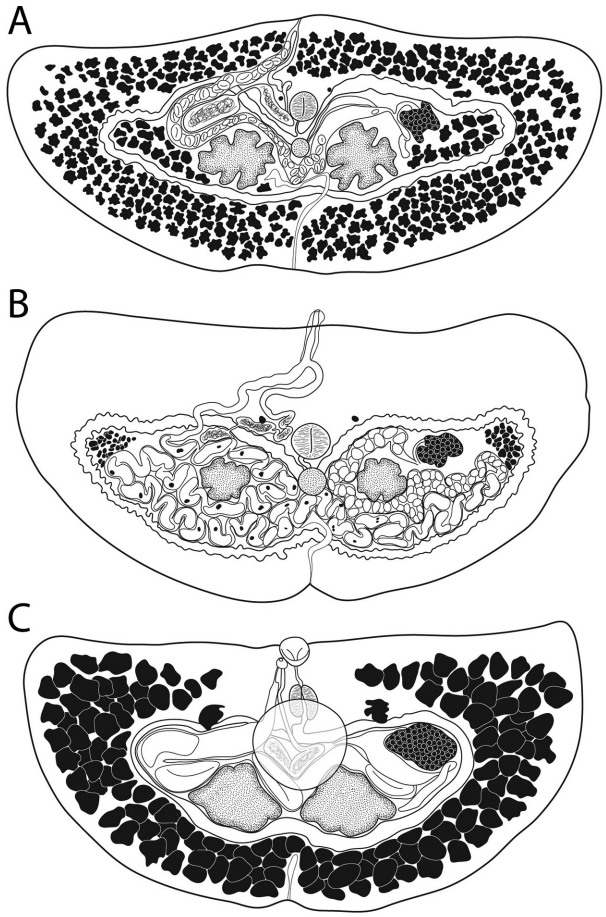

Figure 1. Transversotrematid morphology, showing cross-sections of:. A) *Transversotrema* sp.; B) *Crusziella* sp.; C) *Prototransversotrema* sp. Source: S. C. Cutmore and T. H. Cribb. License: CC BY-NC-SA 4.0.

produce cercariae. The cercaria is relatively enormous. The cercarial body is up to 0.5 mm wide, there is a pair of large eyespots, and the gonads and gut are essentially fully developed. The reproductive system may be so well developed that there is sperm in the seminal vesicle. The cercarial tail is unique among the Digenea. It is large and forked and has arm processes arising from the base of the tail. On their ends these arm processes have distinctive pads which have been shown to be concentrations of sensilla and are critical in host recognition (Whitfield et al., 1975).

Transversotrematid cercariae are highly active although relatively short-lived swimmers. They swim tail-first with the cercarial body wrapped around the tail-stem (Whitfield et al., 1975). When the cercaria bumps into a suitable fish it will recognize it as such with the pads on the arm processes, the cercarial body immediately slips under a scale and the tail detaches and swims away. Development to egg-producing adults is very quick, taking as few as 4 days (Cribb, 1988).

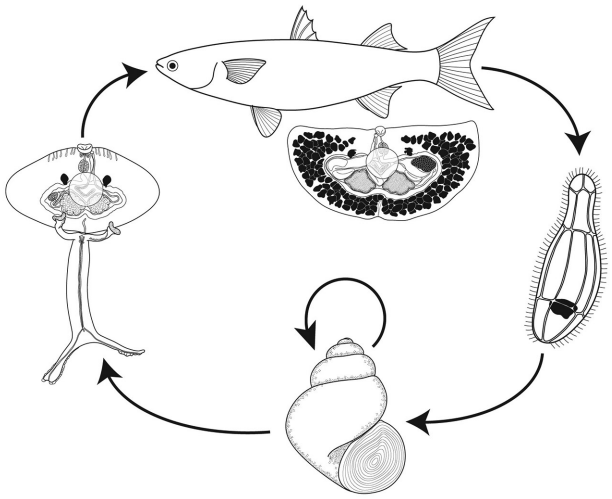

Figure 2. The generalized life cycle of transversotrematids. Source: S. C. Cutmore and T. H. Cribb. License: CC BY-NC-SA 4.0.

Interestingly, members of the Transversotrematidae exhibit a range of host specificities. Although a few species have been found to be **oioxenous** (infecting a single fish species), the overwhelming trend is for **stenoxenous** (infecting more than 1 species of a single fish family) and **euryxenous** (infecting more than 1 fish family) specificity (Hunter and Cribb, 2012; Cribb et al., 2014). Notably, *Transversotrema licinum* Manter, 1970 has been shown, using molecular data, to infect fishes of at least 8 families and 3 orders (Cutmore et al., 2016). It is likely that more extensive host sampling will show that all species of this group are either stenoxenous or euryxenous.

Significance of the Tranversotrematids

The main significance of the Transversotrematidae is in the combination of their evolutionary position and their biology. In the phylogeny of Olson and colleagues (2003), the Transversotrematidae fell unambiguously in the Plagiorchiida, sister to all other taxa except for the Bivesiculidae, the most basal taxon in the Plagiorchiida. In this context, the life cycle of the Transversotrematidae is highly intriguing. Apart from being relatively simple as a 2-host life cycle, there is little apparent connection with the life cycle of the Bivesiculidae in which the cercaria is eaten. Brooks and colleagues (1985) interpreted the ectoparasitic position of the Transversotrematidae as having occurred as the result of a secondary shift and Brooks and colleagues (1989) argued that the life cycle was secondarily reduced from a 3-host life cycle (so that perhaps the present sexual adult was once a metacercaria and the adult has been lost). These interpretations were made prior to what it now understood about the phylogenetic posi-

tion of the Transversotrematidae. Cribb and collagues (2003) suggested that, if the 2-host life cycle of transversotrematids is not a secondary condition, it might be consistent with multiple adoptions of vertebrate parasitism by the Digenea. These matters cannot yet be considered resolved, and thus the Transversotremata is a small group that should not be overlooked in the overall understanding of the evolution of the Trematoda.

The Special Case of *Transervotrema patialense*

An interesting aspect of transversotrematid biology is that 1 species, *Transervotrema patialense*, appears to be invasive. It has been reported from several countries outside its apparent native range (see Womble et al., 2015). It is transmitted by several thiarid gastropods, but especially by *Melanoides tuberculata*, which is itself a seriously invasive species. There is no evidence that *T. patialense* poses any real threat to native fish species outside of its natural range. Rather, these reports are testament to the simplicity of the life cycle.

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