

Observations on the eggs and fecundity of dactylogyrid and diplectanid monogeneans from the Australian marine sparid fish, *Acanthopagrus australis*

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Key words: Monogenea, eggs, fecundity, Sparidae, *Acanthopagrus*

Abstract. The eggs of most dactylogyrid and diplectanid monogeneans that infect *Acanthopagrus australis* are tetrahedral. The adults of larger species deposit more eggs per worm on average in 24h *in vitro*: *Lamellodiscus major* (31.7 eggs) = *Allomurraytrema robustum* (31.6 eggs) > *Haliotrema spariensis* (9.6 eggs) > *Lamellodiscus squamosus* (3.2 eggs). The eggs of *L. squamosus* (55.9 µm) and *H. spariensis* (56.4 µm) are smaller than those of *L. major* (66.1 µm) and *A. robustum* (63 µm). These eggs are normally shed into the water column. On the other hand, the eggs of *Lamellodiscus acanthopagri* are a modified T-shape (97.6 µm) and are attached to the gills by a sclerotised, thorn-like filament. The parasite can auto-infect the host, but has a low fecundity (0.05 eggs), possibly to prevent lethal parasite burdens.

Several species of Monogenea infect the yellowfin bream, *Acanthopagrus australis* (Günther) (family Sparidae) in inshore and estuarine waters along the eastern Australian coastline (Roubal 1981, Byrnes and Rohde 1992). These include the diplectanids *Lamellodiscus acanthopagri* Roubal, 1981, *L. squamosus* Roubal, 1981 and *L. major* Murray, 1931, the dactylogyrids *Haliotrema spariensis* Roubal, 1981 and *Allomurraytrema robustum* (Murray, 1931) Byrnes, 1986 and the microcotylid *Polylabroides multispinosus* Roubal, 1981.

Lamellodiscus acanthopagri has a modified egg that has a modified thorn-like, sclerotised filament that attaches the egg to the gills of yellowfin bream; the ciliated oncomiracidia can rapidly lose their cilia and auto-infect the host (Roubal 1994). Auto-infection is equivalent to increased reproductive capacity of the parasite (Llewellyn 1981), and high reproductive capacity in species that shed eggs into the water column offsets the hazards of host-finding (Kearn 1986). The other species of Monogenea, *L. squamosus*, *L. major*, *H. spariensis* and *P. multispinosus* live on the gills of yellowfin bream, *Acanthopagrus australis*, whereas *Allomurraytrema robustum* usually lives on the upper jaw near the hind teeth (Roubal 1981). The eggs of these parasites are usually shed into the water column. It is not known if the reproductive capacity of *Lamellodiscus acanthopagri* has been modified by its life history strategy (attached eggs and auto-infection) that differs to that of other species of Monogenea on *Acanthopagrus australis*. This study was done to compare the number and size of eggs deposited by the different species of Monogenea from *Acanthopagrus australis*.

MATERIALS AND METHODS

Individuals of *Acanthopagrus australis* were collected by handline from Moreton Bay (153° 10' E, 27° 20' S) or from Sea World, Gold Coast (153° 25' E, 27° 58' S), south east Queensland. The fish were transported in aerated sea water (35 parts per thousand (ppt) salinity) to the laboratory and kept in 20°C sea water for up to 24 hours, killed by spinal severance and the gills excised. *Allomurraytrema robustum* was obtained from the buccal cavity whereas the other worms (*Lamellodiscus acanthopagri*, *L. squamosus*, *L. major*, *Haliotrema spariensis*) were found on the gills.

Adult worms with vitellaria evident were removed carefully with a needle or left attached to a small piece of gill filament and placed in culture medium (autoclaved sea water with 100 i.u. penicillin/ml, 100 g streptomycin/ml and 0.25 g fungizone/ml) at 20°C for 24 hours after which time the numbers of eggs deposited were counted. The experiments were done with fish taken less than 48 h from the field and with freshly dissected fish and active worms.

Deposited eggs were collected, preserved in 10% formalin, mounted on a glass slide with a coverslip supported by vaseline to prevent undue compression, measured and drawn with the aid of a drawing tube. Any malformed eggs were ignored. Adult worms were anaesthetised in cold sea water (4°C), preserved in 10% formalin and measured on a glass slide with supported coverslip to prevent compression. The body length of the parasite includes the haptor. The average sizes for adult worms examined were similar to those given by Roubal (1981). One-way analysis of variance (ANOVA) was used to examine the statistical significance of differences in both the size and number of eggs deposited. Significantly different means were found by Tukey's multiple range test (MRT). These analyses were done with the SAS (Ver. 6.03) package (SAS Institute, Cary, N. C.) with a significance level of 0.05.

Table 1. Number of eggs deposited *in vitro* in 24 h by different species of Monogenea from *Acanthopagrus australis* (Günther) (family Sparidae).

Parasite species	Body size (mm)		No. worms	Total no. eggs	No. eggs/worm		Egg size (µm)		No. measured
	Mean	Range			Mean	Range	Mean	Range	
<i>L. acanthopagri</i>	0.3	0.2–0.35	40	2	0.05	0–1	97.6	95.0–104.0	10
<i>L. squamosus</i>	0.6	0.4–0.7	21	68	3.24	0–7	55.9*	53.2–59.8	9
<i>L. major</i>	1.05	0.8–1.4	7	222	31.7*	20–49	66.1	63.8–67.8	18
<i>H. spariensis</i>	0.57	0.4–0.7	85	819	9.6	0–21	56.4*	53.2–66.5	57
<i>A. robustum</i>	1.4	0.9–1.6	30	947	31.6*	15–58	63.0	53.2–73.1	73

L. – *Lamellodiscus*; *H.* – *Haliotrema*; *A.* – *Allomurraytrema*; No. – number; * – means not significantly different by Turkey's multiple range test (0.05 probability level); parasite body size includes haptor.

RESULTS

The egg deposited by *Lamellodiscus acanthopagri* has two horn-like processes and a sclerotised, thorn-like filament (Fig. 1a) that is inserted into the epithelium at the base of the respiratory lamellae on the gills of yellowfin bream. Tetrahedral eggs of a similar shape were deposited by the diplectanid monogeneans *Lamellodiscus squamosus* (Fig. 1b) and *L. major* (Fig. 1c), and the dactylogyrids *Haliotrema spariensis* (Fig. 1d) and *Allomurraytrema robustum* (Fig. 1e). There was a significant difference (ANOVA, $F = 40.8$, $P < 0.001$) in the size of eggs deposited by the different species. The eggs of *H. spariensis* were not different in size to those of *L. squamosus*, but both were smaller than those of *A. robustum* and *L. major* (Table 1). The eggs of

L. acanthopagri are different in size to those of the other worms, but because of the different shape they cannot be compared directly.

All adult individuals of *L. major* and *A. robustum* deposited eggs *in vitro*, whereas 78 (92%) of 85 *Haliotrema spariensis*, 20 (95%) of 21 *L. squamosus*, but only 2 (5%) of 40 *Lamellodiscus acanthopagri* deposited eggs *in vitro* (Table 1).

There was a significant difference (ANOVA, $F = 106.8$, $P < 0.001$) in the number of eggs deposited in 24 h by individual worms (Table 1). *Lamellodiscus major*, the largest of the species in this genus from the gills of yellowfin bream, deposited the same number of eggs (31.7 eggs/worm/24 h) as the other large parasite, *Allomurraytrema robustum* (31.6 eggs/worm/24 h). When considered over all fish in the sample, both of these species deposited 3.3 times as many eggs as *H. spariensis* (9.64 eggs/worm/24 h), 9.7 times as many eggs as *L. squamosus* (3.24 eggs/worm/24 h), and 600 times as many eggs as *L. acanthopagri* (0.05 eggs/worm/24 h) (Table 1). Each of two *L. acanthopagri* deposited one egg in 24 h.

DISCUSSION

The eggs produced by the dactylogyrid and diplectanid monogeneans from *Acanthopagrus australis*, except *Lamellodiscus acanthopagri*, are tetrahedral in shape. Tetrahedral eggs are produced by many monogeneans (Kearn 1986). There was a general trend for the larger species of Monogenea on the gills of yellowfin bream to deposit more eggs than the smaller species. Thus, *L. major* and *A. robustum* produced more eggs than the smaller *L. squamosus* and *H. spariensis*. Furthermore, *L. major* and *A. robustum* produced larger eggs than *L. squamosus* and *H. spariensis*.

Kearn (1985) pointed out that egg production by *Entobdella soleae* increased as the size of the adult worm

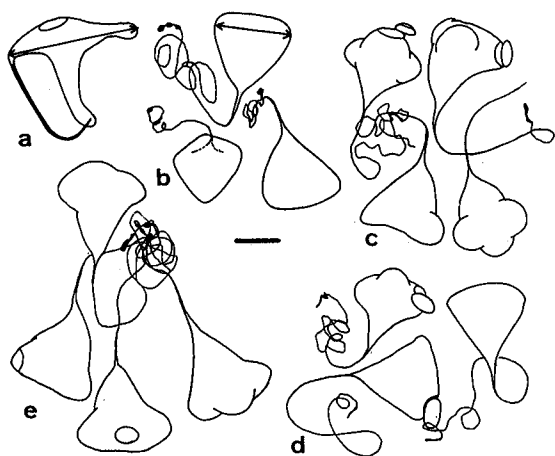


Fig. 1. Eggs deposited by *Lamellodiscus acanthopagri* (a), *L. squamosus* (b), *L. major* (c), *Haliotrema spariensis* (d) and *Allomurraytrema robustum* (e). Lines in Figs. a and b show axis measured in Table 1. Bar = 30 µm.

increased. The limiting factor for small adults was apparently the storage capacity of vitelline reservoirs or the rate of vitelline cell production. It follows, therefore, that the smaller species of dactylogyrid and diplectanid Monogenea from *A. australis* have less vitelline reserve than larger species, and produce fewer and smaller eggs.

The large (1500 µm) polyopisthocotylean microcotylid, *Polylabroides multispinosus*, produced large (190 µm), cigar-shaped eggs, but its reproductive output (14.5 eggs/worm/24 h) (see Diggles et al. 1993) was lower than that of either *L. major* (31.7 eggs/worm/24 h) or *A. robustum* (31.6 eggs/worm/24 h). Perhaps the larger size of the egg of *P. multispinosus* requires a longer time for assembly. As yet, there are no data for the assembly time of eggs by the dactylogyrid and diplectanid Monogenea on *A. australis*, nor for their developmental rate, longevity and reproductive period. It is not possible, therefore, to assess fully the significance of egg size and deposition rate to overall parasite fecundity and population size.

Nonetheless, the present study shows that *Lamellodiscus acanthopagri* employs a different reproductive strategy to that of related parasites on the same host. *Lamellodiscus acanthopagri* attaches its eggs to the gills of *A. australis*, and can auto-infect the host at all levels of infection. The ciliated oncomiracidia also leave the host to infect other bream (Roubal 1994). Commensurate with this reproductive strategy is a low fecundity. Although *L. acanthopagri* is of similar size to *L. squamosus*, it produces far fewer eggs *in vitro*. One reason may be to prevent the buildup of large and potentially lethal populations of *L. acanthopagri* on the gills. Selec-

tive pressure for a low reproductive output may work to curb a high host mortality.

Only a few bream in the wild are very heavily infected by *Lamellodiscus acanthopagri* (see Roubal 1994), but its abundance (15 worms/fish) is higher than that of *H. spariensis* (8.9 worms/fish), *A. robustum* (3.5 worms/fish), *L. squamosus* (3.4 worms/fish), *P. multispinosus* (2.9 worms/fish) and *L. major* (0.26 worms/fish) (Roubal – unpublished data). Although *L. major* and *A. robustum* produce large numbers of large eggs, their populations on the host are smaller than that of *H. spariensis* which is highly prevalent throughout the year (Roubal 1990) but produces fewer and smaller eggs. Obviously, factors other than reproductive output determine the success of infecting the host population.

The bream do not school, except at the spawning grounds during winter (Pollock 1984). There is no evidence that spawning aggregation promotes higher infection levels by any monogenean species (Roubal – unpublished data). Instead, both large and small bream feed in the littoral zone during high tide, and tend to live inshore; there is no age- or sex-related migration into deeper water. Presumably, the larvae of *H. spariensis* are more successful in finding the bream host than are other monogenean species with larger eggs and greater rate of egg deposition.

Acknowledgements. I would like to thank Mr. Bill Clark and the staff at Sea World for assistance in collecting yellowfin bream. This study was supported by an Australian Research Council fellowship to the author and by an ARC grant A18932114.

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