

**FOUR NEW STYLOCHID FLATWORMS  
(PLATYHELMINTHES: POLYCLADIDA) ASSOCIATED WITH  
COMMERCIAL OYSTERS FROM MORETON BAY,  
SOUTHEAST QUEENSLAND, AUSTRALIA**

**K.A. Jennings and L.J. Newman**

**ABSTRACT.** - Four new species of stylochid flatworms, *Imogine kima*, *Imogine mcgrathi*, *Imogine meganae* and *Imogine pardalotus* are described from Moreton Bay, southeast Queensland. These new species differ from other closely related stylochids in their colour pattern, size, eye arrangement and details of the male reproductive anatomy. Three of these species, *I. kima*, *I. meganae* and *I. pardalotus* were found to be associated with the Sydney rock oyster, *Saccostrea glomerata* (Gould, 1850). Only *I. mcgrathi*, was observed to directly feed on oyster tissue in the laboratory and thus could pose a threat to the oyster industry in southeast Queensland.

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**INTRODUCTION**

'Oyster leeches' or 'wafers' are commonly known as pests of commercial bivalves (oysters, mussels and giant clams) throughout the world (Stead, 1907; Pearse & Wharton, 1938; Galleni, 1976; Galleni et al., 1980; Littlewood & Marsbe, 1990; Newman et al., 1993). Although no direct experimental evidence exists to show how these polyclads feed on bivalves, Galleni et al. (1980), Littlewood & Marsbe (1990), and Newman et al. (1993) reported that stylochids kill and consume cultured bivalves, significantly contributing to their mortalities.

Despite the potential importance of acotylean flatworms to the Australian oyster industry, little is known about these flatworms from eastern Australian waters. Only three species: *Stylochus vigilax* Laidlaw, 1904; *Stylochus stellatus* Jennings & Newman, 1996, and *Imogine lesteri* Jennings & Newman, 1996, have been previously reported from the entire east coast of Australia and only eight species are known from Australasian waters (Galleni, 1976; Newman et al., 1993; Jennings & Newman, 1996). Newman & Cannon (1994) also reported two undescribed species of *Stylochus* from the southern Great Barrier Reef. However, none of these species are known to be associated with bivalves. Another acotylean, *Notoplana australis* (Schmarda, 1859), is well known as a pest of oysters from temperate Australian waters (Stead, 1907).

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Four new species of stylochid flatworms associated with the Sydney rock oyster, *Saccostrea glomerata* (Gould, 1850) (see Anderson & Adlard, 1994) are described here and compared to other species. Observations on the feeding biology and a description of the larvae are given for the most common species, *Imogine mcgrathi*. The subgenus *Imogine* is re-elevated to genus level.

## MATERIALS AND METHODS

Flatworms were hand collected from clumps of live and dead oysters from oyster leases, Dialba Passage, North Stradbroke Island, Moreton Bay, southeast Queensland, Australia (27° 29' S, 153° 25' E). Animals were retained in the laboratory in 1 L plastic containers for up to a month in unfiltered seawater (24° C & 35 ‰ salinity) which was changed daily. Specimens were fixed on frozen polyclad fixative (see Newman & Cannon, 1995). Whole mounts were prepared by first staining with Mayer's haemalum, dehydrating in graded alcohols, clearing in xylene and mounting in Canada balsam. Longitudinal serial sections of the reproductive regions were prepared by embedding excised tissue in 56° C Paraplast, cutting at 6-8µm and staining with haematoxylin and eosin.

Drawings and measurements were made by K.A.J with the aid of a camera lucida. Due to the plasticity of these animals measurements are only given as a guide. Body size is expressed as length mm x width mm for the type material only. Detailed measurements of the reproductive anatomy were obtained using a digitising system (see Roff & Hopcroft, 1986). All material is lodged at the Queensland Museum: wholemounts are designated (WM), serial sections (LS) and wet specimens remaining in 70% alcohol (S).

## DESCRIPTION

### *Imogine* Girard, 1853

**Type species.** - *Imogine oculiferus* (Girard, 1853), coast of Carolinas, eastern USA.

**Diagnosis.** - Stylochidae with a tripartite or anchor-shaped, muscular seminal vesicle (Faubel, 1983).

**Remarks.** - According to Marcus & Marcus (1968) the large genus *Stylochus* can be clearly separated into two groups which they considered as subgenera on the basis of the structure of the seminal vesicle; either muscular and tripartite (*Imogine*) or thin walled and simple (*Stylochus*) (see Faubel, 1983; Prudhoe, 1985). With increasing knowledge we consider the two sub-groups of Marcus & Marcus (1968) to each be worthy of generic rank. Here we re-elevate *Imogine* to genus level.

### *Imogine kima*, new species

(Figs. 1A-D, 5A)

**Material examined.** - Holotype - WM (QM G210739), oyster leases, Dialba Passage, Dunwich, North Stradbroke Island, Moreton Bay, Australia, 21 May.1995.

Paratypes - LS (QM G210740), same data, 11 Sept.1995; S (QM G210741), 20 Sep.1995; S (QM G210742), 26 Oct.1995; S (QM G210753), 23 Nov.1995; S (QM G210754), 04 Apr.1996; S (QM G210755), 25 May.1996.

**Description.**- Body oval, thick and fleshy, margin indented, blunt posteriorly with few marginal ruffles (Figs. 1A-C, 5A). Dorsal surface bright orange-pink with light brown mottling medially and light brown flecking at margin. Nuchal tentacles transparent but appear black due to the dense concentration of eyes. Ventrally cream without markings. Size of mature living animals ranged from 30 mm x 18 mm to 50 mm x 32 mm.

Nuchal tentacles small, retractile, varying in shape from short and cylindrical to conical bumps, about 0.48 mm wide and 2.1 mm apart (Fig. 1A). Marginal eyes along the entire margin; densely packed anteriorly in four to five rows, becoming scattered posteriorly in two to three rows (Fig. 1B). Cerebral eyes numerous, embedded in the epidermis between nuchal tentacles, extending into a few scattered frontal eyes. About 100 tentacular eyes in each nuchal tentacle, concentrated on the anterior sides and in tips of tentacles.

Pharynx central, about 1/2 body length; with about 20 complex, ruffled pharyngeal folds; mouth slightly anterior to mid-line of pharynx (Fig. 1C). Gonopores separate, posterior to pharynx, about 0.3 mm between pores and 1.2 mm between female pore and posterior margin. Vas deferens extend anteriorly from pores, along 1/2 length of pharynx.

Testes ventrally scattered throughout the body, vas deferens with ducts arising mid-body passing posteriorly on each side of the pharynx to the region of the prostate where they turn back to enter the lateral lobes of the tripartite seminal vesicle (Fig. 1D). Seminal vesicle lies ventrally, the lateral lobes and central lobe are large and muscular and of approximately equal size (about 0.3 mm x 0.1 mm). The central lobe of the seminal vesicle passes posteriorly and becomes narrower as it leads into the coiled ejaculatory duct, joining the prostatic duct at the proximal end of the penis. Prostatic duct short, joins dorsally to the mid-penis from the oval, highly muscular prostate. Prostate about 0.9 mm x 0.5 mm, with numerous narrow ducts leading into the lumen which is lined with folded epithelium; extracapsular glands not apparent. Penis papilla simple, small (about 0.16 mm x 0.26 mm), within a deep male antrum.

Ovaries scattered dorsally throughout the body; ova collect into the uteri on each side of the pharynx, run posteriorly to the female pore, curve dorsally and join at the distal end of the vagina. Vagina narrow, muscular, receiving numerous secretions from the cement glands proximally and leading into a shallow female antrum (Fig. 1D).

**Diagnosis.**- Belonging to the genus *Imogine* with tripartite seminal vesicle. Body up to 50 mm x 32 mm, dorsal surface bright orange-pink with light brown mottling, eyes around entire margin, about 100 eyes within each nuchal tentacle, cerebral eyes in one restricted group only extending into a few scattered frontal eyes, prostate about twice the size of the seminal vesicle.

**Etymology.**- Named in honour of Miss Kim McGrath who first collected specimens of this flatworm.

**Distribution.**- Common on oyster clumps covered in pink coralline algae, at low tide level, oyster leases, Dialba Passage, North Stradbroke Island, Moreton Bay, eastern Australia.

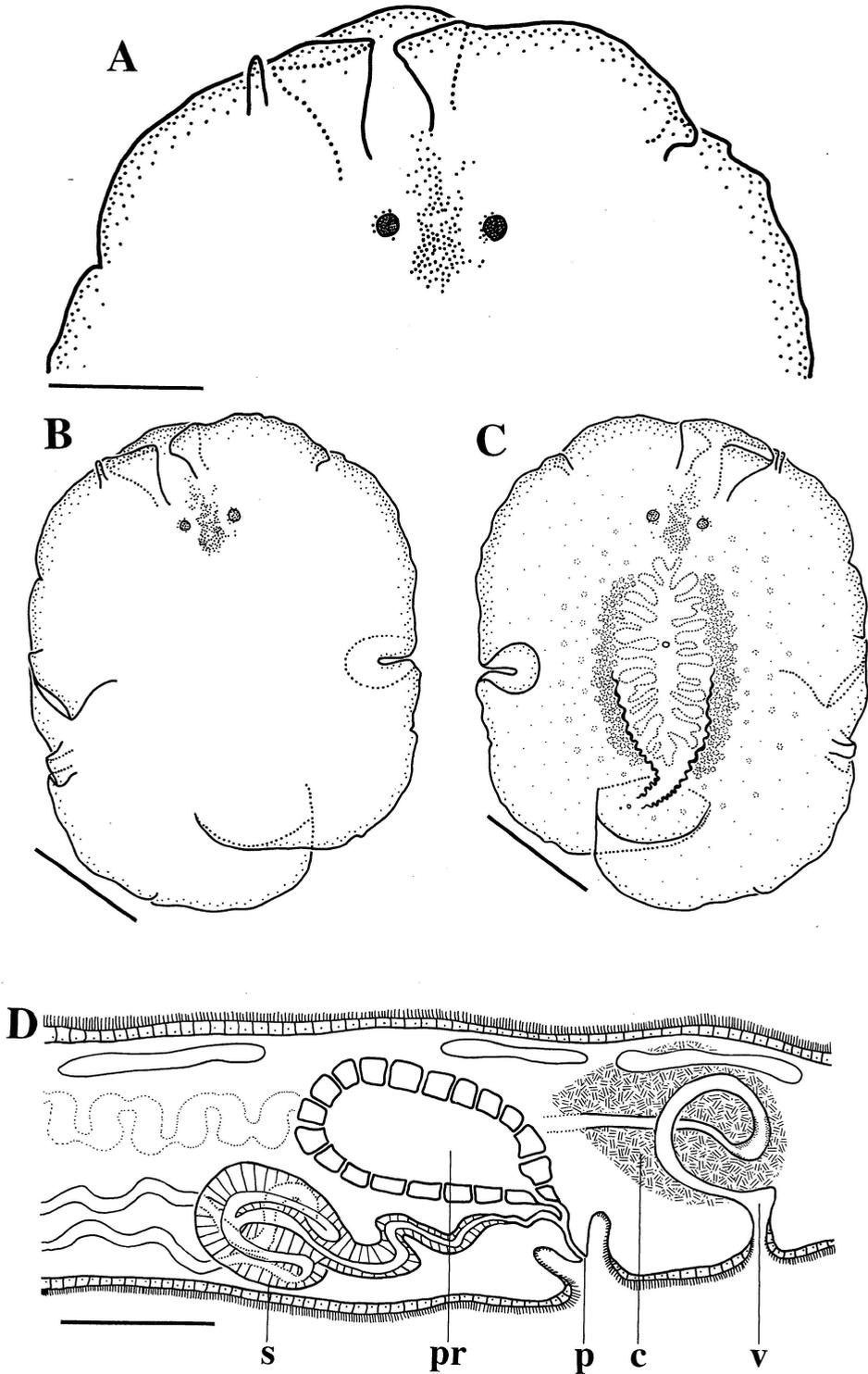


Fig. 1. *Imogine kimae*, new species. A, arrangement of cerebral and frontal eyes; B, arrangement of the dorsal eyes; C, wholemount from the ventral side; D, diagrammatic reconstruction of the reproductive system (c cement glands, p - penis papilla, pr - prostatic vesicle, s - seminal vesicle, v - vagina). Scales: A = 3 mm, B & C = 5 mm, D = 0.5 mm.

**Remarks.**- Faubel (1983), Newman et al. (1993) and Jennings & Newman (1996) recognised 28 species within the genus *Imogine* (i.e. those with a tripartite seminal vesicle); these species can be further separated into two groups based on the arrangement of the marginal eyes. Fourteen species including the ten previously described and four new species with eyes around the entire margin are listed in Table 1. Nine of the 14 species clearly differ from *I. kima*, by having cerebral eyes arranged in two distinct clusters. The four remaining species differ from *I. kima* as follows: *Imogine exiguus* Hyman, 1953 has only a few frontal and cerebral eyes (not >100), a posterior notch and is relatively small in size; *I. lesteri* Jennings & Newman, 1996 has 50 tentacular eyes (not >100) and fewer frontal eyes that do not extend as far anteriorly as those in *I. kima*. The other two species will be described later.

**Biology.**- This species is cryptically coloured and is consistently found with living oysters covered in pink coralline algae. It is not known whether these flatworms are feeding on the oysters or invertebrates living on the coralline algae itself.

***Imogine mcgrathi*, new species**

(Figs. 2A-E, 5B)

**Material examined.**- Holotype- WM (QM G210650), oyster leases, Dialba Passage, North Stradbroke Island, Moreton Bay, Australia, 16 Apr.1992.

Paratypes - LS (QM G210659), same data, 16 Apr.1992; WM (QM 210651), 06 Feb.1993; LS (QM G210656); LS (QM G210653).

Other Material: - S (QM G210654), approx. 100 ex., same data, Jan.1992; S (QM G210655), 8 ex., same data, 12 Apr.1992; WM (QM G210652), 16 Apr.1992; LS (QM G210657); LS (QM G210658); S (QM G210661), 6 ex., 06 Feb.1993; S (QM G210660), 18 ex., 26 Apr.1995.

**Description.**- Worms rounded-oval, body thick and fleshy with few marginal ruffles, blunt posteriorly (Figs. 2A-C, 5B). Brown dorsally with an even mottled pattern of dark brown microdots, slightly darker medially. Nuchal tentacles colourless and transparent. Several specimens were infected with the haplosporidian parasite *Urosporidium cannoni* Anderson et al., 1993 which appears as large black irregular spots on the dorsal and ventral surface. Ventrally beige without markings. Sizes ranged from 10 mm x 6 mm (immature) to 65 mm x 45 mm (mature).

Nuchal tentacles small, retractile, varying in shape from short and conical to only slight bumps, about 0.5 mm wide and 1.9 mm apart (Fig. 2A, B). Marginal eyes along the entire margin, densely packed anteriorly in three or four rows, becoming more scattered posteriorly in one to two rows. Cerebral eyes numerous, embedded in the epidermis, scattered between and posteriorly to the nuchal tentacles, extending anteriorly into frontal eyes which are less numerous and scattered. Tentacular eyes scattered within the nuchal tentacles, about 30 eyes each nuchal tentacle.

Pharynx large about 1/2 body length, situated mid-body with about 20 to 24 complex, ruffled pharyngeal folds; mouth posterior to mid-line (Fig. 2C). Gonopores separate, posterior to the pharynx, about 0.5 mm between pores and 2.8 mm between female pore and posterior margin. Vas deferens extend anteriorly from pores, along 1/3 the length of the pharynx.

Testes ventrally scattered throughout the body, vas deferens with ducts arising mid-body passing posteriorly on each side to the region of the prostate where they turn back to enter

the lateral lobes of the tripartite seminal vesicle (Fig. 2D). Seminal vesicle lies ventrally, the lateral lobes and central lobe are large, muscular and approximately equal in size (about 0.8 mm x 0.4 mm). The central lobe of the seminal vesicle passes posteriorly and becomes narrower as it leads into the coiled ejaculatory duct, joining the prostatic duct in middle of the penis. Prostatic duct short, joins dorsally to the mid-penis from the oval, highly muscular prostate. Prostate about 1.3 mm x 0.7 mm, with numerous narrow ducts leading into the lumen which is lined with a folded epithelium, extracapsular glands are not apparent. Penis papilla simple, small (about 0.20 mm x 0.18 mm) within a deep male antrum.

Ovaries scattered dorsally throughout the body; ova collect into the uteri situated on either side of the pharynx, run posteriorly to the female pore, curve dorsally and join at the distal end of the vagina. Vagina narrow, muscular, receiving numerous secretions from the cement glands proximally leading into a shallow female antrum (Fig. 2D).

Götte's larvae colourless and transparent with four ciliated lobes, anterior and posterior cilia tufts and three eyespots, 0.16 mm long (Fig. 2E).

**Diagnosis.**- Belonging to the genus *Imogine* with tripartite seminal vesicle. Body up to 65 mm x 45 mm, brown dorsally with an even mottled pattern of dark brown microdots, eyes around the entire margin, about 30 eyes within each nuchal tentacle, numerous cerebral eyes extending to the anterior margin (frontal eyes), prostate about twice the size of the seminal vesicle.

**Etymology.**- Named in honour of Mr Lawrie McGrath who first collected this flatworm.

**Distribution.**- Abundant on oysters from oyster leases, Dialba Passage, North Stradbroke Island, Moreton Bay, eastern Australia.

**Remarks.**- Nine of the 14 species listed in Table 1 clearly differ from *I. mcgrathi* by having cerebral eyes arranged in two distinct clusters. The four remaining species differ from *I. mcgrathi*, as follows: *I. exiguus* Hyman, 1953, is relatively small, with few frontal and cerebral eyes (not >100), and a posterior notch; *I. lesteri* Jennings & Newman, 1996, also has few frontal eyes which do not extend into marginal eyes and a colour pattern of mottled pale orange and light brown with irregular dark brown flecks (not even, dark brown microdots, darker medially). *Imogine mcgrathi* differs from *I. kima* by having even, dark brown microdots (not bright orange-pink); unrestricted frontal eyes extending into marginal eyes and the presence of 30 tentacular eyes in each nuchal tentacle (not 100 tentacular eyes).

**Biology.**- *Imogine mcgrathi* is only found with oysters and mussels and in some instances they were found within empty shells. In six instances, flatworms were found actually inside oysters and it was noted that the oyster's adductor muscle was severely damaged. Worms were fed shelled and shelled oysters in the laboratory and observed to engulf the oyster tissue whole. The feeding strategy of this worm is currently under investigation.

Animals kept in the laboratory for two days laid egg masses containing thousands of eggs. Each eggmass was inconspicuous and appeared as a thin, beige film, one layer thick, and variable in size and shape. The largest eggmass was about 20 to 30 mm long and individual eggs measured 0.12 mm in diameter. After eight days, Götte's larvae hatched simultaneously (during a water change). Larvae appeared to be positively phototropic and survived for 11 days without feeding.

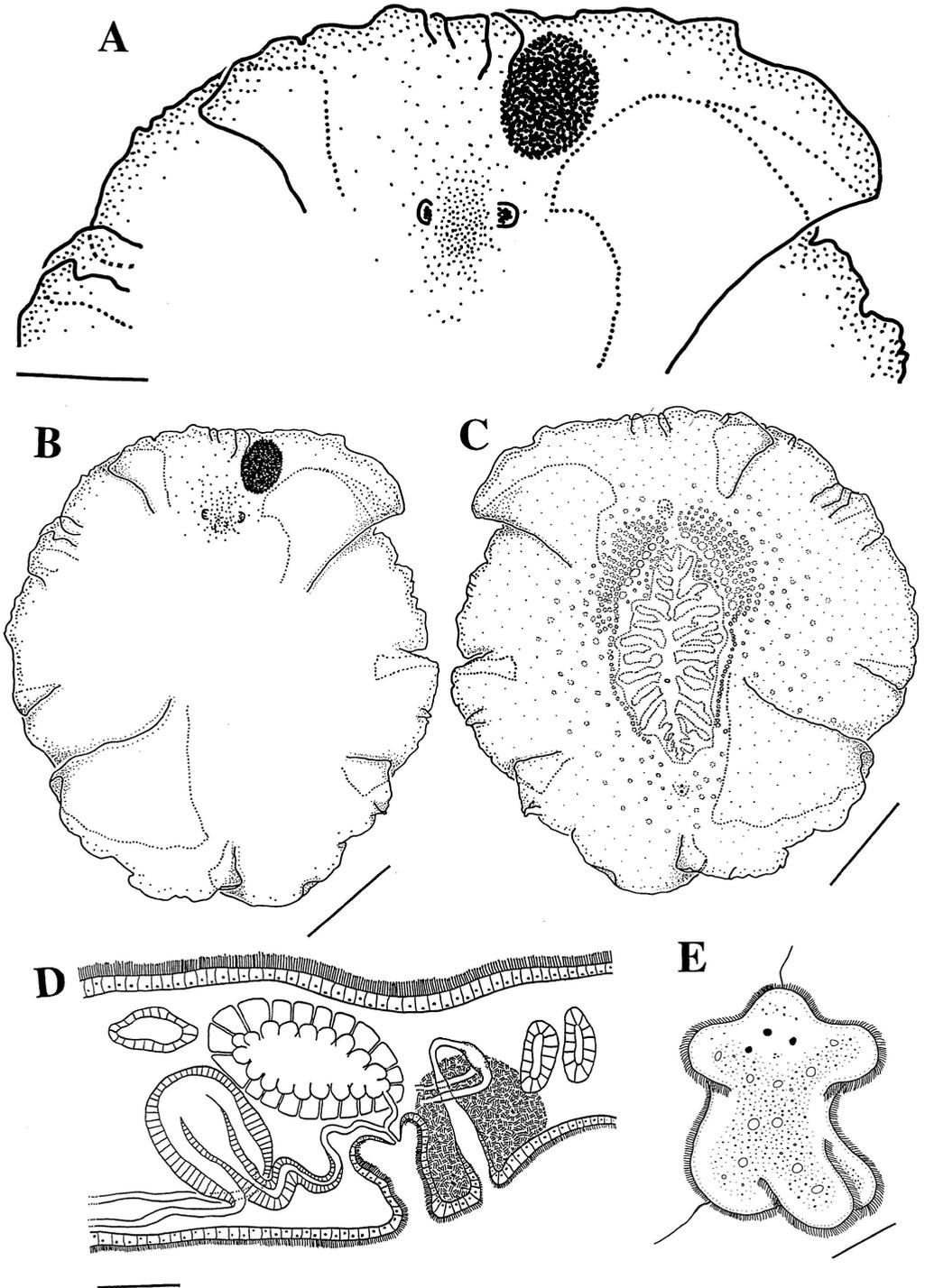


Fig. 2. *Imogine mcgrathi*, new species. A, arrangement of cerebral and frontal eyes; B, arrangement of the dorsal eyes; C, wholemount from the ventral side; D, diagrammatic reconstruction of the reproductive system; E, Götte's larva. Scales: A = 3 mm, B & C = 5 mm, D = 0.5 mm, E = 0.5  $\mu$ m.

***Imogine meganae*, new species**

(Figs. 3A-D, 5C)

**Material examined.**- Holotype - WM (QM G210743), oyster leases, Dialba Passage, North Stradbroke Island, Moreton Bay, Australia, 22 Mar.1993.

Paratypes - LS (QM G210745), same data; S (QM G210747), 3 ex., 22 Mar.1993; WM (QM G210746), 27 Mar.1993; S (QM G210748), 09 Jun.1996.

**Description.**- Body oval, thick and fleshy, margin indented, blunt posteriorly with several marginal ruffles (Figs. 3A-C, 5C). Dorsal surface beige with a concentrated dark brown mottled pattern, darker medially. Margin and nuchal tentacles are heavily flecked yellow. Ventrally beige with a yellow margin. Size of mature living animals ranged from 25 mm x 22 mm to 32 mm x 25 mm.

Nuchal tentacles small, retractile, varying in shape from elongate and cylindrical to conical bumps, about 0.48 mm wide and 2.8 mm apart (Fig. 3A, B). Marginal eyes along the entire margin; densely packed anteriorly in four to five rows, becoming scattered posteriorly in one to two rows. Cerebral eyes numerous, embedded in the epidermis and densely packed between nuchal tentacles, extending into numerous scattered frontal eyes situated anteriorly and laterally from the nuchal tentacles. Frontal eyes merge into anterior marginal eyes. About 50 tentacular eyes present in each nuchal tentacle.

Pharynx central, about 3/4 body length, with about 20 complex, ruffled pharyngeal folds, mouth posterior to midline of pharynx (Fig. 3C). Gonopores separate, posterior to the pharynx, about 1.0 mm between pores and 4.5 mm between female pore and posterior margin. Vas deferens extend anteriorly from pores, along entire length of the pharynx.

Testes ventrally scattered throughout the body, vas deferens with ducts arising at the anterior end of pharynx passing posteriorly on each side to the region of the prostate where they turn back to enter the lateral lobes of the tripartite seminal vesicle (Fig. 3D). Seminal vesicle lies ventrally, the lateral lobes and central lobe are large and muscular and of approximately equal size (about 0.4 mm x 0.2 mm). The central lobe of the seminal vesicle passes posteriorly and becomes narrower as it leads into the coiled ejaculatory duct, joining the prostatic duct in middle of the penis. Prostatic duct short, joins dorsally to the mid-penis from the oval, highly muscular prostate. Prostate about 1.1 mm x 0.5 mm, with numerous narrow ducts leading into the lumen which is lined with folded epithelium, extracapsular glands not apparent. Penis papilla simple, small (0.17 mm x 0.28 mm), within a deep male antrum.

Ovaries scattered dorsally throughout the body: ova collect into the uteri which are on either side of the pharynx, run posteriorly to the female pore, curve dorsally and join at the distal end of the vagina. Vagina narrow, muscular, receiving numerous secretions from the cement glands proximally and leads into a shallow female antrum (Fig. 3D).

**Diagnosis.**- Belonging to the genus *Imogine* with tripartite seminal vesicle. Body up to 32 mm x 25 mm, beige with dark brown mottling which is darker medially, yellow marginal band and nuchal tentacles, eyes around the entire margin, about 50 eyes within each nuchal tentacle, numerous cerebral and frontal eyes extending anteriorly and laterally from the nuchal tentacles to the margin, prostate and seminal vesicle about equal size.

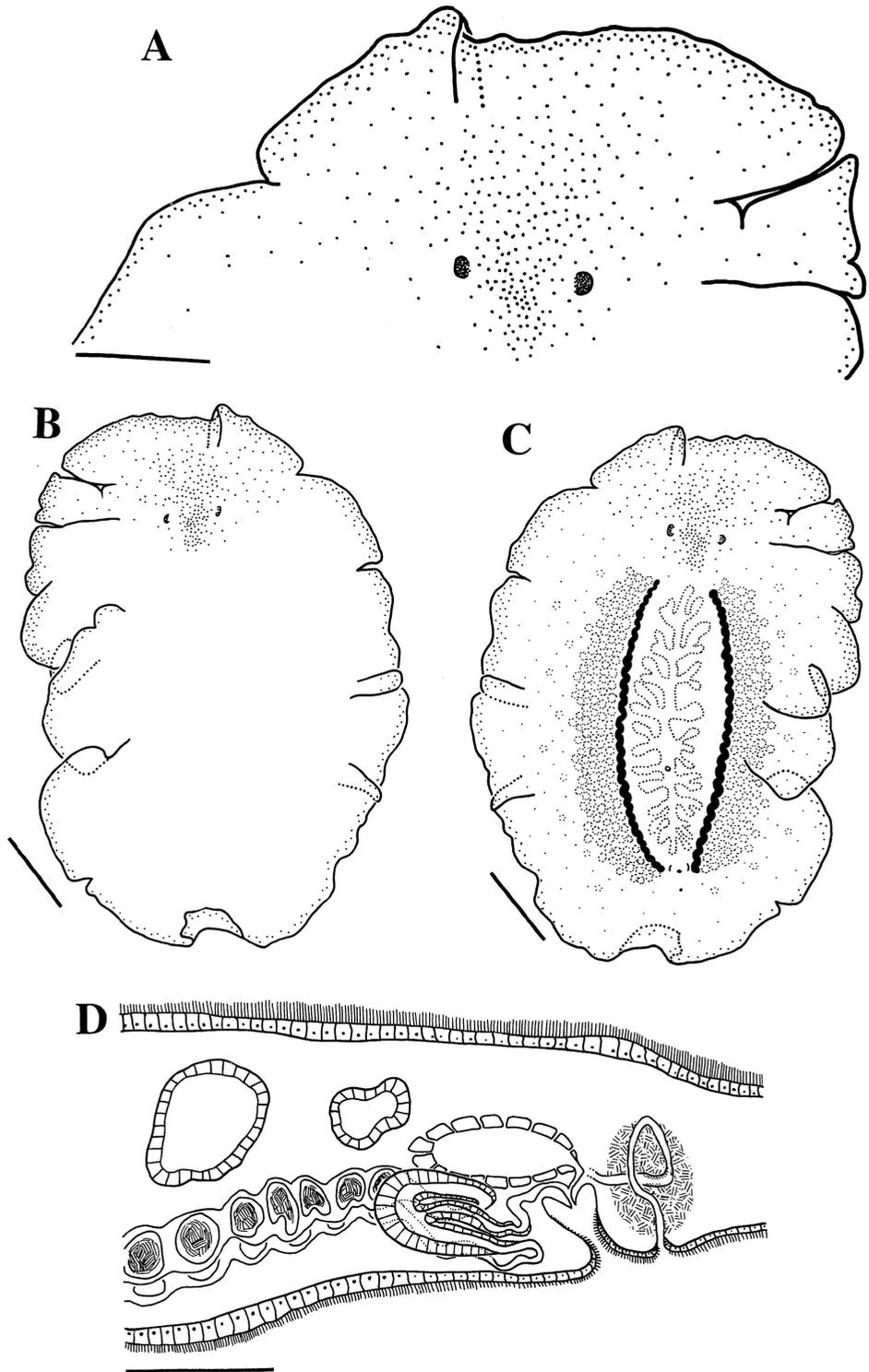


Fig. 3. *Imogine meganae*, new species. A, arrangement of cerebral and frontal eyes; B, arrangement of the dorsal eyes; C, wholemount from the ventral side; D, diagrammatic reconstruction of the reproductive system. Scales: A = 3 mm, B & C = 5 mm, D = 1.0 mm.

**Etymology.**- Named in honour of Miss Megan McGrath who first collected this flatworm.

**Distribution.**- Rare on oysters from oyster leases, Dialba Passage, North Stradbroke Island, Moreton Bay, eastern Australia.

**Remarks.**- Nine of the 14 species listed in Table 1 clearly differ from *I. meganae* by having cerebral eyes arranged in two distinct clusters. The four remaining species differ from *I. meganae* as follows: *I. exiguus* Hyman, 1953, is relatively small, has few frontal and cerebral eyes (not >100) and a posterior notch; *I. lesteri* Jennings & Newman, 1996, has few frontal eyes which do not extend to anterior margin and is mottled pale orange and light brown (not mottled dark brown with yellow margin and nuchal tentacles); *I. kimaie* possesses 100 tentacular eyes (not 50 tentacular eyes), frontal eyes which do not extend to the margin and is orange-pink with light mottling and marginal flecking (not mottled dark brown with yellow margin and nuchal tentacles); *I. mcgrathi* has even mottling (not disrupted with a yellow margin and nuchal tentacles), prostate twice the size of seminal vesicle (not equal in size) and few frontal eyes that do not extend to lateral margins.

### ***Imogine pardalotus*, new species**

(Figs. 4A-D, 5D)

**Material examined.**- Holotype - WM (QM G210749), oyster leases, Dialba Passage, North Stradbroke Island, Moreton Bay, Australia, 22 Mar.1993.

Paratypes - LS (QM G210750), same data, 24 Apr.1995; LS (QM G210751); S (QM G210756), 29 Jan.1996; S (QM G210757), 19 Feb.1996; S (QM G210758), 3 ex., mussel clumps, Sandgate Jetty, north of Brisbane, southeast Australia, Mar.1996.

**Description.**- Body elongate oval, margin indented, blunt posteriorly with few ruffles (Figs. 4A-C, 5D). Dorsal surface beige with a leopard spotted pattern of greenish brown spots, irregular in shape and intensity, spots more concentrated medially. Nuchal tentacles transparent but appear black due to the heavy concentration of eyes. Ventrally cream without markings. Sizes ranged from 9 mm x 4 mm to 15 mm x 6 mm.

Nuchal tentacles retractile, varying in shape from long, thin and distally hooked to conical bumps, about 0.45 mm wide and 1.9 mm apart (Fig. 4A, B). Marginal eyes along the entire margin; densely packed anteriorly in four to five rows, becoming scattered posteriorly in two to three rows. Cerebral eyes numerous, embedded in the epidermis, forming two clusters between nuchal tentacles, extending into a few scattered frontal eyes. About 100 tentacular eyes located throughout each nuchal tentacle.

Pharynx central, about 1/2 body length; with about 22 complex, ruffled pharyngeal folds; mouth slightly anterior to mid-line of pharynx (Fig. 4C). Gonopores separate, posterior to the pharynx, about 0.1 mm between pores and 1.0 mm between female pore and posterior margin. Vas deferens extend anteriorly from pores, along 1/2 the length of the pharynx.

Testes ventrally scattered throughout the body, vas deferens with ducts arising mid-body passing posteriorly on each side of the pharynx to the region of the prostate where they turn back to enter the lateral lobes of the tripartite seminal vesicle (Fig. 4D). Seminal vesicle lies ventrally, the lateral lobes and central lobe are large and muscular and of approximately equal size (about 0.4 mm x 0.1 mm). The central lobe of the seminal vesicle passes posteriorly

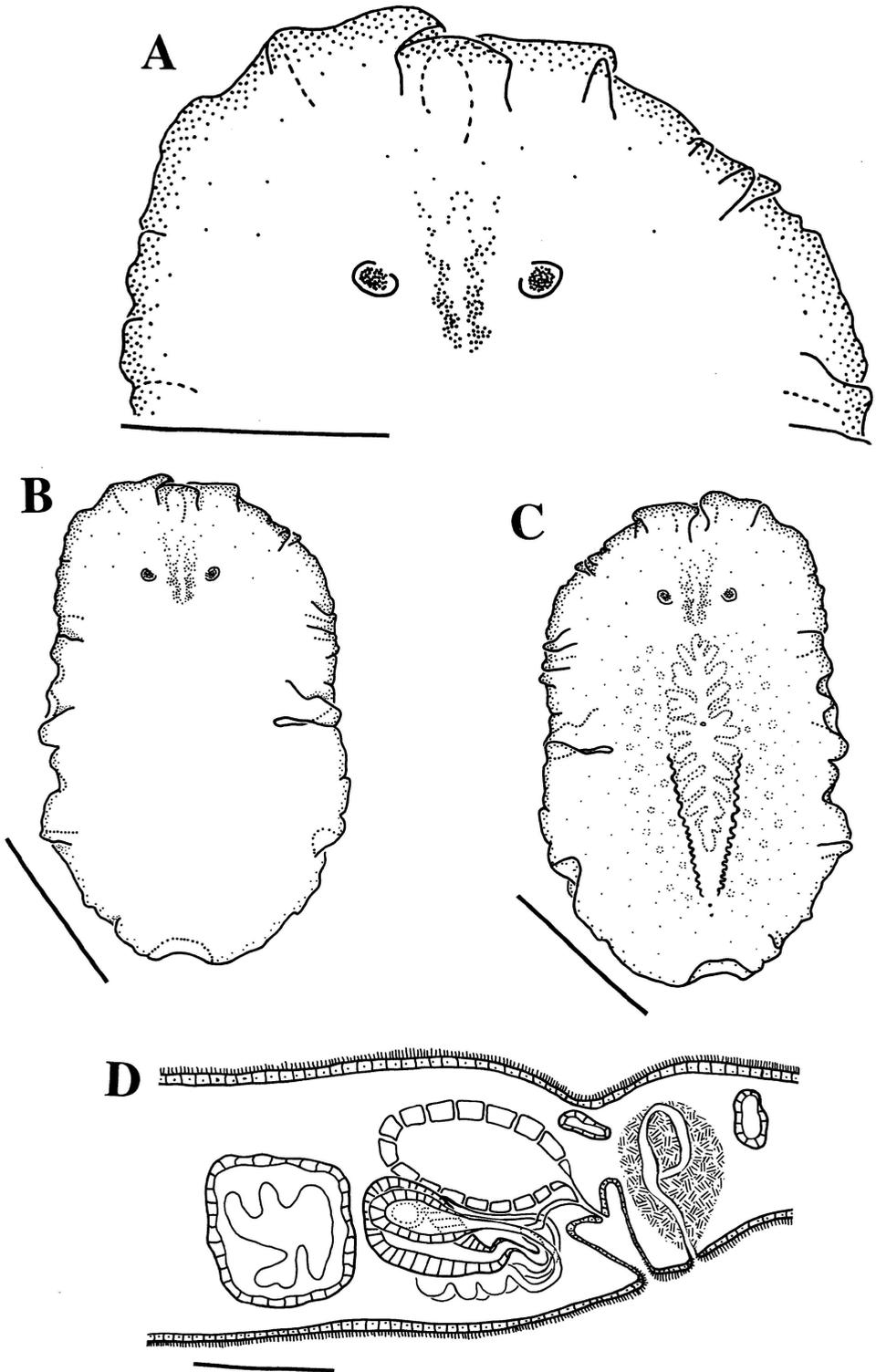


Fig. 4. *Imogine pardalotus*, new species. A, arrangement of cerebral and frontal eyes; B, arrangement of the dorsal eyes; C, wholemount from the ventral side; D, diagrammatic reconstruction of the reproductive system. Scales: B = 3 mm, C & D = 5 mm, E = 0.5 mm.

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Table 1. Diagnostic characters of *Imogine* species with eyes around the entire margin (after Faubel, 1983; Newman et al., 1993; and Jennings & Newman, 1996)

Species, Author, Location	Body size (mm)	Colour Pattern	Nuchal Tentacles	Tentacular Eyes	Cerebral Eyes	Frontal Eyes	Reproductive Organs	Habitat
<i>Imogine arenosus</i> Willey, 1897 New Britain	45 x 16	reddish brown with white & black dots	orange	numerous at	2 clusters base	scarce over area	not given	rubble
<i>Imogine catus</i> Marcus & Marcus, 1968 Brazil	6.6 x 3.2	brown spots in 2 lateral bands	elongate & thin	about 18 per tentacle	2 small clusters	2 pairs	spherical PR	dredged from 6 to 20 m in muddy bottom
<i>Imogine exiguus</i> Hyman, 1953 California	7 x 4	not determinable	not given	present	7 eyes	nil or very few	elongate PR	in burrows of <i>Upogebia pugettensis</i>
<i>Imogine kinae</i> new species Eastern Australia	50 x 32 to 30 x 18	bright orange-pink with light brown mottling & marginal flecking	small & transparent	100 eyes per tentacle	numerous & scattered	few scattered but not extending to margin	elongate PR, twice the size of S, which is posterior	coraline algae on oyster shells, Moreton Bay
<i>Imogine lesteri</i> Jennings & Newman, 1996 Eastern Australia	65 x 40 to 30 x 20	mottled pale orange & light brown with dark brown irregular flecks	small & transparent	50 per tentacle, at base	numerous & scattered	few scattered only slightly anterior of cerebral eyes	elongated PR	coral reef flat, One Tree Island
<i>Imogine mcgrathi</i> new species. Eastern Australia	65 x 45 to 10 x 6	brown with even dark brown microdots, darker medially	small & transparent	30 eyes per tentacle	numerous scattered	numerous scattered to anterior margin	elongated PR, oysters, twice the size of S	Moreton Bay
<i>Imogine meganae</i> new species. Eastern Australia	32 x 25 to 25 x 22	beige with dark brown mottling, darker medially & yellow margin & nuchal tentacles	elongate & yellow	50 eyes per tentacle	numerous & scattered	numerous & scattered, antero-lateral to tentacles extending to margin	S & PR both elongated, equal in size	oysters, Moreton Bay
<i>Imogine meridianus</i> Prudhoe, 1989 South Africa	12 x 10	brown with dark speckles	well developed	20 to 60 at base of tentacles	2 elongate clusters slightly posterior to tentacles	nil or very few, not extending to margin	size of PR & S equal	intertidal, sandy & muddy bottom in <i>Zostera</i> beds
<i>Imogine minimus</i> Palombi, 1940 Atlantic & West coast of Africa	3 x 3	light brown with dark grey flecks & brown spots	transparent	present	2 clusters	nil or very few	PR twice the size of S	not given

<i>Imogine orientalis</i> Bock, 1913 Thailand, Taiwan, Indo-West Pacific region & Western Australia	26 x 20	dark green with brown stripes & light purple dots	not given	30 eyes per tentacle	2 clusters	numerous extending into margin	elongate PR, S posterior to PR	9 m deep from coarse rubble & pebbles
<i>Imogine pardalotus</i> new species Eastern Australia	15 x 6	beige with leopard spotted pattern of green-brown spots, irregular in shape & colour	transparent & elongate	100 eyes per tentacle	2 clusters	very few scattered	elongate PR, twice the size of S	oysters, Moreton Bay
<i>Imogine pulcher</i> Hyman, 1940 Beaufort, N.C.	30 x 8 elongated	Wide, brown, midorsal band, interrupted by large beige spots & lateral bands	rounded	numerous	large cerebral clusters	numerous scattered merging with anterior margin	elongate PR, S posterior to PR	dredged from 60 foot deep
<i>Imogine refertus</i> du Bois-Reymond Marcus, 1965 Brazil	65 x 30	brown with bright orange mesh, larger medially	transparent	present at tips & base of tentacles	2 clusters with about 70 eyes posterior to tentacles	nil	not given	with ascidians on stones in shallow water
<i>Imogine zebra</i> (Verill, 1882) Atlantic	40 x 12	striped transversely, chocolate brown colour	short & white	numerous	2 clusters	eyes merge to anterior margin	PR spherical & erect	shells with hermit crabs from wharfs & pilings

PR = Prostate  
S = Seminal vesicle

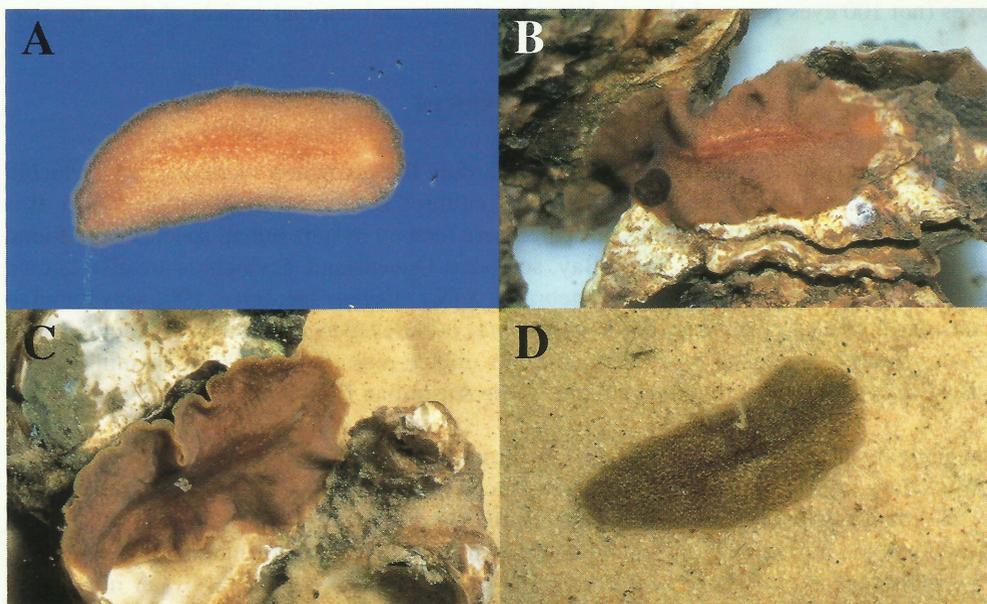


Fig. 5. Live stylochids. A, *Imogine kimae*, new species; B *Imogine mcgrathi*, new species; *Imogine meganae*, new species; *Imogine pardalotus*, new species.

and becomes narrower as it leads into the coiled ejaculatory duct, joining the prostatic duct at the proximal end of the penis. Prostatic duct short, joins dorsally to the proximal end of the penis from the oval, highly muscular prostate. Prostate about 0.7 mm x 0.4 mm, with numerous narrow ducts leading into the lumen which is lined with folded epithelium; extracapsular glands not apparent. Penis papilla simple, small (about 0.12 mm x 0.17 mm), within a deep male antrum (Fig. 4D).

Ovaries scattered dorsally throughout the body; ova collect into the uteri which are on either side of the pharynx, run posteriorly to the female pore, curve dorsally and join at the distal end of the vagina. Vagina narrow, muscular, receiving numerous secretions from the cement glands proximally and leading into a shallow female antrum.

**Diagnosis.**- Belonging to the genus *Imogine* with tripartite seminal vesicle. Body up to 15 mm x 6 mm, dorsal surface beige with a leopard spotted pattern of greenish brown spots, eyes around entire margin, about 100 eyes within each nuchal tentacle, cerebral eyes in two clusters extending into a few scattered frontal eyes, prostate about twice the size of the seminal vesicle.

**Etymology.**- Named from the Greek, *pardalotus* = spotted like a leopard, for its distinct colour pattern.

**Distribution.**- Rare on oysters from oyster leases, Dialba Passage, North Stradbroke Island, Moreton Bay, eastern Australia.

**Remarks.**- Ten of the 14 species listed in Table 1 clearly differ from *I. pardalotus* in size, colour pattern and geographic location. The three remaining species differ from *I. pardalotus* as follows: *Imogine catus* Marcus & Marcus, 1968 has a different colour pattern and few tentacular eyes (not 100 eyes per nuchal tentacle); *I. exiguus* Hyman, 1953 has a characteristic posterior notch; *Imogine meridianus* Prudhoe, 1989, has 20 to 60 tentacular eyes (not 100 eyes per nuchal tentacle) and a prostate and seminal vesicle of the same size.

## DISCUSSION

It is surprising that so little is known regarding the taxonomy or biology of stylochid flatworms since they are well known pests of cultured bivalves throughout the world. It is not known whether all the species presented here feed on oysters but all species were found associated with oysters in Moreton Bay, southeast Queensland. Stylochids are also known to be associated or feed on other invertebrates. *S.(S.) tauricus* Jacobova, 1906 was found to consume barnacles (Jacobova, 1906) and *I. kima* is believed to consume invertebrates living on the coralline algae and is camouflaged by its orange-pink pigment (K. A. Jennings, pers. ob.). Studies on the feeding behaviour of these Australian flatworms are seriously lacking.

*Imogine mcgrathi* brought into the laboratory laid eggmasses after two days. Eggs took only 8 days to hatch and each flatworm produced thousands of larvae. Chintala & Kennedy (1993) suggested that *S. ellipticus* is a 'capital' breeder which relies on stored energy to produce eggs and their high fecundity maintains high population numbers. Although *I. mcgrathi* does not appear to be a problem at present to the commercial oyster industry in southeast Queensland, these worms could pose a threat if conditions were favourable for high larval recruitment. The method of oyster farming using hanging oyster bags (for easier

harvest) may also encourage stylochid populations by excluding possible natural predators such as the toad fish, *Tetractenos hamiltoni* (Gray & Richardson, 1843) and increase oyster mortalities (Mr. L. McGrath, pers. comm.). With more understanding of the diversity of stylochids and their feeding and reproductive biology, changes in natural population numbers may be better understood and ultimately controlled in the advent of an outbreak.

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