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Larval Descriptions of Three Galaxiid Fishes Endemic to South-western Australia: *Galaxias occidentalis*, *Galaxiella munda* and *Galaxiella nigrostriata* (Salmoniformes : Galaxiidae)

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Abstract

The larval development of *Galaxias occidentalis, Galaxiella munda* and *Galaxiella nigrostriata* is described and illustrated with material collected from freshwater habitats in south-western Australia. *Galaxias occidentalis* larvae are very elongate (52–54 myomeres), lightly pigmented and morphologically very similar to those of *Galaxias vulgaris* and *Galaxias maculatus.* Notochord flexion (9.3–13.1 mm), formation of all except the pelvic fins (6.1–21.9 mm) and transition (>26.6 mm) in larval *G. occidentalis* occur at similar sizes to larvae of the strictly freshwater *G. vulgaris* but at smaller sizes than in larvae of diadromous populations of *G. maculatus*. Larvae of *Galaxiella munda* and *G. nigrostriata* are elongate (38–43 myomeres) and heavily pigmented and can be separated primarily by the considerably heavier pigmentation in the latter species. Notochord flexion (6.6–13.1 mm), formation of all except the pelvic fins (5.8–13.6 mm) and transition (>13.2 mm) in both species occur at smaller sizes than in *Galaxias* larvae. *Galaxias* larvae can be distinguished from those of many superficially similar clupeiform species by the combination of a dorsal fin directly above the anal fin, lack of a strongly striated hindgut, absence of a conspicuous gas bladder above the fore- and hindgut junction, and myomeres without cross-hatched muscle fibres. *Galaxiella* larvae are very different from *Galaxias* larvae and are unlikely to be confused with the larvae of any other sympatric species.

Keywords: Galaxiidae, larval development, *Galaxias*, *Galaxiella*, south-western Australia.

Introduction

The fresh waters of temperate Western Australia have a fish fauna that is both depauperate and highly endemic, with eight of the 10 principal freshwater fish species being endemic to that region (Allen 1982, 1989). Data on the age, size composition, growth rates and diets are available for populations of seven of the eight endemic species, including the galaxiids *Galaxias occidentalis* (Pen and Potter 1991*a*, 1991*b*), *Galaxiella munda* (Pen *et al.* 1991) and *Galaxiella nigrostriata* (Pen *et al.* 1993). The detailed information on the distribution within river systems and aspects of the biology of the juvenile and adult stages for these galaxiids contrasts with the paucity of data on the requirements of the spawning adults and their larvae. Thus, although *G. occidentalis* and *G. munda* are known to move out of permanent rivers and to enter creeks and/or floodwaters during winter (Pen and Potter 1991*a*, 1991*b*; Pen *et al.* 1991), there is no information on the precise location and characteristics of the spawning grounds of these native fishes. Similarly, there are no data on the type of habitats that the larvae of these species occupy or the factors that may influence the movement of young fish into the main channels of the rivers.

The management of native fish species clearly demands information on both the distribution and the ecology of their juveniles and adults and also on the requirements of the spawning adults and the biology of their larval stages. Hence, the proper identification of the larvae of these native fishes is a prerequisite to any such work. This paper describes and

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illustrates the larval development of the three galaxiid species endemic to south-western Australia, namely *Galaxias occidentalis, Galaxiella munda* and *Galaxiella nigrostriata,* and compares their morphology and development patterns with those of other galaxiids.

Materials and Methods

Collection of Larvae

Larvae of *Galaxias occidentalis* (*n* = 21, 6.1–26.6 mm body length, BL), *Galaxiella munda* (*n* = 34, 5.0–16.3 mm BL) and *Galaxiella nigrostriata* (*n* = 27, 4.1–16.2 mm BL) were collected from the Collie River, Big Brook and roadside pools in d'Entrecasteaux National Park, respectively (see Pen and Potter 1991*a*, Pen *et al.* 1991 and Pen *et al.* 1993 for details of sampling locations). Larvae were collected from the water column with a 100-μm-mesh conical plankton net of 340 mm diameter and from in and around submerged and emergent vegetation with a 1-mm-mesh sweep net of 340 mm diameter. All specimens were fixed in 2% buffered formaldehyde and later preserved in 70% ethanol.

Measurements, Terminology and Counts

All larvae were measured to the nearest 0.1 mm under a stereomicroscope fitted with an eyepiece micrometer. Body measurements and definitions of larval stages follow Leis and Trnski (1989). Body length refers to the notochord length in preflexion and flexion larvae and the standard length in postflexion larvae. Measurements of head length, body depth and preanal length referred to throughout the text and in Table 1 are given as a percentage of body length. Myomere counts and ray counts of paired fins were made on the left side of the body. The term 'transition' is used here to describe the period between completion of larval life and the juvenile phase, i.e. after all fins are developed in the larvae and before the attainment of juvenile coloration. Pigment refers to melanin unless stated otherwise. Illustrations were prepared with the aid of a camera lucida.

Results

Identification

The larger larvae were identified as belonging to the Family Galaxiidae by their long and slender body, the long, straight gut reaching about 60–75% of the body length, the presence of a single, posteriorly placed dorsal fin that lies above the anal fin, and the lack of an adipose fin (McDowall 1969, 1984). These larvae were further identified by myomere number as either *Galaxias occidentalis* (52–54 myomeres) or *Galaxiella* spp. (39–44 myomeres), which closely corresponded to the vertebral counts (50–54 and 39–44, respectively) in both genera (McDowall and Frankenberg 1981). Larger larvae of *G. munda* and *G. nigrostriata* were separated on the basis of the origin of their dorsal fins, i.e. posterior to the vertical that passes through the fifth anal fin ray in *G. munda* and anterior to this ray in *G. nigrostriata* (Berra and Allen 1989*a*). Pigmentation patterns and sequence of fin development were used to identify successively smaller larvae by the series method (Leis and Trnski 1989). Although the three galaxiid species are sympatric in some waterbodies, positive identification of the larvae of the three galaxiid species was further supported by the fact that extensive sampling for adults and juveniles of these species by one of us (H.S.G.) only ever yielded one of the three species at any one of the sites used for the collection of larvae in this study, i.e. these galaxiids are not sympatric in the localities from which the larvae used in this study were collected.

Description of Larvae

Galaxias occidentalis (Fig. 1)

Morphology. Larvae are very elongate and have a small head. The smallest larva examined (6.1 mm BL) has a functional mouth with a few small, blunt, conical teeth in both jaws (not shown), well developed eyes, the remains of a yolk sac, a small, anteriorly located gas bladder, and a continuous fin fold enclosing most of the body. Teeth become caniniform and the yolk sac is resorbed by late flexion. The relative body depth and head length increase from 6–8 and 13–15% in preflexion larvae to 11–12 and 17–19% in postflexion larvae,

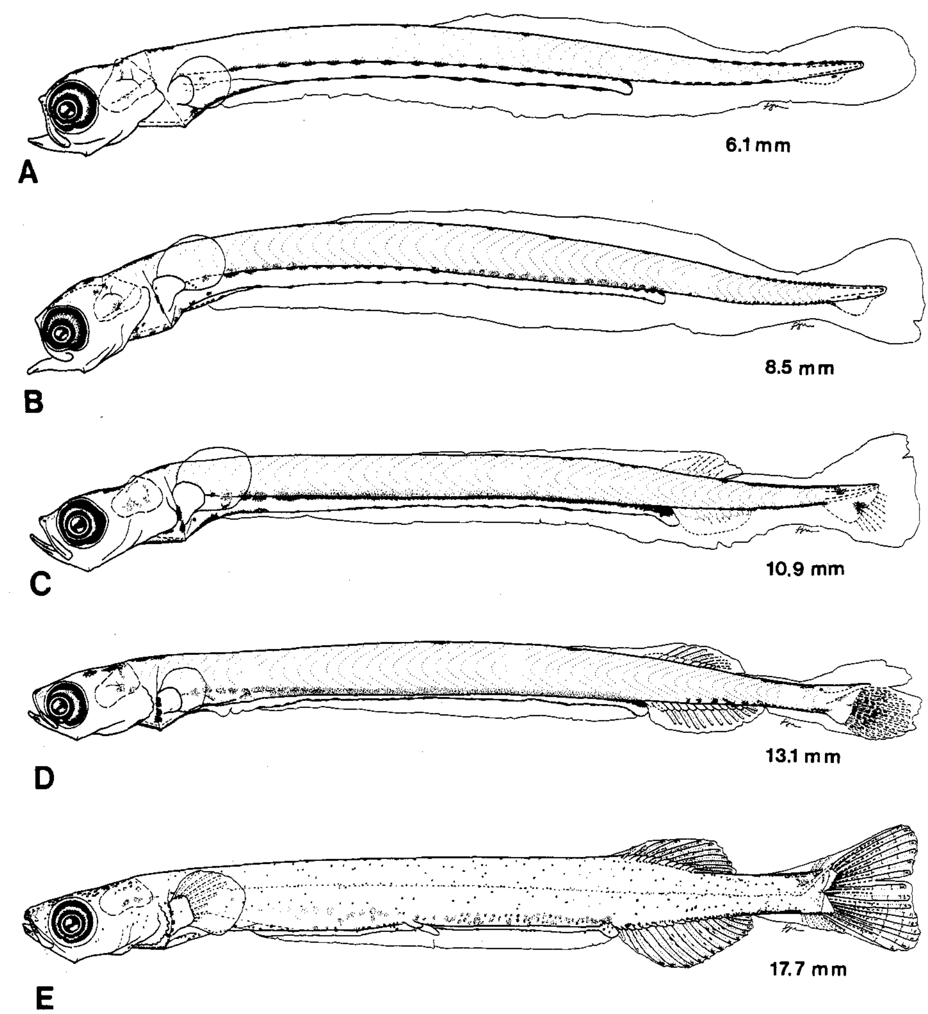

Fig. 1. Larvae of *Galaxias occidentalis* from the Collie River, south-western Australia: (*A*) preflexion; (*B*) early flexion; (*C*) flexion; (*D*) late flexion; (*E*) postflexion (note developing pelvic fin bud).

respectively (Table 1). The gut is very long and straight in all stages and becomes slightly striated prior to transition. The relative preanal length remains constant during development (68–75%). The anus is located below Myomeres 36 or 37 in all stages, and there is no gap between the anus and the fully formed anal fin. A preanal fin fold is present in late flexion larvae and may still be present during transition.

Development of fins. Fin development is summarized in Table 2. The caudal fin starts developing by 6.1 mm and is completely developed by 17.7 mm. The rays of the dorsal and anal fins start to develop by 10.0 mm, and all rays are formed by 17.7 mm, i.e. after notochord flexion is complete. The rays of the pectoral fin appear by 17.7 mm and develop sequentially from dorsal to ventral. The smallest larva in which all pectoral rays were present measured 21.9 mm, although formation of the pectoral fin was still incomplete in a larva measuring 26.6 mm. The buds of the pelvic fins appear by 17.7 mm.

Pigmentation. Larvae are lightly pigmented prior to transition and do not undergo significant changes in pigmentation during development (Fig. 1). Internal pigment is visible at the base of the hindbrain in all stages. All larvae have melanophores scattered on the dorsal

Table 1. Range and mean (± 1 s.e.) of selected body proportions of the preflexion, flexion and postflexion larval stages of *Galaxias occidentalis, Galaxiella munda* and *Galaxiella nigrostriata*

BL, body length; HL, head length; BD, body depth; PAL, preanal length; *n*, sample size. HL, BD and PAL are given as a percentage of BL

	Preflexion			Flexion			Postflexion		
	G. occidentalis $n = 10$)	*G. munda* $n = 10$)	*G. nigrostriata* $n = 9$)	*G. occidentalis* $n = 7$)	*G. munda* $n = 17$)	*G. nigrostriata* $n = 11$)	*G. occidentalis* $n = 4$)	*G. munda* $n = 7$)	*G. nigrostriata* $n = 7$)
BL (mm)	6.1–8.5	5.0–7.5	4.1–7.9	9.3–13.1	6.6–13.1	7.6–10.3	17.7–26.6	12.8–16.3	12.3–16.2
HL (% BL)	12.7–14.9 (14.0 ± 0.26)	19.7–21.9 (20.8 ± 0.25)	15.0–18.0 (16.6 ± 0.44)	13.5–17.6 (15.4 ± 0.86)	19.1–22.8 (21.2 ± 0.27)	16.8–20.0 (18.7 ± 0.35)	17.2–18.9 (17.9 ± 0.59)	19.8–22.3 (21.0 ± 0.43)	18.3–24.2 (21.9 ± 1.19)
BD (% BL)	6.2–7.9 (7.1 ± 0.22)	11.3–14.9 (13.6 ± 0.45)	8.3–11.4 (9.9 ± 0.37)	6.7–9.1 (7.8 ± 0.52)	12.9–15.5 (14.1 ± 0.20)	10.2–14.6 (12.5 ± 0.46)	10.7–10.9 (10.8 ± 0.06)	13.9–17.4 (15.3 ± 0.58)	10.9–14.8 (13.7 ± 0.66)
PAL (% BL)	70.6–74.4 (72.4 ± 0.51)	64.1–68.8 (66.1 ± 0.58)	58.0–60.9 (59.3 ± 0.45)	73.1–76.5 (75.1 ± 0.65)	64.4–69.3 (66.4 ± 0.32)	58.9–63.0 (61.4 ± 0.53)	67.8–74.6 (71.1 ± 2.39)	64.4–68.6 (66.4 ± 0.74)	60.5–65.0 (62.9 ± 0.84)

Table 2. Sequence of fin development (mm body length) and fin ray and myomere counts in *Galaxias occidentalis, Galaxiella munda* and *Galaxiella nigrostriata*

Lower and upper values under fin development are for the smallest larvae in which the anlage for the caudal fin and the fin rays for the remaining fins are starting to form and in which the fin rays are fully formed for all fins, respectively. Fin ray counts given are for larvae with fully formed fins. Counts in parentheses are for juveniles and adults and are taken from McDowall and Frankenberg (1981) and Berra and Allen (1989*a*)

Measurement/count	*Galaxias occidentalis*		*Galaxiella munda*		*Galaxiella nigrostriata*	
Fin development						
Caudal	6.1–17.7		5.8–13.6		6.1–13.2	
Dorsal	10.0–17.7		7.5–13.6		8.8–13.2	
Anal	10.0–17.7		7.5–13.6		8.8–13.2	
Pectoral	17.7–21.9		9.4–13.6		9.5–13.2	
Pelvic	>17.7		>12.0		>12.3	
Meristics						
Caudal	8 + 8	(16)	7 + 7	(13–15)	7 + 7	(12–15)
Dorsal	8–10	(7–10)	7	(6–8)	7–8	(6–7)
Anal	12–13	(11–14)	11–12	(9–12)	10–11	(8–11)
Pectoral	12	(12–15)	10–11	(9–12)	13–14	(11–14)
Pelvic	7		5–7		5–6	
Myomeres	52–54		41–43		38–42	
Vertebrae		(50–54)		(38–43)		(38–43)

surface of the head and nape. One to four melanophores are present along the cleithrum. A dense patch of melanophores is usually present at the isthmus and around the cleithral symphysis and is contiguous with a single row of 6–31 melanophores along the ventral midline of the gut. A paired row of 11–45 melanophores present along the dorsal midline of the gut in preflexion larvae merges into one solid pigmented stripe by flexion and becomes internal after flexion is complete. There is a single melanophore above the anus in all larvae. A sparse, single row of 2–19 melanophores is present along the dorsal midline of the trunk. A single row of up to 29 melanophores on the dorsal surface of the caudal peduncle and another on the ventral surface often merge during transition to form a solid pigmented band on each surface of the caudal peduncle.

Remarks. Galaxias occidentalis is the most abundant endemic freshwater fish in the south-west of Western Australia. This species is commonly found in rivers, streams and lakes and has a range that extends from approximately 250 km north of Perth to approximately 80 km east of Albany (McDowall and Frankenberg 1981; Pen and Potter 1991*a*). In the Collie River, south of Perth, males and females of this species attain total lengths of about 70 and 75 mm at the end of their first year of life and 90 and 100 mm at the end of their second year, respectively, with few fish surviving beyond the second year. The maximum total length recorded for this species is 163 mm TL (Pen and Potter 1991*b*). Individuals in the Collie River attain sexual maturity at the end of their first year of life, at which time they move into flooded creeks to spawn (Pen and Potter 1991*a*). Breeding occurs between early June and late September, with a peak in August. The mean fecundity and mean diameter of preserved mature eggs are 905 and 1.3 mm, respectively (Pen and Potter 1991*a*)

Galaxiella munda (Fig. 2)

Morphology. Larvae are elongate and have a small to moderate head. The smallest larva examined (5.0 mm BL) has a functional mouth without obvious teeth, well developed eyes, remnants of a yolk sac (not shown), a small, anteriorly located gas bladder, and a continuous fin fold. Small villiform teeth are formed on both jaws (not shown), and the yolk sac is resorbed by early flexion. The teeth on the upper and lower jaws develop into relatively large

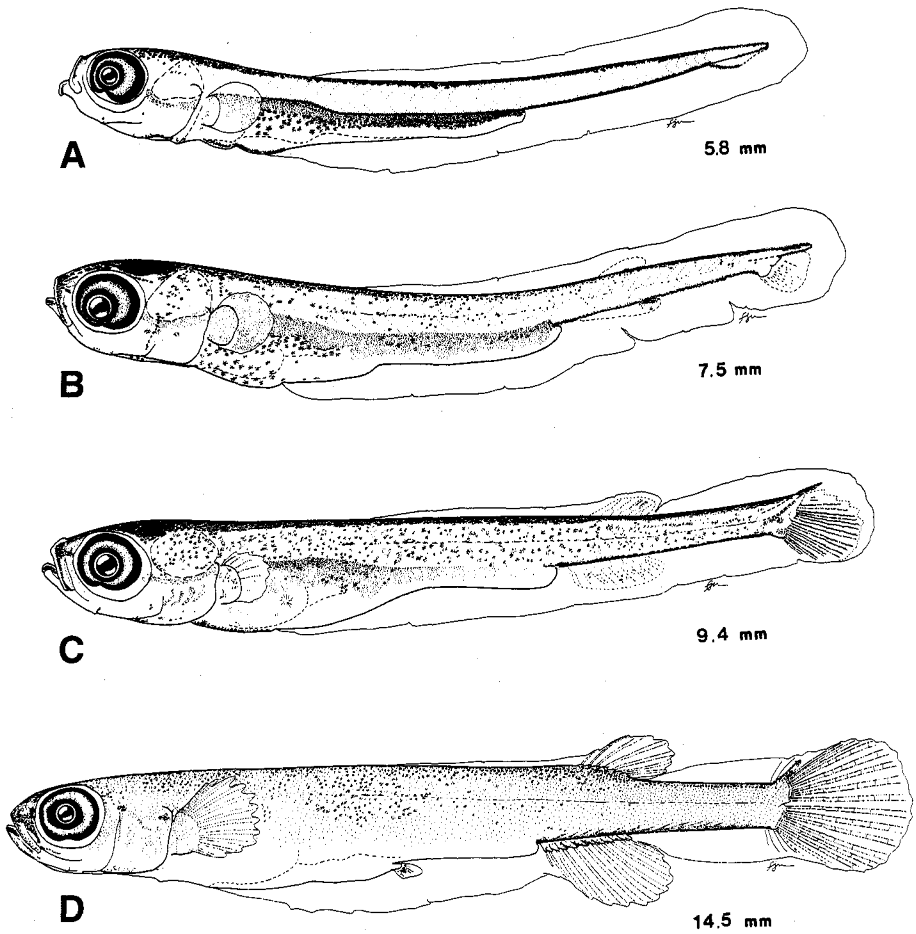

Fig. 2. Larvae of *Galaxiella munda* from Big Brook, south-western Australia: (*A*) preflexion; (*B*) late preflexion; (*C*) late flexion; (*D*) postflexion (note developing pelvic fin bud).

canines during late flexion/early postfexion. The relative body depth increases slightly from 11–15% in preflexion larvae to 14–17% in postflexion larvae (Table 1). The relative head length remains constant during larval development (19–23%). The gut is long, initially straight and with a broad and deep foregut but no distinct stomach. The stomach is clearly visible by early flexion and lies to the right of the intestine when viewed ventrally. The intestine becomes looped during transition. The relative preanal length remains constant during development (64–69%). The anus is located below Myomeres 21 to 25 in all larvae, and there is no gap between the anus and the fully formed anal fin. The preanal fin fold and a remnant of the dorsal fin fold are still present during transition.

Development of fins (Table 2). The caudal fin starts developing by 5.8 mm and is completely developed by 13.6 mm, shortly after notochord flexion is complete. The rays of the dorsal and anal fins start to develop by 7.5 mm, and all rays are formed by 13.6 mm. The rays of the pectoral fin appear by 9.4 mm and develop sequentially from dorsal to ventral. The smallest larva in which all pectoral rays were present measured 13.6 mm, although formation of the pectoral fin was still incomplete in a larva measuring 16.3 mm. The buds of the pelvic fins appear by 12.0 mm.

Pigmentation. Larvae are moderately to heavily pigmented at preflexion, with pigmentation becoming more diffuse during flexion (Fig. 2). Internal pigment is visible over the dorsal surface of the gut and gas bladder and the postero-ventral area of the hindbrain. In all stages, pigment may be prominent along the anterior edge of the cleithrum and around the ribs. Melanophores may be present around the pterygiophores in transition larvae. Pigmentation on the dorsal surface of the head and nape can be heavy or patchy. An unpigmented dorsal area at the nape is followed by a continuous dorsal band of pigment along the trunk and tail. A band of pigment extends along the dorsal surface of the gut and from the ventro-lateral and ventral surfaces of the trunk onto the caudal peduncle ventrally. The area between the dorso-lateral and ventro-lateral bands of the trunk and tail is unpigmented in preserved preflexion and early flexion larvae. A light to moderately dense patch of melanophores is present on the cleithral symphysis, extending anteriorly onto the isthmus and posteriorly onto the anterior region of the gut. During flexion, a narrow unpigmented line forms along the dorsal midline, the dorso-lateral and ventro-lateral bands of the trunk and tail become diffuse and extend into the unpigmented area, and a sparse row of melanophores forms along the lateral line.

Remarks. *Galaxiella munda* is found in slow- and fast-flowing streams, creeks and roadside drains in an area extending from Albany in the east to Margaret River in the west, with an isolated population at Gingin, north of Perth (McDowall and Frankenberg 1981; Allen 1989). Males and females in a population in Big Brook, south of Pemberton, attain respective total lengths of 43 and 47 mm at the end of their first year of life (Pen *et al.* 1991). The life cycle of *G. munda* typically lasts for just over a year, and a maximum length of 58 mm TL has been recorded. This species breeds between July and October, with a peak in late August/early September, and has a mean fecundity and mean diameter of preserved mature eggs of 65 and 1.1 mm, respectively (Pen *et al.* 1991).

Galaxiella nigrostriata (Fig. 3)

Morphology. Larvae are elongate and have a small to moderate head. The smallest larva examined (4.1 mm BL) has a functional mouth, well developed eyes, remnants of a yolk sac (not shown), a small, anteriorly located gas bladder, and a continuous fin fold enclosing most of the body. The yolk sac is resorbed by early flexion. The relative body depth and head length increase from 8–11% and 15–18% in preflexion larvae to 11–15% and 18–24% in postflexion larvae, respectively (Table 1). The gut is long, initially straight, and with a distinct stomach. By early flexion, the stomach is discrete and lies to the right of the intestine when viewed ventrally. The relative preanal length increases slightly from 58–61% in preflexion larvae to 61–65% in postflexion larvae (Table 1). The anus is located below Myomeres 20 to 23 in all larvae, and there is no gap between the anus and the fully formed anal fin. The preanal fin fold and a remnant of the dorsal fin fold are still present during transition.

Development of fins (Table 2). The caudal fin starts developing by 6.1 mm and is completely developed by 13.2 mm, after notochord flexion is complete. The rays of the dorsal and anal fins start to develop by 8.8 mm, and all rays are formed by 13.2 mm. The rays of the pectoral fin appear by 9.5 mm and develop sequentially from dorsal to ventral. The smallest larva in which all pectoral rays were present measured 13.2 mm. The buds of the pelvic fins appear by 12.3 mm.

Pigmentation. Larvae are heavily pigmented at all stages of development (Fig. 3). Internal pigment is visible over the dorsal surface of the gut. Externally, two dense bands of pigment extend along the body. The dorsal-most band extends from the snout along the dorsal and dorso-lateral surfaces of the head, nape, trunk and tail, and the ventral-most band extends along the dorsal surface of the gut onto the tail. The area between the dorsal and ventral bands is unpigmented in preserved preflexion and early flexion larvae but is vivid yellow to red in live larvae. A dense patch of melanophores is present around the cleithral symphysis and extends anteriorly onto the isthmus and posteriorly onto the anterior region of the gut. During flexion, the dense dorsal and ventral bands become diffuse and extend onto the unpigmented

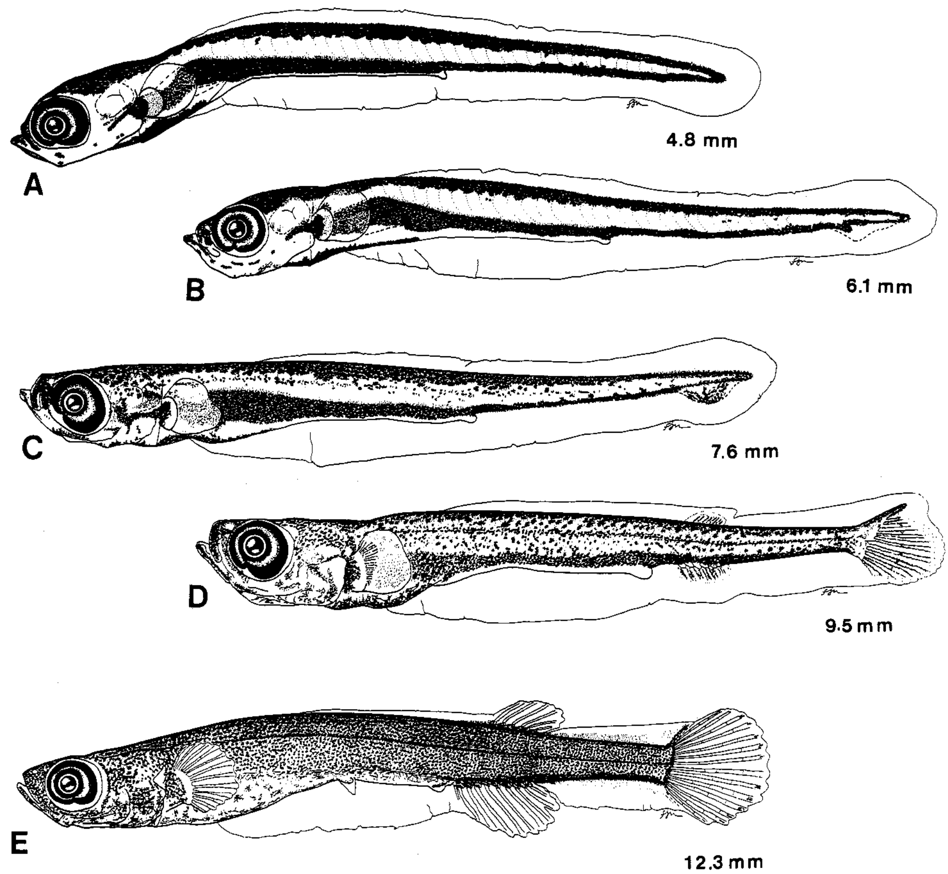

Fig. 3. Larvae of *Galaxiella nigrostriata* from d'Entrecasteaux National Park, south-western Australia: (*A–C*) preflexion; (*D*) flexion; (*E*) postflexion (note developing pelvic fin bud).

lateral areas, with a dense row of melanophores forming along the lateral line. Pigment is present proximally on the dorsal and ventral precaudal membranes, i.e. the membranes contiguous with the caudal fin.

Remarks. Galaxiella nigrostriata is endemic to a small area in the south of south-western Australia that extends from Esperance in the east to Northcliffe in the west, and where it is restricted to slow-flowing streams, swamps and roadside drains (McDowall and Frankenberg 1981; Allen 1989). Many of these waterbodies are ephemeral, and it is possible that this species is able to aestivate (Berra and Allen 1989*b*; Pen *et al.* 1993). In a population in the swamps of d'Entrecasteaux National Park, south of Northcliffe, males and females attain respective total lengths of 33 and 37 mm at the end of their first year of life, at which time individuals reach sexual maturity and develop a bright breeding livery of two black lateral stripes separated by a bright yellow to red band. The life cycle of *G. nigrostriata* typically lasts for just over a year, and a maximum length of 48 mm TL has been recorded (Allen 1989; Pen *et al.* 1993). This species breeds between early June and September, with a peak in late June/early July, and has a mean fecundity and mean diameter of preserved mature eggs of 62 and 0.9 mm, respectively (Pen *et al.* 1993).

Discussion

There are few published descriptions of galaxiid larvae. Descriptions are available for the egg and larval development of diadromous populations of *Galaxias maculatus* (Benzie 1968*a*; Mitchell 1989) and the freshwater species *G. vulgaris* (Benzie 1968*b*). Descriptions of larvae of *Galaxiella* species are given for the first time in the present paper, but larvae of the remaining four genera in this southern salmoniform Family Galaxiidae, namely *Brachygalaxias, Neochanna, Nesogalaxias* and *Paragalaxias,* are still undescribed (McDowall 1984).

Larvae of Galaxias

The length of the smallest *G. occidentalis* larva examined (6.1 mm) falls within the size ranges of live, newly hatched larvae of *G. maculatus* (6.6–8.0 mm) and *G. vulgaris* (6.2–8.0 mm). However, although larvae of the last two *Galaxias* species each possess a large yolk sac with a large oil globule at hatching (Benzie 1968*a*, 1968*b*; Mitchell 1989), the yolk sac was small in the 6.1-mm *G. occidentalis* larva (Fig. 1*A*). Postflexion larvae of the above three *Galaxias* species are morphologically similar prior to the formation of pelvic fins, i.e. slender, very elongate and lightly pigmented, with long, straight guts reaching about 68–77% of body length and fin folds extending along most of the dorsal and ventral midlines of their trunk and tail. Pigmentation patterns are also similar in the larvae of these *Galaxias* species, each having melanophores over the head, a paired row of melanophores along the dorsal surface of the gut, and a solid band of pigment along the dorsal and ventral midlines of the caudal peduncle (Benzie 1968*b*; McDowall 1984; Mitchell 1989).

The development of fins in larval *G. occidentalis* follows the same sequence as that described for *G. maculatus, G. vulgaris* and most other salmoniforms, i.e. C, D and A, P_1, P_2 (Benzie 1968*a*, 1968*b*; Mitchell 1989; Berra and Allen 1991), but is different from the sequence exhibited by *Lepidogalaxias salamandroides,* the other salmoniform endemic to south-western Australia, i.e. C, D and P_2, A, P_1, (Berra and Allen 1991). However, fin development as well as notochord flexion occur at smaller sizes in larvae of *G. occidentalis* and *G. vulgaris* than in larvae of *G. maculatus.* Thus, although the caudal, dorsal and anal fins form between 6.1 and 21.9 mm in *G. occidentalis* and *G. vulgaris,* they form between 17.0 and 27.0 mm in *G. maculatus.* Similarly, the pectoral and pelvic fins develop between 17.0 and 23.0 mm in *G. occidentalis* and *G. vulgaris,* whereas they form between 27.0 and 45.0 mm in *G. maculatus.* Notochord flexion occurs between 9.3 and 14.5 mm in *G. occidentalis* and *G. vulgaris* larvae, whereas it commences at >17.0 mm in *G. maculatus* larvae (Benzie 1968*a*, 1968*b*; Mitchell 1989, fig. 4).

The different sizes at which fin development and notochord flexion are completed in larvae of the above three *Galaxias* species possibly reflect their different types of life cycle. Thus, it is possible that the formation of fins in larvae of the strictly freshwater species *G. occidentalis* and *G. vulgaris* at smaller sizes (i.e. earlier) than in larvae of diadromous populations of *G. maculatus* ensures retention of the freshwater larvae in the rivers at times of increased river flow, i.e. late winter to early spring (Benzie 1968*b*; Pen and Potter 1991*b*). In the case of *G. maculatus,* adults move downstream in autumn–winter to spawn in the mouth of estuaries, and the larvae are swept out to sea before moving back into fresh water five to six months later ('whitebait' stage), at sizes between 42 and 60 mm TL (McDowall 1988; Mitchell 1989).

Larvae of *Galaxias* spp. are likely to be confused with some clupeiform larvae, which are also slender, very elongate and lightly pigmented and which also have long guts, posteriorly placed dorsal and anal fins and high myomere counts. However, most clupeiform larvae have moderate to strongly striated hindguts and a dorsal fin that, in most cases, does not overlap the anal fin. In addition, clupeiform larvae have a conspicuous gas bladder located above the junction of the fore- and hindgut and, except in spratelloidinid clupeids, myomeres with muscle fibres in a cross-hatched pattern (Leis and Trnski 1989).

Larvae of Galaxiella

The development, including the sequence of fin development, of the larvae of the two species of *Galaxiella* follow a pattern similar to that discussed above for the species of *Galaxias*.

Larvae of *Galaxiella munda* and *G. nigrostriata* are morphologically very similar, including the sizes at notochord flexion and the sizes at which the fins form (Tables 1 and 2). However, larvae of both species can be distinguished throughout all stages by the considerably heavier pigmentation in *G. nigrostriata* and by the presence of pigment on the dorsal and ventral precaudal membranes in postflexion larvae of this species. Furthermore, freshly caught larvae of *G. nigrostriata* are characterized by a very bright yellow to red stripe extending along the lateral midline from just behind the eye to the tip of the notochord (Gill, personal observation). It is possible that the heavier pigmentation in *G. nigrostriata* reflects the dark, peat-stained waters in which this galaxiid is usually found (Pen *et al.* 1993).

In addition to pigmentation, the presence or absence of a distinct stomach can be used to separate the preflexion larvae of *G. nigrostriata* and *G. munda,* and late postflexion larvae of these species can be distinguished by the position of their dorsal fins relative to their anal fins. As was originally described for the adults (Berra and Allen 1989*a*), the dorsal fin in postflexion *G. munda* larvae originates posterior to the vertical that passes through the fifth anal ray, whereas in *G. nigrostriata* it originates anterior to this ray. However, care must be taken when using this character since it is reliable only after both the dorsal and the anal fins are completely formed, i.e. in late postflexion larvae.

Comparisons between Galaxias and Galaxiella Larvae

Larvae of the two species of *Galaxiella* described here are very different from those of *Galaxias occidentalis* and of the other two *Galaxias* species described elsewhere. Apart from the difference in the number of vertebrae, and hence the myomere counts (see Table 2), other major differences between the larvae of the two genera include the extent and the distribution of pigment and the relative length of the preanal distance. The difference between the relative preanal length in the larvae of the two genera reflect the higher number of precaudal vertebrae in *Galaxias occidentalis* (36–37) than in *Galaxiella* spp. (20–25).

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