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LARVAL DEVELOPMENT OF *LUPINOBLENNIUS NICHOLSI* WITH COMMENTS ON LARVAL BLENNIINI IDENTIFICATION IN TAMPA BAY, FLORIDA

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ABSTRACT

Eggs and larvae of *Lupinoblennius nicholsi* are described from laboratory-reared and field collected specimens. Eggs are small and compressed, the two axes averaging 0.72 and 0.50 mm. Larvae are 2.4 mm notochord length (NL) at hatching. Distinguishing features of *L. nicholsi* larvae are early development of pectoral fin rays, extremely dark and deeply-notched pectoral membranes, and the lack of pronounced preopercular spination. Larvae are contrasted with *Hypsoblennius hentzi* and *Chasmodes saburrae* for these and other characters. Literature errors are discussed.

The highfin blenny, *Lupinoblennius nicholsi* (Tavolga, 1954), is a small, compressed blenny that inhabits shallow coastal waters of Florida. Nothing is known of its food habits, reproductive habits, or larval development. In 1980, I collected a number of highfin blennies, spawned them in aquaria and reared the larvae to near metamorphosis. Since then, 16 *L. nicholsi* have been identified from ichthyoplankton collections. This paper describes the larval development of *L. nicholsi* and comments on identification of blenniid larvae in the Western North Atlantic.

METHODS

Fifteen juvenile highfin blennies ranging from 20 to 25 mm SL were collected in Tampa Bay, Florida, by dip net during the summer of 1980. Juveniles were reared in aquaria and spawned the following January and February in water 24–27°C and 28–30‰. Spawning occurred in 1.5-in PVC tubes provided for cover and were guarded by the male as in *Hypsoblennius hentzi* and *Chasmodes bosquianus* (Hildebrand and Cable, 1938). After 3–4 days of male parental care, tubes were suspended vertically in separate 20-liter rearing tanks with air bubbling through them. Fifty larvae were allowed to hatch in each of six tanks and were fed rotifers (*Branchionus plicatilis*) until old enough to take newly-hatched *Artemia salina*.

A few eggs were preserved at 3–4 days and every day until hatching. Two to 10 (usually 5) larvae were preserved daily from hatching to near metamorphosis. This produced 186 larvae, 131 were in good shape and used for the description. Larvae were preserved and stored in 5% buffered Formalin and measured 1.5 years later.

Sixteen *L. nicholsi* larvae (2.5–5.2 mm SL) were collected incidental to a fall–early winter plankton survey in Tampa Bay (10/81–1/82). Bay water temperatures ranged from 15–27°C and salinities ranged from 26–32‰. *Lupinoblennius nicholsi* were identified using the laboratory-reared larvae and by eliminating other blenniid species common in the bay (*Hypsoblennius hentzi, Hypleurochilus geminatus,* and *Chasmodes saburrae*).

Morphometric measurements follow Peters (1981) and are grouped into the growth stages of preflexion, flexion, postflexion and juvenile. All lengths given are notochord or standard lengths; proportions are percent notochord or standard length. Development is based on both laboratory-reared and wild-caught specimens except as noted. All *H. hentzi* and *C. saburrae* used for comparison were wild-caught specimens. A series of 16 larvae and 10 juvenile/adult *L. nicholsi* was cleared and stained (Dingerkus and Uhler, 1977) to help delineate fin development. Fin rays were counted as ossified at the first uptake of alizarin. All measurements, counts, and drawings were made using a Zeiss dissecting microscope with a camera lucida attachment.

EGG DEVELOPMENT

Lupinoblennius nicholsi eggs appear to develop similar to, but are much smaller than those of *Chasmodes bosquianus* (Hildebrand and Cable, 1938). The greater

axis of the egg is 0.67–0.74 mm and the lesser axis is 0.46–0.53 mm (mean size—0.72 × 0.50, N = 20). When first viewed at 3–4 days old, the embryo was already well developed with lightly pigmented eyes and the tail free of the yolk. As with 5-day-old *C. bosquianus* embryos (Hildebrand and Cable, 1938; Fig. 120), the tail was bent sharply just beyond the yolk and wrapped laterally around the yolk for 180°, increasing to 360° before hatching. Five- to 6-day-old embryos had patches of light dendritic melanophores anterior to the forebrain and covering the dorsal surface of the gut from the anus to the pharyngeal region. A double row of melanophores lay along the ventral midline of the tail. The pale yellow yolk was covered by many small melanophores at 4–5 days, but the number decreased to only a few by hatching. Eggs hatched in 6–7 days at 24–27°C.

Larval and Early Juvenile Development
Figures 1 and 2

Larval Pigmentation

Head.—Preserved, newly-hatched larvae (2.2–2.5 mm, mean 2.4 mm, N = 20) had darkly pigmented eyes and a group of light dendritic melanophores covering the anterior portion of the forebrain. Larvae >3.0 mm often had 1–2 stellate melanophores on the nape and laboratory-reared larvae >3.6 mm usually had a small melanophore at the symphysis of the upper jaw. After 4.2 mm, laboratory-reared larvae developed a single stellate melanophore over each eye that was found in about half the wild-caught larvae >4.5 mm. An internal melanophore behind each eye was found in all laboratory-reared larvae >4.2 mm and all wild-caught larvae >4.7 mm. Head pigment increased greatly after 5.7 mm when melanophores developed on both the upper and lower jaws and dense pigment covered the head posterodorsal to the eyes.

Gut.—Newly-hatched larvae retained the melanophores covering the dorsal surface of the gut. One to three melanophores were present along the midline ventral to the foregut, but these disappeared by 2.6 mm. Usually a single melanophore (occasionally 2 or none) was present on the ventral midline just anterior to the anus. By 2.6 mm, melanophores covered the anterior end of the abdominal cavity and some laboratory-reared specimens 3.0–3.8 mm had a small melanophore at the cleithral symphysis.

Body (other than gut).—Newly-hatched larvae had a faintly visible row of melanophores along the ventral midline of the tail. By 3.6 mm, this row appeared as a single row of 13–21 Y-shaped melanophores. After 5.6 mm, most larvae developed several patches of melanophores anteriorly along the base of the dorsal fin.

Fins.—Newly-hatched larvae had melanophores covering the inside of the fleshy pectoral fin base and in 4–5 "rays" of pigment on the inside of the fin membrane. By 2.6 mm, dark pigment covered the lower 7–8 fin rays and membrane between them. In specimens >5.6 mm, this pigment was no longer a solid covering, but was broken up into 40–45 individual melanophores. At the same length, 15–20 individual melanophores were seen scattered on the membrane between the first two dorsal fin spines.

Juvenile Pigmentation

The single, early-stage juvenile (8.0 mm) had many melanophores on both jaws and a line of melanophores from the upper jaw to the orbit. The top of the head

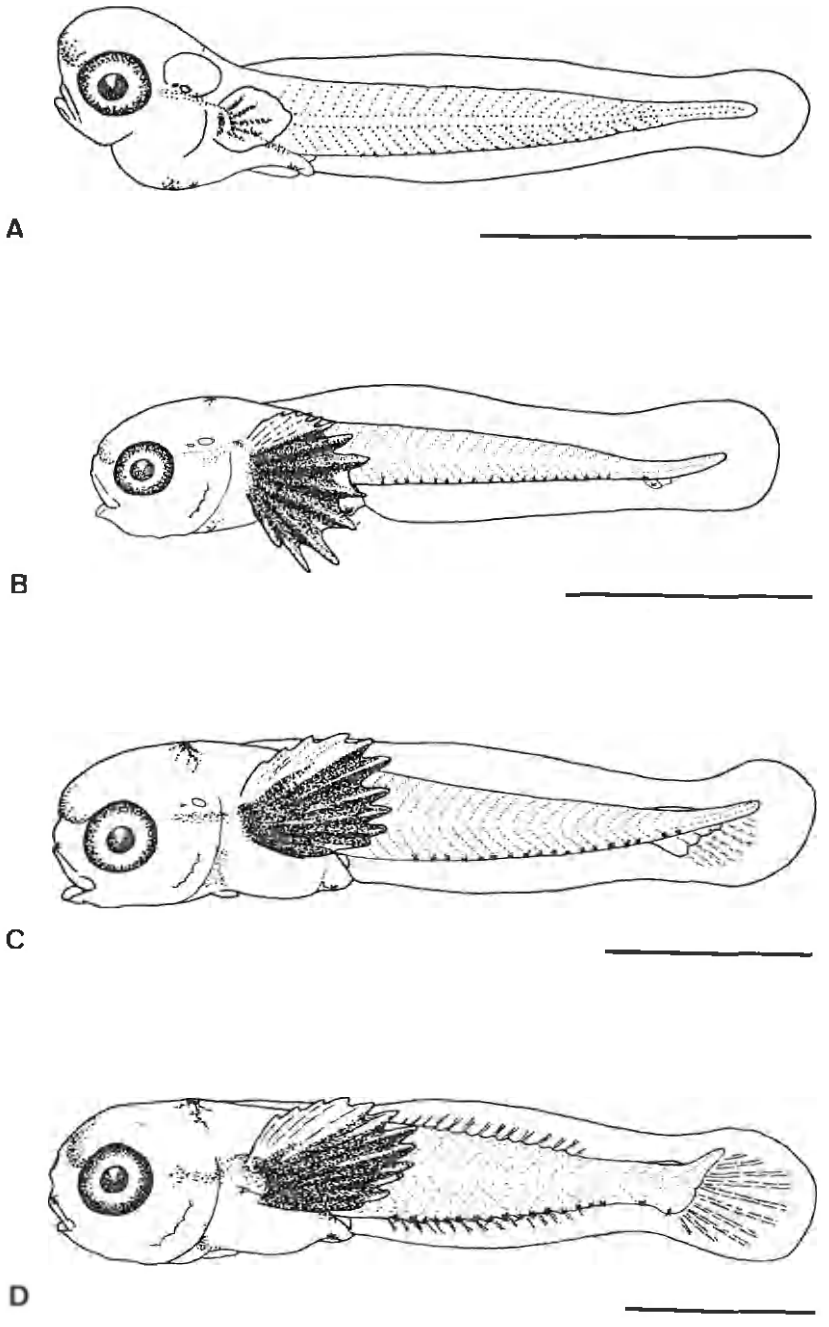

Figure 1. Development of *Lupinoblennius nicholsi*: A, 2.4 mm; B, 2.8 mm; C, 3.7 mm; D, 4.1 mm. Solid line represents 1.0 mm.

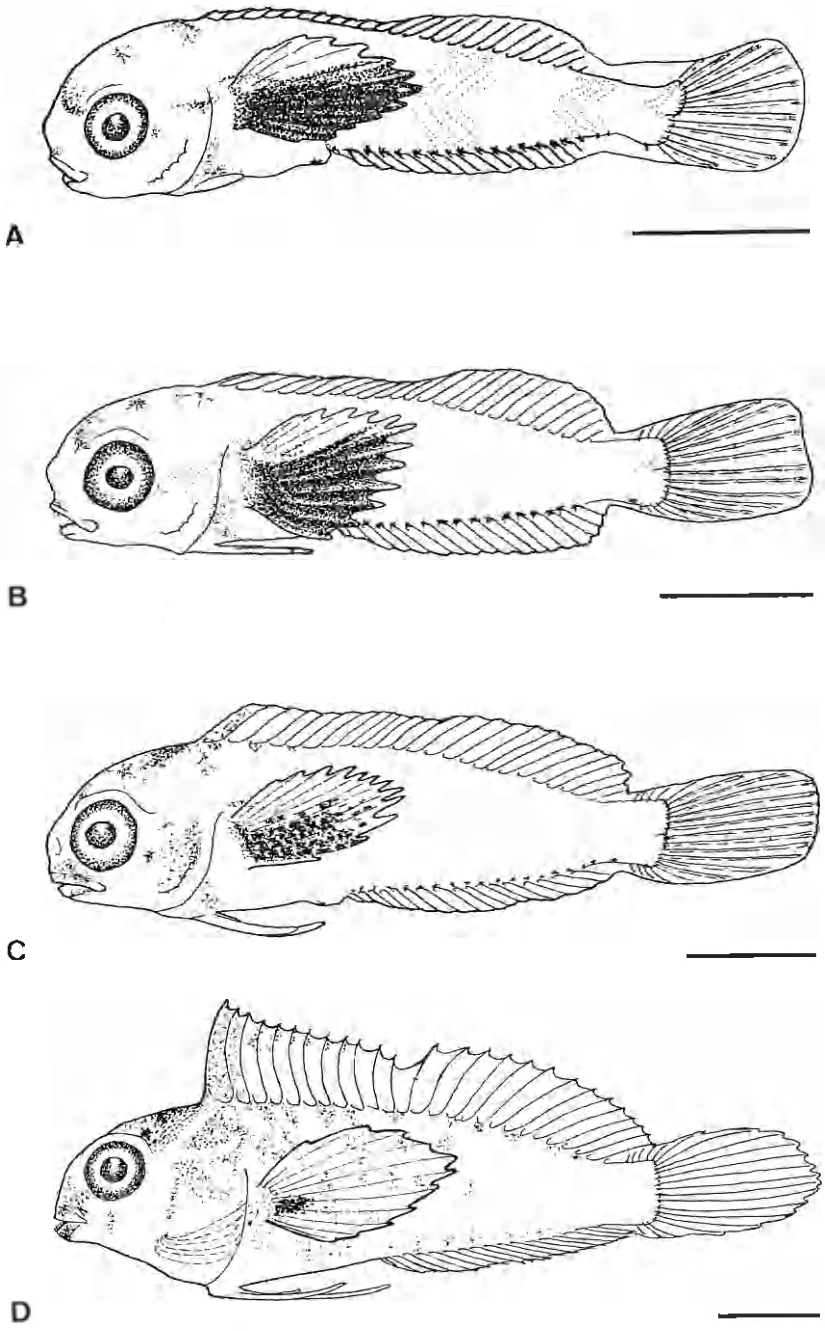

Figure 2. Development of *Lupinoblennius nicholsi*: A, 4.4 mm; B, 5.1 mm; C, 6.0 mm; D, 8.0 mm. Solid bar represents 1.0 mm.

Table 1. Fin ray and preopercular spine counts of 15 cleared and stained *L. nicholsi* larvae (Larvae between dotted lines are undergoing notochord flexion)

SL (mm)	Principal caudal rays	Procurrent caudal rays	Dorsal fin rays	Anal fin rays	Pectoral fin rays	Pelvic fin rays	Preopercular spines
2.2					6–7*		
2.4					6–7*		
2.9					6–7*		
3.1					11		
3.5					12		4
3.7	1/1				12		3
3.9	5/5				12		2–3
4.0	5/6		8		13		5
4.1	7/6	0/1	I,11	9	13		5–6
4.2	broken	—	VIII,11	13	13		3
4.3	7/6	0/2	X,14	15	13	I,3	4–5
4.5	7/6	2/4	XII,13	I,16	13	I,3	5
4.7	7/6	3/4	XI,15	II,17	13	I,3	8
4.9	7/6	4/5	XI,15	II,17	13	I,3	8
5.7	7/6	5/5	XII,14	II,16	13	I,3	8

* Not yet ossified.

was covered with small melanophores interrupted by unpigmented areas over the laterosensory canals and two larger melanophores posterodorsal to each eye. The remainder of the body was partially covered by a mottled pattern of small melanophores—darkest near the head and fading posteriorly. The back of the pectoral fin still retained only a small amount of pigment near the fin base. The membrane between the first and third dorsal spines was heavily pigmented and the membranes around the next six spine tips also contained patches of pigment.

Fin Development (Table 1)

Paired fins of *L. nicholsi* began to develop soon after hatching. The pectoral fin had 6–7 incipient rays at 2.0 mm with the fin membrane deeply notched between them. Eleven pectoral rays had ossified by 3.1 mm and all 13 were present at 4.0 mm. The pelvic fin bud was present at 3.7 mm with the single spine and the three soft rays showing ossification by 4.3 mm.

The first medial fin rays to ossify were the two central principal caudal rays at 3.7 mm, just as the notochord began flexing. All 13 principal rays and one lower procurrent ray were present at 4.1 mm as the notochord completed flexion. All four upper and five lower procurrent rays were ossified by 4.9 mm. Eight soft dorsal rays were ossified at 4.0 mm, followed soon after (4.1 mm) by the first dorsal spines and soft anal rays. The first anal spine to develop (#2) was ossified by 4.5 mm and all dorsal and anal fin rays were generally present by the time the second anal spine (#1) appeared at 4.7 mm. Elongation of the first dorsal spine was beginning to take place in the 8.0-mm juvenile specimen.

Morphology (Table 2)

Measurements of all morphometric characters except eye diameter, prepelvic length and predorsal length increased in proportion to standard length during development. Proportional lengths of the caudal fin (as shown by the proportion

Table 2. Body proportions of *Lupinoblennius nicholsi* through developmental stages as percent SL (Data are presented as mean ± standard deviation with ranges in parentheses)

	Stage				
Size range (mm)	Preflexion 2.2–3.8	Flexion 3.7–4.2	Postflexion 4.2–6.0	Juvenile 8.0	Juveniles–adults 24.3–39.4
Age (days)	0–17	11–23	17–33		
Sample size	56	31	44	1	10
Total length	107.4 ± 0.9 (105.0–109.8)	109.9 ± 3.4 (104.9–118.2)	120.0 ± 2.2 (114.1–125.0)	125.2	118.9 ± 1.0 (118.0–120.8)
Head length	22.5 ± 1.2 (20.8–25.8)	25.2 ± 1.6 (21.2–28.4)	27.5 ± 1.4 (24.3–30.4)	35.0	28.4 ± 1.8 (25.6–30.9)
Snout length	4.3 ± 0.8 (2.6–6.3)	4.9 ± 0.8 (3.2–6.5)	4.6 ± 0.9 (3.2–6.4)	5.8	7.9 ± 0.6 (6.9–8.7)
Eye diameter	10.0 ± 0.6 (9.1–11.6)	10.2 ± 0.4 (9.5–10.9)	10.9 ± 0.5 (9.2–11.7)	11.1	7.0 ± 0.7 (5.8–8.2)
Prepelvic length	—	22.0 ± 0.5* (21.2–22.6)	22.2 ± 1.1 (20.0–24.0)	26.3	22.5 ± 1.9 (19.5–25.4)
Predorsal length	—	26.1 ± 0.8** (25.5–26.7)	26.0 ± 0.9 (24.2–27.3)	26.3	18.2 ± 1.5 (15.4–20.2)
Preanal length	40.7 ± 1.9 (37.5–44.0)	44.1 ± 1.4 (41.8–46.4)	45.5 ± 1.3 (43.1–49.1)	54.5	53.7 ± 2.4 (50.0–57.5)
Pectoral length	19.6 ± 3.8 (13.2–27.1)	26.4 ± 2.2 (21.1–30.5)	29.2 ± 2.1 (24.7–33.3)	32.5	27.5 ± 2.7*** (23.4–30.9)
Pelvic length	—	5.4 ± 1.6* (3.1–8.0)	13.6 ± 5.1 (6.0–22.7)	21.4	17.4 ± 1.9* (15.3–20.6)
Body depth	19.4 ± 2.8 (16.4–24.1)	22.9 ± 1.0 (21.0–25.1)	26.0 ± 1.0 (23.7–28.1)	29.2	26.2 ± 1.6 (23.4–28.2)

* N = 7.
** N = 2.
*** N = 6.

of TL to SL), the head, and the pectoral and pelvic fins were all shortest in newly-hatched larvae and longest in late larvae and early juveniles, but decreased somewhat in adults. Snout length, body depth and preanal length all increased gradually throughout development. The relative prepelvic length, predorsal length and eye diameter all remained constant during larval growth, but the last two decreased somewhat by the adult stage.

Species Comparison
Table 3, Figures 3 and 4

Tampa Bay collections contained larvae of two other species of Blenniini—*Hypsoblennius hentzi* and *Chasmodes saburrae*. Larvae of both species have been described (*H. hentzi*—Hildebrand and Cable, 1938; *C. saburrae*—Peters, 1981), although some confusion has arisen because of errors in the literature. Fahay (1983) noted that based upon preopercular spination, Hildebrand and Cable's 1938 description of *H. hentzi* is suspect. In my opinion, opercular spination, fin ray counts, and myomere counts (see below) of their figure 88 (p. 587) clearly show it to be *C. bosquianus* and not *H. hentzi* as labeled.

Hildebrand and Cable's error has been perpetuated by several authors since 1938 and a number of typographical errors has further confused the issue. Lippson and Moran (1974, p. 240) and Wang and Kernehan (1979, p. 273, figs. h and i) followed Hildebrand and Cable (op. cit.) in labeling the questionable *C. bosquianus* as *H. hentzi*, but also reversed the order of two figures so that the 9.8-mm *C.*

Table 3. Typical characters used to separate larval *L. nicholsi*, *C. saburrae* and *H. hentzi*

	Size interval (mm)	*L. nicholsi*	*C. saburrae*	*H. hentzi*
Total myomeres or vertebrae		32–33 (33)	34–35 (34)	31–34 (31)
Dorsal fin rays	>4.7	XI–XIII,14–15 (XII,15)	XII,17–19	XII,13–15 (14–15)
Anal fin rays	>4.7	II,16–18 (16–17)	II,18–20	II,15–17
Pectoral fin rays	>4.0	13–14 (13)	12	13–15 (14)
Pectoral fin notched?	2.5–4.0	deeply	no	no
	>4.0	deeply	slightly	slightly
Number of preopercular spines	>4.5	4–8	5–6	3
Length of preopercular spines	>4.5	short	moderate	2 moderate, 1 long
Upper limit of pectoral pigment (numbered from top)	>3.0	Base of rays 5–6 to tip of rays 6–7	Base of rays 3–5 to tip of rays 7–8	Midway along ray 1 to tip of rays 8–9
Melanophores:				
On snout	<4.0	0	0	1–2
	4.5–6.5	0	0	0
	>6.5	0	1	0
On head (posterodorsal to orbit)	<4.5	0	0–6 (1–6)	1–5
	4.5–5.7	0–2	2–15	2–15
At cleithral symphysis	>2.5	0	3–5	3–5
Ventral to foregut	<2.5	1–3	0–4 (1–4)	0–1
	>2.5	0	0–4 (1–4)	0–1
Ventral to hindgut	2.5–8.0	0–2 (1)	0–2 (1)	1–4 (3–4)
Angle of jaw	4.5–8.0	0	1	0
	>8.0	0	1	1

bosquianus illustration is labeled 12 mm TL. Fritzsche (1978, pp. 307–308, figs. 171–172) followed Hildebrand and Cable (1938) in labeling the *C. bosquianus* and *H. hentzi*, but reversed the two *H. hentzi* illustrations in figure 172 labeled "A 6.2 mm" and "C 12 mm."

Field samples of Tampa Bay blenniids were separated using meristics, pigmentation, preopercular spine size and counts, and condition of the pectoral fin margin. Myomere and fin ray counts (when developed) are some of the most reliable characters used to separate the larvae, although ranges presented here (Table 3) extend some literature values and make overlapping counts more likely. Preopercular spination begins to develop after 3.5–4.0 mm and in *L. nicholsi* the spines are always small and usually numerous (4–8). *Chasmodes saburrae* has 5–6 moderate sized preopercular spines and 1–2 small spines, while *H. hentzi* larvae develop a moderately large spine above and below the angle of the preopercle and one large spine at the angle which is often discernible by 3.7 mm (Fig. 3). The distal margins of *L. nicholsi* pectoral fins are deeply notched between the developing rays even early in fin development (2.5 mm), while those of *C. saburrae* and *H. hentzi* develop smaller notches later in growth (4–5 mm; Figs. 2 and 4).

Pigmentation characteristics of the three species are variable, however presence/absence and patterns of certain melanophores may help separate the species (Table 3, Figs. 3 and 4). Pectoral fins of *L. nicholsi* are heavily pigmented, but the pigment

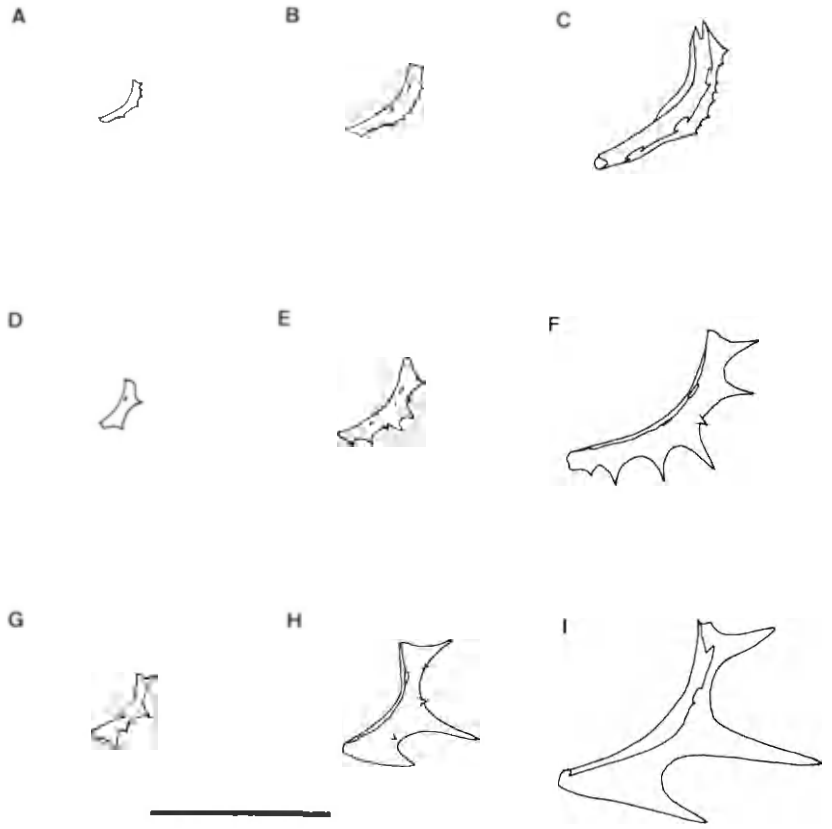

Figure 3. Preopercular development of *Lupinoblennius nicholsi, Hypsoblennius hentzi,* and *Chasmodes saburrae.* Drawn from cleared and stained fishes: A–C, *L. nicholsi*—3.5, 4.2, and 5.7 mm; D–F, *C. saburrae*—3.4, 4.5, and 7.4 mm; G–I, *H. hentzi*—3.6, 4.3, and 6.5 mm. Solid line represents 0.5 mm.

membrane (inner side of fin) is generally damaged in wild-caught specimens. In undamaged specimens, the dorsal rays of the pectoral fin are transparent, divided from the dark, ventral portion along rays 5 and 6 counting from the top (Fig. 4A). In *C. saburrae,* the line dividing the dorsal transparent area from the ventral pigmented area cuts more diagonally from the base of rays 3–5 posteroventrally to the tips of rays 7 or 8 (Fig. 4B). In *H. hentzi,* the line dividing the two areas

Figure 4. Pectoral fin morphology and pigmentation usually found in 4–5 mm *Lupinoblennius nicholsi* (A), *Chasmodes saburrae* (B), and *Hypsoblennius hentzi* (C).

begins on the dorsal-most ray and extends posteroventrally across about eight rays, reaching the fin margin near the tip of ray 8 or 9 (Fig. 4C). One or two melanophores anterior to the forebrain pigment are only present on the snout of *H. hentzi* less than 4.0 mm. *Chasmodes saburrae* develops melanophores on the snout after about 6.0–6.5 mm, but similar snout pigment has not been found in any *L. nicholsi* larvae (Table 3). Small *H. hentzi* and *C. saburrae* both have 0–6 (usually >1) melanophores scattered dorsally over their heads and the range increases to 0–15 in larger larvae. Other than the development of juvenile pigmentation after 5.7 mm, *L. nicholsi* has only one (rarely two) melanophore over each eye and that only after 4.2–4.5 mm. Both *H. hentzi* and *C. saburrae* have 3–5 melanophores at the cleithral symphysis. In addition, *C. saburrae* usually has 1–4 melanophores in a line ventral to the foregut and 1–2 ventral to the hindgut, while *H. hentzi* usually has no or only one melanophore ventral to the foregut and a line of 1–4 (usually 3–4) melanophores ventral to the hindgut (especially in preflexion larvae). In *L. nicholsi* longer than 2.5 mm, there is no pigment ventral to the cleithral symphysis or foregut, and usually only one melanophore ventral to the hindgut. Finally, *C. saburrae* >4.5 mm usually have a melanophore at the angle of the lower jaw as do *H. hentzi* >8.0 mm; this is never found in *L. nicholsi*.

In summary, *L. nicholsi* larvae are distinguished from *H. hentzi* and *C. saburrae* by myomere and fin ray counts, numerous tiny preopercular spines, deeply notched pectoral fin membranes, and pigmentation. Pigment differences include pectoral fin transparent and pigmented regions being divided along rays 5 or 6, only one, if any, melanophore posterodorsal to each eye (>4.5 mm), and a general lack of pigment on the snout, jaw angle and ventral midline of the gut.

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