Abstract.–The larvae and juveniles of two platytroctid species, *Holtbyrnia latifrons* and *Sagamichthys abei*, from the northeastern Pacific are described. Young individuals were collected at a broad range of mesopelagic depths, indicating that they occupy similar depths as adults. The relatively large larvae (~15 mm) have well-developed teeth and fins while carrying the yolksac. Presence of <20 mm sizes from most months of the year may indicate year-round spawning.

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Description of Young of the Mesopelagic Platytroctids *Holtbyrnia latifrons* and *Sagamichthys abei* (Pisces, Alepocephaloidea) from the Northeastern Pacific Ocean

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The only published description of larval platytroctids is that of Beebe (1933). However, Parr (1960) in his review of the family (then known as Searsidae) believed larval platytroctids of 11–17 mm could not be identified even to genus, and showed that Beebe's detailed description of the larvae identified as *Bathytroctes rostratus* was based on several species. In a recent revision of the family, Matsui and Rosenblatt (1987) recognized five species off California. None are congeners. The earliest larvae of the two commonest species, *Holtbyrnia latifrons** and *Sagamichthys abei*, are identifiable by their photophores. This report describes the young of *H. latifrons* and *S. abei* and presents catch data from the Scripps Institution of Oceanography (SIO) Fish Collection and depth of capture data from a series of opening-closing net tows.

Material and methods

Material used in this study is from the SIO Fish Collection and from samples collected on seven cruises sponsored by the Marine Life Research Group (MLRG) of SIO. Most SIO Fish Collection samples and some from the MLRG cruises were captured in 3-m Isaacs-Kidd midwater trawls (IKMT). Other MLRG collections were made with 2-m Stramin nets and 1-m plankton nets. The 1-m nets were attached to modified Leavitt devices (Leavitt 1938) that allowed the nets to be opened and closed by messengers to sample discrete depth intervals. Their sampling depths were either recorded by TSK depth-distance recorders on the nets and activated when the nets were sampling, or estimated from records taken on a Benthos time-depth recorder attached to the bottom net in the cast. Eight depth intervals from surface to nearbottom were sampled at stations 850–1350 m deep, and 12 depth intervals at stations of 1370 m to ~1800 m. Two samples in the Fish Collection were taken in opening-closing Bongo nets (McGowan and Brown 1966).

A total of 167 (young and adult) *H. latifrons* and 220 *S. abei* were examined in the study. The description of *H. latifrons* is based on measurements and counts of 157 individuals (1 larva, 12 transitional specimens, and 144 juveniles). For *S. abei*, 1 larva, 4 transitional specimens, and 37 juveniles were measured and counted. Samples of *H. latifrons* were gener-

* *Holtbyrnia latifrons* may be a junior synonym of *H. baucoti* Mayer and Nalbant 1972. However *H. baucoti* was inadequately described, and I have failed to gain additional information on the holotype.

ally collected near the coast at 22–38°N, off the west coast of California and Baja California (but mainly 28–33°N). Samples of *S. abei* were also collected near the coast at 28–38°N, with one individual from 4°N, 142°W.

Most specimens were initially preserved in formaldehyde and later transferred to 70% isopropanol. Length measurements of small specimens were taken with an ocular micrometer of a dissecting microscope and by dividers for larger measurements. All *S. abei* and *H. latifrons* examined had a flexed notochord. Since the notochord extended more than 1 mm beyond the hypurals in the earlier stages, the standard length (SL) measurements of the larvae were taken from the snout to posterior tip of notochord, or to the most posterior extension of the hypurals, whichever was greater.

Head length (HL) measurements were taken from the tip of the snout to the posterior margin of opercle. In individuals with torn or curled gill covers, the anterior base of pectoral fin was substituted as the posterior reference point for HL.

Photophore nomenclature follows Parr (1960) as modified in Matsui and Rosenblatt (1971).

Key to young platytroctids off California

1a Photophores (or melanophores in the shape of photophores) in gular region (GO_2; Figs. 1, 2) from yolksac through later juvenile stages 2

1b Neither photophores nor patch of melanophores in gular region 3

2a Photophores and silvery reflector present on anterior dorsal margin of eye (OO) and on subopercle (SBO) from yolksac stage; intraventral photophore (IVO) present from yolksac stage; opercular opening extending dorsally to about mideye; body coloration generally whitish blue ..... ***Sagamichthys abei***

2b OO and SBO photophores absent; IVO appearing near end of yolksac stage; opercular opening extending dorsally to top of eye; epidermal layer lightly pigmented from yolksac stage, becoming darkbrown in juvenile .... ***Holtbynia latifrons***

3a Broad edentulous space between innermost tooth of each premaxilla; small photophore between bases of pelvic fins (IVO) present after yolk is resorbed; gill opening extending dorsally to a level with top of eye .... ***Maulisia argipalla***

3b Only narrow edentulous space between innermost tooth of each premaxilla; photophores absent; gill opening on a level with mideye 4

4a Nasal sac nearly bordering maxilla; premaxilla not meeting medially with part extending laterally .... ***Pellisolus eubranchus***

4b Nasal sac midlength of snout; premaxilla meeting medially, with none along lateral margin of mouth .... ***Mirorictus taningi***

Description

Holtbyrnia latifrons (Fig. 1)

Pigmentation The least developed individual examined has pigmented eyes, pigmentation on the shoulder organ and at the site of the posterior gular organ (GO_2); the posterior margin of opercle and the dorsal portion of yolksac are lightly pigmented (Fig. 1A). This is the only specimen examined that is considered a larva; the remaining yolksac stages are already beginning to form the juvenile pigment pattern, and are termed transitional individuals. The most prominent pigmentation in these is the black tissue lining the digestive tract from the mouth and branchial chamber to the anus. Melanophores are concentrated at the dorsal and ventral margins, and on the fins and fin bases. Pigmentation increases with size, and in late juveniles the entire body as well as the head (except for the translucent top of skull) is nearly black in color.

Morphometrics The larva (Fig. 1A) has a small head and mouth and an oblong eye that is nearly twice as long horizontally as vertically. The transitional specimen (Fig. 1B) is much more adult-like with the head and eyes nearly doubling in size, and the eyes almost round.

Much of the growth in transition stages is in the head region, and although the body length of 12–17 mm

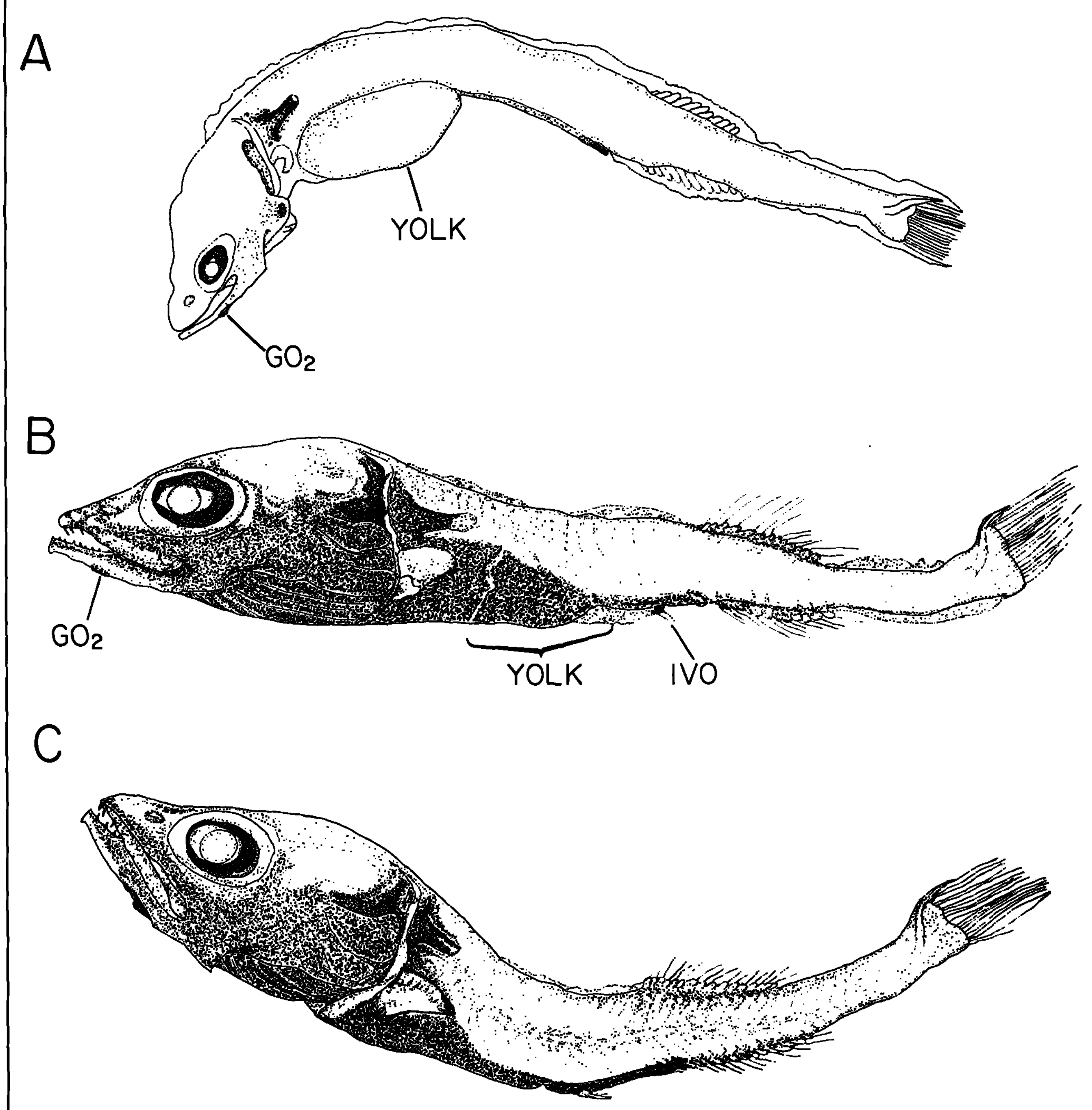

Figure 1
Camera lucida drawings of the young of *Holtbyrnia latifrons*: (A) M1-2-1, 15-mm larva; (B) SIO 65-439, 14-mm transitional specimen; (C) 65-443, 14-mm juvenile. GO_2 = posterior gular organ; IVO = intraventral organ.

juveniles is shorter than that of the larva, their head length is two times greater (Table 1). Head length increased from 15% of SL in the larva to the adult proportion of 30% of SL at the end of the transitional period. Head length of juveniles is proportionately larger than that of adults even from the earliest stages, measuring 29–37% of SL in the 12–18 mm SL range, with maximum of >40% SL at 36–45 mm SL (Table 2). Head depth increased from 9% SL in the larva, to 10–17% SL in transitional specimens, to 16–23% SL in juveniles as large as 50 mm.

Table 1
Measurements (in mm) and counts of *Holtbyrnia latifrons*. SL = standard length, HL = head length, Hd = head depth at angular, asterisks = SIO.

	Sample no.												
	M1-2-1	M11-1-3	M2-A7	M10-1R-2	M13st1	*67-62	*63-447	*65-439	*63-447	*66-398	*65-443	M7st3	*67-101
Lengths													
SL	15	15	15	14	14	13	14	14	14	14	14	16	16
HL	2.3	3.8	3.3	2.4	2.3	3.0	4.2	4.8	3.8	4.3	4.5	5.1	6.0
SL minus HL	13	11	12	12	12	10	10	8.9	11	9.3	9.2	10	9.7
Hd	1.4	1.4	1.7	1.4	1.2	1.4	2.0	2.3	1.8	2.2	2.4	2.7	2.9
Yolksac	3.7	3.6	3.3	3.2	3.0	3.0	2.6	2.5	2.3	0	0	0	0
Eye (long.)	0.72	0.92	0.91	1.1	0.76	1.0	1.3	1.6	1.3	1.5	1.4	1.6	2.0
Eye (vert.)	0.48	0.60	0.58	1.0	0.44	0.52	0.83	0.83	0.52	0.83	0.92	0.75	1.2
Maxilla	1.1	1.4	1.2	1.2	1.0	1.3	1.5	2.1	1.7	1.7	2.1	2.1	2.5
Counts													
Dorsal rays	0	11	15	14	14	12	16	13	16	15	16	18	19
Anal rays	0	10	13	10	—	13	13	13	14	15	14	16	12
Pectoral rays	0	0	0	0	0	0	0	0+2	0	—	4+?	4+?	4+?
Branchiostegals	2	4	5	8	8	8	8	8	8	8	8	8	8
Gill rakers	0	0	0+2	0	0	0+3	1+10	1+11	0+8	2+12	2+12	2+13	3+13
Pseudobranchiae	2	2	2	2	2	2	2	2	2	2	2	2	2
Dentition													
Vomerine	0	0	0	0	1	0	2	2	2	1	2	2	2
Palatine	0	0	0	0	0	0	1+1	1+1	1+1	1+1	1+2	1+1	1+1
Basihyal	0	0	0	0	0	0	1	1	0	0	0	0	1
Dentary	0	0	3+3	0	1+1	0	7+9	12+12	7+7	10+10	10+12	13+17	10+12
Mid-dentary	0	0	0	0	0	0	1+1	0	0	1+1	0+1	2+0	2+1
Maxillary	0	0	0	0	0	0	2+1	1+1	0	0	0	2+1	3+3
Premaxillary	0	0	0	0	0	1+1	2+2	3+4	4+3	3+5	4+5	5+5	4+3

Table 2
Summmarized counts and morphometrics (% SL) of *Holtbyrnia latifrons*. SL = standard length, HL = head length, Hd = head depth at angular.

			Dentition								% SL			
SL (mm)	Gill rakers	Pseudo-branchiae	Vomer-ine	Pala-tine	Pre-maxillary	Max-illary	Dentary	Mid-dentary	Basi-hyal	Basi-branchial	HL	Hd	Eye	Max-illary
Yolksac	0–1+0–11	2	0–2	0–1	0–4	0–2	0–12	0–1	0–1	0	15–35	8–17	5–11	7–15
12–15	1–3+11–14	2	1–2	1	4–5	0–5	7–12	0–2	0–1	0	29–33	15–19	9–12	12–15
16–20	2–5+13–15	2–4	2–3	1–2	4–6	2–8	10–24	0–6	0–4	0	29–42	14–19	7–13	11–16
21–25	2–5+13–17	2–4	2–5	1–2	4–8	5–16	15–27	0–2	0–4	0	33–39	16–20	10–12	14–17
26–30	5–7+16–19	4–5	1–2	1–2	4–9	5–19	16–30	0–5	0–3	0	35–45	17–23	11–13	14–20
31–35	6–7+16–17	5	2–4	1–2	7–10	5–23	15–26	0–5	0–2	0	36–39	16–19	11–12	17–20
36–40	6–8+18–19	6	1–2	1–4	6–9	11–33	19–23	4–5	0–2	0–1	38–42	19–20	10–12	18–21
41–45	7–9+18–21	5–6	2–3	1–4	7–11	11–33	20–27	3–6	0–1	0–5	38–42	19–22	10–13	17–20
46–50	7–8+18–19	8	2–3	1–4	10–12	15–32	33–40	2–4	0–1	0–4	36–42	19–21	10–11	18–21
51–55	7+19	7	2–3	2	9	27–29	30–34	1–4	0–1	0–5	37	20	11	21

Eye length increased from about 5% SL in the larva to as much as 11% SL in some of the transitional specimens and to 11–13% SL in 20–45 mm juveniles. Maxilla length increased from 7% of SL in the larva, to 9–15% SL during transition, to 17–21% SL in 30–50 mm juveniles.

Fins All specimens had the notochord flexed with 19 principal caudal rays present. In larvae, narrow finfolds extend anteriorly along the dorsal (to head) and ventral (to anus) body margins. Only the basal parts of the dorsal and anal rays are discernible on the larva (Fig. 1A), but there are 10–13 anal and 11–16 dorsal rays in the transitional specimens (Table 1). Two pelvic rays are discernible in the most advanced transitional specimen (SIO65-439). Adult counts of dorsal (17–20), anal (14–16), and pelvic (9) fin rays are usually present in 30-mm juveniles. Pectoral fin rays form last, with the first rays appearing at approximately 23 mm SL and adult counts (16–20) by 45 mm SL.

Branchial region Branchiostegal rays appear early and only the larval specimen and the least developed transitional specimen had fewer than the adult count of 8.

Gill rakers are absent in the larva, but as many as 12 are on one side of the 1st gill arch in the transitional specimen. Nearly all of these gill rakers are on the lower arch. Only one transitional specimen (SIO65-439) had gill rakers on the 1st epibranchial. The lowest count for juveniles was 1 on the epibranchial and 12 total on the 1st arch, and ranged from 1 to 5 on the upper arch and 12 to 19 total in juveniles <20 mm SL. The smallest individual with the adult gill raker count of 25 was 27 mm SL and all individuals 42 mm and larger had counts in the adult range of 25–30.

Medial gill rakers of the 3d and 4th arches are in an uninterrupted row in juveniles as small as 19 mm, but no medial gill rakers form on the 1st and 2d arches until after 20 mm. By 45 mm SL, there are about 6 medial rakers on the epibranchial and on the ceratobranchial of the 2d arch, and 5 on these elements of the 1st arch.

There are 2 pseudobranchiae in the larva and transitional specimens. The smallest individual with a 3d pseudobranchium measured 17 mm and the smallest with a 4th was 20 mm. No specimen <50 mm SL had attained the highest adult count of 8. Counts varied as much as 4 between individuals of similar lengths.

Dentition In the study material, only the larva is toothless. Teeth on dentary, premaxilla, maxilla, vomer, palatines, basihyal, and on the lateral face of the dentary (mid-dentary teeth) appear during transition. Teeth are easily dislodged, contributing substantially to individual variation in counts. The most advanced transitional specimen (SIO65-439; Table 1) had a single medial tooth on the basihyal, a tooth on each palatine, and a total of 7 premaxillary, 2 maxillary, 24 dentary, and 2 vomerine teeth. Only one transitional specimen had mid-dentary teeth. There are fewer maxillary than dentary teeth in the early stages, but this gradually changes and the numbers are about even in individuals 25 mm and larger (Table 2). Highest count of premaxillary teeth among transitional individuals was 4 on a side. The numbers increased to 4–6 in 13–20 mm juveniles, with counts as high as 10 at 50 mm SL. The inner pair of premaxillary teeth point horizontally beginning from about 25 mm SL. Frequently, a second smaller tooth forms adjacent to the 1st.

Mid-dentary teeth are probably more susceptible to damage than other dentition and most individuals smaller than 30 mm were without them, although counts of 4 on one side occurred as early as 17 mm. Individuals 30–50 mm long usually had 4–5 mid-dentary teeth. In the youngest stages, a single tooth was usually present on each palatine. The number variably increased to as many as 4 in individuals over 30 mm. Most prejuveniles and early juveniles had a medial tooth on the basihyal, with occasional individuals with 2–4 in a medial row. Basibranchial and mesopterygoid teeth appeared after 40 mm, and ectopterygoid teeth were only found in the adults.

Photophores Photophores of young platytroctids are oriented horizontally (Matsui and Rosenblatt 1971). The posterior gular organ (GO_2; Fig. 1) is the only photophore present during most of the yolksac stage. It is an opaque spot outlined by dark pigment in the larva, and forms at the posterior, narrow end of a black, conically-shaped pouch. Near the end of the yolksac stage, the intraventral organ (IVO) develops inside a silver-lined, anteriorly facing pouch. The photophore at the subopercle (SBO) appears later in juveniles. However, it is considered rudimentary as it is surrounded by opaque tissue and is without an anterior opening. These photophores are covered over and lost in larger individuals.

Additional photophores begin appearing in some juveniles of 26 mm but are uncommon until after 28 mm. Unlike earlier photophores, they face ventrally and persist in adults. Earliest to appear are (1) a transversely barred thoracic organ (THO) located on the ventral body margin midway between the pectoral and pelvic fins, (2) two elliptical supraventral organs (SVO) located anterolateral to the bases of the ventral fins, and (3) two elliptical supraanal organs (SAO), lateral to the anal opening. Other adult photophores appear soon after and include a transversely barred midventral organ (MVO) located anteroventral to the SVO, the elliptical branchiostegal organs (BRO), the infracaudal organ (ICO) located on the ventral margin of the caudal peduncle, the pectoral organ (PO) located on the ventralmost ray of pectoral fins, and a longitudinally barred jugular organ (JO) located between the bases of the pectoral fins. All adult photophores are usually present by 50 mm.

Sagamichthys abei (Fig. 2)

Pigmentation The single larval specimen is nearly unpigmented. Most heavily pigmented areas are the eye, shoulder organ, subopercular photophore (SBO),

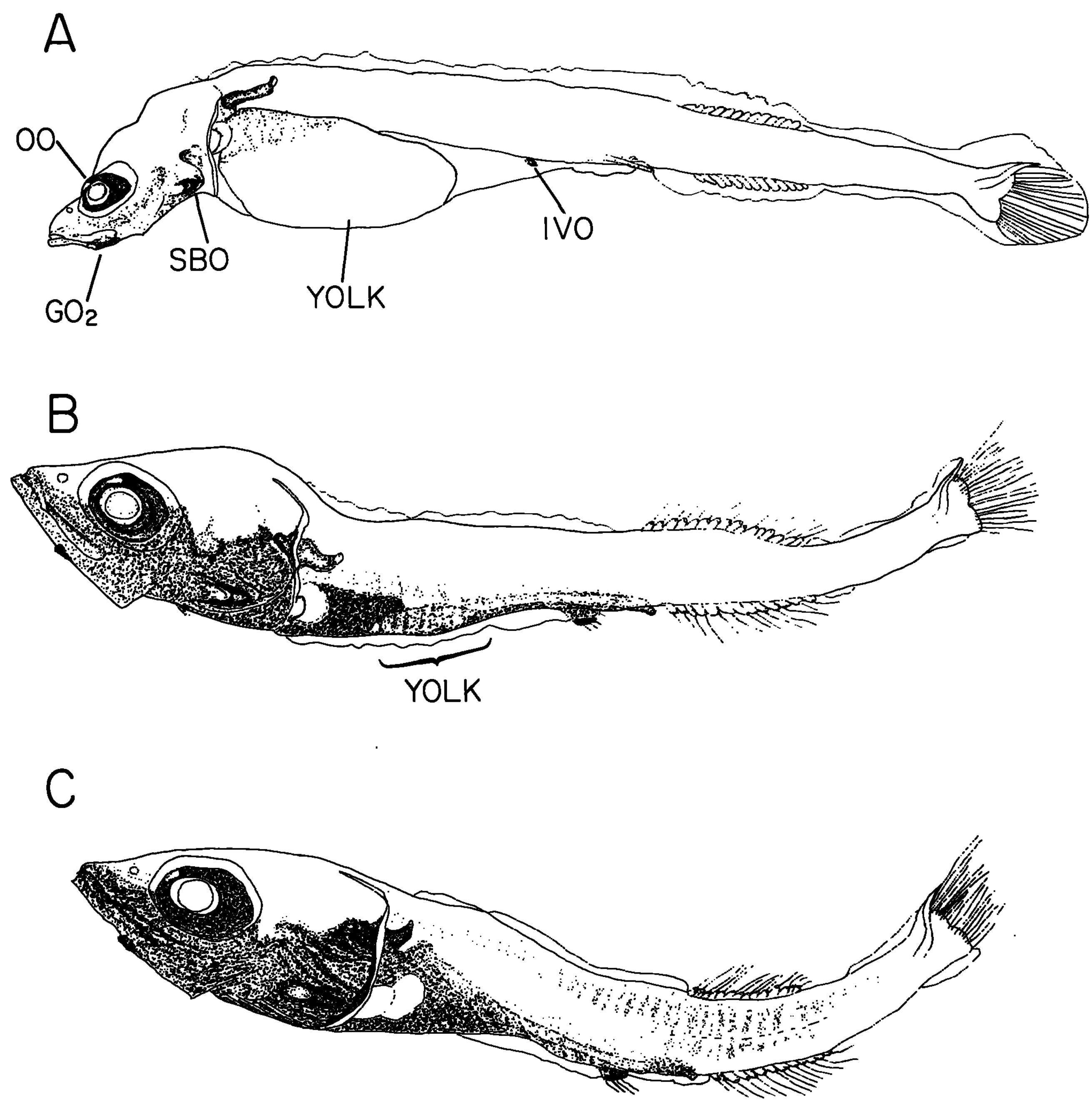

Figure 2
Camera lucida drawings of the young of *Sagamichthys abei*: (A) M13-1A, 16-mm larva; (B) SIO66-390, 14-mm transitional specimen; (C) M7 Sta 3, 16-mm juvenile. OO = orbital organ; GO_2 = posterior gular organ; SBO = subopercular organ; IVO = intraventral organ.

and posterior gular photophore (GO_2), with light pigmentation in the mouth, gill chamber, and on the dorsal region of the yolksac.

In the transitional specimen, the mouth, stomach cavity, and intestine are lined with black tissue. These blackened areas show through the translucent musculature, darkening the ventral half of the head and body anterior to the vent. Muscles between the anal and dorsal fins take on a bluish-black tinge, which spreads anteriorly and posteriorly from that area in larger individuals, with the area around the caudal peduncle darkening last. Among the more advanced transitional

Table 3

Measurements (in mm) and counts of *Sagamichthys abei*. SL = standard length, HL = head length, Hd = head depth at angular; asterisks = SIO.

	Sample no.												
	M13st1A	M4-st1	*66-390	*66-390	*66-422	*63-165	M7-st3	*66-371	*70-8	*65-439	*57-41	*75-472	*54-122
Lengths													
SL	16	16	14	14	14	13	16	16	16	17	17	18	20
HL	2.8	4.2	4.5	4.7	4.5	3.7	5.3	5.1	5.0	5.9	5.5	5.8	7.2
SL minus HL	13	12	9.5	9.3	9.5	9.3	11	11	11	11	12	12	13
Hd	1.5	2.0	2.3	2.3	2.1	2.1	2.7	2.3	2.6	2.4	2.4	2.3	3.2
Yolksac	4.0	4.2	2.5	2.5	3.2	2.6	0	0	0	0	0	0	0
Eye (long.)	0.92	1.1	1.1	0.92	1.0	0.76	1.7	1.8	1.3	1.7	1.3	1.6	2.2
Eye (vert.)	0.54	0.58	0.64	–	0.72	0.60	1.2	0.83	0.80	1.2	1.2	1.2	1.6
Maxilla	1.1	1.5	1.8	–	1.7	0.92	–	2.2	2.1	2.4	2.4	2.3	3.0
Counts													
Dorsal rays	0	16	16	14	13	13	14	16	14	16	15	16	15
Anal rays	0	14	13	14	13	12	14	15	13	15	14	14	14
Pectoral rays	0	0	3	0	3	0	5	–	5	7	4	7	5
Branchiostegals	0	8	8	8	8	8	8	8	8	8	8	8	8
Gill rakers	0	0+9	0+10	0+11	0+8	0+7	1+12	1+11	3+13	2+11	2+10	3+12	3+13
Pseudobranchiae	2	2	2	2	2	2	2	3	3	3	3	3	3
Dentition													
Vomerine	0	0	0	2	2	2	2	2	1	2	2	2	2
Palatine	0	1+0	0	1+1	1+0	1+1	1+1	1+1	0	1+1	1+1	1+1	1+0
Basihyal	0	1	3	3	1	1	4	1	4	7	4	6	5
Basibranchial	0	0	0	0	0	0	0	0	0	0	1	2	4
Dentary	0	3+?	3+5	7+?	8+?	5+5	?+14	10+8	15+11	17+?	14+15	17+?	12+?
Mid-dentary	0	0	0	0	0	0	0	0	3+2	4+?	2+3	2+?	?+3
Maxillary	0	0	0	0	0	0	4+6	–	9+6	10+?	9+?	11+14	12+?
Premaxillary	0	2+?	3+3	–	1+1	2+?	6+5	7+7	5+5	?+5	5+5	6+8	8+?

specimens, sparse epidermal pigment is found around the lower jaw, with a broken line at the midline between the anal and dorsal fins. This pigmentation spreads and intensifies in the juveniles, resulting in the blue-gray to black coloration.

Morphometrics A large yolk mass extends from the cleithrum to about halfway to the anus in the single larval specimen, which has a small head (headlength = 17% of SL) and mouth and undeveloped fins. Head length in transitional specimens nearly doubles to 26–33% of SL. Maxillary length increased from 7% SL to 9–13% SL during transition. Body length shortened or remained about the same (Table 3), as body length behind the head shortened. Head length and depth in transitional specimens are similar proportionately to adults, but the mouth is smaller than in adults and extends only to mideye, instead of behind the eye. Maxillary length is 9–13% SL during transition and 14–16% SL in adults. Eye length in the larva is proportionately similar to eye diameter in adults; however, eye depth is only half of the length in the former.

Head, mouth, and eye are proportionately largest in the 20–60 mm juveniles. Head length was mainly 35–38% of SL at this range (Table 4) but <30% of SL in individuals larger than 150 mm SL.

Fins All specimens have a flexed notochord and 19 principal caudal rays. Dorsal and anal fin rays are absent in the larval specimen, but pterygiophores of 11 anal and 13 dorsal rays are present. Counts of 13–16 dorsal, and 12–15 anal rays of the transitional specimens (Table 3) were nearly in the adult range of 16–18 dorsal and 14–16 anal finrays. Most juveniles over 20 mm SL had the adult counts. Pectoral fin rays are absent in specimens <18 mm. There were 0–7 pelvic rays at that length. Adult counts on all fins are found in juveniles >30 mm SL. There are 9–10 (usually 9) pelvic and 14–18 pectoral fin rays in the adult.

Branchial region Branchiostegal rays and gill rakers are absent in the larval specimen. Except for one individual with 7 rays, transitional specimens have the adult count of 8 branchiostegal rays. There are 8–11

Table 4
Summarized counts and morphometrics (% SL) of *Sagamichthys abei*. SL = standard length, HL = head length, Hd = head depth at angular.

			Dentition								% SL			
SL (mm)	Gill rakers	Pseudo-branchiae	Vomer-ine	Pala-tine	Pre-maxillary	Max-illary	Dentary	Mid-dentary	Basi-hyal	Basi-branchial	HL	Hd	Eye	Max-illary
Yolksac	0+0–11	2	0–2	0–1	0–3	0	3–8	0	0–3	0	18–33	9.3–16	6–8	7–13
16	1–3+11–13	2–3	2	1	5–7	6–9	10–15	0–3	0–4	0	31–33	14–16	8–15	13–14
17–20	2–4+11–13	2–3	2	1	5–9	7–14	12–18	1–4	4–8	0–8	32–43	14–21	8–11	13–18
21–25	3–5+13–15	3	2	1–3	8–9	7–19	12–25	1–3	4–8	2–9	34–35	15–18	9–10	14–16
26–30	4+15	4	3	2	13	19	17	5	9	10	35	16	10	16
31–35	4–5+15–16	4	2	2–5	9–11	17–26	15–19	3–5	6–12	6–9	34–36	16–22	8–10	14–15
36–40	6+16	4–5	2–5	2–3	10–14	25–28	16–22	6–9	5–9	4–6	30–39	17–20	9–11	16–18
41–45	6–7+17–18	5	2	2	11–12	28–29	28	6	3–7	6	32–36	8–16	7–9	15–19
46–50	6–7+15–16	6	2	2	11–12	34–35	22	6–7	5	6	34–38	18–20	9–10	17–20
51–55	7+19	7	2	2	17	41	26	10	7	14	41	22	9	20
56–60	7+16	6–7	2	2	13	37	23	9	2	9	35	20	8	18
61–65	7+16	7	2	2	13	40	24	10	4	5	36	19	8	17

gill rakers on the lower arch of the 1st gill arch in transitional specimens, but none on the upper arch. Epibranchial gill rakers were present in all juveniles examined (Table 4). The adult complement of 23–26 was present at about 50 mm.

An uninterrupted row of medial gill rakers is present on the 3d and 4th arches in 17-mm juveniles, but those on the 1st and 2d arches appear at 30–35 mm SL. There are 2 pseudobranchiae in the larva and transitional specimens. The number generally increased to 3 in juveniles of about 15 mm SL, and 6–7 in juveniles >45 mm SL.

Dentition The single larval specimen is toothless, but all transition specimens have teeth on the dentary, premaxillary, and basihyal, and, except for two individuals, on vomer and palatines as well (Table 3). Earliest appearances of maxillary, mid-dentary, and basibranchial teeth were in 16–17 mm juveniles. As in *H. latifrons*, there were more dentary than maxillary teeth in early stages; however, the number of maxillary teeth increased rapidly, becoming equal to that of the dentary by about 25 mm SL and more numerous after 35 mm (Table 4). Vomerine teeth numbered 2–5 and palatines 1–3 in the 16–50 mm SL range. In individuals 16 mm and larger, there were 3–12 teeth positioned around the perimeter of the basihyal, and 2–14 on the basibranchial. After a gradual increase, mid-dentary teeth numbered about 10 in individuals >50 mm SL. Mesopterygoid teeth appeared after 65 mm SL, and ectopterygoid teeth were found only in large adults.

Photophores The posterior gular organ (GO_2), subopercular organ (SBO), intraventral organ (IVO), and the orbital organ (OO) are the only photophores in individuals as large as 50 mm; they are covered over or lost in adults. The IVO photophore is located behind the yolksac (Fig. 2A). It becomes enclosed in a subconical, black pouch with a silvery, inner lining during the transitional period. The wider end of the pouch faces anteriorly and is covered by a transparent membrane. The photophore is located at the narrower, posterior end of the pouch, and is directed anteriorly. The other photophores are similarly housed in anteriorly facing, subconical pouches with a wider anterior opening and greater silvery surfaces.

Adult photophores face ventrally. Most begin appearing in juveniles. At 50–60 mm, the following organs begin to form: the jugular organ (JO) located between the bases of the pectoral fins; the thoracic organ (THO) behind the JO; the midventral organ (MVO) behind the THO and just before the pelvic fin bases; a pair of supraventral organs (SVO) just dorsal to the base of each pelvic fin; and the supra-anal organs (SAO) on both sides of the anus. The JO photophore first appears as one or more longitudinal bars (as in *H. latifrons*), but at about 65 mm begins to transform into a short transverse bar. Two more transverse bars, the THO and MVO, form behind the JO on the widely flattened ventral margin. Also appearing by 65 mm are several branchiostegal organs (BRO) on the branchiostegal rays, a postorbital organ (POO) just behind the eye, a pair of postanal organs (PAO) at about the middle of the anal fin, and an infracaudal organ (ICO) ventrally on the caudal peduncle. The anterior gular organ

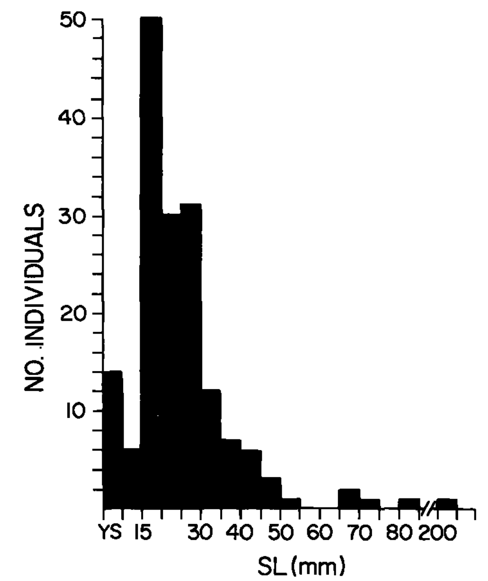

Figure 3
Length-frequency distribution of *Holtbyrnia latifrons* in SIO collections, 1950–73.

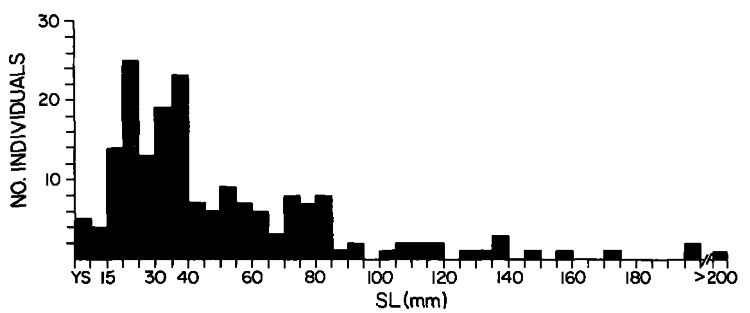

Figure 4
Length-frequency distribution of *Sagamichthys abei* in SIO collections, 1949–79.

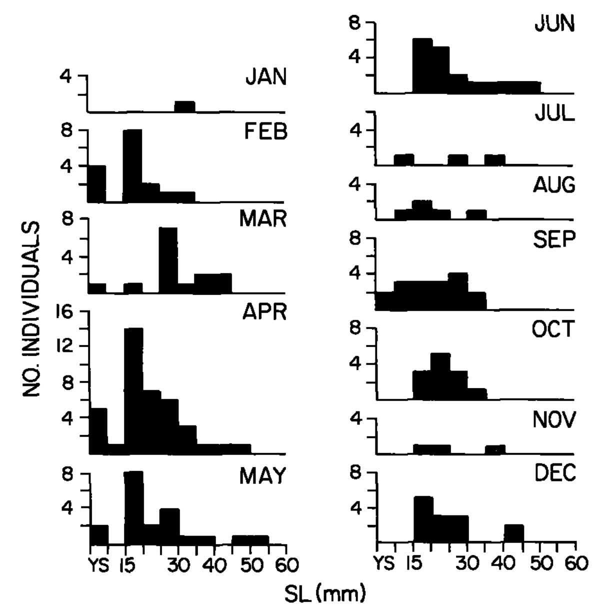

Figure 5
Length-frequency distribution of *Holtbyrnia latifrons* in SIO collections, 1950–73, presented by month of capture.

(GO_1), located just behind the mandibular symphysis, and the pectoral organ (PO) on the pectoral fins, appear by 75 mm. The anal organ (AO), located just before the anus, appears in large adults.

Remarks Some young specimens of *H. latifrons* and *S. abei* with nearly exhausted yolksacs retain characteristics of the earliest stages, i.e., fragile mouth, short head, and toothless mouth. Only the fin rays are relatively well developed. They appear to be starved in spite of the presence of yolk material and may indicate that they need to feed while the yolk is present. The severely underdeveloped head and mouth indicate that development either lagged from the very early stages or had regressed from a more advanced stage. These larvae were assumed to be atypical, and were not included in the larval description.

Distribution

In SIO samples, *H. latifrons* larger than 30 mm are rare and individuals >50 mm are nearly absent (Fig. 3); relatively small *H. latifrons* may avoid nets as large as a 3-m IKMT. Decline in size of *S. abei* in our samples is more gradual. The collection contains a number of individuals as large as 80 mm and a few even larger (Fig. 4). These results point to the inadequacy of nets as large as 3-m IKMT in sampling larger juveniles of both species.

The presence of individuals smaller than 20 mm during most of the year is interpreted as year-round spawning (Figs. 5, 6). These figures represent samples collected over many years pooled by month.

Depth distribution for both species is estimated to be 300–1000 m (Matsui and Rosenblatt 1987). On MLRG-SIO cruises, 63 opening-closing Leavitt net tows made in this depth zone collected 12 specimens of *H. latifrons* and 3 of *S. abei*. Fourteen net tows sampling shallower than 300 m and 30 tows sampling deeper than 1000 m on these cruises failed to catch

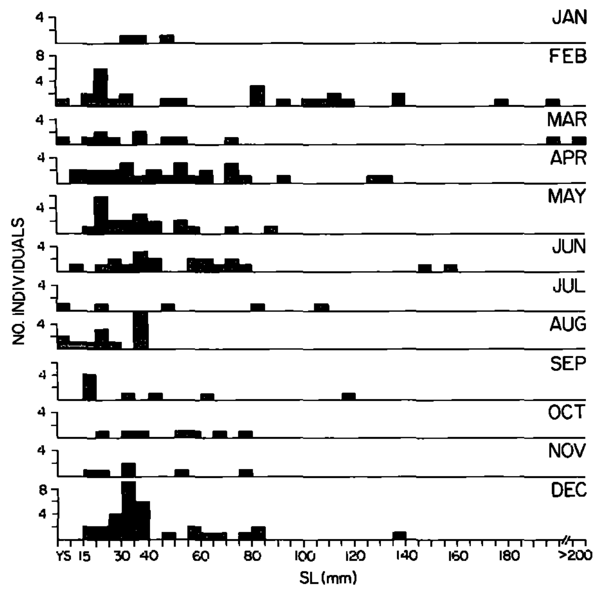

Figure 6
Length-frequency distribution of *Sagamichthys abei* in SIO collections, 1949–79, presented by month of capture.

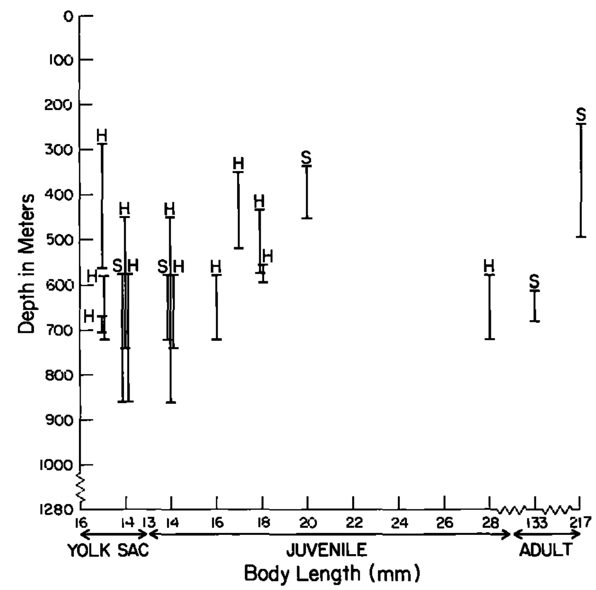

Figure 7
Sampling depths of opening-closing plankton net tows which captured *Holtbyrnia latifrons* (H) and *Sagamichthys abei* (S).

Table 5
Time and depth of capture of *Holtbyrnia latifrons* in opening-closing net tows. Asterisks = yolksac stage. Standard length (SL) in mm.

SL	Date	Time	Depth (m)
*14	2/09/72	0921–1021	450–740
*14	"	"	"
14	"	"	"
*14	4/09/72	1146–1355	580–860
14	"	"	"
*15	4/08/72	1639–1901	580–720
16	"	"	"
28	"	"	"
*15	2/02/71	1745–1845	669–706
18	"	"	558–595
17	12/20/71	1748–1848	350–520
18	2/02/71	2320–0025	433–573
*15	4/13/71	0013–0152	286–563

Table 6
Time and depth of capture of *Sagamichthys abei* in opening-closing nets. Standard length (SL) in mm.

SL	Date	Time	Depth (m)
20	2/09/72	0921–1021	333–450
14	4/08/72	1146–1355	580–860
133	11/04/69	1230–1300	615–680
15	4/08/72	1639–1901	580–720
213	3/28/70	2246–2350	250–500

either of these species. Samples of *H. latifrons* were from nets that had sampled depths of 290–860 m, and *S. abei* of 330–860 m (Fig. 7). All of these individuals were 20 mm and smaller, providing evidence that young stages occur over the entire depth range of the species. Large larval size and early appearance of presumed swimming and foraging capabilities, noted in this study, are apparent specializations for developing at these nutrient-poor depths.

Absence of day and night differences in depth of capture (Tables 5, 6) add to the previous evidence (Matsui and Rosenblatt 1987) suggesting the absence of diel migration in platytroctids. Hart (1973) and Fitch and Lavenberg (1968) mention the migration of young *S. abei* to within 200 m of the surface at night, but did not give the source of their information. However, records of platytroctids from depths 200 m and shallower are extremely rare and the single record from the Pacific Ocean may be an error (Matsui and Rosenblatt 1987).

Hydrographic data (Fig. 8) taken in an area where most Leavitt net tows were made show that samples represented in Figure 7 were taken below the thermocline at depths where the temperature range was ~4–8°C. CalCOFI (California Cooperative Oceanic

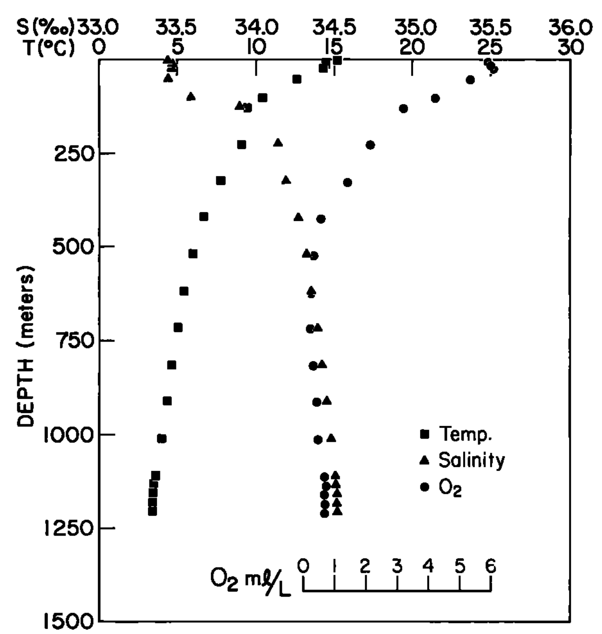

Figure 8

Temperature, oxygen, and salinity distribution at Station 7403G (32°32.4'N, 117°34.5'W), taken 27 March 1974 in the San Diego Trough.

Fisheries Investigation) station data from the area show seasonal changes in temperature below 300 m averaging less than 0.5°C (Lynn et al. 1982). Oxygen values of less than 1 mL/L occurred at these depths (Fig. 8). Gill filaments are highly developed (for platytroctids) in both species and are well adapted for this environment (Matsui and Rosenblatt 1987).

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