Abstract—The Argentine sandperch *Pseudopercis semifasciata* (Pinguipedidae) sustains an important commercial and recreational fishery in the northern Patagonian gulfs of Argentina. We describe the morphological features of larvae and posttransition juveniles of *P. semifasciata* and analyze the abundance and distribution of early life-history stages obtained from 19 research cruises conducted on the Argentine shelf between 1978 and 2001. *Pseudopercis semifasciata* larvae were distinguished from other larvae by the modal number of myomeres (between 36 and 38), their elongated body, the size of their gut, and by osteological features of the neuro- and branchiocranium. *Pseudopercis semifasciata* and *Pinguipes brasilianus* (the other sympatric species of pinguipedid fishes) posttransition juveniles were distinguished by their head shape, pigmentation pattern, and by the number of spines of the dorsal fin (five in *P. semifasciata* and seven in *P. brasilianus*). The abundance and distribution of *P. semifasciata* at early stages indicate the existence of at least three offshore reproductive grounds between 42–43°S, 43–44°S, and 44–45°S, and a delayed spawning pulse in the southern stocks.

Early life history of the Argentine sandperch *Pseudopercis semifasciata* (Pinguipedidae) off northern Patagonia

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The family Pinguipedidae (Osteichthyes, Perciformes) includes six genera and about 50 marine species and one freshwater species (Froese and Pauly, 2004). On the Argentine continental shelf this family is represented by two species, *Pseudopercis semifasciata* (Cuvier, 1829) and *Pinguipes brasilianus* Cuvier, 1829.

The Argentine sandperch *P. semifasciata* is an important incidental catch in the bottom trawl and longline commercial fisheries that target hake (*Merluccius hubbsi*) in the northern Patagonian coast off Argentina (Otero et al., 1982; Elías and Burgos, 1988; González, 1998). In recent years, the reported annual landings have oscillated between 1900 and 3780 metric tons (official statistics, SAGPyA-DNPyA[1]). In northern Patagonia, *P. semifasciata* is also targeted by sport anglers and spear fishermen and represents a tourist attraction for recreational divers. It inhabits rocky and sandy bottoms, from 23°S in Brazil to 47°S in Argentina (Cousseau and Perrotta, 2000), mainly in coastal waters, although it has been found in depths of up to 100 m (Menezes and Figueiredo, 1985).

Very little is known about the ecology and behavior of *P. semifasciata*, and most of what is known is based on limited observations during underwater visual censuses on shallow reefs where adults concentrate (González, 1998). Previous studies have focused on morphological features (Herrera and Cousseau, 1996; Rosa and Rosa, 1997; Gosztonyi and Kuba[2]), age and growth (Elías and Burgos, 1988; Fulco, 1996; González, 1998), diet (Elías and Rajoy, 1992; González, 2002), and reproductive traits, including reproductive season, spawning modality, and age at first maturity (Macchi et al., 1995;

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[1] SAGPyA-DNPyA. 2003. Capturas marítimas totales 1992–2002. Manuscript, 71 p. [Available from Secretaría de Agricultura, Ganadería y Pesca de la Nación, Dirección de Pesca y Acuicultura, Paseo Colón 982 P.B. Of. 59 – (C1063ACW) Buenos Aires, Argentina.] http://www.sagpya.mecon.gov.ar [Accessed July 2004.]

[2] Gosztonyi, A. E., and L. Kuba. 1996. Atlas de huesos craneales y de la cintura escapular de peces costeros patagónicos. Inf. Téc. FPN 4, 29 p. [Available from CENPAT, Blvd. Brown s/n (U9120ACV), Puerto Madryn, Chubut, Argentina.]

Fulco, 1996; González, 1998). *Pseudopercis semifasciata* is a multiple spawner with low batch fecundity and an extended reproductive season (Macchi et al., 1995; González, 1998). There is little information on the early life history of the species because only specimens >20–25 cm are found on reefs and the habitat of juveniles has not been described. In general, information about the early stages of pinguipedid fishes from the southwest Atlantic Ocean is scarce. De Cabo[3] reported pinguipedid larvae from the Argentine shelf but did not identify the specimens to species level.

In the present study, we describe development of *P. semifasciata* from larvae to the posttransition juvenile stage (*sensu* Vigliola and Harmelin-Vivien, 2001) and analyze data on distribution and abundance on the northern Patagonian shelf. This information is needed to locate main reproductive and nursery grounds for the species.

Materials and methods

Fish larvae and posttransition juveniles were collected during 19 research cruises conducted by INIDEP (Instituto Nacional de Investigación y Desarrollo Pesquero) between 1978 and 2001. A total of 592 ichthyoplankton samples and 277 juvenile trawl samples were analyzed (Table 1).

Larvae

Ichthyoplankton was sampled by using Bongo, Nackthai, and PairoVET nets. The Bongo net was fitted with 300-μm mesh and a flowmeter. The Nackthai sampler, a German modification of the Gulf V high-speed sampler (Nellen and Hempel, 1969), was fitted with a 400-μm mesh net and a flowmeter. Both samplers were towed obliquely from bottom to surface. The PairoVET sampler, a Bongo-type version of the CalVET, was fitted with two 200-μm mesh nets to sample fish eggs (Smith et al., 1985) and was towed vertically. Samples were fixed in a solution of 5% formalin to seawater. During most cruises, depths at which *P. semifasciata* were located were determined by a SCANMAR sensor mounted on the sampler.

Table 1

Research cruises in the Argentine Sea during 1978–2001. Only those cruises with at least one positive station containing larvae or posttransition juveniles of *Pseudopercis semifasciata* were included in the analysis. EH=RV *Dr. Eduardo L. Holmberg*; OB=RV *Capitán Oca Balda*; SM= RV *Shinkai Maru*.

Year	Cruise	Dates	No. of stations	Lat. S range	Long. W range
Ichthyoplankton surveys					
1978–79	SM-IX	26 Dec–07 Jan	28	42°27′–45°30′	61°58′–66°01′
1982	EH-05/82	19 Nov–03 Dec	65	35°55′–40°53′	54°45′–61°57′
1983	EH-01/83	14 Jan–26 Jan	43	38°30′–44°32′	58°00′–65°07′
1985	OB-02/85	25 Mar–04 Apr	30	44°41′–46°52′	65°05′–67°18′
1986	OB-01/86	20 Jan–03 Feb	40	41°34′–44°36′	61°27′–65°05′
	OB-07/86	09 Dec–22 Dec	43	43°01′–46°50′	62°40′–66°51′
1991	OB-07/91	01 Nov–11 Nov	35	35°49′–36°51′	56°03′–56°59′
1995	OB-14/95	05 Dec–18 Dec	75	41°16′–45°22′	60°00′–67°00′
1996	EH-17/96	12 Dec–21 Dec	18	42°29′–44°01′	62°03′–65°16′
1998	OB-10/98	07 Dec–20 Dec	87	42°21′–45°36′	61°00′–65°44′
1999	OB-09/99	11 Dec–17 Dec	15	43°21′–44°01′	62°59′–65°12′
2000	OB-14/00	09 Dec–21 Dec	27	43°19′–46°24′	63°37′–66°48′
2001	EH-01/01	06 Jan–29 Jan	28	43°19′–46°54′	62°12′–67°33′
	OB-02/01	12 Feb–25 Feb	40	42°54′–45°25′	62°30′–66°12′
	OB-13/01	10 Nov 13 Nov	18	42°21′–43°42′	61°55′–65°01′
Posttransition juvenile trawls					
1992	EH-02/92	02 Mar–21 Mar	45	42°04′–45°43′	62°45′–66°14′
1998	EH-04/98	01 Apr–10 Apr	41	43°18′–47°02′	63°51′–66°43′
1999	EH-04/99	20 May–31 May	56	43°10′–47°01′	63°51′–66°42′
2000	OB-05/00	01 Jun–20 Jun	112	43°45′–47°02′	61°53′–67°25′
2001	OB-02/01	12 Feb–25 Feb	23	42°54′–45°25′	62°30′–66°12′

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[3] De Cabo, L. 1988. Descripción de tres larvas de peces teleósteos del Mar Argentino: Mugiloididae, Ophidiidae (*Genypterus blacodes*) y Tripterygidae (*Tripterygion cunninghami*). Unpubl. manuscript, 58 p. Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires–INIDEP. [Available from INIDEP: P.O. Box 175 (B7602HSA) Buenos Aires, Argentina.]

A total of 68 preserved larvae, ranging in body length (BL) from 3.3 to 11.7 mm, were used to describe larval development. Terminology for morphometrics followed Neira et al. (1998). Additionally, head depth (HD) was defined as the maximum depth of the head. Preserved larvae were measured to the nearest 0.1 mm with an ocular micrometer fitted to a dissecting microscope, and their pigmentation pattern was recorded. Possible shrinkage was not considered in the measurements. Whenever possible, the number of vertebrae and numbers of dorsal, anal, caudal, pectoral, and pelvic fin rays were recorded. In addition, 14 larvae from 3.4 to 11.7 mm BL were cleared and stained following the methods of Potthoff (1984) and Taylor and Van Dyke (1985), and then examined for meristics and osteological features. Myomere and fin-ray counts and morphometric measurements were made on the left side of the body. Larval abundance was expressed as the number of larvae/10 m^2 of sea surface as recommended by Smith and Richardson (1977).

Posttransition juveniles

Posttransition juveniles were collected with a small bottom trawl called "Piloto," with the following features: 6 m total length, 6-m headrope and groundrope, 25-mm wing mesh size, 10-mm codend mesh size, 0.25-m^2 otter board surface and 12 kg weight, 10-m bridles and 0.80-m vertical opening. In Argentina, commercial fishing vessels use this gear for locating shrimp concentrations. Additionally, an epibenthic sampler (Rothlisberg and Pearcy, 1976) fitted with 1-mm mesh was used on one cruise (EH-02/92). We believe that individuals up to 12 cm total length were well represented in samples obtained with this gear.

A total of 27 posttransition juveniles, ranging from 22 to 83 mm body length (BL), were used to describe Argentine sandperch developmental stages. Samples were either frozen or fixed in 5% formalin to seawater solution. Measurements and degree of pigmentation were recorded after preservation.

Total length (TL), body length (=standard length), head length (HL), predorsal length (PDL), and preanal length (PAL) were measured to the nearest 1 mm. Head depth (HD), body depth (BD), and eye diameter (ED) were measured to the nearest 0.2 mm. Three juveniles between 22 and 33 mm BL were cleared and stained (Potthoff, 1984; Taylor and Van Dyke, 1985) and examined for meristics.

The density of posttransition juveniles, expressed as individuals/square nautical mile (nmi^2), was estimated from swept area. The family Pinguipedidae includes two species (morphologically very similar as juveniles) that overlap in the Argentine Sea. Unfortunately, not all individuals caught during the cruises were examined by us; therefore, to avoid biases caused by identification errors, the posttransition juveniles of both species were considered as a group. Distributional centroids and ellipses were calculated by following the method of Kendall and Picquelle (1989), that is by weighting each station by the density of juveniles caught. For this purpose each density value was standardized with respect to the maximum density observed for each survey season over all years.

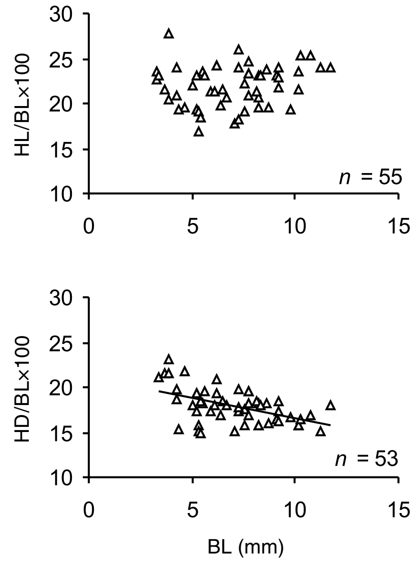

Figure 1

Relative head length (HL/BL × 100) and relative head depth (HD/BL × 100) against body length (BL) in *Pseudopercis semifasciata* larvae, regardless of the flexion stage of the notochord. Solid line represents a linear trend (n=53; r^2=0.2576; P<0.001).

Results

Description of larvae

General morphological features The larval body was elongate and relative BD was <25% in all stages of development (Table 2). The smallest larva collected (yolksac larva) was 3.3 mm BL. Its yolk sac was small and the single oil globule was located on the anterior part of the yolk mass. Notochord flexion began at 6 mm and was complete by 7–8 mm BL. As development proceeded, larvae became slightly deeper and laterally compressed. The head was small, with a rounded snout and no spines. The oblique mouth was open by the end of the yolksac larval stage. By 10 mm BL, premaxilla and dentary bones were covered with caniniform teeth. The premaxilla was an elongated bone with three processes on its dorsal margin—the first one perpendicular to the premaxilla. Relative head length remained constant, whereas relative head depth diminished during development (Fig. 1). The eyes were pigmented and their relative diameter decreased during the preflexion stage, and

Table 2

Body proportions of *Pseudopercis semifasciata* larvae, according to the flexion stage of the notochord. Mean (±SE), range and number of observations are shown in the table. BD=body depth; BL=body length; ED=eye diameter; HD=head depth; HL=head length; PAL=preanal length.

		BD/BL×100	HD/BL×100
Preflexion	3.3–7.1 mm BL; *n*=36:	16.4 ±3.1 (12.4–25.5) *n*=27	18.5 ±2.3 (14.8–23.1) *n*=25
Flexion	6.2–8.7 mm BL; *n*=8:	14.5 ±1.4 (12.2–16.1) *n*=5	17.1 ±1.2 (15.9–19.4) *n*=8
Postflexion	7.3–11.7 mm BL; *n*=20:	16.8 ±1.3 (14.3–19.5) *n*=20	17.4 ±1.4 (15.2–19.8) *n*=20
		PAL/BL×100	ED/BL×100
Preflexion		53.6 ±4.1 (45.0–62.5) *n*=29	7.8 ±1.1 (5.9–10.9) *n*=29
Flexion		52.0 ±2.2 (49.4–56.5) *n*=8	6.1 ±0.3 (5.6–6.5) *n*=8
Postflexion		52.5 ±2.7 (47.3–57.5) *n*=20	6.1 ±0.7 (4.9–7.6) *n*=20
		HL/BL×100	
Preflexion		21.2 ±2.4 (17.0–27.7) *n*=27	
Flexion		20.5 ±1.9 (18.2–24.2) *n*=8	
Postflexion		23.4 ±1.5 (19.3–26.0) *n*=20	

then remained constant (Fig. 2, A and B). The gut was initially straight but began to constrict at 4 mm BL and was loosely constricted throughout development (Fig. 3, A–C). It was moderate to long and extended to near the midpoint of the body, resulting in a relative preanal length of 0.45 to 0.62 BL.

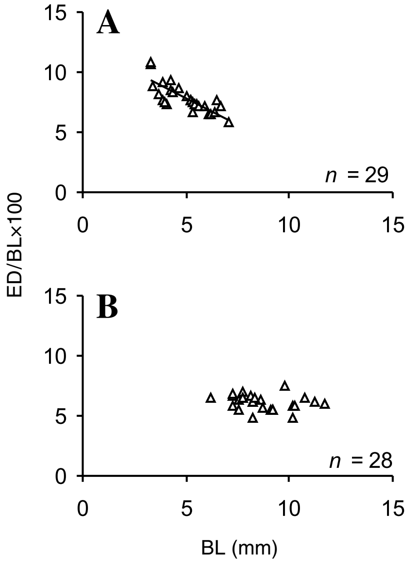

Figure 2

Relative eye diameter (ED/BL × 100) against body length (BL) in *Pseudopercis semifasciata* larvae. (**A**) Preflexion larvae. Solid line represents a linear trend ($n=29$; $r^2=0.6228$; $P<0.001$). (**B**) Flexion and postflexion larvae.

Body pigmentation Argentine sandperch larvae were lightly pigmented during all stages of development (Fig. 3; A–C). The pigmentation on the ventral body surface, between the isthmus and the anus, consisted of small stellate melanophores. Several small melanophores were scattered on the lateral surface of the anterior part of the gut. A double row of minute melanophores along the ventral surface ended in a single melanophore at the constriction of the gut. Pigmentation along the lateral midline of the tail consisted of four to seven stellate melanophores.

In preflexion larvae (Fig. 3A), small spots were evident along the lower jaw and the ventral part of the head. Several small stellate melanophores were present on the dorsal surface of the gut. A few melanophores were scattered at the base of the pectoral fin bud.

Preflexion and flexion larvae (Fig. 3, A and B) showed a distinct pattern of 12 to 23 small postanal melanophores serially arranged, about one per myomere, along the ventral midline. A total of 11 to 18 melanophores, about one melanophore per anal fin pterygiophore, was observed in postflexion larvae (Fig. 3C). As flexion progressed (Fig. 3, B and C), the number of melanophores on the ventral part of the head and over the gut diminished.

Fins and meristic features Modes of preanal and postanal myomeres were 14 and 23, respectively. All specimens examined had 33–40 total myomeres (mode:36–38 myomeres). Vertebral column ossification started anteriorly. A total of 38–39 vertebrae were recorded in 10–12 mm BL postflexion larvae (*n*=2).

In yolksac larvae, finfold and pectoral buds were the first fin development distinguished. In preflexion and flexion larvae, the finfold was present and it was gradually lost as the true fins developed. The sequence of fin-ray formation, characterized by initial development of fin elements, was caudal (7–8 mm BL), then pectoral

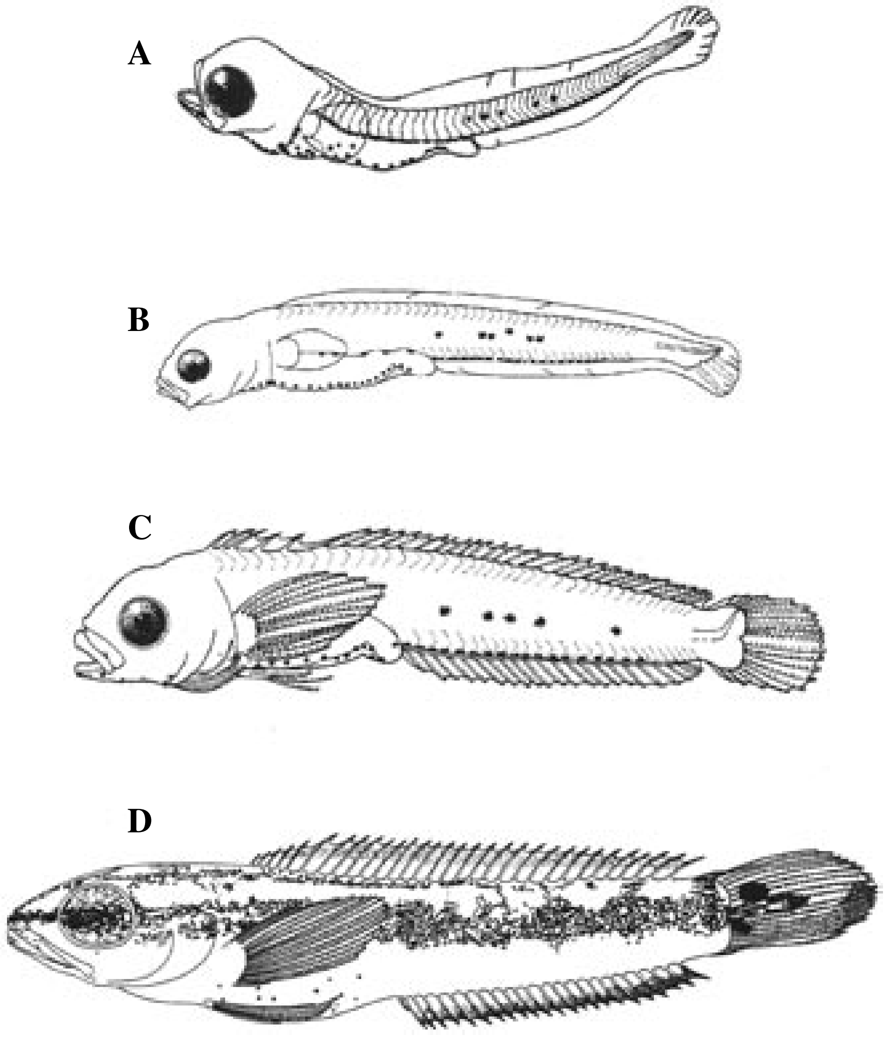

Figure 3

Larvae and posttransition juvenile of *Pseudopercis semifasciata*. (**A**) Preflexion (4.3 mm BL). (**B**) Flexion (8.7 mm BL). (**C**) Postflexion (10.7 mm BL). (**D**) transition juvenile (22 mm BL).

(9–10 mm BL), anal (9–10 mm BL), dorsal (9–10 mm BL), and pelvic (10–11 mm BL). Elements of the caudal fin began forming at flexion stage, and remaining fins at the postflexion stage. By 9–10 mm BL, dorsal (V+26–27) and anal (II+20–22) fin elements reached their full complement.

Description of posttransition juveniles

The posttransition juvenile stage was characterized by the acquisition of complete fin-ray complements and by morphological similarities with the adults (Table 3, Fig. 4). The transition from pelagic to benthic habitat in this species, i.e. settlement, probably occurred at about 20 mm BL because the smallest benthic juvenile of *Pseudopercis semifasciata* reported was 22 mm BL.

Table 3

Body proportions (mean [±SE] and range) of *Pseudopercis semifasciata* posttransition juveniles. BD=body depth; BL=body length; ED=eye diameter; HD=head depth; HL=head length; PAL=preanal length; PDL=predorsal length.

BD/BL×100	HD/BL×100
15.1 ±1.4 (12.7–19.3)	13.8 ±1.5 (11.9–19.3)
PAL/BL×100	ED/BL×100
41.7 ±2.2 (37.7 – 48.0)	8.4 ±1.1 (6.4–11.9)
HL/BL×100	PDL/BL×100
23.0 ±2.4 (17.6–31.6)	27.8 ±1.3 (25.7–30.2)

Individuals became more thick bodied as they developed. The body was elongate and relative body depth remained fairly constant throughout development. The snout was longer and rounded, and relative head length was moderate. The mouth was terminal, reaching to the middle of the eye, and had fleshy lips. Both jaws presented only caniniform teeth. Two opercular spines were also present in all specimens studied. Relative head depth decreased slightly during development, but not relative eye diameter. Gut length was moderate (PAL/BL 0.38–0.48), and the anus was situated near the midpoint of the body (Fig. 3D). Relative predorsal length (0.26–0.30) diminished during development.

The scales were ctenoid. Smaller posttransition juveniles (BL ≤33 mm) retained some of the larval pigmentation pattern. Larger juveniles showed several dark vertical bars, not completely defined at this stage of development, and three horizontal stripes along the body (Fig. 3D). Vertical bars developed progressively from the caudal peduncle to the head. Two lateral stripes formed continuous bands along each side of the body, almost entirely above the midline. The upper stripe developed from the tip of the snout and the lower one began below the eye, both extending to the anterior caudal peduncle. Another stripe developed from the dorsal region of the head between the eyes and extended along the dorsal fin, joining the upper lateral stripe at the posterior third part of the body. In large posttransition juveniles (≥47 mm BL), the membrane of the dorsal fin was pigmented more densely between the spines than between the rays; there were also dark blotches on the membrane between the rays. Anal-fin membranes were more pigmented than those of the dorsal fin. The membranes of the pectoral, pelvic, and caudal fins, and the external border of the membranes of the dorsal fin, were yellow in frozen individuals. By 22 mm BL, the conspicuous dark blotch observed in adult *P. semifasciata* on the base of the caudal fin upper lobe (Herrera and Cousseau, 1996) was already present (Fig. 3D). The pelvic fin was large and slightly shorter than the pectoral fin, whose margin was rounded.

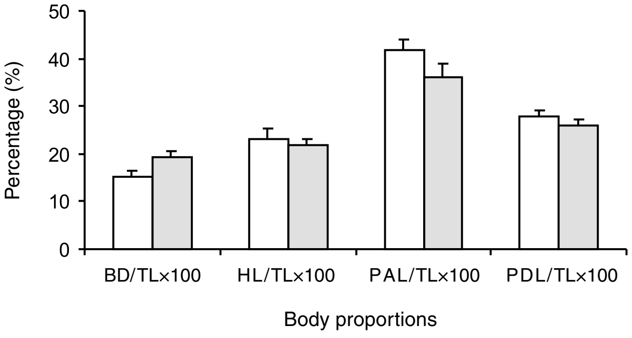

Figure 4

Comparisons between body proportions in posttransition juveniles (white bars) and adults (gray bars) of *Pseudopercis semifasciata*. Relative measures were taken with respect to total length (TL). Body depth (BD), head length (HL), preanal length (PAL), predorsal length (PDL). Proportions for adults were estimated from 99 individuals between <30 cm and 90 cm TL (González, 1998).

Abundance and distribution

Larvae Larvae of Argentine sandperch occurred between 36°42′S and 46°30′S, mainly in coastal waters, in the vicinity of the 50-m isobath (Fig. 5). The southernmost limit where larvae were collected was within San Jorge Gulf, which was surveyed in late March (fall). Larvae were present in only 3.55% of the stations in densities that varied between two and 74 larvae/10 m^2 of sea surface (Table 4). Greater densities (>20 larvae/10 m^2 of sea surface) were obtained in December 1986, 1996, and 1999, off the coast between Engaño Bay and Isla Escondida. Positive stations formed scattered clumps along the whole distributional area of the species. Minimum and maximum depths sampled were 20 and 71 m, respectively. Water temperature at 10 m depth at positive stations varied between 12.3°C (March 1985) and 18.7°C (December 1999) (mean temperature [±SE]: 15.2°C [±2.1°C]).

Posttransition juveniles Posttransition pinguipedid juveniles were found between 42°27′S and 43°37′S in February and March, and between 43°17′S and 44°58′S from April to June, primarily in the vicinity of the 50-m isobath (Fig. 6, A and B). The percentages of positive stations were 5.9% and 7.7% in summer and fall surveys, respectively. Maximum juvenile densities were 4410 individuals/nmi^2 in summer and 27,027 individuals/nmi^2 in fall (Table 5).

The grid of stations used during the summer and fall cruises overlapped (Fig. 6, A and B), covering the main area of concentration of *P. semifasciata* (Otero et al., 1982). Minimum and maximum depths were 54 and 74 m in summer surveys (mean depth [±SE]: 64.5 [±10.0] m), and 34 and 79 m in fall surveys (mean depth [±SE]: 60.4 [±13.7] m). The distributional ellipses calculated for summer and fall from the positive stations were small and widely separated. Maximum summer densities of posttransition pinguipedids were found southeast of Península Valdés, whereas greatest fall densities were detected northeast of Camarones Bay (Fig. 6, A and B).

Discussion

Literature describing the early stages of species belonging to the family Pinguipedidae (formerly Mugiloididae) is scarce. The few available studies refer to the larval development of *Parapercis* spp. (Leis and Rennis, 1983; Watson et al., 1984; Houde et al., 1986; Neira, 1998; Leis and Rennis, 2000) and *Prolatilus jugularis* (Vélez et al., 2003). Larval abundance and distribution have been studied for a few species of *Parapercis* (Houde et al., 1986; Gaughan et al., 1990; Neira et al., 1992) and, more recently, for *Prolatilus jugularis* (Vélez et al., 2003); no information is available for posttransition pinguipedid juveniles.

Larvae of *P. semifasciata* resembled the larvae of other pinguipedids in their gut size, meristics, and general pattern of pigmentation. They differed from *Parapercis* spp. and *P. jugularis* larvae in some relevant features:

- The head had no spines and was less rotund, rather moderate instead of large (HL ranged from 0.17 to 0.30 BL; mean HL/BL=0.22 [±0.02]);
- The body was rather elongate instead of moderate (BD ranged from 0.12 to 0.26 BL; mean BD/BL=0.16 [±0.03]);
- The notochord flexion occurred between 6.2 and 8.7 mm BL, at a relatively large size range compared to that for *Parapercis* spp. (3.7–4.8 mm BL) and to *P. jugularis* (5.7–6.9 mm BL). *Pseudopercis semifasciata* is a larger and more rotund species;
- The finfold was still present in preflexion and flexion larvae.

De Cabo[3] described some osteological, meristic, and morphological characteristics of Argentine Sea pinguipedid larvae. Like De Cabo[3] we found that the first cranial bones that appeared during larval development in *P. semifasciata* were the premaxilla, the dentary and the cleithrum. These structures were already ossified in 3.4 mm BL preflexion larvae. From the adult osteological descriptions by Herrera and Cousseau (1996) and Gosztonyi and Kuba,[2] we determined that the larvae studied were *P. semifasciata*. The only other sympatric species of Pinguipedidae in the Argentine shelf is the Brazilian sandperch (*Pinguipes brasilianus*), which shares several similarities in meristic counts with *P. semifasciata* (Rosa and Rosa, 1987; Herrera and Cousseau, 1996). However, some osteological features from the neuro- and branchiocranium are of great value for identification of larval stages of *P. semifasciata*. The two species could be distinguished by the placement of the first process of the premaxilla, which is perpendicular to the premaxilla in the Argentine sandperch, and back-inclined in the Brazilian sandperch, drawing an acute angle with the premaxilla (Herrera and Cousseau, 1996). The dentary in *P. semifasciata* has a quadrangulate anterior end and a margin almost straight, whereas the margin of the dentary in *P. brasilianus* is oblique (Herrera and Cousseau, 1996). In addition, the head and the teeth patch of the vomer are quadrangulate in *Pinguipes* and triangular in *Pseudopercis* (Herrera and Cousseau, 1996).

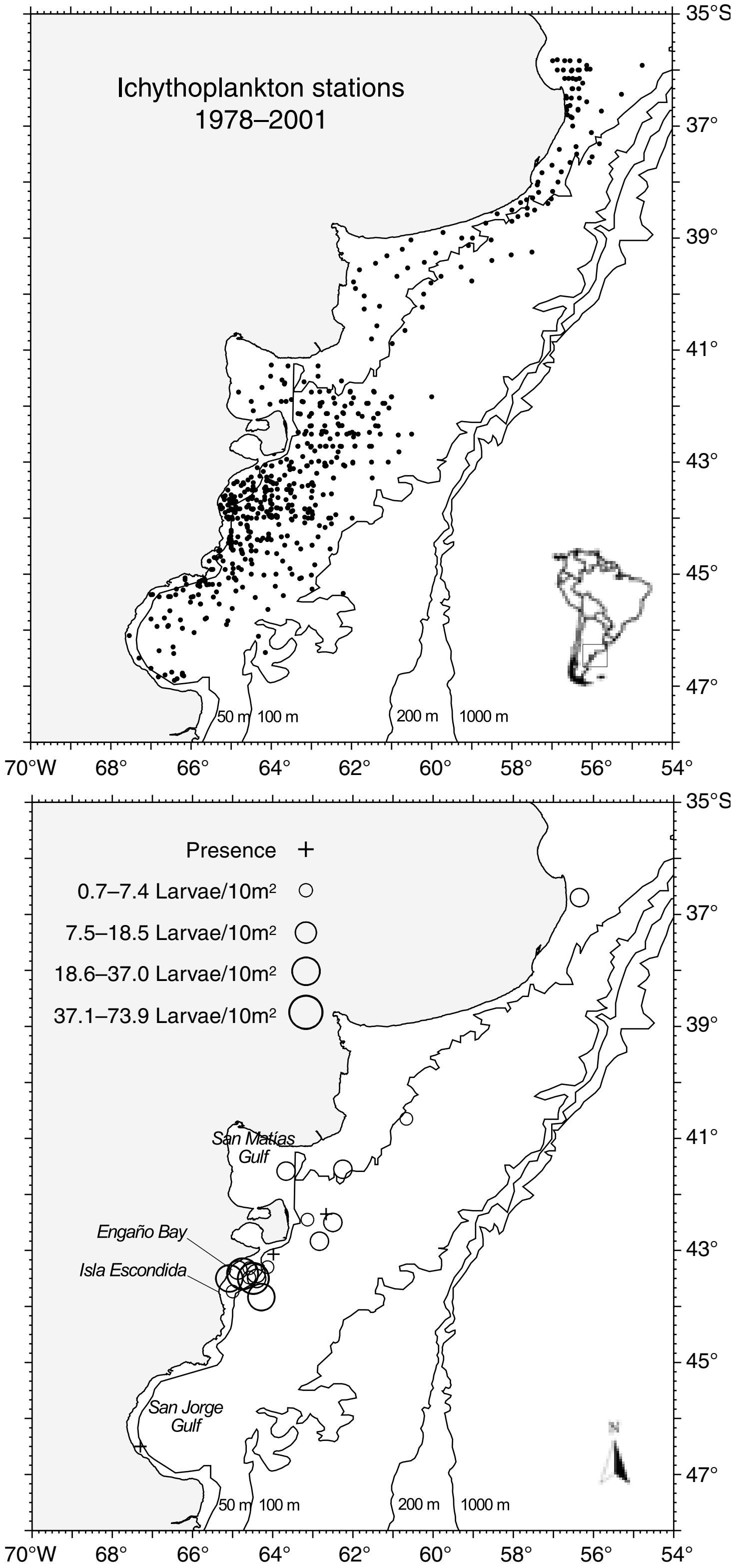

Figure 5

Distribution of ichthyoplankton stations (upper) and *Pseudopercis semifasciata* larvae (lower) in the Argentine Sea in the period 1978–2001. Dot diameter, classified into four categories, is proportional to larval abundance at each station (expressed as larvae/10 m^2 of sea surface).

Table 4

Positive stations for *Pseudopercis semifasciata* larvae in the Argentine Sea, during 1978–2001. Temperature values in parentheses indicate that only surface temperature was registered. W/d=missing data.

Cruise	Date	Sampler	Lat. S	Long. W	Abundance (larvae/10 m^2 of sea surface)	Water temperature (at 10 m depth)	Depth (m)
SM-IX	28 Dec 1978	Bongo	42°27′	63°08′	7.36	w/d	70
EH-05/82	22 Nov 1982	Bongo	40°39′	60°40′	5.85	(12.8)	53
EH-01/83	21 Jan 1983	Bongo	43°44′	65°00′	4.82	16.7	52
OB-02/85	30 Mar 1985	Bongo	46°30′	67°18′	Presence	12.3	56
OB-07/86	20 Dec 1986	Nackthai	43°25′	64°45′	73.91	14.2	34
OB-07/86	20 Dec 1986	Nackthai	43°50′	64°17′	19.78	14.0	47
OB-01/86	22 Jan 1986	Nackthai	41°33′	62°15′	13.76	18.7	45
OB-01/86	22 Jan 1986	Nackthai	41°35′	63°40′	8.64	17.6	51
OB-07/91	02 Nov 1991	Nackthai	36°42′	56°21′	15.33	w/d	20
OB-14/95	12 Dec 1995	Pairovet	43°04′	63°59′	Presence	13.0	65
EH-17/96	15 Dec 1996	Nackthai	43°30′	65°05′	23.92	14.3	24
OB-10/98	10 Dec 1998	Nackthai	42°21′	62°40′	Presence	w/d	66
OB-09/99	12 Dec 1999	Nackthai	43°21′	64°52′	17.22	(14.6)	20
OB-09/99	12 Dec 1999	Nackthai	43°30′	64°29′	41.00	(21.0)	49
OB-14/00	11 Dec 2000	Bongo	43°19′	64°35′	1.81	(12.8)	37
OB-14/00	11 Dec 2000	Bongo	43°30′	64°24′	8.44	13.8	52
EH-01/01	26 Jan 2001	Bongo	43°29′	64°35′	2.51	15.9	47
OB-02/01	16 Feb 2001	Bongo	43°18′	64°08′	5.20	15.8	59
OB-13/01	10 Nov 2001	Bongo	42°30′	62°30′	9.30	w/d	71
OB-13/01	11 Nov 2001	Bongo	42°50′	62°55′	9.36	w/d	71
OB-13/01	13 Nov 2001	Bongo	43°25′	64°49′	7.99	w/d	38

The modal number of myomeres (36–38; n=47) in *P. semifasciata* larvae matched the number of vertebrae reported for adults (36–37; n=50) by González (1998). The dorsal and anal fin elements reached their full complement by 9–10 mm BL, whereas the caudal-, pelvic-, and pectoral-fin elements were still incomplete in the size range analyzed in this study (3.3 to 11.7 mm BL). *Pseudopercis semifasciata* and *P. brasilianus* posttransition juveniles differ in their head shape, pigmentation pattern, and in the number of spines of the dorsal fin. The snout is larger in the Brazilian sandperch and the dorsal profile of the head is less convexly shaped than in *P. semifasciata*. These head shape differences increased with size. In *P. brasilianus*, the lateral stripes were less conspicuous than in *P. semifasciata*, and the vertical bars appeared earlier in the development (seven vertical bars were present in *ca*. 50 mm BL individuals). Furthermore, vertical bars in *P. semifasciata* were more defined at the base of the dorsal fin, whereas they extended below the midline in *P. brasilianus*. *Pseudopercis semifasciata* had five dorsal-fin spines, and *P. brasilianus* had seven spines, both in the range reported by Herrera and Cousseau (1996).

Both the epibenthic sampler and the "Piloto" trawl used to collect juveniles sample the fauna from the bottom to approximately one meter above the bottom. The fact that juveniles were caught in the lowest strata of the water column indicates that juveniles had settled to benthic habitat, even though the *P. semifasciata* posttransition juveniles still conserved some larval pigmentation, had not completely developed adult pigmentation pattern, and had already acquired morphological proportions similar to adults.

Even though the abundance and distribution data used in our study came from cruises that targeted other species, they provide satisfactory spatiotemporal coverage. This was particularly true for the ichthyoplancton surveys, which covered a great portion of the distributional area of *P. semifasciata* in the northern Patagonian shelf, mainly during the peak of the reproductive season (November–December). Among the Piloto positive stations (n=20), *P. brasilianus* was found by itself only at three stations. Also, *P. brasilianus* was far less abundant than *P. semifasciata* posttransition juveniles in the trawl samples. As a consequence, we consider that the abundance and distribution patterns of posttransition pinguipedid juveniles adequately reflect the abundance and distribution of *P. semifasciata* posttransition juveniles in the Argentine shelf.

The abundance and distribution of *P. semifasciata* larvae and posttransition juveniles indicate the presence of at least three main reproductive grounds, one

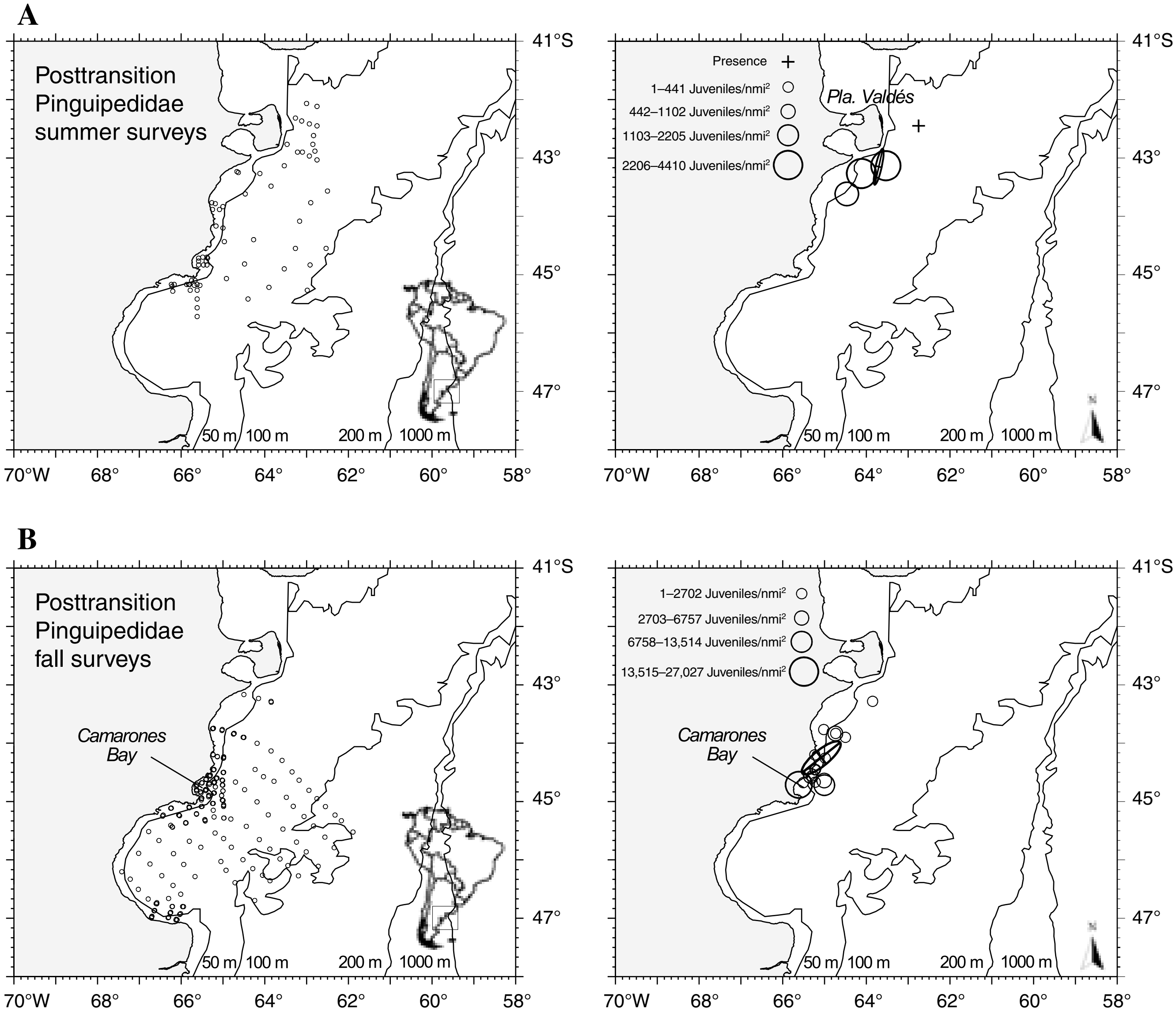

Figure 6

Distribution of "Piloto" or epibenthic sampler stations (left) and Pinguipedidae posttransition juveniles (right) in the Argentine Sea by season. (**A**) Summer surveys. (**B**) Fall surveys. Dot diameter, classified into four categories, is proportional to posttransition juvenile abundance at each station (expressed as no. of juveniles/nmi^2).

located off Peninsula Valdés (42–43°S, 63°W), another off the coast between Engaño Bay and Isla Escondida (43–44°S, 64°W to the coast), and the third off northeastern Camarones Bay (44–45°S, 65°W to the coast). These areas are linked to a frontal zone, the Northern Patagonia frontal system, which is highly productive during the spring and summer and could offer retention mechanisms for larvae (Bogazzi et al., in press). In December 1978, Argentine sandperches of both sexes were observed running near Isla Escondida (Ehrlich, personal observ.). In addition, Elías and Burgos (1988) reported great concentrations of Argentine sandperches off Península Valdés (42–44°S) between October and December, based on commercial fishery data for the period 1981–88. These reproductive grounds are consistent with the principal areas of summer concentration described by Otero et al. (1982). Furthermore, Elías and Burgos (1988) attributed the decline in yields and average size observed in January and February to the dispersal of postspawning individuals. However, initial results from an ongoing tag-recapture program in San José Gulf indicate that this species may have a high site fidelity and a limited dispersal (Venerus et al., 2003). In this case, the declines in yield and average size as the fishing season progresses could be a consequence of the fishing effort itself. Macchi et al. (1995) detected a decrease in the proportion of females in January, which also may imply an emigration from the reproductive sites.

Table 5

Positive stations for posttransition pinguipedids in the Argentine Sea, during 1992–2001. The "Species" column show the categories assigned in the survey reports. Underlined items in the "Abundance" column indicate that some or all of the specimens were preserved and at least one individual was correctly identified as *Pseudopercis semifasciata*. EBS= epibenthic sampler.

Cruise	Date	Season	Sampler	Lat. S	Long. W	Species	Abundance (individuals/nmi^2)	Depth (m)
EH-02/92	18 Mar 1992	Summer	EBS	42°27′	62°45′	*Pseudopercis*	Presence	71
OB-02/01	14 Feb 2001	Summer	Piloto trawl	43°08′	63°32′	Both	4409.5	74
OB-02/01	16 Feb 2001	Summer	Piloto trawl	43°16′	64°07′	Pinguipedidae	2572.2	59
OB-02/01	17 Feb 2001	Summer	Piloto trawl	43°37′	64°28′	Pinguipedidae	1286.1	54
EH-04/98	07 Apr 1998	Fall	Piloto trawl	44°40′	65°13′	*Pseudopercis*	1492.6	74
EH-04/98	07 Apr 1998	Fall	Piloto trawl	44°43′	65°00′	*Pseudopercis*	10,204.1	79
EH-04/98	07 Apr 1998	Fall	Piloto trawl	44°38′	65°01′	*Pseudopercis*	4761.9	78
EH-04/98	07 Apr 1998	Fall	Piloto trawl	44°34′	65°20′	*Pseudopercis*	3448.3	52
EH-04/98	07 Apr 1998	Fall	Piloto trawl	44°28′	65°14′	*Pseudopercis*	1587.3	61
EH-04/99	28 May1999	Fall	Piloto trawl	44°12′	65°14′	*Pseudopercis*	1449.3	34
EH-04/99	28 May1999	Fall	Piloto trawl	43°50′	64°44′	*Pinguipes*	1315.8	64
EH-04/99	29 May1999	Fall	Piloto trawl	43°54′	64°30′	*Pinguipes*	1265.8	65
EH-04/99	29 May1999	Fall	Piloto trawl	43°17′	63°51′	*Pseudopercis*	1250.0	73
OB-05/00	11 Jun 2000	Fall	Piloto trawl	44°27′	65°13′	*Pinguipes*	2631.6	64
OB-05/00	11 Jun 2000	Fall	Piloto trawl	44°34′	65°19′	*Pseudopercis*	1250.0	58
OB-05/00	11 Jun 2000	Fall	Piloto trawl	44°41′	65°31′	*Pseudopercis*	1351.4	43
OB-05/00	11 Jun 2000	Fall	Piloto trawl	44°43′	65°37′	Both	27,027.0	38
OB-05/00	15 Jun 2000	Fall	Piloto trawl	44°15′	64°59′	*Pinguipes*	1449.3	72
OB-05/00	18 Jun 2000	Fall	Piloto trawl	43°50′	64°44′	Both	5194.8	59
OB-05/00	18 Jun 2000	Fall	Piloto trawl	43°46′	65°01′	*Pseudopercis*	1388.9	52

The low number of positive stations in spite of the intense sampling conducted within the area of distribution of *P. semifasciata* suggests a reduced spawning site. Both the area off Península Valdés and the one near Isla Escondida have rocky bottoms, which complicates trawling operations. A few experienced captains were able to target *P. semifasciata* by trawling along sandy corridors between rocky outcrops off Peninsula Valdés during the reproductive season (Elías[4]). Likewise, where running Argentine sandperches were observed near Isla Escondida, trawling is possible only in one orientation (Ehrlich, personal observ.). This could indicate that spawning grounds are associated with rocky outcrops. Spawning associated with rocky reefs and the existence of chromatic sexual dimorphism is compatible with Macchi et al.'s (1995) and González's (1998) suggestions of a complex mating system involving sexual courtship.

Spawning activity of *P. semifasciata* in northern Patagonia (42–44°S) peaks in November and December (Elías and Burgos, 1988; Macchi et al., 1995), and in October within San Matías Gulf (González, 1998). Maximum densities of larvae (>20 larvae/10 m^2 of sea surface) were found in December 1986, 1996, and 1999. The temperature at 10 m depth at positive ichthyoplankton stations varied between 12.3°C and 18.7°C. Such a wide range of temperature reflects the wide latitudinal range in the distribution of *P. semifasciata* and the extended time period (November–March) in which larvae were collected.

Posttransition pinguipedid juveniles were mainly collected at depths between 60 and 65 m, in both seasons sampled (summer and fall). A total of seven *P. semifasciata* juveniles ranging in total length from 66 to 82 mm were collected in fall (June), near the northern coast of San Matías Gulf (40°58′S–41°00′S; 64°18′W–64°24′W), at 29–54 m depth, associated with rib mussel beds (*Aulacomya ater*) (González[5]). Our distributional data indicate that settlement and nursery grounds could be located near shore. The absence of posttransition juveniles off northeast of Camarones Bay during summer and their presence in the fall could be a consequence of a delayed spawning pulse in the southern stocks. Some independent observations support this hypothesis: 1) back-calculations of hatching date based on daily growth increments from 19 post-

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[4] Elías, I. 2004. Personal commun. Centro Nacional Patagónico, Puerto Madryn, Chubut, Argentina.

[5] González, R. A. C. 2004. Personal commun. Instituto de Biología Marina y Pesquera "Alte. Storni," San Antonio Oeste, Río Negro, Argentina.

transition juveniles collected in northeast Camarones Bay, between 43°50′S and 44°43′S, indicated birth dates between February and March (Venerus and Brown, 2003); 2) the collection of one *P. semifasciata* larva in San Jorge Gulf (46°30′S 67°18′W) on 30 March 1985; and 3) macroscopic observations of the ovaries from 24 mature females angled near Islas Blancas, Camarones Bay (ca. 44°46′S 65°38′W) on 26 and 27 January 2002, most of which (58.3%) were in the late developing stage (n=4) or in the gravid and running stage (n=10) (macroscopic maturation stages *sensu* González, 1998). This delayed spawning pulse in the southern stocks apparently follows the annual cycle of seawater warming on the Argentine shelf (Ciancio[6]). Similar delays have been reported for the Argentine hake (*Merluccius hubbsi*) (Pájaro and Macchi[7]; Machinandiarena et al.[8]).

Further investigations focused on the seasonal distribution of spawners are needed to confirm the existence of spawning aggregations indicated by the presence of larvae and posttransition juveniles. Mark-recapture and telemetry studies could be used to investigate the spatial dynamics of reproductive activity of this species in the Argentine Sea. Given the relative sedentary habits of adult Argentine sandperches, the use of reproductive refuges appear *a priori* to provide a suitable approach to protect this species.

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