Progress in the oceanographic knowledge of Chilean interior waters, from Puerto Montt to Cape Horn.
N. Silva & S. Palma (eds.). 2008
Comité Oceanográfico Nacional - Pontificia Universidad Católica de Valparaíso, Valparaíso, pp. 115-120.

7.2. Ichthyoplankton in the austral Chilean channels and fjords

Fernando Balbontín
Facultad de Ciencias del Mar y de Recursos Naturales. Universidad de Valparaíso.
E-mail: fernando.balbontin@uv.cl

Highly diverse and abundant fish larvae were found in the austral Chilean channels and fjords (Fig. 1) during the CIMAR 1 to 4 Fiordos cruises, which began in 1995. Previous research on ichthyoplankton was restricted to Fiordo Aysén and culminated with the publication of diagrams of the most common zooplankton organisms (Zama & Cárdenas, 1984a) and their seasonal variations in abundance (Zama & Cárdenas, 1984b). The region's physical and chemical components are highly dynamic and its complex, estuarine-type circulation results in low salinity values near the fjord heads. Salinity increases progressively closer to the areas where the channels are connected to the exterior (Silva *et al.*, 1997; Guzmán & Silva, 2002; Silva & Calvete, 2002; Valdenegro & Silva, 2003). In estuaries and fjords, larval transportation and retention processes are extremely important, determining which areas are appropriate for breeding so as to avoid transport of the early stages into the oceanic zone through the net water flux. These conditions, along with the reproductive strategies of the fish and the biological processes taking place after spawning, are crucial for larval survival (Epifanio & Garvine, 2001; Hickford & Schiel, 2003).

Using the results obtained from the CIMAR cruises, important changes were detected in the ichthyoplankton composition and abundance associated with latitude; see Figure 2 for some components. Many species such as the deep-sea smelt *Bathylagichthys parini*, the hoki (*Macruronus novaezelandiae magellanicus*), the rockfish (*Sebastes capensis*), species of *Notothenia* from the family Nototheniidae, and a big-eyed flounder species of *Hippoglossina* were found to have wide geographic distributions covering the entire austral area. Nonetheless, species richness clearly tended to decrease from north to south. In fact, 42 species were found between Puerto Montt and Laguna San Rafael (northern zone) during the CIMAR 1 Fiordos and CIMAR 4 Fiordos Stage 1 (spring) and Stage 2 (summer) expeditions; 23 species were found from Golfo de Penas to Strait of Magellan (central zone) during the CIMAR 2 Fiordos cruise; and only 13 species were found between Strait of Magellan and Cape Horn (southern zone) during the CIMAR 3 Fiordos cruise. These species are presented in Table I; other unidentified larvae caught during these campaigns are not included in the table. The larvae of the rockfish are not only widely distributed, but also stand out for their abundance and frequency. The reproductive strategy of this viviparous fish species is similar to that of the brotula (*Cataetyx messieri*) (Landaeta *et al.*, 2008) but different from the rest of the species captured in these studies, as it was highly abundant in spring and summer (Table I) and most frequent (73%) during the CIMAR 1 Fiordos cruise. As the rockfish larvae develop, they locate themselves in different areas of the channels according to food availability and the area's hydrography (Landaeta & Castro, 2006). Some species caught in the southern zone were also distributed in the Atlantic Ocean sector (Bernal & Balbontín, 2003). The Atherinopsidae family was represented by two forms: *Odontesthes regia* (northern zone) and *O. smitti* (southern zone), whose distribution probably continued towards the Argentinean Patagonia (Dyer & Gosztonyi, 1999).

A comparison of the results from the CIMAR 4 Fiordos spring and summer cruises showed that most species (26 morphotypes) reproduce in spring, whereas only 13 morphotypes reproduce in summer. The total larval abundance in spring was eight times higher than in summer (Balbontín & Bernal, 2005). It is interesting to note the presence of larvae and/or eggs of the mesopelagic fishes *Bathylagichthys parini* and *Maurolicus parvipinnis*

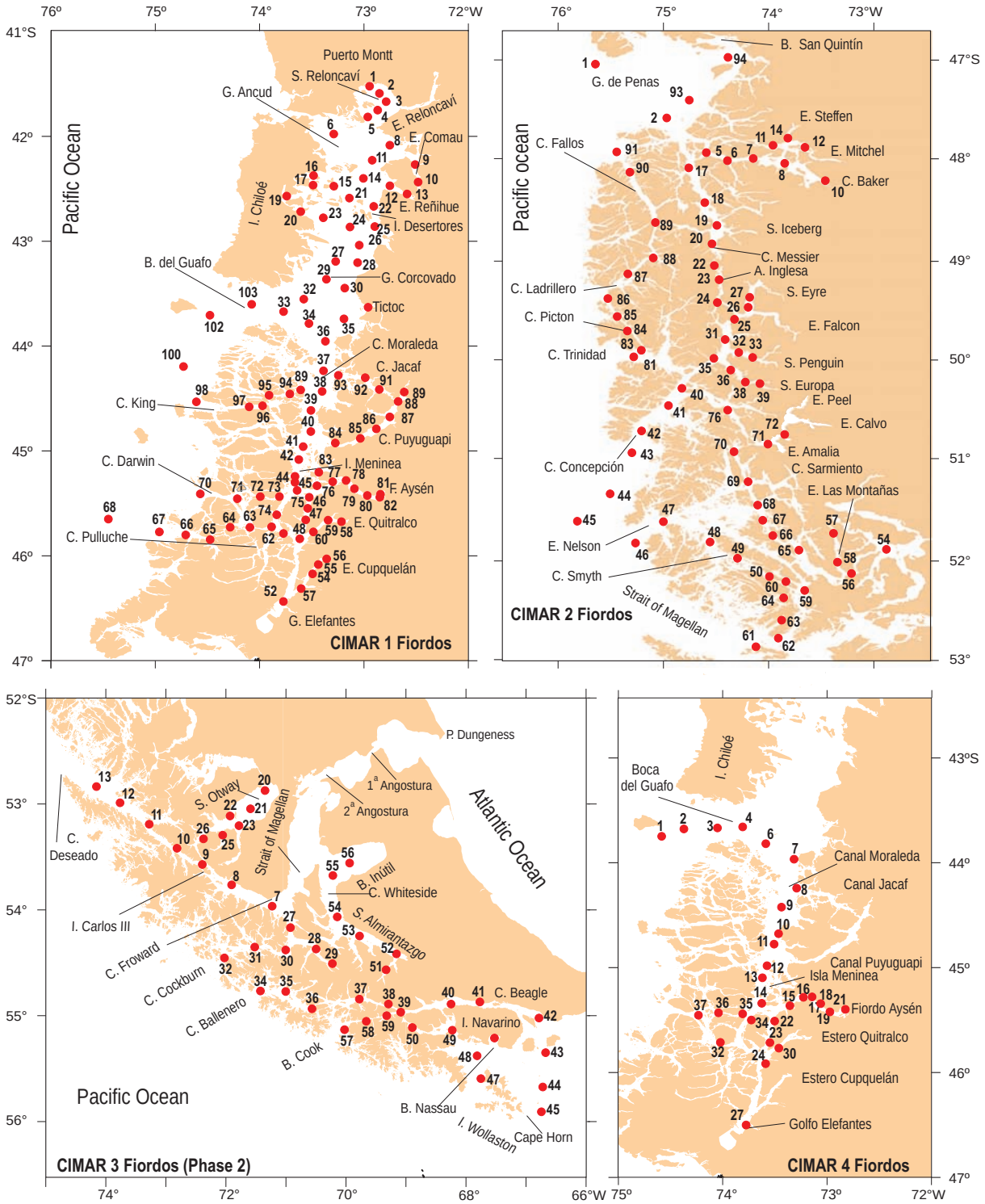

Figure 1: Geographic position of the sampling stations for the ichthyoplankton studies.

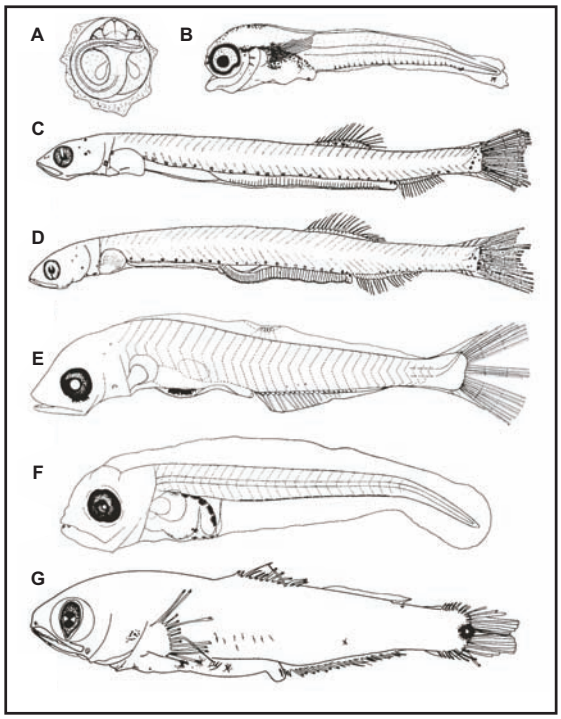

Figure 2: Fish eggs and larvae found in the study area. a) *Hypsoblennius sordidus* demersal egg and b) larva (7.2 mm TL) (taken from Balbontín & Pérez, 1979); c) common sardinae (*Strangomera bentincki*) 18.0 mm SL larva; d) anchoveta (*Engraulis ringens*) larva (19.3 mm SL) (taken from Orellana & Balbontín, 1983); e) *Maurolicus parvipinnis* larva (9.8 mm SL) (original); f) rockfish (*Sebastes capensis*) larva (4.4 mm SL) (original); and g) *Hygophum bruuni* larva (13.0 mm SL) (adapted from Balbontín & Orellana, 1983); TL: total length, SL: standard length.

in the shallow waters of the interior parts of the channels (Table I). These species migrate through the water column and occupy wide areas of the eastern South Pacific. *M. parvipinnis* has even reached the Archipiélago Juan Fernández (Kobyliansky, 1990; Parin & Kobyliansky, 1996). The relative larval abundance for these species was moderate to high. Larvae of *M. parvipinnis* had the highest average value of all the species caught during the CIMAR 1 Fiordos cruise, with 112.1 larvae per 10 m^{-2}, and a frequency of occurrence of 58%. *B. parini* was moderately abundant but widely distributed, occurring from Seno Reloncaví to Canal Beagle, reflecting its successful adaptation to the channel environment (Uribe & Balbontín, 2005).

Several of the species that make up the pelagic small fish fisheries and the austral demersal fishery develop their first life stages in the channels and fjords. In the northern zone, the common sardine (*Strangomera bentincki*) had the second most abundant averages, especially during the spring CIMAR 4 Fiordos cruise (101.2 larvae per 10 m^{-2}). In the summer CIMAR 4 Fiordos cruise, larvae of the anchoveta *Engraulis ringens* were the most abundant (22.1 larvae), thus expanding the species' known spawning area. *E. ringens* larvae were not found farther south, where the Falkland sprat (*Sprattus fueguensis*), a species from the order Clupeiformes, was the most abundant species (CIMAR 2 Fiordos cruise; 151.4 larvae per 10 m^{-2}). When considering the larvae of the austral demersal fishery species (Balbontín *et al.*, 2004), the hoki was widely distributed throughout the study area and had high average abundances, especially during the CIMAR 3 Fiordos cruise (69.5 larvae and a frequency of 25%); however, this species was not found in the interior fjords (Balbontín & Bernal, 1997). The larvae of the southern hake (*Merluccius australis*) had lower average abundances (18.1 larvae during the CIMAR 1 Fiordos cruise) than did the hoki and were restricted to the northern and central zones, although eggs of this species were sometimes located near the fjord heads in low-salinity waters (Silva *et al.*, 1997). This spawning corresponded to resident stocks or migrating adult fish from the oceanic zone that use the area as a nursery for their larvae (Bustos *et al.*, 2006).

The multidisciplinary data generated in recent years on the austral channels and fjords, whose chemical and physical components have highly complex dynamics, provide valuable information about the environment, as do studies of the organisms that live permanently or temporarily (staying in the interior zones for their first life stages) in these areas. Given these results, it can be concluded that the conditions in many channels are favorable for larval growth and protection. The austral channel and fjord region is one of the least studied areas in Chile. However, its great potential for economic development requires that it be subjected to constant environmental evaluations in order to avoid its deterioration.

Table I: Reproductive strategies of the most common fish species found in the austral channels and fjords; and average larval abundances in the northern (Balbontín & Bernal, 1997, 2005), central (Bernal & Balbontín, 1999), and southern zones (Bernal & Balbontín, 2003). References for egg types come from Fischer (1963), Balbontín & Pérez (1979), Brownell (1979), Moreno (1980), Ciechomski & Booman (1981), Moser *et al.* (1984), Herrera *et al.* (1987), Patchell *et al.* (1987), Sánchez & Acha (1988), Cárdenas & Pequeño (1990), and Moser (1996). Average larval abundances were expressed on a scale of 0.1 to 17 (+), 18 to 64 (++), and more than 64 (+++). Cruises are ordered from north to south.

Scientific name	English common name	Chilean common name	Kind of egg	Larval abundance				
				Spring 1995	Spring 1998	Summer 1999	Spring 1996	Spring 1998
				CF 1	CF 4	CF 4	CF 2	CF 3
				North →				South
Strangomera bentincki	common sardine	sardina común	pelagic	+++	+++	+		
Sprattus fueguensis	Falkland sprat	sardina fueguina	pelagic				+++	+++
Engraulis ringens	anchoveta	anchoveta	pelagic		+	++		
Bathylagichthys parini	deep-sea smelt	eperlán negro	pelagic1	++	++	+	+	+
Maurolicus parvipinnis	pearlside	pez hacha	pelagic	+++	++	+	++	
Hygophum brunni	lanternfish	pez linterna	pelagic1	+				
Ptrotomyctophum chilensis	lanternfish	pez linterna	pelagic1	+				
Lampanyctodes hectoris	lantenifish	pez linterna	pelagic1	+	+			
Notoscopelus sp.	lantenifish	pez linterna	pelagic1				+	
Myctophidae 1	lantenifish	pez linterna	pelagic1		+		+	
Coryphaenoides sp.	grenadier	pejerrata	pelagic		+			
Caelorhynchus sp.	grenadier	pejerrata	pelagic	++	+		+	
Salilota australis	tadpole codling	brótula	peagic1	+				
Merluccius australis	southern hake	merluza del sur	pelagic	++	+	+	+	
Macruronus novaezelandiae magellanicus	hoki	merluza de cola	pelagic	++	+++		+	+++
Micromesistius australis	southern blue whiting	merluza de tres aletas	pelagic				+	
Cataetyx messieri	brotula	brótula de La Patagonia	viviparous	+				+
Genypterus sp.	cusk eel	congrio dorado	pelagic	+	+			
Atherinopsidae	silverside	pejerrey	demersal	+	+	+	+	
Leptonotus blainvillianus	deep-bodied pipefish	aguja de mar	incubation	+	+	+		
Sebastes capensis	rockfish	cabrilla	viviparous	++	++	+	++	+
Congiopodus peruvianus	horsefish	pez chancho	pelagic	+				
Agonopsis chiloensis	poacher	pez acorazado	demersal1	+	+			+
Normanichthys crockeri	mote sculpin	mote	pelagic	+			+	
Liparidae	snailfish	pez babosa	demersal1	+				
Paraliparis anarthractae	snailfish	pez babosa	demersal1					+
Helcogrammoides cuninghami	triplefin	trambollito	demersal1	+	+	+		
Blenniidae	blenny	torito, doncella	demersal1					+
Hypsoblennius sordidus	blenny	cachudito	demersal	+	+	+		
Nototheniidae	cod icefish	nototenias	demersal	+	++		+	++
Harpagifer bispinnis	spiny plunderfish	diablito	demersal					+
Seriolella sp.	warehou	cojinoba	pelagic	+	+	+	+	
Stromateus stellatus	butterfish	pampanito	pelagic	+		+	+	
Hippoglossina sp.	big eye flounder	lenguado	pelagic	+	+	+	+	+

[1] Common charactheristics of the Genus or Family.

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