Korean Journal of Polar Research
Volume 4(2): 61-66, 1993

Vertical Distribution and Abundance of *Pleuragramma antarcticum* (Pisces: Nototheniidae) on a 24 Hour Station in Gerlache Strait

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Water salinity, temperature profiles and plankton samples were taken in February 1993 at 2 h intervals in Gerlache Strait (64°13′ 10″S, 61°19′ 50″W) over a 24 h period from the following depths: 400-200, 200-150, 150-100, 50-20, 20-0 m. The most abundant fish larvae were *Pleuragramma antarcticum*, which were mainly found between 100-50 m and in relatively warm waters (>0°C). There were no significant changes in the water column during the study period. The larvae did not show any ontogenic correlation of length with depth though there was a significant correlation between abundance and depth: larval abundance at specific depths showed clear variations over a 24 h period. The larvae were only found at shallower depths (0-50 m) at sunset and sunrise. During the night, they were concentrated between 50-100 m and between 100-150 m during the day. The possible causes of the diurnal migration were not clear. *Pleuragramma antarcticum* feeds mainly on copepods which do not show diel migrations, though *P. antarcticum* follows the general migratory trend of plankton.

Key words: Antarctic silverfish, diel migration, Gerlache Strait

INTRODUCTION

One of the few pelagic notothenioid fishes of the southern ocean is *Pleuragramma antarcticum* whose distribution is circum-Antarctic but restricted to waters of high latitudes close to the continent and adjacent islands (Permitin, 1977; Kellermann, 1986). *Pleuragramma antarcticum*, the Antarctic silverfish, may be the most abundant fish species in high Antarctic waters. In the southern Weddell Sea, adult concentrations are as high as 1 ton·km^{-2} and post-larvae dominate the ichthyoplankton numerically, forming some 85-95% (Hubold, 1985). In the eastern Weddell Sea, *P. antarcticum* overwhelmingly dominated catches, comprising 84.5% of the larvae caught (White and Piatkowski, 1993). In the Antarctic Peninsula area, the larval fish assemblage associated with water flowing from the Weddell Sea is typically dominated by *P. antarcticum* (Kellermann, 1989). In the West Antarctic Peninsula and Gerlache Strait, *P. antarcticum* is abundant during summer, presumably being adverted with Bellingshausen Sea waters (Kellerman, 1989; Loeb, 1991).

Pleuragramma antarcticum is recorded as occurring between 0 and 70 m over the shelf and at 70-200 m beyond the shelf-break front in the Weddell Sea (White and Piatkowski, 1993). The Bransfield Strait and adjacent waters represent nursery grounds for the early stages of *P.antarcticum*, where it occurs in the top 200 m layer (Kellermann, 1986). In the Gerlache Strait, it is relatively uncommon (Loeb, 1991).

Some studies have been conducted on the diel periodicity of krill (Morey, 1976; Huntley and Escritor, 1991) but little is known about the diel vertical distribution of fish larvae (North and Murray, 1992). This paper describes the vertical distribution of fish at a diel station located at the northern mouth of Gerlache Strait in an attempt to provide some clues on fish larvae distribution patterns and their relationships with environmental variables.

MATERIAL AND METHODS

The study was made during the Antarctic summer (February 1993) and samples were taken at one 24 hour station in the Gerlache Strait (64°13′ 10″S, 61°19′ 50″W). Six depths (400-200, 200-150, 150-100, 100-50, 50-20, 20-0 m) were sampled at 2 hourly intervals over a 24 h period.

The water column was sampled within discrete layers by using a multinet which included seven 350 μm nets with electronically-triggered opening and closing mechanisms (Bioness multinet). The net logged CTD data, salinity and temperature, flows and net pitch at two second intervals. Standard procedure was to lower the net below the greatest sampling depth for the station, and to make an oblique ascending tow, opening the nets at appropriate depths. Before each haul, a vertical profile of temperature, salinity and conductivity was obtained with a CTD Mark-III.

Larval and juvenile fish were separated from the plankton samples immediately after each haul. Each larva was measured whilst fresh and identified according to Efremenko (1983) and North and Kellermann (1990).

Abundance estimates of larval fish were standardized to 1000 m^3 of seawater for each depth range. The swept water volume for each net was determined from calibrated flowmeters and adjusted for the effect of pitch on the net frontal area.

The salinity and temperature profiles of each haul were plotted for the CTD and the net CTD. Given that the Bioness CTD was not calibrated, values are approximate and are used for comparison of the hydrographic conditions for each haul.

RESULTS

Physical Oceanography

The upper 100 m of the water column was relatively warm: > 0°C, reaching around 1.5°C at the surface. Between 100-200 m, the temperature was slightly more than 0°C (Fig. 1). The salinity was around 32.7‰ at the surface, increasing with depth to 34.5‰ at 400 m. The thermocline was located at around 45 m, tending to become shallower towards the end of the study period. The halocline was always below 50 m deep and oscillated slightly, becoming deeper during the night. The periodicity of the oscillations suggested that they might be caused by a tidal wave (M. Garcia, pers. comm.).

The data from the CTD and the net CTD showed little change in the physical structure of the water column during the period of sampling (Fig. 1). Thus, there was no physical barrier causing the variation in larval distribution.

Fish Larvae Abundance

Fish larvae were relatively uncommon. Six species were determined from the samples: 5 Nototheniidae and one Paralepidid (Table 1). Two hauls were negative yielding none and only 75 larvae were caught at the 24 h station. The most abundant and frequent species was *Pleuragramma antarcticum* Boulenger 1902, forming 70.7% of all fish larvae caught and appearing in all the hauls which yielded any such larvae. The next most important species (by abundance) was *Notothenia kempi* which formed some 21.3% of the larvae (Table 1). With the exception of *Notolepis coatsi*, all fish larvae were found between 150 m and the surface.

Vertical Distribution

Pleuragramma antarcticum was most abundant between 100-50 m (mean abundance 10.95 larvae 1000/m^3). Following this was the 150-100 m layer (mean abundance 6.2 larvae 1000/m^3). Some fish were found in shallower waters—mainly between 50-20 m (2.84 larvae 1000/m^3)—and were found only between 0-20 m at night. The abundance was related to depth (one way-ANOVA, $F = 2.701 > F_{05,18}$).

The evolution of depth-related *Pleuragramma antarcticum* abundances over the 24 h study period showed clear variations (Fig. 2). The fish larvae were found in waters less than 50 m deep at sunset and sunrise. During the night, they were concentrated between 50-100 m but moved to deeper waters during the day.

Length Distribution

Pleuragramma antarcticum length distribution differs significantly according to depth (one way-ANOVA, $F = 0.936 > F_{05,45}$). A broader length range was found between 50 and 100 m depths, though larger fish were located at between 20-50 m (Fig. 3). The reported vertical ontogenic separation

Table 1. Larval fish abundance in absolute numbers (N) for each depth layer and haul at a 24 h station in the Gerlache Strait. N x 1000/m³ mean relative abundance by depth layer

Haul	Depth layer (m)	Species	N	N x1000/m³
343	400 - 200	*Notolepis coatsi*	1	1.45
343	150 - 100	*P. antarcticum*	3	12.89
343	20 - 0	*Notothenia nudifrons*	1	4.46
344	150 - 100	*P. antarcticum*	3	5.36
344	100 - 50	*P. antarcticum*	1	2.82
345	150 - 100	*P. antarcticum*	1	1.37
345	100 - 50	*P. antarcticum*	5	11.98
345	100 - 50	*Trematomus scotti*	1	2.40
345	50 - 20	*P. antarcticum*	1	2.59
346	100 - 50	*P. antarcticum*	4	11.67
346	50 - 20	*P. antarcticum*	1	3.09
346	20 - 0	*P. antarcticum*	1	5.54
347	150 - 100	*P. antarcticum*	1	4.09
347	100 - 50	*P. antarcticum*	6	21.35
347	50 - 0	*T. scotti*	1	3.31
348	150 - 100	*P. antarcticum*	2	4.80
348	100 - 50	*P. antarcticum*	5	15.65
348	100 - 50	*Nototheniops larseni*	1	3.13
349	150 - 100	*P. antarcticum*	3	8.69
349	100 - 50	*P. antarcticum*	2	6.62
349	50 - 20	*N. larseni*	1	3.59
350	100 - 50	*P. antarcticum*	5	17.16
350	20 - 0	*Notothenia kempi*	1	6.22
351	150 - 100	*P. antarcticum*	1	2.33
351	100 - 50	*P. antarcticum*	7	17.30
351	100 - 50	*N. kempi*	13	32.12
351	50 - 20	*N. kempi*	1	3.72
352	100 - 50	*P. antarcticum*	1	3.36
352	100 - 50	*N. kempi*	1	3.36

with a progressive increase in mean length with depth (Hubolt, 1985) was not detected in this study.

DISCUSSION

The data show that *Pleuragramma antarcticum* was the most abundant species which occurred mainly in the upper 50-150 m of the water column at temperatures over 0°C. The fish larvae caught between 0-20 m could be underestimated, partly because of the disturbance created by the ship, especially the propeller wash which would naturally cause an escape response by the fish larvae. Likewise, larvae may avoid the net during daylight hours (North, 1991) causing underestimation of their true abundance.

Diel variations in the abundance by depth of *Pleuragramma antarcticum* suggested diurnal vertical migration. The larvae were found relatively near the surface (0-20 m) at dusk and deeper at dawn (20-50 m). During the night they were between 50-100 m, migrating to deeper waters during the day.

The diurnal vertical migration of the larval fish may be influenced by various factors. The distribution of their predators and prey has been postulated as one of the causes, but there is no clear evidence of this (North and Murray, 1992). The diet of *Pleuragramma antarcticum* larvae in summer con-

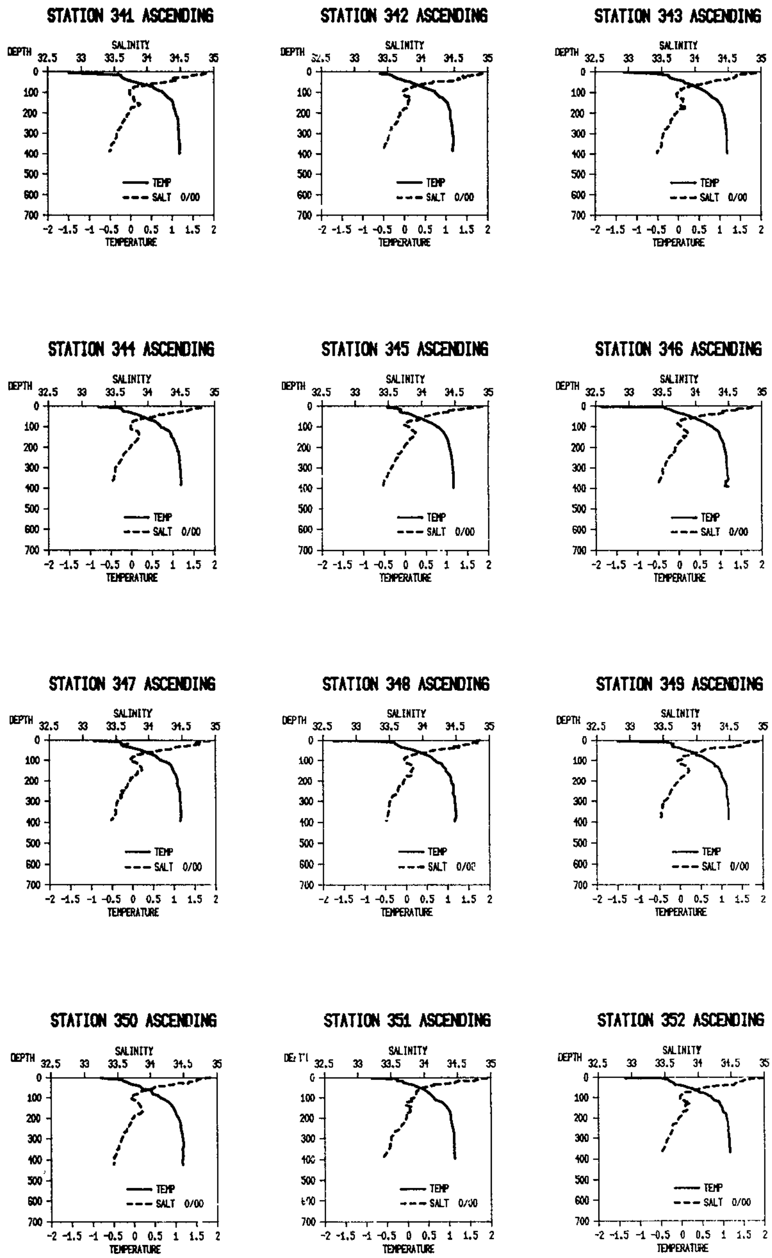

Fig. 1. Vertical profiles of water temperature (°C) and salinity (‰) at the 24 hour station recorded at 2 hour intervals.

sists of copepod eggs, cyclopoid and calanoid copepods and tintinnids (Kellermann, 1987). Recent studies on the vertical distribution of copepods showed that younger stages of *Calanoides acutus* tend to be most abundant in the upper 100 m, older copepodite were evenly distributed and no diel periodicity was evident (Huntley and Escritor, 1991).

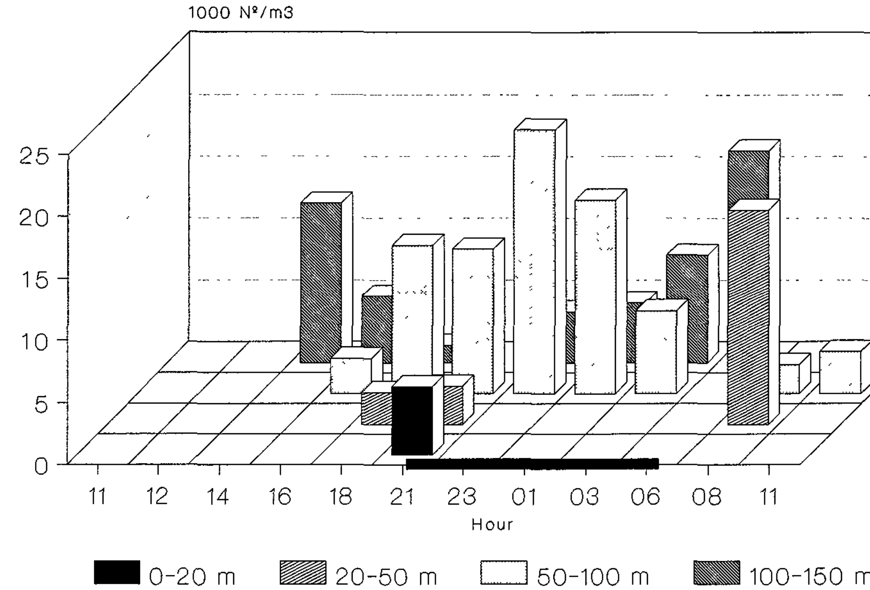

Fig. 2. Vertical distribution of *Pleuragramma antarcticum* at the 24 hour station.

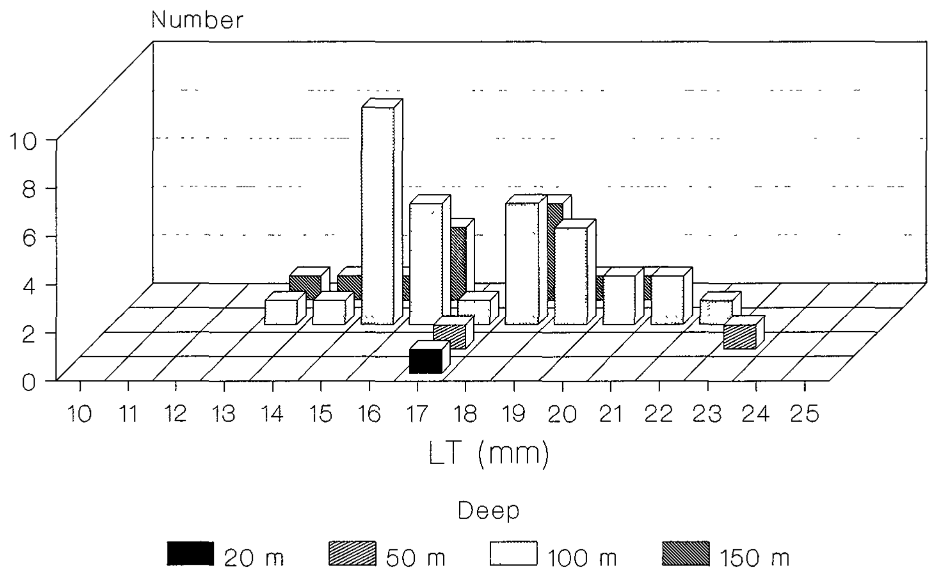

Fig. 3. Vertical length distribution by depth of *Pleuragramma antarcticum*.

In summer around South Georgia, the larvae of several species undergo diurnal vertical migrations, *Calanoides gunnari* (Channichthyidae) being the most conspicuous of these (North, 1990). Channichthyidae are predators of Notothenoiidae larvae, but as they were absent in Gerlache Strait waters (Loeb, 1991; Morales-Nin *et. al.*, 1993), they could not have affected *Pleuragramma antarcticum* migration. Other predators might include birds: the absence of near-surface larvae during the day supports this suggestion. Another factor is the possible effect of ultraviolet radiation which, during the Antarctic summer, could be significant in surficial waters where it may have a negative effect on larval survival.

The larvae were found in relatively warm waters which in poikilothermic fish might be advantageous for growth and metabolism. The vertical distribution by length did not show a clear ontogenic distribution although there may be data bias due to the low number of larvae in the upper layers. Taking the growth rate as 0.07 mm·d^{-1} (Kellermann, 1986), the larvae were 6 to 11 months old, and probably originated from spawning areas in the Bellingshausen Sea (North, 1991).

ACKNOWLEDGEMENTS

Data presented here were collected during the BIOANTAR93 cruise on board the B.I.O. Hespérides, sponsored by the Spanish Science Council (C.I.C.Y.T.). I am especially grateful to Marc García (Universitat Politécnica de Catalunya) for providing hydrographic data, and to Isabel Moreno and Isabel Roca (Universitat de les Illes Balears) for their help in sample collection, and also to Sonja Schadwinkel who classified the larvae. B. Lynas revised the English manuscript.

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