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Geographical Distribution and Abundance of Postlarval and Juvenile *Pleuragramma antarcticum* (Pisces, Notothenioidei) off the Antarctic Peninsula

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Summary. The early life history of *Pleuragramma antarcticum* off the Antarctic Peninsula is described from extensive material collected during four expeditions between 1975/76 and 1982 by means of an RMT 1+8. Postlarvae occurred frequently on the northern continental shelf in February and March except during the 1977/78 season when they were almost absent. Abundance varied mainly between 1.8 and 14.7 postlarvae per 10^3 m^3 with maxima between 32.6 and 143.3 per 10^3 m^3. Juveniles were less abundant with 0.1–4.9 and maxima between 9.8 and 28.3 per 10^3 m^3, but formed a consistent, predominant proportion (83–97%) of the pelagic juvenile fish fauna throughout the years of the study. They were distributed over the whole Bransfield Strait and adjacent waters in the top 200 m. Postlarvae and juveniles showed different patterns of vertical distribution; more than 70% of postlarvae occurred in the top 135 m of the water column whereas 83% of juveniles were encountered between 70 and 200 m with increasing abundance towards the lower depth. Three length groups were identified corresponding to age groups 0, 1 and 2. Hatching was estimated to occur in December. Postlarval distribution patterns and the prevailing transport of water masses suggest that coastal waters south of the tip of the Antarctic Peninsula and in the north-eastern Bellingshausen Sea are probable spawning areas. The Bransfield Strait and adjacent waters represent nursery grounds for the early stages of *P. antarcticum* from these sites.

Introduction

One of the few pelagic notothenioid fishes of the Southern Ocean is *Pleuragramma antarcticum*. Its distribution is circumantarctic (DeWitt 1971), but restricted to waters of high latitudes near the continent and adjacent islands (Permitin 1977). In the permanent pack ice zones of the Ross and Weddell Seas, the species has occupied an important position in the pelagic system in the absence of krill, *Euphausia superba* (DeWitt 1970; Hempel 1985; Eastman 1985). Soon after the first description of the species by Boulenger in 1902, a drawing of a postlarva was given by Pappenheim (1912) from a collection of a thousand specimens caught in the Davis Sea during the German South Polar Expedition 1901–1903. Further postlarvae and juveniles obtained during the "Discovery" and "Terra Nova" Expeditions in 1901–1904 and 1910–1914 were reported by Regan (1916) from the waters off Ross Island along the coast of Victoria Land. Another record from the Ross Sea was listed by DeWitt and Tyler (1960) who observed postlarvae and juveniles floating dead at McMurdo Sound. More recently, large postlarval concentrations in the southern Weddell Sea were reported by Keller (1983) and Hubold (1984, 1985).

All these records of early stages of *Pleuragramma antarcticum* were made in waters adjacent to the great continental ice shelves which therefore may be regarded as potential spawning areas. The waters west and northwest of the Antarctic Peninsula (Fig.1) are at some distance from these ice shelves but they are influenced by water masses of high antarctic origin. The south-western part is dominated by water masses of Bellingshausen Sea origin approaching with the Circumpolar Current whereas the northeastern part is under the regime of coastal waters from the north-western Weddell Sea (Clowes 1934; Anon. 1982; Heywood 1985). Both water masses meet and mix in the Bransfield Strait.

Early stages of *Pleuragramma antarcticum* were collected from off the Antarctic Peninsula during three German Antarctic Expeditions with *FRV Walther Herwig* (1975/76, 1977/78, 1980/81) and the Anglo-German Joint Biological Expedition with *RRS John Biscoe* (1982). The early life history of this species off the Antarctic Peninsula is described in this study.

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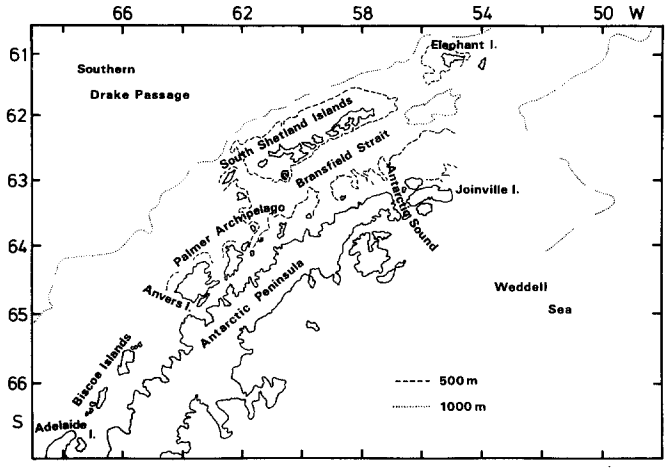

Fig. 1. The research area with location names referred to in the text

Material and Methods

Postlarval and juvenile *Pleuragramma antarcticum* were present in plankton and nekton samples obtained with a Rectangular Midwater Trawl (RMT 1+8) (Baker et al. 1973) and a modified version, the RMT 1+8M (Roe and Shale 1979). The mesh size of the RMT 1 net was 320 µ and 4.5 mm for the RMT 8. All specimens were preserved in 4% buffered seawater formaldehyd solution. Specimens were identified according to the descriptions given by Regan (1916) and Efremenko (1979). Length measurements given are standard lengths to the nearest millimeter below. Relative abundance is referred to 10^3 m^3 of filtered seawater. For calculation of mean abundance and percentage of *P. antarcticum* of the notothenioid ichthyoplankton and juvenile fish fauna only standard hauls are considered. The terminology used follows that of Russell (1976), and the term "juveniles" is applied to specimens with fully formed dorsal and anal fins.

"Walther Herwig" Cruise 1975/76 (WH 75/76)

In February 1976 during the second leg of the cruise, 34 hauls were taken off the tip of the Antarctic Peninsula and around the South Shetland Islands including Elephant Island. The standard procedure was to take a double oblique haul between the surface and 200 m depth or to the bottom in shallower areas. Sub-sampling and sorting procedures are described by Wörner and Kühn (1978). Three hundred and four specimens were identified as *P. antarcticum*. Abundance estimates were referred to the volumes of seawater filtered by the RMT 1+8 during each haul calculated by Pommeranz, Herrmann and Kühn (unpublished data).

"Walther Herwig" Cruise 1977/78 (WH 77/78)

The area investigated was divided into boxes which were sampled repeatedly during the three legs covering most of the summer season. Box A included waters south-west of the South Shetland Islands, box B was a grid of stations around Elephant Island, box C was situated off the tip of the Antarctic Peninsula and included waters of the north-western Weddell Sea. Box C was only sampled during legs 2 and 3. In addition, a number of stations was established in the Bransfield Strait. Standard hauls ranged from the surface to 140 m or to the near bottom in shallower water. Twenty-three hauls were taken from box A and Bransfield Strait during the first leg (November 15 to December 8, 1977), 73 hauls in the same area and in box C during leg 2 (January 6 to February 13, 1978) and 92 hauls in these areas during the third leg (March 3–12, 1978). Box B was worked on each leg, producing a total of 77 hauls. Sub-sampling and sorting proceeded as described by Wörner (1979). A total of 469 specimens were *P. antarcticum*. The filtered volumes of the RMT 1+8 were kindly provided by T. Pommeranz (unpublished data).

"Walter Herwig" Cruise 1980/81 (WH 80/81)

During the second leg, 637 specimens of *P. antarcticum* were collected from 39 hauls taken west of the Antarctic Peninsula from oceanic waters off Anvers Island to Elephant Island in March 10–19, 1981. Standard hauls usually ranged from 140 m to the surface. Sub-sampling and sorting procedures as well as the filtered volumes of the RMT 1+8 are given by Piatkowski and Klages (1983).

"John Biscoe" 1982 (JB 82)

In February 1982, 69 hauls were taken from the area of the Antarctic Peninsula and the southern Scotia Arc. The multiple RMT 1+8M enabled discrete catches to be taken from different water layers during each haul. Fifty-seven standard hauls from 200 m to below the surface were divided into depth strata according to physical oceanographical features recorded by a preceeding STD (see Heywood 1985). Another eight hauls ranged from various depths to below the top 200 meters, and four hauls were fishing from the surface to the bottom in less than 200 m water depth. Juvenile and postlarval fishes were sorted from the total sample on board. Re-examination of the bulk samples revealed that the ship-board sorting had extracted 98% of the 1049 postlarval and young *P. antarcticum*. Filtered volumes of the RMT 1+8M hauls are given by Piatkowski (1983).

The cruise tracks of the four expeditions and additional information can be obtained from Sahrhage et al. (1978); Hempel et al. (1979); Hempel et al. (1982) and Hempel and Heywood (1982).

Results

Net Selection

The different mesh sizes used in the RMT 1 and RMT 8 nets produced catches of different length composition. Results for postlarval *Pleuragramma antarcticum* of 12–31 mm standard length are shown in Fig. 2. The relative abundance at two stations was calculated for each length group from the RMT 1 and RMT 8 and arranged as length frequency ogives. From the different ordinate scales it can be seen that postlarval abundance was much lower in the RMT 8 nets. Between 12 and 24 mm (Station 1250) the mean (median) lengths from the two nets were significantly different by 2.9 mm, the smaller length classes thus being under-represented in the RMT 8 sample. The length frequency of larger postlarvae (17–21 mm, station 230) is quite well represented by the RMT 8 net but abundance is still underestimated. Moreover, the difference of 0.9 mm between mean (median) lengths from the two nets is still significant. Thus, data on postlarvae will refer exclusively to RMT 1 catches. Juvenile *P. antarcticum* from a size of 33 mm onward, were caught mainly by the RMT 8 net (cf. Fig. 5) and only a few specimens were present in the RMT 1 net presumably due to avoidance.

Geographical Distribution

In February 1976, 43% of postlarvae caught in the RMT 1 were *P. antarcticum*, ranging between 18 and 22 mm in length (Fig. 5a). They were present in five standard hauls over the continental shelf and slope (262 to 760 m water depth) north-east of Joinville Island (Fig. 3). Abundance varied between 5.5 and 47.6 individuals per 10^3 m^3

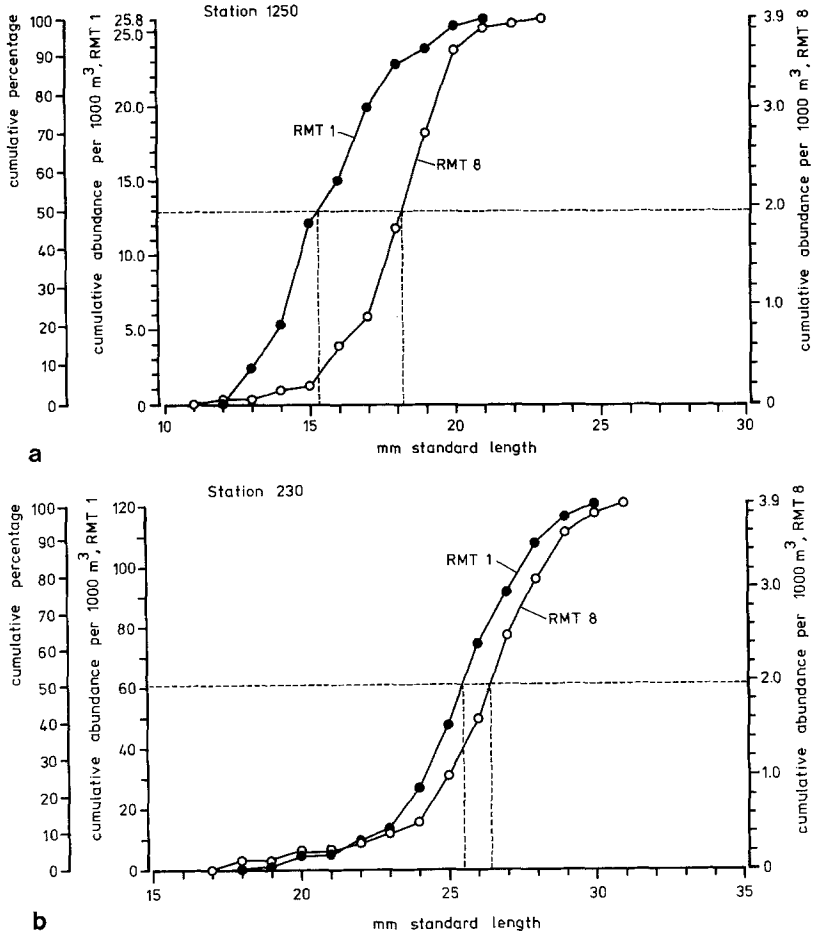

Fig. 2a, b. Length frequency ogives of postlarval *Pleuragramma antarcticum* at two stations basing on the relative abundance of length classes in the RMT 1 and RMT 8 nets. **a** Station 1250, JB 82, Antarctic Sound (RMT 1: $n=53$, RMT 8: $n=96$ specimens). **b** Station 230, WH 80/81, Palmer Archipelago (RMT 1: $n=112$, RMT 8: $n=65$ specimens)

(mean: 15.8±8.0). *P. antarcticum* of 40–52 mm in length (Fig. 5a) formed 89% of the pelagic juvenile fish fauna caught by the RMT 8 net. Abundance ranged from 0.1 to 3.3 individuals per 10^3 m^3 (mean: 1.1±0.1) in waters of depths 172–700 m off Joinville Island and north of the South Shetland Islands (Fig. 3).

In November 1977, no postlarvae were present. Juveniles however were frequently encountered in Bransfield Strait (Fig. 3). In the eastern part of the Palmer Archipelago, abundance as high as 28.3 per 10^3 m^3 was recorded but most hauls revealed lower densities between 0.2 and 0.8 per 10^3 m^3 (mean: 5.2±4.7). The length of the majority of specimens ranged between 33 and 48 mm with a few individuals between 56 and 63 mm (Fig. 5b). *P. antarcticum* comprised 97% of the total juvenile fish caught. The water depth of the hauls containing *P. antarcticum* varied between 80 and 1400 m over the deep central basin in the Strait. In early February 1978, in the total area sampled only one postlarval specimen of 14 mm was caught south of Joinville Island. Juveniles were distributed from the eastern part of the Bransfield Strait to the slope waters in the north-western Weddell Sea, but were absent in the western part of the investigated area (Fig. 3). The abundance varied between less than 0.1 and 4.9 per 10^3 m^3 and the catches were made in waters ranging in depths from 158–1900 m. The length frequency distribution exhibited two distinct peaks with means at 46.2 and 73.5 mm (Fig. 5c). *P. antarcticum* formed 83% of the pelagic juvenile fish fauna.

One month later in March 1978, only three postlarval *P. antarcticum* were found although the sampling effort was similar to that of the preceding leg. These specimens were caught in shelf waters south and north-east of Joinville Island. The distribution of juveniles was similar to that found in February 1978, but far fewer specimens were recorded: of 34 juvenile notothenioids taken 18 were *P. antarcticum* between 42 and 54 mm in length. During all three legs of the 1977/78 expedition no *P. antarcticum* were found in the waters around Elephant Island despite intensive sampling.

In mid March 1981 postlarval *P. antarcticum* made up 33% of the total postlarvae taken. They were particularly abundant in the area of the Palmer Archipelago (Fig. 3). Here, the densities were mainly between 1.8 and 43.4 per 10^3 m^3 over the outer continental shelf, increasing to a maximum of 143.3 individuals per 10^3 m^3 inside the Archipelago (mean: 76.5 ± 60.7). The length frequency has a secondary small peak indicating some lately hatched individuals. Juveniles were encoutered in one haul northwest of the Antarctic Sound; eight *P. antarcticum* of 66–77 mm length were caught here out of a total of 19 notothenioid juveniles for the whole area.

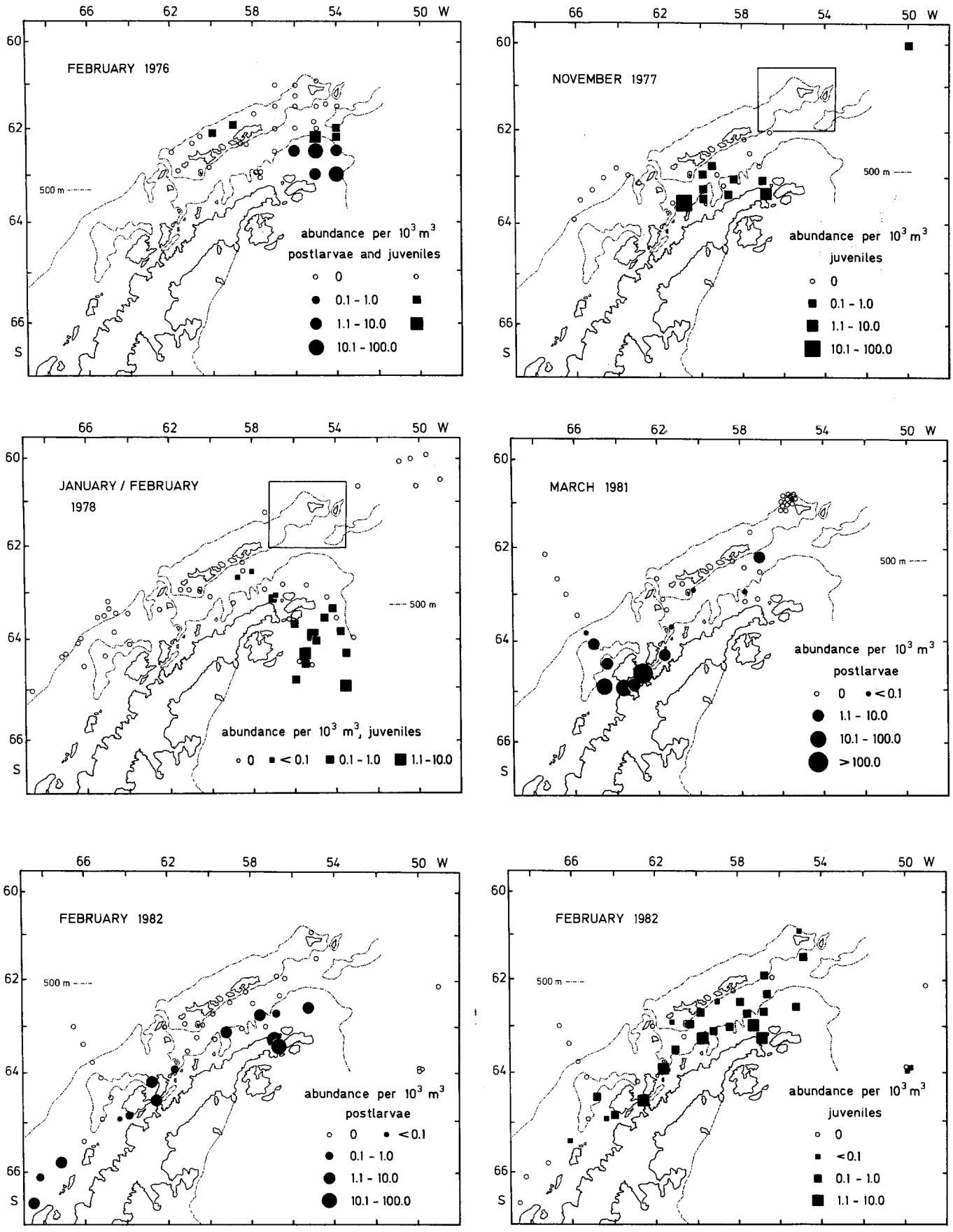

Fig. 3. Geographical distribution and abundance per 10^3 m^3 of postlarval (RMT 1) and juvenile (RMT 8) *Pleuragramma antarcticum* off the Antarctic Peninsula during the four expeditions

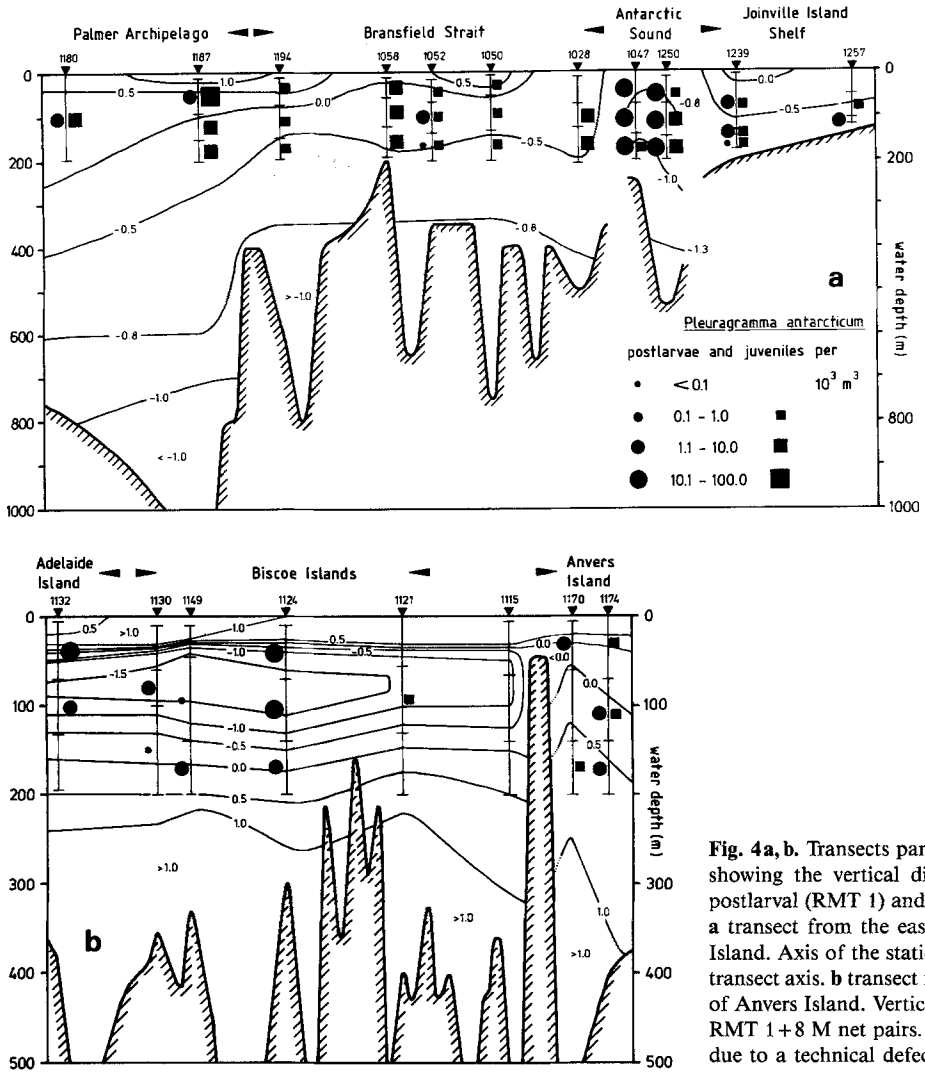

Fig. 4a, b. Transects parallel to the coast along the Antarctic Peninsula showing the vertical distribution of temperature and abundance of postlarval (RMT 1) and juvenile (RMT 8) *Pleuragramma antarcticum*. **a** transect from the eastern Palmer Archipelago to north of Joinville Island. Axis of the stations 1047 and 1250 is at right angle to the main transect axis. **b** transect from northeast of Adelaide Island to south-west of Anvers Island. Vertical bars represent the fishing depths of the three RMT 1+8 M net pairs. Station 1180 ranges from 195 m to the surface due to a technical defect

In February 1982, postlarval *P. antarcticum* were recorded from the northern Bellingshausen Sea, along the Antarctic Peninsula, to north of Joinville Island (Fig. 3). Maximum abundance was recorded in the Antarctic Sound with 14.7 and 32.6 per 10^3 m^3, and at the remaining stations it varied between 0.5 and 8.8 individuals per 10^3 m^3 (mean: 5.0 ± 2.6) and their occurrence was restricted to the continental shelf and upper slope waters of 192 to 535 m depth. The length frequency distribution had a peak between 11 and 21 mm (Fig. 5e). Postlarval *P. antarcticum* formed 34% of the notothenioid ichthyoplankton. Juveniles were found throughout most of the area investigated (Fig. 3) over various depths of water between 140 and 3080 m. They were most abundant on the northern continental shelf of the Antarctic Peninsula, ranging from less than 0.1 to 9.8 individuals per 10^3 m^3 (mean: 1.0 ± 0.4). The highest concentration was found in the eastern part of the Palmer Archipelago. Juvenile *P. antarcticum* formed 97% of the juvenile fish fauna taken. The specimens were between 33 and 67 mm in length with the majority between 33 and 54 mm.

Vertical Distribution

Only the stratified opening-closing hauls carried out during the *John Biscoe* cruise provide information on the vertical distribution of the early stages. Since the main abundance of *P. antarcticum* was confined to the northern continental shelf of the Antarctic Peninsula, two transects running parallel to the coast were selected from this site (Fig. 4). Cold and saline Weddell Sea water enters the shelf through the Antarctic Sound and round Joinville Island, spreading north, and south-west where it is modified into a distinctive water body on the southern, continental shelf of the Bransfield Strait (Anon. 1982, 1983; Heywood 1985). Within the upper 200 m sampled, postlarvae were most abundant in the cold water column of the Antarctic Sound (Fig. 4a), varying between 10.1 and 55.0 individuals per 10^3 m^3. The highest density was observed between 140 and 70 m on both stations. Fewer postlarvae were present over the shallow shelf of Joinville Island and on one station in the southern Bransfield Strait below the 0 °C isotherm. Moderate density was

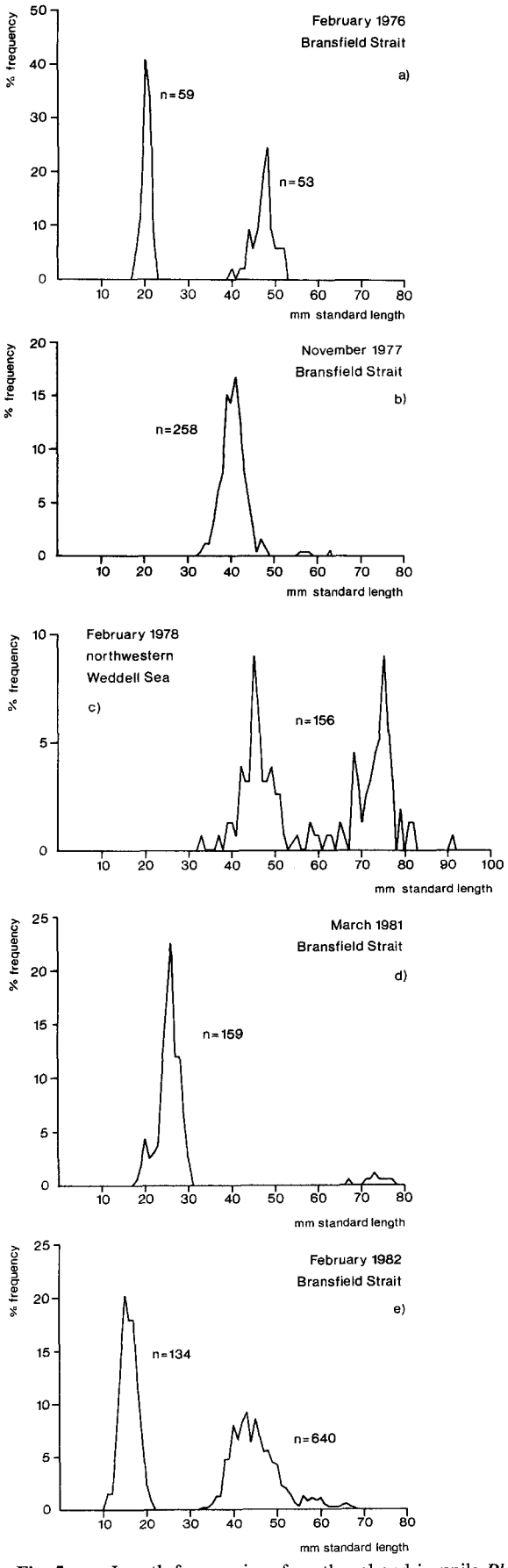

Fig. 5a–e. Length frequencies of postlarval and juvenile *Pleuragramma antarcticum* off the Antarctic Peninsula during the four expeditions

recorded in the eastern part of the Palmer Archipelago were the water in the surface layer was slightly warmed by solar radiation. Juveniles were evenly distributed within the top 200 m over almost the whole transect. Increased abundance was recorded on the southern station in the Antarctic Sound, in Bransfield Strait and at station 1187 (Croker Strait) where the density amounted 21.7 specimens per 10^3 m^3 in the top 50 m.

Unlike the homogenious, mixed waters present on the previous transect, a marked stratification was found between Anvers Island and Adelaide Island (Fig. 4b). Below the seasonal thermocline, the Bellingshausen Sea (Winter) surface water can be traced by the −0.5 °C isotherm with a core temperature below −1.5 °C (cf. Kock and Stein 1978; Heywood 1985). Catches of postlarval *P. antarcticum* were mainly confined to this cold Bellingshausen Sea (Winter) surface water; the abundance varying between 1.5 and 14.8 individuals per 10^3 m^3. They were also present in the surface layer off Adelaide Island which was cooled by melting water from the ice piedmont. Postlarvae (and also juveniles which occurred only on one occasion off the Biscoe Islands) were encountered again off Anvers Island.

In general, most postlarvae of *P. antarcticum* occurred between 135 and 70 m (mean net closing depths) in water below 0 °C (157 specimens or 44.5%), followed by the near surface layer (105 specimens or 29.8%) and the layer below 135 m (91 specimens or 25.8%). In contrast, juveniles showed the highest abundance in the bottom most catches between 200 and 135 m (184 specimens or 53.2%), with decreasing numbers throughout the 135–70 m layer (104 specimens or 30.1%) to the near surface layer (58 specimens or 16.8%). One haul at station 1187 (cf. Fig 4a) was excluded from this calculation because the extreme abundance of juveniles in the surface layer would have turned the numeric relation between the depth strata to the reverse; at this site, 184, 67 and 18 specimens were sampled by the nets from the surface to the deepest layer. Below 200 m haul depth, only one haul south of Elephant Island caught three juvenile *P. antarcticum* between 700 and 480 m over 1000 m water depth.

Table 1. Mean lengths (x in mm) and standard deviations (sx in %) of the age groups of *Pleuragramma antarcticum* calculated from the length frequencies (*n* = number of fish measured). From the juvenile fish in February 1982, specimens of intermediate lengths (see Fig. 5e) excluded from calculation

Month	Age 0			Age 1			Age 2		
	x	sx	*n*	x	sx	*n*	x	sx	*n*
1–13 Feb. 1976	20.2	4.5	59	47.3	5.5	53	–	–	–
24–27 Nov. 1977	–	–	–	40.3	6.5	258	–	–	–
6–10 Feb. 1978	–	–	–	46.2[a]	23.6	75	73.5[a]	8.4	78
11/12 Mar. 1978	–	–	–	50.0[b]	–	18	–	–	–
11–16 Mar. 1981	25.3[a]	43.1	159	–	–	–	73.0[b]	–	8
7–25 Feb. 1982	15.9	12.0	134	44.1	9.5	599	–	–	–

[a] Geometric mean
[b] Median

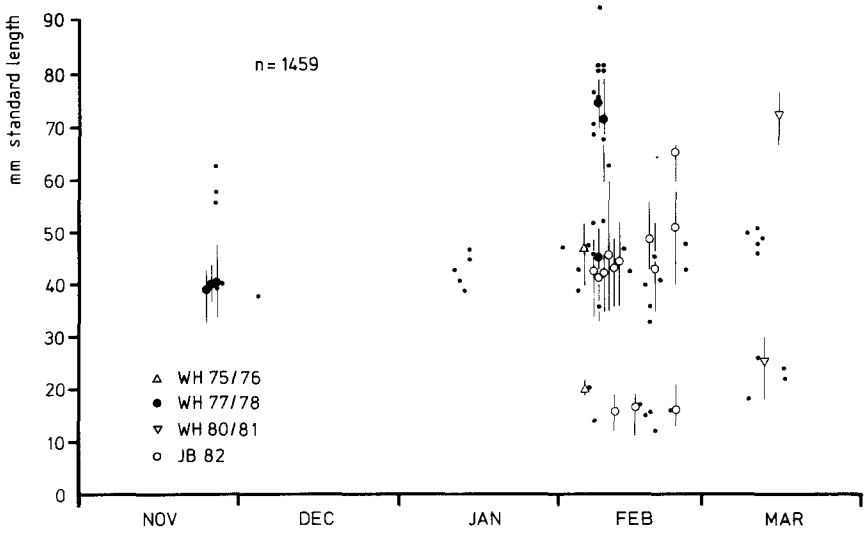

Fig. 6. Standard lengths of *Pleuragramma antarcticum* plotted versus the months covered by the investigations. Symbols indicate means of length frequencies, the *vertical bars* represent frequency ranges. *Dots* indicate single specimens measurements or small-size length frequencies

Age and Growth

Three size groups can be recognized from a general appraisal of the length frequency distributions recorded in February 1976, 1978 and 1982 (Fig. 5a, c, e); postlarvae with a peak between 11 and 22 mm SL and juveniles with peaks between 33 and 53 mm and 65 and 82 mm, respectively. In March, postlarvae had achieved a standard length between 20 and 30 mm (Fig. 5d). The peak in November between 33 and 48 mm (Fig. 5b) may be attributed to overwintered juvenile *P. antarcticum*. The three size groups present in February can therefore be considered as age groups 0, 1 and 2. Mean lengths of postlarvae and juveniles from the respective months are given in Table 1. A more dynamic picture is presented by a plot of length versus time (Fig. 6), where the three different age groups can roughly be identified.

Average growth rates over a period of one year may be estimated by using the differences between mean lengths of co-occurring age groups. For the two age groups 0 and 1 present in February 1976, a difference of 27.1 mm suggests an average growth rate of 0.07 mm per day for the first year. A growth rate of 0.08 mm per day results from a difference of 28.2 mm in February 1982. In February 1978, the difference in mean length for age groups 1 and 2 is 27.2 mm, giving an average growth rate for the second year of 0.07 mm per day.

Moreover, in one instance growth rate during the austral summer has been calculated using the increase in mean length of an age group caught in consecutive months, assuming that the length frequencies are not biased by major immigration or size selective mortality. One year old juvenile *P. antarcticum* were recorded from November 1977 to February 1978 and – but less abundant - March. Mean length increased from 40.3 mm in late November to 46.2 mm in early February, resulting in a daily growth rate of 0.08 mm over a 76 days time period.

Daily growth rates of postlarvae of *Pleuragramma antarcticum* reported from the southern Weddell Sea were 0.20 and 0.24 mm (Keller 1983; Hubold 1985). Larvae may hatch at a length of 6 mm (Regan 1916). Using these postlarval growth rates, the approximate age and moreover the approximate time of hatching can be estimated from the mean lengths of postlarvae in the respective years. Then, individuals caught in February 1976 were about 8–10 weeks old and had hatched in early to mid December. The smaller postlarvae caught in February 1982 (cf. Table 1) were about 6–7 weeks old, having hatched in late December. Postlarvae caught in March 1981 had probably hatched between mid and late December and were 12 to 14 weeks old. Regan (1916) presumed that hatching of *P. antarcticum* in the Ross Sea occurred in early December.

Discussion

The observed length ranges of *Pleuragramma antarcticum* of age groups 0, 1 and 2 are in close agreement with data from the literature. Regan (1916) stated that postlarval *P. antarcticum* in the Ross Sea reach a length of 15–25 mm by the end of the first summer and may be 35 mm when one year old. DeWitt and Tyler (1960) found 8–9 mm long specimens in late December, and assumed specimens of 30–40 mm and 50–70 mm in length to be one and two years old. Keller (1983) reported postlarvae of 8–17 mm from the southern Weddell Sea in early January and of 13–26 mm in mid February. Juvenile *P. antarcticum* were 38–52 mm in length off the Antarctic Peninsula in January/February 1981 with some specimens between 66 and 76 mm (Kellermann and Kock 1984).

Variation in growth rate was evident, particularly among juvenile fishes. This is demonstrated by the presence of juveniles with body lengths intermediate between the main length ranges for age groups 1 and 2. Scales were absent from all the specimens examined in this study. Precise assignment of young *P. antarcticum* to

the respective age groups is therefore only possible by the analysis of otoliths.

The main abundance of postlarval *P. antarcticum* was confined to three areas on the northern continental shelf and upper slope of the Antarctic Peninsula: the north-eastern Bellingshausen Sea, the Antarctic Sound and the shelf of Joinville Island, and the Palmer Archipelago where they were particularly abundant in March 1981. In the research area, adult *P. antarcticum* were recorded near Adelaide and Argentine Islands by DeWitt and Hureau (1979). Daniels (1982) reported the species to be common from south of Adelaide Island to the Palmer Archipelago and observed schools of several thousands under fast ice. Sosinski and Skora (1979) detected concentrations by bottom and pelagic trawling in the shelf waters of the Biscoe Islands. They reported the species less abundant in the shelf waters of the Palmer Archipelago. There is evidence however, that spawning occurs in the vicinity of continental ice shelves, e.g. in the Weddell, Davis and Ross Seas. In the southern and eastern Weddell Sea, postlarval abundance in January and February amounted up to 300–3700 individuals per 10^3 m^3 during several years with means of 150–340 per 10^3 m^3 (Keller 1983; Hubold 1984). Off the Antarctic Peninsula, maximum abundance did not exceed 33–143 per 10^3 m^3 and means were 5–16 per 10^3 m^3 in February 1976 and 1982 and 77 postlarvae per 10^3 m^3 in March 1981. The difference between these two regions of one order of magnitude characterizes the investigated area rather as the periphery of a spawning site. Continental ice shelves which may be the possible origin of the early stages of *P. antarcticum* are present in the north-eastern Bellingshausen Sea and in the north-western Weddell Sea south of the tip of the Antarctic Peninsula (the Larsen Ice Shelf). From these sites, early stages of *P. antarcticum* are drifted to the northeast by the coastal current in Bellingshausen Sea Winter Water (cf. Fig. 4b), and also enter the southern shelf of the Bransfield Strait with the Weddell Sea water flowing through the Antarctic Sound and round Joinville Island (cf. Fig. 4a). Thus, postlarvae caught off Adelaide Island may represent the northern periphery of the postlarval population in February, whereas the higher densities off Joinville Island may reflect closer vicinity of the north-western Weddell Sea spawning ground.

The shelf around the Palmer Archipelago is very limited in area. The low abundance and sporadic vertical occurrence of postlarvae in February 1982 do not support the presence of a local spawning area here especially when compared with the abundance and vertical distribution found in the other sites (Fig. 4). The prevailing direction of the current off the Antarctic Peninsula is to the north-east (Clowes 1934; Stein 1982; Anon. 1983; Heywood 1985). The large concentrations of three months old postlarvae found around the Palmer Archipelago in March 1981 are therefore likely to be from the north-eastern Bellingshausen Sea. However, the northward penetration of Winter Water which *P. antarcticum* was shown to prefer is impeded by the bottom topography south of Anvers Island (Heywood 1985). Some of the large catches of late postlarvae in March 1981 were yet made in the top 90 m and provide evidence for a drift in the surface layer. Stein (1982) noted that during March 1981 the waters inside the Palmer Archipelago as well as the western part of the Bransfield Strait were influenced by Weddell Sea water. These postlarvae could therefore have immigrated into the area along the southern shelf of the Bransfield Strait. Unfortunately, few samples were obtained from over this shelf.

Spawning success is subject to year to year variation as shown by the almost complete lack of postlarvae in the 1977/78 season. Such variations were also noted in the inner Weddell Sea where they were related to the presence and extent of a coastal polynya (Hubold 1984). This hypothesis requires further examination but is yet supported by the fact that in November 1977, severe ice conditions prevented the *FRV Walther Herwig* from entering the shelf east and south of Joinville Island.

The geographical distribution of juvenile *P. antarcticum* extended from off the Palmer Archipelago to north-west of the South Orkney Islands, where they were also observed by Efremenko (1979). Further records have been made west of Anvers Island and between the South Shetlands and Elephant Island where juveniles occurred frequently with krill swarms (Rembiszewski et al. 1978; Chlapowski and Krzeptowski 1978). The highest abundance in this study was recorded over the shelf and slope of the Antarctic Peninsula, as reported also by Slosarczyk and Rembiszewski (1982). The largest catches of juvenile, one year old fishes were made in the north-eastern part of the Palmer Archipelago in November 1977 and also in February 1982. Particularly the latter record and the wide distribution of juveniles during this month may be related to the high abundance of late postlarvae in March of the previous year. If so, the postlarval transport from the Bellingshausen Sea contributes significantly to the recruitment of the juvenile population in Bransfield Strait.

In contrast to postlarvae, juvenile abundance of *P. antarcticum* was much higher than in the inner Weddell Sea. There, it was 0.01–0.1 specimens per 10^3 m^3 with a maximum of 5.3 per 10^3 m^3 (Hubold 1984), whereas in the present study abundance was higher by one order of magnitude with means of 1.0–5.2 and up to 28.3 one year old juveniles per 10^3 m^3. This may be due to a reduced mortality rate of postlarvae off the Antarctic Peninsula, but in addition, immigration of juvenile fish from the north-western Weddell Sea was evident. In the south-west, no juveniles were recorded in the present study. The overwhelming predominance of *P. antarcticum* which forms, almost consistently, 90% of the pelagic juvenile fish fauna reflects the fact that this species is pelagic throughout its life, whereas most notothenioids enter a benthic phase by the end of their first or during their second summer.

The Bransfield Strait and adjacent waters can be characterized as belonging to the seasonal pack ice zone

defined by Hempel (1985). These waters represent the nursery area for the early stages of *P. antarcticum* and are probably only used as a temporary habitat before the mature fish migrate to their spawning grounds in the permanent pack ice zone in the Bellingshausen Sea and north-western Weddell Sea.

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