Winter ichthyoplankton in the northern Benguela upwelling and Angola-Benguela Front regions

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This study describes horizontal and vertical distribution patterns of fish larvae in the Angola-Benguela Front and the Benguela upwelling areas in winter 1999. Stratified plankton samples were collected at 38 stations with a multiple opening-closing net. A total of 418 fish larvae was caught, 372 of which were found in the Angola-Benguela Front area. They were classified into 23 taxa with *Trachurus trachurus, Merluccius* sp. and *Chloroscombrus chrysurus* being the most abundant species. Mesopelagic fish were represented by a number of abundant species, among others *Cyclothone* sp., *Diaphus* sp. and *Hygophum* sp. Fish larvae in the Angola-Benguela Front area were concentrated near the coast in the southern part of the frontal zone, with the distribution pattern following the hydrodynamic regime of this area, where a strong frontal zone divided the transect into three parts: a northern part influenced by the warm Angola Current waters, a southern part dominated by the colder Benguela Current waters, and a central part with mixing water masses from both Angola and Benguela currents. Offshore abundances were very low, indicating that most species made use of the local current fields to maintain themselves inshore on the continental shelf. Only some of the pelagic species were found at the outer stations, indicating offshore transport by the Benguela and Angola currents.

Introduction

The dynamics of the Benguela Current have been described in detail by Nelson and Hutchings,[1] Shannon,[2] Chapman and Shannon,[3] Lutjeharms *et al.*,[4] and Fennel.[5] Briefly, the area off northern Namibia and southern Angola, between 15° and 18°S, is characterized by the convergence of the Angola and Benguela currents. The northern part of this area is dominated by the poleward-flowing Angola Current, which forms a 50-m surface layer of warm equatorial water. The Benguela Current flows northward along the Namibian coast and leaves the shelf at about 18°S. It forces the Angola Current to leave the coastline and to turn towards the open South Atlantic, where it flows parallel to the Benguela Current and both combine to form the South Equatorial Current. Beneath the Angola Current, a poleward-flowing under-current is observed, which continues along the Namibian coastline and forms part of an overall poleward eastern boundary under-current. The convergence of the two large-scale East Atlantic boundary currents results in an extensive system of fronts and counter-currents between 15° and 18°S. These fronts and counter-currents are accompanied by a number of local upwelling and horizontal or vertical transport mechanisms, respectively, which differentially influence the distribution and survival of the different zooplankton components.

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The position and intensity of the Angola-Benguela Front are characterized by seasonal and annual periodicity. The position of the front varies between 14° and 17°S, with its northernmost extension in the austral winter. The width of the front also varies, with an average of 250 km.[6–8] The Angola-Benguela Front separates two basically different ecosystems, which differ in water temperature, nutrient concentration and salinity and hence productivity and species composition. The fauna of the Angola Current is tropical, whereas that of the Benguela Current can be described as a typical upwelling community. This difference in faunal composition is reflected in the type and volume of the respective fisheries. While artesanal fisheries based on a large variety of species dominate along the Angolan coast, large-scale industrial fisheries based on pelagic and benthopelagic resources are prominent off Namibia. This difference may be a reflection of our knowledge of the biology and population dynamics of the exploited species in the two regions. Indeed, most research activities have focused on the upwelling species and their exploitation off Namibia, whereas limited information is available on the distribution and transport processes in the Angola-Benguela Front area and the region north of it.

The aim of this work was to investigate the distribution patterns of the ichthyoplankton in the Angola-Benguela Front region. Investigations in northeastern Brazil showed that the influence of the coast on the coastal waters is restricted to a very narrow longshore band of about 5–10 km.[9–11] The hydrographic regime off northeastern Brazil is dominated by the onshore South Equatorial Current, resulting in the formation of this narrow band of coastal waters. The major part of water masses along the shelf and slope is tropical with high temperatures and low nutrients.[12] By contrast, the situation off southern Angola and northern Namibia is completely different. Offshore water transport induces upwelling along the coast with relatively high nutrient concentrations extending far offshore. The entire shelf area is therefore expected to be more productive than across the ocean at the same latitude off northeastern Brazil. It is postulated that larvae of coastal fish species also occur further offshore and/or that they have developed strategies to remain on the shelf or within the nearshore zone. To test this hypothesis, samples collected during a cruise in the Angola-Benguela Front region during the austral winter with the South African research vessel *Africana* were analysed.

Materials and methods

As part of the BENEFIT Shipboard Research Training Programme for the SADC Region, 1999,[23] seven transects were sampled during the second leg of the South African FRS *Africana* cruise in July 1999 (Fig. 1). The first four transects (T2–T5), with 20 stations, were located in the coastal upwelling region off the Namibian coast between 19° and 21°S, perpendicular to the coast, covering a water depth range of 26–460 m. Three other transects (T6–T8), with 18 stations, were located in the Angola-Benguela Front, parallel to the coast and perpendicular to the front. There was evidence of the presence of Benguela Current water at the southernmost stations in this region, whereas the stations north of the front were characterized by the presence of Angola Current waters. Opposing trends were observed in surface temperature and biomass of both phyto- and zooplankton, although the latter was mixed with phytoplankton (large diatoms) at most stations.[20]

The highest number of fish larvae was caught along transect T7. The hydrographical conditions are therefore shown only for this section (Fig. 2). At the northern stations (7-1 to 7-3), warm water from the Angola Current dominated in the upper 40 m.

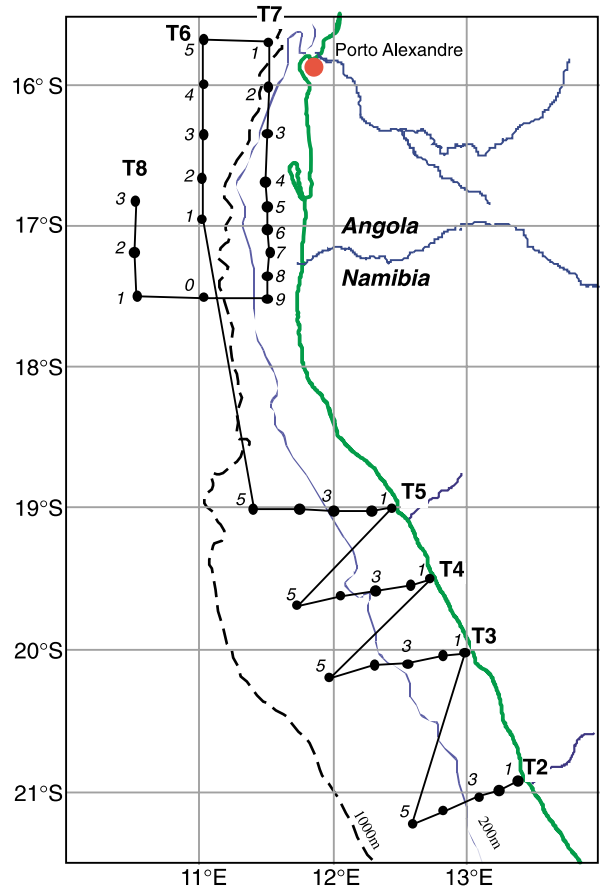

Fig. 1. Cruise track and zooplankton stations during the second leg of the *Africana* cruise in July 1999. Transects T2 to T5 were located in the coastal upwelling area, transects T6 to T8 covered the Angola-Benguela Front area. Station numbers in each transect are indicated in italics.

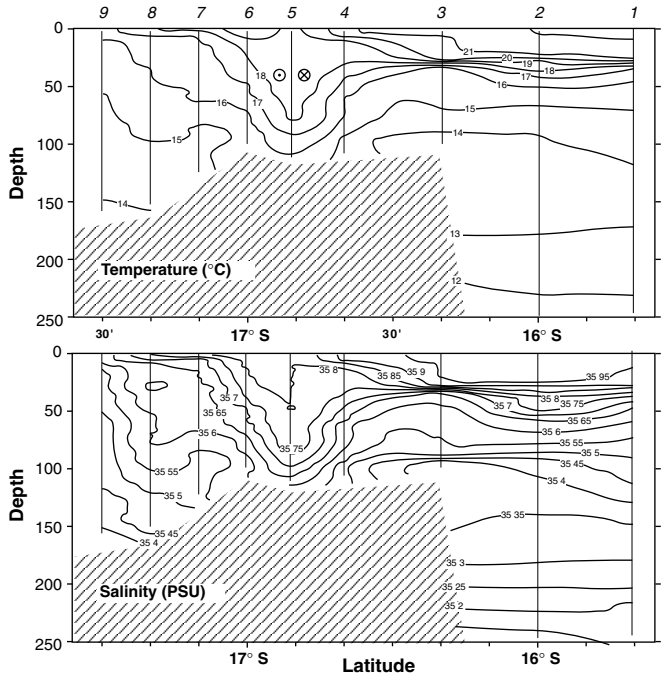

Fig. 2. Temperature and salinity profiles along transect T7 (C. Duncombe Rae, pers. comm., unpubl. data). The top numbers indicate the station positions. The vertical lines represent the depth of the CTD probe at the corresponding station. The suggested vortex at the central stations 4–6 is indicated by current symbols ⊗ (descending into the plain; westward flow) and ⊙ (coming out of the plain; eastward flow). The seafloor is indicated.

Below this surface layer, temperature and salinity declined slowly, and their range indicated the presence of South Atlantic Central Water (SACW). At the southern stations with temperatures less than 18°C and salinities of less than 35.7, we observed the influence of Benguela Current Water (BCW). A mixture of these water masses was found at the central stations of the transect on the continental shelf. The steep isolines in temperature and salinity indicated a strong frontal zone in this area with a nearly vertical halocline at station 7-5 in the depth range 10–50 m. The inverse slopes of the isolines between station 7-4 and 7-6 indicated a vortex in this area with counterclockwise water transport and its centre perhaps at station 7-5 (direction of currents indicated in Fig. 2). More details on temperature distribution, water masses and currents are given elsewhere in this issue.

A multiple opening-closing device (Hydrobios MultiNet® Type *Midi*) with four nets of mesh size 200 μm and a mouth area of 0.25 m^2 was used for plankton sampling. The gear was towed obliquely in up to four depth strata to determine the vertical distribution of fish larvae. Depth ranges of the strata were selected according to temperature profiles recorded by a current-temperature-depth (CTD) probe. All nets were equipped with flowmeters to measure the net's trajectory through the water. In total, 132 stratified samples were collected from 38 stations. Samples were preserved in buffered formalin (4% in seawater). Larval abundance was standardized to individuals per m^2 from a knowledge of the volume of water filtered by each net.

A total of 418 fish larvae was sorted from the samples and stored in Steedman solution.[13] Identification was done to the highest possible taxonomic level according to the published literature.[14–19] Twenty-five taxa were distinguished (Table 1). Standard length of the larvae was measured under a dissecting microscope to the nearest 0.1 mm.

Correlation between larval length and latitude was tested by simple regression analysis in three species: *Trachurus trachurus, Chloroscombrus chrysurus* and *Merluccius* sp.

Results

Horizontal distribution of fish larvae

As a result of different water masses encountered during the cruise, the occurrence and abundance of fish larvae changed along the transects (Fig. 3). Abundance in the frontal region (transects T6–T8) was generally greater than in the southern upwelling region off Namibia (transects T2–T5). Highest concentrations of fish larvae were found at the central stations of transect T7, within the front, tapering off to the north and south of it. From the 418 larvae collected during the cruise, only 46 were found along the upwelling transects T2–T5 (20 stations), whereas the majority (372 individuals or 89%) were caught along the frontal transects T6–T8 (18 stations).

A total of 23 taxa was identified (Table 1). The most abundant group was the Carangidae (horse mackerel), that contributed 140 individuals (33%) to the total number of larvae caught. Another important group were the mesopelagic fishes, represented by five families (Bathylagidae, Gonostomatidae, Myctophidae, Paralepididae, Photichthyidae) with a total of 119 specimens (28%). *Merluccius* larvae contributed 52 specimens to the total catch (12%) and gobiids 51 specimens (12%). Other taxa identified were Clupeidae (n = 17), Soleidae (15), Triglidae (12), Engraulidae (3), Blenniidae (3) and Bothidae (1). There were also five specimens that could not be identified to family level.

The distribution of larvae in the upwelling area (T2–T5) showed a typical winter scenario. Occurrence of fish larvae was very low, varying between 0 and 3 per station (Fig. 3). Only one

Table 1. Species list of fish larvae caught in nets during the second leg of the *Africana* cruise, July 1999. Also given is the number of larvae recorded for each family or taxon.

Family	Number	Species	Number
Clupeidae	17	Unidentified	17
Engraulidae	3	*Engraulis* sp.	3
Blenniidae	3	*Parablennius* sp.	3
Gobiidae	51	sp. 1	1
		sp. 2	36
		Sufflogobius sp.	2
		Yolk sac larvae	12
Merluccidae	52	*Merluccius* sp.	52
Bathylagidae	1	*Bathylagus* sp.	1
Gonostomatidae	33	*Cyclothone* sp.	33
Myctophidae	82	*Diaphus* sp.	20
		Hygophum sp.	53
		Lampanyctodes sp.	2
		Symbolophorus sp.	7
Paralepididae	1	*Lestidiops* sp.	1
Photichthydidae	2	*Vinciguerria poweriae*	2
Carangidae	140	*Chloroscombrus chrysurus*	32
		Trachurus trachurus	108
Bothidae	1	*Bothus* sp.	1
Soleidae	15	*Dicologlossa* sp.	9
		Monochirus sp.	5
		Yolk sac larvae	1
Triglidae	12	Unidentified	12
Yolk sac larvae	1	Unidentified	1
Unidentified	4		4
Total			418

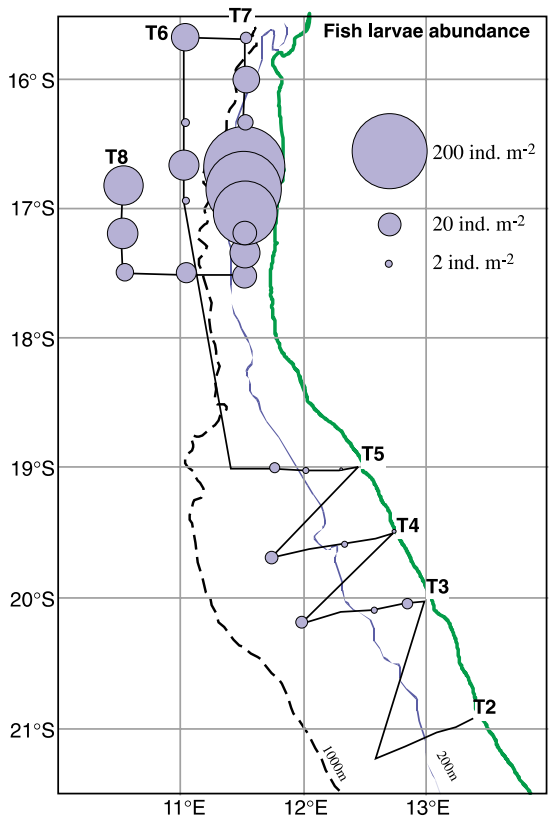

Fig. 3. Horizontal distribution of fish larvae during the *Africana* cruise in July 1999, collected with a multiple opening-closing net. Circle area represents the number of larvae per m^2, integrated over the water column.

station at the shelf edge on the most southern transect showed a considerable number of larvae (25 individuals per station, which is equivalent to 28 larvae per m^2), dominated by gobiids and mesopelagics. Because of the low frequencies of fish larvae in this area, no further analysis of the collections from the upwelling transects was performed and emphasis was placed on the distributions in the Angola-Benguela Front (ABF) area.

The abundance of fish larvae in the frontal area was generally high, varying between 0 and 126 larvae per station, representing up to 245 per m^2. Highest densities were found along the neritic transect T7, where species diversity was also highest. Flatfishes (Soleidae and Bothidae) and gobiids were present only at stations of this transect. Oceanic stations (T6 and T8) were comparatively low in abundance and represented almost exclusively mesopelagic species.

Vertical distribution of fish larvae in the Angola-Benguela Front

The fish larvae collected in the frontal area (transects T6–T8) were grouped into three ecological types to describe their vertical and horizontal distribution. These were: i) mesopelagic species occurring mainly in deeper layers; ii) pelagic species found in the upper layers; and iii) demersal/coastal species occurring only along the near-coast transect T7.

Mesopelagic species

Eight species of mesopelagic fishes were identified. They occurred at some offshore stations of the southern transects (not shown) and at most stations in the frontal area (Fig. 4).

A deep-water distribution typical of mesopelagic fishes was shown by *Cyclothone* sp. It occurred at various stations in the ABF area, but only deeper than 200–300 m at station 7-2 and along transects T6 and T8. Average densities varied between 2 and 52 larvae per m^2 per station.

Myctophidae were represented by four species. Higher concentrations occurred mainly in the upper layers (0–50 m) at the central stations (7-4 to 7-6) of transect T7. *Diaphus* sp. and *Hygophum* sp. were the two dominant species with densities up to 18 individuals per m^2. *Diaphus* sp. was concentrated in the upper 50 m at the central stations of T7, but also occurred at greater depths at stations 7-2 and 8-1. *Hygophum* sp. was distributed more widely, along the entire transect except at stations 7-1 and 7-7. It was also present at stations 8-1 and 8-2. When observed, the species was restricted to the upper 100 m.

The less abundant *Symbolophorus* sp. was found in the surface layer (0–50 m) at stations 6-5, 7-3, 7-6 and 8-1 (densities between 1 and 3 individuals per m^2). Only two specimens of *Lampanyctodes* sp. were collected, at the central station (7-4) in the upper net, representing a density of 35 individuals per m^2.

Only single specimens of *Bathylagus* sp., *Lestidiops* sp. and *Vinciguerria poweriae* were present at the northern stations 7-1, 7-2 and 7-3. They occurred only in the Angola Current-dominated surface waters down to 65 m, representing densities of 0.5–5.0 individuals per m^2.

Pelagic species

Two carangid species were collected in the ABF area: *Trachurus trachurus* and *Chloroscombrus chrysurus* (Fig. 5), which were observed predominantly in the upper 50-m layer at the central stations of T7, where they reached high concentrations of up to 132 (*T. trachurus)* and 31 *(C. chrysurus)* individuals per m^2. Only single specimens of *C. chrysurus* were observed, at a depth of 50–100 m at stations 7-5 and 7-6, and three at the offshore station 6-2. Two specimens of *T. trachurus* (= 1 individual per m^2) were found at the southern stations of the offshore transect T8.

Demersal/coastal species

Gobiids, flatfishes and hakes (Merluccidae) showed similar distribution patterns (Fig. 6), occurring mainly at the central and

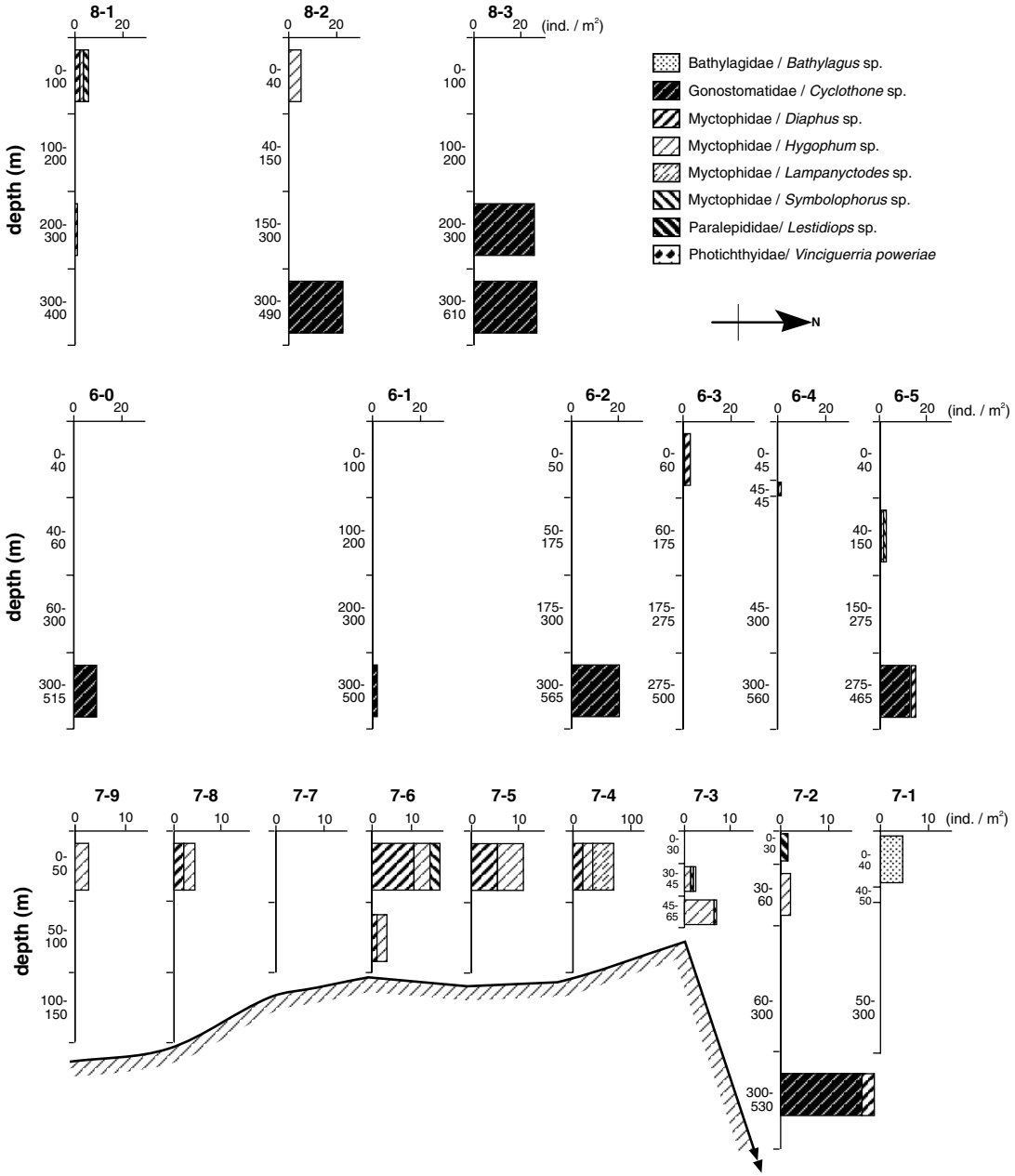

Fig. 4. Vertical distribution of mesopelagic species/taxa collected during the *Africana* cruise in July 1999 along two transects (T7 and T8) crossing the Angola-Benguela Front. The seafloor of transect T7 is indicated. Abundance is given as number of larvae per m^2, integrated over the water column. Note the different scale at station 7-4.

southern stations of transect T7. Abundances at the three northern stations were very low, with one specimen of *Bothus* sp. at station 7-2 and two gobiid specimens (Gobiidae sp. 2 and *Sufflogobius* sp.) at station 7-3 at 30–65 m depth. No larvae of these groups were found along transects T6 and T8.

Merluccius sp. larvae showed high densities along the central stations (7-4 to 7-6) of transect T7 and occurred throughout the water column down to the bottom at densities between 22 and 52 individuals per m^2. Densities at the southern stations (7-7 to 7-9) were lower (2.4–5.4 individuals per m^2), and larvae were restricted to the upper 100 m. No hake larvae were observed at the northern stations.

Gobiids were found in the southern part of transect T7 with increasing densities to the south, but not exceeding 13 larvae per m^2. The dominant stage was an unidentified yolk sac larva, indicating recent spawning in the area. Three taxa of larvae were distinguished, but only one was identified at genus level. *Sufflogobius* sp. was found as single specimens at stations 7-3 and 7-9. Gobiid sp. 1 larvae also occurred only at one station (7-9) and were low in abundance. A wider distribution was found for gobiid sp. 2 larvae. They occurred at stations 7-3 and 7-7 to 7-9, and station 2–3 of transect T2 (shelf edge station, not shown in the figures), at a density of 13 individuals per m^2.

Bothidae and Soleidae were restricted to transect T7. Four types of larvae were distinguished, most of them occurring only at one or two stations: one *Bothus* sp. larva in the north at station 7-2, an unidentified yolk sac larva at station 7-5, and five specimens of *Monochirus* sp. at stations 7-5 and 7-8, both at a depth of 0–100 m. The nine *Dicologlossa* sp. larvae were evenly distributed along the stations 7-6 to 7-9 with a maximum density of 4 individuals per m^2. These larvae were restricted (except one specimen) to the upper 50-m layer.

Length distribution of larvae

Standard length of fish larvae varied between 1.3 and 17.0 mm. Most were between 2.6 and 5.7 mm (percentile 10 and 90),

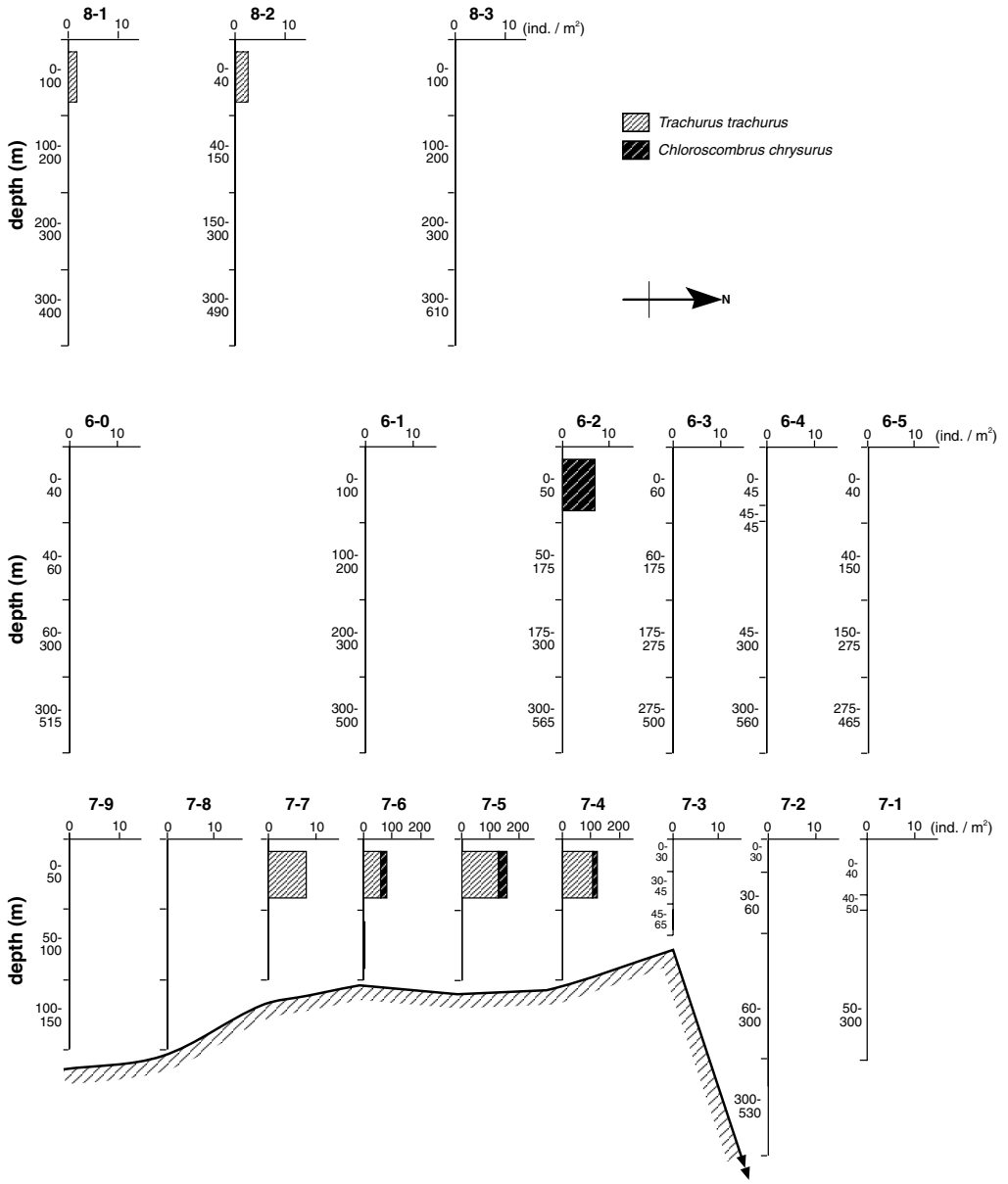

Fig. 5. Vertical distribution of pelagic species *Trachurus trachurus* and *Chloroscombrus chrysurus* collected during the *Africana* cruise in June/July 1999 along two transects (T7 and T8) crossing the Angola-Benguela Front. The seafloor of transect T7 is indicated. Abundance is given as number of larvae per m^2, integrated over the water column. Note the different scale at stations 7-4 to 7-6 and 8-1 to 8-3.

indicating recent spawning in many of the species. The length distributions for the carangid species *Trachurus trachurus* and *Chloroscombrus chrysurus* as well as for *Merluccius* sp. are shown in Fig. 7.

In *T. trachurus* the size ranged from 1.9 to 12.4 mm, increasing in length from the northern to the southern stations with a median length of 2.9–4.1 mm at stations 7-4 to 7-6, and 5.3 and 5.7 mm at stations 7-7 and 7-8, respectively (Fig. 7a) ($r = 0.543$; d.f. = 107; $P < 0.001$). The two larvae found along the offshore transect (T8) were 3.3 and 8.3 mm long. Although only two specimens were found here, their size range appears to reflect the general trend of increasing lengths from north to south as observed along transect T7.

In the pelagic species *C. chrysurus,* the length range of the larvae was narrow, between 2.7 and 5.7 mm, probably representing one single spawning cohort (Fig. 7a). Occurring only at stations 6-2 and 7-4 to 7-6, no significant difference was found between the length ranges at the different stations and latitudes ($r = 0.039$; d.f. = 34).

The third most abundant species where length distribution could be analysed was *Merluccius* sp. (Fig. 7b). As for *T. trachurus,* a similar trend of increasing length from north to south was also found for this species. Lengths at the central stations 7-4, 7-5 and 7-6 ranged from about 2 to 5 mm with a median between 3.0 and 3.6 mm. Larvae at the southern stations 7-7 to 7-9 ranged in length between 2.5 and 7 mm with medians between 3.3 and 6.5. However, length and latitude were only weakly correlated with P slightly above 0.05 ($r = 0.257$; d.f. = 47).

Discussion

This work presents the first results on the distribution of fish larvae in the ABF area. The abundance of larvae during the period of investigation was generally low except for some stations. In the upwelling area between 19° and 21°S especially, these low densities can be explained by the prevailing typical winter conditions. Unfortunately, the distribution of the different taxa along these transects (T2–T5) could not be investigated in detail. The study of zooplankton was planned to focus on the frontal area and the continental shelf area off Angola further north, but could not be performed as foreseen.[20] The focus of the

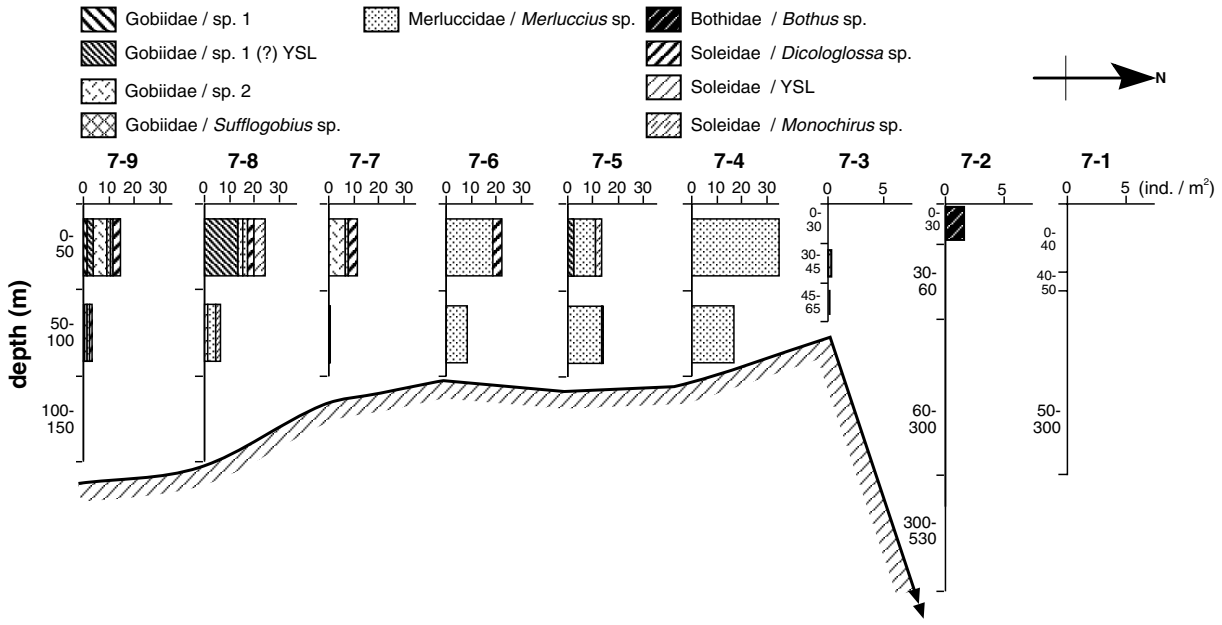

Fig. 6. Vertical distribution of demersal species/taxa caught during the *Africana* cruise in July 1999 along transect T7 crossing the Angola-Benguela Front. The seafloor is indicated. Abundance is given as number of larvae per m², integrated over the water column. Note the different scale at stations 7-1 to 7-3. YSL = yolk sac larvae.

ichthyoplankton analysis in this paper was therefore on its horizontal and vertical distribution in the frontal area at 15°30′ to 17°30′S.

Along the neritic transect T7, the distribution pattern was governed particularly by the hydrographic regime. Three groups of three stations each, divided by the ABF, could be distinguished. In the north, the water column showed a stratification typical of a tropically-influenced water mass (thermocline at about 40–50 m). Larval abundance was very low throughout the water column, and mainly mesopelagic fishes were found in the deeper layers. In the central part of the transect, larval densities were the highest encountered during the cruise, with 245–407 larvae per m². They were concentrated in the upper 50-m layer. The hydrographic data showed very strong thermoclines down to a depth of about 100 m and one could assume the presence of some vortices in that area, which may attract or trap the fish larvae.

Besides some mesopelagic species from different families, a relatively high number of inshore/shelf species was found along transect T7, which ought to remain on the shelf and so avoid being swept away by the prevailing currents, the offshore branches of the Angola and Benguela currents. Most of these species/groups have presumably developed behavioural adaptations which enable them to make use of the current regime for their nearshore distribution. None of the pelagic and demersal species (Figs 5, 6), except single specimens of *Trachurus trachurus* at stations 8-1 and 8-2 and *Chloroscombrus chrysurus,* were observed at the offshore transects T6 and T8. Indeed, they were all concentrated at the central and southern stations of transect T7, especially in the upper 50–100 m, where the concentrating forces of the gyre seemed to have their strongest influence (see the steep isolines in temperature and salinity profiles in Fig. 2).

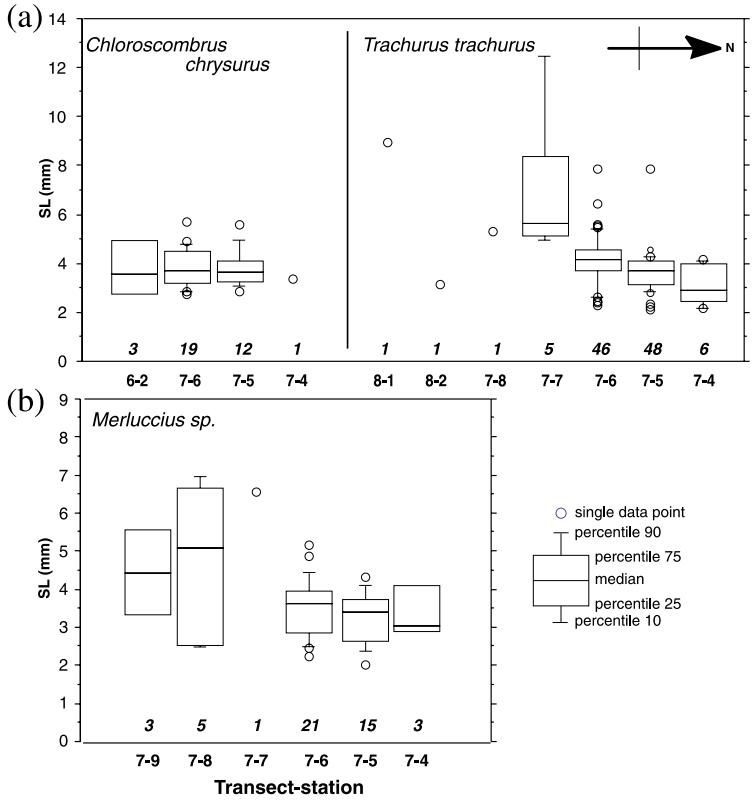

Fig. 7. Length distributions (standard length – SL) of (**a**) *Trachurus trachurus* and *Chloroscombrus chrysurus* and (**b**) *Merluccius* sp. at positive stations along the transects T6, T7 and T8. Given are the median, and the 10, 25, 75 and 90 percentiles. Numbers in italics indicate the number of larvae caught at each station.

T. trachurus and its subspecies *T. t. capensis* inhabit the waters from the Gulf of Guinea to the east coast of South Africa.[15] Spawning off Namibia occurs in summer and autumn and high concentrations of eggs and larvae have been recorded at about 18–22°S, being the most northern record of *T. trachurus* larvae in the Benguela system.[21] During the *Africana* cruise in July 1999, a north–south gradient in larval length was found, suggesting a spawning area further north in the southern part of the Angola Current system. The distribution pattern found during this cruise implies also that some specimens were transported offshore and so were lost to the inshore population.

The presence of the other pelagic species, *C. chrysurus,* has not

been reported previously in the Benguela system,[15] only off West Africa.[19] Matsuura and Olivar[18] recorded *C. chrysurus* larvae in the western South Atlantic off the Brazilian coast, but not in the east. The species occurs, however, in South African waters as adults, and thus spawning there can be expected. A major spawning area may be found on the shelf of southern Angola and northern Namibia. In comparison to *T. trachurus,* the distribution of *C. chrysurus* was restricted mainly to the central stations of transect T7, apart from three specimens at station 6-2. It has been reported[22] that young *C. crysurus* are found far offshore. Adult fish occur mainly in shallow waters or estuaries.[22] We do not know whether or not offshore transport of young stages occurs occasionally or is part of their life cycle. If a stage in their early life history, the larvae should have developed a mechanism to return to the coast to close the developmental cycle. This could be done by means of small, medium or even large-scale vortices. Similar adaptations can be assumed in the life cycle of *T. trachurus.* Much more information is needed to address this issue, which is important to understanding the biology and ecology of commercially important species in this area.

The abundance and size distribution of *Merluccius* larvae reported here were a surprise. Three species are likely to occur in the area: *Merluccius capensis, M. paradoxus* and *M. polli.*[15] *M. capensis* and *M. paradoxus* have their centre of distribution in the entire Benguela system as far north as about 18°S. The distribution of *M. polli* overlaps partly with that of the two other species and extends further north. In the study area, however, all three species may occur. Differentiation of the three species is mainly based on the number of vertebrae, a diagnostic feature difficult to apply in the early larval stages[15] as they were found during the cruise. Both *M. capensis* and *M. paradoxus* are typical upwelling species with their main spawning season from September to January in South African and Namibian waters.[22] The very small size-groups found during this cruise indicate, however, that spawning in the study area still occurred in June and July, and slightly increased larval lengths towards the south may indicate that spawning had taken place in the northern part of the Angola-Benguela Front area rather than that these larvae had been transported from the south by branches of the colder, northward-flowing Benguela Current. No description of *M. polli* larvae was found in the literature. The material we collected was not enough to establish a solid morphological description of the larvae. From catching season and spatial distribution pattern, however, it is reasonable to assume that the larvae caught during the *Africana* cruise belong to *M. polli.*

The distribution of the mesopelagic species is not exclusively restricted to the inshore transect (T7). The Gonostomatidae prefer deeper water below 200 m, thus occurring in colder waters off the continental shelf. The other mesopelagic taxa were found mainly in a surface layer down to a depth of 50 m, but were more evenly distributed than the pelagic and demersal groups. Abundance was generally low, except for station 7-4, and allows only a rough classification with regard to their preference for colder (Benguela) or warmer (Angola) water masses. *Bathylagus* sp., *Cyclothone* sp., *Lampanyctodes* sp., Sy*mbolophorus* sp., *Lestidiops* sp. and *Vinciguerria poweriae* occurred mainly at the northern stations influenced by the warm Angola Current. *Diaphus* sp. and *Hygophum* sp. were found along the entire transect and showed higher abundances only at the central stations, possibly as a result of the prevailing hydrographic conditions. Some species (*Cyclothone* sp., *Diaphus* sp., *Hygophum* sp., *Symbolophorus* sp.) were also found at the offshore stations along transects T6 and T8, at densities similar to those observed at nearshore stations. There is evidence to suggest that, for these mesopelagic species, offshore transport is not unlikely to take place as their life cycles are generally characterized by large-scale distribution offshore.[16]

Although the number of larvae collected during this cruise and the short sampling period and restricted sampling area limit our interpretation of the results, they give a first insight into the distribution of the different ichthyoplankton groups and their ecological adaptations to the hydrography of the ABF area. They are adapted to remain on the continental shelf; moreover, currents are used to transport larvae back to the coast if offshore currents have taken them offshore. Neritic and coastal species occur further offshore (~ 60 km) than Ekau *et al.*[9] reported for species associated with the Brazilian coast at similar latitudes. In contrast to the hydrographic conditions off northeastern Brazil, where inshore and longshore currents dominate, the larvae in the ABF area seem to encounter more shoreward currents, allowing them to return to the coast.

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