

## Cross-front structures in hydrography and fish larvae at the Angola-Benguela Frontal Zone

by

H.-Ch. John, V. Mohrholz, and J.R.E. Lutjeharms

During April 1999 the German RV "Poseidon" surveyed a hydrographic station grid of 97 CTD stations from northern Angola to northern Namibia, and from 8°E to nearshore waters. Additional measurements at CTD stations included meteorological data, oxygen, chlorophyll-a fluorescence, and Rosette water samples. Between the hydrographic stations underway measurements of surface temperature and salinity and with a vessel-mounted acoustic Doppler current profiler (VMADCP) were performed. For the period and region of the survey a sequence of 8 SST satellite images was additionally available (see poster ICES, CM 2000/L:22, by Mohrholz et al.).

Along the western margin of this hydrographic grid 14 plankton stations were sampled by a David-neuston net (NEU) at the surface (0 - 8 cm depth) and 5 strata 0 - 25, 25 - 50, 50 - 100, 100 - 150 and 150 - 200 m by a Bé-multiple-opening-closing-net (MCN). The plankton transect passed closely to the west of the **Angola Dome (AD)** and beyond the center of the **Angola-Benguela Frontal Zone (ABFZ)**.

The survey started near the equator during a Benguela Niño situation, when surface temperatures were above average throughout the area, and unusually warm off northern Namibia. It cut the western edge of the Angola Dome, and ended off northern Namibia at a time when strong equatorward winds had caused upwelling off Namibia and brought the **ABFZ** closer to its normal position centered at 16°S. The meridional gradient of the **ABFZ** was much stronger inshore than farther offshore, but its offshore surface expression reacted within days to changing wind situations, too.

The vertical extent of the thermal front was limited to the surface layer above the thermocline. The subsurface hydrographic conditions north of the **ABFZ** were characterized by a strongly pronounced thermocline at a depth of 20 to 30 m between the tropical surface water and **South Atlantic Central Water (SACW)**. South of 16°S the thermocline was weaker and sloped down to a depth of 40 m. At the **ABFZ** we observed a change of water masses (water cooler than 23°C and with a slightly decreased salinity  $\leq 36.0$ ). Several dome-like elevations of isotherms (and other parameters) can be seen. The most prominent one was located at 15°S, where a minimum of dynamic height was found and VMADCP data showed an eddy-like current pattern. In the **ABFZ** a downsloping of all physical parameters due to converging currents was evident. The centre of vertical distribution of both chlorophyllum and fish larvae coincided roughly with the pycnocline and deepened with it at the front.

Across the **ABFZ** the fish larval abundances decreased towards the south in both types of samplers. For the NEU, diurnal periodicities in the catchability of several species do not allow for any quantification. In the MCN, north of the **ABFZ** average fish larval abundances of some 150 larvae per squaremeter were six times higher than south of it. The gross species richness declined from 36 species (combining NEU and MCN species) per station at 6°S towards the south by about one species per degree of latitude, but did not reveal any distinct

signal at the **ABFZ**, except that at the station of minimum abundance the number of species inevitably dropped, too. However, the community structure changed drastically across the front. The faunal structures north and south of the **ABFZ** had a similarity of only 22 %. The diversity indices reached maxima, percentage similarity between stations minima at the boundary.

A total of 120 species was identified. The top ranking 20 taxa amounted to 87.8 % of the total catch. Off Angola, larvae of mesopelagic fish species apparently adapted to oxygen deficits dominated. Only few oceanic epipelagic species were encountered. Generally **widely distributed tropical-subtropical** species like, e.g., *Ceratoscopelus warmingi* occurred across the **ABFZ**, although they became slightly less abundant within the **ABFZ**, proper, and also in other areas with westward flow. However, **tropical mesopelagic** species became rare (e.g. *Vinciguerria nimbaria*) south of the **ABFZ**, or **tropical epipelagic** species disappeared completely, becoming replaced off northern Namibia by **southern, temperate** species like, e.g., *Scomberesox saurus* at the surface, or by *Hygophum ?bruuni*, *Bathylagus ?tenuis*, *Tetragonurus cuvieri* and *Diplospinus multistriatus* in subsurface waters.

Neustonic or suprathermoclineal larvae of tropical species had more pronounced and more northerly boundaries than respective stages preferring the thermoclineal/subthermoclineal layers. The latter species revealed more scattered and deeper distributions in, and occasionally beyond, the **ABFZ**. However, a vertically differing, horizontally diluted boundary may have been a wind effect. Strong winds from the southeast probably had driven neustonic species equatorwards, and displaced the former position of the southern **ABFZ** within a few days to its actual surface position, leaving rudiments of the Angolan deeper fauna behind. Such displacement has a time lag of only one day in respect to the onset of the wind and can reach 1.5° of latitude per day. Adult mesopelagic fish characterising the Angolan province penetrated somewhat more to the south than their shallow living larvae, again in agreement with a more southern position of the front at depth, but explainable also by a larger temperature tolerance range of adults.

Author's addresses:

H.-Ch. John: Deutsches Zentrum für Marine Biodiversität am Forschungsinstitut Senckenberg, Martin-Luther-King-Platz 3, 20146 Hamburg, Germany [hcjohn@zoologie.uni-hamburg.de].

V. Mohrholz: Institut für Ostseeforschung, Seestraße 15, 18119 Rostock-Warnemünde, Germany [volker.mohrholz@io-warnemuende.de].

J.R.E. Lutjeharms: Department of Oceanography, University of Cape Town, 7700 Rondebosch, South Africa [johann@physci.uct.ac.za].