Zooplankton Biomass in Upwelling Regions off Northwest and Southwest Africa

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SUMMARY: In this study a comparison of amounts and distributions of zooplankton biomass between two oceanographic cruises conducted in each one of the upwelling regions off the African coast during spring was made. In both cases, the samples came from oblique hauls made with a Bongo type engine fitted with 505 µm mesh size nets. The hydrographic features found during the cruises, especially the location of the upwelling centres, could explain the plankton biomass distribution obtained in each case. The comparison between both regions led to the following comments:

— The southwest upwelling region showed better inherent conditions favouring plankton development, and the obtained values of biomass were noticeably higher.
— The peaks of plankton abundance in the northwest region were found at a greater distance from the coast than in the southwest region.
— Lowest values of plankton biomass were found in areas with more stratified waters.

RESUMEN: BIOMASA ZOOPLANCTÓNICA EN LAS REGIONES DE AFLORAMIENTO DEL NO Y SO DE ÁFRICA. — En el presente trabajo se comparan los valores y distribución de la biomasa zooplanctónica entre dos expediciones oceanográficas efectuadas en cada una de las regiones de afloramiento de la costa africana, en primavera. En ambos casos, las muestras proceden de pesca oblicua realizadas con un aparejo tipo Bongo, equipado con redes de 505 µm de abertura de malla. Las características hidrográficas halladas durante las campañas, especialmente la posición de los núcleos de afloramiento, podrían explicar la distribución de la biomasa planctónica obtenida en cada caso. La comparación entre ambas regiones sugiere los comentarios siguientes:

— La región de afloramiento del SO africano muestra mejores condiciones inherentes para el desarrollo del plancton, y los valores de biomasa obtenidos fueron sensiblemente más elevados.
— Los máximos de abundancia planctónica en la región noroccidental se situaron a mayor distancia de la costa que en la región sudoccidental.
— Los valores más bajos de biomasa planctónica se encontraron en las zonas de mayor estratificación de las aguas.

INTRODUCTION

In recent years the upwelling studies have experienced an important increase. The influence of hydrographic conditions and dynamics on develop-
ment of plankton blooms is one of the problems that presents a relevant interest in order to know the distribution of the productivity in such upwelling areas. This problem has been the object of different studies in the areas under consideration, for instance, Postel (1982), Le Clus and Kruger (1982).

Several cruises to study some features of upwelling, such as hydrographic conditions and plankton distribution, have been carried out since 1971 by the IIPB in the main upwelling areas off West Africa. In this paper we selected two of these cruises, corresponding to the same season (spring), one in the Northwest region (Atlór V, April 1974, between 26° 10' N and 23° 20' N), and another in the Southwest region (BENGUELA I, November 1979, between 19° 30' S and 23° S), so as to compare the differences in the behaviour of the structures with regard to the plankton distribution and abundance. The areas studied, together with the sampling grids used, are shown on Figures 1 and 2.

![Diagram](image)

**Fig. 1.** The area off Northwest Africa covered during Atlór V cruise (April 1974), showing the sampling grid used.

**MATERIAL AND METHODS**

During both cruises, oblique hauls with a Bongo type engine fitted with 505 µm mesh size nets were made.

The results concerning the Northwest Africa samples have been published previously (Rubiés, 1976). The plankton biomass was estimated by the volume by displacement method (Prollander, 1957), after the samples had been preserved for more than two months from their collection, as recommended by Ahlstrom and Thrailkill (1963).

As most of the Southwest Africa samples included a large quantity of
Salps and other gelatinous organisms, which would have masked the results if the volume method had been used, dry weight measurement was instead chosen. This was estimated with the method described by Le Borgne (1975).

The hydrographical data obtained in these cruises and used in this paper were published by Manríquez et al. (1976) for Atlor V and by Salat (1981) for Benguela I.

RESULTS AND DISCUSSION

NW Africa (Figs. 3 and 4)

— The continental shelf is very narrow and it has a sharp slope to the North of 26° N. It becomes wider to the South of 25° 30' N, reaching a maximum of more than 60 miles wide at 25° N, with a mean depth of 50 m.

— Upwelling is intense all over the continental shelf and edge in the area located to the North of 25° 30' N. Here, the ascending movement of waters affects the whole water column. Plankton densities in this area are very low over the shelf, probably due to the great turbulence.
— To the South of 25° 30’ N, an intense upwelling is present over the edge, whilst on the shelf, the water climbs up the bottom very close to it, breaking at surface to the South of 24° 30’ N, at very inshore points (less than 15 miles from the shore). At these points as well as over the edge, the highest plankton densities are found.

![Fig. 3. — Distribution of zooplankton biomass off Western Sahara (April 1974), given in ml of plankton volume/1000 m³.](image1)

— Between 24° 45' N and 24° 15' N, and at a mean distance of 40 miles off-shore, there is a more stratified region probably produced by a surface cyclonic gyre similar to the one found in the Namibian upwelling. The plankton density is also very low in this region.

![Fig. 4. — Scheme of water mass circulation in NW Africa during AILOD V (April 1974). Solid arrows show upwelled cold waters, empty arrows show the direction of surface warm waters.](image2)
The upwelled waters are carried offshorewards (WSW direction) without sinking, thus maintaining sizeable plankton populations starting from peak areas in this direction.

**SW Africa (Figs. 5 and 6)**

- The continental shelf has a fairly pronounced slope all over the region, with a mean depth of about 150 m.
- An intense upwelling centre is present South of 22° 30' S spreading inshore to 21° S. The ascending movement of waters follows the shelf bottom and breaks at surface at a maximum distance of 30 miles offshore North of 22° 30' S. The upwelled water is carried across the surface in the WNW direction, gradually sinking as it moves away from the coast. Plankton peaks are found near the upwelling centres, somewhat displaced to the NW.
- Between 23° S and 22° S a shorewards income of surface water occurs, presumably following a cyclonic gyre. The result is an area of more stratified waters with low densities of plankton.

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**Fig. 5.** Distribution of zooplankton biomass off northern Namibia (November 1979), given in mg/m³ of dry weight.
— Separated from the influence of the southern upwelling by an area of stratified as well as plankton-poor waters, there is a second upwelling centre between 20° S and 19° 30' S. It shares similar features with the southern centre, while being somewhat weaker. The plankton distribution here is similar to the southern one, but not quite reaching the same densities.

COMPARATIVE REMARKS

— The Southwest upwelling region shows better inherent conditions favouring plankton development than the Northwest region. The main reasons for that are a more stable and persistent upwelling process and a higher nutrient contents in the water masses upwelled.

— In both regions, the warm surface water appears to carry the plankton populations westwards, though not too far away from the upwelling centres.

— Peaks of plankton abundance in the NW region are found at a greater distance from the coast than in the SW region. This could be due to a higher dynamics of the surface waters and to a lesser mean depth of the continental shelf in the former region.
— Lowest values of plankton biomass are found in areas with more stratified waters.

REFERENCES


