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Comparative productivity and biomass yields of the Guinea Current LME

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ABSTRACT

Plankton production patterns in the Guinea Current Large Marine Ecosystem (GCLME) were investigated using data obtained from Continuous Plankton Recorder (CPR) tows carried out in the GLCME, from December 1995 to November 1999. Four CPR routes were established between Cote d'Ivoire and Cameroon as part of the pilot phase of the GCLME project, funded by the Global Environment Facility. Phytoplankton and zooplankton yields were greatest during the major upwelling compared to the other identifiable hydrographic seasons. The phytoplankton was dominated by diatoms whereas smaller zooplankton (< 2 mm) occurred in greatest abundance. Analyses of ten years sea surface temperature (SST) data from 1990 to 2000 revealed two thermal regimes; a warmer phase followed by a colder phase that commenced in 1997. Annual phytoplankton and zooplankton yields in 1997 were relatively higher than the other years of the CPR sampling. Analyses of zooplankton community structure, in terms of species occurrence and relative abundances, was found to be similar during the minor and major upwelling. The zooplankton taxa contributing to dissimilarity in community structure were Chaetognath (< 2 mm), *Oithona* spp., *Oncaea* spp, copepod nauplii, echinoderm larvae, *Para-Pseudocalanus, Temora* spp., *Eucalanus* spp., and *Clausocalanus* spp. Spatial and seasonal variation in phytoplankton communities did not follow any pattern. It was observed from a multiple regression analysis that phytoplankton distribution alone accounted for a significant proportion of the variation in zooplankton distribution in all hydrographic seasons except the major upwelling, during which period sea surface temperature contributed over 60% of the observed variation. This investigation using CPR is the first of its kind in the GCLME and thus provides a baseline information to guide future studies.

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1. Introduction

The Guinea Current Large Marine Ecosystem (GCLME) is one of sixty-six LMEs (UNESCO, 2008) identified as ecosystem management units (Sherman, 1993) of the world's oceans. There are sixteen countries bordering the 7600 km stretch of the GCLME coastline (Fig. 1), which is uniquely identified by the Guinea Current, bounded at the northern and southern ends by the Canary and Benguela Currents, respectively. This LME is influenced, to a large extent, by the meteorological and oceanographic processes of the South and North Atlantic Oceans, principally their oceanic gyral currents (Merle and Arnault, 1985; Fontaine et al., 1999).

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Fig. 1. The Guinea Current Large Marine Ecosystem (GCLME) region.

The oceanographic regime has been intensely investigated with regards to the timing of the hydrographic seasons (Houghton, 1983). It is fairly conclusive to consider four hydrographic seasons in the form of minor upwelling (January–February), thermal stratification (March–June), major upwelling (July–September), and thermal stratification (October–December). The major upwelling is concentrated off the coasts of Cote d'Ivoire to Nigeria (Verstraete, 1992), and hence recognised as the most productive part of the GCLME. This sector is often referred to as the north western Gulf of Guinea (Ingham, 1970).

The coastal waters of the Gulf of Guinea are associated with a high floral and faunal diversity and low abundance during thermal stratification, and low diversity but high abundance during the upwelling (Bainbridge, 1972; Dandonneau, 1972). Three main phases in phytoplankton development have been recognised in the Gulf of Guinea – low numbers of organisms from February to June, high numbers from July to early November and drop in numbers from November to February (Anang, 1979; Dandonneau, 1971, 1972; Reyssac, 1966, 1970). These periods correspond to the seasonal changes in coastal hydrography which also reflect in the species composition. Diatoms normally constitute the dominant group, especially during the major upwelling season when the water temperature is relatively cold (20–25 °C) and conducive for their growth (Dandonneau, 1971), whiles dinoflagellates on the other hand thrive well when the temperature is above 25 °C.

It has been noted that during the upwelling the total zooplankton is more abundant, though with lower species diversity (Bainbridge, 1972). Binet (1972) drew attention to the importance of the upwelling, especially to the contribution of certain deeper-living copepods for the shallower continental shelf area of Côte d'Ivoire and Ghana. The biomass of zooplankton follows phytoplankton abundance; occurring in deeper waters during the colder season and shallower in the warmer months (Bainbridge, 1972). Young herbivorous stages of copepods tend to be nearer to the surface. For successful survival, Binet (1972) has suggested that zooplankton populations might remain near the surface, where they may well be transported to more oligotrophic waters, but they must reproduce more or less continuously, according to the food available.

Productivity pattern in the Gulf of Guinea closely follows the seasonal hydro-climatic changes. The nutrient-rich waters brought to the surface stimulate phytoplankton production in the coastal waters. This available food results in an increase in zooplankton production, especially of copepods. The upwelling period coincides with the spawning of *Sardinella aurita*, a major species of the commercial inshore fisheries of the Gulf of Guinea. This pelagic fish feeds principally on *Calanoides carinatus* (Mensah, 1974).

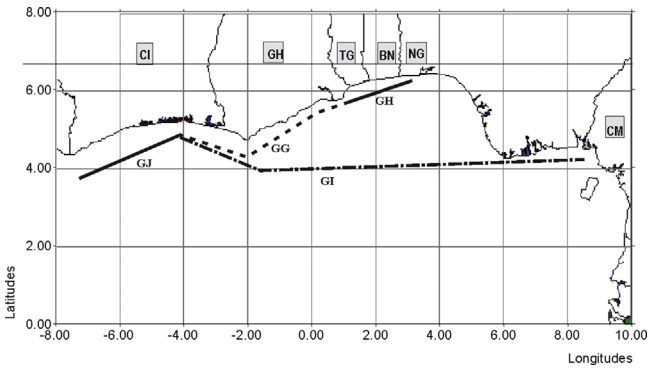

Fig. 2. Continuous Plankton Recorder routes in the Gulf of Guinea. Data used in this study were obtained from stations marked CI (Côte d'Ivoire), GH (Ghana), TG (Togo), BN (Benin), NG (Nigeria) and CM (Cameroon).

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