Spatio-temporal variation of microphytoplankton in the upwelling system of the south-eastern Arabian Sea during the summer monsoon of 2009*

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Abstract

The phytoplankton standing crop was assessed in detail along the South Eastern Arabian Sea (SEAS) during the different phases of coastal upwelling in 2009.

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During phase 1 intense upwelling was observed along the southern transects (8°N and 8.5°N). The maximum chlorophyll *a* concentration (22.7 mg m $^{-3}$) was observed in the coastal waters off Thiruvananthapuram (8.5°N). Further north there was no signature of upwelling, with extensive *Trichodesmium erythraeum* blooms. Diatoms dominated in these upwelling regions with the centric diatom *Chaetoceros curvisetus* being the dominant species along the 8°N transect. Along the 8.5°N transect pennate diatoms like *Nitzschia seriata* and *Pseudo-nitzschia* sp. dominated. During phase 2, upwelling of varying intensity was observed throughout the study area with maximum chlorophyll *a* concentrations along the 9°N transect (25 mg m^{-3}) with *Chaetoceros curvisetus* as the dominant phytoplankton. Along the 8.5°N transect pennate diatoms during phase 1 were replaced by centric diatoms like *Chaetoceros* sp. The presence of solitary pennate diatoms *Amphora* sp. and *Navicula* sp. were significant in the waters off Kochi. Upwelling was waning during phase 3 and was confined to the coastal waters of the southern transects with the highest chlorophyll *a* concentration of 11.2 mg m^{-3}. Along with diatoms, dinoflagellate cell densities increased in phases 2 and 3. In the northern transects (9°N and 10°N) the proportion of dinoflagellates was comparatively higher and was represented mainly by *Protoperidinium* spp., *Ceratium* spp. and *Dinophysis* spp.

1. Introduction

The phytoplankton community in a coastal upwelling system is influenced by the temporal variations in physicochemical factors associated with the progression of upwelling processes. Factors like temperature (Goldman & Mann 1980), illumination (Ryther 1956), turbidity (Estrada & Berdalet 1997) and nutrients (Sanders et al. 1987) have significant effects on the distribution of phytoplankton in such regions. The phytoplankton community in the various upwelling regions of the World Ocean has been assessed in numerous research works. It is usually the case in an upwelling ecosystem that phytoplankton of the class Bacillariophyceae (diatoms) flourish during intense upwelling conditions with enhanced nutrient levels, but is replaced by dinoflagellates (class: Dinophyceae) during the relaxation period of the more or less stratified water column. Earlier studies in upwelling areas off north-west Africa (Estrada & Blasco 1985) revealed an abundance of diatoms belonging to the genera *Chaetoceros*, *Thalassiosira* and *Rhizosolenia* in the phytoplankton community. Recent works have identified certain functional groups of phytoplankton in upwelling regions. According to Tilstone et al. (2000) diatom dynamics in a coastal upwelling system is greatly influenced by physical processes; hence, the upwelling that initiates several biogeochemical responses can be treated as forces shaping the phytoplankton community. Lassiter et al. (2006) examined the diatom community response to upwelling events along the coasts of northern California and stated that *Chaetoceros* sp. together with other