Palaeogeography, Palaeoclimatology, Palaeoecology xxx (2017) xxx–xxx

Contents lists available at ScienceDirect

Palaeogeography, Palaeoclimatology, Palaeoecology

journal homepage: www.elsevier.com/locate/palaeo

Dinoflagellate cyst distribution in sediments of western Bay of Bengal: Role of sea surface conditions

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ARTICLE INFO

Article history:
Received 10 June 2016
Received in revised form 9 January 2017
Accepted 9 January 2017
Available online xxxx

Keywords:
Dinoflagellate cysts
Bay of Bengal
River discharge
Productivity
Upwelling

ABSTRACT

Bay of Bengal is a shallow marine basin exposed to seasonal fluctuation in precipitation and run-off. Thus, salinity, temperature, nutrient and productivity vary along the latitudinal and onshore-offshore gradient in the Bay of Bengal. These parameters directly affect primary productivity, including that of dinoflagellate cysts. The spatial distribution of organic walled dinoflagellates cyst is studied in the 50 surface samples of eight transects from the western Bay of Bengal, to infer variation in the environmental conditions in the region. The cyst diversity consists of 40 taxa with an overall high dominance of protoperidinioid cysts over gonyalaucoides. Based on the study distinct onshore and offshore dinocyst assemblages are identified. The high productive coastal upwelling region is characterised by the dominance of gonyalaucoid dinocyst species *Bitectatodinium spongium* (Zonneveld 1997) Zonneveld and Jurkschat 1999 indicating its adaptability to the fluctuating salinity and high nutrient conditions. The outer shelf to middle slope regions of western Bay of Bengal is dominated by the protoperidinioid species. This is in contrast to the gonyalaucoid dinocyst assemblages of the outer shelf to middle slope regions in other oceans. Since protoperidinioids prefer high nutrient and reducing environmental conditions for growth and preservation, their presence suggest high nutrient availability due to the river discharge and low oxygen condition in the slope region in Bay of Bengal. Statistical analyses of the sea surface parameters and dinoflagellate cyst abundance data indicate that salinity and silicates as a major source of nutrient played a major role in the distribution of dinoflagellate cyst in the Bay of Bengal.

1. Introduction

Dinoflagellates, a group of unicellular protist, produce hypnozygotic cysts through sexual reproduction. It is evident that despite the latitudinal gradient, distribution of dinoflagellate cysts species depends on the physico-chemical conditions such as salinity, temperature, pH parameter as well as physical processes viz., river discharge, upwelling sea ice cover, oxygenated levels in the water column and oceanic current patterns (Bouimetarhan et al., 2009; Dale, 1983; Rochon et al., 1999; Zonneveld and Brummer, 2000; Marret and Zonneveld, 2003; Zonneveld et al., 2001, 2013; Holzwarth et al., 2010). The dinoflagellate cyst assemblage composition, productivity, and preservation vary on the small spatial scales within the same latitudes. Specific environmental conditions can be inferred from the presence of dinoflagellate species in the marine ecosystem. Besides, few studies have reported that cyst production is highly sensitive to the anthropogenic pollution (Matsuoka, 1999; Dale, 2001, 2009; Pospelova et al., 2002, 2004, 2006; Matsuoka et al., 2003) which is evident by the cyst assemblage alteration, dominance of assemblage by monospecific species and change in the cyst productivity.

It is necessary to study dinocyst regional distribution and environmental factors influencing the same for better utilisation of dinoflagellate cysts as a proxy to decipher environmental fluctuations. Such analogues have proved to refine the use of dinoflagellate cysts as potential proxy for the determination of various environmental parameters for that area (Eynaud et al., 2004; Holzwarth et al., 2007).

Till date, detailed dinoflagellate cyst distribution studies from the northern Indian Ocean are limited to the western Arabian Sea. Dinoflagellate cyst distribution from the Bay of Bengal remains poorly documented. A few studies reporting cyst distribution is confined to only 8 coastal sites (Narale et al., 2013). Here, we present the results of dinocyst study undertaken on the surface sediments from the western Bay of Bengal, which is influenced by the seasonal river discharge and monsoon precipitation. Since no studies were carried out from this area, the present study focuses on the following objectives: 1. To document the surface distribution of dinoflagellate cysts and provide distribution maps. 2. To decipher the relationship of the cyst with sea surface parameters and develop a regional database that could form a basis for the paleoproductivity, paleoceanographic, paleomonsoon studies from the Bay of Bengal.

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http://dx.doi.org/10.1016/j.palaeo.2017.01.013
0031-0182/

2. Study area

2.1. Physiognomic setting

Bay of Bengal (BoB) is a shallow embayment in the north-eastern part of the Indian Ocean covering an area of about 2.2 million km^2 (LaFond, 1957; Curray and Moore, 1974). Large river systems such as Ganga-Brahmaputra, Mahanadi, Krishna, Godavari deliver a runoff of ~2950 km^3/yr through their respective deltaic systems, that together with high precipitation ~2 m a^{-1} (Prasad, 1997) turns the BoB a low saline and stratified basin (Shetye et al., 1991, 1993, 1996). Shelf width shows variation in the studied region. From Penner (T1–T4) to Krishna-Godavari river transects shelf width is narrow and wider from T5–T8 transects (Singh and Swamy, 2006).

Surface circulation in the Bay of Bengal is complex due to the interplay among the freshwater discharge, seasonally reversing monsoon winds and heat fluxes (Shetye et al., 1993, 1996; Varkey et al., 1996) (Fig. 1). Besides monsoon winds, Kelvin and Rosby waves play a role in the circulation of the Bay of Bengal (Potemra et al., 1991; Yu et al., 1991; McCreary et al., 1996). During the winter monsoon, circulation is mainly in the form of cyclonic gyre which forms during October and covers the majority of the bay during December and deforms during April. During summer, in the month of June circulation is mostly in an anticyclonic pattern. During the end of August, anticyclonic circulation confines to west of the bay. In September it further confines to the north.

Eastern Indian Coastal Current (EICC) is the major current flowing along the western boundary as a discontinuous flow in the form of a

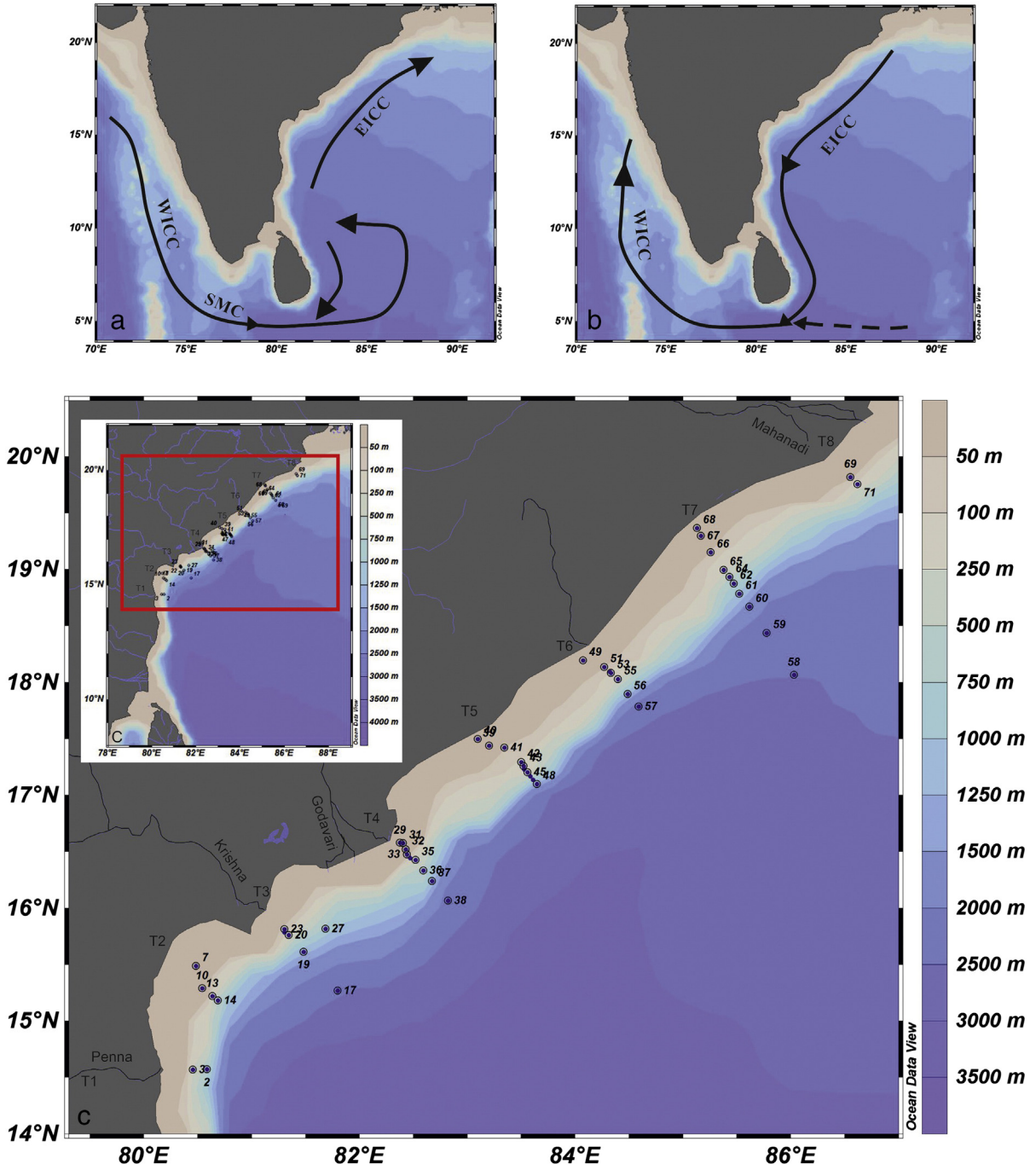

Fig. 1. Map showing rivers, bathymetry (m) and surface currents during A. summers, B. winters. C. sampling sites and depth profile.

Please cite this article as: Uddandam, P.R., et al., Dinoflagellate cyst distribution in sediments of western Bay of Bengal: Role of sea surface conditions, Palaeogeogr. Palaeoclimatol. Palaeoecol. (2017), http://dx.doi.org/10.1016/j.palaeo.2017.01.013