Marine Micropaleontology 69 (2008) 263–281

Contents lists available at ScienceDirect

Marine Micropaleontology

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

Diatom-derived SSTs (*Td′* ratio) indicate warm seas off Japan during the middle Holocene (8.2–3.3 kyr BP)

Itaru Koizumi

Atsubetsu-kita 3-5-18, Atsubetsu-ku, Sapporo 004-0073, Japan

ARTICLE INFO

Article history:
Received 19 April 2008
Revised 18 August 2008
Accepted 20 August 2008

Keywords:
Td′ ratio
Td′-derived annual SST (°C)
Kuroshio
Tsushima Warm Current
Fragilariopsis doliolus

ABSTRACT

Regression analysis was performed between the ratio of warm- and cold-water diatoms (*Td′* ratio) in 123 surface sediment samples in the northwest Pacific Ocean and the mean annual sea surface temperatures (SSTs) (°C) at the core sites, in order to calibrate this proxy for paleo-temperatures. Equations to derive annual SST (°C) from diatom analysis were somewhat different for the Tohoku area ($y = 6.5711^{*} \times {}^{0.273}$, $r = 0.89946$) than for the Japan Sea ($y = 5.4069^{*} \times {}^{0.26841}$, $r = 0.89088$). The annual paleo-SSTs (°C) in the Tohoku Area were in general higher than in the Japan Sea despite lower *Td′* values, because the warm-water species *Fragilariopsis doliolus* is abundant only in the Tsushima Warm Current in the Japan Sea. The reliability of the equations is supported by our understanding of the ecology of recent diatoms. *Td′*-derived annual paleo-SSTs (°C) agree with alkenone-derived summer paleo-SST (°C) at a site off central Japan in the northwestern Pacific. In a south-to-north transect of cores around Honshu and Hokkaido, paleo-SSTs (°C) decreased when the Kuroshio and Tsushima Warm Currents weakened. The middle Holocene (8.2–3.3 cal kyr BP) was warmer by 1–2 °C than earlier and later parts of the Holocene, and mean annual paleo-SSTs (°C) show rhythmic fluctuations with durations of 1000 years and 400–500 years. These new data show that annual SSTs were warm in the northwestern Pacific at times that the northeastern Pacific was cold. In addition, oceanic warm- and cold-water species defined by Kanaya and Koizumi [Kanaya, T., Koizumi, I., 1966. Interpretation of diatom thanatocoenoses from the North Pacific applied to a study of core V20–130 (studies of a deep-sea core V20–130, part IV). Sci. Rep. Tohoku Univ., 2nd series (Geol.) 37, 89–130], and Koizumi et al. [Koizumi, I., Irino, T., Oba, T., 2004. Paleoceanography during the last 150 kyr off central Japan based on diatom floras. Mar. Micropaleontol. 53, 293–365] are illustrated.

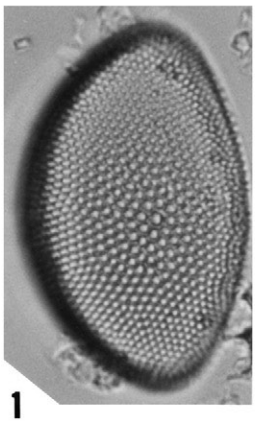
1. Introduction

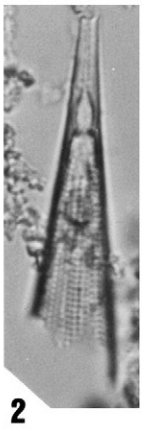
A large area of the seafloor of the northwest Pacific is covered by siliceous sediments containing siliceous microfossils such as diatoms, Radiolaria, and silicoflagellates (Lisitsyn, 1971). Therefore, paleoceanographic and micropaleontological studies on cores recovered from this region have been carried out using siliceous microfossils, especially diatoms (Koizumi, 2006). To estimate paleo-temperatures, the ratio of warm- to cold-water diatom species has been used as a proxy for a long time, but only as a qualitative proxy (SST) (Kanaya and Koizumi, 1966). The proxy used is the diatom temperature (*Td*) ratio: $Td = [Xw/(Xw+Xc)] \times 100$, where *Xw* is the frequency of warm-water species (Plate I) and *Xc* that of cold-water species (Plate II). The proxy as defined by Kanaya and Koizumi (1966) was redefined as the *Td′* ratio, where the taxa used are strictly limited to open ocean (holoplanktonic) taxa, and several warm- and cold-water species were added to the originally defined *Xw* and *Xc* (Plate III) (Koizumi et al., 2004).

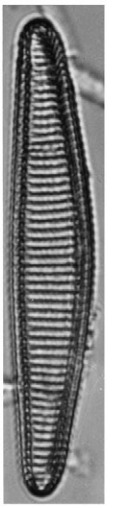
Tanimura (1981) performed Q-mode principal component analysis on data on diatom assemblages in core top and down-core samples from the Japan Sea, and led to the definition of *R*, based on the species associations in the warm-current and cold-current regions as defined by the second principal component: *R* = (species association in warm-current region) / (species association in warm-current region

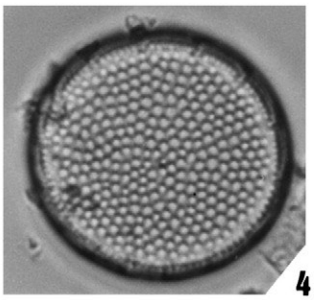
E-mail address: itaru@sci.hokudai.ac.jp.

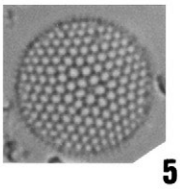
0377-8398/$ – see front matter © 2008 Elsevier B.V. All rights reserved.
doi:10.1016/j.marmicro.2008.08.004

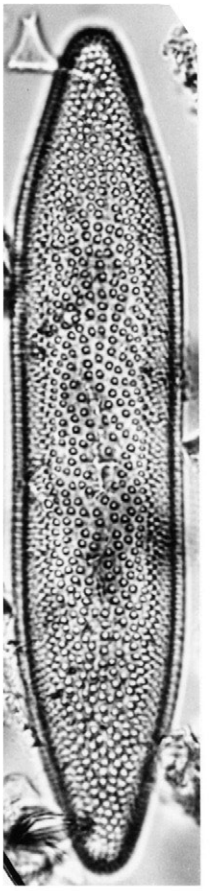

1

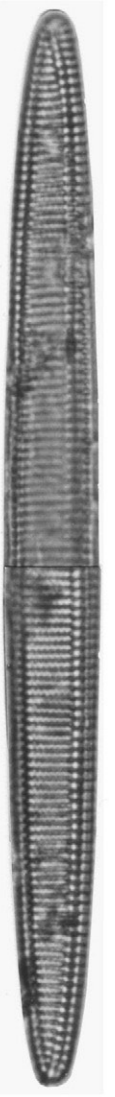

2

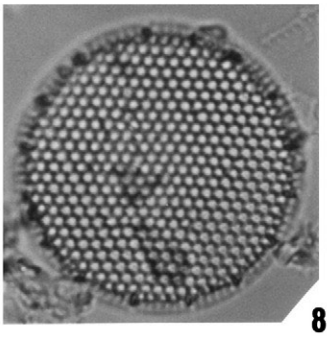

3

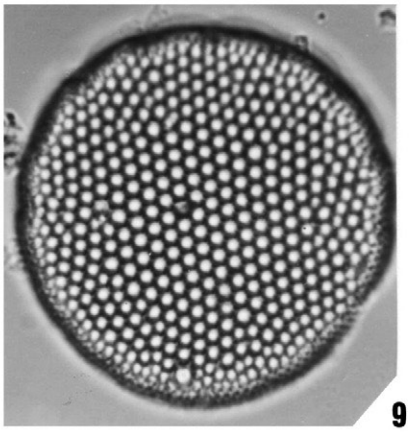

4


5

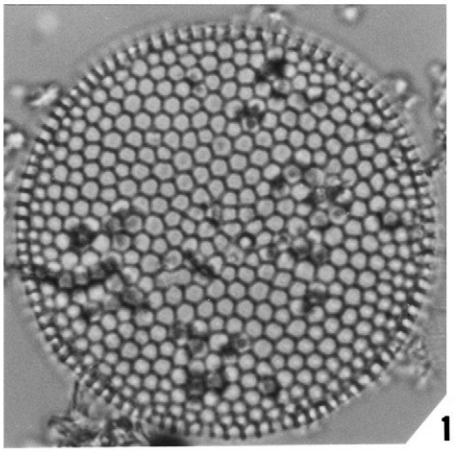

6

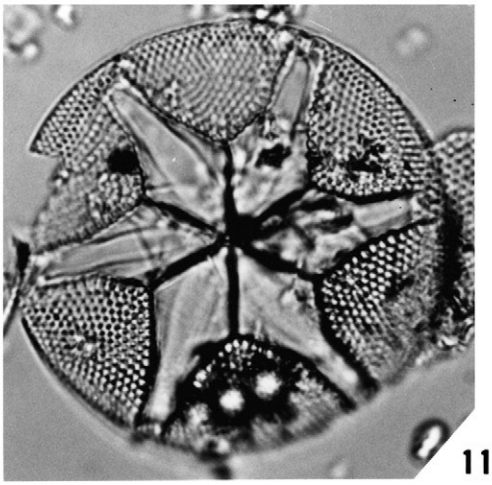

7


8


9

10 µm


10


11