

Paleoceanographic history around the Tsugaru Strait between the Japan Sea and the Northwest Pacific Ocean since 30 cal kyr BP

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Received 25 February 2005; received in revised form 13 July 2005; accepted 5 September 2005

Abstract

The paleoceanographic history around the Tsugaru Strait since 30.0 cal kyr BP was reconstructed using ecological and biogeographical habitats of diatom species and Q-mode factor analysis of diatom flora in six piston cores. At 30.0–17.5 cal kyr BP, a fall in sea level and the intensification of the Oyashio Current caused erosion of submarine sediments near the shore in the eastern area of the Strait and led to deposition of the third and second sequences of thinly laminated layers (TL3 and TL2) in the Japan Sea. At 17.5–11.5 cal kyr BP, cooling intensified around the Strait, producing an inflow of Oyashio water into the Japan Sea through the Strait. At 15.5–14.5 cal kyr BP, a cold-water mass around the Strait developed from subarctic sea-ice to arctic waters. At 13.0–11.2 cal kyr BP, the Younger Dryas cooling was clearly recorded by the increasing of oceanic cold-water diatom species in the eastern area of the Tsugaru Strait but not in the Japan Sea. At 15.5–13.0 cal kyr BP and 11.25–10.25 cal kyr BP, the warming around the Younger Dryas resulted in the deposition of thinly laminated layers off Shimokita in the eastern area of the Strait. At 9.5 cal kyr BP, the Oyashio Current water intruded into deep depths in the mixed water region off Sanriku. At 9.5–7.0 cal kyr BP, the fluctuation of 1.5-kyr intervals in the strength of the Tsushima Warm Current system in the Japan Sea was initiated.

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Keywords: Japan Sea; Diatoms; MD01-2409; Tsushima Warm Current; Tsugaru Warm Current; Oyashio Current; Thinly laminated layer; Younger Dryas cooling

1. Introduction

The Japan Sea is a marginal sea, connecting to the Northwest Pacific Ocean and to adjoining marginal

seas by the narrow and shallow Tsushima (Korea) (sill depth 130 m), Tsugaru (130 m), Soya (55 m), and Mamiya (Tartar) (15 m) straits. The Tsushima Warm Current (TWC) flows into the Japan Sea from the East China Sea through the Tsushima Strait between Kyushu and Korea. The TWC flows along the western margin of Honshu Island and most of the TWC flows out to the Pacific Ocean through the Tsugaru Strait

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between Honshu and Hokkaido. The TWC flows above the Japan Sea Proper Water (JSPW), which is a homogeneous cold water-mass deeper than 200–300 m that forms in the northwestern part of the Japan Sea by the subsidence of strongly cooled surface water (Fig. 1).

The TWC converges southwest of the Tsugaru Strait and then diverges into two branches in western area of the Strait. One branch is Tsugaru Warm Current, which flows into the Northwest Pacific Ocean through the Tsugaru Strait. The other flows along the west coast of the Hokkaido Island as the Northward Current (Onishi and Ohtani, 1997), and flows out to the Okhotsk Sea through the Soya Strait between Hokkaido and Sakhalin. Ohtani and Nishida (1990) reported that the total transport of the modern Tsugaru Warm Current near shore was extremely variable 1–31% of the TWC. However, the TWC deeper than 500 m on the west side of the Tsugaru Strait splits into half, the Northward Current and the Tsugaru Warm Current, with equal average volumes of transport (Onishi and Ohtani, 1997).

Along the southeast coast of Hokkaido, the Oyashio Current flows southward down to approximately Lat. 41°N. The Tsugaru Warm Current flows southward to approximately Lat. 38°N off Kinkazan Island and occasionally comes in contact with the Oyashio Intrusion which forms a tongue-like shape ~160 km in width (Kawai, 1972). The Oyashio Intrusion water subsides as North Pacific Intermediate Water, which is characterized with a salinity minimum (Yasuda et al., 1996).

The Japan Sea responded distinctly to sea level fluctuations during the last glacial–interglacial period. Oba et al. (1991) presented four distinct stages of environmental changes which were modified chronologically by Oba et al. (1995): (1) the surface water was freshened and distinctly stratified from 30–14 ¹⁴C kyr BP and salinity reached a minimum at 15 ¹⁴C kyr BP, (2) the Oyashio Current entered into the Japan Sea from 14–10 ¹⁴C kyr BP, (3) TWC temporally formed from 10–8 ¹⁴C kyr BP, and (4) the modern oceanographic regime was established after 8 ¹⁴C kyr BP.

Tada et al. (1999) noted that the strong penetration of waters from the East China Sea into the Japan Sea

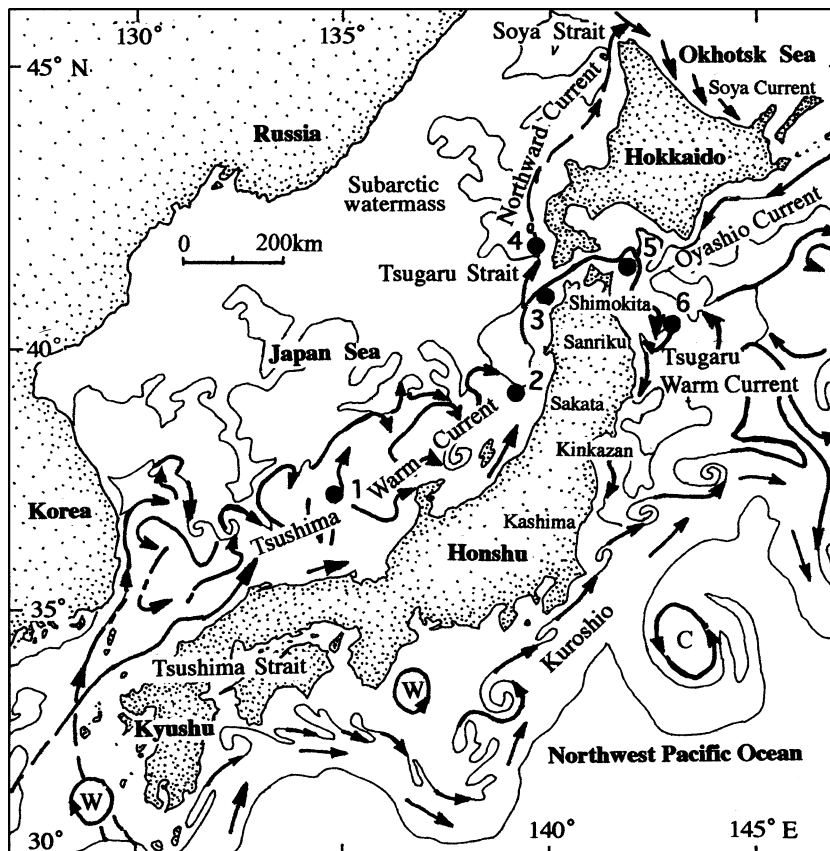


Fig. 1. Location (black circles) of six cores. 1=D-GC-6, 2=KH-86-2-9, 3=KH-84-3-33, 4=KH-84-3-9, 5=MD01-2409, 6=MR97-04-1. Arrows indicate flow of the currents and contour interval show the boundary between water masses. W=warm-water, C=cold-water.

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