Early summer radiolarian fauna in surface waters off Tassha, Aikawa Town, Sado Island, central Japan

Atsushi MATSUOKA*, Midori SHINZAWA**, Kazuhiro YOSHIDA**, Satoru MACHIDORI*, Hiroshi KURITA* and Takashi TODO***

Abstract

The early summer radiolarian fauna in surface waters (<70 m) off Tassha is characterized by the abundant occurrence of cold-water species such as *Larcopyle butschlii* Dreyer, *Spongotrochus glacialis* Popofsky and *Cyrtidosphaera reticulata* Haeckel associated with subordinate warm-water species. The faunal composition is different from that in late summer which is dominated exclusively by warm water species derived from the Tsushima Warm Current. This suggests that most warm water species cannot survive during the winter season when sea surface temperatures drop to ca. 10 °C around Sado Island.

Key words: Japan Sea Proper Water, plankton, radiolaria, Sado Island, Sea of Japan, Tsushima Warm Current.

Introduction

Seasonal change in plankton communities including radiolarians was studied in Tassha Bay of Sado Island during January 1982 to January 1983 (Abe et al., 1984; Abe, 1993). Since that time, no similar investigations were conducted until the inception of our project in 2000 which began with the introduction of a new research boat "IBIS 2000". In the first step of our research project performed in late summer 2000, it was determined that surface waters were well stratified in terms of temperature and were characterized by the abundant occurrence of warm water radiolarians that were transported by the Tsushima Warm Current, a branch of the Kuroshio Current (Matsuoka et al., 2001). No cold water species indigenous to deep waters of the Sea of Japan were recovered at that time.

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* Department of Geology, Faculty of Science, Niigata University, Niigata 950-2181, Japan
** Graduate School of Science and Technology, Niigata University, Niigata 950-2181, Japan
*** Sado Marine Biological Station, Faculty of Science, Niigata University, Aikawa, Sado, Niigata 952-2135, Japan
(Manuscript received 28 December, 2001; accepted 12 February, 2002)

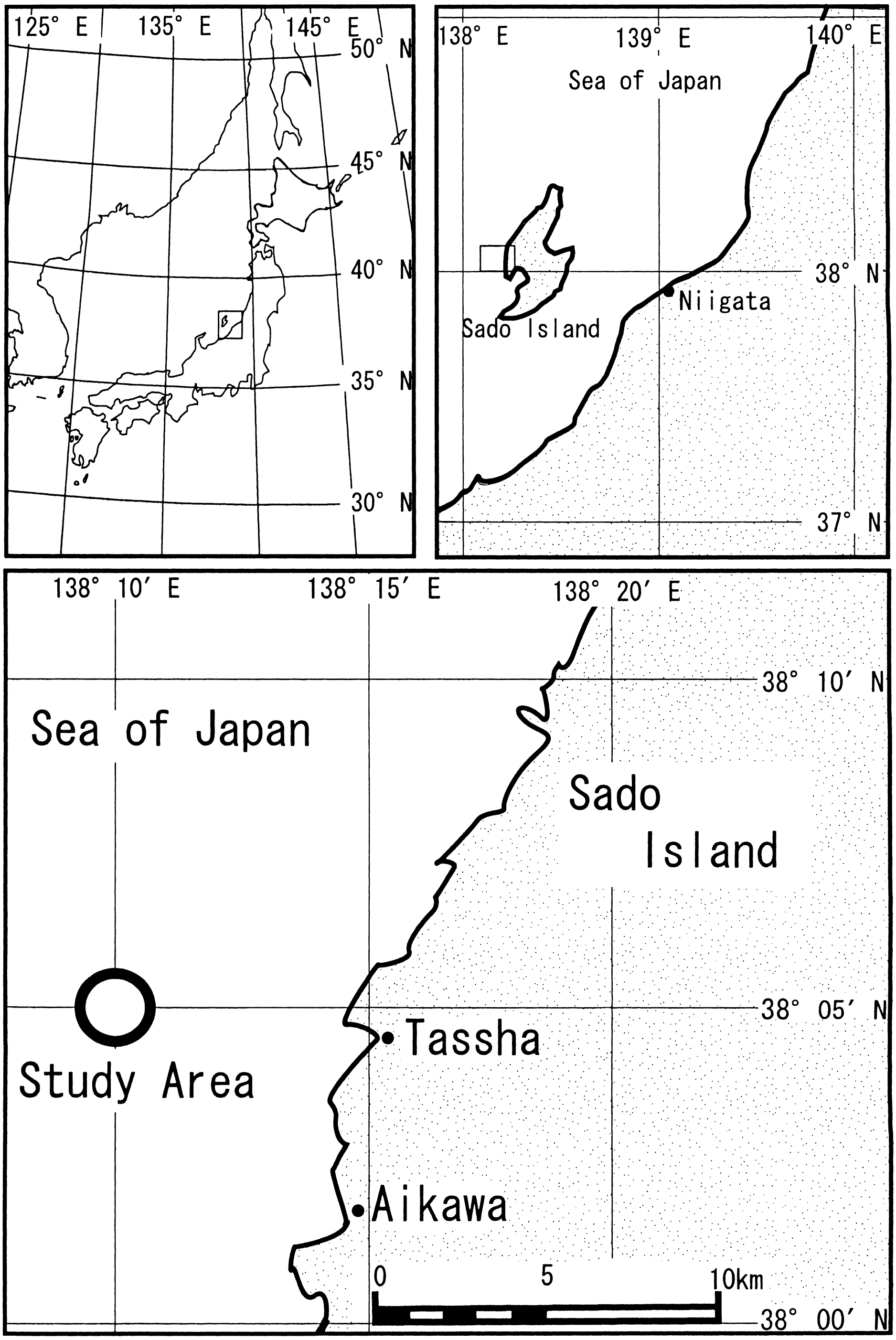

Fig. 1. Map showing the study area.

To assess seasonal change in radiolarian faunal composition, it is necessary to collect samples in different seasons. In the current project, we sampled plankton on June 25, August 31, September 26 and October 22 in 2001. In the June 25 plankton samples, we recovered some cold water radiolarian species probably from the cold Japan Sea Proper Water. This paper reports radiolarian assemblages in early summer surface waters; specimens are illustrated and assemblage composition is discussed.

Materials and methods

Plankton samples were obtained at a location approximately 6 km west of Tassha, Aikawa Town, Sado Island, Niigata Prefecture, central Japan (Fig. 1). Sampling was carried out in the morning of June 25, 2001. Five plankton samples were collected using a 100 μm opening net of the Marukawa type with a 0.3m diameter mouth. Two samples (62501 and 62504) were obtained from a water depth between 71m and 57m and between 57m and 42m, respectively, by closing the net with a messenger. Three samples (62502, 62503 and 62505) were taken from 57-42m deep to the surface without closing the net. At the sampling site, we attemped to record temperature profiles with a digital thermometer. A temperature record (11.4 °C) at ca. 70m deep (maximum depth in the sampling operation of that day) was obtained. Following this the thermometer was damaged and no further temperature data could be recorded.

All plankton samples were placed in ca. 50 % sulfuric acid for a day to obtain silica skeletons of radiolarians. The residues were collected on a 46 μm opening sieve and rinsed with water. The residues of four samples (62501, 62502, 62504 and 62505) were mounted in Canada balsam for light microscopic observation. One sample (62503) is stored for future scanning electron microscopic studies. Microscopic images of radiolarian skeletons were taken by a Nikon light microscope equipped with a digital microscope (Keyence VH-7000).

Results and discussions

Radiolarian species recovered in each tow are listed in Table 1. Light microscopic images of radiolarian tests are illustrated in Plates 1 and 2. In all samples *Larcopyle butschlii* Dreyer is the most abundant species and comprises more than 40% of the total assemblage. *Spongotrochus glacialis* Popofsky and *Cyrtidosphaera reticulata* Haeckel are the next most abundant species. These three species are Spumellaria and total more than 70% of the fauna. Other spumellarian species include *Didymocyrtis tetrathalamus* (Haeckel), *Sphenosphaera socialis* Haeckel, *Spongaster tetras* Ehrenberg, *Stylodictya multispira* Haeckel and *Tetrapyle octacantha* Müller. Nassellarian species are generally minor and include *Ceratocyrtis* sp., *Lithomellisa setosa* Jørgensen, *Peridium* sp., *Plectacantha* sp., *Pseudocubus obeliscus* Haeckel, *Pseudodictyophimus gracilipes* (Bailey) and *Zygocircus productus* (Hertwig).

Table 1. List of radiolarian species from the surface waters off Tassha, Sado Island in early summer. Abundance code: ++++ = 11 or greater, +++ = 5 – 10, ++ = 2 – 4, + = 1 per residue of each tow sample.

SAMPLE	62501	62504	62502	62505
DEPTH	71-57m	57-42m	57-0m	42-0m
SPUMELLARIA				
Cyrtidosphaera reticulata Haeckel	++++	+++	++++	+
Didymocyrtis tetrathalamus (Haeckel)		+		
Larcopyle butschlii Dreyer	++++	++++	++++	++++
Sphenosphaera socialis Haeckel		+		
Spongaster tetras Ehrenberg		++		
Spongotrochus glacialis Popofsky	+++	++++	++++	+++
Stylodictya multispira Haeckel	+			
Tetrapyle octacantha Müller	++	++	+	++
NASSELLARIA				
Ceratocyrtis sp.	++			+
Lipmanella dictyoceras (Haeckel)	++		++	
Lithomellisa setosa Jørgensen		++	+++	
Peridium sp.			+++	
Plectocantha sp.	+	++	++	++
Pseudocubus obeliscus Haeckel	+	++	+	
Pseudodictyophimus gracilipes (Bailey)			+	
Zygocircus productus (Hertwig)		++	+	++

The radiolarian fauna in samples from deeper waters (62501 and 62504) is almost similar to that from shallower waters (62502 and 62505). Comparing faunal composition between sample 62502 (57-0m) and sample 62505 (42-0m), the former contains a more abundant and diversified radiolarian fauna than the latter. This means that most radiolarians dwell in deeper horizons and surface waters (ca. 40-0m) are poor in radiolarians.

Previous plankton sampling in late summer 2000 (Matsuoka et al., 2001) was conducted at almost the same location and depth. In this study, the late summer radiolarian fauna was characterized by the abundance of warm water species such as *Didymocyrtis tetrathalamus* (Haeckel), *Tetrapyle octacantha* Müller, *Lophophaena hispida* (Ehrenberg) and *Pseudocubus obeliscus* Haeckel, which are transported by the Tsushima Warm Current (Matsuoka et al., 2001). Species common to the early summer and late summer assemblages include *Didymocyrtis tetrathalamus*, *Tetrapyle octacantha* and *Pseudocubus obeliscus* but these species are generally minor in the early summer samples. Conversely, the early summer radiolarian assemblage is dominated by *Larcopyle butschlii*, *Spongotrochus glacialis* and *Cyrtidosphaera reticulata* as mentioned above.

It is well known that *L. butschlii* is the most dominant species in Holocene sediments in the Sea of Japan (Motoyama, 1995; Itaki et al., 1996, 1997; Itaki, 2000). Itaki et al. (2000) also reported that *L. butschlii* is the most abundant species in the 40-160m horizon in the present water column of the Sea of Japan off western Hokkaido, and its adult forms were recovered from waters as deep as 1000m. All lines of the evidence indicate that *L. butschlii* is a deep dweller and is adapted to the cold Japan Sea Proper Water. *S. glacialis* is also regarded as a deep dweller on the basis of its vertical distribution in the Sea of Japan shown by Itaki et al. (2000). Although the habitat of *C. reticulata* is not yet known, this species may also prove to be a deep dweller like *L. butschlii* and *S. glacialis*.

In conclusion, the early summer radiolarian fauna in surface waters (<70m) off Tassha is characterized by a mixture of abundant cold-water individuals and minor warm-water ones. The faunal composition is different from that of late summer which is dominated exclusively by warm water species. This suggests that most warm water species cannot survive during the winter season when sea surface temperatures drop to ca. 10 °C off Tassha Bay, Sado Island based on last 10 year temperature records (Sado Marine Biological Station, Niigata University, 2001). In future work we hope to detail more clearly when and how surface water radiolarian faunas change seasonally in the Sea of Japan.

Acknowledgements

Prof. M. Nozaki at the Sado Marine Biological Station, Niigata University, allowed us use of facilities in the station. Messrs. K. Iwami and K. Murayama assisted in plankton sampling. This paper was greatly improved by reviews from Drs. T. Itaki and E.S. Carter. This research is partly supported by a Niigata University Project Grant "Biota around coastal areas in the Sea of Japan" (Project Leader: A. Matsuoka).

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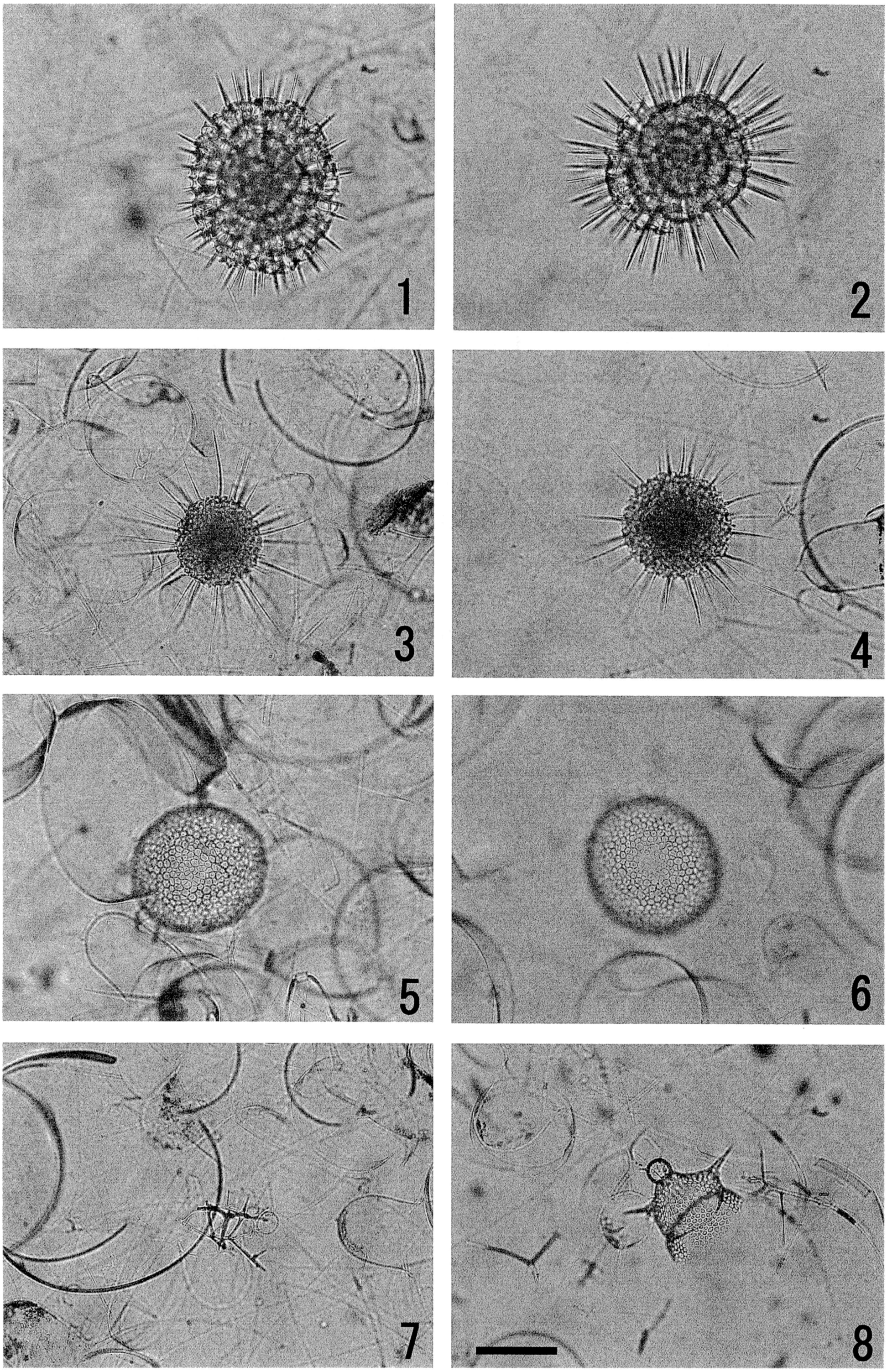
Explanation of Plate 1

Photomicrographs of radiolarian skeletons from the surface waters off Tassha. The scale bar in Fig. 8 equals 100 μm. The number in parentheses indicates sample number.

1. *Larcopyle butschlii* Dreyer (62502)
2. *Larcopyle butschlii* Dreyer (62505)
3. *Spongotrochus glacialis* Popofsky (62501)
4. *Spongotrochus glacialis* Popofsky (62501)
5. *Cyrtidosphaera reticulata* Haeckel (62501)
6. *Cyrtidosphaera reticulata* Haeckel (62501)
7. *Pseudocubus obeliscus* Haeckel (62501)
8. *Lipmanella dictyoceras* (Haeckel) (62501)

Plate 1



Explanation of Plate 2

Photomicrographs of radiolarian skeletons from the surface waters off Tassha. The scale bar in Fig. 8 equals 100 μm. The number in parentheses indicates sample number.

1. *Larcopyle butschlii* Dreyer (62501)
2. *Cyrtidosphaera reticulata* Haeckel (62501)
3. *Sphenosphaera socialis* Haeckel (62502)
4. *Tetrapyle octacantha* Müller (62501)
5. *Lithomellisa setosa* Jørgensen (62502)
6. *Lithomellisa setosa* Jørgensen (62502)
7. *Pseudodictyophimus gracilipes* (Bailey) (62502)
8. *Plectacantha* sp. (62502)

Plate 2