

Thalassiosira castanea, a new diatom species useful for the Late Miocene diatom biostratigraphy in the North Pacific

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Abstract: A new stratigraphically useful Neogene diatom species *Thalassiosira castanea* Akiba et Yanagisawa is described. The species has a very short range in the lower part of the Upper Miocene *Neodenticula kamtschatica* - *Nitzschia rolandii* Subzone (NPD 7Ba) of the *N. kamtschatica* Zone (NPD 7B). The first occurrence of this species is coincident with the boundary between this zone and the underlying *Rouxia californica* Zone (NPD 7A), and hence it is a good marker for this boundary. *Thalassiosira spinosa* Schrader (1976), a species which bears a close resemblance to *Thalassiosira castanea* n. sp., is a later homonym of *Thalassiosira spinosa* Simonsen (1974), and therefore it is herein renamed *Thalassiosira spinoconvexa* Akiba et Yanagisawa nom. n.

1. Introduction

Neogene diatom biostratigraphy for the middle- to high-latitude North Pacific has been widely used for dating and correlating Neogene marine sedimentary sequences (e.g. Koizumi, 1985, 1992; Barron, 1985; Akiba, 1986). Recently, Barron and Gladenkov (1995) accomplished direct correlation between diatom zones and magnetostratigraphy and provided precise ages for primary zonal marker biohorizons. Thus Neogene North Pacific diatom biostratigraphy has become a powerful correlation tool with high precision and resolution.

However, there are some practical problems in the diatom stratigraphy. One of these is the difficulty in identifying the boundary between the upper Miocene *Rouxia californica* Zone (NPD 7A) and the overlying *Neodenticula kamtschatica* Zone (NPD 7B) of Akiba (1986). This boundary is defined by the last common occurrence of *R. californica*, but it is often difficult to recognize the boundary when the abundance of *R. californica* decreases upward gradually.

This problem has been overcome in part by Akiba (1987) who described *Azpeitia komurae*, a useful diatom which is restricted in the uppermost *R. californica* Zone (NPD 7A) and serves to recognize the top of this zone. We describe here another stratigraphically useful diatom species *Thalassiosira castanea* n. sp., which is helpful for identifying the boundary between the *R. californica* Zone (NPD 7A) and *N. kamtschatica*

Zone (NPD 7B), and further improves the practical utility of the Neogene North Pacific diatom biostratigraphy (Yanagisawa and Akiba, 1998). In addition, we propose here a new name *Thalassiosira spinoconvexa* Akiba et Yanagisawa nom. n. for *Thalassiosira spinosa* Schrader (1976), a species which closely resembles *Thalassiosira castanea* n. sp., because *T. spinosa* Schrader (1976) is a later homonym of *Thalassiosira spinosa* Simonsen (1974).

2. Materials and Methods

Stratigraphic occurrences of *Thalassiosira castanea* n. sp. are examined in four deep sea cores: (1) DSDP, Leg 57, Hole 438A, off Northeast Honshu; (2) DSDP, Leg 87, Hole 584, off Northeast Honshu; (3) DSDP, Leg 19, Hole 183, off Alaska Peninsula, and (4) DSDP, Leg 19, Hole 192, off Kamchatka (Fig. 1). These cores have already been examined by Akiba (1986) and

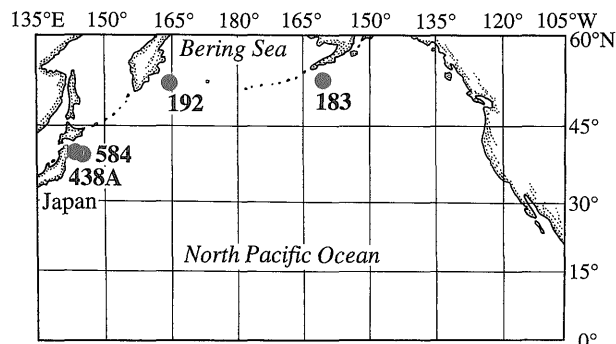


Fig. 1 Locations of DSDP Holes 438A, 584, 192 and 183.

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Keywords: *Thalassiosira castanea*, *Thalassiosira spinoconvexa*, diatom, biostratigraphy, Neogene, Miocene, North Pacific.

Yanagisawa and Akiba (1998). The preparation and counting methods of diatoms follow Akiba (1986).

3. Taxonomy

Thalassiosira castanea Akiba et Yanagisawa n. sp.
Plate 1, Figs. 1a-4b

Synonymy:-*Thalassiosira convexa* Mukhina, Kozumi, 1973, pl. 7, figs. 13-15; 1975, pl. 4, figs. 19-20; Oreshkina, 1985, pl. 2, fig. 8; *Thalassiosira* aff. *zabelinae* Jousé Akiba, 1986, p. 446, pl. 8, figs. 6-7, 9-10.

Description:-Valve heavily silicified, highly convex and circular, 14-25 μm , usually 15-20 μm in diameter (Fig. 2). Areolae, circular to hexagonal-rounded, covering the entire valve face, 7-8 areolae in 10 μm in almost entire valve face, sometimes scattered and solitary, decreasing in size abruptly at the margin, ca. 10 areolae in 10 μm . Margin ca. 1 μm in width, usually hardly discernible, with radial striae 10-12 striae in 10 μm . One row of heavily silicified spines present at the margin in most cases. Spines more or less irregularly spaced, and number of discernible spines per valve varies from 1 to 8, or none

Holotype:-Plate 1, Figs. 1a-d, Sample DSDP Leg 57, Hole 438A, 40-6, 10-14 cm; GSJ F15031 deposited in the Geological Museum of the Geological Survey of Japan.

Paratype:-Plate 1, Figs. a, 4b, Sample DSDP Leg 57, Hole 438A, 41-3, 45-49 cm; GSJ F15032 deposited in the Geological Museum of the Geological Survey of Japan.

Derivation of name:-The specific name of this new taxon refers to its heavily silicified and highly convex valve which resembles a chestnut (=L.: *castanea*).

Age:-Latest Late Miocene (6.4-6.1 Ma)

Stratigraphic occurrence:-This new species has a very short stratigraphic range in the lower part of the uppermost Upper Miocene *Neodenticula kamtschatica-Nitzschia rolandii* Subzone (NPD 7Ba) of the *N. kamtschatica* Zone (NPD 7B) in DSDP Leg 57, Hole 438A (Fig. 3). The first occurrence (FO) of this species coincides with the base of the subzone, and its last occurrence (LO) approximates the FO of *Thalassiosira praeoestrupii* (Fig. 4). The species is common in the lower part of the *Neodenticula kamtschatica* Zone (NPD 7A) in DSDP Leg 19, Holes 183 and 192 (Akiba, 1986) and is also consistently observed in the same horizons in Leg 87, Hole 584 (Akiba, 1986).

Geographic distribution:-The geographic distribution pattern of *T. castanea* n. sp. suggests that it is a boreal species. *Thalassiosira castanea* n. sp. has been found in four DSDP cores: Hole 438A, Hole 584, Hole 183 and Hole 192, all of which are located in the middle- to high-latitude in the North Pacific. This species occurs commonly in the Hole 183, where it

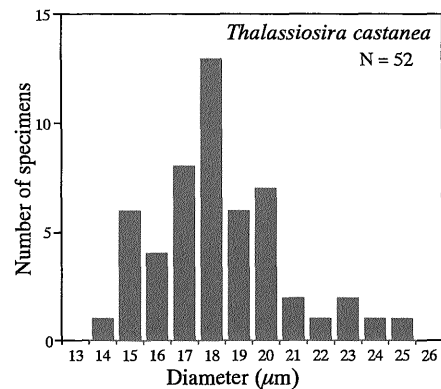


Fig. 2 Size variation in valve diameter of *Thalassiosira castanea* Akiba et Yanagisawa n. sp. All specimens from DSDP Hole 438A.

constitutes about 5-10 percent of the total assemblage. In the remaining three holes, *T. castanea* n. sp. represents only 1-4 percent.

Remarks:-This new species is very close to *Thalassiosira spinoconvexa* nom. n., whose name is proposed below, in that the both species have strongly convex valve and heavily silicified spines, but it is differentiated from the latter by coarser and more scattered areolae.

Thalassiosira castanea n. sp. is also similar to *Thalassiosira fraga* Schrader (Schrader and Fenner, 1976, p. 1001, pl. 16, figs. 9-12) and *Thalassiosira praeffraga* Gladenkov et Barron (1995, p. 30, pl. 2, figs. 3-6, 9). However, *T. castanea* n. sp. differs from *T. fraga* by the lack of the wide margin with regularly and densely arranged spines, and from *T. praeffraga* by the presence of the more convex valve, coarser areolae and larger valve.

The new species also resembles three Late Miocene to Pliocene species, *Thalassiosira convexa* Mukhina, *T. miocenica* Schrader and *T. zabelinae* Jousé as above-mentioned synonym list suggests. *Thalassiosira castanea* is distinguished from *T. convexa* and *T. miocenica* by having rather irregularly shaped and scattered areolae, which do not form secondary tangential rows of areolae, and from *T. zabelinae* by the lack of hyaline margin with radially elongated petal-shaped areolae.

Thalassiosira spinoconvexa
Akiba et Yanagisawa, nom. n.
(No illustration)

Basionym:-*Thalassiosira spinosa* Schrader, 1976, p. 636, pl. 6, figs. 5-7.

Synonym:-*Thalassiosira spinosa* var. *aspinosa* Schrader, 1976, p. 636, pl. 6, fig. 3.

Holotype:-Schrader, 1976, pl. 6, fig. 6 (DSDP Hole 278, 27-1, 50-51 cm, southwest Pacific)

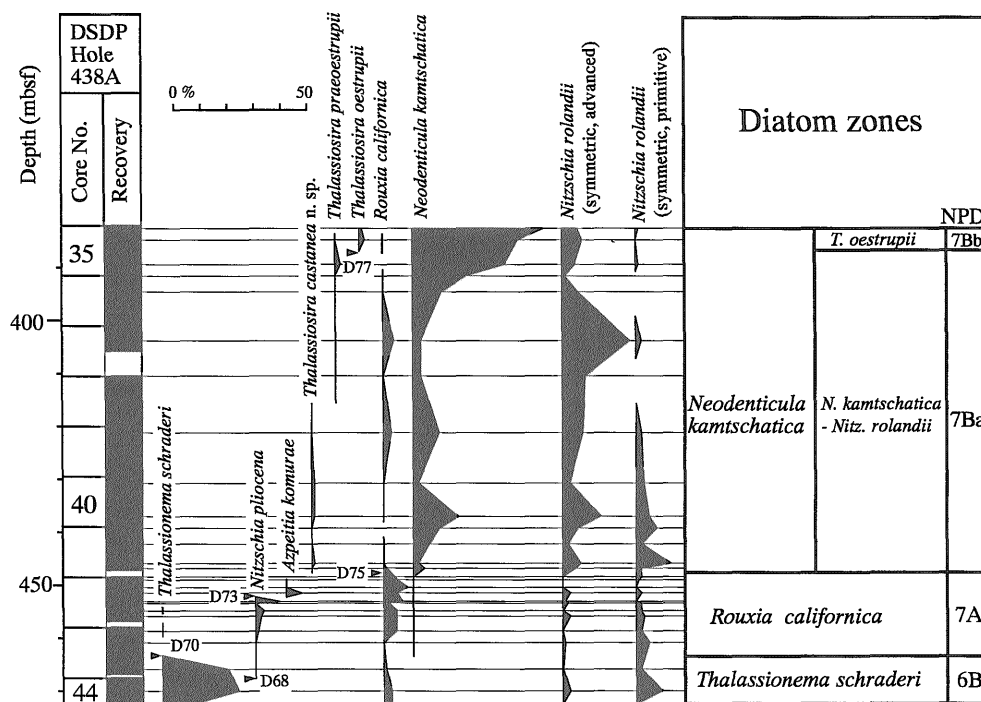


Fig. 3 Stratigraphic occurrences of *Thalassiosira castanea* Akiba et Yanagisawa n. sp. and other stratigraphically useful diatoms in DSDP Hole 438A. Diatom zones after Yanagisawa and Akiba (1998). D68-D77: Code numbers of Neogene North Pacific diatom biohorizons defined by Yanagisawa and Akiba (1998; see Fig. 4).

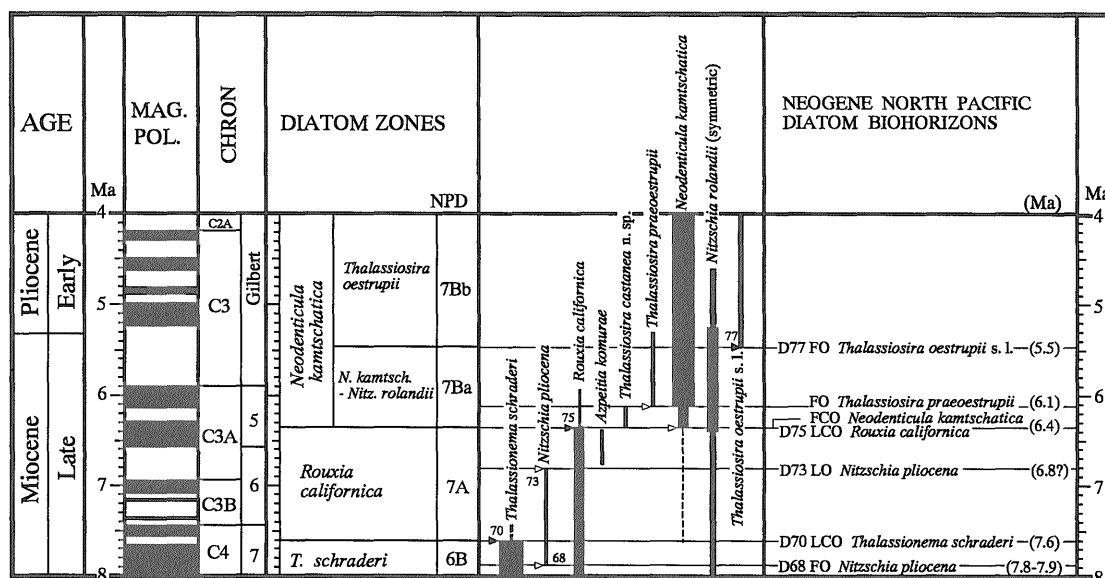


Fig. 4 Stratigraphic ranges of *Thalassiosira castanea* Akiba et Yanagisawa n. sp. and other stratigraphically useful diatoms in the latest Late Miocene to earliest Early Pliocene interval (after Yanagisawa and Akiba, 1998). Geomagnetic polarity time scale after Cande and Kent (1995). Chronostratigraphic units (age) in the left hand column after Berggren *et al.* (1995a, b).

Description (Schrader, 1976):—"Valve strongly convex, 18-20 μm in diameter. Areolae hexagonal forming closed network over the entire valve, 9-10 in 10 μm , decreasing in size gradually towards the margin. Areolae in radial rows, sometimes fasciculate or arranged in convex lines. Margin 1-1.5 μm wide with radial striae, 10 in 10 μm . One row of heavily silicified spines near margin, spines mostly broken off, but detectable by the base. Spines sometimes absent."

Remarks:-The specific name of *Thalassiosira spinosa* Schrader (1976) is a later homonym of *T. spinosa* Simonsen (1974, p. 10, pl. 4, figs. 1a-c, pl. 5, figs. 1a-2b), a name previously and validly published for an extant tropical *Thalassiosira* species. It is therefore herein renamed *Thalassiosira spinoconvexa* Akiba et Yanagisawa nom. n.

Thalassiosira spinoconvexa nom. n. occurs in the Lower Miocene sediments in the Southern Ocean (Schrader, 1976). The species was reported as *T. spinosa* Schrader in the equatorial Pacific (Barron, 1983, p. 512, pl. IV, fig. 8) and in the high-latitude North Pacific (Barron, 1985, p. 793, p. 11, fig. 15). On the basis of these occurrences, Barron (1985) proposed the *T. spinosa* Zone for earliest Miocene interval in the middle- to high-latitude North Pacific. However, the specimens in the equatorial Pacific and the middle- to high-latitude North Pacific were found to differ in morphology from those in the Southern Ocean, and thus they were named *Thalassiosira prae-fragra* Gladenkov et Barron (Gladenkov and Barron, 1995, p. 30-31, pl. 2, figs. 3-6, 9). Consequently, *T. spinoconvexa* nom. n. seems endemic to the high latitude Southern Ocean.

4. Discussion

The top of the *Rouxia californica* Zone (NPD 7A) defined by the last common occurrence (LCO) of *R. californica* is not always easy to identify when *R. californica* shows a gradual decrease in abundance or rare occurrences. Possibly for this reason, Barron and Gladenkov (1995) excluded the *R. californica* Zone from their zonation.

The first common occurrence (FCO) of *Neodenticula kamtschatica* can be employed as an additional stratigraphic marker for the top of the *R. californica* Zone (NPD 7A) (Fig. 4). However, the practical utility of this biohorizon is restricted by the difficulty in distinguishing *N. kamtschatica* from its ancestor *Nitzschia rolandii* because of a gradual evolutionary change in morphology between the two species (Yanagisawa and Akiba, 1990). In addition, diachronous nature of the FCO of *N. kamtschatica* across latitude also limits the application of this biohorizon throughout the middle- to high-latitude North Pacific (Akiba, 1987).

Instead, the LO of *Azpeitia komurae* (Akiba, 1987)

is a good secondary marker for the top of the *R. californica* Zone (NPD 7A). This species, restricted in the uppermost part of this zone, has its LO near the top of this zone (Figs. 3, 4).

Thalassiosira castanea n. sp. described here is also helpful for recognizing the top of the *R. californica* Zone (NPD 7A), with its FO just coincidental with the LCO of *R. californica* (Fig. 3). The species also provides the most reliable guide to the recognition of the lower part of *N. kamtschatica* - *Nitzschia rolandii* Subzone (NPD 7Ba) because of its limited stratigraphic range as well as its easily distinguishable characteristics. Thus this new species, coupled with *Azpeitia komurae*, serves to improve the precision and resolution of the uppermost Upper Miocene diatom biostratigraphy of the North Pacific.

Both Barron (1980) and Koizumi (1985) have suggested a hiatus between cores 22 and 23 in DSDP Hole 192, primarily based on the occurrence of a tropical species *Thalassiosira convexa* Mukhina reported by Koizumi (1973) in the same hole. However, the specimens regarded as *T. convexa* in this hole can be clearly identified as *T. castanea* n. sp., and then the suggested hiatus in Hole 192 seemingly has no supporting evidence at present.

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北太平洋後期中新世珪藻化石層序において有用な珪藻の1新種 *Thalassiosira castanea*

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要 旨

新第三紀化石珪藻の1新種 *Thalassiosira castanea* Akiba et Yanagisawa を記載した。本種は上部中新統最上部の *Neodenticula kamtschatica* - *Nitzschia rolandii* 亜帯 (NPD 7Ba) の下部に産出が限定され、その初産出はこの化石亜帯と下位の *Rouxia californica* 帯 (NPD 7A) の境界に一致する。従来この境界を決めるには実際上困難な場合もあったが、本種を使うことによって正確に層準を決定できるようになった。本種に形態的によく類似する *Thalassiosira spinosa* Schrader 1976 は、*T. spinosa* Simonsen 1974 の後続同名 (later homonym) であるので、*Thalassiosira spinoconvexa* Akiba et Yanagisawa と再命名した。

New Late Miocene diatom species Thalassiosira castanea (Akiba and Yanagisawa)

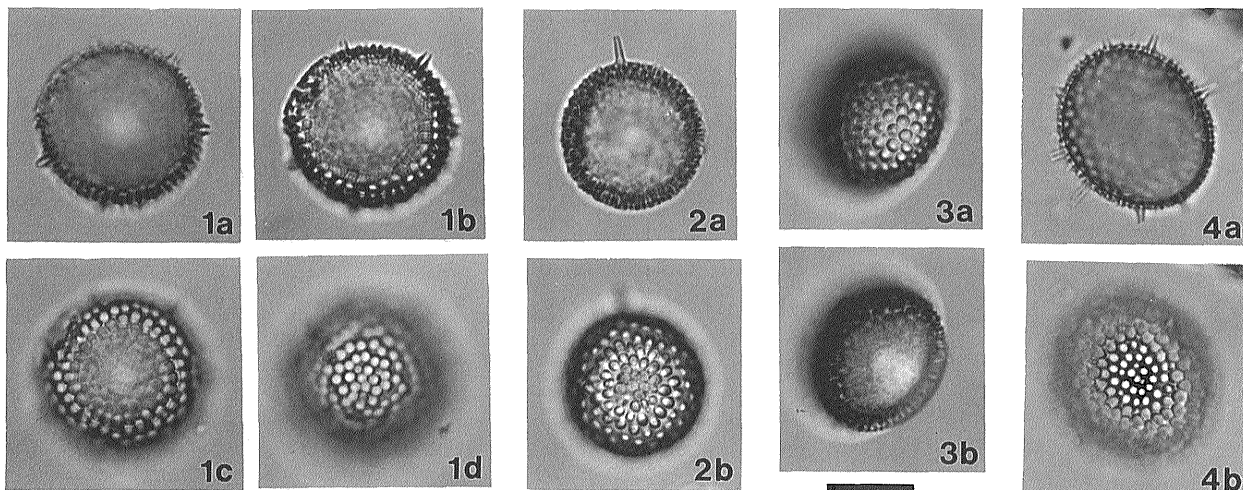


Plate 1 Transmitted light micrographs of *Thalassiosira castanea* Akiba et Yanagisawa n. sp. Scale bar equals $10\mu\text{m}$.
Figs. 1a-1d: Holotype, GSJ F15031, DSDP Hole 438A, 40-6, 10-14cm; 2a-2b: DSDP Hole 438A, 40-6, 10-14cm;
3a-3b: DSDP Hole 438A, 40-6, 10-14cm; 4a-4b: Paratype, GSJ F15032, DSDP Hole 438A, 41-3, 45-49cm.