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First record of genera *Rutilaria* and *Trigonium* (Bacillariophyta) and 11 diatom taxa (species and varieties) in South China Sea*

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Abstract Diatom taxa in samples collected from the uppermost 1-cm sediment of the South China Sea (SCS) during cruises in 2000, 2001, and 2007 were investigated. Among them, two genera, *Rutilaria* and *Trigonium*, and 11 marine taxa (species and varieties) were described for the first time in China. The 11 taxa, *Rutilaria radiata*, *Asterolampra grevillei*, *Biddulphia turrigera*, *Cocconeis cyclophora* var. *decora*, *Cocconeis ocellata*, *Dictyoneis marginata*, *Entogonia davyana*, *Tryblionella campechiana*, *Plagiogramma kinkeri*, *Plagiogramma nankoorense* and *Trigonium* cf. *contumax*, were mainly extant species, although *Rutilaria radiata* and *Entogonia davyana* are fossils. Available data show that these species are mainly present in the eastern and western Pacific Ocean and the Indian Ocean. A large number of taxa newly recorded in this study were previously reported in the Philippines. The presence of these taxa in both locations is likely a result of seawater exchange in the SCS through the Bashi Channel. Taxonomic descriptions, habitats, and distributions of each diatom taxon are provided herein.

Keyword: diatoms; surface sediments; new record; South China Sea (SCS)

1 INTRODUCTION

The South China Sea (SCS) is the largest marginal sea in the world, with a surface area of approximately 3.5×10^6 km^2. The main basin of the SCS extends from the equator along the northwestern coast of Borneo to approximately 23°N along the southern coast of China, and from near 105°E along the coast of the Indochinese Peninsula to 120°E along the eastern coast of the Philippines. The deepest basin, which is located in the northeast SCS, is reported to be 5 000 m. The shelf is narrow and has an area of approximately 1.2×10^6 km^2 (Shaw and Chao, 1994). The main water masses flow into the SCS from the western Pacific, and include the warm Kuroshio Current through the Bashi Strait north of Luzon during winter, and Indian Ocean surface water across the Sunda Shelf in summer (Wyrki, 1961) (Fig.1). Various studies of the SCS have been conducted using foraminifera (Jian and Wang, 1997), radiolarians (Wang and Abelmann, 2002), and calcareous nanofossils (Wei et al., 1997). However, available diatom data are limited.

Diatoms are microscopic algae found in almost all aquatic and wet terrestrial habitats, with each habitat having unique diatom flora that developed in response to its chemical and physical environments. The silica cell walls of diatoms, which are especially well preserved in sediments, provide a record of paleoenvironmental information (Stoermer and Smol,

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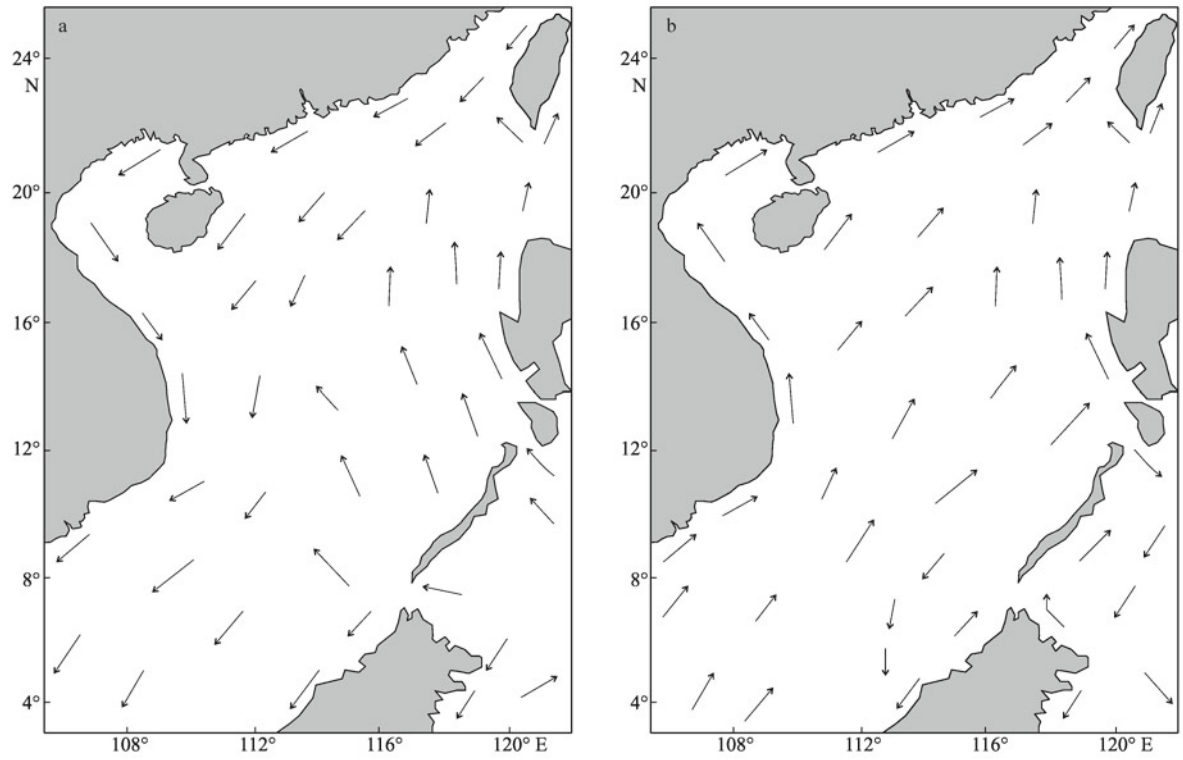

Fig.1 The flow direction of major currents in the South China Sea (according to Chen et al., 1985)

a. Winter; b. Summer

1999). Taxonomic studies of sediment diatoms have been conducted in many areas worldwide (Schmidt et al., 1874–1959; Van Landingham, 1967–1979; Round et al., 1990), including Chinese seas (Gao et al., 2003, 2004; Jin et al., 1980, 1982, 1992). However, there have been few taxonomic investigations of sediment diatoms in the SCS (Liu et al., 1982, 1984; Liu and Cheng, 1994; Lan et al., 1995).

In the present study, a preliminary investigation of the diatom species in surface sediment samples from the SCS was conducted using light microscopy. Among the recovered diatoms, several newly recorded diatoms were identified, and are described in detail herein.

2 MATERIAL AND METHOD

Diatom samples were collected from the uppermost 1-cm sediment using a grab (ven Veen Grab) or box-type sampler (Ekman-Birge) during cruises on R/Vs *Ocean-4* in the summer of 2000 and 2001, on *Shiyan-3* during the summer of 2007, and on *Yanping-2* in the summer of 2007. Overall, 62 sampling stations were located in an area of 3°56.61′N–18°23.83′N/108°30.75′E–116°46.70′E (Fig.2). The sampling depth ranged from 101 to 4 185 m. Samples were collected with polyethylene bags and cryo-preserved. For analysis, samples were prepared as described by Håkansson (1984). Briefly, all samples were treated with 10% HCl to remove calcareous matter and treated with 30% H_2O_2 for 1–2 h in a water bath at 60°C to destroy organic materials. Samples with a high proportion of clay were washed repeatedly by suspending and dispersing the material in distilled water in a 100-mL beaker. The supernatant was decanted after a minimum of 3–5 h. An aliquot of the shaken suspension was then placed on a cover slip. After the materials dried completely, the samples were mounted with naphrax. An Olympus BX-51 microscope at a magnification of 1 000× was used for diatom identification and cell counting. Diatoms were identified based on studies conducted by Schmidt (1874–1959), van Heurck (1896), Mann (1925), Hustedt (1930), Jin et al. (1982, 1992), and Lan et al. (1995).

Grain size and detrital mineral analyses were conducted according to the Specifications for Oceanographic Survey (No. GB/T 13909-92, National Standard of China). One gram of sediments for grain size analysis was taken, dried, weighed, mixed with sodium hexametaphosphate and distilled water, soaked, and passed through a 0.063 mm filter. Grains passing through the mesh (<0.063 mm) were

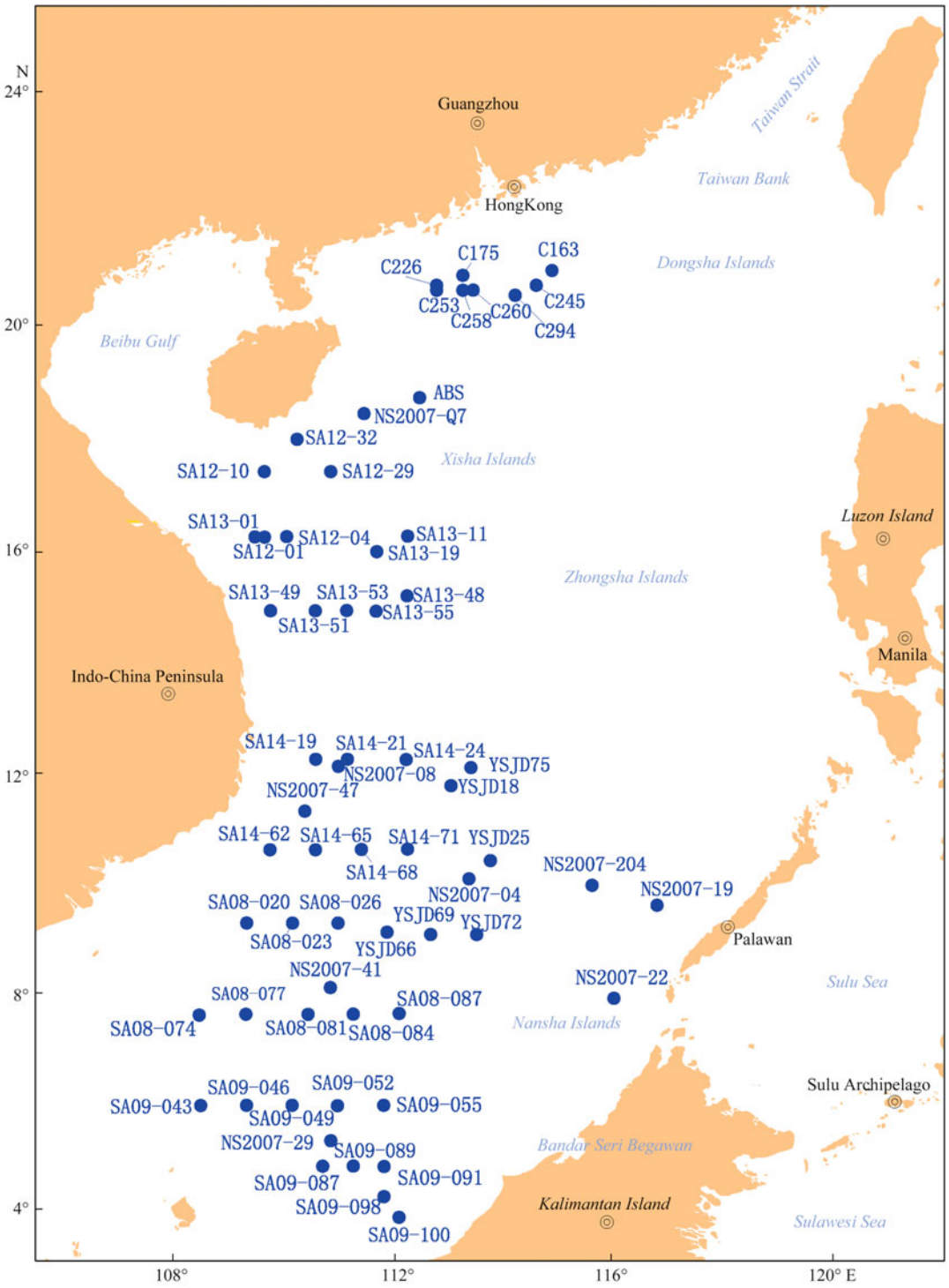

Fig.2 Locations of sampling stations for diatoms in surface sediment in SCS

analyzed using a Mastersizer 2000 laser diffraction particle size analyzer (measurement range, 0.02–2 000 μm). The results of the grain size analysis were then plotted using the Wentworth scale, and the sediments were classified using the Shepard triangular diagram.

3 RESULT

Observation and identification of diatoms from sediments in the uppermost 1 cm of the SCS were made. The results showed a higher diatom diversity than previously reported in the SCS. Among the

diatoms, two genera, *Rutilaria* and *Trigonium*, and 10 species and one variety were found in the area for the first time. These diatom taxa were: *Rutilaria radiata*, *Asterolampra grevillei*, *Biddulphia turrigera*, *Cocconeis cyclophora* var. *decora*, *Cocconeis ocellata*, *Dictyoneis marginata*, *Entogonia davyana*, *Tryblionella campechiana*, *Plagiogramma kinkeri*, *Plagiogramma nankoorense*, and *Trigonium* cf. *contumax*. Taxonomic descriptions and the distribution of each of these diatoms are given below:

(1) *Rutilaria* Greville, 1863 emend. Greville, 1866

Greville (1863), p. 227; van Heurck (1896), p. 433; Round et al. (1990), p. 314; Engler (1928), p. 250.

Synonyms: *Syndetocystis* Ralfs ex Greville (1866), p.125.

Syndetoneis Grunow (1888), p. 36; De Toni, (1894), 1019.

Description: Frustules typically united into short chains. In valve view, they are normally bipolar, circular, elliptical, broad lanceolate, or subhexagonal, often with long and subcapitate or capitate projections. In some species, there are small apical elevations. An ocellus without a thickened rim occurs at each pole on the elevated distal face or the mantle. A subcircular to circular hyaline central area is present. Marginal spines are present in most individuals. Scattered superficial spines are occasionally present on the valve face. A periplekton is present in the center of the valve. Identification within the genus is based on the presence of marginal spines, the height of the apical elevation, whether or not the central area reaches the valve margin, the presence of superficial spines, the number of striae, and the number of areolae in 10 μm.

Two species were included in *Rutilaria* when it was first described, *R. epsilon* and *R. elliptica* (Greville, 1863). Currently, 28 species of *Rutilaria* have been recorded.

Rutilaria radiata Grove and Sturt (Plate I, Fig.a)

Grove and Sturt (1886), p. 323, pl. 18, figs. 4–5; Lautour (1889), pl. 22, fig. 10; Schmidt et al. (1874-1959), Taf. 183, figs. 21–23; De Toni (1894), p. 1022; Laporte and Lefébure (1929), pl. 3, fig. 19; Tsumura (1964), p. 90, pl. 3, figs. 1–2; Jurilj (1965), p. 77, figs. 9–10; Desikachary and Sreelatha (1989), p. 226, pl. 97, figs. 1–10.

Description: Frustules compressed laterally and united into short filaments. Valves depressed at the center with a slight elevation. The valves are 36 μm long and 21 μm wide, tapering cuneately to narrowly rounded apices. The central area is circular and the valve striae are radially arranged with 5–10 in 10 μm. Areolae are indistinct under light microscopy (LM). Marginal spines are 10–12 μm tall at the apical axis, almost reaching the apices. There are no superficial spines. The periplekton has an elliptical stem, and equal arms with a long overlap.

Habitat: Marine benthic (fossil)

Distribution: Specimens of this species were collected from surface sediments at station NS2007-Q7 (18°23.83′N, 111°28.22′E, 1 184 m deep, sediment type T) in the Northern SCS and station SA08-26 (9°10.28′N, 110°59.96′E, 2 091 m deep; sediment type YT) in the southern SCS.

(2) *Trigonium* Cleve 1867

Description: Valves are triangular to multiangular with straight or slightly concave sides. The valve surface is smooth and lower at the center with elevated rimoportulae at the corners. Areolae are nearly rounded, arranged in rows radiating from the centre, and become smaller at the angles to form pseudocelli. In girdle view, cells are rectangularin. Under scanning electronic microscopy (SEM), the mantles are deep. At each corner there is a septum on the valvocopula. Copula has pores and the cingulum of the completed copulae is deep.

Trigonium cf. *contumax* Mann (Plate I, Fig. b)

Mann (1925), p. 162, pl. 39, fig. 6.

Description: The valves are triangular and the side length is 60 μm. The margins are slightly tilted. Valves are slightly concave in the middle part, with elevated rimoportulae at the corners and slightly raised at each acute angle. Coarse and roundish or square areolae are well separated, close to proximal to the margins and almost perpendicular to each margin. However, at the center of the valve, the areolae are more continuous and radially disposed, becoming smaller at the angle to form pseudocelli.

The areolae are well-separated in the margin, but more continuous, with radii drawn at the center of the valve. These radii are arranged by shining watery lines that radiate from each row of beads to the center, where there is a small rosette of similar rounded beads.

Habitat: Marine

Distribution: Specimens of this species were collected from surface sediments at station SA08-23 (9°10.26′N, 110°10.51′E, 2 012 m deep; sediment type YT) near the Zhongnan Peninsula and at the Xisha Islands Station, SA13-11 (16°10.73′N, 112°15.65′E, 1 076 m deep; sediment type YT).

(3) *Asterolampra grevillei* (Wall.) Greville (Plate I, Fig.c)

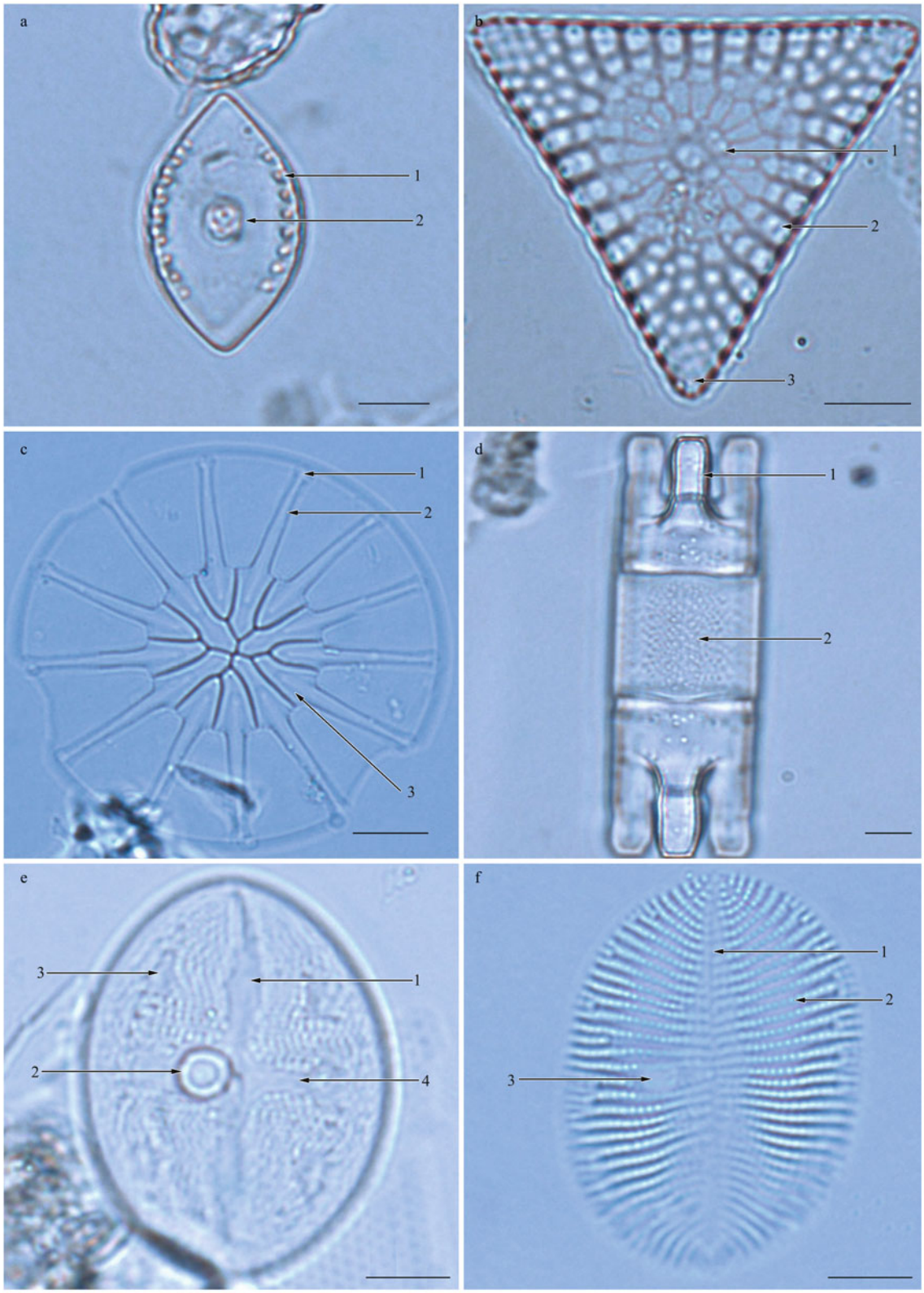

Plate I New record of diatom in China

a. *Rutilaria radiata* (1: marginal spines; 2: periplekton); b. *Trigonium* cf. *contumax* (1: rimoportulae; 2: areolae; 3: pseudocelli); c. *Asterolampra grevillei* (1: spinulous process; 2: ray; 3: central areas); d. *Biddulphia turrigera* (1: horn; 2: striae); e. *Cocconeis cyclophora* var. *decora* (1: central axial area; 2: ocellus; 3: hyaline spaces; 4: narrow boat-shaped hyaline space); f. *Cocconeis ocellata* (1: raphe; 2: striae; 3: ocellus). Scale bar: 10 μm

Greville (1860), S. 113, Taf. IV, fig. 21

Synonym: *Asteromphalus grevillei* Wallich (1860), S. 47, Taf.II, fig.15.

Asterolampra rotula Greville (1860), S.111, Taf. III, fig.5.

Asterolampra variabilis Greville (1860), Taf.III, figs.6–8.

Asteromphalus variabilis Rattray (1890), S. 655.

Asterolampra grevillei var. *adriatica* Grunow (1881), Taf. 127, fig.12.

Asterolampra variabilis var. *richardi* Peragallo (1904), S.12, fig.3.

Description: The valves are circular, with a diameter of 51 μm. The width of the central hyaline areas is almost one third of the valve diameter. The central area is divided into 13 cuneate areas, four of which radiate from the valve center. Rays emerge from the central part of the cuneate areas with a width of about 2.5 μm, and a short, spinous process occurs at the end of the ray. Rays extend almost completely to the valve margin, dividing the valve surface into 13 equal areas. Hexagonal areolae are 20 to 22 in 10 μm, and always smaller near the margins.

The valve diameter (51 μm) is smaller than previously described (70–120 μm) (van Heurck, 1896), although other typical characteristics such as the central area structure, number of cuneate areas (usually 13), and hexagonal areolae are as previously described.

Habitat: Marine

Distribution: Specimens of this species were collected from the surface sediments at station NS2007-19 (9°29.61′N, 116°46.70′E, 2 150 m deep; sediment type YT), in the southern SCS.

(4) *Biddulphia turrigera* Mann (Plate I, Fig.d)

Mann (1925), p. 42, pl. 11, fig. 2.

Description: Frustules 93 μm in height and 28 μm in width in girdle view. The valve is triangular and slightly convex. Horn-like processes (elevations) erected at the valve angles with truncated apices. The entire valve surface is hyaline and flat near the margin. In girdle view, the three flat-topped horns have notched apices. The rows of striae on the girdle are vertical, with eight striae in 10 μm.

Habitat: Marine

Distribution: Specimens of this species were collected from surface sediments at station NS2007-Q7 (18°23.83′N, 111°28.22′E, 1 184 m deep; sediment type T) in the northern SCS and station YSJD-69 (8°57.82′N, 112°40.69′E, 2 353 m deep; sediment type T) in the SCS basin.

(5) *Cocconeis cyclophora* var. *decora* A. Schmidt (Plate I, Fig.e)

Schmidt et al. (1874-1859), pl. 198, figs.1–3.

Description: Valve broadly oval, 50 μm long and 40 μm wide. The central axial area of the upper valve is slightly S-shaped. Striae on the upper valve are 15 per 10 μm and somewhat radially arranged. Four hyaline spaces close to the margins. The horizontal expansion at both sides of the central area forms a narrow boat-shaped hyaline space that does not reach the margin. A round ocellus is focused at one side of the center.

Habitat: Marine

Distribution: Specimens of this species were collected from surface sediments of the southeast SCS near the Zhongnan Peninsula at station SA08-20 (9°10.41′N, 109°20.70′E, 1 071 m deep; sediment type YT).

(6) *Cocconeis ocellata* Mann (Plate I, Fig.f)

Mann (1925), p.63, pl. 14, fig.1.1

Description: Valve broadly elliptical, 50 μm in length and 35 μm in width. Valves have longitudinal wavy striae, 10 in 10 μm. The spaces between rows are about equal in width in the center, while no hyaline space occurs on either side of the raphe. The striae near the margin are regularly bifurcated into two smaller striae. The ornamentations on the hypotheca and epitheca valves are the same. At one side of the valve close to the central area a large, but indistinctly outlined ocellus, was detected, while a smaller, less distinct ocellus was found at the hypotheca valve close to the central area.

Habitat: Marine

Distribution: Specimens of this species were collected from surface sediments at station SA09-43 (5°52.03′N, 113°24.64′E, 101 m deep; sediment type MFS) on the Sunda shelf of the SCS.

(7) *Dictyoneis marginata* (F. W. Lewis) Cleve (Plate II, Fig.a)

Cleve (1890), vol. 1, p. 14; Schmidt et al. (1874–1859), Taf. 188; Boyer (1928), p. 343; Round et al. (1990), p. 468; Hustedt (1959), vol. 1, p. 577, fig. 1009.

Synonyme: *Navicula marginata* Lewis (1862), S. 161.

Navicula strangulata Greville (1866), Bd. 14, Taf. 12, fig. 24

Navicula reticulata Grunow (1867), S. 26.

Mastogloia reticulata Grunow (1877), S. 175, Taf. 195, fig. 4.

Navicula kossuthi Pantocsek (1886), Bd. 1, Taf. 14,

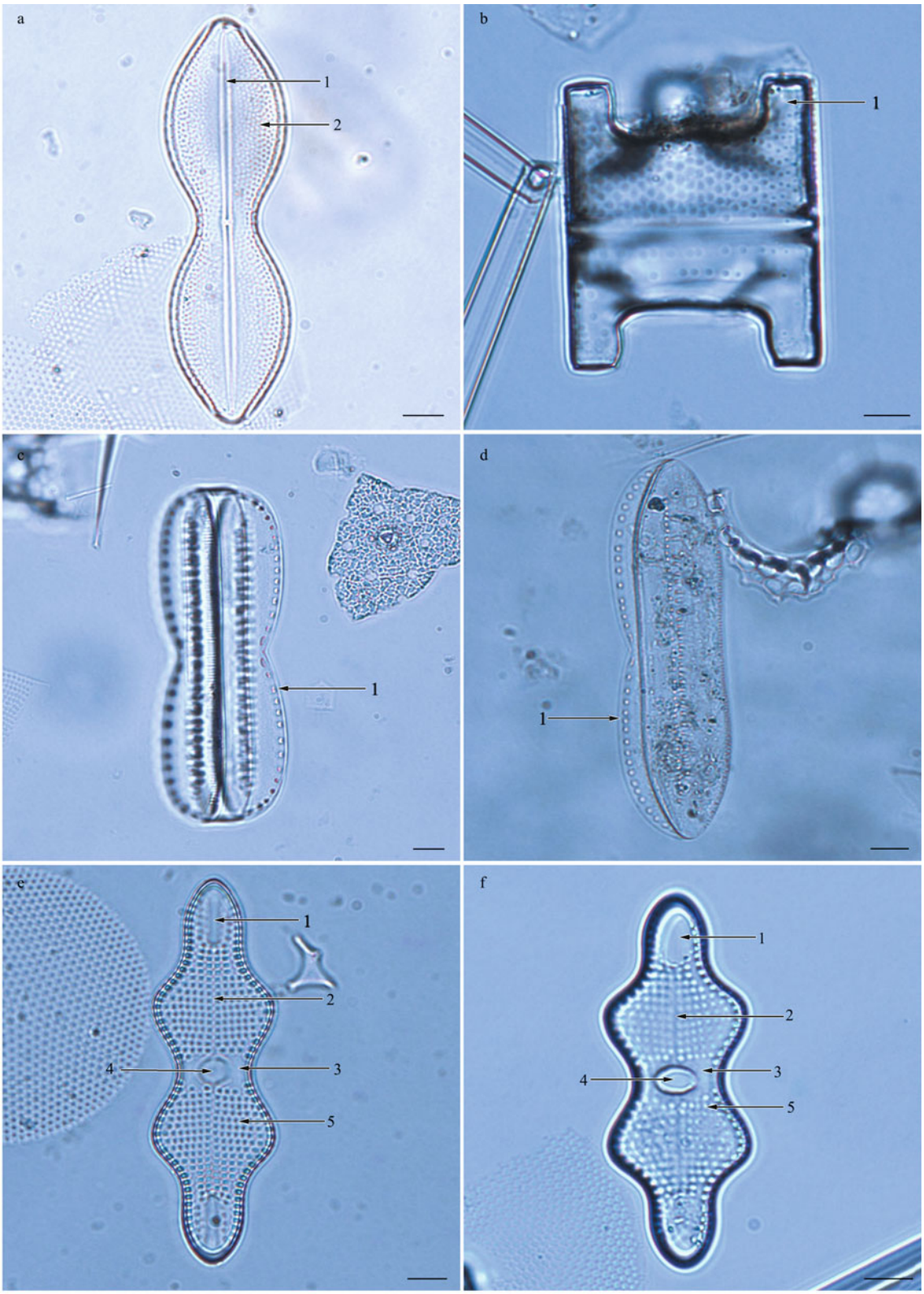

Plate II New record of diatom in China

a. *Dictyoneis marginata* (1: raphe; 2: loculate); b. *Entogonia davyana* (1: horn); c. *Tryblionella campechiana* (1: fibulae) (girdle view); d. *Tryblionella campechiana* (valve view); e. *Plagiogramma kinkeri* (1: hyaline space; 2: pseudo-raphe; 3: hyaline space; 4: hyaline raised space; 5: striae); f. *Plagiogramma nankoorense* (1: hyaline space; 2: pseudo-raphe; 3: hyaline space; 4: hyaline raised space; 5: striae). Scale bar: 10 μm

fig. 120.

Dictyoneis marginata var. *typical* Cleve (1894), S. 30.

Description: Valves panduriform. Valves are 105 μm long and 28 μm wide. The valve face is loculate. Valves near the margin are often expanded into longitudinal grooves. The raphe is narrow, centrally located, and slightly expanded in the middle. The raphes fissures terminal is deflected to opposite sides at the two poles; therefore, the raphe is slightly sigmoidal. The loculi are four in 10 μm at the margins, and seven in 10 μm at the center.

Habitat: Marine

Distribution: Specimens of this species were collected from surface sediments in the SCS Basin at station YSJD75 (11°59.84′N, 113°24.64′E, 4 185 m deep; sediments type YT).

(8) *Entogonia davyana* Grev. (Plate II, Fig. b)

Schmidt et al. (1874–1859), Taf. 152; Greville (1863), vol. 3, p. 235.

Description: The valve is triangular, with barely convex valval sides. The horns in the angles are 10 μm tall, erect, with truncated apices. The girdle is densely covered with punctae that form vertical rows. The frustule is 54 μm long and 43 μm wide. There are six striae in 10 μm.

The genus *Entogonia* includes about 20 species, all of which have been found in fossil deposits from Barbados and Jerenada (Haiti).

Habitat: Marine benthic (fossil)

Distribution: Specimens of this species were collected from surface sediments of the southern SCS at station SA08-81 (7°31.10′N, 110°27.46′E, 1 838 m deep; sediment type YT) and located in the Kalimantan Shelf at station SA09-100 (3°56.61′N, 112°06.29′E, 62 m deep; sediment type TS).

(9) *Tryblionella campechiana* Grunow (Mann) (Plate II, Fig.c–d)

Round et al. (1990), p. 678.

Synonyme: *Nitzschia campechiana* Grunow (1880), vol. 3, p. 395, pl. 13, fig. 16; Mann (1925), p. 126. pl. 28, figs.3–4.

Description: The valves are cocoon-shaped with a central constriction and acute-to-obtuse ends. Valves are acute to rather obtuse in valve view and almost rostrate in girdle view, with a central constriction. The valve is 105 μm long and 30 μm wide, with a width of 25 μm at the constriction area. The raphe system is extremely exocentric, and slightly longer, with four fibulae 10 μm in length. There are 10 valve striae in 10 μm.

Habitat: Marine

Distribution: Specimens of this species were collected from the surface sediments of the southern SCS at station SA08-81 (7°31.10′N, 110°27.46′E, 1 838 m deep; sediment type YT).

(10) *Plagiogramma kinkeri* A. Schmid (Plate II, Fig.e)

Schmidt et al. (1874–1859) Heft 53, Taf, 210, fig.32.

Description: Valves are bi-undulate, and extended at the apical axis, 85 μm long and 28 μm wide. There are seven striae in 10 μm, which are clear and perpendicular to the apical axis under LM, and a pseudoraphe with a central and apical hyaline space. The fascia in the central portion of the valve was about 18 μm×8 μm in the hyaline space, while a 6 μm hyaline raised area was observed in the central hyaline space.

Habitat: Marine

Distribution: Specimens of this species were collected from surface sediments at station NS2007-19 (9°29.61′N, 116°46.70′E, 2 150 m deep, sediment type YT) in the southern SCS.

(11) *Plagiogramma nankoorense* Grunow (Plate II, Fig.f)

Schmidt et al. (1874–1859), Heft 53, Taf. 210, fig. 31.

Description: The valves are bi-undulate and extended at the apical axis. The length and width of the valve are 80 μm and 29 μm, respectively. Striae were clear and perpendicular to the apical axis under LM. Five striae, 10 μm long, were observed. The pseudo-raphe is clear. Central and apical hyaline spaces are present in the valve. The fascia in the central portion of the valve is about 15 μm×8 μm. An 8 μm×6 μm hyaline raised area is present in the central hyaline space.

Identification of *P. kinkeri* and *P. nankoorense* was based on the number of striae, hyaline space at the apical fields, and the shape of the hyaline raised area in the center.

Habitat: Marine

Distribution: Specimens of this species were collected from surface sediments at station NS2007-19 (9°29.61′N, 116°46.70′E, 2 150 m deep, sediments type YT), in the southeastern SCS near the Palawan Island.

4 DISCUSSION

4.1 Description of genus *Rutilaria*

When *Rutilaria* was first described by Greville (1863), the genus was thought to be related to *Nitzschia* because the specimens were observed in girdle view and the marginal spines were equated in

density with the fibulae. Greville (1866) provided a more accurate description of the genus and suggested that it was more closely related to *Biddulphiineae* but *Nitzschia*. Jurilj (1965) introduced the term-periplekton in the center of the valves of the genera *Syndetocystis* and *Syndetoneis*. Nevertheless, the first accurate description of the periplekton (based on scanning electron microscopy) was provided by Ross and Sims (1972). Given that the periplekton is a slightly raised papilla, it can only be viewed by SEM. The periplekton has a modified rimoportula and its internal opening is a straight slit across a slightly raised papilla. The external portion of the periplekton consists of a vertical tube, a stem, and two lateral arms at its upper end that form a ring clasping the tube of the periplekton of the sibling valve (Ross and Sims, 1972). The presence of an ocellus at each pole of the *Rutilaria* valve was reported over a century ago after the genus was first described. When compared with the ocelli of *Auliscus* and *Eupodiscus*, those of *Rutilaria* are usually small and do not have well-developed rims (Simonsen, 1972). *Syndetocystis* Greville (1866) and *Syndetoneis* Grunow (1888) have been shown to be synonyms of *Rutilaria*, although they have been regarded as genera separate from one another and from *Rutilaria*. Specifically, the three genera differ only in the height of the vertical tube of the periplekton and the shape of its arms, the height of the elevations at the poles, the arrangement and size of the areolae, and the position of the spines (Ross, 1995).

Rutilaria is primarily a fossil genus. Only two of its 28 species are known to be living, and both of these have fossil records as well. This extant genus has a geologic record dating back to the Paleocene. The two living species, *R. tenuicornis* Grunow and *R. philippinarum* Cleve & Grove, are both very uncommon members of the neritic plankton in tropical and subtropical seas. *Rutilaria* has been recorded in Portugal, Denmark, Slovakia, Hungary, Ukraine, Russia, Saudi Arabia, Tanzania, Indonesia, the Philippines, Japan, the USA, Mexico, New Zealand, Barbados, Haiti, the Indian Ocean, the South Atlantic and the North Atlantic (Ross, 1995). *Rutilaria radiata* has been found from the Early Eocene in Russia, the Upper Eocene in Oamaru, New Zealand and the Late Miocene in California, USA (Ross, 1995).

4.2 The main features of the genus *Trigonium*

Trigonium is a widely distributed marine diatom genus, fossil or extant that was first described by Cleve (1867). The main features of this genus are as follow: frustules are triangular or multiangular in valve view, and rectangular in girdle view. The valves are elevated at the angles, and a septum is detected on the vavlocopula at each angle. Areolae are more-or-less simple and arranged in rows radiating from the center. Pseudocelli, which actually consist of smaller areolae, occur at angles. The organism is very similar to *Triceratium*, and their main differences are listed in Table 1. Based on these features, the studied specimens were tentatively classified into the genus *Trigonium*.

4.3 The distribution of diatoms in SCS

Eleven newly recorded diatom taxa in sediments of SCS were observed. Based on the available data, these species have primarily been recorded in the eastern and western Pacific Ocean, and the Indian Ocean (Table 2). *D. marginata* and *P. kinkeri* have been found in Java, and Sumbawa in Indonesia, *B. turrigera*, *C. ocellata*, *T. campechiana* and *T.* cf. *contumax* are distributed in the Philippines, and *R. radiata*, *A. grevillei* and *P. nankooerense* were previously found in California. Most of these species

Table 1 Differences between *Trigonium* and *Triceratium*

Structure	*Trigonium*	*Triceratium*
Valve	Tri- to multiangular	Triangular or sometimes square/spines
Girdle view	Rectangular	Narrowly oblong
Mantles	Deep	Very shallow
Rimoportulae	Clustered in the valve center	Valve margin/or only one in center
Corner ending	Pseudocelli	Ocelli
Corner valvocopula	Septum	Absent
Areolae	More-or-less simple, closed externally by a layer of silica in which there is a ring usually composed of six pores in rows radiating from the center (external)	Loculate, opening externally via large foraminia, radiating (internal)

Table 2 Diatom species in SCS and their known distribution

Species	Location	Sample (vicinity stations)
Rutilaria radiata	Upper Eocene in USA; Late Miocene in,USA, Early Eocene in Russia (Ross, 1995)	NS2007-Q7 (Northern SCS) SA08-26 (Sunda Shelf)
Trigonium cf. *contumax*	Philippines (Mann, 1925)	SA08-23 (Sunda Shelf) SA13-11 (Xisha Island)
Asterolampra grevillei	USA (Ross, 1995)	NS2007-19 (Mindoro Strait)
Biddulphia turrigera	Philippines (Mann, 1925)	NS2007-Q7 (Northern SCS) YSJD-69 (Nansha Basin)
Cocconeis cyclophora var. *decora*	Japan (Schmidt, 1874–1959)	SA08-20 (Sunda Shelf)
Cocconeis ocellata	Philippines (Mann, 1925)	SA09-43 (Sunda Shelf)
Dictyoneis marginata	Java, Indonesia (Schmidt, 1874–1959)	YSJD75 (Nansha Basin)
Entogonia davyana	USA (Van Heurck, 1896)	SA09-43 (Sunda Shelf)
Nitzschia campechiana	Malaysia and the Philippines (Mann, 1925)	SA08-81 (Sunda Shelf) SA09-100 (Sunda Shelf)
Plagiogramma kinkeri	Indonesia (Schmidt, 1874–1959)	NS2007-19 (Balabec Strait)
Plagiogramma nankoorense	USA (Schmidt, 1874–1959)	NS2007-302 (Mindoro Strait)

are extant species; except for *R. radiata* and *E. davyana*, which are fossil marine species (van Heurck, 1896). *R. radiata* and *E. davyana* occurred in the surface sediments of our samples, which may have resulted from reworked sediments.

The SCS is a semi-enclosed sea that is connected to the adjacent sea area through a number of channels. The survey area is mostly influenced by western Pacific water via the Bashi Channel (depth about 2 600 m), through which the surface and intermediate waters of the Western Pacific enter the northern South China Sea. SCS water invasion through Luzon Strait into the Philippines Sea appears to occur throughout the year, which influences the distribution of water masses within the SCS (Shaw, 1991; Qu, 2000; Liu et al., 2008). Therefore, the species composition of the survey area was most similar to that recorded for the Philippines Sea.

Different from many previous studies conducted in the northern SCS continental shelf, few studies of diatoms have been carried out in the southern SCS (Cheng and Liu, 1997; Guo et al., 1978; Guo, 1981; Lan et al., 1995; Liu et al., 1982, 1984; Liu and Cheng, 1994). The present study contributes to the existing knowledge regarding diatom taxonomy and benthic diatom species diversity and distribution in the SCS.

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