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Contributed Paper

Fifty Three New Record Species of Benthic Diatoms from Mekong River and Its Tributaries in Thailand

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ABSTRACT

A study on the diversity of benthic diatoms in Mekong River and its tributaries in Thailand was carried out during July 2005 to April 2007. Two hundred and fifty three species of benthic diatoms were found. Fifty three species have never been previously recorded in Thailand. It could be classified into 3 classes, 11 orders, 22 families and 32 genera. The detailed descriptions of these new records were reported.

Keywords: benthic diatoms, mekong river, new record of Thailand.

1. INTRODUCTION

Studies on freshwater benthic diatoms are relatively limited in America, Europe, Australia and Asia. The studies of diatoms in Asia were lead by Japanese scientist for long time. However, there are now widely study in many Asian countries. In Thailand, even less work has been done. Diatom flora was studies by foreign scientists for many years. In recent day, there has been increased interest in the diatoms of Thailand by Thai researchers.

However, very little is known about the diatoms of Mekong River, the biggest international river in mainland Southeast Asia. This contribution deals with the description of 53 new records from Thailand.

2. MATERIAL AND METHODS

2.1 Sampling sites

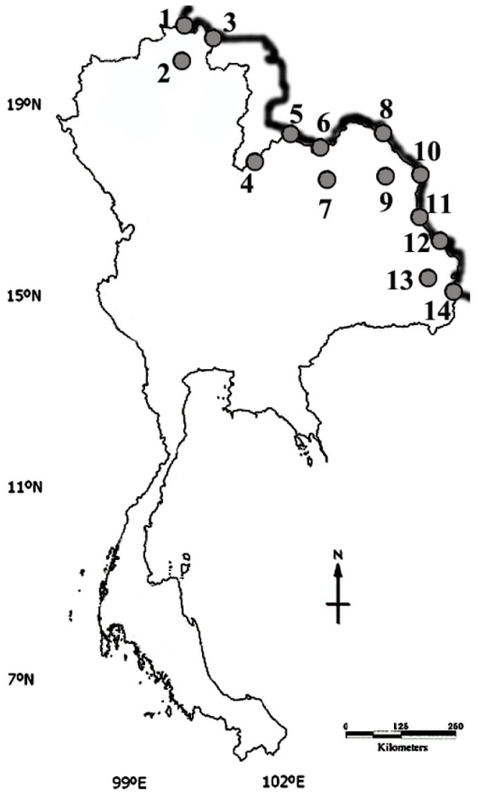
Fourteen sampling sites along the Mekong River and their tributaries in Chiang Rai, Loei, Nong Khai, Nakhon Phanom, Sakonnakorn, Mukdahan, Amnat Charoen and Ubon Ratchathani Provinces were selected. The details of each sampling site are show in Figure 1.

2.2Sampling and Benthic Diatoms Study

The samples were collected 3 times per year from July 2005 to April 2007. In each sampling site, diatoms samples were scraped off 10 stones with a toothbrushes using a plastic sheet with a 10 cm^2 cutout placed on the upper surface of the selected stone and kept in the boxes. Diatoms valves, cleaned with concentrated nitric acid (HNO_3) were mounted in diatoms mountant. Up to 300 valves were counted and identified in each sample.

3. RESULTS

In Mekong River and its tributaries, 252 diatom taxa have been identified. *Nitzschia* was the most species rich genus (24 species) followed by *Navicula* (16 species), *Gomphonema* and *Eunotia* (11 species). In addition, fifty three



sampling site 1 Golden Triangle, Chiang Rai Province
sampling site 2 Kok River, Chiang Rai Province
sampling site 3 Ban Had Krai, Chiang Rai Province
sampling site 4 Hueng River, Loei Province
sampling site 5 Kaeng Khood Khoo, Loei Province
sampling site 6 Ponpisai, Nong Khai Province
sampling site 7 Laung River, Nong Khai Province
sampling site 8 Mueang, Nakhon Phanom Province
sampling site 9 Songkram River, Sakonnakorn Province
sampling site 10 Kaeng Ka Bao, Nakhon Phanom Province
sampling site 11 Had Hin Win Chai, Amnat Charoen Province
sampling site 12 Kaeng Hin Kan, Mukdahan Province
sampling site 13 Kaeng Sapue, Ubon Ratchathani Province
sampling site 14 Khong Jium, Ubon Ratchathani Province

Figure 1. Sampling sites in Mekong River and their tributaries.

species of benthic diatoms were considered to be newly recorded in Thailand. It could be classified into 3 classes, 11 orders, 22 families and 32 genera. The species of diatoms were compared with the checklist of freshwater algae in Thailand by Lewmanomont et al. [1], Pekthong [2-4], Waiyaka [5], Kunpradid [6,7], Wanathong et al. [8], Peerapornpisal et al. [9], Suphan [10], Peerapornpisal [11], Inthasotti [12,13], Leelahakriengkrai [14,15] and Preuthiworanon [16]. The species list of new records of Thailand was shown in Table 1. Light micrographs, hand drawing micrographs and scanning electron micrographs were shown in figures 2-8 respectively.

Taxonomic Notes

The diatom description of each new record species was described. The diatom list was shown in Table 1. The structural data are abbreviated as follows, D: Diameter, L: Length, W: Width, Str: Striae, Cs: Costae, Fb: Fibulae, Ar: Areolae, Ma: Mantle.

Order Thalassiosirales

Family Stephanodiscaceae

***Discostella pseudostelligera* (Hustedt) Houk & Klee** (Figure 2:1, 5:1)

D: 5–8 mm, Str: 20–24 in 10 mm, Ar: 55–80 in 10 mm.

Heterovalvar, shortly cylindrical frustules. central area occupies half the valve diameter and is ornamented with a ring of areolae or short striae surrounding an isolated central areola.

***Discostella stelligera* (Cleve & Grunow) Houk & Klee** (Figure 2:2, 5:2)

D: 7.5–20 µm, Str: 8.9-11.5 in 10 µm, Ar: 28–

Table 1. New record species of benthic diatoms that found in Mekong River and its tributaries of Thailand.

Division Bacillariophyta
Class Coscinodiscineae
Subclass Thalassiosirophycidae
Order Thalassiosirales
Family Stephanodiscaceae
Discostella pseudostelligera (Hustedt) Houk & Klee
Discostella stelligera (Cleve & Grunow) Houk & Klee

Subclass Coscinodiscophycidae
Order Aulacoseirales
Family Aulacoseiraceae
Aulacoseira ambigua (Grunow) Simonsen

Subclass Biddulphiophycidae
Order Biddulphiales
Family Biddulphiaceae
Hydrosera whampoensis (Schwarz) Deby

Class Fragilariophyceae
Subclass Fragilariophycidae
Order Fragilariales
Family Fragilariaceae
Diatoma mesodon (Ehrenberg) K□ tzing
Synedra ulna var. *amphirhynchus* (Ehrenberg) Grunow
Synedra ulna var. *spathulifera* Grunow
Synedra ulna var. *subaequalis* Grunow
Tabularia fasciculata (C. Agardh) D.M.Williams & Round
Ulnaria ulna (Nitzsch) Comp□ re

Class Bacillariophyceae
Subclass Eunotiophycidae
Order Eunotiales
Family Eunotiaceae
Eunotia camelus var. *arcuata* Frenguelli
Eunotia repens A. Berg

Subclass Bacillariophycidae
Order Cymbellales
Family Cymbellaceae
Encyonema prostratum (Berkeley) K□ tzing
Encyonopsis microcephala (Grunow) Krammer
Placoneis gracilis Metzeltin, Lange-Bertalot & Garcia-Rodriguez
Placoneis symmetrica (Hustedt) Lange-Bertalot

Family Gomphonemataceae
Gomphonema contraturris Lange-Bertalot & Reichardt
Gomphonema pseudoaugur Lange-Bertalot
Gomphoneis rhombica (Fricke) Merino *et al.*

Order Achnanthales
Family Achnanthaceae
Achnanthidium catenatum (Bily & Marvan) Lange-Bertalot
Achnanthidium convergens (H. Kobayasi) H. Kobayasi
Achnanthidium minutissimum (Kützing) Czarnecki
Planothidium delicatulum (Kützing) Round&Bukhtiyarova

Order Naviculales
Family Diadesmidaceae
Diadesmis confervacea K□ tzing
Luticola nivalis (Ehrenberg) D.G. Mann
Luticola peguana (Grunow) D.G. Mann

Family Amphipleuraceae
Frustulia pararhomboides var. *pararhomboides* Lange-Bertalot

Family Neidiaceae
Neidium floridanum Reimer

Family Sellaphoraceae
Fallacia insociabilis (Krasske) D.G. Mann
Fallacia meridionalis Metzeltin, Lange-Bertalot and Garcia-Rodriguez

Family Diploneidaceae
Diploneis pseudovalis Hustedt

Family Naviculaceae
Eolimna minima (Grunow) Lange-Bertalot
Eolimna subminuscula (Manguin) Gerd Moser
Eolimna tantula (Hustedt) Lange-Bertalot
Geissleria punctifer (Hustedt) Metzeltin, Lange-Bertalot & Garcia-Rodriguez
Hippodonta capitata (Ehrenberg) Lange-Bertalot, Metzeltin & Witkowski
Navicula cryptotenelloides Lange-Bertalot
Navicula kuseliana Lange-Bertalot & Rumrich
Navicula phyllepta K□ tzing
Navicula radiosafallax Lange-Bertalot

Family Pleurosigmataceae
Gyrosigma obscurum (W.Smith)J.W.Griffith&Henfrey

Order Bacillariales
Family Bacillariaceae
Nitzschia linearis (C.Agardh ex.W.Smith)W.Smith var. *linearis*
Nitzschia liebetruthii Rabenhorst
Nitzschia pseudofonticola Hustedt
Nitzschia supralitorea Lange-Bertalot
Nitzschia tabellaria (Grunow) Grunow
Nitzschia terrestris (J.B.Petersen) Hustedt
Tryblionella acuminata W.Smith
Tryblionella balatonis (Grunow in Cleve & Grunow) D.G.Mann
Tryblionella calida (Grunow) Mann
Tryblionella coarctata (Grunow) D.G.Mann
Tryblionella levidensis W.Smith

Order Rhopalodiales
Family Rhopalodiaceae
Rhopalodia operculata (C.Agardh) H□ k.

36 in 10 mm.

Valve circular, convex central areas always with a star-shaped structure composed of circular to elongated alveoli. Concave central areas always lack alveolae, marginal area is occupied by striae, each composed of a double row of areolae. Areolae tend to fuse towards the centre of the valve, ending in a bigger areola in most cases.

Order Aulacoseirales

Family Aulacoseiraceae

***Aulacoseira ambigua* (Grunow) Simonsen** (Figure 2:3, 5:3)

D: 4-17 µm, Ma: in 5-13 µm, Ar: in 10 mm.

Cylindrical frustules and chains form, 1 or 2 large mantle and 4-8 short spines in the margin of the valve, with longitudinal grooves where large spines match to the neighboring cell. Parallel striae and thick areolae.

Order Biddulphiales

Family Biddulphiaceae

***Hydrosera whampoensis* (Schwarz) Deby (Figure 2:4, 5:4)**

D: 60-110 µm, L: 80-170 µm.

Multipolar, thick and appear as two superimposed triangles in valve view. The protuberances that form one of the triangles have well-developed pore fields at their apices. In girdle view the cells are quite elongate and appear grooved due to the shape of the valves.

Order Fragilariales

Family Fragilariaceae

***Diatoma mesodon* (Ehrenberg) Kützing (Figure 2:10, 5:10)**

L: 12-40 µm, W: 6-15 µm, Str: 18-24 in 10 µm, Cs: 2-4 in 10 µm.

Valve elliptical to elliptical-lanceolate, some time rhombic in shape. Pseudoraphe linear and narrow. Costae very few.

***Synedra ulna* var. *amphirhynchus* (Ehrenberg) Grunow** (Figure 2:6, 5:6)

L: 180-250 µm, W: 4-7 µm, Str: 10-12 in 10 µm.

Valve linear, suddenly constricted to yhe attenuate-rostrate or sometimes slightly capitate apices. Pseudoraphe very narrow. Central area absent. Striae parallel.

***Synedra ulna* var. *spathulifera* Grunow** (Figure 2:8, 5:8)

L: 100-600 µm, W: 6.5-8 µm, Str: 10-12 in 10 µm.

Valve linear, swollen near the ends of the valve. Apices wedge-shaped and rounded at ends of the valve, appear spatulate. Pseudoraphe narrow. Central area variable in size. Striae parallel.

***Synedra ulna* var. *subaequalis* Grunow** (Figure 2:7, 5:7)

L: 200-250 µm, W: 3-5 µm, Str: 7-9 in 10 µm.

Valve linear, slightly narrowed at the somewhat rostrate ends. Pseudoraphe very narrow. Central area absent.

***Tabularia fasciculata* (C. Agardh) D.M. Williams & Round** (Figure 2:12, 5:12)

L: 20-400 µm, W: 2-8 µm, Str: 7.5-26 in 10 µm.

Valve elliptic or elongate and variable in outline, from narrowly linear to linear-lanceolate or lanceolate valves with rounded or capitate ends.

***Ulnaria ulna* (Nitzsch) Compère** (Figure 2:5, 5:5, 8:12)

L: 50-250 µm, W: 2-9 µm, Str: 9-11 in 10 µm.

Linear or linear-lanceolate valves narrowing to blunt sub-rostrate or rostrate apices. Central area distinct, roughly square in outline and usually reaching the valve margin. Striae parallel.

Order Eunotiales

Family Eunotiaceae

***Eunotia camelus* var. *arcuata* Frenguelli** (Figure 2:13, 5:13)

L: 35.0-52.5 µm, W: 6.2-6.5 µm, Str: 10-14 in 10 µm.

Valves dorsiventral and symmetrical to the transapical axis, Valves highly arched, with 4 humps. Ventral margin is continuous, without swellings. Ends of the valves are sub-capitate.

***Eunotia repens* A. Berg** (Figure 2:9, 5:9)

L: 81-218 µm, W: 3.0-7.7 µm, Str: 8-10 in 10 µm.

Valves dorsiventral and symmetrical to

the transapical axis. Dorsal margin convex, smooth, ventral margin concave. Raphe fissures positioned apically. Striae are parallel

Order Cymbellales

Family Cymbellaceae

***Encyonema prostratum* (Berkeley) Kützing** (Figure 2:14, 5:14)

L: 38-92 µm, W: 16-31 µm, Str: 7-21.5 in 10 µm.

Valves robust, broadly dorsiventral and symmetrical to the transapical axis. Dorsal margin normally arched, ventral margin biarcuate to convex. Valve apices bluntly rounded. Raphe straight with central endings deflected dorsally and apical ends deflected ventrally. Striae course.

***Encyonopsis microcephala* (Grunow) Krammer** (Figure 2:11, 5:11)

L: 20-25 µm, W: 5.0-6.5 µm, Str: 14-16 in 10 µm.

Valves are cymbelloid with dorsal margin strongly curved and straight ventral margin. Axial area narrow,straight and without a central area. Small central nodule. A stigmoid presented near the dorsal central striae.

***Placoneis gracilis* Metzeltin, Lange-Bertalot & Garcia-Rodriguez** (Figure 3:3, 6:3)

L: 15-25 µm, W: 15-25 µm, Str: 8-10 in 10 µm.

Valves lanceolate to elliptical-lanceolate, with obtuse, slightly protracted ends. Striae radiate throughout. Axial area narrow, Slightly winded toward the center area. Striae radiate throughout the valve.

***Placoneis symmetrica* (Hustedt) Lange-Bertalot** (Figure 3:4, 6:4)

L: 25-35 µm, W: 15-25 µm, Str: 18-20 in 10 µm.

Valves linear with subcapitate apices. Striae porate, radiate over almost all the valve, central striae shorter, forming a transverse, central area occupying more than half the valve width.

Family Gomphonemataceae

***Gomphonema contraturris* Lange-Bertalot & Reichardt** (Figure 3:7, 6:7)

L: 45-86 µm, W: 10-14 µm, Str: 8-12 in 10 µm.

Valves only slightly asymmetrical to transapical axis. Apices rounded, sub-rostrate or rostrate. Raphe often slightly sinuous. A single stigma presented. Striae coarse and parallel.

***Gomphonema pseudoaugur* Lange-Bertalot** (Figure 3:6, 6:6)

L: 25-55 µm, W: 7-10 µm, Str: 9-12 in 10 µm.

Valve asymmetrical to transapical axis. Symmetrical to apical axis, often broadly lanceolate in outline. Cells wedge-shaped in girdle view with pseudosepta visible. Raphe often slightly sinuous. A single stigma presented. Striae relatively coarse and evenly spaced.

Gomphoneis rhombica* (Fricke) Merino *et al. (Figure 3:5, 6:5)

L: 39-53 µm, W: 5-9 µm, Str: 9-12 in 10 µm.

Valve linear-rhombical in shape. Apices rounded. Striae relatively coarse, parallel and evenly spaced.

Order Achnanthales

Family Achnanthaceae

***Achnanthidium catenatum* (Bily & Marvan) Lange-Bertalot** (Figure 3:8, 6:8)

L: 8-26 µm, W: 2-3 µm, Str: 28-34 in 10 µm.

Valve linear-lanceolate with subcapitate to capitate ends. Raphe valve with narrow, raphe filiform. Striae slightly radiate. Central area small or lacking in pseudoraphe valve.

***Achnanthidium convergens* (H. Kobayasi) H. Kobayasi** (Figure 3:10, 6:10)

L: 9-20 µm, W: 3.5-5 µm, Str: 20-22 in 10 µm.

Valve elliptical-lanceolate to linear-lanceolate with capitate ends. Raphe valve with rhombic central area. Striae slightly radiate. Pseudoraphe valve with linear pseudoraphe, Central area lacking.

***Achnanthidium minutissimum* (Kützing) Czarnecki** (Figure 3:9, 6:9, 8: 4-5)

L: 6-15 µm, W: 1.5-3.5 µm, Str: 20-30 in 10 µm.

Valve linear-elliptic, slightly or more elongated near the end, and with bluntly rounded poles. Striae slightly radiate and often

a shortened striae near the small central area, Axial area narrow.

***Planothidium delicatulum* (Kützing) Round&Bukhtiyarova** (Figure 3:15, 6:15-16)
L: 9-31 µm, W: 6-10 µm, Str: 10-12 in 10 µm.

Valve elliptic, elliptic-lanceolate or lanceolate. The rapheless (convex) valve has a similar density of striae to that on the raphe valve Lacking of the horseshoe shaped structure on the rapheless valve

Order Naviculales

Family Diadesmidaceae

***Diadesmis confervacea* Kützing**
(Figure 3:2, 6:2)
L: 9-28 µm, W: 4-10 µm, Str: 18-26 in 10 µm.

Valve broadly lanceolate to elliptic lanceolate with rounded apices. Raphe straight. Central raphe endings slightly expanded. Striae slightly radiate, comprised of distinct pores that are sometimes slightly elongate in a transapical direction.

***Luticola nivalis* (Ehrenberg) D.G. Mann**
(Figure 3:16, 6:17)
L: 11-23 µm, W: 6.5 -9 µm, Str: 17-19 in 10 µm, Fb: 6 in 10 µm.

Valve linear to linear-elliptical. Transapical striae radiate throughout, composed of two to four rounded areolae. Largest areolae near the valve margins. One isolated, circular stigma present.

***Luticola peguana* (Grunow) D.G.Mann**
(Figure 3:17, 6:18)
L: 10-25µm, W: 6-9µm, Str: 26-30 in 10 µm.

Valve lanceolate with bluntly rounded apices. Central raphe endings deflected to one side and polar raphe fissures hooked over valve apices. Axial area widening towards the broad, transverse central area. Striae radiate. Stigma on one side of central area.

Family Amphipleuraceae

***Frustulia pararhomboides* var. *pararhomboides* Lange-Bertalot** (Figure 3:18, 6:19)
L: 70-160 µm, W: 15-30 µm, Str: 20-30 in 10 µm.

Valve rhombic-lanceolate, narrowing sharply to the rounded apices. Axial and central areas narrow but distinct. Transverse striae perpendicular to the raphe at the center of the valve, sometimes becoming slightly convergent toward the ends of the valve, but radiate at the apices.

Family Neidiaceae

***Neidium floridanum* Reimer**
(Figure 3:19, 6:20)
L: 50-57 µm, W: 12-14 µm, Str: 24 in 10 µm.

Valve triundulate with protracted, distinctly rostrate ends. Axial area narrow, Raphe straight or slight diagonal, narrower near the central area and the ends. Striae radiate, becoming convergent or oblique at the ends.

Family Sellaphoraceae

***Fallacia insociabilis* (Krasske) D.G. Mann**
(Figure 3:12, 6:12)
L: 12-20 µm, W: 10-15 µm, Str: 22-30 in 10 µm.

Valve linear, lanceolate to elliptical, with bluntly rounded apices, girdle view narrowly rectangular. Striae uniseriate, but interrupted by lateral hyaline areas that connect with the central area. Raphe central in a narrow axial area, central fissures straight and expanded.

***Fallacia meridionalis* Metzeltin, Lange-Bertalot and Garcia-Rodriguez**
(Figure 3:13, 6:13)
L: 13-16 µm, W: 5-6 µm, Str: 16-20 in 10 µm.

Valve elliptical with rounded ends. Axial area narrow, bordered by coarse puncta. Central area joining with smooth lateral areas to form a rather broad clear area. Striae marginal, composed of coarse puncta. Striae radiate throughout the valve.

Family Diploneidaceae

***Diploneis pseudovalis* Hustedt**
(Figure 3:11, 6:11)
L: 16-31 µm, W: 9-14 µm, Cs: 8-12 in 10 µm.

Valve linear-elliptical with rounded ends. Central area large. Longitudinal canals narrow and district, suddenly swollen around the central area. Costae radiate.

Family Naviculaceae

***Eolimna minima* (Grunow) Lange-Bertalot** (Figure 3:22, 6:22, 8:11)

L: 5-18 µm, W: 2-4.5 µm, Str: 25-30 in 10 µm.

Valve linear to linear-elliptical with bluntly rounded apices. Striae fine, slightly radiate but shorter and more widely spaced at the centre, forming a butterfly-shaped to rectangular central area. Axial area narrow. Raphe fissures straight, slightly expanded at the centre .

***Eolimna subminuscula* (Manguin) Gerd Moser** (Figure 3:20-21, 6:21)

L: 7-12.5 µm, W: 3.5-6 µm, Str: 15-26 in 10 µm.

Valve broadly lanceolate with rounded apices. Striae transverse or slightly radiate, central striae slightly wider apart. Raphe slit in a well-defined axial area, the raphe fissures curving slightly to one side at each end. Central area of similar width to axial area.

***Eolimna tantula* (Hustedt) Lange-Bertalot** (Figure 3:23, 6:23, 8:10)

L: 7-13 µm, W: 4-7 µm, Str: 13-25 in 10 µm.

Valve linear-elliptical to elliptical. Valve lightly silicified. Axial area narrow. Central area slightly wider than the axial area. Striae transverse or slightly radiate.

***Geissleria punctifer* (Hustedt) Metzeltin, Lange-Bertalot & Garcia-Rodriguez** (Figure 3:1, 6:1)

L: 17-25 µm, W: 6-7.5 µm, Str: 14-16 in 10 µm.

Valve elliptical-lanceolate with slightly rostrate ends. Axial area district, becoming wider toward the center of the valve. Striae slightly radiate, central striae widely spaced than the striae in the rest of valve.

***Hippodonta capitata* (Ehrenberg) Lange-Bertalot, Metzeltin & Witkowski** (Figure 3:14, 6:14)

L: 20-30 µm, W: 5-7 µm, Str: 8-10 in 10 µm.

Valve elliptic-lanceolate, ends subcapitate to capitate. Raphe straight, Filiform, central pores fairly close. Striae noticeably broad, radiate in the middle, convergent at the ends.

***Navicula cryptotenelloides* Lange-Bertalot** (Figure 3:24, 6:24)

L: 9-18 µm, W: 3-4.5 µm, Str: 16-18 in 10 µm.

Valve lanceolate, ends acutely rounded. Raphe filiform. Central pores very delicate, axial area very narrow, linear. Striae radiate, convergent at the ends.

***Navicula kuseliana* Lange-Bertalot & Rumrich** (Figure 3:28, 6:28)

L: 30-55 µm, W: 5-9 µm, Str: 12-15 in 10 µm.

Valve linear-elliptic to linear-lanceolate, ends narrowed to wedge, obtusely rounded. Raphe filiform. Central pores close. Axial area very narrow. Striae strongly radiate.

***Navicula phyllepta* Kützing** (Figure 3:25, 6:25)

L: 25-46 µm, W: 6-9 µm, Str: 17-20 in 10 µm.

Valve lanceolate, ends acutely rounded. Raphe filiform. Central pores close. Axial area very narrow and rounded. Striae radiate, parallel or convergent towards the poles.

***Navicula radiosafallax* Lange-Bertalot** (Figure 3:27, 6:27)

L: 30-50 µm, W: 5-7 µm, Str: 13-14 in 10 µm.

Valve linear-lanceolate, ends obtusely wedge-shaped. Raphe weakly lateral with indistinct central pores. Axial area moderately narrow and laceolate central area. Striae radiate, convergent at the ends.

Family Pleurosigmataceae

***Gyrosigma obscurum* (W.Smith) J.W. Griffith & Henfrey** (Figure 4:1, 7:1)

L: 85-150 µm, W: 10-15 µm, Str: 35-40 in 10 µm.

Valve slightly sigmoid and narrowly rounded Axial area and raphe eccentric throughout, sigmoid, closed to the margin near the ends. Proximal raphe ends indistinct, but appearing straight. Central area small, orbicular or longitudinally elliptical. Terminal area inconspicuous. Longitudinal striae very fine.

Order Bacillariales

Family Bacillariaceae

Nitzschia linearis* (C.Agardh ex.W.Smith) W.Smith var. *linearis (Figure 4:2, 7:2)

L: 70-180 µm, W: 2.5-7.5 µm, Str: 28-32 in 10 µm.

Valve bilaterally symmetrical, linear or linear-lanceolate. Transverse striae. Raphe system fibulate, marginal. Fibulae appearing like short transverse ribs in girdle and valve view. Central pair of fibulae more widely separated than the others.

***Nitzschia liebetruthii* Rabenhorst**
(Figure 4:6, 7:6, 8:6)
L: 6-45 µm, W: 3-5 µm, Str: 24-27 in 10 µm.

Valve bilaterally symmetrical, linear to linear-lanceolate with subrostrate or cuneate poles. _Raphe system fibulate. Fibulae small, dot-like to square. Central raphe endings absent.

***Nitzschia pseudofonticola* Hustedt**
(Figure 4:4, 7:4, 8:7-8)
L: 19-40 µm, W: 4-5.5 µm, Str: 40-44 in 10 µm.

Valve bilaterally symmetrical, lanceolate or linear-lanceolate, with subcapitate or capitate poles. Central part of the valve with slightly convex sides. Raphe system fibulate. marginal. Fibulae small, dot-like to square.

***Nitzschia supralitorea* Lange-Bertalot**
(Figure 4:5, 7:5)
L: 45-55µm, W: 7-12 µm, Str:35-45 in 10 µm.

Valves linear-lanceolate, slightly wide at the center, parallel margins, acute apices and rounded poles. Apical and pervalvar straight. Raphe marginal with irregularly distant fibulae.

***Nitzschia tabellaria* (Grunow) Grunow**
(Figure 4:7, 7:7)
L: 20-22 µm, W: 7-7.5 µm, Str: 18-25 in 10 µm.

Valve narrowly linear to linear-lanceolate or lanceolate valves with rounded or capitate ends. Valve surface is undulate and has a wide keel. Raphe system fibulate. marginal. Areolation is coarse.

***Nitzschia terrestris* (J.B.Petersen) Hustedt**
(Figure 4:3, 7:3)
L: 23-60 µm, W: 6-9 µm, Str: 34-40 in 10 µm.

Valve linear-lanceolate or linear, slightly sigmoid at the ends. Apices rounded and blunt poles. Raphe system fibulate, marginal. A slight central constriction and slightly sigmoid poles.

***Tryblionella acuminata* W.Smith**
(Figure 4:11, 7:12)
L: 50-100 µm, W: 13-18 µm, Str: 12-16 in 10 µm.

Valve broadly linear or llinear-lanceolate, sometimes slightly constricted centrally. Poles cuneate or subrostrate. Transverse striae prominent. Raphe system fibulate, marginal. Central raphe endings presented.

***Tryblionella balatonis* (Grunow in Cleve & Grunow) D.G.Mann** (Figure 4:8, 7:8)
L: 12-23 µm, W: 8-11 µm, Str: 9-11 in 10 µm.

Valve small, linear and straight with parallel margins and acute-cuneate apices that have rounded poles._Striae coarse.

***Tryblionella calida* (Grunow) D.G.Mann**
(Figure 4:12, 7:11)
L: 45-70 µm, W:10-16 µm, Str: 17-22 in 10 µm.

Valve panduriform, isopolar, isobilateral with cunate ends. Striae coarse to very fine transverse the cell.

***Tryblionella coarctata* (Grunow) D.G. Mann** (Figure 4:10, 7:10)
L: 30-50 µm, W:12-16 µm, Str: 25-30 in 10 µm.

Valve panduriform, isopolar, isobilateral with cunate ends. Striae coarse in central area and slightly curve in the ends.

***Tryblionella levidensis* W. Smith**
(Figure 4:9, 7:9)
L: 12-20 µm, W: 10-15 µm, Str: 9-11 in 10 µm.

Valve linear or sigmoid. Ends rostrated or capitated. Raphe along one margin and fibulae present. Striae coarse to very fine transverse the cell and central area absent.

Order Rhopalodiales
Family Rhopalodiaceae

***Rhopalodia operculata* (C.Agardh) Håk.**
(Figure 4:13-14, 7:13-14, 8:3)
L: 20-30 µm, W: 7-10 µm, Str: 15-19 in 10 µm.

Valve isopolar and dorsiventral, lanceolate-elliptical in shape, acute apices. The dorsal margin curved and straight at the ventral margin. Striae composed of a single row of puncta composes. Fibulae radiate.

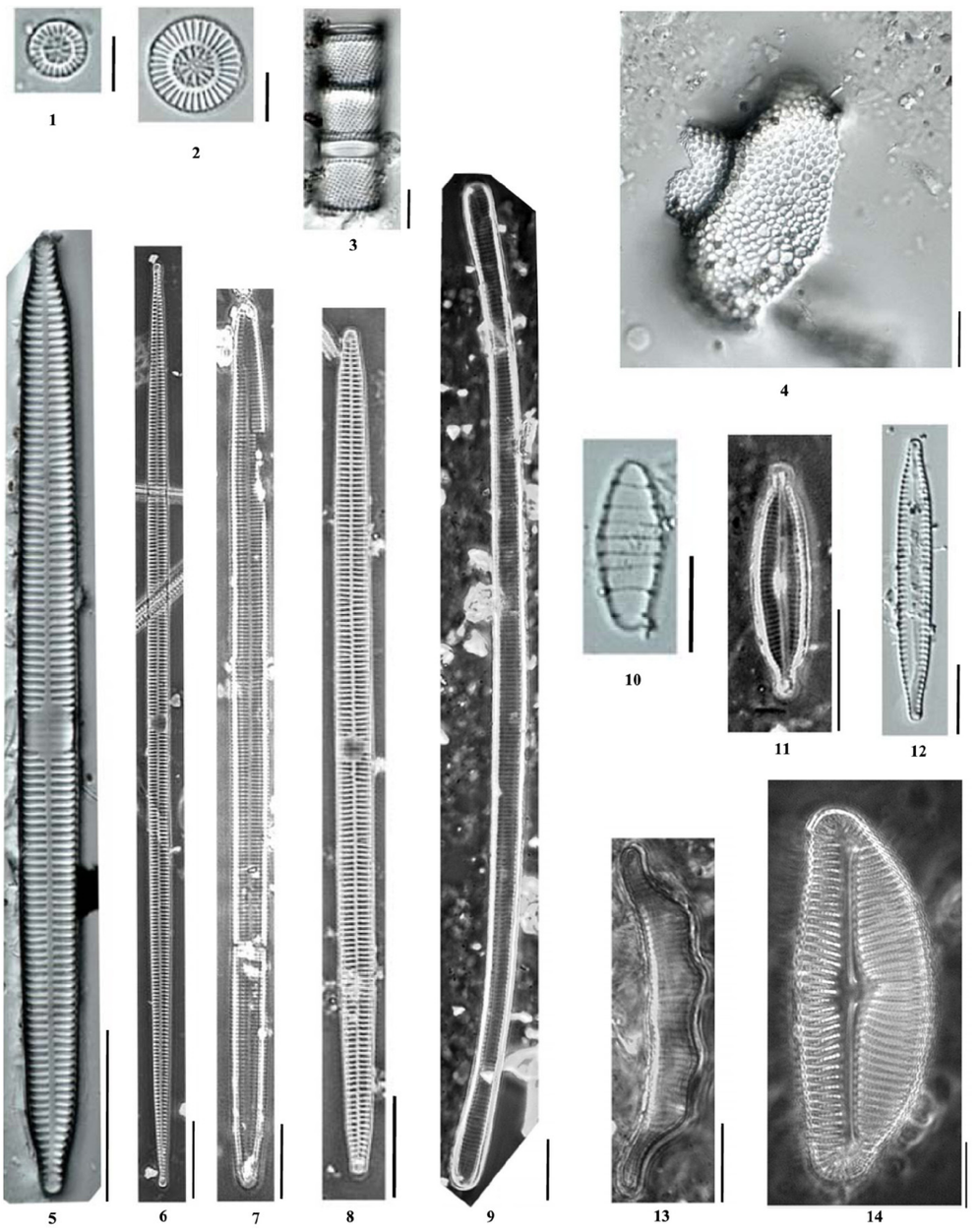


Figure 2. Light micrographs of cleaned diatoms in Mekong River and its tributaries in the part of Thailand (scale bar = 10 μm).
(1) *Discostella pseudostelligera* (Hustedt) Houk & Klee, (2) *Discostella stelligera* (Cleve & Grunow) Houk&Klee, (3) *Aulacoseira ambigua* (Grunow) Simonsen, (4) *Hydrosera whampoensis* (A.F.Schwarz) Deby, (5) *Ulnaria ulna* (Nitzsch) Comp□re, (6) *Synedra ulna* var. *amphirhynchus* (Ehrenberg) Grunow, (7) *Synedraulna* var. *subaequalis* Grunow, (8) *Synedra ulna* var. *spathulifera* Grunow, (9) *Eunotia repens* A. Berg, (10) *Diatoma mesodon* (Ehrenberg) Kützing, (11) *Encyonopsis microcephala* (Grunow) Krammer, (12) *Tabularia fasciculata* (C. Agardh) D.M. Williams & Round, (13) *Eunotia camelus* var. *arcuata* J. Frenguelli, (14) *Encyonema prostratum* (Berkeley) Kützing.

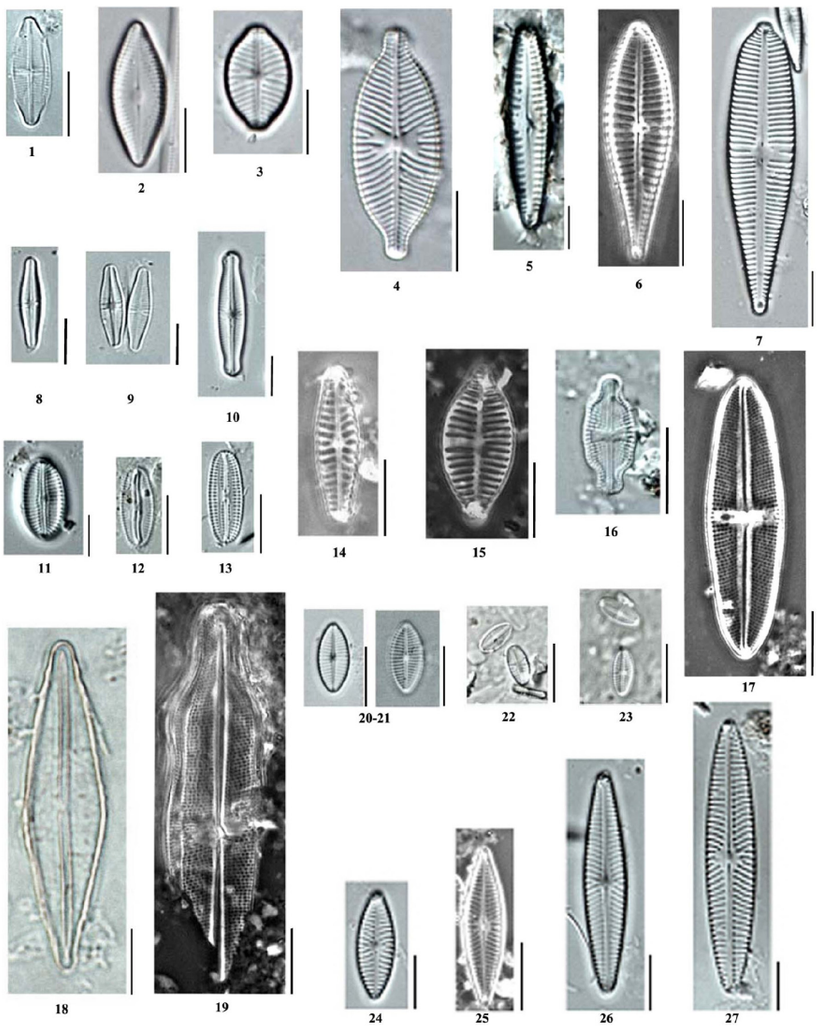


Figure 3. Light micrographs of cleaned diatoms in Mekong River and its tributaries in the part of Thailand (scale bar = 10 μm).
(1) *Geissleria punctifer* (Hustedt) Metzeltin, (2) *Diadesmis confervacea* Kützing, (3) *Placoneis gracilis* Metzeltin, Lange-Bertalot & Garcia-Rodriguez, (4) *Placoneis symmetrica* (Hustedt) Lange-Bertalot, (5) *Gomphoneis rhombica* (Fricke) V. Merino *et al.*, (6) *Gomphonema pseudoaugur* Lange-Bertalot , (7) *Gomphonema contraturris* Lange-Bertalot & Reichardt, (8) *Achnanthidium catenatum* (Bily & Marvan) Lange-Bertalot, (9) *Achnanthidium minutissimum* (Kützing) Czarnecki, (10) *Achnanthidium convergens* (H. Kobayasi) H. Kobayasi , (11) *Diploneis pseudovalis* Hustedt, (12) *Fallacia insociabilis* (Krasske) D.G. Mann, (13) *Fallacia meridionalis* Metzeltin, Lange-Bertalot and Garcia-Rodriguez, (14) *Hippodonta capitata* (Ehrenberg) Lange-Bertalot, Metzeltin & Witkowski, (15) *Planothidium delicatulum* (Kützing) Round & L. Bukhtiyarova, (16) *Luticola nivalis* (Ehrenberg) D.G. Mann, (17) *Luticola peguana* (Grunow) D.G. Mann, (18) *Frustulia pararhomboides* var. *pararhomboides* Lange-Bertalot, (19) *Neidium floridanum* Reimer, (20-21) *Eolimna subminuscula* (Manguin) Gerd Moser, (22) *Eolimna minima* (Grunow) Lange-Bertalot, (23) *Eolimna tantula* (Hustedt) Lange-Bertalot, (24) *Navicula cryptotenelloides* Lange-Bertalot, (25) *Navicula phyllepta* Kützing, (26) *Navicula radiosafallax* Lange-Bertalot, (27) *Navicula kuseliana* Lange-Bertalot & U.Rumrich.

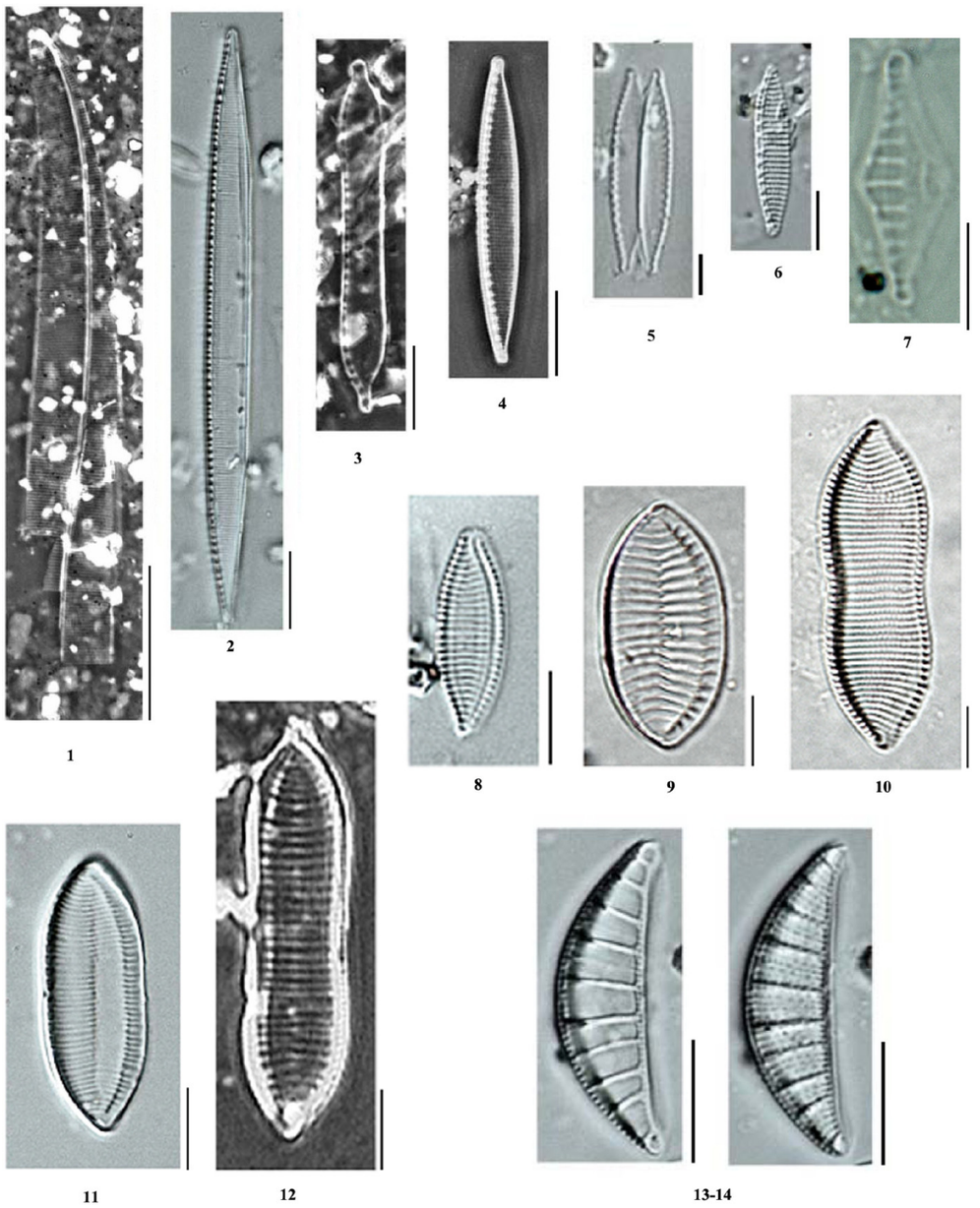


Figure 4. Light micrographs of cleaned diatoms in Mekong River and its tributaries in the part of Thailand (scale bar = 10 μm).
(1) *Gyrosigma obscurum* (W.Smith) J.W.Griffith&Henfrey, (2) *Nitzschia linearis* (C.Agardh ex.W. Smith)W.Smith var. *linearis*, (3) *Nitzschia terrestris* (J.B.Petersen) Hustedt, (4) *Nitzschia pseudofonticola* Hustedt, (5) *Nitzschia supralitorea* Lange-Bertalot, (6) *Nitzschia liebetruthii* Rabenhorst, (7) *Nitzschia tabellaria* (Grunow) Grunow, (8) *Tryblionella balatonis* (Grunow in Cleve & Grunow) D.G.Mann, (9) *Tryblionella levidensis* W.Smith, (10) *Tryblionella coarctata* (Grunow) D.G. Mann, (11) *Tryblionella acuminata* W.Smith, (12) *Tryblionella calida* (Grunow) D.G.Mann, (13-14) *Rhopalodia operculata* (C.Agardh) Håk.

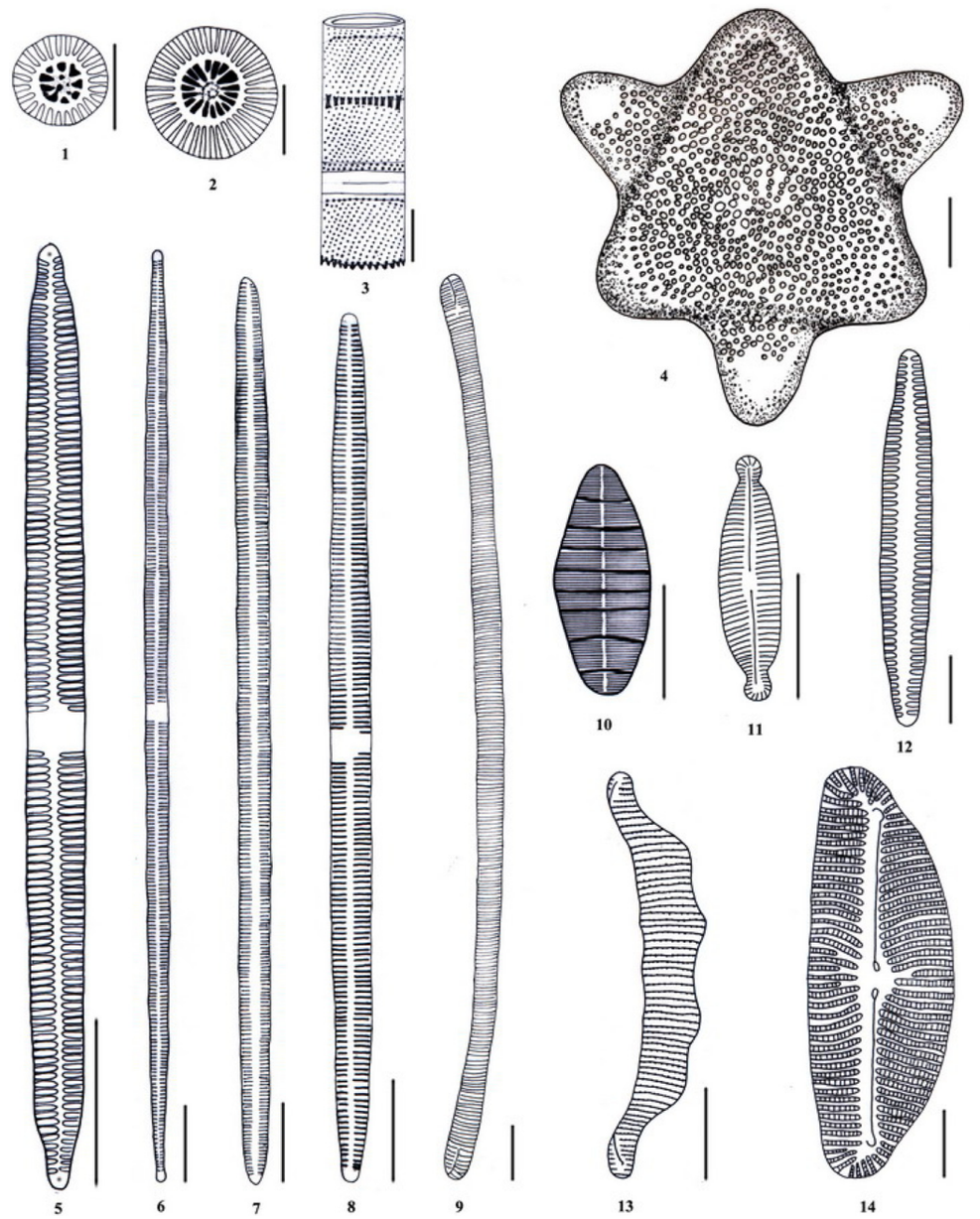


Figure 5. Hand drawing micrographs of cleaned diatoms in Mekong River and its tributaries in the part of Thailand (scale bar = 10 mm).
(1) *Discostella pseudostelligera* (Hustedt) Houk & Klee, (2) *Discostella stelligera* (Cleve & Grunow) Houk & Klee, (3) *Aulacoseira ambigua* (Grunow) Simonsen, (4) *Hydrosera whampoensis* (A.F.Schwarz) Deby, (5) *Ulnaria ulna* (Nitzsch) Comp□re, (6) *Synedra ulna* var. *amphirhynchus* (Ehrenberg) Grunow, (7) *Synedraulna* var. *subaequalis* Grunow, (8) *Synedra ulna* var. *spathulifera* Grunow, (9) *Eunotia repens* A. Berg, (10) *Diatoma mesodon* (Ehrenberg) Kützing, (11) *Encyonopsis microcephala* (Grunow) Krammer, (12) *Tabularia fasciculata* (C. Agardh) D.M. Williams & Round, (13) *Eunotia camelus* var. *arcuata* J. Frenguelli, (14) *Encyonema prostratum* (Berkeley) Kützing.

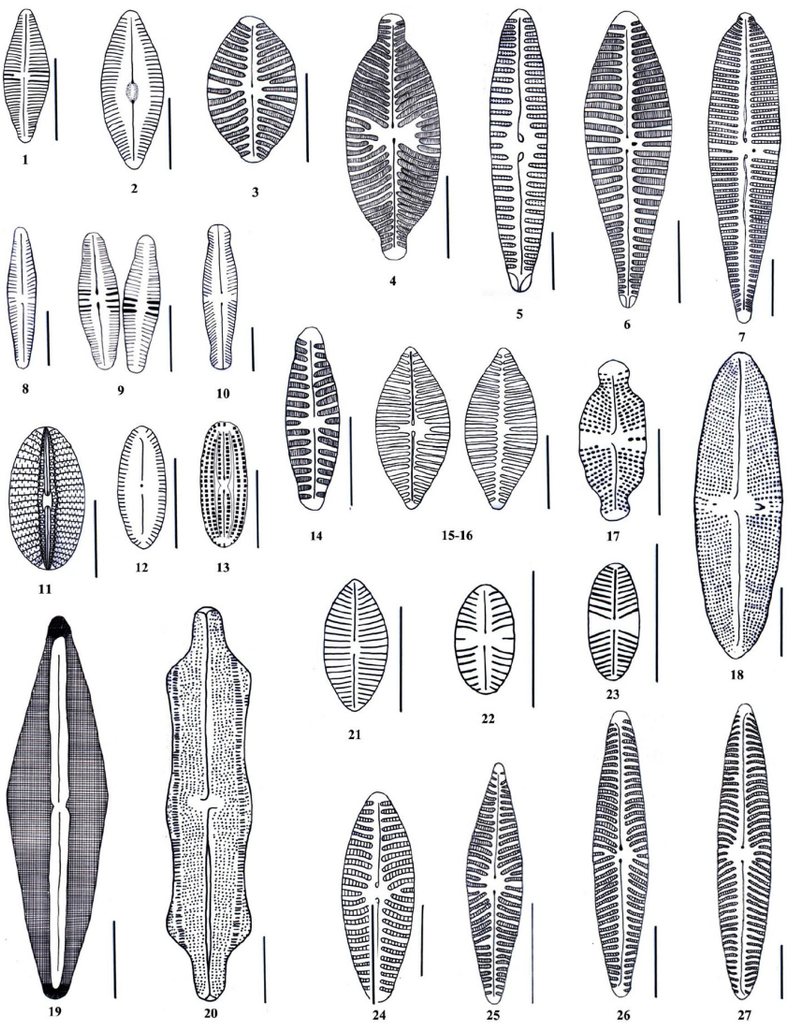


Figure 6. Hand drawing micrographs of cleaned diatoms in Mekong River and its tributaries in the part of Thailand (scale bar = 10 mm).
(1) *Geissleria punctifer* (Hustedt) Metzeltin, (2) *Diadesmis confervacea* Kützing, (3) *Placoneis gracilis* Metzeltin, Lange-Bertalot & Garcia-Rodriguez, (4) *Placoneis symmetrica* (Hustedt) Lange-Bertalot, (5) *Gomphoneis rhombica* (Fricke) V. Merino *et al.*, (6) *Gomphonema pseudoaugur* Lange-Bertalot, (7) *Gomphonema contraturris* Lange-Bertalot & Reichardt, (8) *Achnanthidium catenatum* (Bily & Marvan) Lange-Bertalot, (9) *Achnanthidium minutissimum* (Kützing) Czarnecki, (10) *Achnanthidium convergens* (H. Kobayasi) H. Kobayasi, (11) *Diploneis pseudovalis* Hustedt, (12) *Fallacia insociabilis* (Krasske) D.G. Mann, (13) *Fallacia meridionalis* Metzeltin, Lange-Bertalot and Garcia-Rodriguez, (14) *Hippodonta capitata* (Ehrenberg) Lange-Bertalot, Metzeltin & Witkowski, (15-16) *Planothidium delicatulum* (Kützing) Round & L.Bukhtiyarova, (17) *Luticola nivalis* (Ehrenberg) D.G. Mann, (18) *Luticola peguana* (Grunow) D.G. Mann, (19) *Frustulia pararhomboides* var. *pararhomboides* Lange-Bertalot, (20) *Neidium floridanum* Reimer, (21) *Eolimna subminuscula* (Manguin) Gerd Moser, (22) *Eolimna minima* (Grunow) Lange-Bertalot, (23) *Eolimna tantula* (Hustedt) Lange-Bertalot, (24) *Navicula cryptotenelloides* Lange-Bertalot, (25) *Navicula phyllepta* Kützing, (26) *Navicula radiosafallax* Lange-Bertalot, (27) *Navicula kuseliana* Lange-Bertalot & U.Rumrich.

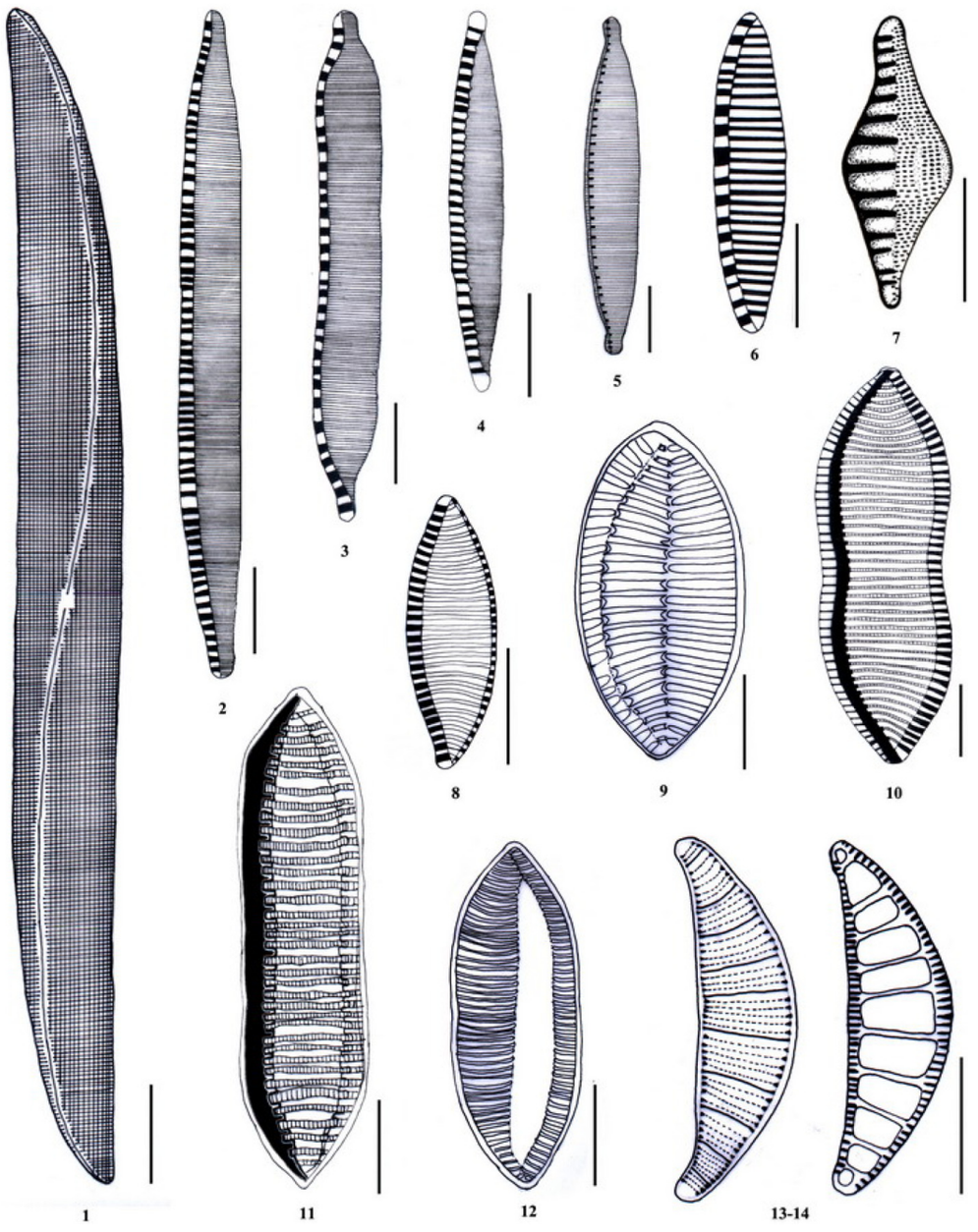


Figure 7. Hand drawing micrographs of cleaned diatoms in Mekong River and its tributaries in the part of Thailand (scale bar = 10 mm).
(1) *Gyrosigma obscurum* (W.Smith) J.W.Griffith&Henfrey, (2) *Nitzschia linearis* (C.Agardh ex. W.Smith)W.Smith var. *linearis*, (3) *Nitzschia terrestris* (J.B.Petersen) Hustedt, (4) *Nitzschia pseudofonticola* Hustedt, (5) *Nitzschia supralitorea* Lange-Bertalot, (6) *Nitzschia liebetruthii* Rabenhorst, (7) *Nitzschia tabellaria* (Grunow) Grunow, (8) *Tryblionella balatonis* (Grunow in Cleve & Grunow) D.G. Mann, (9) *Tryblionella levidensis* W.Smith, (10) *Tryblionella coarctata* (Grunow) D.G. Mann, (11) *Tryblionella calida* (Grunow) D.G.Mann, (12) *Tryblionella acuminata* W.Smith, (13-14) *Rhopalodia operculata* (C.Agardh) Håk.

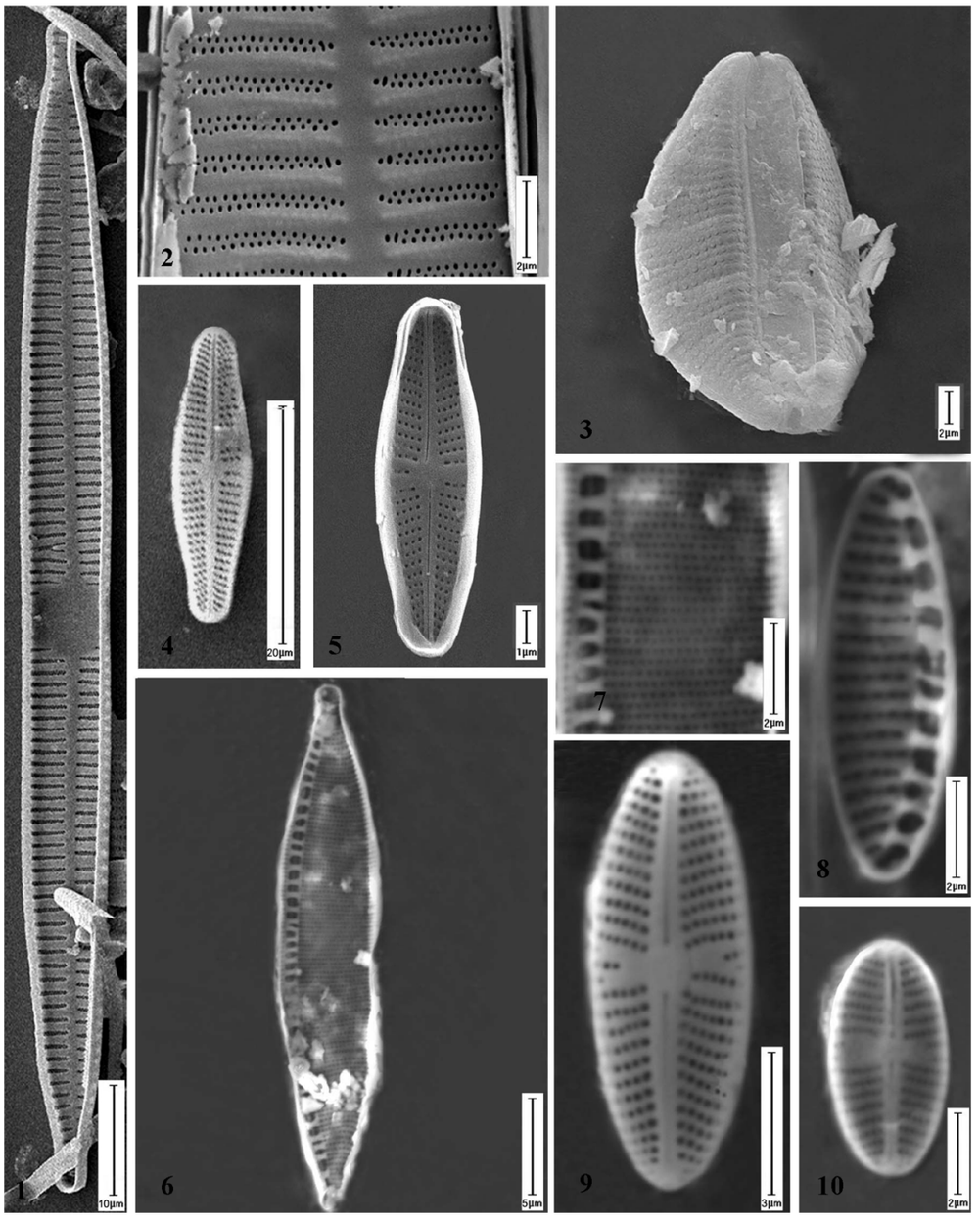


Figure 8. Scanning Electron Micrographs of new record species of diatoms in Mekong River and its tributaries of Thailand.
(1-2) *Ulnaria ulna* (Nitzsch) Comp□ re, (3) *Rhopalodia operculata* (C.Agardh) Håk., (4-5*) Achnanthidium minutissimum* (Kützing) Czarnecki, (6-7) *Nitzschia pseudofonticola* Hustedt, (8) *Nitzschia liebetruthii* Rabenhorst, (9) *Eolimna tantula* (Hustedt) Lange-Bertalot, (10) *Eolimna minima* (Grunow) Lange-Bertalot.

4. DISCUSSION

The study of diatoms in Thailand was started by Östrup [17] reported 81 different diatoms from the island of Koh Chang in the Gulf of Thailand. Then, Patrick [18] reported a total of 185 diatom species in the study of the intestinal contents of tadpoles from Thailand and the Federal Malay States. Furthermore, Hirano [19] published an account of 143 diatom species, 114 of them were found in the samples from Thailand. Most of these samples were collected in Chiang Mai areas and the others from localities in the central and southern parts of Thailand. Foged [20] reported the freshwater diatoms in Thailand. The material collected in central and northern parts of Thailand. Three hundred and seventy eight taxa of diatoms were published. In this work, 8 new species, 5 new varieties and 2 forms were additionally reported.

In this study, 53 species of benthic diatoms were new record of Thailand. The comparison between the number of new records in Thailand from another works was considered. Fifty one species were found in Mae Sa stream [4], 45 species were found in many streams of Thong Pha Phum National Park and Huay Kha Yang Watershad [10], 28 species were found from Ping and Nan River [7] and 24 species were from Mae Kham River [13]. The list of diatoms species in Thailand was increased with each time of publication. According to van den Hoek et al. [21] estimated numbers of diatom were as many as 100,000 species in total, only 12,000 species have been described so far. Consequently, there are many diatoms species waiting for discovery especially in Thailand.

Some species found in this research were similar to a reported diatom flora of the Mekong water system in Cambodia by Ohno et al. [22]. Thirty six taxa of diatoms were found in the Mekong River. The dominant species were *Melosira granulate* (This name is currently regarded as a synonym of *Aulacoseira granulata* (Ehrenberg) Simonsen), *Cyclotella stelligenera* (This name is currently regarded as a synonym of *Discostella stelligera* (Cleve & Grunow) Houk & Klee) and *Synedra ulna* (This name is currently regarded as a synonym of *Ulnaria ulna* (Nitzsch) Compère). In addition, *Fragilaria ulna* (This name is currently regarded as a synonym of *Ulnaria ulna* (Nitzsch) Compère) was one of the most abundant diatoms in New Zealand [23].

There were marked variations in richness and diversity between sites that reflected variations in physico-chemical parameters and habitat characters. The dominant species such as *Eolimma minima* and *Achnanthidium minutissimum* were found in many sampling sites. *Achnanthidium minutissimum* were common species in streams in agricultural catchments of Kathmandu Valley, Nepal Jüttner et al. [24]. Similarly *Eolimma minima* was found in Tolich River that impacted from urban pollution in Hanoi, Vietnam [25].

Cosmopolitan as diatoms can be, diatoms in the tropics may have different environmental preferences than those in the well studied temperate streams. This present research provider basic information of diatom in tropical streams which can be applied to monitor water quality of the rivers in Thailand and neighbor countries. The checklist of freshwater algae including diatom of Thailand is under preparation by Office of Natural Resources and Environmental Policy and Planning, Thailand. It will be published in September 2010.

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