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Full Length Article

Diversity of Benthic Diatoms in Six Main Rivers of Thailand

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ABSTRACT

The diversity of benthic diatoms in six main rivers of Thailand during three seasons, were investigated in the months of March 2008, August 2008 and January 2009. Samples were collected from 6 regions in Thailand: Ping River (northern regions), Tha Chin River (central regions), Chi River (northeast regions), Chanthaburi River (eastern regions), Kwai River (western regions) and Tapee River (southern regions). Samples were taken from the upper, middle and lower parts of each river. A total of 214 of benthic diatoms were found and classified into 3 classes, 6 subclasses, 13 orders, 28 families and 50 genera. Of these, 41 taxa were recorded for the first time in Thailand. The most abundant species found in the main rivers of Thailand were *Achnanthidium minutissimum*, *Cyclotella pseudostelligera*, *Gomphonema lagenula*, *Navicula cryptocephala*, *N. symmetrica* and *Nitzschia palea*. © 2011 Friends Science Publishers

Key Words: Benthic biodiversity; Bacillariophyta; Lotic ecosystem; *Navicula* spp; *Nitzschia* spp; *Gomphonema* spp

INTRODUCTION

The recording of data related to biodiversity is very important for national resource information, especially that of diatoms. Recently, diatoms have been investigated as organisms, which could potentially be utilized in a variety of beneficial applications. Hayakawaa *et al*. (1996) and Khan *et al*. (2009) reported that high fatty acid content in diatoms could be the reason they are prospective candidates for cultivation as a biofuel source. Moreover, Watson *et al*. (2004) and Chen (2007) have reported that diatoms are widely used as feed for aquatic animals and commercially cultivated in many countries. In addition, diatoms have also been known to be a promising type of bioindicator. Many species of diatoms could be used to indicate water quality. For example, abundance of *Nitzschia palea* in a pond indicated polluted water quality (Duong *et al*., 2007), while *Gomphonema lagenula* and *Navicula symmetrica* indicated moderate water quality (Reichardt, 1999).

Unfortunately, the diatom database in Thailand has not been developed when compared with other countries. However, the diatom flora of Thailand has been investigated by scientists for more than hundred years (Østrup, 1902; Patrick, 1936; Hirano, 1967; Foged, 1971; Lewmanomont *et al*., 1995). Since 1971, Thai scientists are also interested in diatoms, but the studies have not been conducted intensively. The most recently published reports of benthic diatom studies were done in the northern and northeast regions (Peerapornpisal *et al*., 2000; Pekthong & Peerapornpisal, 2001; Yana & Peerapornpisal, 2009; Leelahakriengkrai *et al*., 2009; Suphan & Peerapornpisal, 2010; Leelahakriengkrai & Peerapornpisal, 2010). Freshwater benthic diatoms in other regions of Thailand have not yet been intensively investigated. These regions include the central, eastern, western and southern regions.

This research presents the first report and useful checklist of the diversity of benthic diatoms in the main rivers of Thailand covering six regions. The results of this study will increase the benthic diatom database for further applications.

MATERIALS AND METHODS

The study areas were located in six regions of Thailand. In northern Thailand, five sites in the Ping River were selected, in the central region there were five sites in the Tha Chin River. In the northeastern region, five sites were selected in the Chi River; in the western region five sites were selected in the Kwai River; in the eastern region, there were four sites in the Chanthaburi River and in the southern region, four sites were selected in the Tapee River (Fig. 1). Water was sampled from both upstream and downstream sites during summer and the rainy and cool-dry seasons ranged from March 2008 to January 2009.

The benthic diatom samples were scraped from 5-10 stones (or other hard substrates) from each site. The stones were brushed with a toothbrush. A plastic sheet with a 10 cm^2 cutout area was placed on the upper surface of the selected stone. Diatoms were brushed from the square hole and preserved with Lugol's iodine solution. In the laboratory, the samples were cleaned by concentrated acid digestion method (Hendey, 1974). The permanent slides

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were prepared by evaporating drops of the cleaned diatoms suspended in distilled water onto cover-slips and the mounting on these slides was done using Naphrax®, a mountant with a high refractive index (Renberg, 1990; Kelly *et al.*, 1998). At least 300 valves were identified and counted per slide by 100X light microscope. The samples were identified according to (Krammer & Lange-Bertalot, 1986, 1988, 1991a & b), (Lange-Bertalot 2001, 2007) and Kelly and Haworth (2002). The relative abundance of each taxon was then indicated with: d = dominant (50–20%), f = frequent (20–5%), c = common (5–1%), r = rare (>1%).

RESULTS AND DISCUSSION

A total of 214 species of benthic diatoms were found from the six main rivers of Thailand. These were classified into 3 classes, 6 subclasses, 13 orders, 28 families and 50 genera. Among these, 41 species were divided into 2 classes, 8 orders, 16 families and 25 genera of benthic diatoms and this was revealed to be a new record for Thailand. The newly recorded species were compared with the check list of freshwater algae, publications and relevant books (Lewmanomont *et al*., 1995; Pekthong & Peerapornpisal, 2001; Pekthong, 2002; Kunpradid, 2005; Inthasotti, 2006; Suphan, 2009; Leelahakriengkrai *et al*., 2009; Yana & Peerapornpisal, 2009; Suphan & Peerapornpisal, 2010; Leelahakriengkrai & Peerapornpisal, 2010). The species of new records of Thailand are shown with the symbol (***) on the species names in Table I.

Fig. 1: Map of Thailand showing the Ping, Tha Chin, Chi, Kwai, Tapee and Chanthaburi Rivers and sampling sites (•)

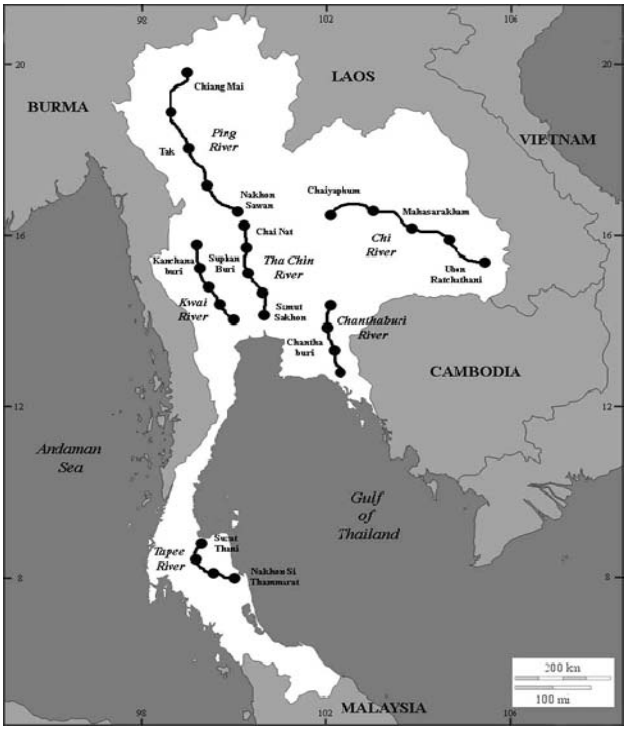

Fig. 2: The common species of benthic diatoms in the main rivers of Thailand (scale bar = 10 µm)

(1) *Navicula rostellata*, (2) *N. symmetrica*, (3) *N. cryptotenella*, (4) *Achnanthes hungarica*, (5) *A. oblongella*, (6) *Diploneis elliptica*, (7) *Brachysira neoexilis*, (8) *Gomphosphenia tenerrima*, (9) *Luticola goeppertiana*, (10) *Planothidium lanceolatum*, (11) *Gomphonema augur var. turris*, (12) *G. helveticum*, (13) *Pinnularia mesolepta*, (14) *Cymbella helvetica*, (15) *Nitzschia clausii*, (16) *N. dissipata*, (17) *N. sinuata var. tabellaria*, (18) *Seminavis strigosa*, (19) *Surirella angusta*

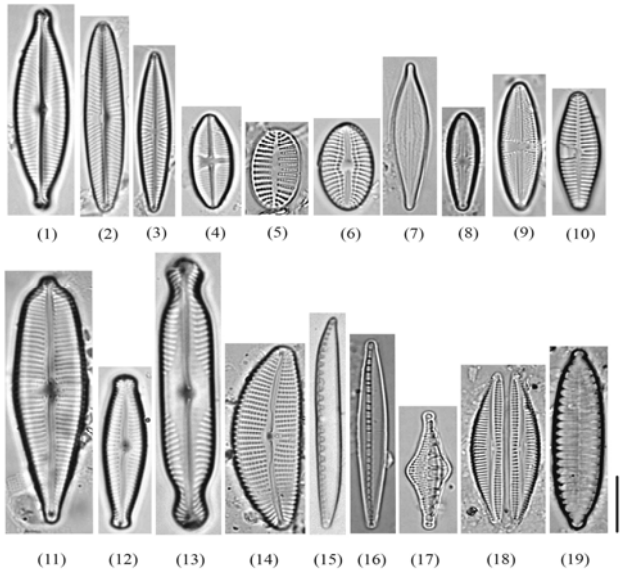

Fig. 3: The dominant species of benthic diatoms in the main rivers of Thailand (scale bar = 10 µm)

(1) *Navicula angusta*, (2) *N. cryptocephala*, (3) *N. subminuscula*, (4) *Cymbella leptoceros*, (5) *C. turgidula*, (6) *C. minuta*, (7) *Fragilaria crotonensis*, (8) *Nitzschia palea*, (9) *Aulacoseira granulata*, (10) *Luticola permuticoides*, (11) *Rhopalodia gibberula*, (12) *Gomphonema lagenula*, (13) *G. clevei*, (14) *Cocconeis placentula*, (15) *Achnanthidium minutissimum*, (16) *A. saprophilum*, (17) *Diadesmis contenta*, (18) *Cyclotella pseudostelligera*

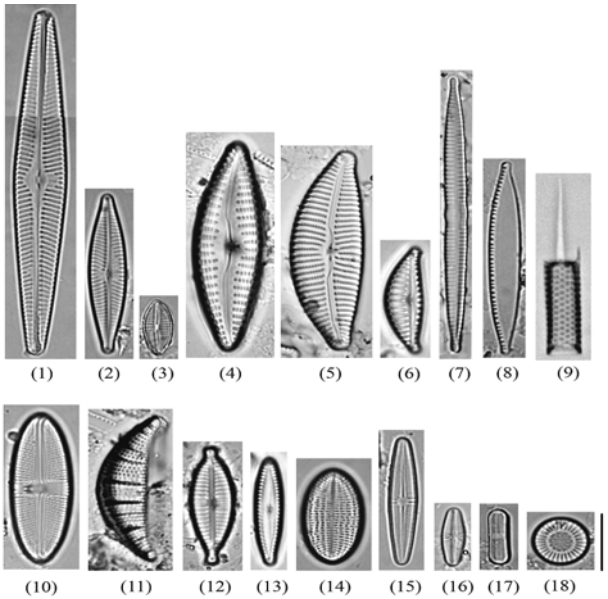

Table I: Relative abundance of each taxon of benthic diatoms in 6 main rivers of Thailand

Taxa	Ping River	Tha Chin River	Chi River	Kwai River	Chanthaburi River	Tapee River
Division: Bacillariophyta						
Class: Coscinodiscineae						
Subclass: Thalasiosirophycidae						
Order: Thalassiosirales						
Family: Stephanodiscaceae						
Cyclotella atomus Hust.		r				
C. meneghiniana Kütz.	r	c	r	r	r	
C. pseudostelligera Hust.	f	c	r	r	r	c
Cyclostephanos invisitatus (Hohn & Hellerm.) Theriot, Stoermer & Håk.					r	
Family: Thalassiosiraceae						
Thalassiosira weissflogii (Grun.) Fryxell & Hasle					r	
Subclass: Coscinodiscophycidae						
Order: Melosirales						
Family: Melosiraceae						
Melosira varians C. Agardh	r	r	r		r	r
Order: Aulacoseirales						
Family: Aulacoseiraceae						
Aulacoseira granulata (Ehr.) Simonsen	r	c	r	r	r	r
Subclass: Biddulphiophycidae						
Order: Triceratisles						
Family: Triceratiaceae						
Pleurosira laevis (Ehr.) Compère				r		
Order: Biddulphiales						
Family: Triceratiaceae						
Hydrosera triquetra Wallich				r		
Class: Fragilariophyceae						
Subclass: Fragilariophycidae						
Order: Fragilariales						
Family: Fragilariaceae						
Fragilaria capucina Desm.			r	c	r	c
F. capucina var. *vaucheriae* (Kütz.) Lange-Bert.		c	r	r		
F. crotonensis Kitton	r	r	r	r	r	f
F. fasciculata (Agardh) Lange- Bert.				r		
Fragilaria nanana Lange-Bert.***		r				r
Fragilaria sp.1			r			
Opephora olsenii Møller***					r	
Synedra ulna (Nitzsch.) Ehr.	r	r	r	r	c	r
S. ulna var. *aequalis* (Kütz.) Hust.			r	c		
S. acus Kütz.			r	c		
S. sp.1			r			
Class: Bacillariophyceae						
Subclass: Eunotiophycidae						
Order: Eunotiales						
Family: Eunotiaceae						
Eunotia bilunaris (Ehr.) Schaarschmidt			r	r	r	r
E. camelus Ehr.						r
E. eruca Ehr.***			r			
E. exigua (Bréb. ex Kütz.) Rabenh.***						r
E. flexuosa (Bréb.) Kütz.						r
E. minor (Kütz.) Grun.	r	r				
E. naegelii Migula***		r				r
E. pectinalis (Kütz.) Rabenh.						r
E. soleirolii (Kütz.) Rabenh.						r
Subclass: Bacillariophycidae						
Order: Cymbellales						
Family: Cymbellaceae						
Cymbella affinis Kütz.	r	r	r	r		r
C. amphicephala Näeg.	r					
C. falaisensis (Grun.) Krammer & Lange-Bert.***				r		
C. helvetica Kütz.			c			
C. japonica Reich						r
C. leptoceros (Ehrenb.) Kütz.				r	c	
C. minuta Hilse in Rabenh.				r	f	f
C. subaequalis Grun. in van Heurck***		r	r		r	
C. tumida (Bréb.in Kützing)van Heurck	r	r	r	r	r	r
C. turgidula Grun.	r	r	f	r	c	r

Table I: Continued

Table I: Continued

Encyonema gracile Rabenh.***						c
E. mesianum (Cholnoky) D.G.Mann***		r	r	r	r	r
E. minutum (Hilse in Rabenh.) D.G. Mann	r	r	r		r	c
Encyonopsis krammeri Reich.***				c		
E. microcephala (Grun.) Krammer				c		
E. minuta Krammer & Reich.***				c		
Placoneis dicephala (W. Sm.) Meresch***	r			r		r
P. gastrum (Ehrenb.) Mereschk.			r			
P. gastrum var. *signata* Hust.	r		r	r		
P. sp. 1			r			
P. sp. 2					r	
Family: Gomphonemataceae						
Gomphonema affine Kütz.				r		r
G. augur var. *turris* (Ehrenb.) Lange-Bert.		r			r	
G. clavatum Ehrenb.***		f	r		c	
G. clevei Fricke	r		r		f	
G. gracile Ehrenb.	r	r	r	r	r	r
G. hebridense Greg.***				r		r
G. helveticum Brun			r		r	r
G. lagenula Kütz.	f	c	f	r	r	c
G. parvulum (Kütz.) Kütz.	r		c	r	r	r
G. pumilum(Grun.)Reich.& Lange-Bert.	c			r		
G. vibrio var. *intricatum*(Kütz.) Playf.***		r		r		
G. sp.1	r	r	r	r	r	
G. sp.2					r	
Family: Rhoicospheniaceae						
Gomphosphenia tenerrima (Hust.) Reich.***	r	c				
Order: Achnanthales						
Family: Achnanthaceae						
Achnanthes brevipes var. *intermedia* (Kütz.) Cleve					r	
A. exigua Grun.	r	r		r	r	
A. grana Hohn & Hellerm.***		r	r			
A. hungarica (Grun.) Grun.						
A. inflata (Kütz.) Grun.						r
A. oblongella Østrup	r	r	r		c	c
A. pusilla (Grun.) De Toni	r					
A. suchlandtii Hust.***	r					
*A.*sp.1				r	r	
Planothidium lanceolatum (Bréb. ex Kütz.) Lange-Bert.	c	r	c	r	r	r
P. rostratum (Østrup) Lange-Bert.	r			r	r	r
P. sp. 1		r				
Family: Cocconeidaceae						
Cocconeis placentula Ehrenb.	r	r	r	c	r	r
C. sp.1					r	
Family: Achnanthidiaceae						
Achnanthidium saprophilum (Kobayasi & Mayama) Round & Bukht.	r	c	r		f	f
A. minutissimum (Kütz.) Czarn.	c	r	c	d	f	f
A. jackii Rabenh.***						f
A. sp.1			r			
Order: Naviculales						
Family: Diadesmidaceae						
Diadesmis confervacea Kütz.		c	r		r	r
D. contenta (Grun. ex VanHeurck) D.G.Mann	f			r	r	r
D. brekkaensis (Krasske) D.G.Mann***					r	
Luticola cohnii (Hilse) D.G. Mann	r	r				
L. goeppertiana (Bleisch) D.G.Mann	c	r	c	c	r	
L. mitigata (Hust.) D.G. Mann***		r			r	
L. mutica (Kütz.) D.G. Mann	r			c	r	r
L. permuticoides Metzeltin & Lange-Bert.	r	c	r		r	
L. sp. 1						r
L. sp. 2					r	
Family: Amphipleuraceae *Frustulia rhomboides* (Ehrenb.) De Toni	r				r	r
F. vulgaris (Thwaites) De Toni	r					
Family: Brachysiraceae						
Brachysira neoexilis Lange-Bert.	r	r		c	r	r
B. vitrea (Grun.) Ross***				c		
Family: Neidiaceae						

Table I: Continued

Table I: Continued

Neidium ampliatum (Ehrenb.) Krammer		r	r	r	r	
N. dubium (Ehenb.) Cleve	r			r		
N. sp.1	r		r			
N. sp.2						r
N. sp.3				r		
N. sp.4			r			
Family: Sellaphoraceae						
Fallacia insociabilis (Krasske) D.G. Mann	r	r	r			
F. monoculata (Hust.) D.G. Mann***	r					
F. pygmaea (Kütz.)Stickle & D.G.Mann	r	r				
Sellaphora bacillum (Ehrenb.) D.G. Mann	r	r				
S. japonica (Kob.) Kob. Mayama & Kawashima***					r	r
S. pupula (Kütz.) Meresch.	c	r	r	r	r	r
S. seminulum (Grun.) D.G.Mann***	r	r		r		
Family: Pinnulariaceae						
Pinnularia divergens W. Sm.						r
P. episcopalis Cleve						r
P. legumen (Ehrenb.) Ehrenb.						r
P. macilenta Ehrenb.						r
P. microstauron (Ehrenb.) Cleve	r	r	r			
P. mesolepta (Ehrenb.) W. Sm.		r		r	r	r
P. nobilis (Ehrenb.) Ehrenb.***						r
P. stomatophora (Grun.) Cleve				r		
P. subcapitata Greg.	r	r				
P. sp.1				r		
P. sp.2			r			
P. sp.3	r	r			r	
P. sp.4			r			
Family: Diploneidaceae						
Diploneis elliptica (Kütz.) Cleve		r			r	r
Family: Naviculaceae						
Adlafia sp.1		r	r	c	c	
Caloneis bacillum (Grun.) Cleve	r				r	
C. silicula (Ehrenb.) Cleve			r		r	r
Geissleria decussis (Østrup) Lange-Bert. & Metzeltin	r		r	r	r	
Hippodonta lueneburgensis (Grun.) Lange-Bert., Metzeltin & Witkowski***		r	r			r
Mayamaea atomus (Kütz.) Lange-Bert.			r		r	r
Myamea sp. 1	r					
Navicula angusta Grun.***			r	r	c	f
N. capitatoradiata Germain	r			c		
N. cinctaeformis Hust.		r	f	r		
N. confervacea (Kütz.) Grun.	r					
N. cryptocephala Kütz.		r	c	f	c	d
N. cryptocephaloides Hust.***		r		r		
N. cryptotenella Lange-Bert.	r	r	r	d	c	
N. difficillima Hust.***						r
N. erifuga Lange-Bert.***		r			r	
N. germainii Wallace	r	r	r		r	
N. heimansioides Lange-Bert.***			r			
N. minima Grun.			c	r	r	
N. novaesiberica Lange-Bert.	r	r	r		r	
N. phyllepta Kütz.***	r	r	c	r	c	r
N. radiosa Kütz.	c			r	r	f
N. radiosafallax Lange-Bert.	c					
N. recens (Lange-Bert.) Lange-Bert.		c	r			
N. rhynchocephala Kütz.				r		c
N. rostellata Kütz.	r	c	r	r	r	r
N. stroemii Hust.***			r	r		
N. subminuscula Mang.	r	c				
N. symmetrica R.M. Patrick	c	c	f	r	f	c
N. tridentula Krasske				r		
N. tuscula (Ehrenb.) Grun.			r			
N. viridula (Kütz.) Kütz.		c	r	r		
N. sp.01	r	r				
N. sp.02	c					
N. sp.03			r			
N. sp.04	r					
N. sp.05			r			r
N. sp.06			r			

Table I: Continued

Table I: Continued

Naviculadicta nanogomphonema Lange-Bert. & Rumrich	r	r	c		r	r
Seminavis strigosa (Hust.) Danielidis et D.G. Mann***	c	r	r	r	c	r
Family: Pleurosigmataceae						
Gyrosigma spencerii (Quek.) J.W.Griff. & Henfr.	r	r	r	r	r	r
G. scalproides (Rabenh.) Cleve	r				r	
Pleurosigma salinarum (Grun.) Grun.		r	r			
Family: Stauroneidaceae						
Stauroneis kriegeri Patrick	r					
S. phoenicenteron (Nitzsch.) Ehrenb.						r
S. schimanskii Krammer***	r					
Craticula cuspidata (Kutz.) D.G. Mann						r
C. riparia (Hust.) Lange-Bert.	r					
C. molestiformis (Hust.)Lange-Bert.***	r	c	r			
Order: Thalassiophysales						
Family: Catenulaceae						
Amphora aequalis Krammer			r			
A. libyca Ehrenb.	r			r		
A. montana Krasske	r		r			
normanii Rabenh.	r					
Order: Bacillariales						
Family: Bacillariaceae						
Bacillaria paradoxa Gmelin		r	r	r	r	
Hantzschia amphioxys (Ehrenb.) Grun.	r			c		
H. distinctepunctata Hust.	r					
Nitzschia amplectens Hust.***					r	
N. amphibia Grun.	r	r		c		
N. brevissima Grun.					r	
N. clausii Hantzsch	c	c	f		c	r
N. compressa (Bail.) Boyer***				r		
N. constricta (Kütz.) Ralfs		r			r	
N. dissipata (Kütz.) Grun.	c	r	r	r	c	r
N. draveillensis Coste & Ricard			r	r	r	
N. fonticola (Grun.) Grun. in Van Heurck		r				
N. graciliformis Lange-Bert.& Simonsen	r	r		r		
N. intermedia Hantzsch ex Cleve & Grun.						r
levidensis (W. Sm.) Grun.	r	r			r	
N. levidensis var. *salinarum* (Grun. in Cleve & Grun) K&LB	r	r			r	
N. lorenziana Grun.	r		r			
N. palea (Kütz.) W. Sm.	d	d	d	r	f	f
N. pumila Hust.		r				
N. reversa W.Sm.	r	r	r		r	
N. scalpelliformis Grun.	r	r	r			
N. sinuata var. *tabellaria* (Grun.)Grun.				r		
N. subcohaerens (Grun.) Van Heurck		r	r		c	
N. umbonata (Ehrenberg) Lange-Bertalot		r				
N. sp.1		r			c	
N. sp.2	f					
Order: Rhopalodiales						
Family: Rhopalodiaceae						
Epithemia adnata (Kütz.) Bréb.		r	r			r
Rhopalodia gibberula (Ehrenb.)O.Müll.		r	c	r		r
R. gibba (Ehrenb.)O. Müll.			r	r		r
R. gibba var. *minuta* Krammer***	r		r			
Order: Surirellales						
Family: Surirellaceae						
Stenopterobia curvula (W. Sm.) Krammer						r
Surirella angusta Kütz.	r		r	r	r	r
S. gracilis (W. Sm.) Grun.***					r	
S. splendida (Ehrenb.) Kütz.	r					r
S. terricola Lange-Bert. & Alles					r	r
*S.*sp.1					r	
S. sp.2						r
S. sp.3	r					

d = dominant (50-20%), f = frequent (20-5%), c = common (5-1%), r = rare (>1%)
*** = new record of Thailand

In this study, *Navicula*, *Nitzschia* and *Gomphonema* were the dominant genera, which was similar to that reported in Europe and Asia by Tien (2004), Atazadeh *et al*. (2007), Chatháin and Harrington (2008) and Kupe *et al.* (2008). *Navicula* spp. was found in the highest number of species (31 species) followed by *Nitzschia* spp. (23 species), *Gomphonema* spp. (13 species), *Pinnularia* spp. (13 species), *Cymbella* spp. (10 species) and *Achnanthes* spp., *Luticola* spp., *Surirella* spp. (7 species), respectively (Fig. 1). The most abundant species of the six main rivers of Thailand were *Nitzschia palea*, *Achnanthidium minutissimum*, *Cyclotella pseudostelligera*, *Gomphonema lagenula*, *Navicula cryptocephala* and *N. symmetrica* (Fig. 2).

The Ping River was characterized by having the highest number of species (94 species, 36 genera) as compared with the other rivers because this river contains some of the most suitable substrate for benthic diatoms. The most abundant species of the Ping River were *Nitzschia palea*, *Gomphonema lagenula*, *Cyclotella pseudostelligera*, *Cymbella turgidula* and *Diadesmis contenta* (Fig. 2).

Thirty-five genera and 87 species of benthic diatoms were found from the Tha Chin River. *Achnanthidium saprophilum*, *Aulacoseira granulata*, *Gomphonema clavatum*, *Luticola permuticoides*, *Nitzschia palea* and *Navicula subminuscula* were the most abundant species of the Tha Chin River (Fig. 2). Ninety-two species related to thirty-seven genera of benthic diatoms were found from the Chi River. This river was dominated by *Achnanthidium minutissimum*, *Cymbella turgidula*, *Navicula cryptocephala*, *Navicula cincta*, *Nitzschia palea* and *Rhopalodia gibberula* (Fig. 2). From the Kwai River, 32 genera and 84 species of benthic diatoms were found. The most abundant species of this river were *Achnanthidium minutissimum*, *Adlafia* sp. 1, *Cocconeis placentula*, *Navicula capitatoradiata*, *N. cryptocephala* and *N. cryptotenella* (Fig. 2).

Thirty-seven genera and 92 species of benthic diatoms were found from the Tapee River. The most abundant species of this river were *Achnanthidium minutissimum*, *A. saprophilum*, *Cymbella japonica*, *C. minuta*, *Gomphonema clevei*, *G. helveticum*, *Navicula symmetrica*, *N. cryptocephala* and *Nitzschia palea* (Fig. 2). The Chanthaburi River was characterized by having the least number of species, because of having a short length and the nutrients discharged into each site may not differ. In this river, 82 species belonging to 36 genera were found. The most abundant species of this river were *Achnanthidium minutissimum*, *A. jackii*, *Cyclotella pseudostelligera*, *Cymbella minuta*, *Fragilaria crotonensis*, *Navicula angusta*, *N. radiosa*, *N. cryptocephala* and *Nitzschia palea* (Fig. 2).

The Tha Chin, Kwai and Chanthaburi Rivers were found to have the highest number i.e., 15 newly recorded species. The lowest number of species found in the Ping River was 10. Some newly recorded species showed a high abundance in the main rivers of Thailand, such as *Achnanthidium jackii*, *Brachysira vitrea*, *Craticula molestiformis*, *Encyonema gracile*, *Encyonopsis krammeri*, *Encyonopsis minuta*, *Gomphonema clavatum*, *Gomphosphenia tenerrima* and *Navicula angusta* (Table I) and were used as bioindicators in America and Europe (Potapova & Charles, 2004; Coste *et al*, 2009).

In addition at the upstream sites, different dominant species in each river were found to be *Cymbella minuta*, *Gomphonema lagenula*, *G. clevei*, *Navicula symmetrica*, *N. cryptocephala* and *Rhopalodia gibberula* that were all found in rather clean to moderate water quality (Krammer & Lange-Bertalot, 1986; Reichardt, 1999; Wan Maznah & Mansor, 2002; Lobo *et al*, 2004). *Nitzschia palea* was found in higher abundance at the downstream sites in each of the rivers and this could be considered as the tolerant species and as the polluted water indicator (Jüttner *et al*., 2003; Duong *et al*., 2007).

CONCLUSION

Out of 214 benthic diatoms from the main rivers of Thailand, 41 species of benthic diatoms were revealed to be a new record for Thailand. The Ping River showed the highest number of species (94 species) followed by the Chi River (92 species), the Tapee River (92 species), the Tha Chin River (87 species), the Kwai River (84 species) and the Chanthaburi River (82 species), respectively. In addition, the distribution of benthic diatoms found in each river was different when compared to the distribution found in the other rivers. The diversity of benthic diatoms could be used as a resource database for further applications.

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