APPENDICES

APPENDIX A

WATER QUALITY ASSESSMENT

The Evaluation Water Quality by AARL-PC score
(AARL = Applied Algal Research Laboratory, PC = Physical and chemical)

The water quality in Mekong River and its tributaries were evaluated by AARL PC Score (Peerapornpisal *et al*, 2002). The method was modified from Wetzel (1983), Lorraine and Vollenweider (1981) and Kelly (2000). The standard justified the water quality category using alkalinity, conductivity, nitrate nitrogen, ammonia nitrogen and soluble reactive phosphorus. The physico-chemical parameters of water quality was shown in Table 19

Table 19 Water quality scores followed phyco-chemical parameters

Dissolved Oxygen ($mg.l^{-1}$)

dissolved oxygen ($mg.l^{-1}$)	score
> 9	0.1
8-9	0.2
7-8	0.3
6-7	0.4
5-6	0.5
4-5	0.6
3-4	0.7
2-3	0.8
1-2	0.9
<1	1.0

Biochemical Oxygen Demand ($mg.l^{-1}$)

Biochemical Oxygen Demand ($mg.l^{-1}$)	score
< 0.3	0.1
0.3-0.8	0.2
0.8-1.5	0.3
1.5-3	0.4
3-5	0.5
5-10	0.6
10-20	0.7
20-40	0.8
40-80	0.9
> 80	1.0

Conductivity (µS.cm^{-1})

Conductivity (µS.cm^{-1})	score
< 10	0.1
10-30	0.2
30-60	0.3
60-100	0.4
100-200	0.5
200-350	0.6
350-600	0.7
600-1,000	0.8
1,000-2,000	0.9
>2,000	1.0

Nitrate Nitrogen (mg.l^{-1})

Nitrate Nitrogen (mg.l^{-1})	score
< 0.05	0.1
0.05-0.1	0.2
0.1-0.3	0.3
0.3-0.8	0.4
0.8-1.5	0.5
1.5-3.0	0.6
3.0-10.0	0.7
10.0-20.0	0.8
20.0-40.0	0.9
> 40.0	1.0

Ammonia Nitrogen (mg.l^{-1})

Ammonia Nitrogen (mg.l^{-1})	score
< 0.01	0.1
0.01-0.05	0.2
0.05-0.1	0.3
0.1-0.2	0.4
0.2-0.5	0.5
0.5-1.0	0.6
1.0-2.0	0.7
2.0-4.5	0.8
4.5-10.0	0.9
>10.0	1.0

Soluble Reactive Phosphorus ($mg.l^{-1}$)

Soluble Reactive Phosphorus ($mg.l^{-1}$)	score
<0.05	0.1
0.05-0.10	0.2
0.1-0.2	0.3
0.2-0.4	0.4
0.4-1.0	0.5
1.0-2.0	0.6
2.0-3.5	0.7
3.5-7.0	0.8
7.0-15.0	0.9
>15.0	1.0

Table 20 Water quality scores followed trophic level and general water quality

Score	**Water quality by trophic level**	**General water quality**
0.1-0.8	Ultraoligotrophic status	Very clean
0.9-1.6	Oligotrophic status	clean
1.7-2.4	Oligotrophic-mesotrophic status	Clean-moderate
2.5-3.2	Mesotrophic status	moderate
3.3-4.0	Mesotrophic-eutrophic status	Moderate-polluted
4.1-4.8	Eutrophic status	polluted
>4.8	Hypereutrophic status	Very polluted

Table 21 Surface water quality standards of Thailand

Surface Water Quality Standards								
Parameter[1/]	Units	Statistics	Standard Value for Class[2/]					Methods for Examination
			Class1	Class2	Class3	Class4	Class5	
1. Colour,Odour and Taste	-	-	n	n'	n'	n'	-	-
2. Temperature	C°	-	n	n'	n'	n'	-	Thermometer
3. pH	-	-	n	5-9	5-9	5-9	-	Electrometric pH Meter
4. Dissolved Oxygen (DO)[2/]	mg/l	P20	n	6.0	4.0	2.0	-	Azide Modification
5. BOD (5 days, 20°C)	mg/l	P80	n	1.5	2.0	4.0	-	Azide Modification at 20°C , 5 days
6. Total Coliform Bacteria	MPN/100 ml	P80	n	5,000	20,000	-	-	Multiple Tube Fermentation Technique
7. Fecal Coliform Bateria	MPN/100 ml	P80	n	1,000	4,000	-	-	Multiple Tube Fermentation Technique
8. NO_3 -N	mg/l	-	n	5.0			-	Cadmium Reduction
9. NH_3 -N	mg/l	-	n	0.5			-	Distillation Nesslerization
10.Phenols	mg/l	-	n	0.005			-	Distillation,4-Amino antipyrene
11.Copper (Cu)	mg/l	-	n	0.1			-	Atomic Absorption - Direct Aspiration
12.Nickle (Ni)	mg/l	-	n	0.1			-	Atomic Absorption - Direct Aspiration
13.Manganese (Mn)	mg/l	-	n	1.0			-	Atomic Absorption - Direct Aspiration
14.Zinc (Zn)	mg/l	-	n	1.0			-	Atomic Absorption - Direct Aspiration
15.Cadmium (Cd)	mg/l	-	n	0.005* 0.05**			-	Atomic Absorption - Direct Aspiration
16.Chromium Hexavalent	mg/l	-	n	0.05			-	Atomic Absorption - Direct Aspiration
17.Lead (Pb)	mg/l	-	n	0.05			-	Atomic Absorption - Direct Aspiration
18.Total Mercury (Total Hg)	mg/l	-	n	0.002			-	Atomic Absorption-Cold Vapour Technique
19.Arsenic (As)	mg/l	-	n	0.01			-	Atomic Absorption - Direct Aspiration
20.Cyanide (Cyanide)	mg/l	-	n	0.005			-	Pyridine-Barbituric Acid
21.Radioactivity - Alpha - Beta	Becqurel/l	-	n	0.1 1.0			-	Gas-Chromatography
22.Total Organochlorine Pesticides	mg/l	-	n	0.05			-	Gas-Chromatography

23.DDT	µg/l	-	n	1.0	-	Gas-Chromatography
24.Alpha-BHC	µg/l	-	n	0.02	-	Gas-Chromatography
25.Dieldrin	µg/l	-	n	0.1	-	Gas-Chromatography
26.Aldrin	µg/l	-	n	0.1	-	Gas-Chromatography
27.Heptachlor & Heptachlorepoxide	µg/l	-	n	0.2	-	Gas-Chromatography
28.Endrin	µg/l	-	n	None	-	Gas-Chromatography

Classification and Objectives	
Classification	**Objectives/Condition and Beneficial Usage**
Class 1	Extra clean fresh surface water resources used for : (1) conservation not necessary pass through water treatment process require only ordinary process for pathogenic destruction (2) ecosystem conservation where basic organisms can breed naturally
Class 2	Very clean fresh surface water resources used for : (1) consumption which requires ordinary water treatment process before use (2) aquatic organism of conservation (3) fisheries (4) recreation
Class 3	Medium clean fresh surface water resources used for : (1) consumption, but passing through an ordinary treatment process before using (2) agriculture
Class 4	Fairly clean fresh surface water resources used for : (1) consumption, but requires special water treatment process before using (2) industry
Class 5	The sources which are not classification in class 1-4 and used for navigation.

Remark : [1/]Guideline value for Class 2-4
[2/] Minimum value of DO
P Percentile value
n naturally
n' naturally but changing not more than 3°C
* when water hardness not more than 100 mg/l as $CaCO_3$
** when water hardness more than 100 mg/l as $CaCO_3$
Based on Standard Methods for the Examination of Water and Wastewater recommended by APHA : American Public Health Association, AWWA : American Water Works Association and WPCF : Water Pollution Control Federation

Source : Notification of the National Environmental Board, No. 8, B.E. 2537 (1994), issued under the Enhancement and Conservation of National Environmental Quality Act B.E.2535 (1992) , published in the Royal Government Gazette, Vol. 111, Part 16, dated February 24, B.E.2537 (1994).

APPENDIX B

Diatom species with trophic index values

Table 22 List of taxa with trophic index values for computing the Saprobic Index of Rottt *et al.* (2003)

Species	Indicator weight	Saprobic Index Values
Achnanthes Helvetica (Hustedt) Lange-Bertalot	5	1.0
Achnanthes lanceolata var. *lanceolata* (Brébisson) Grunow	0	2.3
Achnanthes minutissima Kützing	1	1.7
Achnanthes oblongella Oestrup	5	1.0
Achnanthes pusilla (Grunow) De Toni	5	1.0
Amphora libyca Ehrenberg	2	1.6
Amphora ovalis (Kützing) Kützing	2	1.5
Amphora pediculus (Kützing) Grunow	2	2.1
Bacillaria paradoxa Gmelin	3	2.3
Caloneis bacillum (Grunow) Cleve	4	2.0
Caloneis silicula (Ehrenberg) Cleve	4	1.2
Cocconeis placentula Ehrenberg var. *placentula*	2	1.8
Cymatopleura solea (Brébisson) W. Smith	3	2.1
Cymbella affinis Kützing	4	1.2
Cymbella amphicephala Naegeli	4	1.1
Cymbella minuta Hilse	2	1.6
Cymbella naviculiformis (Auerswald) Cleve	3	1.3
Cymbella tumida (Brébisson) Van Heurck	4	1.6
Diploneis elliptica (Kutzing) Cleve	4	1.1
Diploneis oblongella (Naegeli) Cleve-Euler	5	1.0
Diploneis ovalis (Hilse) Cleve	5	1.0
Encyonema silesiacum (Bleisch) D.G. Mann	0	2.0
Eunotia bilunaris (Ehrenberg) Mills var. *bilunaris*	2	1.7
Eunotia minor (Kützing) Grunow	2	1.5
Fragilaria unla (Nitzsch) Lange-Bertalot	0	2.7
Frustulia rhomboids (Ehrenberg) De Toni	5	1.0
Gomphonema augur Ehrenberg	3	2.1
Gomphonema gracile Ehrenberg	4	1.2
Gomphonema minutum (Agardh) Agardh	5	2.0
Gomphonema pavulum (Kützing) Kützing	0	2.6
Gomphonema pumilum var. *rigidum* E. Reichardt et Lang-Bertalot	3	1.6
Hantzschia amphioxys (Ehrenberg) Grunow	1	1.8
Melosira varians Agardh	2	2.3
Navicula bacillum Ehrenberg	4	1.6

Table 22 (Continued)

Species	Indicator weight	Saprobic Index Values
Navicula clementis Grunow	4	1.7
Navicula cryptotenella Lange-Bertalot	2	1.5
Navicula elginensis (Gregory) Ralfs var. *elginensis*	3	1.5
Navicula goeppertiana var. *dapaliformis* (Husredt) Lange-Bertalot	2	3.3
Navicula mutica Kützing	3	2.0
Navicula radiosa Kützing	4	1.3
Navicula schroeterii Meister	4	1.6
Navicula trivialis Lange-Bertalot	3	2.7
Navicula viridula var. *rostellata* (Kützing) Cleve	4	2.2
Navicula viridula (Kützing) Ehrenberg var. *viridula*	4	2.2
Neidium affine (Ehrenberg) Pfitzer	5	1.0
Neidium ampliatum (Ehrenberg) Krammer	5	1.0
Neidium binodis (Ehrenberg) Hustedt	3	1.3
Neidium iridis (Ehrenberg) Cleve	5	1.0
Nitzschia cf. *acula* Hantzsch	3	2.0
Nitzschia dissipata (Kützing) Grunow	3	2.0
Nitzschia fonticola Grunow	4	2.1
Nitzschia levidensis (W. Smith) Grunow var. *levidensis*	4	2.9
Nitzschia palea (Kützing) W. Smith	0	2.8
Nitzschia umbonata (Ehrenberg) Lange-Bertalot	4	3.8
Pinnularia borealis var. *scalaris* (Ehrenberg) Rabenhorst	3	1.4
Pinnularia viridis (Nitzsch) Ehrenberg	4	1.2
Reimeria sinuate (Gregory) Kociolek & Stoermer	2	2.0
Rhopalodia gibba (Ehrenberg) O. Müller var. *gibba*	3	1.5
Rhopalodia gibba var. *parallela* (Grunow) Fryxell & Hasle	5	1.0
Sellaphora pupula (Kützing) Mereschkowsky	2	2.4
Stauroneis anceps Ehrenberg	4	1.2
Stauroneis smithii Grunow	2	1.5
Surirella angusta Kützing	2	2.2
Suriella ovalis Brébisson	4	2.9
Suriella roba Leclercq	5	1.0

Table 23 List of taxa with trophic index values for computing the Mae Sa Index (Pektong, 2002)

Species	Index value
Achnanthes crenulata Grunow	2
Achnanthes exigua Grunow *var. exigua*	3
Achnanthes lanceolata (Brébisson) Grunow	3
Achnanthes oblongella Oestrup	3
Amphora libyca Ehrenberg	3
Bacillaria paradoxa Gmelin	4
Cocconeis placentula Ehrenberg	4
Cymbella tumida (Brébisson) Van Heurck	4
Cymbella turgidula Grunow	4
Eunotia minor (Kützing) Grunow	1
Fragilaria biceps (Kützing) Lange-Bertalot	3
Fragilaria ulna (Nitzsch) Lange-Bertalot	4
Gomphonema clevei Fricke	2
Gomphonema parvulum (Kützing) Kützing	5
Gomphonema pumilum var. *rigidum* E. Reichardt et Lange-Bertalot	2
Gyrosigma scalproieds (Rabenhorst) Cleve	5
Melosira varians Agardh	5
Navicula cryptotenella Lange-Bertalot	4
Navicula schroeterii Meister	3
Navicula viridula (Kützing) Ehrenberg var. *viridula*	4
Nitzschia palea (Kützing) W. Smith	5
Pinnularia mesolepta (Ehrenberg) W. Smith	2
Sellaphora pupula (Kützing) Mereschkowsky	2
Stauroneis anceps Ehrenberg	2
Synedra lanceolata Kützing	4

Table 24 List of benthic diatom with trophic index values for computing the Ping and Nan Index (Kunpradid, 2005)

Species	Index value
Achnanthes biasolettiana Grunow var. *biasolettiana*	4
Achnanthes crenulata Grunow	5
Achnanthes minutissima Kützing	3
Bacillaria paradoxa Gmelin	3
Cocconeis placentula Ehrenberg	4
Cymbella tumida (Brébisson) Van Heurck	4
Cymbella turgidula Grunow	5
Encyonopsis leeilata Lange-Bertalot	2
Gomphonema parvulum (Kützing) Kützing	4
Gyrosigma scalproieds (Rabenhorst) Cleve	5
Melosira varians Agardh	4
Navicula flabellate Meist	3
Navicula symmetrica Patrick	3
Navicula viridula var. *linearis* Hustedt	2
Navicula viridula (Kützing) Ehrenberg var. *viridula*	4
Nitzschia dissipata (Kützing) Grunow	3
Nitzschia levidensis (W. Smith) Grunow var. *levidensis*	3
Nitzschia palea (Kützing) W. Smith	3
Plathidium minutum Lange-Bertalot	5
Rhopalodia gibba (Ehrenberg) O. Müller var. *gibba*	3
Rhopalodia gibberula Ehrenberg O. Müller	4
Sellaphora gibbula Lange-Bertalot	2
Sellaphora popula (Kützing) Mereschkowsky	3
Surirella splendida (Ehrenberg) Kützing	5
Synedra ulna (Nitzsch) Ehrenberg	3

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Awards:

1. ***2nd Prize of Poster Competition*** entitle "Relationship between water quality and diversity of Macroalgae and Benthic Diatoms in Golden Jubilee Thong Pha Phum Project, Thong Pha Phum district, Kanchanaburi Province,Thailand". From The International Conference on Water resources Management for Safe Drinking Water, 25-29 March 2003, Novotel Hotel, Chiang Mai, Thailand.
2. ***1st Prize of Poster Competition*** entitle "Diversity of Macroalgae and Benthic Diatoms in the Golden Jubilee Thong Pha Phum Project, Thong Pha Phum District, Kanchanaburi Province". From 8th BRT Annual Conference, 13-16 October 2004, Dimon Plaza, Suratthani, Thailand.
3. ***1st Prize of Poster Competition*** entitle "Benthic Diatoms and Their Applications in Monitoring Water Quality of Mekong River, Passing Thailand". From Thailand Research Fund (TRF) in RGJ-Ph.D Congress VIII, 20-22 Aprill 2007, Jomtein Palmbeach Resort Hotel, Chonburi, Thailand.

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Scanning Electron Microscope of Benthic Diatoms in Mekong River and its Tributaries, Thailand

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Abstract

The Mekong River is one of the most important rivers in Asia. Originating in the Tibet mountains, it runs through China, Myanmar, Lao PDR, Thailand, Cambodia and finally flows into the sea in Vietnam. In this present study, the diversity of benthic diatoms in Mekong River and its tributaries in the part of Thailand was carried out from July 2005 to April 2007. Fourteen sampling sites along the Mekong River and its tributaries were investigated. The results indicated the occurrence of 184 species distributed in 46 genera. The most genera are *Nitzschia*, *Navicula, Gomphonema*, *Eunotia*, *Cymbella* and *Cymbella*. The most abundant taxa were *Eolimna minima*, *Mayamaea atomus*, *Achnanthidium minutissimum*, *Navicula cryptotenella*, *Navicula symmetrica*, *Nitzschia palea* and *Gomphonema lagenula*. In this study, scanning electron microscope was very useful for diatom identification in species level.

Background

Benthic diatoms are in Division Bacillariophyta. The sculptured parts of the cell walls are composed of silica. Diatoms have special characteristics of their cell structure known as frustules. The frustules include bivalves which are similar to a petri dish. The color of the diatoms is yellow-brown. Single cells of diatoms are 5-500 µm. The shape of diatoms could be separated as being symmetrical and asymmetrical. The valve structure is called striae and includes a range of little pores of panctae and longitudinal valves called raphe. These characteristics are a major consideration to be used in their identification. In this study, SEM was used for identification in the small structure of the diatoms.

Materials and Methods

Fourteen sampling sites along the Mekong River and their tributaries in Chiang Rai, Loei, Nong Khai, Nakhon Phanom, Sakonnakron, Mukdahan, Amnat Charoen and Ubon Ratchathani Provinces of Thailand were selected. The sampling period collected from July 2005 to April 2007.

In the rivers the diatoms samples were scraped off 10 stones per river using a dental brush and kept in plastic boxes. Diatom frustules were cleaned successively in boiling HNO_3 and peroxide. The acid solution was removed by washing with distilled water. Prepare samples for SEM micrograph by dropping the cleaned diatom samples on a coverslip and drying it on hot plate. Kept it in desiccator overnight and fixed it stub and coated with gold. LEO 1450 VT scanning electron microscope were used for observations. The taxonomy was based mainly on relevant books [1-7].

Results and Discussion

In the Mekong River and its tributaries, 184 diatom taxa have been identified. 107 taxa could be identified to species level and 77 only to the level of genus. *Nitzschia* was the most species rich genus (24 species) followed by *Navicula* (16 species), *Gomphonema* and *Eunotia* (11 species); see listing in Table 1.

The most frequent and abundant taxa for Mekong River and its tributaries were *Eolimna minima*, *Mayamaea atomus*, *Achnanthidium minutissimum*, *Navicula cryptotenella*, *Navicula symmetrica*, *Nitzschia palea* and *Gomphonema lagenula*. Beside that *Mayamaea atomus* and *Nitzschia palea* were found with high frequency in Kathmandu Valley, Nepal [8].

Most species found in this study can be considered as cosmopolitan such as *Achnanthidium minutissimum* that is one of most frequently occurring diatoms in freshwater benthic samples globally [4]. Nevertheless, some of them are reported to prefer tropical regions. *Diploneis subovalis* was found with higher frequency in tropical river [1]. *Cymbella tumida* is cosmopolitan but very often found in the tropical region.

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Table 1 Species list of benthic diatoms in Mekong River and its tributaries of Thailand.

TAXON
Division Bacillariophyta
Order Centrales
Suborder Coscinodisineae
Family Thalassiosiraceae
Aulacoseira granulata (Ehrenberg) Simonsen
Aulacoseira muzzanensis (Meister) Krammer
Cyclotella meneghiniana Kützing
Cyclotella stelligera Cleve
Family Melosiraceae
Melosira varians C. Agardh
Family Triceratiaceae
Pleurosira laevis (Ehrenberg) Compère
Family Biddulphiaceae
Hydrosera triquetra G.C.Wall
Order Pennales
Suborder Araphidineae
Family Fragilariaceae
Diatoma mesodon (Ehrenberg) Kuetzing
Fragilaria acus Kützing
Fragilaria capucina Desmazières
Fragilaria vaucheriae (Kützing) J.B. Petersen
Synedra ulna (Nitzsch) Ehrenberg
Synedra ulna var. *aequalis* (Kützing) Hustedt
Synedra sp.1
Synedra sp.2
Synedra sp.3
Tabularia fasciculata (Agardh) Will. & Round
Tabularia sp.1
Suborder Raphidineae
Family Eunotiaceae
Eunotia repens A. Berg
Eunotia sp.1
Eunotia sp.2
Eunotia sp.3
Eunotia sp.4
Eunotia sp.5
Eunotia sp.6
Eunotia sp.7
Eunotia sp.8
Eunotia sp.9
Eunotia sp.10
Family Achnanthaceae
Achnanthes crenulata Grunow
Achnanthes exigua var. *constricta* (Torka) Hustedt
Achnanthes exigua var. *elliptica* Hustedt
Achnanthes inflata (Kützing) Grunow
Achnanthidium minutissimum (Kützing) Czarnecki
Achnanthidium minutissimum var. *robusta* Hustedt
Achnanthidium sp.1
Cocconeis placentula Ehrenberg
Cocconeis placentula Ehrenberg var. *linear*
Cocconeis pediculus Ehrenberg
Planothidium frequentissimum (Lange-Bertalot) Lange-Bertalot
Planothidium sp.1
Planothidium sp.2
Family Naviculaceae
Amphora Montana Krasske
Amphora submontana Hustedt
Amphora sp.1
Brachysira neoexilis Lange-Bertalot
Caloneis bacillum (Grunow) Cleve
Caloneis sp.1
Craticula sp.1
Craticula sp.2
Cymbella cistula (Hempr.) Grunow
Cymbella sumatrensis Hustedt
Cymbella tumida (Brébisson) Van Heurck
Cymbella turgidula Grunow
Cymbella sp.1
Cymbella sp.2
Cymbella sp.3
Cymbella sp.4
Cymbella sp.5
Cymbopleura cf. *laterostrata* var. *rostrata* Krammer
Diadesmis contenta (Grunow) D.G. Mann
Diadesmid sp.1
Diploneis pseudovalis Hustedt
Diploneis puella (Schumann) Cleve
Diploneis subovalis Cleve
Eolimna minima (Grunow) Lange-Bertalot
Eolimna subminuscula (Manguin) Gerd Moser
Eolimna tantula (Hust.) Lange-Bertalot
Encyonema silesiacum (Bleisch) D.G. Mann
Encyonema sp.1
Encyonema sp.2
Encyonema sp.3
Encyonema sp.4
Encyonopsis microcephala (Grunow) Krammer
Fallacia insociabilis (Krasske) D.G. Mann
Fallacia meridionalis Metzeltin, Lange-Bertalot & Garcia-Rodriguez
Fallacia pygmaea (Kützing) Stickle & Mann
Frustulia undosa Metzeltin & Lange-Bertalot
Frustulia sp.1
Frustulia sp.2
Geissleria decussis (Østrup) Lange-Bertalot&Metzeltin
Geissleria punctifer Hustedt
Gomphoneis rhombica (Fricke) Merino et al.
Gomphonema gracile Ehrenberg
Gomphonema inaequilongum (H.Kobayasi) H.Kobayasi
Gomphonema lagenula Kützing
Gomphonema parvulum (Kützing) Kützing var. *parvulum*
Gomphonema truncatum Ehrenberg
Gomphonema turris var. *brasiliense* Frenguelli
Gomphonema sp.1
Gomphonema sp.2
Gomphonema sp.3
Gomphonema sp.4
Gomphonema sp.5
Gyrosigma acuminatum (Kützing) Rabenhorst
Gyrosigma scalproides (Rabenhorst) Cleve
Gyrosigma spencerii (Quekett) Griffith&Herfrey
Gyrosigma sp.1
Gyrosigma sp.2
Gyrosigma sp.3
Luticula goeppertiana (Bleisch) D.G.Mann
Luticula monita (Hustedt) D.G.Mann
Luticula sp.1
Luticula sp.2
Luticula sp.3
Luticula sp.4
Mayamaea atomus (Kützing) Lange-Bertalot
Navicula capitatoradiata Germain
Navicula cryptotenella Lange-Bertalot
Navicula radiosa Kützing
Navicula rostellata Kützing
Navicula symmetrica Patrick
Navicula viridula (Kützing) Ehrenberg var. *viridula*
Navicula sp.1
Navicula sp.2
Navicula sp.3
Navicula sp.4
Navicula sp.5
Navicula sp.6
Navicula sp.7
Navicula sp.8
Navicula sp.9

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TAXON
Navicula sp.10
Naviculadicta nanogomphonema Rumrich, Lange-Bertalot and Rumrich
Naviculadicta tridentula Krasske
Neidium dubium (Ehrenberg) Cleve
Neidium sp.1
Neidium sp.2
Neidium sp.3
Neidium sp.4
Pinnularia sp.1
Pinnularia sp.2
Pinnularia sp.3
Pinnularia sp.4
Pinnularia sp.5
Pinnularia sp.6
Placoneis abundans Metzeltin, Lange-Bertalot & García-Rodríguez
Placoneis undulata (Østrup) Lange-Bertalot
Placoneis sp.1
Pleurosigma salinarum Grunow
Pleurosigma sp.1
Sellaphora populа (Kützing) Mereschkowsky
Sellophora sp.1
Stauroneis anceps Ehrenberg
Family Epithemiaceae
Epithemia sorex Kützing
Rhopalodia gibberula Ehrenberg O. Müller
Rhopalodia sp.1
Family Bacillariaceae
Bacillaria paxillifer (O.F.Mülleur) Hendey
Hantzschia amphioxys (Ehrenberg) Grunow
Nitzschia acicularis (Kützing) W.Smith

TAXON
Nitzschia acidoclinata Lange-Bertalot
Nitzschia clausii Hantzsch
Nitzschia coarctata Grunow
Nitzschia dissipata (Kützing) Grunow
Nitzschia filiformis (W.Smith) Van Heurck
Nitzschia gracilis Hantzsch
Nitzschia inconspicua Grunow
Nitzschia intermedia Hantzsch
Nitzschia microphala Grunow
Nitzschia nana Grunow
Nitszchia obtusa W. Smith
Nitzschia palea (Kützing) W. Smith
Nitzschia palea var. *debilis* (Kützing) Krammer
Nitzschia paleacia (Grunow) Grunow
Nitzschia pumila Hustedt
Nitzschia pseudofonticola Hustedt
Nitzschia reversa W. Smith
Nitzschia supralitorea Lange-Bertalot
Nitzschia tabellaria (Grunow) Grunow
Nitzschia sp.1
Nitzschia sp.2
Nitzschia sp.3
Nitzschia sp.4
Tryblionella calida (Grunow) D.G.Mann
Tryblionella levidensis W. Smith
Tryblionella salinarum (Grunow) Pelletan
Family Bacillariaceae
Surirella roba Leclercq
Surirella splendida Krammer
Surirella sp.1
Surirella sp.2
Surirella sp.3
Surirella sp.4

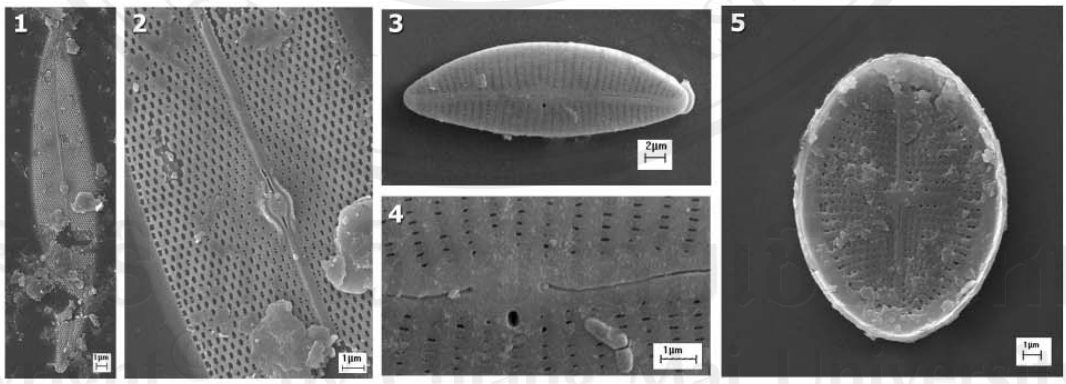

Fig.1 Scanning electron micrographs of benthic diatoms in Mekong River and its tributaries. (1-2) *Pleurosigma salinarum* Grunow, internal view showing central area; (3-4) *Cymbella* sp.1, external view showing one stigmata; (5) *Cocconeis pediculus* Ehrenberg, internal view showing raphe in the central of valve.

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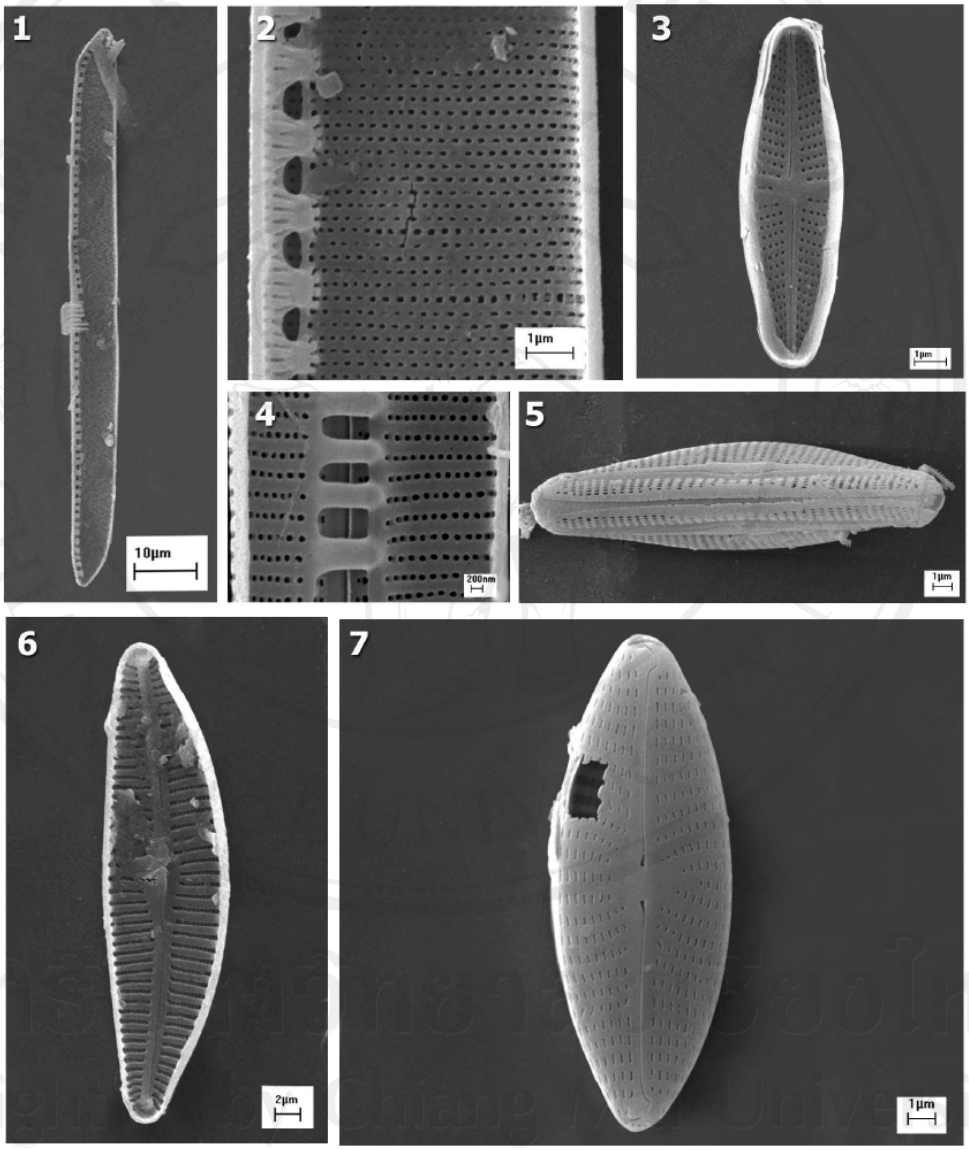

Fig.2 Scanning electron micrographs of benthic diatoms in Mekong River and its tributaries. (1-2) *Nitzschia obtusa* W. Smith; internal view showing the small fibula in bar shape; (3) *Achnanthidium minutissimum* (Kützing) Czarnecki, interior surface of a raphe valve; (4) *Bacillaria paxillifer* (O.F.Mülleur) Hendey, showing raphe system central and striae uniseriate; (5) *Encyonema silesiacum* (Bleisch) D.G. Mann; (6) *Cymbella sumatrensis* Hustedt, external view; (7) *Navicula* sp.1, external view of valve face.

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Conclusion

A study on benthic diatoms from Mekong River and its tributaries from from July 2005 to April 2007. One hundred and eighty four species of diatoms were found. The most abundant taxa were *Eolimna minima*, *Mayamaea atomus*, *Achnanthidium minutissimum*, *Navicula cryptotenella*, *Navicula symmetrica*, *Nitzschia palea* and *Gomphonema lagenula*. In this study, scanning electron microscope was very useful for diatom identification in species level. Especially, small structure of the diatoms that can not see by compound microscope.

Further work will apply the results of benthic diatoms diversity and trophic status of water quality to establish the Mekong River Diatoms Index to indicate water quality in Thailand freshwater resources.

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Table 25 Some physico-chemical parameters and water quality of sampling sites

	NO_3	NH_4	SRP	BOD	pH	Cond	Alk	DO	Temp	Velo	Turbid
GT1	0.60	0.41	0.55	2.20	7.98	197.00	72.50	5.40	26.20	9.20	293.00
GT2	0.20	0.19	0.20	2.90	7.84	312.00	38.00	9.20	19.30	4.72	74.00
GT3	0.77	0.18	0.13	2.13	7.78	170.93	55.37	8.00	30.27	7.11	79.67
GT4	0.73	0.39	0.06	3.88	7.35	154.33	10.25	6.60	25.03	6.98	297.33
GT5	0.13	0.08	0.07	1.93	7.63	248.67	55.33	10.00	18.20	2.57	57.33
GT6	1.73	0.12	0.15	2.27	7.78	277.57	102.00	7.93	30.50	4.07	83.00
KO1	3.00	0.31	1.19	2.80	7.78	103.00	28.00	5.20	27.60	6.70	210.00
KO2	0.90	0.30	0.23	3.40	7.05	135.00	56.00	9.80	23.50	5.32	57.00
KO3	1.20	0.36	0.15	2.97	7.24	187.63	68.50	7.73	29.07	6.42	126.67
KO4	2.33	0.40	0.13	3.20	7.03	78.97	7.08	6.00	25.80	4.23	244.00
KO5	0.83	0.32	0.12	3.13	6.96	127.60	34.67	10.93	20.57	6.50	174.00
KO6	1.67	0.44	0.22	3.27	7.21	172.90	53.33	8.67	29.07	6.17	295.33
HK1	2.80	0.51	0.67	3.10	8.10	201.00	69.00	5.20	26.60	8.80	419.00
HK2	0.30	0.18	0.30	3.00	7.79	248.00	47.00	9.80	19.90	6.00	65.00
HK3	1.27	0.23	0.11	2.50	7.48	204.13	80.53	8.13	28.47	9.17	54.67
HK4	2.70	0.61	0.10	0.83	7.44	164.67	17.85	6.40	25.97	3.10	346.33
HK5	0.23	0.17	0.04	0.47	7.43	246.00	50.33	8.13	18.83	10.60	293.33
HK6	2.00	0.18	0.13	1.33	7.64	266.80	96.33	8.87	29.50	8.87	136.67
HG1	1.00	0.32	0.12	1.40	7.19	168.00	55.00	4.20	27.00	0.50	438.00
HG2	1.40	0.24	0.17	1.10	7.28	251.00	77.00	8.00	23.30	0.90	149.00
HG3	1.27	0.33	0.13	3.07	7.61	177.07	56.30	6.77	30.50	11.10	44.33
HG4	0.17	0.60	0.14	0.53	7.24	84.77	20.33	5.57	35.60	4.60	84.77
HG5	0.80	0.22	0.18	4.47	7.75	64.17	48.33	8.13	27.30	1.77	4.33
HG6	1.07	0.60	0.47	3.67	8.08	376.33	101.00	8.20	30.73	13.33	55.67
KK1	2.00	0.40	0.29	2.30	7.80	235.00	72.00	4.80	28.00	3.20	453.00
KK2	0.50	0.20	0.19	4.95	8.70	177.00	91.00	8.60	26.00	2.80	105.00
KK3	1.77	0.30	0.20	2.47	7.67	271.00	80.70	5.63	29.57	5.40	130.33
KK4	0.27	0.38	0.16	0.13	7.03	139.00	36.67	5.07	32.67	4.92	363.33
KK5	1.13	0.16	0.19	0.27	7.36	49.67	43.33	7.27	23.97	0.10	165.67
KK6	1.60	0.26	0.16	5.50	7.96	302.67	101.33	5.50	30.70	4.00	112.33
PS1	1.00	0.48	0.20	1.90	7.65	227.00	79.00	4.40	30.00	2.20	367.00
PS2	1.20	0.23	0.26	4.40	7.06	213.00	88.00	8.20	26.00	2.00	126.00
PS3	1.20	0.39	0.21	2.17	7.52	274.33	76.50	5.43	31.10	5.23	133.33
PS4	0.73	0.52	0.10	0.23	7.13	148.33	25.00	4.57	32.87	4.70	323.33
PS5	1.30	0.18	0.18	0.40	7.39	270.00	45.00	7.20	27.60	1.45	129.67
PS6	1.27	0.41	0.25	0.60	7.71	326.00	104.67	5.07	29.60	0.00	105.33
LG1	1.00	0.20	0.20	1.00	6.36	201.00	28.00	2.60	32.00	0.40	47.00
LG2	1.10	0.31	0.10	1.70	6.70	203.00	27.00	3.30	26.50	0.20	125.00
LG3	0.90	0.36	0.31	2.92	6.87	389.00	43.50	4.03	33.30	0.01	103.00
LG4	0.63	0.72	0.07	0.27	6.65	148.67	8.67	3.57	33.97	6.21	52.67
LG5	0.80	0.26	0.22	0.40	7.98	291.67	15.67	5.73	28.77	0.02	15.33
LG6	0.67	0.41	0.25	1.70	7.50	398.67	82.00	5.17	31.23	0.00	20.33
NP1	1.00	0.40	0.25	4.40	7.48	186.00	33.00	4.40	30.00	2.40	230.00
NP2	0.80	0.20	0.33	4.90	7.74	205.00	81.00	8.20	25.10	4.40	122.00

Table 25 (continued)

	NO_3	NH_4	SRP	BOD	pH	Cond	Alk	DO	Temp	Velo	Turbid
NP3	1.13	0.34	0.16	2.83	7.65	201.70	54.07	5.07	32.17	0.02	103.67
NP4	0.33	0.45	0.09	0.23	6.76	92.47	21.00	4.00	32.77	4.13	249.33
NP5	0.27	0.18	0.01	0.47	7.47	227.67	79.00	7.33	27.37	0.08	90.67
NP6	1.20	0.52	0.15	1.10	7.78	261.00	93.67	5.97	32.00	0.00	33.33
SK1	1.20	0.45	0.10	1.40	6.05	222.00	30.00	2.20	32.00	2.20	28.00
SK2	1.80	0.38	0.07	3.60	6.59	484.00	23.00	7.00	27.00	3.20	288.00
SK3	1.47	0.24	0.17	2.47	6.68	219.00	38.02	4.20	34.57	0.13	98.67
SK4	0.53	0.67	0.02	0.17	6.07	129.33	6.33	3.17	34.23	2.62	71.00
SK5	0.57	0.41	0.04	0.23	7.09	753.00	4.25	6.47	28.00	4.25	41.00
SK6	1.07	0.28	0.15	0.83	7.46	255.33	42.33	4.57	29.90	8.33	11.33
KB1	0.80	0.20	0.29	2.30	7.71	197.00	66.30	4.60	30.00	2.60	248.00
KB2	0.30	0.18	0.24	4.60	7.98	186.00	85.00	8.40	24.50	4.00	111.00
KB3	0.13	0.26	0.12	3.40	7.62	156.63	38.20	5.93	31.67	16.17	111.67
KB4	0.33	0.49	0.10	0.33	6.90	147.67	20.17	4.77	32.50	6.79	264.00
KB5	1.17	0.19	0.20	1.80	7.42	218.33	40.33	7.00	27.13	11.35	105.67
KB6	1.17	0.32	0.13	0.87	7.96	251.33	90.67	5.87	32.30	2.24	25.00
HW1	1.00	0.24	0.30	2.60	7.34	134.00	29.50	4.60	29.00	10.00	267.00
HW2	0.90	0.10	0.22	4.90	7.93	184.00	78.00	8.60	27.10	8.87	103.00
HW4	0.17	0.53	0.04	0.20	6.78	66.47	19.00	4.60	34.67	5.49	270.33
HW5	0.43	0.23	0.00	1.13	7.61	188.00	38.67	7.53	28.83	0.06	85.67
HW6	0.80	0.26	0.34	0.27	7.79	249.33	87.00	5.97	31.50	13.30	19.33
KH1	1.00	0.40	0.14	2.40	7.72	193.00	59.60	4.60	31.00	1.20	251.00
KH2	0.80	0.25	0.22	4.80	7.70	172.00	80.00	8.40	25.50	5.00	104.00
KH3	0.53	0.30	0.16	3.03	7.55	136.70	46.27	5.87	31.33	0.03	98.00
KH4	0.33	0.52	0.07	0.13	6.83	77.63	20.83	4.13	36.27	3.57	316.33
KH5	0.27	0.21	0.00	0.60	7.74	49.33	42.33	7.13	22.43	1.17	114.00
KH6	0.83	0.21	0.45	0.37	7.82	244.33	89.00	6.03	32.43	5.88	25.67
KP1	1.90	0.27	0.30	1.60	6.77	167.00	30.50	3.60	32.00	4.40	117.00
KP2	1.60	0.40	0.07	5.20	7.90	233.00	49.00	7.20	28.00	6.75	119.00
KP3	0.47	0.68	0.11	2.07	6.86	201.43	72.27	4.00	32.10	5.93	78.67
KP4	0.27	0.81	0.09	0.07	6.22	141.00	12.17	3.80	35.80	8.69	111.00
KP5	0.53	0.37	0.05	1.20	6.97	80.67	49.33	6.40	30.17	0.09	54.67
KP6	0.60	0.38	0.09	1.13	7.20	263.33	44.67	4.87	31.57	5.81	16.00
KJ1	0.90	0.30	0.16	2.60	7.63	198.00	44.90	4.60	32.00	2.70	224.00
KJ2	1.30	0.22	0.20	5.10	8.20	163.00	81.00	8.50	27.00	3.80	96.00
KJ3	0.97	0.29	0.14	3.20	7.64	181.33	50.57	5.80	32.93	1.13	89.00
KJ4	0.23	0.55	0.09	0.77	6.64	76.57	21.83	4.83	34.67	4.40	249.00
KJ5	0.27	0.18	0.01	1.20	7.59	44.33	81.00	7.67	27.73	0.09	99.33
KJ6	0.97	0.69	0.31	3.27	7.80	239.33	84.00	6.67	32.03	0.00	15.33

Table 26 Percent of relative abundant of benthic diatoms in Mekong River and it's tributaries

	GT1	GT2	GT3	GT4	GT5	GT6	KO1	KO2	KO3	KO4	KO5	KO6	HK1	HK2	HK3	HK4	HK5	HK6	HG1	HG2	HG3	HG4	HG5	HG6	KK1	KK2	KK3	KK4	KK5
Achcre	0.1																		0.8										
Achcon							2.1	0.2	6.7		1.4	2.7			0.5						0.7								
Achell								0.1	0.6																				
Achinf									0.1																				
Acdcat					1.3						0.3																		
Acdcon									0.1																				
Acdjap																					1.4								
Acdmin	2.9		28.4			6.7			2.1	0.0	1.8										9.5			2.5			10.0		
Acdrob	2.4																		23.2										
Acdsp1																0.2													0.1
Ampmon					2.2													10.3		0.1									
Ampsp1	0.1				0.2																								
Aulalp		0.1																											
Aulamb																													
Aulgra		1.7													1.1														
Aulmuz																													
Bacpax	0.1							0.2	0.1															0.1					
Braneo																					1.5								
Brasp1								0.1																					
Calbac																													
Calsp1																													
Cocped						0.1													3.2										
Cocpla	7.4	1.9	2.9		0.9	3.9			1.0	1.5	1.4				0.3		4.2	0.4		0.1		3.2		85.5					8.3
Coceug						0.1																							
Coclin																													
Cocpse																			0.1										
Craamb																				0.1									
Crasub								0.1																					
Cycmen						1.6		0.2												0.2						0.1			
Cymcis									4.0																				
Cymnav																													
Cymsun	0.2				0.4													2.0	2.8	0.1				0.5	1.3	0.2			
Cymtum					0.8			0.2	0.1		4.0				6.2					0.2				0.1					
Cymtur										0.3	6.4				0.5					4.7						0.8			
Cymsp1			**12.1**		**9.5**						**0.9**			**25.1**					**5.2**	**0.7**						**3.9**			
Cymsp2																													
Cypros																					0.1								
Diacon										11.3											0.2	6.0	0.9						
Diaten										0.4																			
Diasp1																													
Ditmes						0.1									0.1														
Dipell																													
Dippse																				0.1									
Dippue																													
Dipsub																			0.5										
Disste																													
Dispse																										0.1			
Encmin																										0.1			
Encpro														0.1															
Encsil	0.1													0.3															
Encsp1			0.9		1.3												1.3			8.6						7.6	0.2		4.8
Encsp2	5.2																			12.0	0.9						0.1		
Enylee								0.1																					
Enymic																													
Eolmin	3.9					6.1	81.9	59.4		15.4	35.2	42.2						41.4							41.7		40.2		
Eolsub	5.2					0.4	3.1	0.8			3.7	0.1						0.2		1.3						10.4			12.7
Eoltan			6.6			2.6			26.0																				
Eolsp1						2.3																							
Eolsp2									2.1																				
Eolsp3											0.1																		
Episor										0.3																			
Euncam		0.1																											
Euncur																													
Eunfem																													
Eunind																													
Eunmuc																													
Eunrep																													
Eunsp1																													
Eunsp2																		0.1											
Eunsp3																													
Eunsp4																													
Eunsp5																													
Eunsp6																													
Eunsp7																													
Eunsp8																													
Falins																													
Falmer																													
Falpyg																													
Fraacu																													
Frabid		0.2				4.1							0.8							0.3									
Fracap				0.5		0.3			1.0						0.2			7.4											
Fravau										0.1																			
Fruund																			0.1										
Frusax																			0.5										
Frurho																													
Frupar						0.1																							
Frusp1										0.1																			
Geidec					2.7	1.0		0.3		1.8					0.7				2.1	0.1									
Geipun																													
Gonrho																													
Gonhet				0.1																									

Table 26 (continued)

	GT1	GT2	GT3	GT4	GT5	GT6	KO1	KO2	KO3	KO4	KO5	KO6	HK1	HK2	HK3	HK4	HK5	HK6	HG1	HG2	HG3	HG4	HG5	HG6	KK1	KK2	KK3	KK4	KK5
Gomgra																													
Gomina																													
Gomlag	4.9			9.5	0.9	3.7			5.3	0.3					5.1			3.6		2.7				1.3		1.5			5.4
Gompar							2.5																	0.1					
Gomexi																													
Gomaff				2.9																									
Gompse																													
Gomsub					0.4																				11.4				
Gommin																													
Gomcon		2.0																											
Gomtra																													
Gomtur																									0.2				
Gomsp1																								0.1					
Gomsp2																			0.1										
Gyracu																									0.1				
Gyrexi																				0.1									
Gyrexl													0.1																
Gyrnod																													
Gyrobs																													
Gyrsca		0.6					1.3		0.1							5.0													
Gyrspe																				0.6									
Hanamp									0.5	0.8															1.6				
Hipcap																													
Hiphun																		0.1											
Hydwha				0.1																									
Lutfal										0.8																			
Lutgoe			5.1	6.2	1.2			1.5	1.4	18.0			8.3		0.4		3.4			0.1		17.1		0.1	7.1			5.7	
Lutmon									0.2																				
Lutniv										1.4																			
Lutpeg				0.5																									
Lutper															0.2														
Lutsax											0.1																		
Lutsp1						1.0											10.8												5.1
Lutsp2																													
Lutsp3																													
Lutsp4					0.2	0.4									0.3							1.5							
Lutsp5										0.1																			
Melvar				4.1	2.3	0.2			0.6					4.3						6.4			2.9	3.5					
Mayato	38.8		5.9	40.7	18.3	33.2				4.9	5.3	11.9			37.7		28.6	2.2	50.9	12.9	30.2	34.1	66.0		33.7	54.8	46.4		35.2
Navcap					0.8	0.6					0.3	0.9																	
Navcry	0.5	58.8		21.6	2.6					1.3	8.4	11.4						6.9			5.1	16.7		2.6					
Navrad																													
Navros					0.1	0.9		0.7	18.1	0.4	4.4	4.5		9.2	3.7					0.9	4.0					0.2			
Navsym	1.1		8.5	1.4	8.8			34.0	6.0	2.4	9.7	11.8	20.4	3.4		83.3	30.9			16.2	6.7					0.4	0.3	5.2	
Navvir														47.4			4.7		0.2										
Navmen		6.6			28.3										13.7		3.6	5.0		1.1						0.3			
Navcrp			11.6	0.7										10.4	6.6			1.0	3.5	0.9					0.3	1.6	2.8		10.6
Navlan												1.6								11.3						1.1			
Navcin																													
Navphy																													
Navmic																													
Navsch									0.9																				
Navcar																													
Navrad																													
Navkus															0.1				0.1										
Navger			0.1																										
navnov																													
Navrhy																						0.1							
Navsp1																													
Navsp2				0.2																									
Navsp3								0.2																					
Navsp4																													
Navsp5																													
Navsp6																													
Nadnan										7.2	0.1				9.1					0.4						0.2			17.9
Nadtri															0.6														
Neiaff													0.1																
Neibin					0.1																								
Neidub															2.4														
Neiflo																													
Neikoz																													
Nitaci																										0.1			
Nitacd																													
Nitamp																													
Nitcap																													
Nitcla		0.2																9.1										63.9	
Nitdis	0.1				4.4				0.8				3.7		0.2		1.6			0.3									
Nitfil	5.5	19.1	0.2	8.9	0.1	0.3				0.2							5.3												
Nitfon		0.4																										1.1	
Nitgra																													
Nitgei										2.4																			
Nitinc	2.1	8.6	3.3		12.3	13.7			10.0	13.0	3.5	1.9			1.3			1.8			23.1							23.7	
Nitint																													
Nitlin																													
Nitlie																					1.1								
Nitlor													0.2																
Nitmic	2.2		2.5			8.0																							
Nitnan	0.1																												
Nitobt																													
Nitpal						3.3			6.5	10.0	8.4		66.8		0.8	11.4	2.8	2.8	6.7	1.2	13.3		21.6		0.6	1.4			
Nitpde	2.7	0.2							0.4								2.8				1.7								

Table 26 (continued)

	GT1	GT2	GT3	GT4	GT5	GT6	KO1	KO2	KO3	KO4	KO5	KO6	HK1	HK2	HK3	HK4	HK5	HK6	HG1	HG2	HG3	HG4	HG5	HG6	KK1	KK2	KK3	KK4	KK5
Nitpac						0.4			0.6																				
Nitper									0.1																				
Nitpum																													
Nitpse																										0.2			
Nitsub			2.5												8.2													1.5	
Nitsuc									0.1																				
Nitsup						3.3		2.4			3.8	10.1								11.2					2.4	15.1			
Nittab																													
Nitter																						18.5							
Nitrev																				0.1									
Nitsp1			0.2							0.1						0.4				0.1									
Nupsp1	3.7		5.2																		0.1								
Pinacr																													
Pinbra																													
Pingra									0.1																				
Pinmic									0.1																				
Pinsim																													
Pinsub									0.1																				
Pinsp1																													
Pinsp2																													
Plaabu										0.1																			
Plagra																													
Plasym																							0.1						
Plaund										0.1																			
Plasp1									3.1													1.5							
Plndel										0.1																			
Plnfre			4.2	0.6		3.7	6.9			10.3	0.8	1.0			0.2			5.8		0.4	1.5								
Plnros																													
Plnsp1																													
Plelae	0.1			1.1		0.4									0.1														
Plusal																				1.6				0.1					
Pluboy																	0.1												
Plusp1																		0.2											
Rhobre		0.1																											
Rhogib																													
Rhogbb																													
Rhoope																													
Rhosp1																													
Selbac																													
Selpop	0.7								1.6						2.3														
Selsp1																			0.4										
Selsp2						0.1																							
Staanc									0.3	0.3												1.1							
Stasmi									0.1																				
Steves																				0.1									
Stesp1																													
Stesp2																													
Stesp3																													
Surang																													
Surcap																													
Surner																													
Surrob											0.1									0.1		0.2							
Surspl																				1.2									
Sursp1																													
Sursp2																				0.1									
Sursp3																													
Synamp																													
Synlan																													
Synaeq						0.3												7.4											
Synamr									0.3																				
Synsub									0.7																				
Tabfas				0.5											0.2														
Tabacu																													
Tabbal				0.1																									
Trycal																													
Trycoa																				0.1									
Trylev	0.1																			0.1									
Trysal																													
Ulnbic									0.7																				
Ulnuln	10.0			1.7			2.2		1.0											1.3				8.6	3.5				

Table 26 (continued)

	KK6	PS1	PS2	PS3	PS4	PS5	PS6	LG1	LG2	LG3	LG4	LG5	LG6	NP1	NP2	NP3	NP4	NP5	NP6	SK1	SK2	SK3	SK4	SK5	SK6	KB1	KB2	KB3	KB4
Achcre																													
Achcon								0.6						1.4															
Achell																												2.3	
Achinf																													
Acdcat				0.3																									
Acdcon																													
Acdjap																													
Acdmin	19.2			15.5				12.7	24.9			29.5	48.4			7.5							33.2	4.5		0.3		12.2	
Acdrob																										16.0			
Acdsp1																													
Ampmon		1.5										3.3				5.1	49.6							11.0	6.9				
Ampsp1														0.1															
Aulalp											0.3																		
Aulamb											0.1																		
Aulgra											2.3																		
Aulmuz																													
Bacpax		0.5				0.2									0.1			6.8	0.3										
Braneo																				4.9									
Brasp1																													
Calbac																													
Calsp1										0.7	0.8	1.3																	
Cocped												1.1																	
Cocpla				0.3		7.3	11.0							1.9	0.1	3.6								0.7	2.2			0.1	
Coceug																													
Coclin				0.3														0.7											
Cocpse																													
Craamb																													
Crasub																													
Cycmen											2.3							2.4	10.3							0.2	0.2		
Cymcis																													
Cymnav																								0.8					
Cymsum			0.4			5.2								0.3	2.6											3.7	0.8	8.0	
Cymtum		0.4	0.1	1.2		0.2			0.1					0.1	0.1			0.1	0.2									0.1	
Cymtur																											0.1		
Cymsp1			**0.5**			**1.3**									**8.4**	**11.5**		**5.9**						**7.3**		**1.1**	**26.7**	**14.1**	**10.3**
Cymsp2																													
Cypros																													
Diacon		1.6				14.3																							
Diaten																													
Diasp1																													
Ditmes	2.3																												
Dipell	0.1																												
Dippse																													
Dippue												0.1												0.4					
Dipsub																					0.1								
Disste																												0.4	
Dispse																													
Encmin																													
Encpro																													
Encsil								0.5	0.1			6.2								1.5	0.3	0.5							
Encsp1			12.1			0.6	7.7		1.5			1.7		0.2	6.1							3.0		3.4		3.2	13.9		
Encsp2																	41.2												
Enylee																													
Enymic																													
Eolmin	48.5	5.2		10.1	37.7	7.0		6.3									9.2		19.7					24.6	34.4	14.0			
Eolsub	6.0	9.4							0.2						19.1				0.1					0.4		3.0			
Eoltan																			8.7										
Eolsp1																													
Eolsp2																													
Eolsp3																													
Episor																													
Euncam																													
Euncur																					0.1								
Eunfem																			0.1				0.3						
Eunind																				0.3									
Eunmuc																				0.3									
Eunrep																													
Eunsp1																					0.1								
Eunsp2																													
Eunsp3																				0.1									
Eunsp4																				3.9									
Eunsp5																				1.1									
Eunsp6																				7.6									
Eunsp7																				0.2									
Eunsp8																				0.1									
Falins														0.1										0.2					
Falmer												0.2		0.1										4.8					
Falpyg									0.2																				
Fraacu																				1.4									
Frabid	17.2			4.2				2.8	0.1		4.4										0.3	1.0				1.9			
Fracap																									9.2				
Fravau														0.1															
Fruund								1.7	0.1		2.1			2.9						12.1	0.3		12.3	0.8					
Frusax								0.1												3.3	11.0			0.1					
Frurho											10.1	0.1								3.0	0.6								
Frupar																													
Frusp1																													
Geidec		2.6																		2.8	0.1	1.3		1.5				1.1	
Geipun				0.1																									
Gonrho							0.7	0.3							0.1														
Gonhet																													

Table 26 (continued)

	KK6	PS1	PS2	PS3	PS4	PS5	PS6	LG1	LG2	LG3	LG4	LG5	LG6	NP1	NP2	NP3	NP4	NP5	NP6	SK1	SK2	SK3	SK4	SK5	SK6	KB1	KB2	KB3	KB4
Gomgra									0.9			0.5			0.1					14.8	1.8								
Gomina			0.5																										
Gomlag		12.2	0.2	1.4				49.7	5.5	96.1	26.6	17.1		1.3	6.8			1.8		28.8	25.1	14.1			8.4			4.9	
Gompar								0.7	23.4						1.1						32.8	10.3							
Gomexi																													
Gomaff						0.3															2.9			0.4					
Gompse																													
Gomsub																													
Gommin																													
Gomcon								0.8	0.6			0.4			0.1														
Gomtra																													
Gomtur																													
Gomsp1																													
Gomsp2																													
Gyracu																													
Gyrexi																													
Gyrexl																													
Gyrnod		0.1																											
Gyrobs																													
Gyrsca						0.1						3.1										0.1					0.1		
Gyrspe												0.2															0.1		
Hanamp														0.7															
Hipcap																				0.1									
Hiphun																													
Hydwha																													
Lutfal																													
Lutgoe		2.4						6.7				0.4		9.2	0.1													5.9	53.0
Lutmon									0.1																				
Lutniv																													
Lutpeg																													
Lutper																													
Lutsax																													
Lutsp1												1.1						4.9											
Lutsp2						0.7												0.3									0.2		
Lutsp3									0.2																				
Lutsp4																													
Lutsp5																													
Melvar						0.3			0.1									1.4								2.3	0.8		
Mayato		22.6		0.4	27.9		77.9		2.9		1.7			16.8	5.6					4.4		7.2		8.4		6.3	0.9	10.8	
Navcap																											0.1		
Navcry		18.0		12.6				0.3						0.4					15.5						8.3				9.0
Navrad																													
Navros	9.4	2.9		3.8					1.7			10.7				1.2		1.4		5.5							0.1		
Navsym		18.5	13.3	0.5	7.6	0.3			5.8	3.2	2.4	12.5		6.9	2.5			0.3				1.0		6.1			5.1	12.9	
Navvir																								0.9					
Navmen																								1.0	7.5	8.8			
Navcrp		0.9	68.2		7.2	40.3			0.2					18.8	33.5	71.2		18.9	6.6	1.9	0.1						42.6	5.2	
Navlan			1.8						0.6																		4.0		
Navcin			0.2																										
Navphy			1.4																										
Navmic																					0.1								
Navsch																													
Navcar																													
Navrad		0.9																											
Navkus																													
Navger																													
navnov		0.1																											
Navrhy																													
Navsp1																													
Navsp2																													
Navsp3																													
Navsp4			0.1																										
Navsp5																												0.1	
Navsp6																								0.1					
Nadnan				0.6	0.9		0.3								0.1				0.3									10.1	
Nadtri							2.4																						
Neiaff																					0.1								
Neibin																													
Neidub															0.2														
Neiflo																		0.2											
Neikoz													0.1																
Nitaci									1.4												0.1	0.1							
Nitacd									9.9												0.1								
Nitamp																													
Nitcap																													
Nitcla		0.3		0.5				5.4	0.6		27.0			0.2	0.5			4.8	15.5		0.2	1.0		2.6	7.0		0.1	3.6	
Nitdis			0.3					0.6	0.1					2.0	0.2							0.9					0.8		
Nitfil						16.1						6.7			0.3			50.4	10.1							3.0	0.1		
Nitfon																													
Nitgra									0.1																				
Nitgei																													
Nitinc		0.1		21.3	10.3										0.2									4.6		4.7		0.8	
Nitint									0.6																	0.1			
Nitlin									2.7						0.1														
Nitlie																													
Nitlor																													
Nitmic															3.0													4.6	
Nitnan									1.2					0.5							22.7			1.2					
Nitobt									0.2			0.2										0.1				0.1			
Nitpal	2.4		0.8	2.6	7.8			3.4	8.5		16.3		46.6	13.7	0.2				0.9		1.2	57.7		0.4	5.1	13.3	0.7	1.1	14.3
Nitpde								0.1																					

Table 26 (continued)

	KK6	PS1	PS2	PS3	PS4	PS5	PS6	LG1	LG2	LG3	LG4	LG5	LG6	NP1	NP2	NP3	NP4	NP5	NP6	SK1	SK2	SK3	SK4	SK5	SK6	KB1	KB2	KB3	KB4
Nitpac								1.3	7.7																		2.3		
Nitper																													
Nitpum								0.3	0.1																				
Nitpse									0.1																				
Nitsub																								2.0					
Nitsuc																													
Nitsup				12.9									5.1	20.3					11.2				54.5			17.6		0.4	
Nittab																													
Nitter																													
Nitrev						0.2			0.2			1.7		0.1															
Nitsp1																													
Nupsp1				9.2																	0.1								
Pinacr				1.1																									
Pinbra				0.1																									
Pingra																				0.1									
Pinmic												1.5																	
Pinsim																				0.1									
Pinsub																				0.3									
Pinsp1												0.1																	
Pinsp2																				0.1									
Plaabu																													
Plagra												0.1																	
Plasym																													
Plaund																													
Plasp1												0.2																	
Plndel																													
Plnfre											4.0													6.2	10.9			0.7	
Plnros																												0.5	
Plnsp1																				1.6				2.0					
Plelae																													
Plusal						5.3																					0.1		
Pluboy																													
Plusp1																													
Rhobre																													
Rhogib																													
Rhogbb																													
Rhoope																													
Rhosp1																											0.1		
Selbac																								0.2					
Selpop				0.8										1.8															
Selsp1																													
Selsp2																													
Staanc																										0.4			
Stasmi																													
Steves																													
Stesp1																							0.1						
Stesp2																						0.2							
Stesp3																								0.1					
Surang																													
Surcap													0.1																
Surner				0.1																									
Surrob				0.2																									
Surspl																					0.1								
Sursp1																													
Sursp2																													
Sursp3																									0.1				
Synamp																									0.2				
Synlan																													
Synaeq																									9.2				
Synamr																													
Synsub																													
Tabfas																													
Tabacu																													
Tabbal																													
Trycal																													
Trycoa																													
Trylev												0.1															0.1		
Trysal																													
Ulnbic																													
Ulnuln					0.4	0.4																1.7							13.3

Table 26 (continued)

	KB5	KB6	HW1	HW2	HW4	HW5	HW6	KH1	KH2	KH2	KH3	KH3	KH4	KH5	KH6	KP1	KP2	KP3	KP4	KP5	KP6	KJ1	KJ2	KJ3	KJ4	KJ5	KJ6
Achcre																											
Achcon	0.2	1.2					0.1	1.0											3.4								
Achell																		1.0									
Achinf																						0.2					
Acdcat							2.0																				
Acdcon																											
Acdjap															0.1												
Acdmin			5.1												16.7			12.2			47.9	18.8		53.3			18.6
Acdrob			49.6																								
Acdsp1																											
Ampmon			4.9			2.0		0.5						0.5													
Ampsp1						11.9		0.7												0.1							
Aulalp																											
Aulamb																											
Aulgra																0.6	0.3	2.8	0.3		0.7			0.4			
Aulmuz							0.1									0.3		0.2			3.0						
Bacpax	0.1	1.5												0.3		0.1											
Braneo																0.1								4.4			
Brasp1																											
Calbac		0.8																									
Calsp1																											
Cocped																									0.3		
Cocpla	3.3	2.7					9.8	4.4						1.1		0.1				17.0	5.8	3.0			0.1	10.6	1.0
Coceug																											
Coclin																											
Cocpse																											
Craamb																											
Crasub																											
Cycmen						10.6	1.5			0.1				5.4	0.2		0.7										
Cymcis																0.2		4.2			3.9						
Cymnav																											
Cymsun	0.2	3.1		0.6	6.5			6.8									23.2				5.3		18.6	0.1			
Cymtum					1.3										0.3		50.4					0.3	0.1		0.1		
Cymtur					1.1						1.1	1.1					0.6			0.9							
Cymsp1	**27.3**			**92.5**	**74.0**	**47.1**	**12.4**			**19.0**	**7.9**	**7.9**		**3.0**	**1.5**		**22.5**			**2.9**			**68.8**	**0.3**			
Cymsp2										0.3																	
Cypros																											
Diacon											0.7	0.7		2.9													
Diaten																											
Diasp1																			2.3								
Ditmes																											
Dipell																											
Dippse																											
Dippue																								0.2			
Dipsub																					0.1						
Disste		2.7													0.6	0.3			3.5		11.9			0.4			
Dispse																											
Encmin																											
Encpro																											
Encsil			9.7				0.3									0.1			0.3		1.1				2.2		
Encsp1	9.9	14.6				7.9				11.5				0.1		3.2							0.4	0.8			
Encsp2																											
Enylee																											
Enymic																						5.4		37.2			
Eolmin		4.8							37.7				19.4		6.2	7.8		7.1		31.5					0.3		32.7
Eolsub											16.9	16.9			0.7	5.5						1.7					
Eoltan							5.1													3.9						5.3	
Eolsp1																											
Eolsp2																											
Eolsp3																											
Episor																											
Euncam																											
Euncur																											
Eunfem																											
Eunind																											
Eunmuc																											
Eunrep																				0.1							
Eunsp1																											
Eunsp2																											
Eunsp3																											
Eunsp4																											
Eunsp5																											
Eunsp6																											
Eunsp7																											
Eunsp8																											
Falins																0.1											
Falmer																0.1											
Falpyg																											
Fraacu																											
Frabid								1.9								3.8		6.5	1.5		5.7			0.1			10.3
Fracap							3.9				4.3	4.3	17.8		0.5	1.2			0.4		7.6	0.5			5.4		
Fravau																											
Fruund			1.2																			0.1					
Frusax			1.0																								
Frurho																											
Frupar																											
Frusp1																											
Geidec								6.4							0.3	0.9						0.2		1.3			
Geipun																								0.3			
Gonrho															0.1												
Gonhet																											

Table 26 (continued)

	KB5	KB6	HW1	HW2	HW4	HW5	HW6	KH1	KH2	KH2	KH3	KH3	KH4	KH5	KH6	KP1	KP2	KP3	KP4	KP5	KP6	KJ1	KJ2	KJ3	KJ4	KJ5	KJ6
Gomgra					0.2										0.5							3.1					
Gomina																											
Gomlag			8.1								9.1	9.1				13.9			27.1				0.8				
Gompar																			16.8			0.1					
Gomexi			0.2																								
Gomaff													0.2		1.5												
Gompse													2.6		1.2												
Gomsub																2.4					1.9						
Gommin															0.7												2.8
Gomcon																											
Gomtra																						0.3					
Gomtur																											
Gomsp1																											
Gomsp2																											
Gyracu																											
Gyrexi																											
Gyrexl																											
Gyrnod															0.1												
Gyrobs																											
Gyrsca							0.3																		0.1		
Gyrspe							0.1							0.2													
Hanamp																			1.4								
Hipcap																											
Hiphun																											
Hydwha																									0.2		
Lutfal																											
Lutgoe								1.1					42.2	1.7						8.3		9.0			5.0		
Lutmon																											
Lutniv																											
Lutpeg																											
Lutper																											
Lutsax																											
Lutsp1		2.1							0.9	0.9																59.1	
Lutsp2									3.0	3.0																	
Lutsp3																						0.4					
Lutsp4																											
Lutsp5																											
Melvar	5.0	1.5		0.3			1.0		1.3	1.3	0.3	0.3		9.8									0.2		3.5		
Mayato		40.6					0.1	6.1			6.0	6.0		3.2	11.6	8.9			8.3	11.6		4.3			3.8	8.1	
Navcap																											
Navcry			18.4		3.7		1.0						11.7		2.4					6.2		22.8		0.9	33.6	16.9	12.5
Navrad	0.3																										
Navros					1.1		0.3		0.2	0.2	3.1	3.1			2.5			0.4				2.5	0.1				
Navsym	18.6				11.8	8.4	7.5		6.4	6.4	21.6	21.6		1.9				5.9		11.3		15.0	0.2		4.1		
Navvir					0.3																						
Navmen						3.5								7.3						1.9			8.8				
Navcrp	33.2	8.4		6.3		0.4	9.4	2.9	52.9	52.9	36.5	36.5		55.1	0.8						2.1		1.9				
Navlan				0.2			0.5		0.6	0.6														0.2			
Navcin									0.1	0.1																	
Navphy																											
Navmic																											
Navsch																											
Navcar															0.6												
Navrad															0.1						0.8						
Navkus																											
Navger																											
navnov																											
Navrhy																											
Navsp1																											
Navsp2																											
Navsp3																											
Navsp4																											
Navsp5																											
Navsp6																											
Nadnan																											
Nadtri																											
Neiaff																											
Neibin																											
Neidub																											
Neiflo																											
Neikoz																											
Nitaci																											
Nitacd																											
Nitamp															1.4												
Nitcap																			2.1								
Nitcla	0.2					8.1		0.3					3.9			9.3			0.6			1.6			0.7		
Nitdis															0.3	0.6			0.1	0.5							
Nitfil	0.5													7.4	0.8	0.1						2.1			15.6		
Nitfon																											
Nitgra																		0.4									
Nitgei																											
Nitinc		12.5						43.6					1.0		27.2	1.7		6.2	12.8						15.1		14.1
Nitint																						0.3					
Nitlin																											
Nitlie																											
Nitlor																											
Nitmic																		10.4									
Nitnan																											
Nitobt																0.2	0.4										
Nitpal	0.6	3.5					6.2	13.2	1.5	1.5	2.9	2.9			7.8	15.7		19.0	0.2	3.5	1.7	1.7			4.5		7.0
Nitpde											13.7	13.7			11.6	15.3		10.0				4.0					

Table 26 (continued)

	KB5	KB6	HW1	HW2	HW4	HW5	HW6	KH1	KH2	KH2	KH3	KH3	KH4	KH5	KH6	KP1	KP2	KP3	KP4	KP5	KP6	KJ1	KJ2	KJ3	KJ4	KJ5	KJ6
Nitpac											0.5	0.5			0.6				3.0								
Nitper																											
Nitpum																0.3		0.6									
Nitpse									0.1	0.1																	
Nitsub																											
Nitsuc																											
Nitsup							28.6		1.5	1.5						0.4		11.2	7.3					0.1	3.2		
Nittab								1.1								0.1			1.6					0.1			
Nitter																											
Nitrev																0.2						0.9					
Nitsp1									0.1	0.1																	
Nupsp1							0.2	10.0			1.7	1.7															
Pinacr							1.4																				
Pinbra																											
Pingra																											
Pinmic																											
Pinsim																											
Pinsub																											
Pinsp1																											
Pinsp2																											
Plaabu																					0.1						
Plagra																											
Plasym																											
Plaund																											
Plasp1																											
Plndel																											
Plnfre		1.4					7.9		0.1	0.1			1.2		2.3	5.3			3.9								0.8
Plnros																											
Plnsp1																											
Plelae																									1.6		
Plusal	0.4															0.2											
Pluboy																											
Plusp1																											
Rhobre																											
Rhogib		**0.6**					**0.5**								**0.2**			**1.7**									
Rhogbb																			0.1								
Rhoope													0.2														
Rhosp1																											
Selbac																											
Selpop			1.8													0.9			0.6								
Selsp1																											
Selsp2																											
Staanc																											
Stasmi																											
Steves																											
Stesp1																											
Stesp2																											
Stesp3																											
Surang	0.1																										
Surcap																											
Surner																											
Surrob																											
Surspl																		0.2									
Sursp1																									0.1		
Sursp2																											
Sursp3																											
Synamp																											
Synlan							0.8														1.1						
Synaeq							3.9								0.5	1.2			0.4		7.6				0.3		
Synamr																											
Synsub																											
Tabfas											4.3	4.3	17.8									0.5			5.1		
Tabacu											0.2																
Tabbal																											
Trycal											0.8	0.8															
Trycoa																0.1						0.4					
Trylev															0.1												
Trysal							0.1																				
Ulnbic																											
Ulnuln	0.1			0.1					0.2	0.2	0.8	0.8					1.9		4.7		0.9		0.1		0.5		