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Epilithic freshwater diatoms in Jakarta, Surabaya and Singapore

Michiaki SUMITA and Toshiharu WATANABE

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The nine samples of epilithic algae were collected from inland water in Jakarta and Surabaya, Indonesia and in Singapore in February, 1974. The present report deals with the epilithic diatoms in the collections done at nine stations, among which stations 1-6 were lentic environments and stations 7-9 were lotic environments. The authors have made some investigations from ecological view point on the diatom floras at nine sampling stations.

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One of authors, SUMITA, had an opportunity to make collections at several inland waters in Jakarta and Surabaya, Indonesia and in Singapore during the period from 5th to 15th, February, 1974. The collections of epilithic algae were made at nine stations at a reservoir, ponds and streams: one in Singapore, six in Jakarta and its surburbs, two in Surabaya. In the present report, the authors have made some investigations from ecological view point on the diatom flora at nine sampling stations.

Stations and methods

The materials treated in this paper were collected from lentic environments (Stations 1-6) and lotic environments (Stations 7-9). The location and characteristic features of sampling stations are as follows:

A. Lentic environments (Stations 1-6)

Station 1. Seletar Reservoir. It lies 9.2 km north of the city of Singapore. The sample was collected at the lakeside near the control tower.

Station 2. A pond of Keban Bintang (Surabaya Zoo) in Surabaya. The pond is roughly elliptical, being about 150 m in its major diameter.

Station 3. A drainage from station 2. It is about 2 m wide. When the collection was made, it had little water and larvae of *Chironomus* were found abundantly on the muddy bed.

Station 4. An artificial pond of concrete in southern intersection of Jalan Husmi Tharin, Jakarta. The pond water was clear and many floating macrophytes, like water lilies, were found.

Station 5. A paddy field of Lebak Bulus. It lies 15 km south of Jakarta. The irrigation water is supplied from a river near by.

Station 6. A pond in the Lalarn Park, the southeastern suburbs of Jakarta. It is about 150 m long and 120 m wide. Many water plants were seen along the coast.

B. Lotic environments (Stations 7-9)

Station 7. A creek in the Bogor Tropical Botanic Garden situated 60 km south of the city of Jakarta. The width of the creek is about 3 m.

Station 8. A stream in the Jalan Prot Muh of Jakarta, about 5 m wide. Both of the banks are built of stone, and the bed of the stream is gravelled. Outlets of domestic sewages were seen here and there.

Table 1. Water temperature at each station

Station	Date	Water temperature (°C)
1	II- 7	28.5
2	II-12	29.5
3	II-12	30.2
4	II-14	30.0
5	II-15	25.6
6	II-15	25.3
7	II- 8	29.2
8	II-14	30.2
9	II-15	25.3

Station 9. A river in Lebak Bulus situated 15 km south of Jakarta. Its width is about 4 m. It is used for the irrigation of station 5. The river water was reddish brown, rich in humus.

The water temperature observed at each station is as shown in Table 1. At the stations 1, 3, 5, 6, 7, 8 and 9, the epilithic algae were collected from flat upper surfaces of stones about 20 to 40 cm deep in the water. At the stations 2 and 4, the materials were collected from surfaces of submerged stalks and leaves of water plants. The materials were treated by TSUMURA's method.

Results

In nine samples collected in 1974, a total of 109 diatom taxa from 23 genera were found. The numbers of taxa belonging to the genera are shown in Table 2.

The identification of each species is based on the literature given after the name.

In Tables 3 and 4, the relative frequencies of principal species are shown: Those of lentic environments in Table 3, those of lotic environments in Table 4. The following taxa are common in the lentic environments (Table 3). These taxa are: *Melosira granulata* (EHR.) RALFS (Stations 1, 2, 3, 5), *Navicula cryptocephala* var. *veneta* (KÜTZ.) GRUN. (Stations 1, 2, 3, 5) and *Nitzschia palea* (KÜTZ.) W. SMITH (Stations 2, 3, 4, 5).

Table 2. Genera and number of taxa belonging to each genus

Genus	Number of taxa
Melosira	4
Cyclotella	2
Fragilaria	2
Synedra	4
Eunotia	5
Cocconeis	3
Achnanthes	6
Frustulia	1
Gyrosigma	2
Neidium	4
Diploneis	1
Stauroneis	2
Anomoeoneis	1
Navicula	22
Caloneis	2
Pinnularia	6
Amphora	3
Cymbella	6
Gomphonema	9
Rhopalodia	1
Hantzschia	3
Nitzschia	16
Surirella	4

In Table 3 *Cymbella affinis* KÜTZ. which drew our attention because of the high relative frequency. On the other hand, other taxa do not exceed 23% in relative frequency.

In the lotic environments, widely distributed taxa are *Eunotia lunaris* (EHR.) GRUN., *Navicula pupula* KÜTZ., *Pinnularia braunii* var. *amphicephala* (A. MAYER) HUST., *Gomphonema grunowii* var. *grunowii*, *Nitzschia amphibia* GRUN. and *Nitzschia palea* (KÜTZ.) W. SMITH. The abundant taxa occuring in the materials are as follows: *Navicula cryptocephala* var. *veneta* (37.8% at Station 9), *Nitzschia palea* (36.4% at Station 8), *Gomphonema grunowii* var. *grunowii* (22.6% at Station 7) and *Achnanthes linearis* (16.1% at Station 9).

Table 3. Principal diatom taxa and their relative frequencies in lentic environments

Taxon	Station					
	1	2	3	4	5	6
Melosira granulata	16.0	9.5	3.0		5.3	
M. distans var. *alpigena*		3.6				
Cyclotella stelligera	20.4					2.2
C. Meneghiniana		+	3.0			
Synedra rumpens	4.4					
S. rumpens var. *familiaris*	3.8					
S. ulna	+	+		4.5	3.8	
Cocconeis placentula var. *lineata*						8.8
Achnanthes exigua	+		2.0			
A. linearis	2.7					
Neidium gracile					2.4	
Navicula confervacea		10.5				+
N. cryptocephala		3.1	+			6.5
N. cryptocephala var. *veneta*	6.0	8.2	5.6		4.8	
N. halophila var. *tenuirostris*					2.4	
N. laterostrata			4.6			
N. mutica		2.2	+			
N. notha					2.9	
N. pupula		3.1	4.1		+	
N. pygmaea			12.3			
Caloneis bacillum		+	2.5			
Pinnularia braunii var. *amphicephala*			2.0		+	+
P. microstauron					2.9	
Amphora fontinalis		+	6.1			
Cymbella affinis	32.0			55.3	+	66.9
C. thienemanni				22.1		
C. sinuata						3.6
C. turgidula	+	+				4.4
Gomphonema grunowii var. *grunowii*	+	3.6		2.8	5.3	
G. angustatum var. *producta*	+		+	3.3	+	2.2
G. gracile		+		3.9		
G. gracile var. *lanceolata*				+	2.4	
G. parvulum		2.2			4.3	+
Rhopalodia gibberula			3.0		3.8	
Nitzschia amphibia	+	16.4	+	3.3	+	
N. commuta			4.6			
N. fonticola var. *genuina*			8.7			
N. frustulum		7.3			+	
N. frustulum var. *perpusilla*		2.2				
N. gracilis		4.1				
N. Lorenziana var. *subtilis*					3.8	
N. obtusa		3.7	3.0		+	
N. palea		2.7	13.8	+	17.9	
N. tryblionella var. *levidensis*			3.5			
Number of taxa observed	20	42	37	11	51	12

Table 4. Principal diatom taxa and their relative frequencies in lotic environments

Taxon	Station 7	8	9
Melosira granulata		+	9.6
Synedra rumpens	2.6		
S. ulna	+	2.8	
Eunotia lunaris	4.0		3.2
Cocconeis placentula var. *lineata*	2.6		
Achnanthes linearis			16.1
Gyrosigma scalpoides			6.4
Navicula contenta var. *parallela*	8.0		
N. cryptocephala	4.0		
N. cryptocephala var. *veneta*			38.7
N. pupula	6.6	10.2	
Caloneis bacillum	2.6		
Pinnularia borealis			9.6
P. braunii var. *amphicephala*	5.3	2.8	
Amphora fontinalis	2.6	+	
Cymbella affinis	4.0	+	
Gomphonema grunowii var. *grunowii*	22.6	4.6	+
G. angustatum var. *producta*		15.8	
G. gracile	2.6		
G. tenerrimum	2.6		
G. longiceps var. *subclavata*	4.0		
Hantzschia amphioxys		8.4	
Nitzschia amphibia	8.0	6.5	+
N. palea	2.6	36.4	3.2
N. thermalis		4.6	
Stenopterbia arctica			6.4
Number of taxa observed	27	16	11

Discussion and Conclusion

Epilithic algae were collected at nine stations of inland water in Jakarta, Surabaya and Singapore. From these materials, diatoms of 23 genera and 109 taxa were identified in the present study.

Among these taxa, *Achnanathes crennlata* GRUN. (Fig. 2) occurred in the material from lotic station 8. HUSTEDT (1937–1939) described that it is widely distributed in tropical Asia and in Australia. Furthermore FOGED recorded it from Thailand (1971) and Srilanka (1976). From upper facts, it seems to be tropical species. However, as it has been often recorded from some rivers in Japan (WATANABE 1957), it may be quite all right to consider to be widespread forms in anywhere, not only in the tropics but also in the temperate zone.

Cymbella thienemanni HUST. (Fig. 6) was abunduntly found in the present material of station 4 where is lentic environment. HUSTEDT (1937–1939) cites the original publication for the species name from taxonomical investigation to materials collecting from waterfall in Java. The taxon resembles to *Cymbella ruttneri* HUST. in the valve shape, however, the present taxon can be distinguished from *Cymbella ruttneri* in that the last few striae toward ends become slightly convergent or parallel in the present taxon.

Gomphonema tenerrimum HUST. (Fig. 8) occurred in the present material of lotic station 7 was nomenculated by HUSTEDT (1937–1939). The striae of this taxon is strongly radiate and without isolated punctum. FOGED (1971) recorded it from Thailand.

From the relative frequencies of all taxa at each station, SHANNON's diversity index of the diatom community of each station was calculated by the following equation:

$$\bar{H} = -\Sigma (Ni/N) \log_e (Ni/N)$$

Table 5. SHANNON's diversity index of the epilithic diatom communities at each station

Station		Diversity index
Lentic environments	1	2.0
	2	3.0
	3	3.1
	4	1.4
	5	4.9
	6	1.3
Lotic environments	7	2.9
	8	2.2
	9	1.9

where $\bar{H}$ is the SHANNON's diversity index, N is the total number of individuals of diatom at each station, Ni is the number of individuals of the taxon i.

Table 5 indicates SHANNON's diversity index at each station. In the lentic environments, the numbers of taxon occurring in stations 1, 4 and 6 were small and few taxa were to be found very dominant, while at stations 2, 3 and 5, the numbers of taxon were comparatively large and dominancy of limited taxon was not so remarkable (Table 3). Accordingly, the SHANNON's diversity indexes were obviously small in the former stations (Table 5).

Cymbella affinis is clearly dominant in the lentic environments, showing the highest frequency at station 1 (32.0%), station 4 (55.3%) and station 6 (66.9%).

The diatom community of station 5 where the number of diatom taxon is the most abundant and the value of SHANNON's index is accordingly the largest among nine samples, is an example of the paddy field distributed widely in Java Inland.

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墨田延彰*・渡辺仁治**: ジャカルタ・スラバヤ・シンガポールにおける陸水の付着珪藻

1974年2月5日から15日の期間に，ジャカルタ，スラバヤ，シンガポールの止水域6地点，流水域3地点において採集した，9個の付着藻類のサンプル中から，23属109種の珪藻を同定した。それぞれの水域で，比較的相対頻度が大きく，各地点に共通して出現する taxa を代表種と考えて列挙すると，止水域では *Melosira granulata*, *Navicula cryptocephala* var. *veneta*, *Cymbella affinis*, *Nitzschia palea* を，流水域では，*Eunotia lunaris*, *Navicula pupula*, *Pinnularia braunii* var. *amphicephala*, *Gomphonema grunowii* var. *grunowii*, *Nitzschia amphibia*, *Nitzschia palea* を挙げることができる (Tables 3, 4)。また，109種の珪藻中，*Gomphonema tenerrimum* HUST., *Amphora fontinalis* HUST., *Achnanthes crenulata* GRUN., *Cymbella thienemanni* HUST., *Navicula* sp. (種名検討中) 以外の種は，ほとんど総て世界普遍種である。

SHANNON の式により，珪藻群集の多様性指数を各サンプルごとに求めて，その結果を Table 5 に示した。止水域の地点5における珪藻群集の多様性は，他と比べて著しく大きいが，これはジャバに広く分布する稲田の珪藻群集の一例として興味深い。

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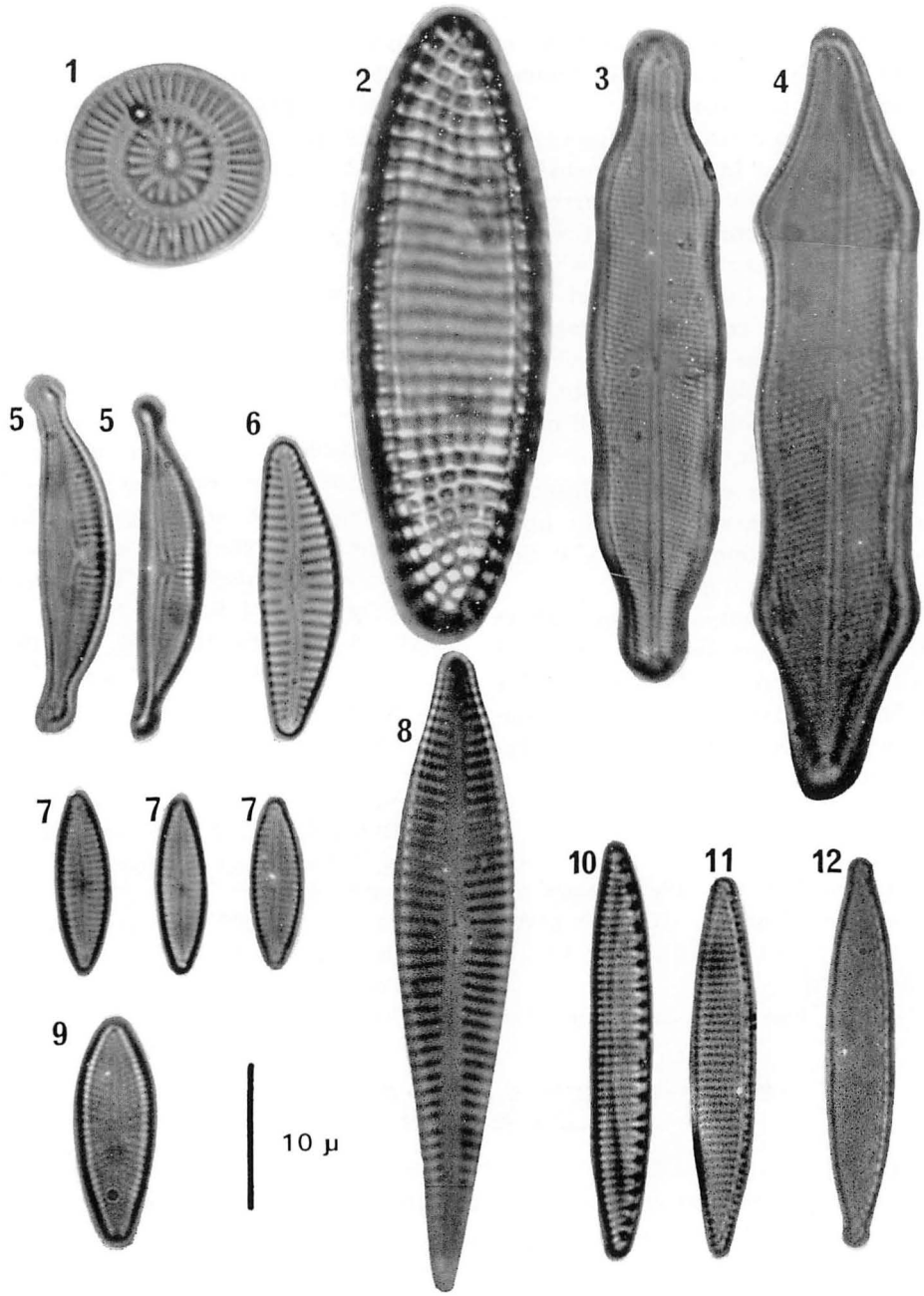

Fig. 1. *Cyclotella stelligera* CLEVE et GRUN. Fig. 2. *Achnanthes crenulata* GRUN. Fig. 3. *Neidium gracile* HUST. Fig. 4. *Neidium gracile* HUST. f. *aequalis* HUST. Fig. 5. *Amphora fontinalis* HUST. Fig. 6. *Cymbella affinis* KÜTZ. Fig. 7. *Cymbella thienemanni* HUST. Fig. 8. *Gomphonema grunowii* PATR. var. *grunowii* Fig. 9. *Gomphonema tenerrimum* HUST. Fig. 10. *Nitzschia amphibia* GRUN. α *genuina* MAYER. Fig. 11. *Nitzschia amphibia* GRUN. β *acutiuscula* GRUN. Fig. 12. *Nitzschia palea* (KÜTZ.) W. SMITH.