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The Diatom-Vegetation of the River Yoshino-gawa, Nara Prefecture *

By

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ABSTRACT From the River Yoshino-gawa, Nara Prefecture, the author has found 33 forms of diatom, one of which is described here as a new variety to science.

The River Yoshino-gawa in Nara Prefecture is the upper course of the River Kinokawa in Wakayama Prefecture. It rises in the eastern mountainous boundary of Nara Prefecture, where Mt. Ôdai-ga-hara (1695 m over the sea) is the highest summit, and runs down in deep gorges forming rapids and pools in quick succession, receiving several tributaries over a stretch of 25 km. Having run out into the middle portion of Nara Prefecture about 30 km south of Nara City, the river flows along the northern foot of the Yoshino Plateau, which is an attractive land noted for many historic sites and beautiful cherry-blossoms, and reaches to Gojô City, a main town in the western boundary of the prefecture.

From Gojô the river runs in its lower course of about 50 km length from east to west through the alluvial plains in the northern region of Wakayama Prefecture and empties into the sea at Wakayama.

The upper part of the River Yoshino-gawa is composed of augites, amphiboles, and phyllites, which belong to the so-called Mikabu Series of Paleozoic Era, and is sometimes accompanied by limestones.

Late in April of 1965 I have carried out a survey of the River Yoshino-gawa concerning its diatom-vegetation. On 28th April, it was fine and 15.0 to 23.0°C in atmospheric temperature, while on 29th April, it was rainy and somewhat colder (11.5 to 14.5°C). Throughout this survey, the temperature of river water was in the upper region (a tributary called the River Nakaoku) 9.8-12.6°C and in the lower region (the middle course of the main stream) 12.8 - 14.6°C. The reaction of river water was generally almost neutral (pH 7.4 - 7.5), but in some stations alkaline (pH 7.8, > 8.4), perhaps owing to the

* Contributions from the Otsu Hydrobiological Station, Kyoto University, No. 199.

outcrops of limestones.

At following stations were performed the survey of the river and the collection of algal samples (Table 1) :

Table 1. Some data on the survey-stations in the River Yoshino-gawa

	Height above the sea (about m)	Distance from Gojo City (about km)	algal sample No.
Station A. Kawakami Village, Seto-oku (the River Nakaoku)	700	48	1, 2
Station B. Kawakami Village, Seto-shimo (the River Nakaoku)	600	46	3, 4
Station C. Kawakami Village, Shirakawato (the confluence of the main stream with the Nakaoku)	400	41	5, 6, 7
Station D. Yoshino Town, Shimoyaji	200	21	14
Station E. Yoshino Town, Narai	190	18	13
Station F. Yoshino Town, Kamiichi Kawaraya	160	16	8
Station G. Yoshino Town, under an iron bridge of the Kintetsu Electric Cars	160	15	9
Station H. Ôyodo Town, Shimoichi-guchi	150	9	10
Station I. Ôyodo Town, Sanaden	120	7	11
Station J. Gojô City, Nohara- guchi	100	0	12

The volume of the sessile algae on stones or rocks was calculated per 100 cm² of the substrate as follows :

No. 1	8.0 cm ³	No. 13	3.2 cm ³
No. 2	1.0 "	No. 8	3.7 "
No. 3	4.8 "	No. 9	2.2 "

No. 5	10.3 "	No. 10	3.6 "
No. 7	6.9 "	No. 11	2.7 "
No. 14	0.5 "		

A great portion of the sessile algae was occupied by diatoms. Green alga *Ulothrix*, desmid *Cosmarium*, and several species of blue-green algae were also found there.

From samples were enumerated the following 33 forms of diatom, the majority of which belongs to Pennatae and only one species to Centricae :

Centricae

- 1) *Melosira varians* C. A. Agardh

Pennatae

Araphidineae

Fragilariaceae

- 2) *Diatoma hiemale* (Lyngb.) Heiberg
 3) *Diatoma hiemale* var. *mesodon* (Ehr.) Grunow
 4) *Ceratoneis recta* (Skv.) Iwahashi
 5) *Fragilaria Vaucheriae* (Kütz.) Peter.
 var. *capitellata* (Grun.) Patrick
 6) *Synedra ulna* (Nitzsch) Ehrenberg
 7) *Synedra ulna* var. *Ramesi* (Héríb. et Perag.) Hustedt

Monoraphidineae

Achnanthaceae

- 8) *Cocconeis placentula* Ehr. var. *lineata* (Ehr.) Cleve
 9) *Achnanthes linealis* W. Smith
 10) *Rhoicosphenia curvata* (Kütz.) Grunow

Biraphidineae

Naviculaceae

- 11) *Navicula cryptocephala* Kützing
 12) *Navicula salinarum* Grun. var. *intermedia* (Grun.) Cleve
 13) *Navicula cari* Ehrenberg
 14) *Navicula viridula* (Kütz.) Kütz. var. *rostellata* Kützing
 15) *Cymbella prostata* (Berkeley) Cleve
 16) *Cymbella ventricosa* Kützing
 17) *Cymbella turgidula* Grun. var. *nipponica* Skvortzow
 18) *Cymbella excisa* (Kütz.) De Toni
 19) *Cymbella sinuata* Gregory var. *reniformis* var. nov.
 20) *Gomphonema Clevei* Fricke
 21) *Gomphonema olivaceum* (Lyngb.) Kützing
 22) *Gomphonema quadripunctatum* (Östr.) Wisl.
 var. *hasta* Wislouch
 23) *Gomphonema acuminatum* Ehr. var. *coronata* (Ehr.) w. Smith
 24) *Gomphonema intricatum* Kütz. var. *pumila* Grunow

Nitzschiaceae

- 25) *Nitzschia linealis* W. Smith
 26) *Nitzschia tabellaria* Grunow
 27) *Nitzschia frustulum* Kütz. Grun. var. *subsalina* Hustedt
 28) *Nitzschia fonticola* Grunow
 29) *Nitzschia palea* (Kütz.) W. Smith
 30) *Nitzschia acicularis* W. Smith

Surirellaceae

- 31) *Cymatopleura solea* (Bréb.) W. Smith
 32) *Surirella angustata* Kützing
 33) *Surirella biseriata* Bréb. var. *bifrons* (Ehr.) Hustedt

The distribution of these diatoms from the upper course to the middle course of the river is shown in the following table (Table 2) related to the presence or absence of each form in each station:

Table 2. The distribution of diatoms in the River Yoshino-gawa

	Station Sample	A	A	B	B	C	C	D	E	F	G	H	I	J
		(1)	(2)	(3)	(4)	(5)	(7)	(14)	(13)	(8)	(9)	(10)	(11)	(12)
1) <i>Melosira varians</i>		-	-	-	-	+	+	+	+	+	+	+	+	+
2) <i>Diatoma hiemale</i>		-	-	+	-	-	-	+	+	+	+	+	+	+
3) <i>Diatoma hiemale</i> var. <i>mesodon</i>		+	+	+	+	+	+	+	+	+	+	+	+	-
4) <i>Ceratoneis recta</i>		-	-	+	+	+	+	+	+	+	+	+	+	+
5) <i>Fragilaria Vaucheriae</i> var. <i>capitellata</i>		-	-	-	-	-	-	+	-	+	-	-	+	-
6) <i>Synedra ulna</i>		-	-	+	-	+	-	-	+	+	+	-	-	-
7) <i>Synedra ulna</i> var. <i>Ramesi</i>		-	-	+	+	+	+	+	+	+	+	+	+	+
8) <i>Cocconeis placentula</i> var. <i>lineata</i>		+	+	-	+	-	-	-	+	-	-	-	+	+
9) <i>Achnanthes linealis</i>		+	+	+	+	+	+	+	+	+	+	+	+	+
10) <i>Rhoicosphenia curvata</i>		-	-	-	-	-	-	+	-	-	+	-	-	+
11) <i>Navicula cryptocephala</i>		-	-	-	-	-	-	+	-	-	-	-	-	-
12) <i>Navicula salinarum</i> var. <i>intermedia</i>		-	-	-	-	-	-	-	-	-	-	-	+	-
13) <i>Navicula cari</i>		-	-	-	-	-	-	-	+	-	+	+	+	+
14) <i>Navicula viridula</i> var. <i>rostellata</i>		-	-	-	-	-	-	-	-	-	+	+	+	+
15) <i>Cymbella prostata</i>		-	-	-	-	-	-	-	+	-	+	-	-	+
16) <i>Cymbella ventricosa</i>		+	+	+	+	+	+	+	+	+	+	+	+	+
17) <i>Cymbella turgidula</i> var. <i>nipponica</i>		+	+	+	+	+	+	+	+	+	+	+	+	+
18) <i>Cymbella excisa</i>		-	-	-	-	-	-	-	+	-	-	-	+	-

19) <i>Cymbella sinuata</i>	
var. <i>reniformis</i>	- - - - - + + - - - - +
20) <i>Gomphonema Clevei</i>	+ + - - - - - - - - - -
21) <i>Gomphonema olivaceum</i>	+ + + + + + + + + + + +
22) <i>Gomphonema quadripunctatum</i>	
var. <i>hasta</i>	+ + - - - - + - - + - + +
23) <i>Gomphonema acuminatum</i>	
var. <i>coronata</i>	- - - - - - - - - + - - -
24) <i>Gomphonema intricatum</i>	
var. <i>pumila</i>	- - - - - + + - - - - -
25) <i>Nitzschia linealis</i>	- - - - - + + + + + + +
26) <i>Nitzschia tabellaria</i>	- - - - - - - - - - + -
27) <i>Nitzschia frustulum</i>	
var. <i>subsalina</i>	- - - - - + + - - - - +
28) <i>Nitzschia fonticola</i>	+ - + - - - - - - - - -
29) <i>Nitzschia palea</i>	- - - - + - + + + + + +
30) <i>Nitzschia acicularis</i>	- - - - - - - + + + + +
31) <i>Cymatopleura solea</i>	- - - - - - - + + - -
32) <i>Surirella angustata</i>	- - - - - - - - - + -
33) <i>Surirella biseriata</i>	
var. <i>bifrons</i>	- - - - - - - - - - +

From Table 2 the following facts are known:

- 1) The forms, which are found in all stations and show namely the widest distribution in the river, are *Achnanthes linealis*, *Cymbella ventricosa*, *Cymbella turgidula* var. *nipponica*, and *Gomphonema olivaceum*.
- 2) The forms, which are found not in all, but in the most stations, and also distribute widely, are *Diatoma hiemale* var. *mesodon*, *Ceratoneis recta*, and *Synedra ulna* var. *Ramesi*.
- 3) *Gomphonema Clevei* and *Nitzschia fonticola* are found only in the upper course of the river (the Nakaoku-gawa).
- 4) *Navicula viridula* var. *rostellata*, *Navicula cari*, *Nitzschia linealis*, *Nitzschia palea*, *Nitzschia acicularis* etc. do not distribute in the upper course of the river.
- 5) Forms found in the middle course of the river are generally more numerous than in the upper course.

The dominant form in each sample was as follows :

- | | | |
|-------|-------|--|
| No. 1 | | <i>Gomphonema olivaceum</i> |
| No. 2 | | <i>Gomphonema Clevei</i> |
| No. 3 | | <i>Diatoma hiemale</i> var. <i>mesodon</i> |
| No. 4 | | <i>Diatoma hiemale</i> var. <i>mesodon</i> |
| No. 5 | | <i>Synedra ulna</i> var. <i>Ramesi</i> |
| No. 7 | | <i>Synedra ulna</i> var. <i>Ramesi</i> |
| No. 8 | | <i>Achnanthes linealis</i> |

- No. 9 *Cymbella ventricosa*
 No. 10 *Achnanthes linealis*
 No. 11 *Nitzschia aciculare*

Notes on some forms

***Ceratoneis recta* (Skv.) Iwahashi**

(Pl. I, figs. 1-3)

Y. Iwahashi (1936), Studies on Fresh-water Diatoms of Western Japan, I. Jour. Jap. Bot., Vol. 12, p. 391, fig. 1, a-c.

Length 38-61 μ , breadth 5.5-6.5 μ at the widest, middle portion, striae 13-14 in 10 μ . (Data on the form from the River Yoshino).

This taxon is closely related to *Ceratoneis arcus* Kütz. var. *Hattoriana* Meister (Fr. Meister, Beiträge zur Bacillariaceenflora Japans, II. Arch. f. Hydrobiol., Bd. 9, 1914, S. 226-227, Taf. 8, Fig. 1-3). B. W. Skvortzow (1936) has described this form from Kizaki Lake under the name of *Ceratoneis arcus* var. *Hattoriana* (Diatoms from Kizaki Lake. Philip. Jour. Sci., Vol. 61, p. 15, Pl. 1, fig. 38).

***Fragilaria Vaucheriae* (Kütz.) Petersen**

var. *capitellata* (Grun.) Patrick

(Pl. I, figs. 9, 10)

R. Patrick and Ch. W. Reimer (1966), The Diatoms of the United States, Vol. I, p. 121, Pl. 3, fig. 16.

Synonyms : *Synedra capitellata* Grun. H. van Heurck (1880-1881), Synopsis des Diatomées de Belgique. Atlas, Pl. 40, fig. 26 ; *Synedra Vaucheriae* Kütz. var. *capitellata* Grun. Fr. Hustedt (1930). Bacillariophyta (Diatomeae). Pascher's Süßwasser -Flora Mitteleuropas. Heft 10, Aufl. 2, S. 161, Fig. 194.

Length 17-23 μ , breadth 3.5-5 μ at the widest, middle portion, striae 16-18 in 10 μ . (Data on the form from the River Yoshino).

***Synedra ulna* (Nitzsch) Ehr.**

var. *Ramesi* (Hérib. et Perag.) Hustedt

(Pl. I, figs. 4-6)

Hustedt (1930), Bacil. Pascher's Süßw.-Fl. Mitteleuropas, Heft 10, Aufl. 2, S. 152, Fig. 163 ; Skvortzow (1936), Diatoms from Biwa Lake. Philip. Jour. Sci., Vol. 61, p. 258, Pl. 6, fig. 14 ; Patrick and Reimer (1966), Diat. United States, Vol. I, p. 153, Pl. 6, fig. 9.

Synonyms : *Synedra ulna* var. *contracta* Östrup. Patrick and Reimer (1966), Diat. United States, Vol. I, p. 150, Pl. 7, fig. 3 ; *Synedra Goulardi* Brébisson. P. T. Cleve und A. Grunow (1880), Beiträge zur Kenntnis der arctischen Diatomeen. Kongl. Svenska Vetenskapa-Akademiens Handlingar, Bd. 17, No. 2, S. 107, Taf. 6, Fig. 119 ; Ch. S. Boyer (1916), The Diatomaceae of Philadelphia and Vicinity, p. 48, Pl. 11, figs. 12 and 13 ; H. Kobayashi (1960), Diatoms in Nagatoro Park, Bull. Chichibu Mus. Nat. Hist., No. 10, p. 69, Pl. 1, figs. 2 and 3 ; Patrick and Reimer (1966), Diat. United States,

Vol. I, pp. 154-155, Pl. 6, fig. 8.

Synedra ulna var. *contracta* is longer than *Synedra ulna* var. *Ramesi*. *Synedra Goulardi* is distinguished from *Synedra ulna* var. *Ramesi* only by the presence of faint striae through out the central area.

Length 45-60 μ , breadth 7-9 μ , striae 11-12 in 10 μ . (Data on the form from the River Yoshino).

Navicula salinarum Grun.

var. intermedia (Grun.) Cleve

(Pl. I, fig. 11)

Patrick and Reimer (1966), Diat. United States, Vol. I, p. 503, Pl. 48, fig. 2.

Synonym : *Navicula cryptocephala* Kütz. var. *intermedia* Grun. Van Heurck (1880), Synops. Diat. Belg., Pl. 8, fig. 10.

Length 33-36 μ , breadth 8-9 μ , striae 14-16 in 10 μ . (Data on the form from the River Yoshino).

Navicula viridula (Kütz.) Kütz.

var. rostellata (Kütz.) Cleve

(Pl. I, fig. 12)

Hustedt (1927), Bacillariales aus dem Aokikosee in Japan. Arch. f. Hydrobiol., Bd. 18, S. 164 ; Patrick and Reimer (1966), Diat. United States, Vol. I, pp. 507-508, Pl. 48, fig. 12 ; H. Kobayasi (1968), A Survey of the Fresh Water Diatoms in the Vicinity of Tokyo. Jap. Jour. Bot., Vol. 20, p. 110, Pl. 5, fig. 65.

Length 42-45 μ , breadth 9-10 μ , striae 9-10 in 10 μ . (Data on the form from the River Yoshino).

Cymbella turgidula Grun.

var. nipponica Skvortzow

(Pl. I, figs. 24, 25)

Skvortzow (1936), Diat. Biwa Lake. Philip. Jour. Sci., Vol. 61, p. 283, Pl. 2, fig. 8, Pl. 4, fig. 4.

Length 32-35 μ , breadth 9.5-10.5 μ , striae 12-13 in 10 μ . (Data on the form from the River Yoshino).

Cymbella excisa (Kütz.) De Toni

(Pl. I, figs. 22, 23)

A. Schmidt (1887), Atlas der Diat., Taf. 71, Fig. 35 u. 36 ; Boyer (1916), Diat. Philadelphia, p. 61, pl. 18, fig. 19.

The valve has a tumid and excised ventral margin. Length 30-35 μ , 9-10 μ , striae 11-13 in 10 μ . (Data on the form from the River Yoshino).

Cymbella sinuata Gregory

var. reniformis var. nov.

(Pl. I, figs. 13-15)

Valvis reniformibus, 12-16 μ longis, 3-4 μ latis, striis 11-13 in 10 μ .

Var. *reniformis* differs from the type by its kidney-shaped valve. Moreover it is smaller than the type and has dense striae.

Length 12-16 μ , breadth 3-4 μ , striae 11-13 in 10 μ . (Data on the form from the River Yoshino).

Ceratoneis reniformis Iwahashi, (Y. Iwahashi, Studies on Fresh-water Diatoms of Western Japan, I. Jour. Jap. Bot., Vol. 12, 1936, pp. 392-393, fig. 1, g-h) is probably identical with this new variety of *Cymbella sinuata* Greg.

Gomphonema Clevei Fricke

(Pl. I, figs. 17, 18)

A. Schmidt, Atlas d. Diat., Taf. 234, Fig. 44-46 ; Fr. Hustedt (1938), Untersuchungen über die Diatomeen-Flora von Java, Bali und Sumatra. Arch. f. Hydrobiol., Suppl.-Bd. 15, S. 441-442, Taf. 27, Fig. 15-18.

H. Okuno (1952) has figured this form as *Gomph. brasiliense* Grun. (Atlas of Fossil Diatoms from Japanese Diatomite Deposits, Pl. 28, figs. 10 and 13), but H. van Heurck' figure of *Gomph. brasiliense* Grun. (Syn. Diat. Belg., Atlas, Pl. 25, fig. 17) differs considerably from Okuno's one and has dense striae.

Length 35-40 μ , breadth 5-6 μ , striae 10-11 in 10 μ . (Data on the form from the River Yoshino).

Gomphonema olivaceum (Lyngb.) Kützing

(Pl. I, figs. 19-21)

A. Cleve-Euler (1955), Die Diatomeen von Schweden und Finnland, Teil IV, S. 191-192, Fig. 1291, f.

Valve ovale, with broad rounded apex. Margins at basal portion sometimes slightly concave.

Length 14-26 μ , breadth 6.5-9 μ , striae 15-17 in 10 μ . (Data on the form from the River Yoshino).

Gomphonema quadripunctatum (Östr.) Wisl.

var. hasta Wislouch

(Pl. I, figs. 7, 8)

S. M. Wislouch (1924), Beiträge zur Diatomeenflora von Asien, II. Ber. d. Deut. Bot. Ges., Bd. 42, S. 166-167, Fig. a-c ; Skvortzow (1936), Diat. Kizaki Lake. Philip. Jour. Sci., Vol. 61, p. 52, Pl. 10, fig. 31 ; Cleve-Euler (1955), Diat. Schweden u. Finnland, Teil IV, S. 191, Fig. 1290, b-d.

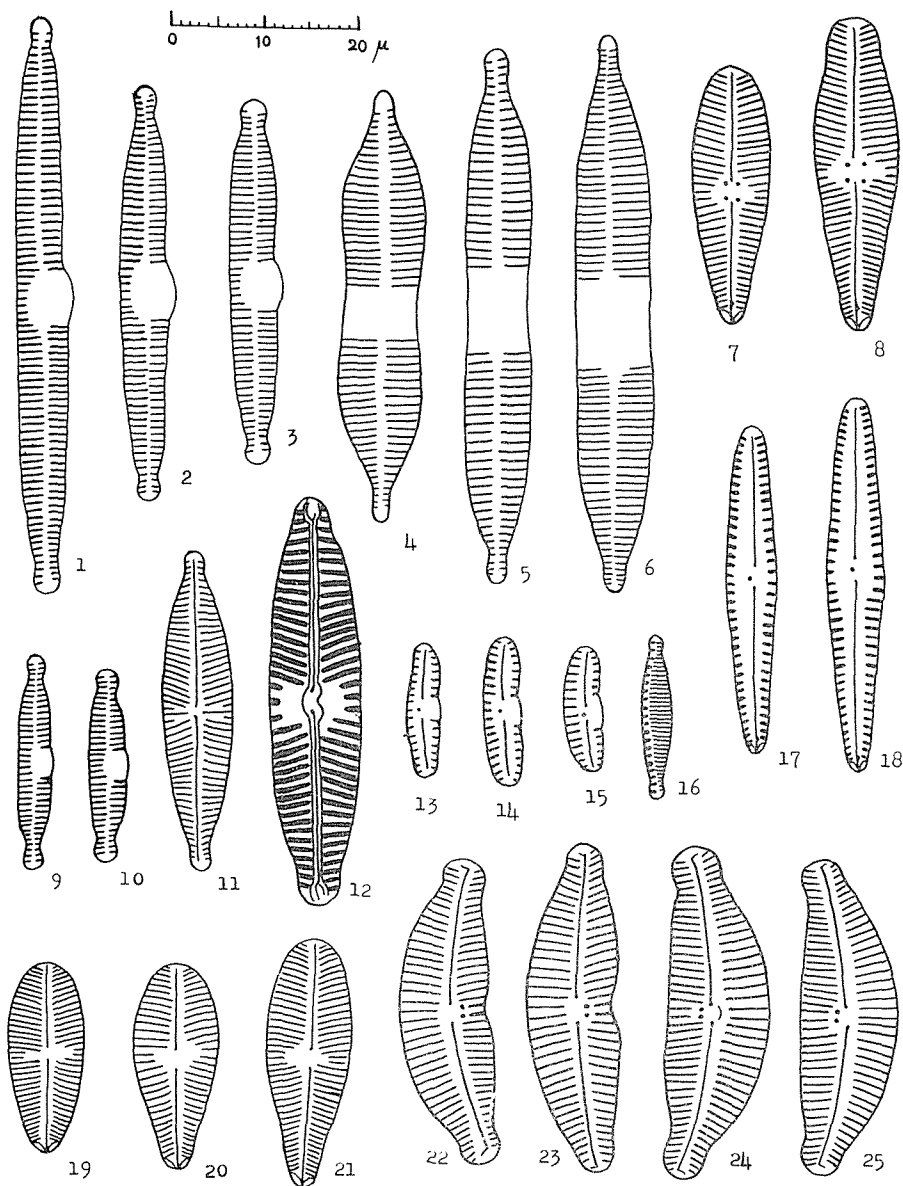
Length 20-23 μ , breadth 8-9 μ , striae 14-15 in 10 μ . (Data on the form from the River Yoshino).

Nitzschia fonticola Grunow

(Pl. I, fig. 16)

Hustedt (1930), Bacil. Pascher's Süßw.-Fl. Mitteleuropas, Heft 10, Aufl. 2, S. 415, Fig. 800 ; Cleve-Euler (1952), Diat. Schweden u. Finnland, Teil V,

Plate I



S. 88-89, Fig. 1500.

Length 17-18 μ , breadth 3-4 μ , keel puncta 12-13 in 10 μ , striae 28-30 in 10 μ .
(Data on the form from the River Yoshino).

Explanation of Plate I

- | | |
|------------------|--|
| 1, 2, 3. | <i>Ceratoneis recta</i> (Skv.) Iwahashi |
| 4, 5, 6. | <i>Synedra ulna</i> (Nitzsch) Ehr.
var. <i>Ramesi</i> (Hérib. et Perag.) Hustedt |
| 7, 8. | <i>Gomphonema quadripunctatum</i> (Östr.) Wisl.
var. <i>hasta</i> Wislouch |
| 9, 10. | <i>Fragilaria Vaucheriae</i> (Kütz.) Peter.
var. <i>capitellata</i> (Grun.) Patrick |
| 11. | <i>Navicula salinarum</i> Grun.
var. <i>intermedia</i> (Grun.) Cleve |
| 12. | <i>Navicula viridula</i> (Kütz.) Kütz.
var. <i>rostellata</i> (Kütz.) Cleve |
| 13, 14, 15. | <i>Cymbella sinuata</i> Gregory
var. <i>reniformis</i> var. nov. |
| 16. | <i>Nitzschia fonticola</i> Grunow |
| 17, 18. | <i>Gomphonema Clevei</i> Fricke |
| 19, 20, 21. | <i>Gomphonema olivaceum</i> (Lyngb.) Kützing |
| 22, 23. | <i>Cymbella excisa</i> (Kütz.) De Toni |
| 24, 25. | <i>Cymbella turgidula</i> Grun.
var. <i>nipponica</i> Skvortzow |