

A CONTRIBUTION TO OUR KNOWLEDGE OF THE FRESH-WATER DIATOMS OF PARTABGARH, RAJASTHAN

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INTRODUCTION

WHILE going through introductions given by Venkataraman (1939), Subrahmanyan (1946), Gonzalves and Gandhi (1952) and Krishnamurthy (1954) who have surveyed the available information on the Indian Diatomaceæ, it becomes evident that nowhere any record of Diatoms of Rajasthan and particularly of that of Partabgarh exists. The author, therefore, got interested to undertake the work.

LOCATION OF PARTABGARH

Partabgarh—once a Native State, better known as Deolia-Partabgarh, is situated on the extreme South of Rajputana (now Rajasthan), lies between 23° 32' and 24° 18' North and 74° 29' and 75° East and has an area of 886 square miles. It is bounded on the North and North-West by Udaipur*; on the West and South-West by Banswara*; on South by Ratlam† and on East by Jaora,† Scindhia's districts of Mandsaur† and Neemuch and a detached portion of the Rampura-Bhanpura districts of Indore.† Leaving the North-West part which is rocky and wild, the whole area is a fine open land.

GEOLOGY

A large proportion of Partabgarh is covered with the Deccan Trap, the denudation of which has exposed underlying area of older rocks belonging to the System, such as shales, quartzites, limestones, etc.

CLIMATE AND RAINFALL

The climate is generally good and the temperature moderate. The average annual rainfall as recorded at the capital (Partabgarh) is a little over 34 inches. The highest record of 63 inches in 1893 and the lowest of 11 inches was registered in 1899.

A BIT OF HISTORY

The town Partabgarh is situated in 24° 2' North and 74° 47' East, twenty miles by a metalled road west of Mandsaur Station on the Western-Railway. This town was founded by and named after Maharawat Pratapsingh in 1698, has 1,660 feet elevation above the sea-level, in a hollow formerly known as "Deolia-ka-khera". It is defended by a fortification all around, built by Salimsingh in about 1758.

* All these places now make Rajasthan Union

† All these States and places are embodied into Madhya Bharat Union

PLACE OF COLLECTION

Very close to the fortification stated above, rain-water streams flow all around and meet into a rivulet Jakam which pours into the Som tributary of the Mahi River. These rain-fed streams continue their flow till the end of November when the rainfall is well distributed, otherwise they dry up entirely by the end of October except for some bigger pools and ditches. The author, during his 1949-52 Diwali vacations had collected the present material from several such bodies of water of the drying streams. The water of these pools and ditches is generally polluted and non-potable

The present investigation was carried out in the Biology Departments of the Ismail Yusuf College, Jogeswari, Bombay and the Rajaram College, Kolhapur. The interesting feature of the material noted is the preponderance of *Surirella ovata* Kütz., with some degree of variation in its outline. Of other more important forms, mention must be made of *Navicula krasskei* Hust., *N. fluens* Hust., *Caloneis clevei* (Lagst.) Cl., *C. bacillum* (Grun.) Meresch., *Cymbella aspera* (Ehr.) Cleve, *Nitzschia frustulum* Kütz. and *N. amphibia* Grun., whereas others included in this paper may be regarded as just present or rare forms. A few frustules of *Caloneis permagna* (Bailey) Cleve present in the material were found to be most beautiful specimens

All the drawings were made from the slides prepared in canada balsam with the help of camera-lucida.

The classification adopted here is that of Hustedt (1930). All those references which have been actually consulted are given under the several forms.

The locality marked (!) thus, is the one from where the author has collected the material

BACILLARIOPHYTA (DIATOMEÆ)

A. Order	CENTRALES
I. Sub-order	DISCINEÆ
1. Family	COSCINODISCACEÆ
(a) Sub-family	COSCINODISCOIDEÆ
Genus	<i>Cyclotella</i> Kütz. 1834

1. *Cyclotella meneghiniana* Kütz.

(Fig 1)

Van Heurck, *Treatise on the Diatomaceæ* (Trans. by Baxter), 1896, p. 447, pl 22, fig. 656; Schönfeldt, H., Pascher's *Süßwasser-Flora*, Heft 10, 1913, p 19, fig. 17; Hustedt, F., Pascher's *Süßwasser-Flora*, Heft 10, 1930, p 100, fig. 67; Venkataraman, G., A Systematic Account of Some South Indian Diatoms, *Proc. Indian Acad Sci.*, Vol. 10, No. 6, Sect. B, 1939, p 299, figs. 11, 14; Iyengar and Subrahmanyam, Fossil diatoms from Karewa Beds of Kashmir, *Proc. nat. Acad Sci.*,

Vol. 13, Pt. 4, 1943, p. 226, figs 1-2; Gonzalves and Gandhi, A Systematic Account of Diatoms of Bombay and Salsette—I, *J. Indian bot Soc.*, Vol. 31, No 3, 1952, p. 120, fig. 6; Tiffany and Britton, *Algae of Illinois*, 1952, p. 218, pl. 58, fig. 660; Cleve-Euler, A., Die Diatomeen von Schweden und Finnland—I, *Kungl. Svenska Vetensk. Handl.*, Bd. 2, No. 1, 1951, p. 48, figs. 63 a-c (*C. meneghiniana* v. *genuina*).

Frustules rectangular in girdle view with undulate walls. Valves discoid with strong margin. Central field large and apparently smooth. Striæ thick, radial and becoming narrow towards the centre. Common.

Dimensions . . . Diameter of cells 16-26 μ
Striæ 9-11 in 10 μ

Distribution . . . India—Madras (Venkataraman, 1939), Kashmir (Iyengar & Subrahmanyam, 1943), Bombay (Gonzalves & Gandhi, 1952), Partabgarh (!) and Dharwar (!). Fresh-water and Brackish water.

2. *Cyclotella catenata* Brun.

(Fig. 2)

Hustedt, F., *op. cit.*, 1930, p. 108, fig. 83 b; Gonzalves and Gandhi, *op. cit.*, 1952, p. 122, fig. 9; Cleve-Euler, A., *op. cit.*, 1951, p. 47, fig. 58.

Frustules formed in chains, walls convex in the girdle view. Valves small discoid with thick margin. Central field marked with coarsely punctate, radial, long and short alternating striæ. Marginal striæ thick, radial and wedge-shaped. Rare.

Dimensions . . . Diameter of cells 18-22 μ
Striæ 10-11 in 10 μ
Punctæ of the middle striæ 11-13 in 10 μ

Distribution . . . India—Bombay (Gonzalves and Gandhi, 1952), and Partabgarh (!). Fresh-water.

B. Order . . . PENNALES

I. Sub-order . . . ARAPHIDINEÆ

1 Family . . . FRAGILARIACEÆ

(a) Sub-family . . . FRAGILARIOIDEÆ

Genus . . . *Synedra* Ehrenberg, C. G. 1830

3. *Synedra nula* (Nitz.) Ehr.

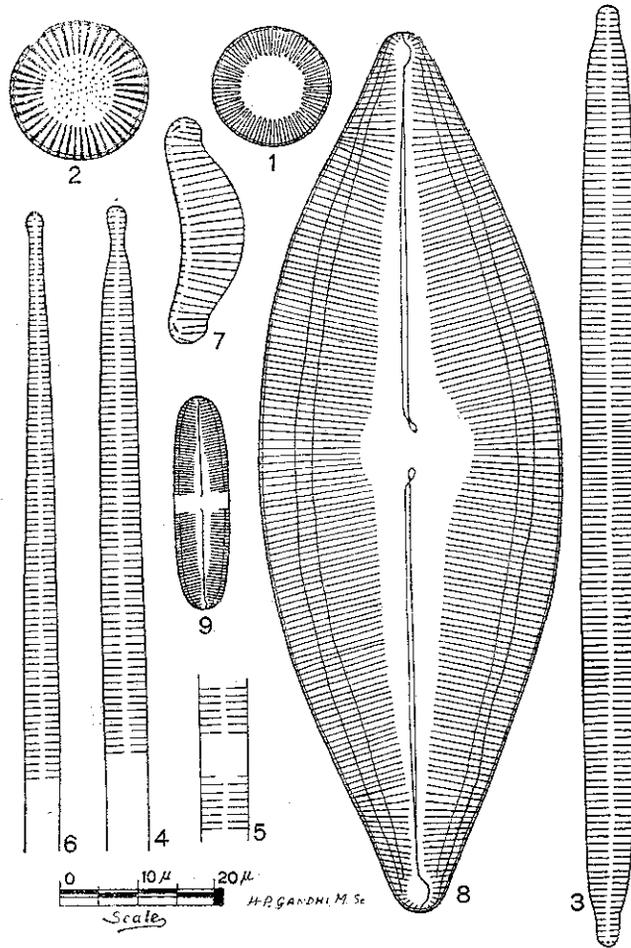
(Fig. 3)

Van Heurck, *op. cit.*, 1896, p. 310, pl. 10, fig. 409; Schönfeldt, H., *op. cit.*, 1913, p. 39, fig. 60; Hustedt, F., *op. cit.*, 1930, p. 151, fig. 159 b; Venkataraman, G., *op. cit.*, 1939, p. 305, figs 37, 39, 43; Tiffany and Britton, *op. cit.*, 1952, p. 237, pl. 63, fig. 713; Gonzalves and Gandhi, *op. cit.*, 1952, p. 126, fig. 15.

Frustules large, in the girdle view linear with widened truncate ends. Valves linear to linear-lanceolate with constricted, produced and broadly rounded ends. Pseudoraphe narrow, linear. Central area absent. Striæ strong Common.

*Dimensions*Length 117-145 μ Breadth 6.8-7.5 μ Striæ 10-11 in 10 μ *Distribution*

India—Calcutta (Ehrenberg, 1840), Assam (Biswas, 1936), Burma (West & West, 1907),



FIGS. 1-9.—Fig. 1. *Cyclotella meneghiniana* Kütz. Fig. 2. *Cyclotella catenata* Brun. Fig. 3. *Synedra ulna* (Nitz.) Ehr. Fig. 4. *Synedra ulna* (Nitz.) Ehr. var. *danica* (Kütz) Grun. Fig. 5. *Synedra ulna* v. *amphihynchus*—central portion showing the central area. Fig. 6. *Synedra ulna* (Nitz.) Ehr. var. *danica* (Kütz) Grun. Fig. 7. *Eunotia praeurupta* Ehr. var. *inflata* Grun. Fig. 8. *Caloneis permagna* (Bailey) Cleve. Fig. 9. *Caloneis bacillum* (Grun) Mereschkowsky.

Madras (Venkataraman, 1939), Partabgarh and Kolhapur (!)

4. *Synedra ulna* (Nitz.) Ehr. var. *amphirhynchus* (Ehr.) Grun.

(Figs. 4-5)

Van Heurck, *op. cit.*, 1896, p. 311, pl. 10, fig. 414; Schönfeldt, H., *op. cit.*, 1913, p. 39; Hustedt, F., *op. cit.*, 1930, p. 154, fig. 167; Venkataraman, G., *op. cit.*, 1939, p. 308, figs. 28, 30-32; Gonzalves and Gandhi, *op. cit.*, 1952, p. 128, fig. 19.

Frustules very elongated, in the girdle view linear with widened ends. Valves linear-lanceolate with abruptly constricted, large capitate ends. Pseudoraphe narrow, linear. Central area moderate, reaching the sides. Striæ strong. Not common.

Dimensions Length 237-250 μ
 Breadth 4-6 μ
 Striæ 8-11 in 10 μ

Distribution India—Panjab (A. Majeed, 1935), Madras (Venkataraman, 1939), Bombay (Gonzalves and Gandhi, 1952), Partabgarh and Kolhapur (!). Fresh-water.

5. *Synedra ulna* (Nitz.) Ehr. var. *danica* (Kütz.) Grun.

(Fig. 6)

Van Heurck, *op. cit.*, 1896, p. 311, pl. 10, fig. 415; Schönfeldt, H., *op. cit.*, 1913, p. 39; Hustedt, F., *op. cit.*, 1930, p. 154, fig. 168; Tiffany and Britton, *op. cit.*, 1952, p. 237, pl. 63, fig. 715; Gonzalves and Gandhi, *op. cit.*, 1952, p. 127, fig. 17.

Valves elongated and slender, narrowly lanceolate with slightly capitate ends. Pseudoraphe narrow, linear. Central area present reaching the sides. Striæ delicate but distinct. Not common.

Dimensions Length 237-280 μ
 Breadth 5-5.6 μ
 Striæ 10-12 in 10 μ

Distribution India—Bombay (Gonzalves and Gandhi, 1952), Partabgarh and Dharwar (!). Fresh-water.

II. Sub-order RAPHDINEÆ

I. Family EUNOTIACEÆ

(a) Sub-family EUNOTIOIDEÆ

Genus *Eunotia* Ehrenberg, C. G. 1837

6. *Eunotia prærupta* Ehr. var. *inflata* Grun

(Fig. 7)

Van Heurck, *op. cit.*, 1896, p. 302, pl. 9, fig. 378; Hustedt, F., *op. cit.*, 1930, p. 174, fig. 212; Gonzalves and Gandhi, *op. cit.*, 1952, p. 130, fig. 25.

Frustules small and robust. Valves with highly convex dorsal and slightly concave ventral-side, ends dorsally constricted and somewhat capitate. Polar nodules clearly seen. Striæ more or less irregularly placed, coarse, interrupted by a thin but clear space (line) near the ventral side. Rather rare.

Dimensions Length 29–33 μ
 Breadth 8–8.4 μ
 Striæ 8–11 in 10 μ

Distribution India—Bombay (Gonzalves and Gandhi, 1952),
 Partabgarh (!). Fresh-water.

The present form agrees well with the type described by Hustedt except that ends in this form are not distinctly truncate-capitate.

III. Sub-order BIRAPHIDIOIDINEÆ
 1. Family NAVICULACEÆ
 (a) Sub-family NAVICULOIDEÆ
 Genus *Caloneis* Cleve 1894

7. *Caloneis permagna* (Bailey) Cleve

Schönfeldt, H., *op. cit.*, 1913, p. 71, fig. 129; Hustedt, F., *op. cit.*, 1930, p. 231, fig. 349.

Navicula permagna Bailey, Van Heurck, *op. cit.*, 1896, p. 218, p. 5, fig. 202.

Frustules solitary, large and robust. Valves rhombic-lanceolate with somewhat produced, broadly rounded ends. Raphe thick and straight, central pores large, unilaterally bent; terminal fissures broadly curved and clear. Axial area moderately lanceolate; central area large, circular and somewhat unilateral. Striæ radial in the middle and convergent at the ends, crossed by two fine longitudinal lines near the margins. Rare.

Dimensions Length 105–150 μ
 Breadth 35.6–47 μ
 Striæ 11–13 in 10 μ

Distribution India—Partabgarh (!). Fresh-water

This form agrees well with the type described and figured by Hustedt and others. It is a very beautiful form.

8. *Caloneis pulchra* Messikommer forma *partabgarhensis* f. nov.

Frustula luteis-brunis pigmentis ornata, rectangularia in aspectu zonali. Valvæ lineari-lanceolatae, distincte in medio gibbosæ, gradatim ad apices late rotundatos tenuiores. Raphe tenuis et recta, poris centralibus distinctis et fissuris terminalibus paululum curvatis. Area axialis lineari-lanceolata; area centralis ampla et rotundata. Striæ subtiles, paululum radiales in medio sed perpendiculares ad mediam

lineam ad apices versus tenui longitudinali linea ad marginem decussatæ. Frustula 48·7–52 μ longa; 10–10·6 μ lata; striæ 18–22 in 10 μ

Frustules with yellow-brown chromatophores, rectangular in the girdle view. Valves linear-lanceolate, prominently gibbous in the middle, gradually narrowing to broad rounded ends. Raphe thin and straight with distinct central pores and slightly curved terminal fissures. Axial area linear-lanceolate; central area large and rounded. Striæ fine, slightly radial in the middle, perpendicular to the middle line towards the ends, crossed by a fine longitudinal line near the margins. Not common.

Dimensions Length 48·7–52 μ
 Breadth 10–10·6 μ
 Striæ 18–22 in 10 μ

Distribution India—Partabgarh (!). Fresh-water.

This form resembles closely *Caloneis pulchra* Messikommer as described by Hustedt (Hustedt, *op. cit.*, 1930, p. 235, fig. 357), except that it is proportionately a larger and much broader form with a prominent gibbosity in the middle. Moreover, it differs in the outline which is somewhat linear-lanceolate and the roundish central area. It is, therefore, regarded as a new form.

9. *Caloneis clevei* (Lagerstedt) Cleve

(Fig. 11)

Hustedt, F., *op. cit.*, 1930, p. 236, fig. 359.

Valves linear-lanceolate with convex sides and slightly constricted, broadly capitate rounded ends. Raphe thin and straight with unilaterally bent central pores and large, slightly curved terminal fissures. Axial area large, linear-lanceolate; central area large, reaching the sides. Striæ radial in the middle and convergent at the ends, crossed by a fine but distinct longitudinal line close to the margins. Common.

Dimensions Length 46·5–54 μ
 Breadth 9·4–10 μ
 Striæ 19–21 in 10 μ

Distribution India—Partabgarh (!). Fresh-water.

This form also resembles *Caloneis hultenii* Petersen (Petersen, J. B., *Det. Kgl. Danske Vidensk. Selskab Biol. Meddel.*, Bd XX, Nr. 1, 1946, p. 75, fig. 8) in the outline, but differs from it in dimensions, striæ and other details.

10. *Caloneis bacillum* (Grun.) Mereschkowsky

(Fig. 9)

Hustedt, F., *op. cit.*, 1930, p. 236, fig. 360; Tiffany and Britton, *op. cit.*, 1952, p. 248, pl. 65, fig. 748; Krishnamurthy, V., A contribution to the Diatoms flora of S. India, *J. Indian bot. Soc.*, Vol. 33, No. 4, 1954, p. 362, fig. 25.

Valves linear to linear-lanceolate with broad rounded ends. Raphe thin and straight with slightly unilaterally bent central pores. Axial area moderate, linear-lanceolate; central area wide reaching the sides. Striæ slightly radial, becoming perpendicular to the middle line towards the ends, crossed by a fine longitudinal line near the margins. Common.

Dimensions Length 22-27 μ
Breadth 7-7.5 μ
Striæ 25-28 in 10 μ

Distribution India—Madras (Krishnamurthy, 1954) and Partabgarh (!). Fresh-water.

11 *Caloneis silicula* (Ehr.) Cleve

(Fig. 35)

Schönfeldt, H., *op. cit.*, 1913, p. 72, fig. 132; Hustedt, F., *op. cit.*, 1930, p. 236, fig. 362; Tiffany and Britton, *op. cit.*, 1952, p. 248, pl. 65, fig. 743

Valves linear to linear-lanceolate with triundulate margins and broadly wedge-shaped ends. Raphe thin and straight with slightly curved terminal fissures. Axial area moderate, linear-lanceolate; central area large. Striæ slightly radial throughout, crossed by a fine longitudinal line near the margins. Fairly common.

Dimensions Length 32.5-54 μ
Breadth 6-7 μ
Striæ 18-22 in 10 μ

Distribution India—Bombay and Partabgarh (!). Fresh-water.

Genus *Neidium* Pfitzer 1871

12. *Neidium bisulcatum* (Lagerstedt) Cleve

(Fig. 12)

Schönfeldt, H., *op. cit.*, 1913, p. 74, fig. 134; Hustedt, F., *op. cit.*, 1930, p. 242, fig. 374; Krishnamurthy, V., *op. cit.*, 1954, p. 363, fig. 34.

Valves linear with almost parallel sides and broad rounded ends. Raphe thin and straight with central pores bent in the opposite directions and terminal fissures bifurcated. Axial area narrow, slightly widened between the middle and the ends; central area large, roundish or transversely elliptical. Striæ fine but distinctly punctate, radial in the middle, perpendicular to the middle line in between and convergent at the ends, crossed by a hyaline furrow near the margins. Rare.

Dimensions Length 25.6-40.5 μ
Breadth 7.5-9 μ
Striæ 25-30 in 10 μ

Distribution India—Madras (Krishnamurthy, 1954) and Partabgarh (!), Himalaya? (*Navicula bisulcata*, Dickie, 1882). Fresh-water.

13. *Neidium bisulcatum* (Lagerstedt) Cleve f. *undulata* O. Müll.

(Fig. 13)

Schönfeldt, H., *op. cit.*, 1913, p. 74; Hustedt, F., *op. cit.*, 1930, p. 242, fig. 375; Gonzalves and Gandhi, *Syst. Acc. Diat.*, etc.—II, *J. Indian bot. Soc.*, Vol 32, No 4, 1953, p. 248, fig. 77.

Valves linear with triundulate sides and subcuneate ends. Raphe thin and straight with central pores bent in the opposite directions and terminal fissures bifurcated. Axial and central areas as in the type. Striæ fine but distinctly punctate, radial in the middle, perpendicular to the middle line in between and convergent at the ends, crossed by a hyaline furrow near the margins. Not common.

Dimensions Length 45–60 μ
 Breadth 7.5–8 μ
 Striæ 28–30 in 10 μ

Distribution India—Bombay (Gonzalves and Gandhi 1953)
 and Partabgarh (!) Fresh-water.

Genus *Stauroneis* Ehrenberg 1843

14. *Stauroneis partabgarhensis* sp. nov

(Fig. 14)

Frustula solitaria, libere natantia, in aspectu zonali rectangularia, septis polaris nullis. Valves late-lanceolatae, utroque apice constricto et aliquantum elongato ac capitato. Raphe crassa, ornata poris centralibus paulum unilateraliter inclinatis atque fissuris terminalibus curvatis. Area axialis modica, linearis vel inter polos et centrum dilatata; area centralis staurodea rectangularis versus latera dilatata. Striæ radiales, tenues sed distincte punctatae. Frustula 61–65 μ longa; 16–18 μ lata; striæ 19–21 in 10 μ .

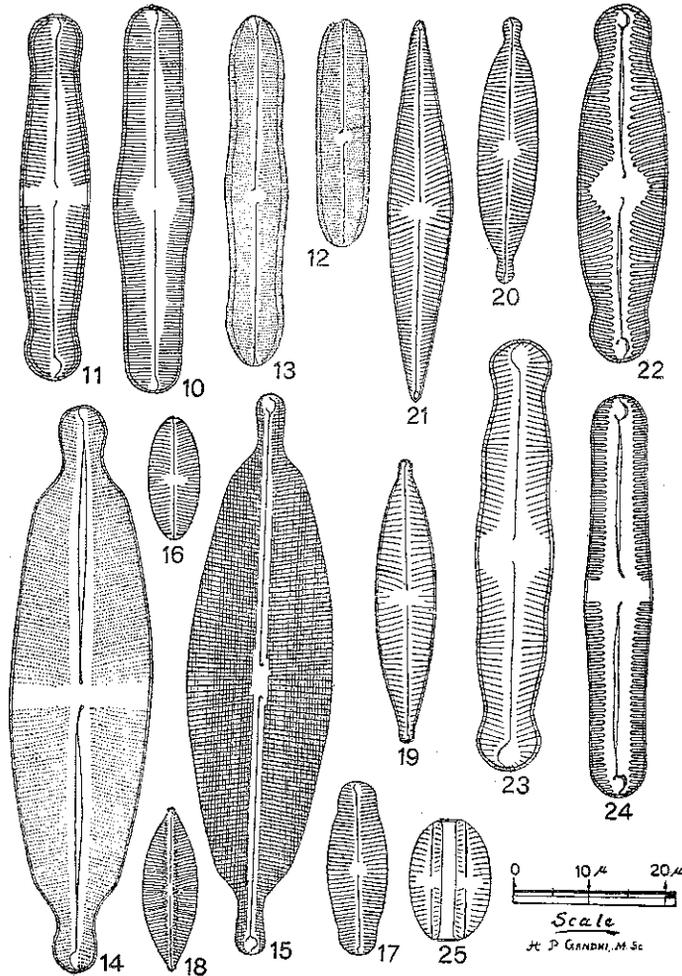
Frustules solitary, free-floating, rectangular in the girdle, view without polar septa. Valves broadly lanceolate with abruptly constricted, somewhat produced capitate ends. Raphe thick with slightly unilaterally bent central pores and curved terminal fissures. Axial area moderate, linear or slightly widened between the middle and ends; central area a rectangular stauros, somewhat widened towards the margins. Striæ radial, fine but distinctly punctate. Rather rare.

Dimensions Length 61–65 μ
 Breadth 16–18 μ
 Striæ 19–21 in 10 μ

Distribution India—Partabgarh Fresh-water

This form remotely resembles *Stauroneis alabamæ* Heiden var. *angulata* Heiden as described and figured by Hustedt (Hustedt, *op. cit.*, 1930, p. 258, fig. 413), in the outline and raphe, but the stauros and striæ in this form are not at all characteristic of *Stauroneis alabamæ* or its var. *angulata*, hence it differs. It also differs from *S. phyllodes* Ehr., described and figured by Tiffany and Britton (Tiffany and Britton,

op. cit., 1952, p. 266, pl. 71, fig. 821), in having distinctly capitate ends, less radial striæ and broad rectangular stauros which slightly widens near the margins. It further differs from *S. phænicenteron* (Nitz.) Ehr. var. *amphilepta* (Ehr.) Cleve (Tiffany and Britton, 1952, p. 266, pl. 71,



FIGS. 10-25.—Fig. 10. *Caloneis pulchra* Messikommer forma *partabgarhensis* f. nov. Fig. 11. *Caloneis clevei* (Lagerstedt) Cleve Fig. 12. *Neidium bisulcatum* (Lagerstedt) Cleve Fig. 13. *Neidium bisulcatum* (Lagerstedt) Cleve f. *undulata* O. Müll. Fig. 14. *Stauroneis partabgarhensis* sp. nov. Fig. 15. *Navicula cuspidata* Kütz. var. *ambigua* (Ehr.) Cleve. Fig. 16. *Navicula pupula* Kütz. var. *elliptica* Hustedt. Fig. 17. *Navicula protracta* Grun. Fig. 18. *Navicula krasskei* Hustedt. Fig. 19. *Navicula cryptocephala* Kütz. Fig. 20. *Navicula partabgarhensis* sp. nov. Fig. 21. *Navicula radiosa* Kutz. var. *tenella* (Bréb.) Grun. Fig. 22. *Pinnularia gibba* Ehr. var. *mesogongyla* (Ehr.) Hustedt. Fig. 23. *Pinnularia gibba* Ehr. f. *subundulata* Mayer. Fig. 24. *Pinnularia brevicostata* Cleve Fig. 25. *Amphora ovalis* Kütz. var. *pediculus* Kütz.

fig. 826), in not having broadly rostrate, but distinctly capitate ends. Moreover, the striæ are more closely set and fine but distinctly punctate. It does not resemble any other known forms, hence it is regarded as a new species

Genus *Navicula* Bory, 1822

Section *Naviculæ orthostichæ* Cleve

15 *Navicula cuspidata* Kütz. var. *ambigua* (Ehr.) Cleve

(Fig. 15)

Schönfeldt, H., *op. cit.*, 1913, p. 76; Hustedt, F., *op. cit.*, 1930, p. 268, fig. 434; Venkataraman, G., *op. cit.*, 1939, p. 327, fig. 94; Tiffany and Britton, *op. cit.*, 1952, p. 254, pl. 68, fig. 790; Cleve-Euler, A., *Diat. Schweden u. Finnland, Kungl. Svenska Vetens. Handl.*, Pt. V, Bd. 3, No. 3, 1952, p. 18, fig. 1353 d.

N. ambigua (Ehr.) Cl.—Van Heurck, *op. cit.*, 1896, p. 214, pl. 4, fig. 192.

Frustules solitary, in the girdle view rectangular. Valves rhombic-lanceolate with abruptly narrowed, constricted, much produced capitate ends. Raphe thin and straight with hook-like central pores. Axial area narrow, linear, slightly widened in the middle due to interruption of longitudinal striæ. Striæ radial, punctate; longitudinal striæ finer and more closely set than the transverse ones. Craticular plates were seen in some of the forms. Not common.

Dimensions Length 72-8-80 μ
 Breadth 19-21 μ
 Trans. striæ 17-20 in 10 μ
 Long striæ 23-26 in 10 μ

Distribution India—Madras (Venkataraman, 1939), Bombay, Dharwar, Mugud, Kolhapur, and Partabgarh (!). Fresh-water.

Section *Naviculæ bacillares* Cleve

16. *Navicula pupula* Kütz. var. *capitata* Hust.

(Fig. 46)

Hustedt, F., *op. cit.*, 1930, p. 281, fig. 467 c.

Valves linear with slightly convex sides and constricted, broadly capitate rounded ends. Raphe thin and straight. Axial area narrow and linear; central area transversely rectangular and large; terminal nodules distinct. Striæ radial and curved, long and short striæ alternate in the middle. Not common.

Dimensions Length 27-30 μ
 Breadth 7-7 μ
 Striæ 22-24 in 10 μ

Distribution India—Bombay and Partabgarh (!). Fresh-water.

17. *Navicula pupula* Kütz. var. *elliptica* Hust.

(Fig. 16)

Schönfeldt, H., *op. cit.*, 1913, p. 79; Hustedt, F., *op. cit.*, 1930, p. 282, fig. 467 d.

Valves broadly elliptic-lanceolate with rounded ends. Raphe thin and straight. Axial area narrow, linear; central area rectangular, large; polar nodules distinct. Striæ fine, radial and curved; long and short striæ alternate in the middle. Common.

Dimensions Length 16-18 μ
 Breadth 6.8-7 μ
 Striæ 16-18 in 10 μ

Distribution India—Bombay and Partabgarh (!). Fresh-water.

Section *Naviculæ decipientes* Cleve18. *Navicula protracta* Grun.

(Fig. 17)

Hustedt, F., *op. cit.*, 1930, p. 284, fig. 472; Venkataraman, G., *op. cit.*, 1939, p. 328, fig. 93; Tiffany and Britton, *op. cit.*, 1952, p. 254, pl. 67, fig. 775.

Valves linear or slightly linear-elliptical with constricted, broadly rostrate, subtruncate ends. Raphe thin and straight with slightly curved terminal fissures. Axial area very narrow, linear; central area small, rounded. Striæ strong, radial, indistinctly punctate, distantly placed in the middle, closely set and parallel at the ends. Not common.

Dimensions Length 16-27.5 μ
 Breadth 6-8.8 μ
 Striæ 16-22 in 10 μ

Distribution India—Madras (Venkataraman, 1939), Bombay Partabgarh (!). Fresh-water.

19. *Navicula fluens* Hust.

(Fig. 47)

Hustedt, F., *op. cit.*, 1930, p. 285, fig. 474.

Valves elliptic-lanceolate with broad rounded ends. Raphe thin and straight. Axial area very narrow, linear; central area scarcely formed. Striæ slightly radial throughout, somewhat distantly placed in the middle. Fairly common.

Dimensions Length 11-16 μ
 Breadth 5-6 μ
 Striæ 30-32 in 10 μ

Distribution India—Partabgarh (!). Fresh-water.

This form agrees well with the type described and figured by Hustedt

Section *Navicula minuscula* Cleve20. *Navicula krasskei* Hust.

(Fig. 18)

Hustedt, F., *op. cit.*, 1930, p. 287, fig. 481.

Valves broadly lanceolate with constricted, slightly produced acute ends. Raphe thin and straight with indistinct terminal fissures. Axial area very narrow, linear with longitudinal depressions; central area scarcely formed. Striæ radial throughout, very fine and indistinct. Very common.

Dimensions Length 13–22 μ
 Breadth 6–8 μ
 Striæ about 30 in 10 μ

Distribution India—Partabgarh (!). Fresh-water.

This form agrees well with the type described and figured by Hustedt, and also the longitudinal depressions in the axial area are noted. Some larger forms also are recorded from this region.

21. *Navicula vitrea* (Østrup) Hust

(Fig. 48)

Hustedt, F., *op. cit.*, 1930, p. 289, fig. 489

Valves small, linear-lanceolate with parallel sides in the middle; ends narrowed, broadly wedge-shaped and rounded. Raphe thin and straight. Axial area very narrow, linear; central area only slightly developed. Striæ radial throughout, crossed by a very thin hyaline line close to the margins. Not common.

Dimensions Length 15–22 μ
 Breadth 6–7 μ
 Striæ 30 in 10 μ

Distribution India—Partabgarh (!). Fresh-water.

This form agrees well with the type described and figured by Hustedt, except that some smaller forms were also observed.

Section *Navicula lineolata* Cleve22. *Navicula cryptocephala* Kütz.

(Fig. 19)

Van Heurck, *op. cit.*, 1896, p. 180, pl. 3, fig. 122; Schönfeldt, H., *op. cit.*, 1913, p. 92, fig. 189; Hustedt, F., *op. cit.*, 1930, p. 295, fig. 496; Tiffany and Britton, *op. cit.*, 1952, p. 255, pl. 67, fig. 767.

Valves lanceolate with constricted, more or less produced capitate ends. Raphe thin and straight with distinct central pores and slightly curved terminal fissures. Axial area narrow, linear; central area moderate and squarish. Striæ finely lineate, radial in the middle and convergent at the ends; long and short striæ alternate in the middle. Not common

- Dimensions* Length 30–37.5 μ
 Breadth 6.6–8 μ
 Striæ 14–16 in 10 μ
- Distribution* India—Himalaya (Dickie, 1882), Burma (West & West, 1907), Calcutta (Skvortzow, 1935), Bombay (Gonzalves and Gandhi), Kolhapur and Partabgarh (!). Fresh-water.

This form resembles very closely the type described by Hustedt and others, except that it is somewhat a broader form and has fewer striæ.

23. *Navicula partabgarhensis* sp. nov.

(Fig. 20)

Valvæ lineares-ellipticæ, utroque apice abrupte constricto et distincte rotundato ac capitato. Raphe tenuis et recta, fissuris terminalibus paululum curvatis. Area axialis angusta, linearis; area centralis lata ac rotundata. Striæ lineatæ, radiales et in medio curvatæ, in utroque apice convergentes. Frustule 35–38 μ longa; 7.5–8.2 μ lata; striæ 18–20 in 10 μ .

Valves linear-elliptical with abruptly constricted and distinctly capitate rounded ends. Raphe thin and straight with slightly curved terminal fissures. Axial area narrow, linear; central area large, roundish. Striæ lineate, radial and curved in the middle, convergent at the ends. Rather rare.

- Dimensions* Length 35–38 μ
 Breadth 7.5–8.2 μ
 Striæ 18–20 in 10 μ

Distribution India—Partabgarh (!) Fresh-water

This form can satisfactorily be placed in the Section—*Navicula lineolata* Cleve, on account of its striæ being lineate, radial in the middle and convergent at the ends. Further, this form remotely resembles *Navicula exigua* (Greg.) O Müll. (Hustedt, *op. cit.*, 1930, p. 305, fig. 538) in the outline, but as striæ are not radial throughout and long and short striæ do not alternate in the middle, it thus differs. It does not agree with or come near to any other known forms, hence it is regarded as a new species.

24. *Navicula cari* Ehr

(Fig. 49)

Hustedt, F., *op. cit.*, 1930, p. 299, fig. 512.

Valves narrowly lanceolate with almost acute rounded ends. Raphe thin and straight with curved terminal fissures. Axial area narrow, linear; central area large, obliquely rectangular. Striæ radial in the middle, at the ends convergent and somewhat closely placed. Fairly common.

<i>Dimensions</i>	Length 24-33.3 μ
	Breadth 5-6.5 μ
	Striæ 14-18 in 10 μ
<i>Distribution</i>	India—Bombay and Partabgarh (!). Fresh-water

This form agrees well with Hustedt's type except that it is somewhat smaller and slender form.

25. *Navicula radiosa* Kütz. var. *tenella* (Bréb.) Grun.

(Fig 21)

Van Heurck, *op. cit.*, 1896, p. 180, pl. 3, fig. 114; Schönfeldt, H., *op. cit.*, 1913, p. 95; Hustedt, F., *op. cit.*, 1930, p. 299; Tiffany and Britton, *op. cit.*, 1952, p. 255, pl. 67, fig. 781.

Valves narrowly lanceolate and gradually tapering to acute rounded ends. Raphe thin and straight with distinct terminal fissures. Axial area narrow, linear; central area large, obliquely rectangular. Striæ radial in the middle and convergent at the ends. Not common.

<i>Dimensions</i>	Length 45-50 μ
	Breadth 8-8.7 μ
	Striæ 14-18 in 10 μ
<i>Distribution</i>	India—[Ceylon (Skvortzow, 1932)], and Partabgarh (!). Fresh-water.

This form is slightly broader than Hustedt's form (breadth 5-6 μ), but agrees well in other respects. Van Heurck does not give the dimensions of his form, but states that the striæ are finer and approximate (15-18 in 10 μ). Schönfeldt states that this form is smaller than the type with a fewer striæ.

26. *Navicula vanhæffeniformis* sp. nov.

(Fig 50)

Valvæ parvæ, lineares, marginibus parallelis ac cuneatis-acutis in utroque apice. Raphe tenuis et recta atque fissuris terminalibus anguste curvatis. Area axialis angusta, linearis; area centralis paullum dilatata. Striæ ubique radiales, indistincte lineatæ, paullum distanter in medio positæ. Frustula 16.7-25.5 μ longa; 4-6 μ lata; striæ 13-16 in 10 μ .

Valves small, linear with parallel sides and wedge-shaped acute ends. Raphe thin and straight with narrow, curved terminal fissures. Axial area narrow, linear; central area slightly dilated. Striæ throughout radial, indistinctly lineate, slightly distantly placed in the middle. Not common.

<i>Dimensions</i>	Length 16.7-25.5 μ
	Breadth 4-6 μ
	Striæ 13-16 in 10 μ
<i>Distribution</i>	India—Partabgarh (!). Fresh-water.

This form strongly resembles *Navicula vanhæffeni* Gran., in the outline and cuneate ends, as figured by Cleve-Euler (Cleve-Euler, *op. cit.*, 1952, p. 25, fig. 1379), but differs very much in the dimensions, absence of stauros, habitat and other details. And as the author has not given any information regarding the striæ both in the text and the figure, I am unable to refer my form to *N. vanhæffeni*. It also resembles *N. natchikæ* Petersen (Petersen, J. B., *Algæ collected by etc. . .*, *Det Kgl. Dansk Viden. Sels Biol. Meddel.*, Bd. XX, Nr. 1, 1946, p. 92, fig. 15) somewhat in the outline and radial striæ, but as this form is rather slender and has sharply defined cuneate ends and indistinctly lineate striæ, it differs from it (*N. natchikæ*). It again, except for the outline, differs from *N. gracilis* A. Mayer (Hustedt, F., *op. cit.*, 1930, p. 299, fig. 514), in having smaller size, distinctly radial, closely set and indistinctly lineate striæ. Further, it does not agree with any other known forms, hence it is regarded as a new species.

27 *Navicula gonzalvesiana* sp. nov.

(Fig. 51)

Valvæ parvæ, late-lanceolatæ, apicibus acutis rotundatis. Raphe paullum crassa et recta atque fissuris terminalibus latis ac curvatis. Area axialis angusta, linearis; area centralis parva atque elliptica. Striæ fortes, lineatæ, ubique radiales, distincte in utroque apice geniculatæ. Frustula 28–32 μ longa; 7.8–8.4 μ lata; Striæ 12–14 in 10 μ .

Valves small, broadly lanceolate with acute rounded ends. Raphe slightly thick and straight with large, curved terminal fissures. Axial area narrow, linear; central area small, elliptical. Striæ strong, lineate, throughout radial, at the ends distinctly geniculate. Not common.

Dimensions Length 28–32 μ
 Breadth 7.8–8.4 μ
 Striæ 12–14 in 10 μ

Distribution India—Partabgarh (!). Fresh-water.

This form, except for the geniculate striæ at the ends, differs from *N. oblonga* Kütz. (Hustedt, *op. cit.*, 1930, p. 307, fig. 550), in the outline, dimensions and the number of striæ. It also differs from *N. opima* Grun. (Van Heurck, *op. cit.*, 1896, p. 184, pl. 25, fig. 714) in several features but for the outline. Moreover, the striæ are not being described as geniculate in the text though they appear to be so in the figure, hence it cannot be ascribed to *N. opima* with any certainty. However it is a distinctive form, hence it is regarded as a new species and named in honour of my esteemed Prof. (Mrs.) E. A. Gonzalves.

Genus **Pinnularia** Ehrenberg 1840

Section **Divergentes** Cleve

28. *Pinnularia microstauron* (Ehr.) Cleve

(Fig. 52)

Schönfeldt, H., *op. cit.*, 1913, p. 103, fig. 220; Hustedt, F., *op. cit.*, 1930, p. 320, fig. 582.

Frustules solitary, rectangular in the girdle view. Valves linear-lanceolate with constricted, produced or somewhat capitate ends. Raphe thin and slightly undulate; central pores unilaterally bent and terminal fissures slightly curved. Axial area moderate, lanceolate; central area large, reaching the sides. Striæ strong, radial in the middle and convergent at the ends. Not common.

<i>Dimensions</i>	Length 45-54 μ Breadth 10.6-11 μ Striæ 12-14 in 10 μ
<i>Distribution</i>	India (Ceylon—Skvortzow, 1932), Bombay, Mugud and Partabgarh (!). Fresh-water. Section <i>Tabellariæ</i> Cleve

29. *Pinnularia gibba* Ehr. f. *subundulata* Mayer

(Fig. 23)

Hustedt, F., *op. cit.*, 1930, p. 327, fig. 601; Venkataraman, G., *op. cit.*, 1939, p. 338, fig. 108.

Valves linear to linear-lanceolate with slightly undulate margins and constricted, broadly capitate rounded ends. Raphe thin and straight with very closely placed central pores slightly unilaterally bent, terminal fissures curved. Axial area broad, linear; central area very wide reaching the sides. Striæ strong, radial in the middle and strongly convergent at the ends. Rare.

<i>Dimensions</i>	Length 56-70 μ Breadth 11-12 μ Striæ in the middle 10-12 in 10 μ Striæ at the ends 12-14 in 10 μ
<i>Distribution</i>	India—Madras (Venkataraman, 1939) and Partabgarh (!). Fresh-water.

30. *Pinnularia gibba* Ehr. var. *mesogongyla* (Ehr.) Hust.

(Fig. 22)

Hustedt, F., *op. cit.*, 1930, p. 327, fig. 602.

Frustules solitary and robust, rectangular in the girdle view. Valves linear-lanceolate with convex sides in the middle; ends constricted, capitate rounded. Raphe thick, slightly undulate with distinct unilaterally bent central pores and short terminal fissures. Axial area moderate, linear; central area very large, rounded, almost reaching the sides. Striæ strong and thick, radial in the middle and strongly convergent at the ends. Rare.

<i>Dimensions</i>	Length 37-50 μ Breadth 11.8-12.5 μ Striæ 9-10 in 10 μ
<i>Distribution</i>	India—Bombay and Partabgarh (!). Fresh-water.

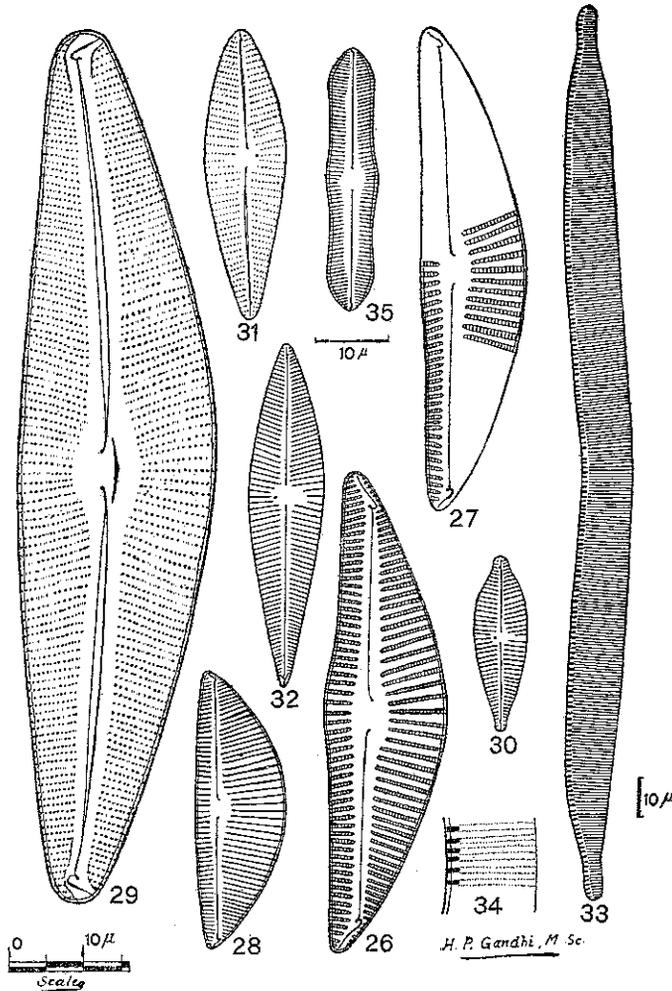
This form agrees well with the type described and figured by Hustedt.

Section *Brevistrieta* Cleve31. *Pinnularia brevicostata* Cleve

(Fig. 24)

Schönfeldt, H., *op. cit.*, 1913, p. 107, fig. 230; Hustedt, F., *op. cit.*, 1930, p. 329, fig. 609.

Frustules solitary, rectangular in the girdle view. Valves linear with almost parallel sides or slightly gibbous in the middle; ends



FIGS. 26-35.—Figs 26-27. *Cymbella turgida* (Greg.) Cleve. Fig 28. *Cymbella ventricosa* Kütz. Fig 29. *Cymbella aspera* (Ehr.) Cleve. Fig 30. *Gomphonema parvulum* (Kütz.) Grun Fig 31. *Gomphonema lanceolatum* Ehr. var. *insignis* (Greg.) Cleve. Fig 32. *Gomphonema gracile* Ehr. Fig 33. *Hantzschia elongata* (Hantzsch) Grun. Fig 34. *Hantzschia elongata*—under higher magnification, showing the punctate striae. Fig 35. *Caloneis silicula* (Ehr.) Cleve.

broadly rounded. Raphe thick, but simple, slightly undulate on the strongly marked side; central pores unilaterally bent and terminal fissures large comma-shaped. Axial area broad, linear-lanceolate, $\frac{1}{3}$ – $\frac{1}{2}$ the breadth of the valve; central area large reaching the sides. Striæ strong and thick, scarcely radial, throughout parallel. Rather rare.

Dimensions Length 47·5–50 μ
 Breadth 9·3–10 μ
 Striæ 8–10 in 10 μ

Distribution India—Partabgarh (!). Fresh-water.

This form resembles very closely the type described and figured by Hustedt, except that it is a smaller form.

(b) *Sub-family* GOMPHOCYMBELLOIDÆ

Genus *Amphora* Ehrenberg 1840

32. *Amphora ovalis* Kütz. var. *pediculus* Kütz.

(Fig. 25)

Van Heurck, *op. cit.*, 1896, p. 127, pl. 1, fig. 19; Schönfeldt, H., *op. cit.*, 1913, p. 142; Hustedt, F., *op. cit.*, 1930, p. 343, fig. 629.

Frustules small to very small, broadly elliptical with truncate-rounded ends in the girdle view. Valves lunate with highly convex dorsal—and straight or slightly concave ventral-side, ends broad, rounded. Raphe thin and slightly arcuate. Axial area narrow; central area very large, reaching the ventral side, and almost the dorsal side. Striæ radial, punctate, convergent at the ends on the ventral side. Common.

Dimensions Length 10–17 μ
 Breadth 8–10·6 μ
 Striæ 10–12 in 10 μ

Distribution India—Bombay and Partabgarh (!). Fresh-water.

Genus *Cymbella* Agardh 1830

33. *Cymbella rupicola* Grun.

(Fig. 40)

Schönfeldt, H., *op. cit.*, 1913, p. 131, fig. 282; Hustedt, F., *op. cit.*, 1930, p. 353, fig. 655

Valves slightly asymmetrical, lanceolate with strongly convex dorsal and slightly convex ventral-side; ends somewhat acute, constricted and produced. Raphe thin, very slightly excentric, arcuate with central pores ventrally bent. Axial area very narrow and slightly widened in the centre. Striæ radial throughout, closely set at the ends and on the ventral side. Fairly common.

- Dimensions* Length 22-4-30 μ
 Breadth 9-10 μ
 Striæ on the dorsal side 12-13 in 10 μ . Striæ
 at the ends and on the ventral side 15-16 in
 10 μ
- Distribution* India—Partabgarh (!). Fresh-water
- This form agrees well with Hustedt's type.

34. *Cymbella turgida* (Greg.) Cleve

(Figs. 26-27)

Schönfeldt, H., *op. cit.*, 1913, p. 138, fig. 302; Hustedt, F., *op. cit.*, 1930, p. 358, fig. 660; Venkataraman, G., *op. cit.*, 1939, p. 343, fig. 125; Voigt, M., Note sur Quelques Espèces Chinoises du Genre *Cymbella*, Musée Heude *Notes de Botanique Chinoise*, No. 5, 1943, p. 34, pl. II, fig. 14; Tiffany and Britton, *op. cit.*, 1952, p. 279, pl. 74, fig. 862.

Encyonema turgidum (Greg.) Cl.—Van Heurck, *op. cit.*, 1896, p. 149, pl. 1, fig. 45

Valves lunate with strongly convex dorsal- and almost straight or often centrally gibbous ventral-side; ends more or less acute, rounded. Raphe strongly excentric, straight with central pores dorsally bent and the terminal fissures ventrally directed. Axial area moderate, linear; central area small, ellipsoidal. Striæ strong, distinctly lineate, radial and distantly placed in the middle; convergent at the ends on the ventral side. Common.

- Dimensions* Length 48-60 μ
 Breadth 11-15 μ
 Striæ in the middle 7-9 in 10 μ
 Striæ at the ends 10-12 in 10 μ

Distribution India—Madras (Venkataraman, 1939), Bombay, Dharwar, Mugud, Kolhapur and Partabgarh (!). Fresh-water

35. *Cymbella ventricosa* Kütz.

(Fig. 28)

Schönfeldt, H., *op. cit.*, 1913, p. 139, fig. 308; Hustedt, F., *op. cit.*, 1930, p. 359, fig. 661; Voigt, M., *op. cit.*, 1943, p. 35; Tiffany and Britton, *op. cit.*, 1952, p. 279, pl. 74, fig. 871.

Encyonema ventricosum Kütz.—Van Heurck, *op. cit.*, 1896, p. 150, pl. 1, fig. 49.

Valves lunate to half-elliptical with highly convex dorsal- and almost straight to slightly convex ventral-side; ends acutely rounded. Raphe thin and straight, strongly excentric with dorsally bent central pores and ventrally directed terminal fissures. Axial area narrow, linear-lanceolate; central area small. Striæ finely punctate, radial,

distantly placed in the middle, at the ends convergent only on the ventral side.

- Dimensions* Length 35–47 μ
 Breadth 11–12 μ
 Striæ in the middle 10–11 in 10 μ
 Striæ at the ends 13–17 in 10 μ
- Distribution* India—(Afghanistan—Schaarschmidt, 1886),
 Madras (Krishnamurthy, 1954), (Burma—
 “*Cocconema ventricosum*” West & West,
 1907), Calcutta (Biswas, 1937), Bombay,
 Kolhapur, Dharwar and Partabgarh (!).
 Fresh-water.

36. *Cymbella aspera* (Ehr.) Cleve

(Fig. 29)

Schönfeldt, H., *op. cit.*, 1913, p. 138, fig. 301; Hustedt, F., *op. cit.*, 1930, p. 365, fig. 680; Iyengar and Subrahmanyam, *op. cit.*, 1943, p. 232, figs. 25–26; Voigt, M., *op. cit.*, 1943, p. 7; Tiffany and Britton, *op. cit.*, 1952, p. 279, pl. 73, fig. 858

Cymbella gastroides Kütz.—Van Heurck, *op. cit.*, 1896, p. 146, pl. 1, fig. 35.

Frustules large and robust, found in gelatinous masses. Valves asymmetrical, semi-lanceolate with strongly convex dorsal- and straight or slightly convex or swollen ventral-side; ends obtusely rounded. Raphe thick, arcuate, slightly excentric with large, ventrally bent central pores and dorsally directed terminal fissures. Axial area moderate, linear; central area slightly formed, rounded with an arcuate marking on the dorsal side. Striæ radial in the middle and somewhat perpendicular to the middle line towards the ends, clear and coarsely punctate. Common and variable form.

- Dimensions* Length 102–144 μ
 Breadth 25–31 μ
 Striæ in the middle 7–9 in 10 μ
 Striæ at the ends 9–11 in 10 μ
 Punctæ 14–18 in 10 μ
- Distribution* India—Kashmir (Iyengar & Subrahmanyam
 1943), Bombay, Dharwar, Kolhapur and
 Partabgarh (!). Fresh-water.

This form agrees well with the type described and figured by Hustedt and others, except that it is somewhat convex on the ventral side.

Genus **Gomphonema** Agardh 1824

37. *Gomphonema parvulum* (Kütz.) Grun

(Fig. 30)

Van Heurck, *op. cit.*, 1896, p. 272, pl. 7, fig. 306; Schönfeldt, *op. cit.*, 1913, p. 124, fig. 270; Hustedt, F., *op. cit.*, 1930, p. 372,

Distribution . . . India—(Afghanistan—Schaarschmidt, 1886), (Ceylon—Skvortzow, 1932; West & West, 1902), Madras (Krishnamurthy, 1954), Calcutta (Ehrenberg, 1845), Dharwar, Kolhapur, Bombay and Partabgarh (!) Fresh-water.

2. *Family* . . . *NITZSCHIACEÆ*
 (a) *Sub-family* . . . NITZSCHIOIDEÆ
Genus . . . *Hantzschia* Grunow 1880

40. *Hantzschia elongata* (Hantz.) Grun.

(Figs. 33, 34)

Hustedt, F., *op. cit.*, 1930, p. 395, fig. 751; Cleve-Euler, A., *op. cit.*, 1952, p. 51, fig. 1421 g, h.

H. amphioxys var. *elongata* Grun—Van Heurck, *op. cit.*, 1896, p. 381, pl. 15, fig. 487 b.

Frustules elongated, generally free, linear in the girdle view. Valves slender, linear with parallel sides, distinctly bent in the middle with constricted, narrowed and produced, backwardly bent subcapitate ends. Keel excentric, keel punctæ small, distantly placed in the middle. Striæ fine and indistinctly punctate. Rare.

Dimensions . . . Length 195–227 μ
 Breadth 13–8 μ
 Keel punctæ 8–10 in 10 μ
 Striæ 13–16 in 10 μ

Distribution . . . India—Bombay and Partabgarh (!). Fresh-water.

This form agrees well with the type described and figured by Hustedt and others, except that it is a little smaller form.

Genus . . . *Nitzschia* Hassall 1845

Section Tryblionellæ (W. Smith, Grunow) Hustedt, etc.

41. *Nitzschia tryblionella* Hantz. var. *levidensis* (W. Smith) Grun.

(Fig. 36)

Van Heurck, *op. cit.*, 1896, p. 385, pl. 15, fig. 494; Schönfeldt, H., *op. cit.*, 1913, p. 151; Hustedt, F., *op. cit.*, 1930, p. 399, fig. 760; Venkataraman, G., *op. cit.*, 1939, p. 352, fig. 141; Cleve-Euler, A., *op. cit.*, 1952, p. 58, fig. 1430 i-l.

Valves linear with parallel or slightly concave sides in the middle, ends broadly wedge-shaped and very slightly produced. Longitudinal folds are formed in the middle. Keel strongly excentric and slightly constricted in the middle, keel punctæ small. Striæ coarse, somewhat wavy due to the longitudinal folds on the valve. Not common.

<i>Dimensions</i>	Length 32.5–43 μ Breadth 7.5–10 μ Keel punctæ 12–13 in 10 μ Striæ 11–14 in 10 μ
<i>Distribution</i>	India—Madras (Venkataraman, 1939), Bombay, and Partabgarh (!). Fresh-water.

Section *Lineares* (Grun) Hustedt, etc.

42. *Nitzschia sublinearis* Hustedt

(Fig. 37)

Hustedt, F., *op. cit.*, 1930, p. 411, fig. 786; Cleve-Euler, A., *op. cit.*, 1952, p. 80, fig. 1481.

Frustules linear to linear-lanceolate in the girdle view with gradually narrowed truncate ends. Valves linear with wedge-shaped, somewhat backwardly bent capitate ends. Keel excentric, slightly constricted in the middle, keel punctæ small. Striæ fine. Not common.

<i>Dimensions</i>	Length 40–82.5 μ Breadth 5–6.2 μ Keel punctæ 12–15 in 10 μ Striæ 33–37 in 10 μ
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Distribution India—Partabgarh (!). Fresh-water.

This form agrees well with the type described and figured by Hustedt and others.

Section *Dubiæ* Grun

43. *Nitzschia jugata* sp. nov.

(Fig. 38)

Frustula ampla ac robusta, lineari-rectangularia in aspectu zonali, apice utroque aliquantum truncato. Valvæ lineares, robustæ, binæ inter se pæne rectis ventralibus muris conjunctæ. Latera dorsalia in medio concava, gradatim in utrumque apicem tenuiora, constrictis apicibus atque aliquantum truncato-capitatis. Carina dorsalis, excentro, in medio concava, magnis crassisque carinæ punctis impariter positæ. Striæ fortes, lineatæ ac pariter positæ. Frustula 110–162.5 μ longa; 11.6–15 μ lata; carinæ punctis 6–9 in 10 μ ; striæ 12–15 in 10 μ .

Frustules large and robust, linear-rectangular in the girdle view with somewhat narrowed truncate ends. Valves linear, robust, united in pairs by more or less straight ventral walls. Dorsal side concave in the middle, gradually narrowed towards the ends which are constricted, somewhat truncate-capitate. Keel dorsal, excentric, depressed in the middle with large, thick keel punctæ placed at unequal distances. Striæ strong, lineate and uniformly placed. Rather rare.

<i>Dimensions</i>	Length 110-162.5 μ
	Breadth 11.6-15 μ
	Keel punctæ 6-9 in 10 μ
	Striæ 12-15 in 10 μ
<i>Distribution</i>	India—Mugud and Partabgarh (!). Fresh water.

This form somewhat resembles *Nitzschia latestriata* (Østrup) A. Cleve var. *major* Cleve (Cleve-Euler, A., *op. cit.*, 1952, p. 63, fig. 1442 a), in the outline, dorsally situated keel and the dimensions. However, this form differs from *N. latestriata* or its var. *major*, in having fewer keel punctæ, semi-wedge-shaped, constricted, truncate-capitate ends and very straight ventral side. Moreover, these frustules always were found united into pairs by the ventral side, of this fact nothing is stated in the literature. As this form appears to be distinctive, it is regarded as a new species.

Section *Lanceolata* (Grun.)44. *Nitzschia amphibia* Grun.

(Figs 39 a, b)

Van Heurck, *op. cit.*, 1896, p. 403, pl. 17, fig. 563; Schönfeldt, H., *op. cit.*, 1913, p. 158, fig. 349; Hustedt, F., *op. cit.*, 1930, p. 414, fig. 793; Venkataraman, G., *op. cit.*, 1939, p. 353, fig. 149; Cleve-Euler, A., *op. cit.*, 1952, p. 86, figs. 1496 a-e (*N. amphibia* v. *genuina*).

Frustules small, rectangular in the girdle view, Valves linear- to linear-lanceolate, with slightly constricted, shortly wedge-shaped, acute rounded ends. Keel excentric with large, squarish keel punctæ. Striæ strong with coarse punctæ. Common

<i>Dimensions</i>	Length 25-38.5 μ
	Breadth 4-5.6 μ
	Keel punctæ 7-9 in 10 μ
	Striæ 14-18 in 10 μ
	Punctæ 18-22 in 10 μ
<i>Distribution</i>	India—Calcutta (Skvortzow, 1935), Madras (Venkataraman, 1939), Bombay, Kolhapur and Partabgarh (!). Fresh-water.

45. *Nitzschia frustulum* (Kütz.) Grun.

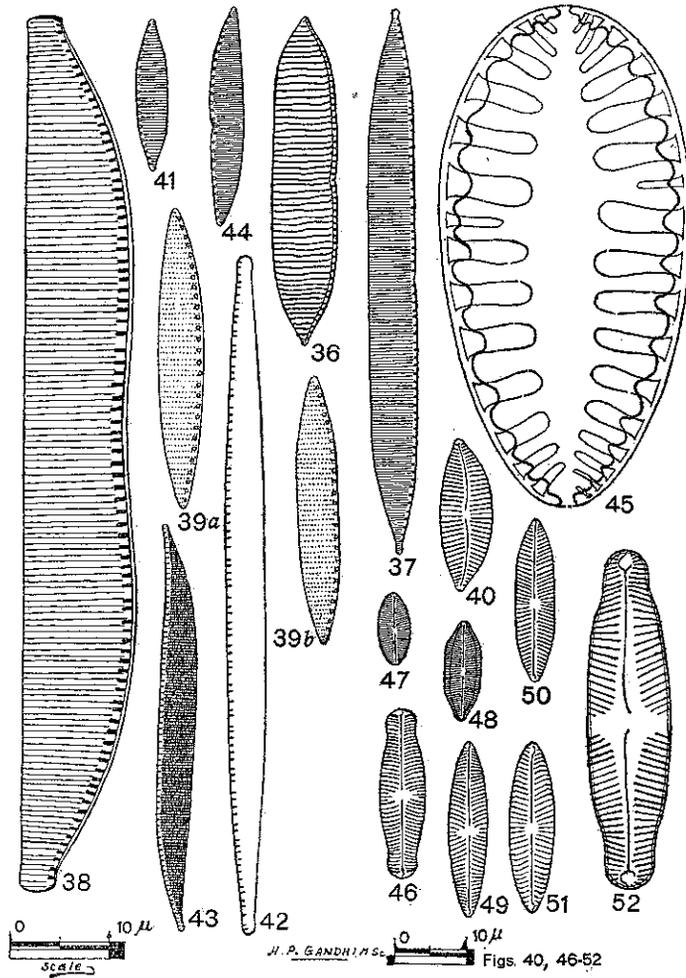
(Fig 41)

Van Heurck, *op. cit.*, 1896, p. 403, pl. 17, fig. 564; Schönfeldt, H., *op. cit.*, 1913, p. 159, fig. 354; Hustedt, F., *op. cit.*, 1930, p. 414, fig. 795; Cleve-Euler, A., *op. cit.*, 1952, p. 87, fig. 1497 a, b (*Nitzschia frustulum* v. *genuina*).

Valves linear to somewhat linear-lanceolate with abruptly narrowed, wedge-shaped acute ends. Keel excentric, keel punctæ large. Striæ strong and distinct. Common.

Dimensions

Length 21–28 μ
 Breadth 4–5 μ
 Keel punctæ 9–12 in 10 μ
 Striæ 20–22 in 10 μ



FIGS. 36–52.—Fig. 36. *Nitzschia tryblionella* Hantz var. *levidensis* (W. Smith) Grun. Fig. 37. *Nitzschia sublinearis* Hustedt. Fig. 38. *Nitzschia jugata* sp. nov. Fig. 39 a & b. *Nitzschia amphibia* Grun. Fig. 40. *Cymbella rupicola* Grun. Fig. 41. *Nitzschia frustulum* (Kütz.) Grun. Fig. 42. *Nitzschia gandersheimensis* Krasske. Fig. 43. *Nitzschia sigma* (Kütz.) W. Smith. Fig. 44. *Nitzschia filiformis* (W. Smith) Hustedt. Fig. 45. *Surirella robusta* Ehr. forma minor f. nov. Fig. 46. *Navicula pupula* Kütz. var. *capitata* Hustedt. Fig. 47. *Navicula fluens* Hustedt. Fig. 48. *Navicula vitrea* (Østrup) Hust. Fig. 49. *Navicula cari* Ehr. Fig. 50. *Navicula vanhæffeniformis* sp. nov. Fig. 51. *Navicula gonzalvesiana* sp. nov. Fig. 52. *Pinnularia microstauron* (Ehr.) Cleve.

Distribution India—Bombay, Kolhapur, and Partabgarh (!).
Fresh-water.

This form appears much like *N. amphibia* Grun., but the keel punctæ and the striæ are rather closely set and the latter are not clearly punctate.

46. *Nitzschia gandersheimensis* Krasske

(Fig. 42)

Hustedt, F., *op. cit.*, 1930, p. 417, fig. 804.

Frustules rectangular in the girdle view, slightly bent, with pale-yellow chromatophore. Valves linear to linear-lanceolate with slightly constricted, broadly rounded or somewhat capitate ends. Keel excentric with irregularly set keel punctæ. Striæ very fine and scarcely seen. Not common.

Dimensions Length 35–89 μ
Breadth 5.6–6 μ
Keel punctæ 8–11 in 10 μ
Striæ over 30 in 10 μ

Distribution India—Partabgarh (!). Fresh-water.

This form agrees well with the type described and figured by Hustedt, except that it is a little larger and broader form.

Section *Sigmoideæ* (Grun) Hustedt, etc.

47. *Nitzschia sigma* (Kütz.) W. Smith

(Fig. 43)

Van Heurck, *op. cit.*, 1896, p. 396, pl. 16, fig. 531; Schönfeldt, H., *op. cit.*, 1913, p. 156, fig. 344; Hustedt, F., *op. cit.*, 1930, p. 420, fig. 813; Cleve-Euler, A., *op. cit.*, 1952, p. 74, figs. 1470 a, b (*N. sigma* v. *genuina*).

Frustules sigmoid, almost linear with narrow ends in the girdle view. Valves sigmoid, linear in the middle with gradually tapering, slightly constricted, produced, acute rounded ends. Keel strongly excentric, keel punctæ small. Striæ fine and punctate, punctæ of the striæ are arranged in more or less longitudinal wavy lines. Rather rare.

Dimensions Length 54–80 μ
Breadth 4.6–6 μ
Keel punctæ 10–12 in 10 μ
Striæ 22–30 in 10 μ

Distribution India—Partabgarh (!). Fresh-water.

This form agrees well with the type described and figured by Hustedt in all respects. It is mainly a brackish-water or marine form, but Cleve-Euler reports its occurrence in the fresh-water and mentions it as a rather rare form.

Section *Obtusæ* (Grun) Hustedt, etc.

48. *Nitzschia filiformis* (W. Smith) Hustedt

(Fig. 44)

Schönfeldt, H., *op. cit.*, 1913, p. 161, fig. 358; Hustedt, F., *op. cit.*, 1930, p. 422, fig. 818; Cleve-Euler, A., *op. cit.*, 1952, p. 78, figs. 1478 a, b (*N. filiformis* v. *genuina*).

Frustules small, slightly sigmoid, linear-lanceolate in the girdle view. Valves linear or slightly sigmoid with obliquely narrowed and obtuse rounded ends. Keel slightly excentric, constricted in the middle with large keel punctæ. Striæ fine but distinct. Rare.

Dimensions Length 25–28 μ
 Breadth 4–5 μ
 Keel punctæ 9–12 in 10 μ
 Striæ 33–35 in 10 μ

Distribution India—Partabgarh (!). Fresh-water.

This form agrees well with the type described and figured by Hustedt and others.

3. Family *SURIRELLACEÆ*

(a) Sub-family *SURIRELLOIDÆ*

Genus *Surirella* Turpin 1828

49. *Surirella robusta* Ehr. forma *minor* f. nov.

(Fig. 45)

Frustula parvæ, cuneata in aspectu zonali. Valvæ heteropolares, ovatæ, apice late-rotundato. Linea media nulla. Area media linearilanceolata. Costæ crassissimæ, ad medium versus latiores, imparibus positæ intervallis. Striæ indistincte punctatæ inter costus ut in typo. Frustula 56–66 μ longa; 31–35 μ lata; costæ 10–15 in 100 μ .

Frustules small, wedge-shaped in the girdle view. Valves heteropolar, ovate with broad rounded ends. Middle line absent. Middle field linear-lanceolate. Costæ very thick, widening towards the middle, set at unequal distances. Punctate striæ indistinctly present between the costæ as in the type. Rare.

Dimensions Length 56–66 μ
 Breadth 31–35 μ
 Costæ 10–15 in 100 μ

Distribution India—Partabgarh (!). Fresh-water.

This form resembles *S. robusta* Ehr. (Hustedt, *op. cit.*, 1930, p. 437, fig. 850), in the outline, robust walls, etc. However, it is a much smaller form and the middle line in the central field is absent. It is therefore regarded as a new form.

50 *Surirella tenera* Greg. var. *splendidula* A. S. Schm.

(Fig. 53)

Cleve-Euler, A., *op. cit.*, 1952, p. 105, fig. 1525 f.

Frustules robust, wedge-shaped in the girdle view. Valves heteropolar, ovate with broad, rounded apex and much narrowed, cuneate acute base. Middle line interrupted, towards the ends it forms spines seated on narrow cushions. Central field linear-lanceolate, fairly large. Marginal folds strongly developed with distinct projections. Costæ thick and strong with linear sides, radial at the ends. Striæ marginal, fine and almost indistinct, present in between the costæ. Not common.

Dimensions Length 97–114 μ
 Breadth 42–61 μ
 Costæ 18–23 in 100 μ

Distribution India—Bombay and Partabgarh (!). Fresh-water.

This form agrees well with the type described and figured by Cleve-Euler.

51. *Surirella ovata* Kütz.

(Figs. 54–55)

Hustedt, F., *op. cit.*, 1930, p. 442, figs. 863–64; Tiffany and Britton, *op. cit.*, 1952, p. 296, pl. 79, fig. 926; Cleve-Euler, A., *op. cit.*, 1952, p. 122, figs. 1566 a–c (*S. ovata* v. *typica*).

S. ovalis Bréb. v. *ovata* Kütz.—Van Heurck, *op. cit.*, 1896, p. 373, pl. 13, fig. 587; Schönfeldt, H., *op. cit.*, 1913, p. 170.

Frustules small, wedge-shaped in the girdle view, found embedded in brownish scum encrusting the wet rocks. Valves heteropolar, broadly ovate to ovate-lanceolate with somewhat narrower base. Pseudoraphe narrow, linear. Marginal folds scarcely developed. Costæ radial, thick, rib-like, variously reaching the pseudoraphe. Striæ very distinct and coarse, 2–5 alternating with the costæ. Abundant.

Dimensions Length 23–65 μ
 Breadth 21–35 μ
 Costæ 40–65 in 100 μ
 Striæ 16–20 in 10 μ

Distribution India—Partabgarh (!). Fresh-water.

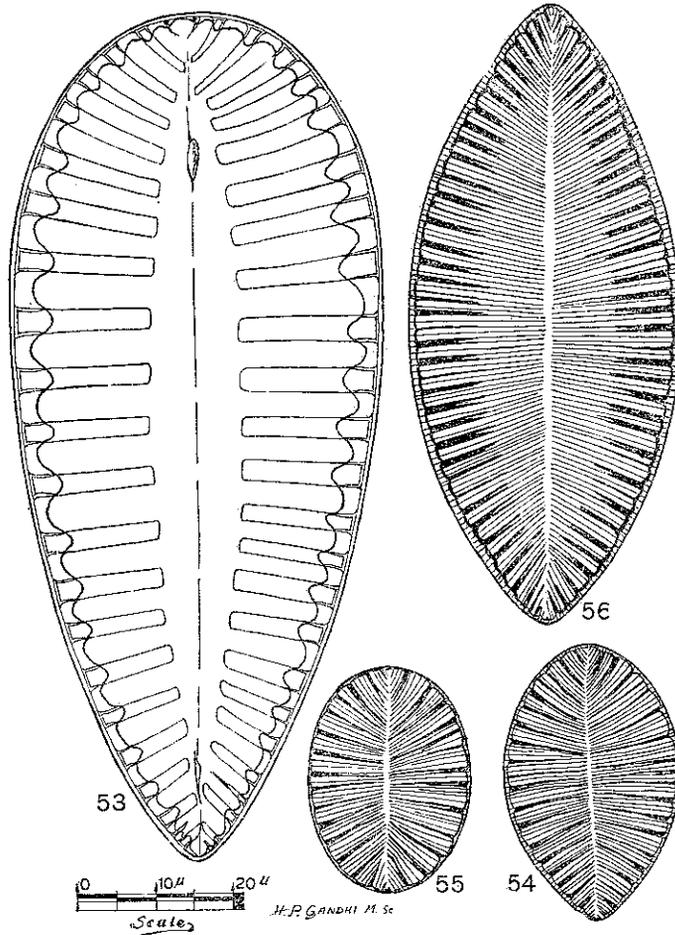
This form is a variable one, agrees very well with the type described and figured by Hustedt and others.

52. *Surirella lanceolata* sp. nov.

(Fig. 56)

Frustula magna ac robusta, aspectu medio rectangularia. Valvæ isopolares, late-lanceolatae, apicibus acutis et rotundatis. Pseudoraphe

angustissima, linearis. Costæ costellis similes, radiales, alternæ singulis usque trinis striis validis, ad quartam partem ad latitudinem valvæ veniens. Striæ ad median valvæ partem perveniunt, et pseudoraphen angustissimum reddunt. Frustula 62-91 μ longa; 35-42 μ lata; costæ 40-60 in 100 μ ; striæ 15-19 in 10 μ .



FIGS 53-56.—Fig 53. *Swirella tenera* Greg. var. *splendidula* A. S. Schm. Figs 54-55. *Swirella ovata* Kütz Fig 56. *Swirella lanceolata* sp nov.

Frustules large and robust, rectangular in the girdle view. Valves isopolar, broadly lanceolate with acute rounded ends. Pseudoraphe very narrow, linear. Costæ rib-like, radial, alternating with 1-3 strong striæ and reaching $\frac{1}{4}$ the breadth of the valve. Striæ reach the middle part of the valve to make a very narrow pseudoraphe. Rather rare.

Dimensions	Length 62-91 μ
	Breadth 35-42 μ
	Costæ 40-60 in 100 μ
	Striæ 15-19 in 10 μ

Distribution . . . India—Partabgarh (!) Fresh-water

This form was found embedded in the brownish scum along with *S. ovata* Kütz. It differs from *S. biseriata* Bréb. and its var. *bifrons* (Ehr.) Hust. (Hustedt, F., *op. cit.*, 1930, p. 432, figs. 831-832; p. 433, fig. 833 respectively), in not having distinct marginal folds and thick costæ. Moreover, the costæ here are rib-like and more numerous with very distinct and rather coarse striæ alternating with them. It also differs from *S. birostrata* Hust. (Hustedt, F., *op. cit.*, 1930, p. 434, fig. 841), in not having produced, acutely rounded ends, strong marginal folds, marginal rib-like costæ and marked striæ, etc. It is a distinctive form and does not resemble any other known types. Hence it is regarded as a new species.

SUMMARY

For the first time the Diatomaceæ of Partabgarh Rajasthan has been investigated and almost all the forms have been fully described and illustrated in these pages.

Brief accounts of topography, climate, geology, location and the history of the place are given.

The material for the present investigation was collected from a number of pools and ditches of the drying rain-water streams which surround the town.

In all fifty-two forms have been described, representing fourteen genera; of these fifty-two forms, twenty are new records for India, six are new species and two new forms.

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