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Freshwater Diatoms from Kolhapur and its immediate Environs[1]

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(*With fifty-one figures*)

INTRODUCTION

There are no records available of the freshwater diatom flora of Kolhapur, except for one on soil diatoms by the present author (1956). It is, therefore, considered desirable to survey the freshwater flora of the said area. This account is based on extensive collections made by the author during 1951-56, from many permanent, temporary, and ephemeral bodies of water in and around the city.

Kolhapur is a prosperous city and a vital hub of commerce to many towns and villages extending far beyond the Western Ghats. It lies on latitude 16° 42′ N. and longitude 74° 16′ E. at the terminus of the Miraj-Kolhapur section of the Southern Railway, on a plateau approximately of 1500 feet elevation. The annual average rainfall is 35 inches, the bulk of which is received during the monsoon. The climate is moderate. The geology is essentially of the Deccan Trap.

Material collected practically from all possible wet situations in and around the city was examined at the Rajaram College, Kolhapur, during 1953-56. While examining the material, it became evident that many forms found here are also recorded from Bombay and Salsette (Gonzalves and Gandhi, 1952-54), some of them widely distributed.

The classification and indentification of the forms has been done according to Hustedt's (1930) and Cleve-Euler's (1951-55) monographs. Besides these major works, Van Heurck's TREATISE ON DIATOMACEAE and several other works and papers have been referred to in preparation of this paper.

The dimensions given for the individual forms are those actually recorded. At the end of this paper a table is given suggesting the distribution of these diatoms in the said area and elsewhere in India as recorded by previous workers.

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[1][Article 35 of the *International Code of Botanical Nomenclature*, 1956 edition, reads as follows: 'Publication on or after 1 Jan 1958 of the name of new taxon of recent plants of the rank of order or below is valid only when the nomenclatural type is indicated (see Arts. 7—10).' Accordingly the various new forms published in this paper, even when the Latin description is supplied, must be considered as not validly published.—EDS]

Family COSCINODISCACEAE

1. **Melosira granulata** (Ehr.) Ralfs (Figs. 1-2)

Van Heurck, Treat. Diat. 444, t. 19, f. 621; Hustedt, Bacil. 87, f. 44: Cleve-Euler, A., Diat. Schwed. Finn.—I: 25, f. 15 a-b (=*M. granulata* v. *typica* A. Cl.).

Frustules 6-10 μ in diameter, semi-cell 12-14 μ high, cylindrical, united in short or long chains. End cell with spines and furrows, and straight rows of areoles, 8-10 in 10 μ; other cells have 9-11 rows in 10 μ, spirally disposed.

2. **Melosira granulata** v. **muzzanensis** Meister (Fig. 3)

Hustedt, Bacil. 88, f. 47; Cleve-Euler, A., Diat. Schwed. Finn.—I: 25, f. 15 f.

Frustules 14-16 μ in diameter, semi-cell 10-11 μ high, short-cylindrical or discoid, otherwise like the type. Rows of areoles 9-10 in 10 μ.

3. **Cyclotella meneghiniana** Kütz. f. **binotata** Grun. (Fig. 4)

Cleve-Euler, A., Diat. Schwed. Finn.—I: 48, f. 63 c (=C. *meneghiniana* v. *genuina* A. Cl. f. *binotata* Grun.).

Valves 13-16 μ in diameter, discoidal. Central field inconspicuously punctate with two distinct dots. Striae 8-9 in 10 μ, thick and radial.

The varietal epithet 'v. *genuina*' which refers to the type proper is eliminated since it is out of vogue.

Family FRAGILARIACEAE

4. **Fragilaria rumpens** (Kütz.) Carlson v. **familiaris** (Kütz.) A. Cl. (Figs. 5-6)

Cleve-Euler, A., Diat. Schwed. Finn.—II: 42, f. 352 c-e; Hustedt, Bacil. 156, f. 176 [=*Synedra rumpens* Kütz. v. *familiaris* (Kütz.) Grun.].

Valves 69-96 μ long and 2.7-3 μ broad, narrowly lanceolate, walls twice constricted in the middle with ends produced and somewhat capitate. Pseudoraphe narrow. Central area present. Striae 17-19 in 10 μ, fine.

The form agrees well with the type except that some forms found in this region were definitely longer than those recorded in the literature.

5. **Synedra ulna** (Nitz.) Ehr. v. **subaequalis** Grun. (Fig. 17)

Cleve-Euler, A., Diat. Schwed. Finn.—II: 61, f. 382 f-i.

Valves 300-495 μ long and 6.5-8 μ broad, linear, slightly bent with narrowed, constricted, produced broadly subcapitate ends. Pseudoraphe narrow, linear; central area present or absent. Striae 8-9 in 10 μ, coarse.

FIGURES 1-16

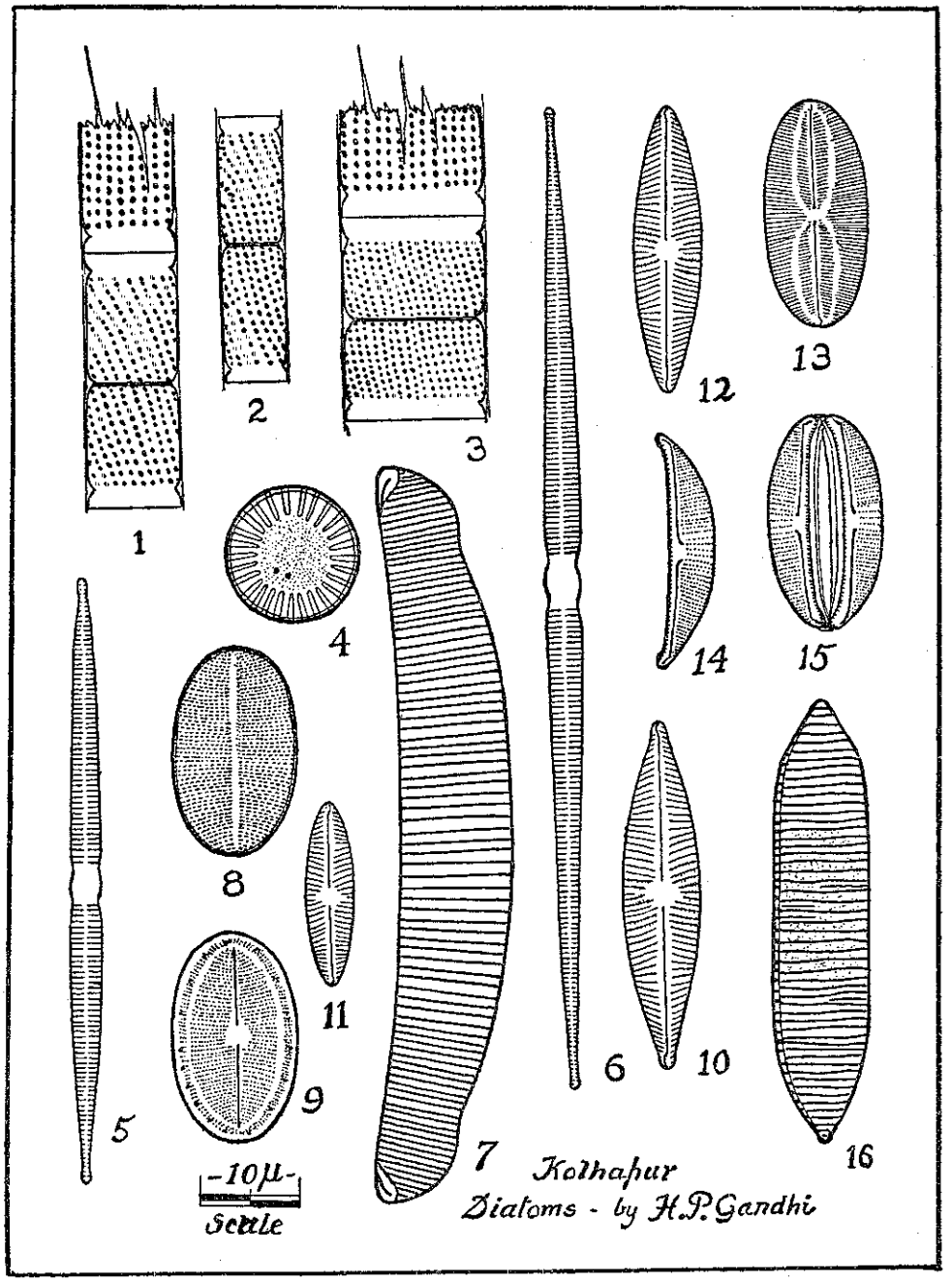

Fig. 1-2. *Melosira granulata* (Ehr.) Ralfs ; 3. *M. granulata* v. *muzzanensis* Meistei ; 4. *Cyclotella meneghiniana* Kütz. f. *binotata* Grun ; 5-6 *Fragilaria rumpens* (Kütz.) Carl. v. *familiaris* (Kütz.) A. Cl. ; 7. *Eunotia major* (W. Sm.) Rabh. v. *indica* (Grun.) A. Berg ; 8-9. *Cocconeis placentula* Ehr. ; 10. *Navicula cryptocephala* Kütz. ; 11-12. *N. cayptocephala* v. *subsalina* Hustedt ; 13. *N. pygmaea* Kütz. ; 14-15 *Amphora veneta* Kütz. ; 16. *Nitzschia tryblionella* Hantz v. *levidensis* (W. Sm.) Grun.

FIGURES 17-31

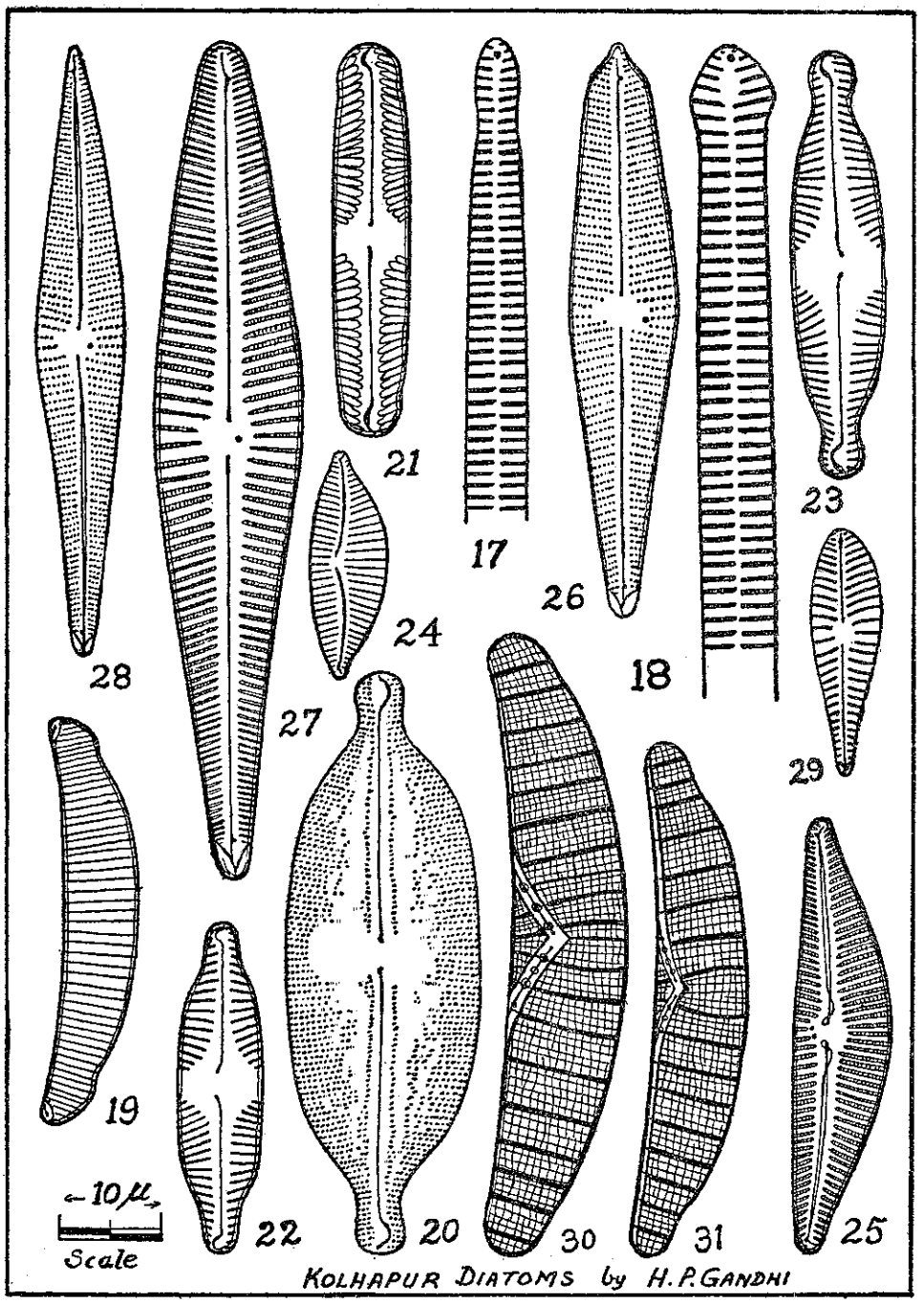

Fig. 17. *Synedra ulna* (Nitz.) Ehr. v *subaequalis* Grun ; 18. *S. ulna* v. *biceps* Kütz. ; 19. *Eunotia major* (W. Sm) Rabh. v. *indica* (Grun.) A. Berg ; 20. *Anomoeoneis sphaerophora* (Kütz.) Pfit. ; 21 *Pinnularia kolhapurensis* sp. nov. ; 22. *P. notata* (Perag. & Hèr.) A. Cl. v. *rostrata* A. Cl. ; 23. *P. biceps* Greg. v. *amphicephala* (May.) A. Cl. ; 24. *Cymbella kerkevarensis* A. Cl. ; 25. *C. tumidula* Grun. ; 26. *Gomphonema subapicatum* Fritsch & Rich. ; 27. *G. lanceolatum* Ehr. ; 28. *G. spicula* sp. nov. ; 29. *G. olivaceum* (Lyng) Kütz. ; 30. *Epithemia zebra* (Ehr) Kütz. ; 31. *E. zebra* v. *proboscidea* (Kütz.) Grun.

6. **Synedra ulna** v. **biceps** Kütz. (Fig. 18)

Hustedt, Bacil. 154, f. 166 ; Cleve-Euler, A., Diat. Schwed. Finn.—II : 62, f. 382 1.

Valves 250-425 μ long and 6-7 μ broad, linear, bent in the middle, with swollen, broadly subcapitate ends. Pseudoraphe narrow. Striae 7-8 in 10 μ, very coarse.

Family EUNOTIACEAE

7. **Eunotia major** (W. Sm.) Rabh. v. **indica** (Grun.) Å. Berg (Figs. 7, 19)

Berg. Å., *Bot. Not.* 1939 : 452 ; Cleve-Euler, A., Diat. Schwed. Finn.—II : 120, f. 456 r.

Valves 38-68 μ long and 7.7- 10μ broad, sublinear, arcuate with ventral side concave and dorsal side convex, ends constricted on the dorsal side, obliquely capitate-wedge-shaped. Polar nodules small. Striae 9-10 in the middle and 12-14 in 10 μ, at the ends.

Family ACHNANTHACEAE

8. **Cocconeis placentula** Ehr. (Figs. 8-9)

Hustedt, Bacil. 189, f. 260 a-b ; Cleve-Euler, A., Diat. Schwed. Finn.—III : 8, f. 492 a-b (= *C. placentula* v. *genuina* Mayer)

Valves 15-30 μ long and 10-16 μ broad, elliptical. Valve with raphe : raphe thin and straight ; axial area very narrow ; central area small, roundish ; striae 27 in 10 μ, finely punctate, marginal rim distinct. Valve without raphe : pseudoraphe narrow, linear ; striae 23-25 in 10 μ, interrupted by many closely placed longitudinal, somewhat wavy hyaline bands.

Family NAVICULACEAE

9. **Mastogloia recta** Hustedt (Fig. 32)

Voigt, M., *J. roy. microsc. Soc.* 75 : 191, t. 2, f. 3.

Valves 41-47 μ long and 13-13.5 μ broad, linear-elliptical with slightly constricted, produced obtusely rounded ends. Raphe thick, complex with slightly unilaterally bent central pores. Axial area narrow, linear ; central area fairly large, roundish. Belt of loculi arcuate, slightly away from the margins ; loculi 9-10 in 10 μ, each loculus 1-1.3 μ long and 2-3 μ broad. Striae 12-14 in 10 μ, radial throughout or sometimes inconspicuously convergent at the extreme ends, coarse and clearly punctate, 1-2 median striae smaller or deformed.

This form agrees well with the type (photomicrograph) given by Voigt, except that the margins are feebly convex and the ends slightly produced.

10. **Mastogloia recta** v. **pulchella** Voigt (Figs. 33-35)

Voigt, M., *J. roy. microsc. Soc.*, 75 : 191, t. 2, f 4.

Frustules epiphytic on *Chara*, united in short ribbons, broadly rectangular in girdle view with two longitudinal belts of loculi. Valves 24-35 μ long and 11-13 μ broad, broadly lanceolate with slightly constricted, produced obtuse ends. Raphe, central and axial areas as in the type. Loculi 8-9 in 10 μ, each loculus except the end ones, 1-1.2 μ long and 2-3 μ broad. Striae 13-14 in 10 μ radial throughout or at the extreme ends 2-3 striae either perpendicular or convergent, coarse and clearly punctate, punctae 22-23 in 10 μ, 1-2 median striae smaller or somewhat deformed

11. **Anomoeoneis sphaerophora** (Kütz.) Pfitzer (Fig. 20)

Hustedt, Bacil. 262, f. 422 ; Cleve-Euler, A., Diat. Schwed. Finn.—III : 202, f. 928 a (=*A. sphaerophora* v. *genuina* A. Cl.).

Valves 50-55 μ long and 17-18.5 μ broad, sub-elliptical to elliptical lanceolate with narrowed, produced, slightly capitate ends. Raphe thin with curved central pores. Axial area very narrow ; central area large, unilaterally widened. Striae 16-18 in 10 μ, coarsely punctate, towards the axial part interrupted by broad, irregular, longitudinal wavy hyaline bands

12. **Navicula cuspidata** Kütz. f. **brevirostrata** f. nov. (Fig. 36)

Valvae 58.8-68 μ longae atque 18-20 μ latae, elliptico-lanceolatae, apicibus constrictis ac brevi-rostrato-subtruncatis. Raphe tenuis et recta, poris centralibus hamo-similibus. Area axialis angustissima, linearis ; area centralis vix evoluta. Striae transversales 14-16 in 10 μ, plerumque perpendiculares ad lineam mediam, striae longitudinales tenuissimae, indistinctae, circa 26-28 in 10 μ.

Valves 58.8-68 μ long and 18-20 μ broad, elliptic-lanceolate with constricted, shortly rostrate subtruncate ends. Raphe thin and straight with central pores hook-like. Axial area very narrow, linear ; central area scarcely formed. Striae transverse 14-16 in 10 μ, mostly perpendicular to the middle line, longitudinal striae very fine, almost indistinct, about 26-28 in 10 μ.

A few frustules observed in the collection, differed from the type in being more elliptical-lanceolate with constricted, shortly rostrate-subtruncate ends. Hence, such specimens have been tentatively regarded as a new form.

13. **Navicula cuspidata** v. **ambigua** (Ehr.) Cl. (Fig. 37)

Hustedt, Bacil. 268, f. 434 ; Cleve-Euler, A., Diat. Schwed. Finn.—V : 18, f. 1353 g (=*N. cuspidata* Kütz. v. *ambigua* (Ehr.) Cl. f. *crati-*

cularis A. Cl.); Van Heurck, Treat. Diat. 214, t. 4, f. 193 (=*N. ambigua* Ehr. f. *craticula* V. H.)

Valves 81-91 μ long and 17-18 μ broad, narrowly rhombic-lanceolate with constricted, produced feebly capitate ends. Craticular plates sometimes present. Raphe thin and straight with central pores hook-like. Axial area very narrow, linear; central area scarcely formed. Striae transverse 16-17 in 10 μ, almost perpendicular to the middle line, longitudinal striae fine, almost indistinct, about 28 in 10 μ.

This form appears to be slender as compared to Hustedt's form but agrees well with others. In some forms craticular plates were also observed as indicated by Van Heurck and Cleve-Euler in their illustrations and such forms they have regarded as forma *craticula* and f. *craticularis*, respectively. Here, these forms have been included under *N. cuspidata* v. *ambigua* (Ehr.) Cl., since craticular stages are immobile stages induced under unfavourable conditions of the environment (Smith, G. M., Cryptogamic Botany, II : 207).

14. **Navicula minuta** (Cleve) A. Cl. (Fig. 38)

Cleve-Euler, A., Diat. Schwed. Finn.—III : 142, f. 791 a (=*N. minuta* v. *genuina* A. Cl.).

Valves 19-20 μ long and 7 μ broad, broadly lanceolate with constricted, shortly capitate ends. Raphe thin and straight with central pores closely set. Axial area very narrow; central area small, roundish. Striae 22-24 in 10 μ, radial and fine.

This diatom agrees well with the type, except that it is somewhat smaller in dimensions. It also compares well with *N. carassius* Ehr., as described by Donkin (Donkin, Brit. Diat. 20, t. 3, f. 7), in the outline. But as the dimensions are not indicated, the comparison is difficult. Moreover, the ends are described to be produced which are here capitate, hence it differs.

15. **Navicula cryptocephala** Kütz. (Fig. 10)

Hustedt, Bacil. 295, f. 496; Cleve-Euler, A., Diat. Schwed. Finn.—III : 154, f. 813 a-e (= *N. cryptocephala* v. *genuina* A. Cl.).

Valves 27-44 μ long and 6-7 μ broad, lanceolate with somewhat constricted produced ends. Striae 14-17 in 10 μ, lineate, radial in the middle and convergent at the ends.

16. **Navicula cryptocephala** v. **subsalina** Hust. (Figs. 11-12)

Cleve-Euler, A., Diat. Schwed. Finn.—III : 154, f. 813 i-j, n.

Valves 18-27 μ long and 5-6.6 μ broad, lanceolate with rounded ends. Raphe thin and straight. Axial area very narrow, linear; central area small, elliptical. Striae 14-17 in 10 μ, radial in the middle and convergent at the ends, lineate.

17. **Navicula pygmaea** Kütz. (Fig. 13)

Hustedt, Bacil, 312, f 561; Cleve-Euler, A., Diat Schwed Finn.—III: 105, f. 708.

Valves 18-25 μ long and 9-10 μ broad, elliptical Raphe thin and straight with central pores closely set and distinct. Axial area very narrow; central area small, rectangular. Striae 26-28 in 10 μ, radial, interrupted in the axial region by a H-shaped hyaline area.

18. **Pinnularia kolhapurensis** sp. nov. (Fig 21)

Valvae 36-40 μ longae atque 8.5 μ latae, sublineares, apicibus aliquantum constrictis, productis atque truncato-rotundatis. Raphe tenuis et recta, ornata poris centralibus unilateraliter inclinatis, fissuris terminalibus aliquantum curvatis. Area axialis angusta ; area centralis lata, rhomboidea ad latera perveniens. Striae 11-13 in 10 μ, crassae, proximae positae, radiales in medio ac convergentes in utroque apice.

Valves 36-40 μ long and 8.5 μ broad, sublinear with slightly constricted, produced, truncate rounded ends. Raphe thin and straight with unilaterally bent central pores and slightly curved terminal fissures Axial area narrow ; central area wide, rhomboid, reaching the sides. Striae 11-13 in 10 μ, thick, closely set, radial in the middle and convergent at the ends.

This form remotely resembles *P. subcapitata* Greg. (Hustedt, Bacil 317, f 571; Cleve-Euler, A , Diat. Schwed. Finn —IV : 64, f. 1090 a-b) (=*P. subcapitata* v. *genuina* A. Cl.); Lund, J. W. G , *New Phytol.* 45: 90, f. 10 I-V), in the outline and somewhat in ends However, the present form appears to be distinctive, as it is proportionately much broader than *P subcapitata*, besides having closely set striae and rhomboidal central area. Hence it is tentatively considered to be a new species.

19. **Pinnularia notata** (Perag. & Hér.) A. Cl. v. **rostrata** A. Cl (Fig 22)

Cleve-Euler, A., Diat. Schwed Finn.—IV : 56, f 1075 e-f, k.

Valves 27-35 μ long and 8-8.5 μ broad, linear with somewhat abruptly constricted, produced rounded ends Raphe thin and straight. Axial area narrow, linear ; central area very large reaching the sides. Striae 10-12 in 10 μ, coarse, radial in the middle and convergent at the ends.

This diatom agrees well with the type, except that some smaller forms were also recorded in the area.

20. **Pinnularia biceps** Greg. v **amphicephala** (May.) A. Cl (Fig 23)

Cleve-Euler, A., Diat. Schwed. Finn.—IV : 63, f 1088 i; Hustedt, Bacil. 319, f 578 [= *P. braunii* (Grun) Cl. v. *amphicephala* (A. Mayer) Hustedt].

Valves 42-45 μ long and 8.5-9 μ broad, sublinear with slightly convex sides and constricted capitate ends. Raphe thin and straight with central pores unilaterally bent and closely set; terminal fissures curved. Axial area narrow; central area very large, rhomboid, reaching the sides. Striae 10-12 in 10 μ, coarse, radial in the middle and convergent at the ends.

The form recorded from this area agrees well with the type, except that they are slightly broader.

21. **Amphora veneta** Kütz. (Figs. 14-15)

Hustedt, Bacil. 345, f. 631 ; Cleve-Euler, A , Diat. Schwed Finn.—III : 96, f. 682,

Frustules 13-24 μ long and 8-10 μ broad, broadly elliptical with somewhat subtruncate ends in the girdle view. Valves 4-4.5 μ broad, strongly convex on the dorsal side and slightly concave on the ventral margin with inwardly bent rounded ends. Raphe thin, very close to the ventral margin with central pores dorsally directed. Striae 16-20 in 10 μ, in the middle and up to 27 at the ends, median striae clearly punctate, end striae very finely punctate and rather indistinct, radial throughout. Ventral margin very shortly punctate.

This form is described by Krishnamurthy (1954) where he indicates that the frustules have constriction in the middle zone. However, the present author observed no such constrictions in any of his forms collected from several places, and he finds no such point mentioned either by Hustedt (1930) or Cleve-Euler (1953).

22. **Cymbella kerkevarensis** A. Cl. (Fig. 24)

Cleve-Euler, A., Diat. Schwed. Finn.—IV: 146, f. 1215.

Valves 22-25 μ long and 7.7-8 μ broad, asymmetrical with strongly convex dorsal side and slightly convex ventral side, ends slightly constricted and rostrate. Raphe thin, slightly arcuate or apparently straight, excentric and strongly marked. Axial area very narrow; central area very small. Striae 11-13 in 10 μ, throughout radial and finely punctate.

This form agrees well with the type, except that it is somewhat smaller in dimensions.

23. **Cymbella tumidula** Grun. (Fig 25)

Hustedt, Bacil. 361, f. 669; Cleve-Euler, A., Diat. Schwed Finn.—IV : 157, f. 1239 a-b (= *C. tumidula* v. *genuina* A. Cl.)

Valves 35-40 μ long and 8.8-9 μ broad, asymmetrical, lanceolate with strongly convex dorsal side and slightly convex ventral side ; ends constricted and produced, rounded. Raphe thick, excentric. Axial area very narrow ; central area slightly widened towards the dorsal side, ventral side with two distinct puncta. Striae 12-14 in 10 μ, radial, indistinctly punctate and somewhat closer at the ends.

24 **Gomphonema subapicatum** Fritsch & Rich. (Fig. 26)

Gandhi, H. P., *J. Indian bot. Soc.* 35 : 205, f. 22.

Valves 55-60 μ and 10-11 μ broad, lanceolate-clavate with constricted, subapiculate apex and attenuated base. Raphe thin and straight. Central area with an isolated stigma on one side. Striae 10-13 in 10 μ, radial and distinctly punctate.

25 **Gomphonema lacus-rankala** sp. nov. (Fig. 39)

Valvae 69-90 μ longae atque 18.5-20 μ latae, late lanceolato-clavatae, apice constricto, late rostrato-rotundato, ad basim concavo, attenuato-rotundato. Raphe crassa, cum portione centrali unilateraliter inclinata. Area axialis angustissima, lanceolata; area centralis aliquantum unilateralis cum unico stigmate in latere opposito. Striae 8-9 in 10 μ, radiales, crassae atque distincte punctatae, punctis 16-17 in 10 μ.

Valves 69-90 μ long and 18 5-20 μ broad, broadly lanceolate-clavate with constricted, broadly rostrate rounded apex and somewhat concave attenuated rounded base. Raphe thick with central portion unilaterally bent. Axial area narrowly lanceolate ; central area slightly unilateral with a stigma on the opposite side. Striae 8-9 in 10 μ, radial, coarse and distinctly punctate, puncta 16-17 in 10 μ

This form bears some resemblance with *G. subapicatum* Frit. & Rich. described above, in the outline and constricted apex. However, it differs from it in having thick raphe with unilaterally bent central part, conspicuously rostrate apex, very coarsely punctate striae and some other details. It, therefore, appears to be a distinctive form, hence it is considered to be a new species

26. **Gomphonema lacus-rankala** v. **robusta** v. nov. (Fig. 40)

Valvae 90-101 μ longae atque 18.7 μ latae, robustae, longo-lanceolato-clavatae, apice aliquantum constricto, rostrato-rotundato, ad basim attenuato, rotundato Striae 8-10 in 10 μ, crasse punctatae, ac aliquantum radiales. In coeteris ut typus.

Valves 90-101 μ long and 18.7 μ broad, robust, long-lanceolate-clavate with slightly constricted, rostrate-rounded apex and attenuated rounded base. Striae 8-10 in 10 μ, coarsely punctate and slightly radial. In other details like the above type.

This form differs from the above type in being elongated, more lanceolate-clavate, robust with somewhat prominently rostrate apex. It is, therefore, regarded as a new variety of *G. lacus-rankala*, with which it occurred in a good number.

27 **Gomphonema lacus-rankala** v. **gracilis** v. nov. (Fig 41)

Valvae 100-112 μ longae atque 15 μ latae, angustissime-lanceolato-clavatae, apice aliquantum constricto, tenuissime producto, ad basim

FIGURES 32-51

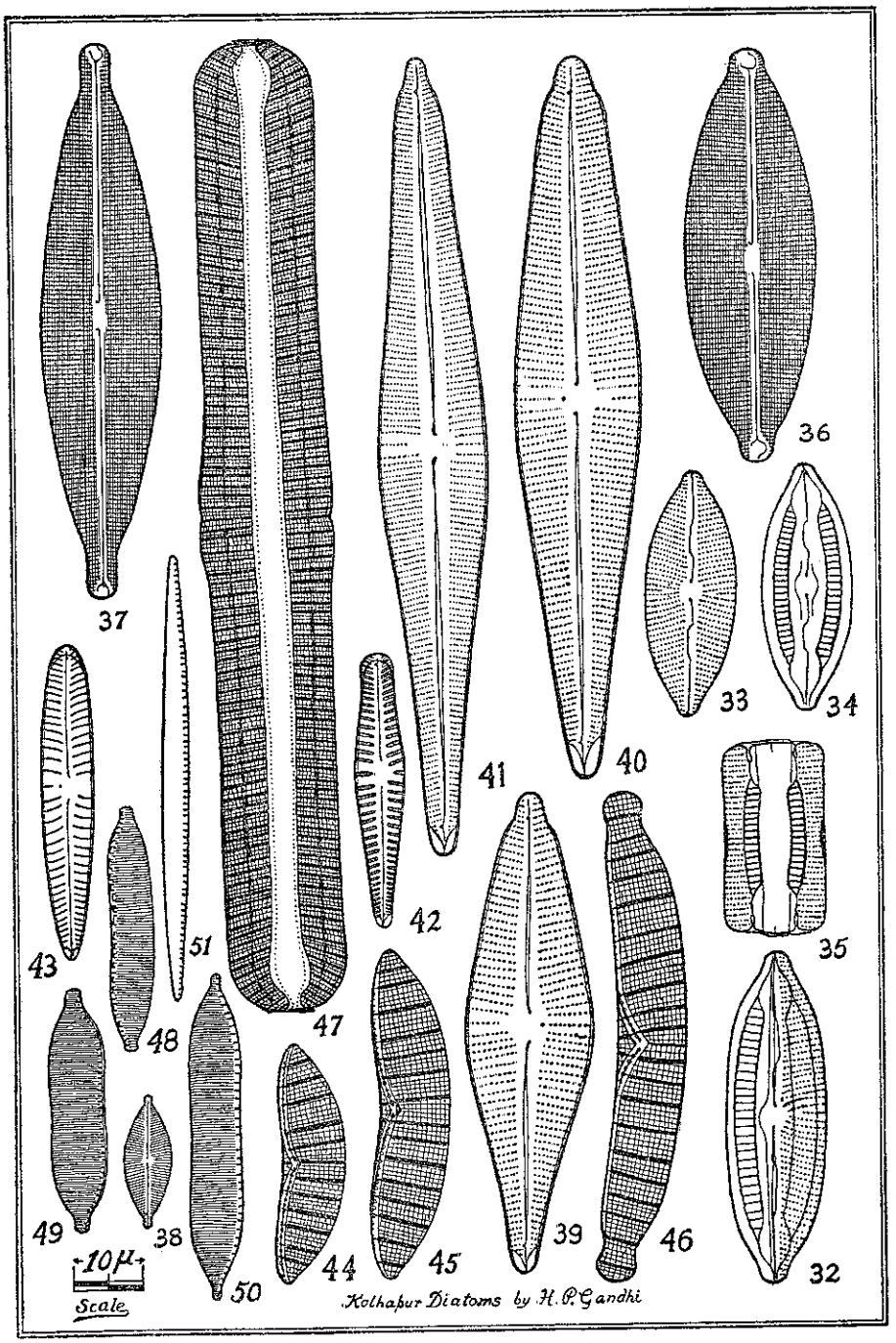

Fig 32. *Mastogloia recta* Hustedt ; 33-35. *M. recta* v. *pulchella* Voigt ; 36. *Navicula cuspidata* Kütz f. *brevirostrata* f. nov. ; 37. *N. cuspidata* v. *ambigua* (Ehr.) Cl. ; 38. *N. minuta* (Cleve) A. Cl. ; 39. *Gomphonema lacus-rankala* sp. nov. ; 40. *G. lacus-rankala* v. *robusta* v. nov. ; 41. *G. lacus-rankala* v. *gracilis* v nov. ; 42. *G. intricatum* Kütz. ; 43. *G. intricatum* v *bohemicum* (Reichelt & Fricke) A. Cl ; 44-45. *Epithemia zebra* (Ehr.) Kütz. v. *frickei* A. Cl. ; 46. *E. zebra* v. *porcellus* (Kütz.) Grun. ; 47. *Rhopalodia gibba* (Ehr.) O. Müll. ; 48. *Hantzschia amphioxys* (Ehr.) Grun. v. *densestriata* (Font.) A. Cl. ; 49. *Nitzschia thermalis* Kütz. v. *minor* Hilse ; 50. *N. commutata* Grun. v *pamirensis* (Hust.) A. Cl ; 51. *N. gandersheimiensis* Krasske.

attenuato rotundato. Raphe, area axialis atque centralis ut in typo. Striae 8-10 in 10 μ, radiales atque punctatae, punctis 20-22 in 10 μ, striae aliquantum proxime positae in utroque apice.

Valves 100-112 μ long and 15 μ broad, narrowly-lanceolate-clavate with very slightly constricted, much produced narrower apex and attenuated rounded base. Raphe, central and axial areas as in the type. Striae 8-10 in 10 μ, radial, punctate, puncta 20-22 in 10 μ, striae somewhat closely set at the apices.

This form agrees well with *G. lacus-rankala*, in the outline, apex, raphe and striae. However, it differs from the same in being slender, with more pointed apex. Moreover, the striae have comparatively finer puncta. It is, therefore, regarded as a new variety of *G. lacus-rankala* with which it occurred in a smaller number.

28. **Gomphonema lanceolatum** Ehr. (Fig. 27)

Hustedt, Bacil. 376, f. 700 ; Cleve-Euler, A., Diat. Schwed. Finn.— IV : 184, f. 1280 a-e (= *G. lanceolatum* v. *genuinum* A. Cl.).

Valves 60-70 μ long and 12 μ broad, lanceolate-clavate with distinctly rounded apex and base, base somewhat narrower. Raphe slightly thick and straight. Axial area narrow, linear ; central area slightly unilateral with an isolated stigma on the opposite side. Striae 8-13 in 10 μ, radial and lineate.

29. **Gomphonema spicula** sp. nov. (Fig. 28)

Valvae 38-58 μ longae atque 5.5-8 μ latae, anguste lanceolato-clavatae, aliquantum arcuatae, apice acutissimo, basi gradatim fastigata. Raphe crassa, cum portione centrali unilateraliter inclinata, fissuris terminalibus distinctis. Area axialis angustissima, linearis ; area centralis quadrata, unilateralis cum unico stigmate in latere opposito. Striae 12-15 in 10 μ, radiales, distincte punctatae, punctis tenuibus sed distinctis.

Valves 38-58 μ long and 5.5-8 μ broad, narrowly lanceolate-clavate, slightly curved with very acute apex and gradually attenuated base. Raphe thick with central part unilaterally bent and terminal fissures distinct. Axial area very narrow, linear ; central area quadrate and unilateral with an isolated stigma on the opposite side. Striae 12-15 in 10 μ, radial, distinctly punctate, but fine.

This form does not agree with any of the known types of *Gomphonema*, hence, it is considered to be a new species.

30. **Gomphonema intricatum** Kütz. (Fig. 42)

Hustedt, Bacil. 375, f. 697 ; Cleve-Euler, A., Diat. Schwed. Finn.— IV : 187, f. 1283 a-d (= *G. intricatum* v. *genuinum* Mayer).

Valves 39-42 μ long and 5.5-6.7 μ broad, subclavate with constricted slightly swollen broadly rounded apex and attenuated rounded base

Raphe slightly thick. Axial area narrow, linear ; central area unilateral with an isolated stigma on the opposite side. Striae 8-9 in 10 μ, in the middle up to 12 at the apices, radial, coarse, punctate, median striae very small and widely set

31. **Gomphonema intricatum** v **bohemicum** (Reich. & Fricke) A. Cl. (Fig. 43)

Cleve-Euler, A., Diat. Schwed Finn. IV : 189, f. 2183 v-w ; Hustedt, Bacil 377, f. 718 a-c (= *G. bohemicum* Reich. & Fricke).

Valves 40-45 μ long and 7-7.5 μ broad, linear-clavate with broadly rounded, somewhat thickened apex and acutely rounded base. Raphe thin and straight. Axial area linear ; central area unilaterally reaching the side, large with an isolated stigma on the opposite side. Striae 6-8 in 10 μ in the middle and up to 11 at the ends, slightly radial and curved, indistinctly punctate.

32 **Gomphonema olivaceum** (Lyng.) Kütz. (Fig 29)

Hustedt, Bacil 378, f. 719 a-c ; Cleve-Euler, A , Diat. Schwed. Finn.—IV : 192, f. 1291 f-g (= *G. olivaceum* v. *genuinum* Mayer)

Valves 20-24 μ long and 6-6.5 μ broad, clavate with broadly rounded apex and attenuated base. Raphe thin and straight. Axial area somewhat narrow ; central area moderate without an isolated stigma. Striae 8-11 in 10 μ, radial and curved.

Family EPITHEMIACEAE

33 **Epithemia zebra** (Ehr.) Kütz. (Fig. 30)

Van Heurck, Treat. Diat. 296, t. 9, f. 357 ; Hustedt, Bacil. 384, f. 729 ; Cleve-Euler, A., Diat. Schwed. Finn.—V : 37, f. 1409 a-f (= *E. zebra* v *genuina* Grun.).

Frustules free or were found as epiphyte on *Hydrilla* and *Chara*, rectangular in girdle view. Valves 40-50 μ long and 8-9 μ broad, arcuate with dorsal side convex and ventral side concave, ends very slightly or not at all constricted, narrow to obtusely rounded. Raphe in the raphe-canal reaching $\frac{1}{3}$–$\frac{1}{2}$ the breadth of the valve. Costae 3-4 in 10 μ, strong and radial, alternating with 3-5 rows rarely 2 rows of alveoli, rows of alveoli 12-13 in 10 μ.

34. **Epithemia zebra** v. **frickei** A. Cl. (Figs. 44-45)

Cleve-Euler, A., Diat. Schwed Finn.—V : 37, f. 1409 h ; Hustedt, Bacil. 387, f. 732 (= *E. intermedia* Fricke).

Frustules were found epiphytic on *Chara* and *Hydrilla*, rectangular in girdle view. Valves 36-49 μ long and 9.7-10 μ broad, slightly arcuate ; dorsal side convex or in larger forms somewhat straight in the middle

part; ventral side more less concave; ends slightly depressed, backwardly oriented and rounded. Raphe in the raphe-canal very close to the ventral margin, slightly curved in the middle or sometimes reaching ¼ the breadth of the valve. Costae 3-4 in 10 μ, almost parallel with one another, alternating with 3-5 rows of alveoli, rows of alveoli 12-13 in 10 μ, fairly well developed.

This form is treated according to Cleve-Euler's diagnosis, since it does not show any appreciable difference with *E. zebra*, in its general organisation. Here, therefore, Hustedt's *E intermedia* Fricke is considered to be the variety of *E. zebra*.

35. **Epithemia zebra** v. **proboscidea** (Kütz.) Grun. (Fig. 31)

Cleve-Euler, A., Diat. Schwed. Finn.—V : 38, f. 1409 m-n.

Frustules were found epiphytic on *Chara* or *Hydrilla*, sometimes isolated rectangular in girdle view. Valves 50-53 μ long and 8-8 μ, broad, linear, arcuate with strongly constricted, produced rounded ends. Raphe in the raphe-canal reaching ⅓ the breadth of the valve. Costae 3-3.5 in 10 μ, alternating with 3-5 rows of alveoli; rows of alveoli 12-13 in 10 μ, quite distinct.

A few forms observed in the collection, none showed capitate ends as indicated by Van Heurck for his specimen (Van Heurck, Treat. Diat. 297, t. 9, f. 358). However, the present form agrees well with figure '1409 m', given by Cleve-Euler, hence it is so treated.

36. **Epithemia zebra** v. **porcellus** (Kütz.) Grun. (Fig. 46)

Skvortzow, B. W., *Philipp. J. Sci.*, 65 : 416, t. 2, f. 3; Cleve-Euler, A., Diat. Schwed. Finn.—V : 38, f. 1409 q.

Frustules were found epiphytic on *Chara* and *Ceratophyllum* along with the type, rectangular in girdle view. Valves 60-71.5 μ long and 8.8-10 μ broad, slightly arcuate, linear with conspicuously constricted, broadly capitate rounded ends, sometimes ends slightly backwardly bent. Raphe in the raphe-canal reaching the centre. Costae 3-3.5 in 10 μ, radial, alternating with 3-4 rows of alveoli, rarely 5, rows of alveoli 12-13 in 10 μ.

Hustedt's *E. zebra* v. *porcellus* (Kütz.) Grun. (Hustedt, Bacil. 385, f. 731) is treated as *E. zebra* v. *proboscidea* (Kütz.) Grun., by Cleve-Euler, since its ends are neither strongly constricted-capitate nor backwardly bent.

37. **Rhopalodia gibba** (Ehr.) O. Müll. (Fig. 47)

Hustedt, Bacil. 390, f. 740; Cleve-Euler, A., Diat. Schwed. Finn.—V : 44, fig. 1416 a, e (=*R. gibba* v. *genuina* Grun.); Van Heurck, Treat. Diat. 296, t. 9, f. 352 (=*Epithemia gibba* Kütz.).

Frustules free or found epiphytic on *Chara* and *Ceratophyllum*, 80-124 μ long and 18-20 μ broad, elongated, linear with slightly notched inflations in the middle ; ends subtruncate, slightly swollen with rounded corners. Valves 7-9 μ broad, dorsal side slightly bulged in the middle with a notch, ventral side straight with a slight depression at the ends which are acutely rounded. Costae 6-7 in 10 μ, becoming strongly radial towards the ends, alternating with 2-3 rows of alveoli, rows of alveoli 12-14 in 10 μ, fine but distinct, crossed by a hazy longitudinal band or fold.

This specimen agrees very well with illustrations given by Cleve-Euler and Van Heurck, but differs from that of Hustedt's which shows ends to be gradually narrowed in girdle view, as in *R. gibba* v. *ventricosa* (Ehr.) Grun. (Hustedt, Bacil. 391, f. 741 ; Cleve-Euler, A., Diat. Schwed. Finn.—V : 44, f. 1416 c-d).

Family NITZSCIACEAE

38. **Hantzschia amphioxys** (Ehr.) Grun. v. **densestriata** (Font.) A. Cl. (Fig. 48)

Cleve-Euler, A., Diat. Schwed. Finn.—V : 49, f. 1419 n-p.

Valves 35-38 μ long and 5-5.5 μ broad, slightly arcuate, linear with constricted, rostrate obtuse ends. Keel excentric with keel puncta 9-10 in 10 μ, distinct. Striae 23-24 in 10 μ, fine but distinct.

39. **Nitzschia tryblionella** Hantz. v. **levidensis** (W. Sm.) Grun. (Fig. 16)

Hustedt, Bacil. 399, f. 760 ; Cleve-Euler, A., Diat. Schwed. Finn.—V : 51, f. 1430 i-l.

Valves 31-50 μ long and 8.7-10.5 μ broad, linear with constricted, slightly produced ends. Keel excentric, notched in the middle, keel puncta 10-11 in 10 μ. Striae 11-13 in 10 μ, coarse and undulate.

40. **Nitzschia thermalis** Kütz. v. **minor** Hilse (Fig. 49)

Hustedt, Bacil. 403, f. 772 ; Cleve-Euler, A., Diat. Schwed. Finn.—V. 6, 4f. 1445 g-h.

Valves 30-35 μ long and 7-7.5 μ broad, linear, concave in the middle with wedge-shaped, constricted rostrate ends. Keel excentric, keel puncta 10-12 in 10 μ. Striae over 30 in 10 μ, fine and seen with difficulty.

41. **Nitzschia commutata** Grun. v. **pamirensis** (Hust.) A. Cl. (Fig. 50)

Cleve-Euler, A. Diat. Schwed. Finn.—V : 64, f. 1443 c.

Valves 45-47 μ long and 7.7 μ broad, linear, concave in the middle with wedge-shaped, constricted, shortly capitate ends. Keel excentric, keel puncta 8-9 in 10 μ, distinct. Striae about 24 in 10 μ, fine.

42. **Nitzschia gandersheimiensis** Krasske (Fig. 51)

Hustedt, Bacil. 417, f. 804 ; Cleve-Euler, A., Diat. Schwed. Finn.—V : 86, f. 1495 b.

Valves 46-63 μ long and 3.4-4.4 μ broad, narrowly linear-lanceolate or lanceolate with somewhat constricted, produced rounded ends. Keel excentric, keel puncta distinct, somewhat irregularly disposed, 8-11 in 10 μ. Striae very fine, indistinct probably over 35 in 10 μ.

In the following table, in addition to the above named diatoms, others are also included which occurred in the said area. Since these are being described and illustrated from other places by the author and as they do not show any special feature of interest, it is therefore considered sufficient merely to list them and indicate their distribution in this region and other places in India

TABLE SHOWING THE DISTRIBUTION OF DIATOMS COLLECTED FROM KOLHAPUR AND ITS IMMEDIATE VICINITY

List of Diatoms	Place of collection in Kolhapur	Previous place of collection in India and its author[1]
Achnanthes minutissima Kütz	Rankala, Kalamba, and other tanks; common.	17, 28.
Amphora ovalis Kütz v. *pediculus* Kütz.	Widely distributed in pools and tanks; frequent.	5, 16, 19.
A veneta (Kütz) Hustedt	Widely distributed; very common	17, 18, 28, 43.
Anomoeoneis sphaerophora (Kütz) Pfit.	Rankala and Kalamba tanks and pools; occasional	1, 5, 23, 42
Caloneis silicula (Ehr.) Cl	Rankala and Kalamba tanks; not common	16, 17.
Cocconeis placentula Ehr	do.	1, 5, 14, 23, 33, 46.
C. — v. *euglypta* (Ehr.) Cl	Widely distributed; very common	1, 16, 17, 19, 22, 42.
Cyclotella meneghiniana Kütz	Widely distributed, particularly in slimy matrix; frequent	1, 5, 16, 17, 19, 22, 39, 42.
C — f *binotata* Grun.	Rankala tank, pools, and filter-house drainage; rare.	17, 18.

[1] Numbers in this column refer to the bibliography at the end of this paper

List of Diatoms	Place of collection in Kolhapur	Previous place of collection in India and its author
Cymbella kerkevarensis A Cl	Pools, puddles, and tanks; not common. Also collected from Sagar and Jog Falls	A new record for India
C. tumidula Grun	Rankala tank; rare	do
C. turgida (Gerg) Cl	Pools, puddles, and tanks; frequent but never abundant	5, 16, 17, 21, 25, 42
C. ventricosa Kütz	Pools, puddles, and tanks; common	4, 5, 16, 17, 28
Diploneis puella (Schum.) Cl	Stagnant water of drainage, pools, and puddles; not common	1, 21, 28, 34, 39
Epithemia zebra (Ehr.) Kütz	Widely distributed in tanks; common	1, 4, 5, 27
E — v *frickei* A Cl	Rankala tank; occasional	A new record for India
E — v. *porcellus* (Kütz.) Grun	Rankala tank; common	do
E — v. *proboscidea* (Kütz) Grun	Rankala tank; not common Also in Kalamba tank	do
Eunotia lunaris (Ehr) Grun	Marginal slime of tanks; occasional	1, 4, 5, 12, 23, 28, 47
E major (W. Sm.) Rabh. v. *indica* (Grun.) A. Berg	Rankala and Kalamba tanks and puddles; not common	5, 25 (= *E. indica* Grun.)
Fragilaria intermedia Grun	Pools, puddles, and tanks; common	21, 22, 42
F. rumpens (Kütz.) Carl v. *familiaris* (Kütz) A. Cl	Rankala, Kalamba, and other tanks; common	22 (= *Synedra rumpens* v. *familiaris* Kütz.)
Gomphonema augur Ehr.	Pools and tanks; not common	5, 17, 43
G gracile Ehr.	Pools, tanks, and ditches; common	5, 6, 14, 15, 21, 28, 33, 46
G. intricatum Kütz	Rankala and Kalamba tanks; rare	1, 5, 28, 33, 47
G — v. *bohemicum* (Reich. & Fricke) A Cl	Rankala tank and paddy fields; not common	A new record for India

List of Diatoms	Place of collection in Kolhapur	Previous place of collection in India and its author
G. lacus-rankala sp. nov.	Rankala tank; common	A new record
G. — v. *gracilis* v. nov.	Rankala tank; rare	do.
G. — v *robusta* v. nov.	Rankala tank; less common	do.
G. montanum Schum. v. *acuminatum* May.	Rankala tank and pools; not common.	17.
G. olivaceum (Lyng.) Kütz.	Rankala and temple tanks, and paddy fields; fairly common	4, 5, 28.
G. parvulum (Kütz.) Grun	Widely distributed; common	5, 16, 17, 21, 25, 34, 42.
G. sphaerophorum Ehr.	Rankala and Kalamba tanks, pools; fairly common.	21, 28.
G spicula sp nov.	do. Also recorded from Bombay.	A new record
G subapicatum Fritsch & Rich.	Tanks, ponds, pools; common	1, 5, 17.
Hantzschia amphioxys (Ehr.) Grun. v. *densestriata* (Font.) A. Cl.	Rankala tank and pools; rare.	A new record for India
Mastogloia recta Hustedt	Rankala tank; occasional.	do
M — v. *pulchella* Voigt	Rankala tank; common. Also recorded from Ahmedabad.	do
Melosira granulata (Ehr.) Ralfs	Marginal slime of tanks, pools, ponds, and filter-house drainage pools; very common	5, 6, 17, 19, 22, 46.
M. — v. *angustissima* O. Müll	Rankala and Kalamba tanks, filter-house drainage; rare.	42.
M. — v. *muzzanensis* Meister	Rankala and Kalamba tanks, filter-house drainage fairly common.	22
Navicula cryptocephala Kütz.	Widely distributed; common	5, 12, 16, 24, 25, 47.
N. — v. *subsalina* Hust.	Rankala and Kalamba tanks and some pools; not common.	17
N. — *cuspidata* Kütz.	Pools, ponds, and tanks; less common.	1, 5, 24, 46, 47

List of Diatoms	Place of collection in Kolhapur	Previous place of collection in India and its author
N. — f. *brevirostrata* f. nov.	Rankala tank ; occasional. Also recorded from Lonavla	A new record
N. — v *ambigua* (Ehr.) Cl.	Widely distributed ; common	16, 24, 46, 47
N. — v *conspicua* Venkat	Tanks and ponds ; not common	17, 24, 42.
N minuta (Cleve). A. Cl	Rankala tank ; rare	A new record for India.
N. mutica Kütz	Desiccated soils, marginal slime of tanks ; common	5, 18, 46, 47
N. pupula Kütz.	Rankala and Kalamba tanks, and pools ; common	5, 19, 24, 46.
N. — v. *capitata* Hust	Rankala and Kalamba tanks, and pools ; fairly common	16, 24, 43.
N. — v. *elliptica* Hust.	Rankala and Kalamba tanks, and pools ; not common.	17.
N. pygmaea Kütz	Rankala and Kalamba tanks ; fairly common	24, 42.
N. radiosa Kütz	Pools and puddles, tanks ; not common	1, 5, 43
Nitzchia amphibia Grun.	Widely distributed ; common	5, 6, 16, 17, 34, 42
N. — v *acutiuscula* Grun.	Small drying pools and ponds; less common	17.
N. commutata Grun. v *pamirensis* (Hust) A. Cl	Rankala and Kalamba tanks ; not common.	A new record for India
N. frustulum (Kütz.) Grun.	Wet soils, pond, pools, and puddles ; fairly common	16.
N. gandersheimiensis Krasske	Rankala and Kalamba tanks, and ponds ; not common.	16.
N. obtusa W. Sm. v *scalpelliformis* Grun.	Widely distributed ; common.	16, 17, 34, 42
N palea (Kütz.) W. Sm.	Widely distributed, also in wet soils ; very common	1, 5, 17, 18, 34, 42
N thermalis Kütz v *minor* Hilse	Marginal slime of tanks, wet soils ; fairly common	18
N. sublinearis Hust	Pools and tanks ; common.	16, 17

List of Diatoms	Place of collection in Kolhapur	Previous place of collection in India and its author
N. tryblionella Hantz. v. *levidensis* (W Sm.) Grun	Pools and tanks; not quite common.	16, 42
Pinnularia acrosphaeria Brèb.	Rankala, Kalamba, and other tanks; frequent.	5, 6, 19, 20, 21, 33, 42
P. — v *minor* Cleve	Widely distributed in ponds and tanks; never abundant.	17, 19, 20
P. biceps Greg v. *amphicephala* (May.) A. Cl.	Pools and tanks; not common.	A new record for India
P. notata (Perag. & Hèr.) A Cl v. *rostrata* A. Cl.	Rankala tank; rare.	do
P. kolhapurensis sp. nov.	Rankala tank; rare.	A new record.
Rhopalodia gibba (Ehr) O Müll.	Kalamba and Rankala tanks and some ponds; less common.	1, 4, 5, 17, 42
R. gibba v. *ventricosa* (Ehr.) Grun.	Widely distributed; more frequent than the above type	17, 42
Stauroneis phoenicenteron Ehr.	Tanks, ponds, and puddles; fairly common	5, 6, 21, 23, 27, 31 34, 46, 47.
Surirella tenera Greg.	Kalamba tank; rare	19, 42
Synedra acus Kütz.	Pools and tanks; common	5, 6, 17, 28, 47.
S ulna (Nitz.) Ehr.	Widely distributed; very common.	1, 4, 5, 16, 19, 21, 22, 42
S. — v. *amphirhynchus* (Ehr.) Grun	Widely distributed; frequent.	1, 5, 16, 17, 19, 22, 47.
S. — v. *biceps* Kütz	Rankala and Kalamba tanks; occasional	19
S — v. *danica* (Kütz) un.	Tanks, ponds, and pools; fairly common.	16, 19, 21, 22.
S — v. *subaequalis* Grun	Rankala and Kalamba tanks; not common.	22, 33, 46.

SUMMARY

For the first time the freshwater Diatomaceae of Kolhapur and its immediate environs are investigated. Of these an illustrated account is presented in these pages. In a separate table the distribution of forms is given indicating the places of collection in Kolhapur, previous places of collection in India and their authors, and new records for science as well as for India.

In all seventy-nine diatoms are recorded from the said area, of which thirteen are new records for India, and three species, two varieties, and one form considered to be new.

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