

Taxonomic account on Genus *Closterium* Nitzsch ex Ralfs (desmids) from Anjani Dam of Erandol, District Jalgaon (M.S.)

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Abstract

Desmids are a distinctive and diverse group of microscopic, unicellular green algae of the order Desmiales. There is little knowledge about the Desmids from Jalgaon district of Maharashtra. The total of 148 taxa of desmids belonging to the family Desmidiaceae has been recorded during the course of the study. The present study aims to contribute the data of species diversity of the Genus *Closterium* of the desmids group from Anjani dam, Erandol Tahsil, district Jalgaon, Maharashtra. This paper deals with the description of 25 taxa of *Closterium*, with 15 species, 8 varieties, and 2 forms from Anjani Dam. All the taxa of *Closterium* recorded for the first time from Anjani dam and are described systematically with illustrations.

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1. INTRODUCTION

Genus *Closterium* is a common unicellular elongate placoderm desmids found in freshwater habitats. The cells are longer than broad and are variably elongated to crescent-shaped; some are quite straight and needle-like, while others are much broader with curved ends. The cell ends are usually tapered and may be rounded or pointed. Semicells joined at the middle and lacks isthmus; the surface of the cell may be smooth or ornamented with various features such as striations or punctations. Each Semicell contains a single axial chloroplast dotted with several pyrenoids; nucleus is located in the center of the cell. The isthmus is not constricted so that *Closterium* is an example of placoderm desmids. The exploration of desmids diversity of Maharashtra were known the through work of

Dixit (1937), Gonzalves and Joshi (1943), Kamat (1963,1968,1974, 1975), Ashtekar and Kamat (1979), Freitas and Kamat (1979), Pingle (1988), Nandan (1993), Divekar *et.al* (2005), Jawale *et.al* (2005), Nandan and Jain (2005), Mahajan and Nandan (2007, 2008), Sanap *et.al* (2008), Jadhavar and Papdiwal (2011, 2012), Mahajan (2011), Patil and Jawale (2014), Patil and Kumawat (2015), Reddy and Chaturvedi (2017), Patil (2020), Valvi and Gautam (2020), Pawar and Nandan (2022). The present study is a step to explore and document the diversity of *Closterium* from Anjani dam of Jalgaon district.

2. MATERIALS AND METHODS

Anjani dam is located near the Palasdal village (20°54' North latitude and 75°19' East longitude) and constructed on Anjani river in Erandol Tahsil,

Jalgaon district, Maharashtra. The collections of algal samples were made early in the morning between 7.00 to 09.00 am during May, 2017 to April, 2019 from different sites of Anjani dam. All the algal samples always freshly examined as far as possible. Camera lucida drawings were made with the help of mirror type of camera lucida. The identification of taxa was made following the monographs like West and West (1904), Prasad and Misra (1992), Scott and Prescott (1961) and relevant research publications.

3. OBSERVATION (TAXONOMIC DESCRIPTION)

***Closterium acerosum* Ehrenberg ex Ralfs Pl., 1, Fig.1**

Prasad B.N. and Misra P.K. 1992, P. 97, Pl. 16, Fig.15.

Dimension: Cell 345.0 µm long, 41.1-52.5 µm broad and apex 6.4 -7.5 µm wide.

Description: Cells large, more or less straight or slightly curved, narrowly fusiform, 11-14 times longer than broad, curved outer margin with 30-36 degree of arc, inner margin almost straight, semi cells gradually tapering to the rounded-truncate or sub acute apices; cell wall apparently smooth; chloroplast having 3-5 ridges and in each semi cell 5-6 pyrenoids arranged in a row

Collection No. 263.

***Closterium acerosum* var. *borgei* Willi Krieger Pl., 1, Fig.2**

Banod Tadashi, Nakano Taketo and Watanabe Masayuki, 1989, P. 3 and 9, Fig. 3 c

Dimension: Cell 318.7 µm long 52.5 µm broad, apex 7.5 µm wide.

Description: Large cells, about 9 times longer than wide, stouter than the typical, curved slightly or almost straight, tapering gradually to apical regions which are abruptly narrowed, conical and slightly concave on the dorsal margin; chloroplast with 7-11 pyrenoids.

Collection No. 4101.

***Closterium acerosum* var. *elongatum* Brébisson Pl., 1, Fig.3**

Prasad B.N. and Misra P.K. 1992, P. 98, Pl. 16, Fig. 20

Dimension: Cell 558 µm long, 41.2 µm broad and apex 11.2 µm wide.

Description: Cells much longer than specific, inner margin more or less straight, outer margin

moderately curved, cell apices tapering with rounded to sub-acute ends; fine striations on cell wall; chloroplast rigid, containing 12-16 pyrenoids in a median series.

Collection No. 163.

***Closterium acerosum* f. *rectum* A.M. Scott & Prescott. Pl., 1, Fig.4**

Scott A.M. and Prescott G.W., 1961, P. 10, Pl. 3, Fig. 2

Dimension: Cell 686 µm long, 45.0 µm broad and apex 7.2 µm wide.

Description: Axis of cell exactly straight, uniformly and slightly curved lateral margins, forming a gradual and uniform taper from the center of the cell towards the poles which are rounded narrowly and at the tip with an internal thickening wall very finely striated and colourless.

Collection No. 491.

***Closterium acutum* Brébisson. Pl., 1, Fig.5a, b**

West W. and West G.S., 1904, P. 177, Pl. 23, Fig. 9-14.

Dimension: Cells 42.3-73.0µm long, 2.2-8.3 µm broad; apex 1.1-3.7 µm wide.

Description: Cells small in size with needle shaped, 14-21 times longer than wide, straight, 14° of arc very much less than the typical; slightly curved lateral margins, attenuated gradually to the acutely rounded poles; smooth and colourless cell wall; axial chloroplast with 4 axial pyrenoids.

Collection Nos. 116,165.

***Closterium acutum* var. *variabile* (Lemmermann) Willi Krieger Pl., 1, Fig.6**

Hortybagy.T.1973, P.112, Fig. 587.

Dimension: Cell 87.3µm long, 4.1 µm broad.

Description: Cell variously bent; apices attenuating and pointed; smooth cell wall; chloroplast with two-three pyrenoids Terminal vacuole with one large gypsum crystal each.

Collection No. 287.

***Closterium arcuarium* E.O.Hughes Pl., 1, Fig.7**

Croasdale H., 1955, P. 521, Pl.5, Fig. 18

Dimension: Cell 249.7µm long, 17.5 µm broad; apex 3.7 µm wide.

Description: Cell elongate 10-11 times as long as broad, moderately curved; middle part is little swollen, attenuated towards the extremities (end).

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Cell wall smooth yellowish, chloroplast with 2-5 pyrenoids on row.

Collection No. 228.

Closterium croasdaleae A.K. Islam. **Pl., 1, Fig.8**

Prasad B.N. and Misra P.K.1992, P. 103, Pl. 17, Fig. 7.

Dimension: Cell 438.7µm long, 56.2 µm broad.

Description: Cells 4-6 times longer than wide, outer margin sharply curved, inner margin concave but in the middle slightly tumid, apices slightly recurved with rounded ends; cell wall smooth with a median girdle; chloroplast with ridges, containing numerous scattered pyrenoids.

Collection No. 226.

*Closterium diana*e Ehrenberg ex Ralfs **Pl., 1, Fig.9**

Hirano, M. 1955, P.44-45, Pl. 3, Fig. 3-4.

Dimension: Cell 177.5 µm long, 16.0 µm broad.

Description: Cell slightly to moderately curved, concave to slight tumid in middle part, gradually attenuated towards the apices; obtusely rounded apices with the dorsal margin, obliquely truncate and thickened; cell wall smooth; lamellate chloroplast with single row of 4-8 pyrenoid.

Collection No.122.

*Closterium diana*e Ehr. var. *diana*e f. *diana*e Ehr. **Pl., 1, Fig.10**

Ruzicka, J. 1973, P. 200, Pl.5, Figs. 3-4.

Dimension: Cell 209 µm long 24.0 µm broad, apex 4.6 µm wide.

Description: Medium sized cell, strongly curved outer margin with 112-125 degrees of arc, slightly tumid inner margin; cell mostly attenuated to acute or sub-acute apex; smooth cell wall having chloroplast with 6-8 pyrenoids, arranged in a row.

Collection No. 2210.

*Closterium diana*e var. *pseudodiana*e (J.Roy) Willi Krieger **Pl., 1, Fig.11**

Groenblad R., Scott A. M. and Croasdale H., 1968, P. 9, Fig. 17.

Dimension: Cell 225.6 µm long, 19.6 µm broad.

Description: Cells slightly curved, little inflated in the middle towards the inner side; 10 pyrenoids in the chloroplast in a linear series; apices acutely rounded.

Collection No.122.

Closterium ehrenbergii Meneghini ex Ralfs. **Pl., 1, Fig. 12**

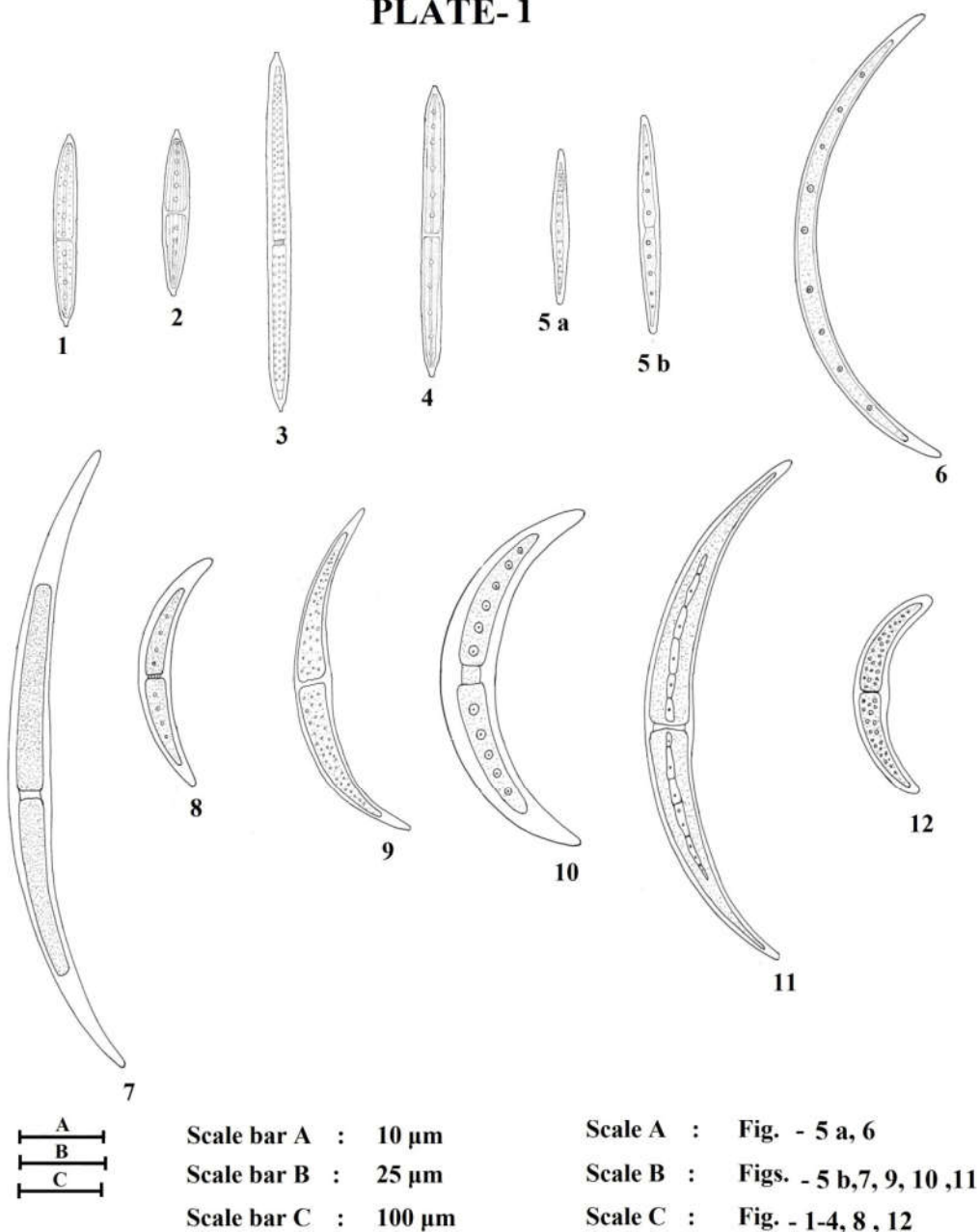
Prasad B.N. and Misra P.K.1992, P. 106, Pl. 17, Figs. 1, 2.

Dimension: Cells 420 - 431 µm long, 52.2-56.2 µm broad and apex 15.0-18.7 µm wide.

Description: Cells large, stout, longer than broad, moderately curved; outer margin with 92-110 degrees of arc, concave inner margin, in the middles lightly inflated, cells gradually tapering to the obtusely rounded ends; cell wall colourless, smooth; 6-8 ridged chloroplast with numerous scattered pyrenoid.

Collection Nos.286, 2122.

PLATE-1



Figures:

- | | |
|---|---|
| 1. <i>Closterium acerosum</i> | 2. <i>Closterium acerosum</i> var. <i>borgei</i> |
| 3. <i>Closterium acerosum</i> var. <i>elongatum</i> | 4. <i>Closterium acerosum</i> f. <i>rectum</i> |
| 5. a, b <i>Closterium acutum</i> | 6. <i>Closterium acutum</i> var. <i>variabile</i> |
| 7. <i>Closterium arcuarium</i> | 8. <i>Closterium croasdale</i> |
| 9. <i>Closterium diana</i> | 10. <i>Closterium diana</i> var. <i>diana</i> f. <i>diana</i> |
| 11. <i>Closterium diana</i> var. <i>pseudodiana</i> | 12. <i>Closterium ehrenbergii</i> |

***Closterium lanceolatum* Kützing ex Ralfs Pl., 2, Fig.1**

Prescott, G. W. 1966, P.5, Pl.1, Figs. 9, 10.

Dimension: Cells 223.8-268.2 µm long, 34.2-38.8µm broad, apices 9.2-10.1µm wide.

Description: Cells lanceolate, dorsal side concave in the center while ventral side slightly curved, uniformly narrowed apices; the apex rounded with smooth wall and colourless; each semicell have chloroplast with 5 pyrenoids in a single series.

Collection Nos. 2121,146.

***Closterium leibleinii* Kützing ex Ralfs Pl., 2, Fig. 2**

West W. and West G.S., 1904, P. 141, Pl. 16, Fig. 9-14.

Dimension: Cell 180.3µm long, 23.1 µm broad.

Description: Medium sized cell; 6-8 times longer than broad, curved strongly, with outer margin 135°-190° of arc, strongly concave inner margin, slightly tumid in the middle; gradually attenuated towards the apices, which are acutely rounded; cell-wall; the chloroplasts with six ridges and a median row of 3-8 pyrenoids.

Collection No.171.

***Closterium leibleinii* var. *recurvatum* West & G.S.West Pl., 2, Fig.3**

Prasad B. N. and Misra P. K., 1992, P. 109, Pl. 17, Figs. 3, 8.

Dimension: Cell 185.5 µm long 24.0 µm broad, apex is 3.5 µm wide.

Description: Cells of medium size, 6-7 times longer than wide, curved strongly, outer margin having 115-120 degrees of arc, inner margin deeply concave with inflated middle part, slightly recurved apices of cells; cell wall is smooth; each semi cell having chloroplast with 4 ridges and 6 pyrenoids arranged in a row.

Collection No. 122.

***Closterium closterioides* var. *intermedium* (J.Roy & Bisset) Ruzicka Pl., 2, Fig.4**

Synonyms

***Closterium libellula* var. *intermedium* (J.Roy & Bisset) G.S. West .**

Prasad B.N. and Misra P.K.1992, P. 110, Pl. 17, Fig. 16.

Dimension: Cell 166.8µm long, 24.9 µm broad and apex 10.7 µm wide.

Description: Cells of medium size, 5-6 times as long as broad, fusiform, more or less straight with both the margins moderately convex, cell gradually attenuated from middle towards broadly rounded and sub-truncate poles with smooth cell wall; each cell with chloroplast having 5-7 ridges and 8-9 pyrenoids in an axial row.

Collection No.122.

***Closterium limneticum* Lemmermann Pl., 2, Fig.5**

Compere P. 1991, P.254-255, Fig. 309

Dimension: Cell 197.9 µm long, 6.4 µm broad; apices rounded narrowly and 2.7 µm wide.

Description: Cells slender, longer than wide straight and cylindrical along the major part of their length, ends curved and gradually attenuated. Cell wall colorless and seemingly smooth.

Collection No. 165.

***Closterium moniliferum* Ehrenberg ex Ralfs. Pl., 2, Fig. 6**

West, W. and West, G.S. 1904, P 143, Pl. 16, Figs.15, 16

Dimension: Cells 360-348 µm long, 48.7-48.7 µm broad and apex 15.0-18.1 µm wide.

Description: Cells large, about 8 times as long as broad, cell wall smooth. Cells moderately, curved inner margin concave with distinct inflation in the middle. From center attenuated gradually to obtuse apices. Chloroplast with 6-7 pyrenoids arranged in a row.

Collection Nos.146, 291.

***Closterium nasutum* Nordstedt ex Wolle Pl., 2, Fig.7**

Compere, P. 1977, P 90, Pl 24, Fig. 353.

Dimension: Cell 532.5 µm long 60.0 µm broad, apex 11.2 µm wide.

Description: Cell large fusiform, slightly curve; as long as broad gradually tapering from the middle to near the ends; apex abruptly attenuated, being rounded or slightly truncated; cell wall smooth, numerous pyrenoids dispersed in the chloroplast.

Collection No. 139.

Closterium parvulum Nägeli **Pl., 2, Fig. 8**

Prasad B.N. and Misra P.K.1992, P. 114, Pl. 16, Fig. 17.

Dimension: Cells 112.8 µm long, 10.1 µm broad and apex 2.7 µm wide.

Description: Cells small, longer than wide; moderately to strongly curved, inner margin concave, gradually attenuated to the apices; acutely rounded to bluntly pointed apices; cell wall smooth colourless; chloroplast lamellate with single series of 2-6 pyrenoids; apical vacuoles with several moving granules.

Collection No.231.

Closterium parvulum var. *cornutum* (Playfair)

Willi Krieger **Pl., 2, Fig.9**

Scott A.M. and Prescott G.W., 1961, P. 13, Pl. 2, Fig. 9

Dimension: Cell 131.3.µm long, 16.6 µm broad.

Description: Strongly curved cell, attenuated gradually to the acutely rounded apices, cell-wall smooth.

Collection No.164.

Closterium pritchardianum W. Archer **Pl., 2,**

Fig.10

Prasad B.N. and Misra, R., 1987, P. 166-167, Figs. 2, 3.

Dimension: Cell 532.5µm long, 67.5 µm broad and apex 15.0 µm wide.

Description: Cells of medium size or large, curved slightly to almost straight, 11-12 times longer than broad, outer margin 24-40 degree of arc, inner margin straight or slightly concave, cell gradually attenuated to narrow, truncate and faintly recurved apices; cell wall striated; chloroplast with 5-7 ridges and pyrenoids 6-8 arranged in a row.

Collection No.286

Closterium rectimarginatum A.M. Scott &

Prescott **Pl., 2, Fig.11**

Scott A.M. and Prescott G.W., 1961, P. 13, Pl. 1, Fig. 27, 28.

Dimension: Cell 222.0 µm long and 36.0µm broad and apex 9.2 µm wide.

Description: Cells larger, 10-11 times as long as broad, spindle shaped lateral margins almost straight and converging from middle to narrow rounded apices, smooth cells wall, chloroplast with four ridges, containing 6-7 pyrenoids.

Collection No.2124.

Closterium striolatum Ehrenberg ex Ralfs. **Pl., 2, Fig.12**

Scott A.M. and Prescott G.W., 1961, P. 13, Pl. 2, Fig. 22

Dimension: Cell 265.4 µm long, 40.7 µm broad, apex is 9.2 µm wide.

Description: Cells straight both margins are concave, outer margin more convex than the inner, outer margin regularly attenuated towards apex; obtusely rounded apices; smooth cell wall with brownish striated, linear striae; chloroplast with 12 pyrenoids with linear series.

Collection No.2124.

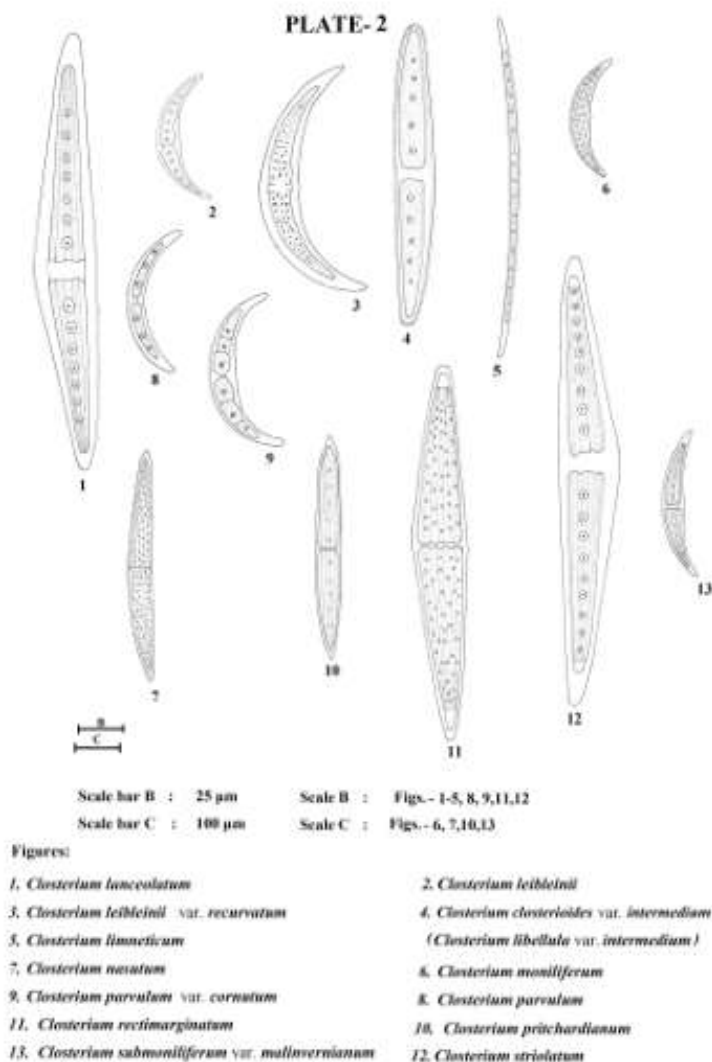
Closterium submoniliferum var. *malinvernianum* (De Notaris) Coesel **Pl., 2, Fig.13**

Coesel, P.F.M. and Meesters, K.J. 2007. P 53, Pl. 15, Fig. 5

Dimension: Cell 420.0 µm long, 56.2 µm broad and apex 11.2 µm wide.

Description: Cells large, 5-7 times as long as broad; curved moderately, 90 to 110° of arc; concave ventral margin but inflated in the middle, strongly convex dorsal wall, attenuated gradually to rounded poles; chloroplast axial with many scattered pyrenoids; cell wall colourless and striated.

Collection No. 3121.



4. CONCLUSION

During the study there are total 25 taxa of *Closterium* with 15 species 08 varieties and 02 forms were reported from Anjani dam. The identified species of genus *Closterium* are first report from study area and will enrich the documentation of *Closterium* diversity in Jalgaon district.

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REFERENCES

- Ashtekar, P. V. and Kamat, N. D. (1979). Additions to the desmid flora of Marathwada, Maharashtra. *Phykos*, 18 (1&2), 45-50.
- Banod, T., Nakano, T., and Watanabe, M. (1989). The Desmid Flora of Kathmandu, Nepal. *Bull. Natn. Sci. Mus., Tokyo, Ser. B*, 15 (1), 1-2

3. Coesel, P.F.M. and Meesters, K. (2007). of the Lowlands Mesotaeniaceae and Desmidiaceae of the European Lowlands. *KNNV Publishing*, PP: 1-352
4. Compere, P. (1977). Algues de la region du lac Tchad VII. Chlorophycophytes (3e partie: Desmidiées). *Cah. O.R.S.T.O.M., Ser. Hydrobiol.* 11 (2), 77-177.
5. Compère, P. (1991). Contribution à l'étude des algues du Sénégal 1. Algues du lac de Guiers et du Bas-Sénégal. *Bull. Nat. Plantentuin Belg.* 61(3/4), 171-267
6. Croasdale, H. (1955). Fresh water algae of Alaska. 1. Some desmids from the interior. *Farlowia* 4, 513-565.
7. Divekar, M. V., Pingle, S. D. and Deshmukh, B. S. (2005). Algal Biodiversity of Dairy Waste Water in Sangamner Area (Maharashtra) *Proc. Natl. Conf. in Plant Sci. Pravaranagar*, pp. 261-264.
8. Dixit, S.C. (1937). The Chlorophyceae of the Bombay Presidency, India-I. *Proc. Indian Acad. Sci. Sec. B*, 5(1):16-25.
9. Freitas, J. F., and Kamat, N. D. (1979). Desmidiaceae of Nagpur. *Phykos* 18(1&2), 97-103.
10. Groenblad, R., Scott, A. M. and Croasdale, H. (1968). Desmids from Sierra Leone, Tropical West Africa. *Acta Bot. Fenn.* 78:1-41
11. Gonzalves, E. A. and Joshi, D. B. (1943). The algal flora of temporary water around Bombay -II. A study of algae in some rain water puddles near Jogeshwari. *J. Uni. Bombay*, 11, 120-128.
12. Hirano, M. (1955). Flora Desmidianum Japonicarum. *Contributions from the Biological Laboratory, Kyoto University*, 1, 1-74.
13. Hortobagyi, T. (1973). The microflora in the settling and sub-soil water enriching basins of the Budapest waterworks. *A comparative study in Ecology, Limnology and Systematics* pp: 1-338.
14. Jadhavar, P.B. and Papdiwal, P.B. (2011). Diversity of desmids at Nathsagar water reservoir. *Bioinfolet*, 8 (3), 280-284.
15. Jadhavar, P.B. and Papdiwal, P.B. (2012). Some desmids from Nathsagar water reservoir, Paithan, Maharashtra *J. Indian Bot. Soc.* 91 (4), 317-32.
16. Jawale, A.K., Kumawat, D.A. and Dhande, J. S. (2005). Desmids from fish ponds at Anjale, district Jalgaon (M.S.) India. *Proc. Nal. Conf. Plant Sci., Pravaranagar*, pp: 472-478.
17. Kamat, N.D. (1963). The algae of Kolhapur, India. *Hydrobiologia*, 22(3-4), 209-305. <https://doi.org/10.1007/BF00036426>.
18. Kamat, N.D. (1968). Algae of Alibag, Maharashtra. *J. Bombay Nat. Hist. Soc.*, 65 (1), 88-104.
19. Kamat, N.D. (1974). Algae of Marathwada, Maharashtra. *Phykos* 13(1): 22-32
20. Kamat, N.D. (1975). Desmids of Marathwada, Maharashtra *J. Bombay Nat. Hist. Soc.*, 72(2), 616-618.
21. Mahajan, S. R. and Nandan S.N. (2007). Green algae of Hartala Lake of Jalgaon, Maharashtra. *Proc. Nat. Symp. Rescent Trends in Algal Biotechnology & Biodiversity*, pp. 51-54.
22. Mahajan, S. R. and Nandan S.N. (2008). Morphology of desmids from Jalgaon, North Maharashtra. *J. Indian bot. Soc.* 87 (3&4), 213-217.
23. Mahajan, S.R. (2011). Diversity of desmids at Jalgaon, North Maharashtra. *Bioinfolet*, 8 (1), 37.
24. Meena Lakshpat (2023). Freshwater Desmids from Sawai Madhopur Part-I *Closterium Nitzsch. International Journal of Science and Research* 12(1), 350-355
25. Nandan, S. N. (1993). Algal flora of fishponds in Dhule, Maharashtra. *Indian Bot. Repr.* 12 (1&2), 61-63.
26. Nandan, S. N. and Jain, D. S. (2005). Biodiversity of desmids in Sonvad project dam and Devbhane dam of Dhule district of Maharashtra. *Plant Diversity and Biotechnology*, pp. 79-85.
27. Patil, S.A. (2020). Contribution to Desmidiaceae Genus- *Closterium Nitzsch* from Jalgaon district, Maharashtra. *Int. Res. J. of Science and Engineering*, Special Issue A9, 69-74.
28. Patil, S.A. and Jawale, A.K. (2014). Desmids from Mangrul dam district Jalgaon, Maharashtra. *Inter. Jour. of Geology, Earth and Environmental Sciences*, 4 (1), 137-146.
29. Patil, S.B. and Kumawat, D.A. (2015). Desmids from Abhora dam of Raver Tahsil of Jalgaon district of Maharashtra. *Jour. of Microbiology*. 4 (1), 28-37.
30. Pawar N.N. and Nandan S.N. (2022). A Taxonomic study of the Genus *Closterium*

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- Nitzsch ex Ralfs in rainy season from Tamaswadi Dam, Parola Taluka Dist. Jalgaon (MS). Part- I. *International Journal of Current Science* 12(3), 678-680.
31. Pingale, S. D. (1988). Algae of Khadakwasla. *Indian bot. Repr.* 7(1&2), 91-92.
32. Prasad B.N. and Misra, R., (1987). Desmid flora of Sikkim-I; *Geophytology* 17(2), 163-173.
33. Prasad, B. N. and Misra, P. K. (1992). *Fresh water algal flora of Andaman and Nicobar Islands* II. Bishen Singh Mahendra Pal Singh Publ., Dehradun. pp.1-284.
34. Prescott, G. W. (1966) Algae of the Panama Canal and its Tributaries-II Conjugales *Phykos*, 5(1&2):1-49
35. Reddy, M. B. and Chaturvedi, A. (2017). Desmids from the rivers of Chandrapur district, Maharashtra. *NeBIO*8(1), 25-34
36. Ruzicka, J. 1973. Die Zieralgen des Naturschutzgebietes "Řežabinský". *Presila*, 45(2), 193-241.
37. Sanap, R.R., Pingle, S.D., Gunale, V.R. and Mohite, A.K. (2008). Chlorophyceae from Godavari River at Nashik (M.S.), India. *Indian Hydrobiology* 11 (1), 91-97.
38. Scott, A. M. and Prescott G. W. (1961). Indonesian desmids. *Hydrobiologia* 17(1&2), 1-132. <https://doi.org/10.1007/BF00040416>.
39. Valvi, A. B. and Gautam, P.K. (2020). Studies on Some Desmids of Toranmal Reserve Forest of Satpura Ranges, Nandurbar District, Maharashtra, India *Journal Aegaeum* 8 (4), 355-361.
40. West W. and West G.S.(1904). A monograph of the British Desmidiaceae. Vol.-I Ray Soc., London, pp. 1-224.
