**RESEARCH ARTICLE**

# Taxonomy of the green filamentous algae of the family Chaetophoraceae (order Chaetophorales) in Thane District, Maharashtra, India

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**ABSTRACT**

In the present communication the eight species of the filamentous green algae belonging to the family Chaetophoraceae collected from Thane district have been described. During the study, three species of the genus *Stigeoclonium* Kützing, two species of the genus *Chaetophora* F. Schrank and one species each of the genus *Draparnaldia* Bory, genus *Gongrosira* Kützing and genus *Pleurastrum* Chodat were recorded. Of these, the three species viz. *Chaetophora tuberculosa, Gongrosira papuasica* and *Pleurastrum insigne* have been probably recorded for the first time in India.

**Keywords:** Chaetophoraceae, taxonomy, Thane district

## INTRODUCTION

Thane District is a part of the Konkan region of the state of Maharashtra and lies between the Sahayadri hills in the East and the Arabian Sea in the West. The district is situated between 18°42' and 20°20' north latitudes and 72°45' and 73°48' east longitudes. (http://www.thane.nic.in/htmldocs/DistrictProfile.html)

The major rivers in the district are the Vaitarna and Ulhas. Pinjal, Deharja, Surya and Tansa are the main tributaries of the Vaitarna, while, Barvi and Bhatsa are the main tributaries of the Ulhas. (http://www.thane.nic.in/htmldocs/DistrictProfile.html)

The maximum temperature lies between 28.0 - 35.2 °C and the minimum temperature lies between 16.3 - 26.5 °C. The district receives a rainfall of 2000 – 4000 mm from the South-West monsoons during the months of June to September and generally the highest rainfall is recorded in the month of July. October and November constitute the post monsoon season. The Winter season is from December to February and is followed by the Summer season from March to June. (http://www.thane.nic.in/htmldocs/DistrictProfile.html ; http://www.dcmsme.gov.in/publications/traderep/thane.htm)

Kamat (1968, 1974), Kamat and Harankhedkar (1976), Nandan (1993), Jafari and Gunale (2006), Pingle (2007), Sanap et al. (2008), Dhande and Jawale (2011), Kshirsagar (2013), Deshmukh and Tarar (2014) have contributed the Chaetophorales of Maharashtra. (Dhande, J. S. and Jawale, A. K., 2011; Jafari, N. G., Gunale, V. R., 2006; Kshirsagar, A. D., 2013). There is very little information available on the status of the algae belonging to the family Chaetophoraceae in Thane District. In this investigation an attempt was made to identify the algae belonging to the family Chaetophoraceae in Thane District and ten species - three species of the genus *Stigeoclonium* Kützing, two species of the genus *Chaetophora* F. Schrank and one species each of the genus *Draparnaldia* Bory, genus *Gongrosira* Kützing and genus *Pleurastrum* Chodat were recorded.

## MATERIALS AND METHODS

**Collection of Algae:** The samples of algae were collected from various permanent and temporary sources of freshwater in some selected areas in Thane district. The collection of sample was done in small plastic containers with the help of forceps, scalpels etc. The samples were allotted 'Collection Codes' based on the name of the place of collection.

**Observation and Preservation of Algae:** The collected samples were brought to the laboratory and temporary mounts were prepared by mounting small part of samples in water. The slides were observed using Labomed Lx 300 Trinocular Research Microscope and photographs were taken using PixelPro Software. Part of collected samples was preserved using a preservative containing Ethanol, Formaldehyde, Glacial Acetic Acid, Glycerol, Water and Copper Sulfate.

**Taxonomy:** The dimensions of the algal cells in the filaments were measured using Pixel Pro Software. The algae were identified using various monographs and research papers.
The places of collection are marked in Figure 1.

## RESULTS

### Family Chaetophoraceae

Thallus usually macroscopic and mucilaginous, sometimes microscopic. Filamentous, sometimes colonial; usually branched. Prostrate and/or erect; sometimes having basal distal differentiation. Cells cylindrical, sometimes spherical; chloroplasts parietal with one to several pyrenoids. Filaments sometimes ending in hyaline setae. Reproduction both sexual and asexual.

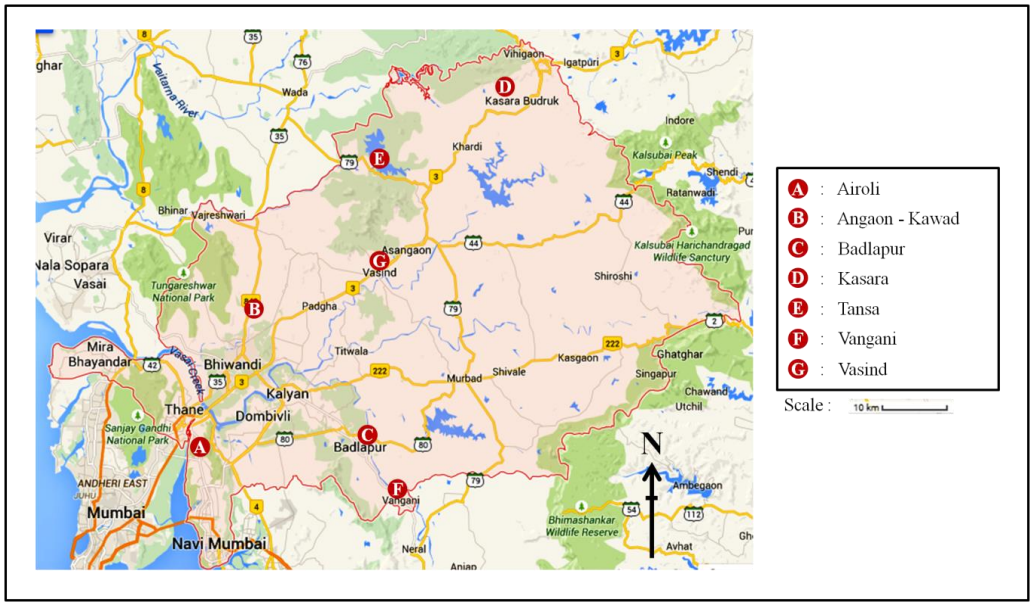


**Figure 1: Map of Thane District showing places of collection**
The red line indicates the boundary of Thane district. The red dots indicate the places of collection. The arrow indicates North.

**Key to Genera**

1. Filaments enclosed in mucilage …….. 2
1. Mucilage absent; if present, not evident …….. 3

2. Filaments enclosed within a delicate mucilaginous envelope, main filaments distinct and bearing laterally, soft tufts of narrower celled branches .. ***Draparnaldia***
2. Thallus macroscopic, almost spherical or cushion-like, filaments embedded in soft or firm mucilage …….. ***Chaetophora***

3. Filaments usually ending in setae, prostrate and erect system usually present, sometimes embedded in soft mucilage, which may not be evident ... ***Stigeoclonium***
3. Setae absent …….. 4

4. Thallus green, forming crusts; prostrate and erect system present …… ***Gongrosira***
4. Filaments compact; forming colonies of one to few cells …… ***Pleurastrum***

***Chaetophora*** F. Schrank 1783

Thallus macroscopic; globular or spherical, warty (tuberculate) or nodulose, enclosed within a soft or firm mucilaginous envelope. Microscopic filaments dichotomously, trichotomously or alternately branched usually radiating from a common center. The basal system may or may not have rhizoids. Filaments terminating in sharply pointed cells or acute apices or a multicellular hair (setiferous cells). Chloroplasts parietal, sometimes band-like with 1 to several pyrenoids. Reproduction by quadriflagellate zoospores usually formed in the outer cells of the branches. (Prescott, G. W., 1970; John, D. M., Whitton, B. A., Brook, A. J., 2011)

Type species: *Chaetophora lobata* Schrank 1783

**Key to Species**

1. Mucilage soft; microscopic branches loose (lax) …… ***Chaetophora elegans***
1. Mucilage firm; microscopic branches not as above; basal system not rhizoidal …… ……***Chaetophora tuberculosa***

***Chaetophora elegans*** (Roth) C. Agardh 1812

Basionym: *Rivularia elegans* Roth

Homotypic Synonym: *Rivularia elegans* Roth 1802

N (02) – 11, Bl (12) – 03 **PLATE I Fig. 1 (a – d)**

**References:**

John, D. M., Whitton, B. A., Brook, A. J., 2011, p. 528, Plate 133 I; Narul Islam, A. K. M., Md. Irfanullah, H., 2005, p. 29 - 30, Plate 4, Fig. 65; Prescott, G. W., 1970, p. 118, Plate 14, fig. 3, 4; Skinner, S. and Entwisle, T. J., 2004, p. 617 – 618, Fig. 2 (a – c).

**Description:**

Thallus attached, globose green masses of soft mucilage; colonies often confluent with one another to form irregularly shaped masses, in which dichotomous filaments spread out from a common centre. Branches rather loose; branches of the second order somewhat more numerous near the upper part of the thallus, ending in abruptly pointed, sometimes setiferous cells. Vegetative cells (3 - ) 7 – 14 in diameter and 8 – 30 (-62) µm long. Zoospores 4 – 9 X 7 – 15 µm.

**Occurrence:**

The alga was found in Kasara and Badlapur, Dist. Thane, Maharashtra [N (02) – 11 and Bl (12) – 03].

**Note:**

This alga differs in having some vegetative cells that are narrower and some that are broader than those described for the species. Also, some of the vegetative cells are shorter and some are longer than described for the species.

**Distribution in India:**

Chhattisgarh (Pandey, P., Sahu, P. K., Jha, Y. N., Shrivastava, A. K., 2014); Kerala (Nasser, K. M. M. and Sureshkumar, S., 2014); Madhya Pradesh (Sagar, T. P. et al., 2014); West Bengal (Keshri, J. P., 2007); Maharashtra (Deshmukh, R. N., Tarar, J. L., 2014); Uttar Pradesh (Indian Institutes of Technology, 2012).

***Chaetophora tuberculosa*** (Roth) C. Agardh 1824

Basionym: *Rivularia tuberculosa* Roth

Homotypic Synonym: *Rivularia tuberculosa* Roth 1802

AK – 38 **PLATE I Fig. 2 (a – d)**

**Reference:**
John, D. M., Whitton, B. A., Brook, A. J., 2011, p. 528, Plate 134 A.

**Description:**
Thallus warty (tuberculate) or nodular, green; microscopic filaments embedded in a firm mucilage, alternately or dichotomously divided, radiating from a common centre, basal system not rhizoidal, uppermost branches densely clustered and all tapering slightly to an acute apex or more rarely, terminating in a multicellular hair. Vegetative cells (3 - ) 8 – 9 X 15 – 54 µm. Zoospores tetraflagellate; 5 – 7 X 9 – 11 µm.

**Occurrence:**
This alga was found attached firmly to rocks with the help of mucilage in a stream in Angaon – Kawad mining area on National Highway 3, Taluka Bhiwandi, Dist. Thane, Maharashtra (AK – 38)

**Note:**
The alga differs from *Chaetophora tuberculosa* (Roth) C. Agardh in having narrower cells.

**Distribution in India:**
This is probably the first record of the species from India.

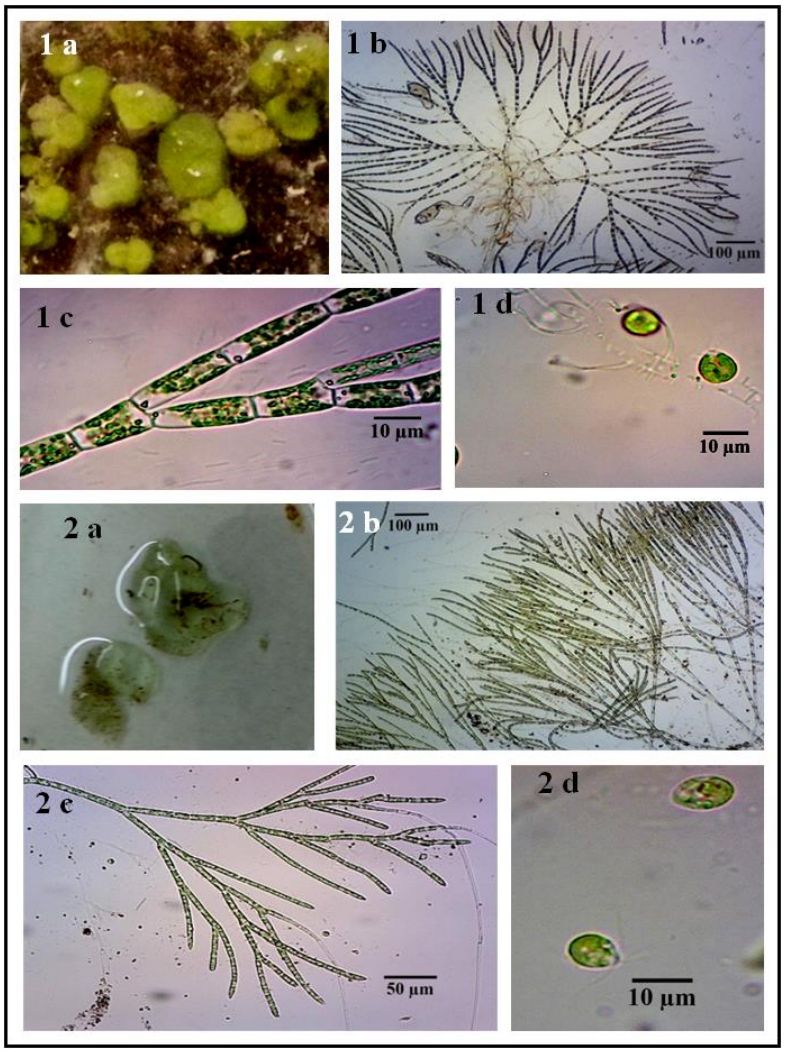


**PLATE I: *Chaetophora* F. Schrank**
**Fig. 1: *Chaetophora elegans* (Roth) C. Agardh** [1 a – Macroscopic structure of thallus; 1 (b, c) - Arrangement of filaments in the thallus and branching; 1 d – Zoospores]; **Fig. 2: *Chaetophora tuberculosa* (Roth) C. Agardh** [2 a – Macroscopic structure of thallus; 2 (b, c) - Arrangement of filaments in the thallus and branching; 2 d – Zoospores]

***Draparnaldia*** Bory 1808
Filamentous; filaments erect, uniseriate filaments attached at the base by rhizoids and enclosed within a soft mucilaginous envelope. Cells of the main axis oppositely branched and bear tufts made up of smaller cells. These apices of these branches terminate in a blunt cell or multicellular hair. Cells of the main axis are barrel-shaped or cylindrical, each with a parietal entire or net-like chloroplast with smooth or lobed (lancinate) margin with several pyrenoids. Cells of the branches have a single laminate chloroplast with pyrenoids. Reproduction both sexual and asexual. Asexual reproduction by zoospores.
Type species: *Draparnaldia glomerata* (Vaucher) C. Agardh 1824

***Draparnaldia glomerata*** (Vaucher) C. Agardh 1824
Basionym: *Batrachospermum glomeratum* Vaucher
Heterotypic Synonym: *Conferva glomerata* Vaucher
Barvi (02) – 06 **PLATE II Fig. 1 (a – d)**

**References:**
John, D. M., Whitton, B. A., Brook, A. J., 2011, p. 530, Plates 134 B, 2 F; Prescott, G. W., 1970, p. 120, Plate 15, fig. 5.

**Description:**
Filaments enclosed in soft mucilaginous envelope, delicate, somewhat feathery in appearance; main axis composed of inflated (barrel – shaped) cells, repeatedly branched; branches usually opposite and bearing opposite or whorled fascicles of small branches, which are tufted, orbicular, nearly lanceolate or ellipsoid in outline, and spreading with or without a distinct main axis (rachis). Cells of the main axis 21 – 27 X 10 – 45 µm. Chloroplasts about 1/3 the length of the cell in the main axis. Cells of the branches 6 – 8 X 10 – 20 µm.

**Occurrence:**
The alga was found growing in Barvi, Badlapur, Dist. Thane, Maharashtra [Barvi (02) – 06].

**Note:**
The alga differs in having narrower and shorter vegetative cells in the main axis than described for the species.

**Distribution in India:**
Maharashtra (Deshmukh, R. N., Tarar, J. L., 2014), Kashmir (Lone, S. A., Pandit, A. K. and Bhat, S. U., 2013).

***Gongrosira*** Kützing 1843
Thallus crustose, filaments uniseriate, branched; both prostrate and erect system present; prostrate system loose or pseudoparenchymatous; erect system often of short branches with blunt apices; hairs absent; cells cylindric or somewhat inflated. Chloroplasts parietal, pyrenoids 1 (to several). Reproduction asexual.
Type species: *Gongrosira sclerococcus* Kützing 1843
(Taxonomic synonym of *Gongrosira viridis* (Kützing) De Toni 1889)

***Gongrosira papuasica*** (Borzì) Tupa 1974
Basionym: *Pleurothamnion papuasicum* Borzì
Homotypic Synonym: *Pleurothamnion papuasicum* Borzì 1892
AI - 01 **PLATE II Fig. 2 (a, b)**

**References:**
John, D. M., Whitton, B. A., Brook, A. J., 2011, p. 537, Plate 132 H; Johnson, L. R. and John, D. M., 1992, p. 157 – 159, Figs. 7 – 10.

**Description:**
Thallus of small green crusts; prostrate system loose or pseudoparenchymatous, the degree of development of erect system very variable. Cells 4 – 6 µm wide and 8 – 16 µm long, usually 1.5 – 4 times longer than wide; cylindrical to somewhat swollen, sometimes becoming coccoidal; pyrenoid single and prominent. Zoosporangia not observed.

**Occurrence:**
The alga was found in Airoli Mangrove, Dist. Thane, Maharashtra (AI – 01) along with *Rhizoclonium riparium* and *Ulva intestinalis*.

**Note:**
The alga was observed only in laboratory culture when the natural specimen was inoculated for growth on Bold 1NV agar plates.

**Distribution in India:**
This is probably the first record of the species from India.

***Pleurastrum*** Chodat 1894
Cells solitary, in groups of 2 or 4, or in more or less regular masses, sometimes contiguous and filaments unbranched or with a few branches; chloroplasts parietal, pyrenoids 1 (or more). Reproduction asexual.
Type species: *Pleurastrum insigne* Chodat 1894
***Pleurastrum insigne*** Chodat 1894

**Heterotypic Synonym:** *Pseudopleurococcus vulgaris* Snow 1899
Vasind (04) – 06 **PLATE II Fig. 3**

**Reference:**
John, D. M., Whitton, B. A., Brook, A. J., 2011, p. 542, Plate 133 A.

**Description:**
Cells solitary, or clustered to form compact colonies consisting of small pairs, triads or tetrads of cells (at least when grown on agar); filaments short, unbranched and readily dissociating into short fragments; cells cylindrical or ellipsoid, 4 – 7 µm wide, 7 – 9 µm long, walls generally thin and smooth.

**Occurrence:**
The alga was found growing on Bold 1 NV medium agar plate from a specimen collected from Vasind, Taluka Shahapur, Dist. Thane, Maharashtra [Vasind (04) – 06].

**Note:**
The alga differs in having some cells that are slightly narrower than described for the species.

**Distribution in India:**
This is probably the first record of the species from India

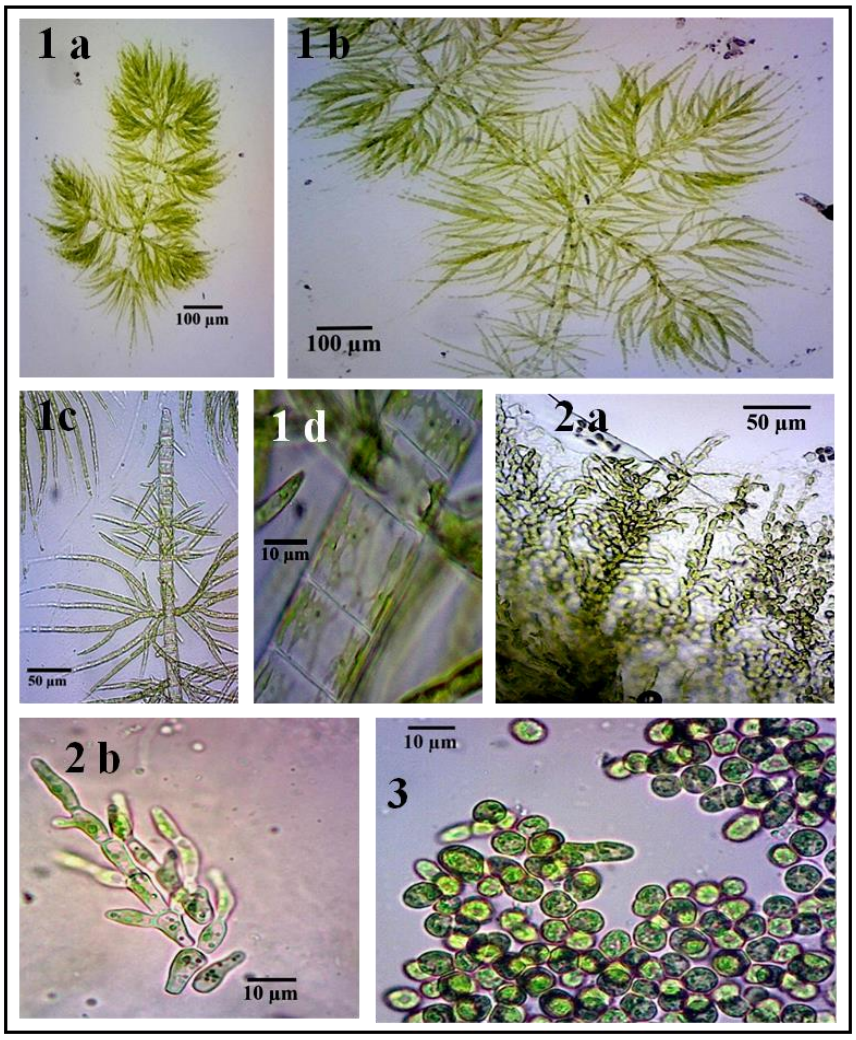


**PLATE II:** ***Draparnaldia*** **Bory,** ***Gongrosira*** **Kützing and** ***Pleurastrum*** **Chodat**

**Fig. 1:** ***Draparnaldia glomerata*** **(Vaucher) C. Agardh** [Fig.1 (a – c) – Morphology of the filament and branching; Fig. 1 d – Cells of the main axis]; **Fig 2:** ***Gongrosira papuasica*** **(Borzí) Tupa** [1 (a, b) – Details of the thallus and cells]; **Fig. 3:** ***Pleurastrum insigne*** **Chodat** [Details of filaments and cells]
***Stigeoclonium*** Kützing 1843

Filaments uniseriate, often somewhat mucilaginous, branched; usually differentiated into a prostrate and an erect system; filaments of erect system alternate, opposite or dichotomous, or irregularly arranged; apices acute or blunt, each frequently bearing a colourless, multicellular hair; prostrate system of creeping or rhizoidal filaments, occasionally forming a pseudoparenchymatous, disc-like expansion; cells cylindrical or swollen, chloroplast parietal, pyrenoids 1 to several. Reproduction both sexual and asexual.

Type species: *Stigeoclonium tenue* (C.Agardh) Kützing 1843

**Key to species**

1. Branches of erect system often arising from almost every cells of the prostrate system, usually in unilateral series …….. ***Stigeoclonium nanum***
1. Erect and prostrate system not as above …….. 2

2. Branches of the erect system alternate, never opposite……***Stigeoclonium subsecundum***
2. Branches of the erect system alternate or opposite …….. ***Stigeoclonium tenue***

***Stigeoclonium nanum*** (Dillwyn) Kützing 1849

Basionym: *Conferva nanum* Dillwyn

Homotypic Synonym: *Conferva nanum* Dillwyn

Tansa (02) – 12 **PLATE III Fig. 1 (a, b)**

**Reference:**

John, D. M., Whitton, B. A., Brook, A. J., 2011, p. 550, Plate 134 J; Prescott, G. W., 1970, p. 116, Plate 9, fig. 7, 8.

**Description:**

Prostrate system consisting of separate creeping filaments with erect branches arising from almost every cell, or as a loose and pseudoparenchymatous disc-like expansion of angular or sub-globose cells; erect system sometimes branched, mostly alternate, rarely opposite, branching cells not distinctive, primary and secondary branches short, apical cells blunt, acute or terminating in a hair; cells similar throughout branch systems, cells 1 – 2 (- 3) times longer than wide, inflated and barrel-shaped; cells 4 – 7 X 8 - 21 µm.

**Occurrence:**

The alga was found in Tansa, Dist. Thane, Maharashtra.

**Distribution in India:**

Bhandara, Nagpur, Maharashtra (Deshmukh, R. N., Tarar, J. L., 2014).

***Stigeoclonium subsecundum*** (Kützing) Kützing 1843

Basionym: *Conferva subsecunda* Kützing

Homotypic Synonym: *Myxonema subsecundum* (Kützing) Hazen, *Conferva subsecunda* Kützing

Bl (06) – 12 **PLATE III Fig. 2 (a, b)**

**Reference:**

John, D. M., Whitton, B. A., Brook, A. J., 2011, p. 550; Prescott, G. W., 1970, p. 117, Plate 10, fig. 3, 4.

**Description:**

Filaments delicate green to yellowish green, prostate system variously developed, filaments branched with evident main axis, erect system sparingly dichotomously or alternately (never oppositely) branched, often with several unilateral branches arising from successive cells, branching cells shorter and inflated or in some cases cells of the erect system either all similar irrespective of whether or not bearing a side branch; secondary branches frequently short, narrowing terminally and sometimes with curved apices; cells cylindrical or somewhat inflated or barrel-shaped, thin-walled; cells (3 -) 7 – 9 X 6 – 23 µm.

**Occurrence:**

The alga was found growing in Badlapur, Dist. Thane, Maharashtra along with *Spirogyra* sp. and *Oscillatoria* sp.

**Note:**

The alga differs from *Stigeoclonium subsecundum* (Kützing) Kützing in having somewhat narrower and shorter cells.

**Distribution in India:**

Maharashtra (Dhande, J. S. and Jawale, A. K., 2011); Tamil Nadu (Christi, R. M., Kala, T. C., Renukabai, N. and Shajini, R. S., 2014); Northern Eastern Ghats of India (Dash, P. K., Mohapatra, P. K. and Kar, M., 2010).

***Stigeoclonium tenue*** (C. Agardh) Kützing 1843
Basionym: *Draparnaldia tenuis* C.Agardh

Homotypic Synonym: *Draparnaldia tenuis* C.Agardh 1814

Homotypic Synonyms: *Stigeoclonium irregulare* Kützing 1845, *Myxonema tenue* (C.Agardh) Rabenhorst 1847, *Stigeoclonium tenue* var. irregulare (Kützing) Rabenhorst 1868, *Stigeoclonium subsecundum* var. tenuis Nordstedt 1880, *Stigeoclonium pygmaeum* Hansgirg 1886, *Stigeoclonium longearticulatum* (Hansgirg) Heering 1914, *Stigeoclonium subsecundum* var. javanicum Ritcher 1914

VAN – 08, VAN (06) – 03 **PLATE III Fig. 3 (a, b)**

**Reference:**
Prescott, G. W., 1970, p. 117; John, D. M., Whitton, B. A., Brook, A. J., 2011, p. 551, Plate 134 E; Skinner, S. and Entwisle, T. J., 2004, p. 625 – 628, Fig. 6, 7.

**Description:**
Thallus an elongate tuft of very slender, gracefully tapering filaments, branches opposite or alternate, mostly tapering to setae. Cells long and cylindrical, sometimes nearly quadrate or with walls slightly convex and constricted at the cross walls; cells 4 – 11 X (6 - ) 12 – 31 µm. Chloroplasts parietal. Zoospores 4 – 8 X 8 – 10 µm.

**Occurrence:**
The alga was found in Vangani, Dist. Thane, Maharashtra [VAN – 08 and VAN (06) – 03].

**Note:**
The alga has some cells that are narrower and shorter than described for the species.

**Distribution in India:**
Uttar Pradesh (Verma, S., Tiwari, D. and Verma, A., 2013); Uttar Pradesh (Suryakant and Awasthi, A. K., 2012); Uttar Pradesh (Kumar, M., Khare, P. K. and Singh, R., 2014); Uttar Pradesh (Tiwari, A. and Chauhan, S. V. S., 2006); Uttar Pradesh (Indian Institutes of Technology, 2012); Telengana (Singh, L. D., Swamy, N. E., Swamy, B. K. and Rao, B. D., 2014); Gujarat (Kumar, R. N., Solanki, R. and Kumar, N. J. I., 2012); Maharashtra (Jafari, N. G., Gunale, V. R., 2006); Maharashtra (Kshirsagar, A. D., 2013); Rajasthan (Bhatnagar, M. and Bhardwaj, N., 2013); Punjab (Jindal, R., Sharma, C., 2011).

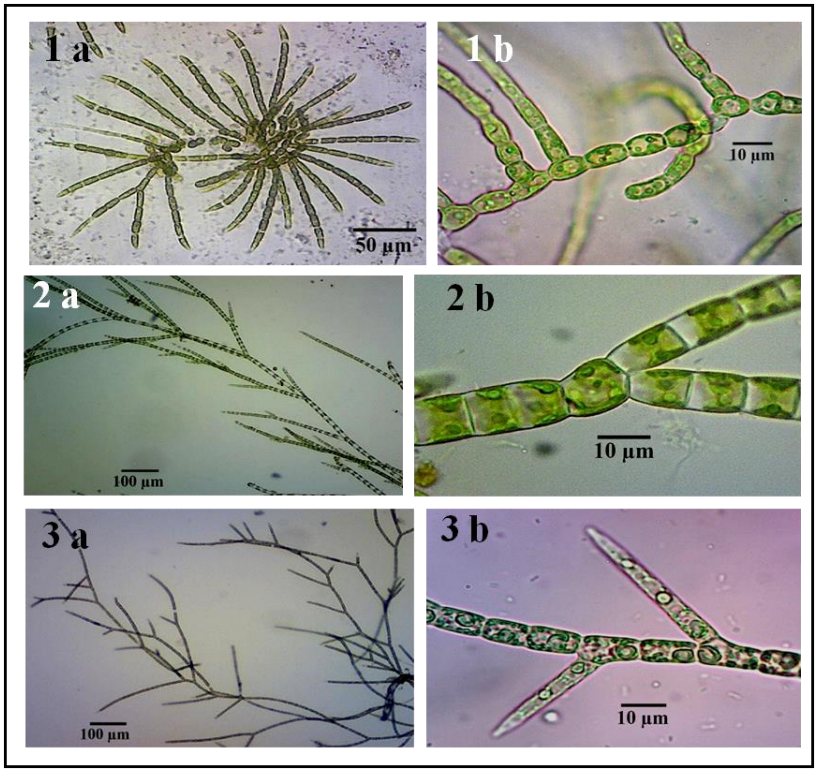


**PLATE III: *Stigeoclonium* Kützing**

**Fig. 1: *Stigeoclonium nanum* (Dillwyn) Kützing** [1 (a, b) - Arrangement of filaments in the thallus and branching]; **Fig. 2: *Stigeoclonium tenue* (C. Agardh) Kützing** [2 (a, b) - Arrangement of filaments in the thallus and branching]; **Fig. 3: *Stigeoclonium subsecundum* (Kützing) Kützing** [1 (a, b) – Branching of the thallus]

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