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MORPHOLOGICAL STUDIES ON FAMILY PHORMIDIACEAE

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ABSTRACT

In present study most of the algal sample of blue-green algae were isolated from various habitats included Marble pond, shells and on mud of Mandakini river, Epiphytic on submerged grass, drain, wall of an old building, low land rice field and fresh water from five districts viz. Allahabad, Banda, Fatehpur, Kaushambi and Chitrakoot of U.P. After a thorough scrutiny sample only 7 genera 16 species were selected for study.

KEYWORDS : Oscillatoriales, *Arthrospira*, *Planktothrix*, *Pseudophormidium*, *Phormidium*, *Porphyrosiphon*

Blue-green algae or cyanobacteria are one of the important groups of algae in tropical region of the word. Blue-green algae are prokaryotic micro-organism with oxygen evolving photosystem and they are known to have bestowed a plant characteristic chloroplast to heterotrophic eukaryotic cells by the process called endosymbiosis.

The morphology of non-heterocystous filamentous blue-green algae is much variable under different environmental conditions. The studies based on materials directly collected from nature could not give an accurate knowledge about any alga due to phenomenon of polymorphism. Culture studies are best substitute for this in which the algal materials are grown under standard laboratory conditions. In the present study sixteen species of Oscillatoriales belonging to seven genera of one family and two sub-families are taken under study.

MATERIALS AND METHODS

Non-heterocystous filamentous blue-green algal samples (total 16) were collected from different geographical localities in different seasons from various habitats from five districts of U.P. After a thorough scrutiny sample only 16 were selected for further study.Macro observation like growth pattern on solid dish has been taken with the help of Nikon Coolpix 8400 digital camera and Micro observations like photomicrographs were made with the help of Leica DMLB microscope and DC 300 camera with Quin imaging system. All the growth stages were recorded upto drying of culture and it took more than a year.

The photographs of different localities were also taken with the help of Nikon Coolpix 8400 camera and other necessary information about habitat, locality and date was also noted in the field diary. The collected field samples were examined under the microscope immediately on arrival in the Phycology Lab, Department of Botany, University of Allahabad to evaluate the composition of Cyanobacterial strains. The isolation of non-heterocystous filamentous form was carried out by dilution and pour plate method (Kaushik, 1987). Cyanobacterial strains were streaked in BG-11 solid media. After appearance of growth, colonies were picked up and examined with the help of microscope. The axenic cultures were maintained in liquid as well as in solid BG-11 medium (Hughes etal., 1958, Stanier et al., 1971, Rippka et al., 1979) and Spirulina medium (Zarrouk, 1966) for further studies.

Non-heterocystous filamentous taxa were studied by examining their morphological characters and identification was confirmed by cross-checking with the authentic illustration and description of related Papers, Monographs and Manuals of Tilden (1910), Geitler (1932), Tiffany and Britton (1952), Desikachary (1959), Starmach (1966), Baker and Bold (1970) Drouet's (1968), Boone & Castenholz (2001) and Anagnostidis & Komarek (1988, 2005).

RESULTS AND DISCUSSION

Result show in table 1 and figure 1 - 15. Deals with the morphological studies on family *Phormidiaceae* where 7 genera were recorded. This family is classified into two subfamilies i.e. *Phormidioideae* and Microcoleoideae. Five genera belonging to *Phormidioideae* which include *Arthrospira, Planktothrix*, *Pseudophormidium, Phormidium, Porphyrosiphon* Two species of *Arthrospirawere* recorded which include *A. jenneri* and *A.*

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maxima. Both species have been found mainly in saline water habitats and in culture grow only in *Spirulina* solid and liquid medium and are distinguished to each other on the basis of its identical characters. Thallus of *A. jenneri* is thin, mucilaginous, irregularly spreaded growth, broken margin, coiling of trichomes over on solid agar plate. Trichomes long, loosely screw like coiled sometimes spiral rarely straight, terminal end circular. Reproduction occur by fragmentation of trichomes with the help of necridia while thallus of *A. maxima* is thin, less mucilaginous, expanded, scattered, growth radiate uniformly from centre to the periphery forms discrete colonies over on solid agar surface. Trichomes very loosely screw like coiled, mostly straight rarely spiral, terminal end slightly attenuated, slow motile. Reproduction occurs by fragmentation of trichomes and cells divided cross wise to the longitudinal axis of the trichomes (Grover and Pandhol, 1975).

One species recorded i.e. *Planktothrixisothrix*. The main characteristic attributes of genus is free floating and forming water bloom in natural habitat. Numerous aerotopes are present in whole cell. Cells are 7-10 µm broad and 5.5 µm long. Motility is slow with peculiar oscillations.

Three species of *Pseudophormidiumwere* recorded which include *P. golenkinianum, P. hollerbachianum* and *P. purpureum*. All species of *Pseudophormidium* shows "*Scytonema*" like false branching and they are distinguished on the basis of specific characters. Thallus of *P. golenkinianum* is dull blue-green in colour, clustered growth settled at the bottom. Trichomes long, entangled, repeatedly pseudobranched, pseudobranching occur mostly in pair rarely single, erect or divergent. Cells are 1-2 broad and 1.5-3 µm long. Reproduction occurs by fragmentation of trichomes with the help of necridia. Thallus of *P. hollerbachianum* is gelatinous, bright blue-green in colour. In liquid medium growth attached to wall of flask as well as in submerged condition. Trichomes are variously curved, densely entangled, richly pseudobranched which are single or geminate. Cells are 2-4 µm broad and 1.5µm long, slightly constricted at the granulated cross-walls. Sheath is thin. Thallus of *P. purpureum* is bright blue-green in colour. In liquid flask growth in submerged condition and on solid dish trichomes secrete a lot of mucilage. Trichomes are straight sometimes loosely spiral. Pseudobranched single or geminate. Cells are 1 µm broad and 5 µm long. Sheath is thin.

Seven species of *Phormidium* were recorded which include *P. paulsenianum*, *P. pavlovskoense*, *P. okenii*, *P. deflexoides*, *P. inundatum*, *P. retzii* and *P. beggiatoiforme*.

Thallus of *Phormidium paulsenianum* is blackish blue-green. Trichomes straight rarely coiled, apical end slightly attenuated and curved. Cells are 5-7µm broad, and 3-5µm long.

Thallus of *Phormidium pavlovskoenseis* mucilaginous, trichomes grow uniformly in all direction, fuse to form homogenize circular colonies. Trichomes straight or slightly curved constricted at cross-walls. Cells are greenish-blue in colour, 4µm broad and 1.4µm long. Slow motility is in forward direction. Thallus of *Phormidium okeniiis* bright blue-green, light sensitive grow only in dim light. Cells are 4-7µm broad and 4-6µm long (terminal cell up to 7-9µm long). Slow movement in forward direction. Thallus of *Phormidium deflexoidesis* bright blue-green, mucilaginous, growth in liquid medium containing numerous air bubbles. Cells are 4µm broad, 1.5-2.3µm long, isodiametric or slightly shorter than width. Apical cells rounded without calyptra. Thallus of *Phormidium inundatum* is thin, membranous, growth firmly attached to glass walls and creeps in upward direction. Cells are 4-5µm broad and 4-10µm, usually quadrate or length is more than width. Apical cells are obtuse to acute conical or rounded without calyptra. Sheath is thin. Thallus of *Phormidium retzii* is thick, compact, tuft. Trichomesun constricted at cross-walls, ends scarcely attenuated. Cells are 8-10µm broad and 6-7µm long, apical cells truncate or obtuse rounded. The thallus of *Phormidium beggiatoiforme* is cespitose, blackish blue-green, trichomes solitary, long, screw like coiled at the ends. Cells are 5µm broad and 4.5-5µm long, apical cells capitate with ± conical calyptra. Sheath is thin (Kutizing, 1849, Parukutty, 1940; Komarek et al., 2005).

One species recorded i.e. *Porphyro siphonn-otarisii*, the thallus of *Porphyro siphonnotarisii* is papery, red brown thick flakes in nature. Filaments long, variously

Table 1 : Showing Taxonomic Description of Arthrospira, Planktothrix, Pseudophormidium, Phormidium, Porphyrosiphon, *Microcoleus* and Symplocastrum Species of Family Phormidiaceae

Species	**Habitat / Thallus**	**Trichomes / Sheath**	**Constriction / Motility**	**Cell sizeWxL (in µm) & Shape**
Arthrospira jenneri Plate-A, Fig -1 Gomont, 1892, Desikachary, 1959, Grover and Pandhol, 1975,	Marble pond. Thin, blue-green in colour, irregularly spreaded over on solid surface.	Long, loosely screw like coiled, some time spiral rarely straight. Absent.	Not or rarely constricted at the granulated cross walls. *Absent.*	5x3.4-4 Isodiametric or shorter than wide.
Arthrospira maxima Plate-A, Fig -2 Komarek and Anagnostidis, 2005,	Temporary small pond. Expanded, scattered growth from center to periphery forms discrete colonies.	Long, very loosely screw like coiled,mostly straight rarely spiral Absent.	Not constricted or slightly constricted at the granulated cross walls. Very slow movement.	6.5x4-6 Isodiametric or width is more than length.
Planktothrix isothrix Plate-A, Fig -3 Komarek and Anagnostidis, 2005,	Pond. Bloom forming, free-floating, dark blue- green.	Commonly straight rarely slightly curved, containing numerous gas vacuoles Absent.	Not constricted or very slightly constricted at the inconspicuous cross walls. Very slow motile with peculiar oscillation.	7-10x5.5 Isodiametric or slightly shorter than width, apical cell widely rounded.
Pseudophormidium golenkinianum Plate-A, Fig -4 Komarek and Anagnostidis, 2005,	Lowland rice field. Bright blue-green, produce a lot of mucilage over on solid dish.	Mostly straight sometimes loose spiral, pseudobranches single or geminate. Very fine.	Constricted at the cross walls. Absent.	1x5 Length is more than width, apical cells rounded.
Pseudophormidium hollerbachianum Plate-A, Fig -5 Komarek and Anagnostidis, 2005	Wall of an old building. Gelatinous and bright blue-green in colour.	Variously curved and densely Entangled. Very fine.	Constricted at the translucent, ungranulated cross-walls. Absent.	2-4x1.5 Shorter than width.
Pseudophormidium purpureum Plate-A, Fig -6 Komarek and Anagnostidis, 2005	Molluscs shells & on mud. Dull blue-green clustered growth settles at the bottom.	Long, entangled, repeatedly pseudobranched. Very fine, delicate, hyaline.	Very slightly constricted at the cross walls. Absent.	1-2x1.5-3 Longer than wide or isodiametric.
Phormidium paulsenianum Plate-A, Fig -7 Komarek&Anagnostidis, 2005	Lowland rice field. In young blackish - blue & in old pale blue-green.	Mostly straight rarely coiled. Thin, colourless sheath appears at the time of hormogones formation.	Slightly constricted at the cross walls. Absent.	5-7x3-5 Isodiametric or shorter than broad, highly granulated in periphery.

contd.

Phormidium pavlovskoense Plate-A, Fig -8 Komarek&Anagnostidis, 2005	Moist soil of rice field. Mucilaginous, dark blue-green mat submerged in liquid flask and coiled growth of trichomes over on solid dish.	Straight or slightly curved. Absent.	Slightly constricted or unconstricted at the cross walls. Very slow movement in forward direction.	4x1.4 Mostly isodiametric rarely less than width.
Phormidium okenii Plate-A, Fig -9 Komarek&Anagnostidis, 2005	Epiphytic on submerged grass. Bright blue-green, tuft, attached to submersed grass in nature.	Long, Straight, irregularly curved. Usually absent rarely thin, delicate, colourless.	Distinctly constricted at the granulated or ungranulated cross walls. Slow movement in forward direction.	4-7x4-6 Mostly isodiametric rarely shorter or longer than wide.
Phormidium deflexoides Plate-A, Fig -10 Komarek&Anagnostidis, 2005	Fresh water Bright blue-green, mucilaginous, clusters.	Straight or wavy, solitary or aggregated in group. Thin, colourless.	Indistinctly constricted at the granulated cross walls. Absent.	4x1.5- 3 Isodiametric or slightly shorter than wide
Phormidium inundatum Plate-A, Fig -11 Kutzing, *Species Algarum*, 1849 Gomont, 1892, Geitler, 1932, Komarek&Anagnostidis, 2005	Lowland rice field Thin, membranous, in liquid dish growth firmly attached to glass wall and creeps in upward.	Usually straight, slightly attenuated at terminal ends Thin, colourless	Slightly constricted or unconstricted at the cross walls. Fragmented trichomes or hormogones move slowly within sheath.	4-5x4-10 Quadrate or length is more than width.
Phormidium retzii Plate-A, Fig -12 Gomont, 1892, Schimidle, 1900b, Forti, in De Toni, 1907, Geitler, 1932, Parukutty, 1940, Srinivasan, 1963, Shrivastava, 2000	Attached to stones or other object in fresh water pond. Thick, compact, tufty, attached to base in nature.	Long, isopolar, more or less straight. Thin, firm, usually diffluent.	Commonly unconstricted rarely constricted at the ungranulated cross wall. Absent.	8-10x6-7 Isodiametric or length is less or more than width.
Phormidium beggiatoiforme Plate-A, Fig -13 Komarek&Anagnostidis, 2005,	Moist wall of old buildings. Cespitose to mat like, float in submerged and also attached to wall and bottom.	Solitary, long, usually straight rarely regularly coiled. Thin, colourless only in culture.	Not constricted at the granulated cross walls. Absent.	5x4.5-5 All most isodiametric or shorter than wide.

contd.

Porphyrosiphon notarisii Plate-A, Fig -14 Schimidle, 1900b, Tilden, 1910, Geitler, 1932, Tiffany, 1952, Desikachary, 1959, Starmach, 1966 Baker&Bold, 1970, Tiwari,*etal,* 2001	Upland rice field Papery, forming red brown thick flakes on surface, tomentose.	Long, variously curved, densely aggregated &entangled. Firm, thin or thick (5µm wide), colourless but later brown red to purple red.	Constricted at the ungranulated cross walls. *Absent.*	18-20x6-11 Isodiametric or less than the width.
Microcoleus chthonoplastes Plate-A, Fig -15 Tilden, 1910, Geitler, 1932, Desikachary, 1959, Starmach, 1966 Tiwari, *etal*., 2001	Soil of rice field. Expanded, thin strata, in liquid medium air bubble present in side biomass, filaments creep spirally on solid agar surface.	Densely aggregated in fascicles, entangled, parallel arranged inside sheath. Colourless or yellow, attenuated at ends, usually open rarely closed at end.	Constricted at the granulated cross-walls. Absent.	3-4x6.7 Isodiametric or length more than width, apical end acute conical.
Symplocastrum purpurascens Plate-A, Fig -16 Komarek&Anagnostidis, 2005	Water fall Cespitose, submerged, Filaments creep uniformly.	Isopolar, straight rarely contorted. Firm, thick, lamellated.	Constricted at cross-walls. Absent.	5-6x5 Isodiametric, apical ends conically pointed or hemispherical.

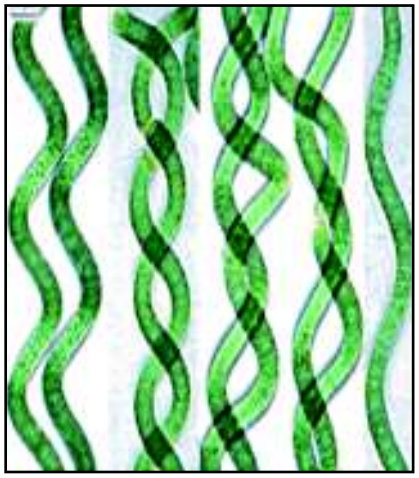
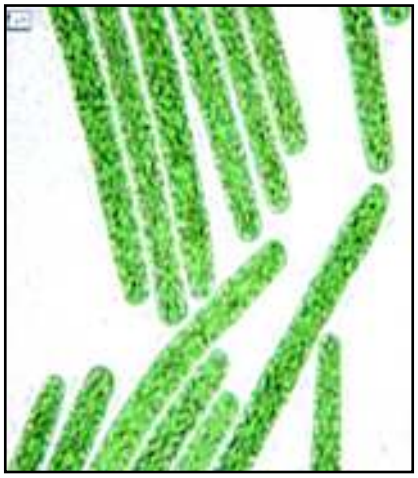


Figure 1



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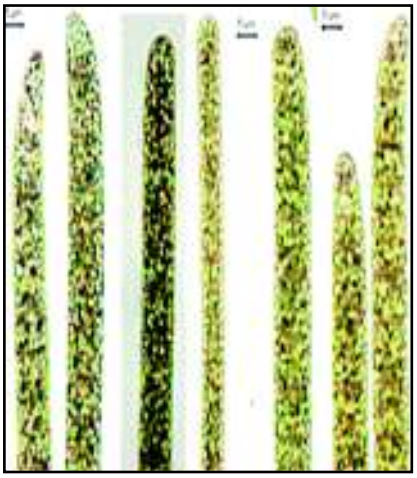

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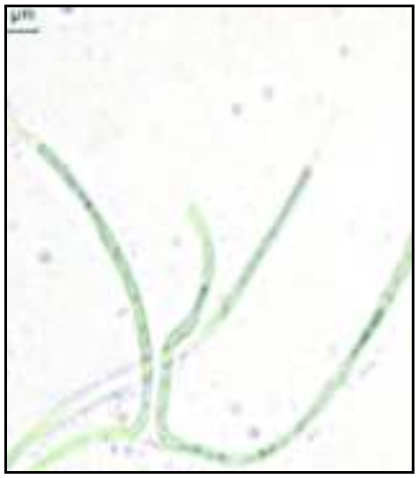

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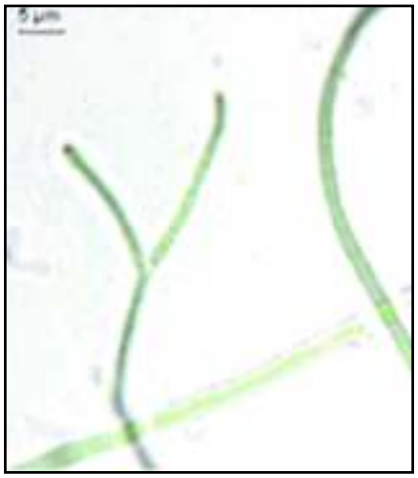

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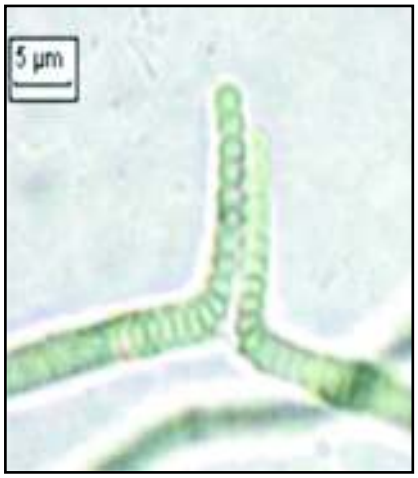

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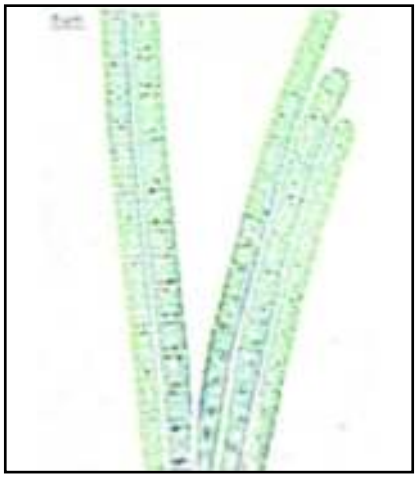

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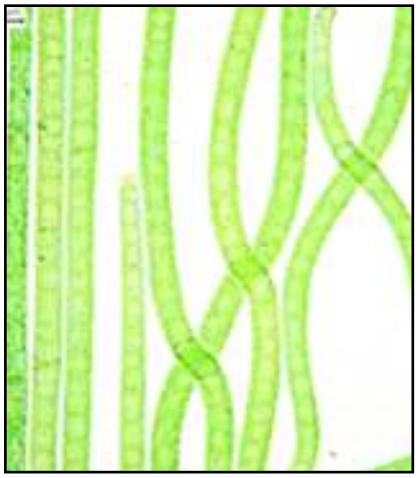

Figure 9

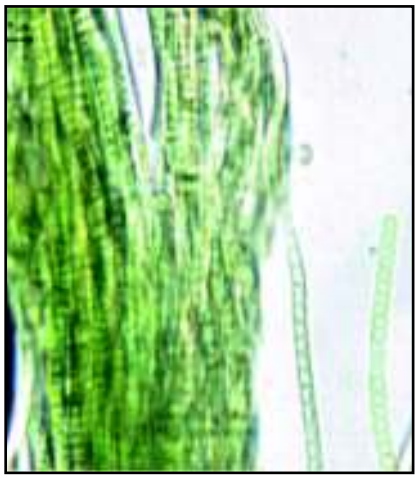

Figure 10

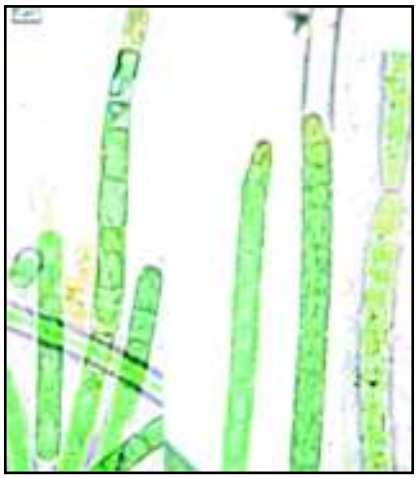

Figure 11

Figure 12

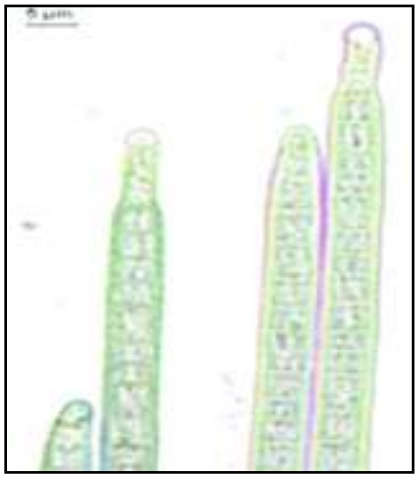

Figure 13

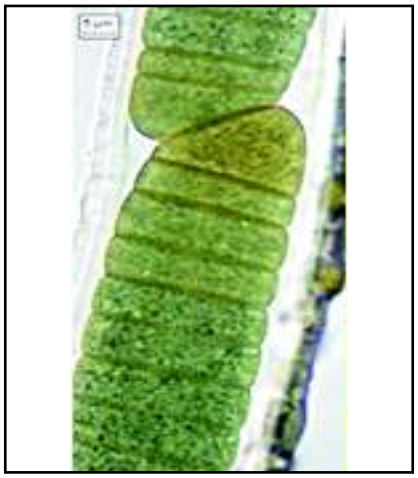

Figure 14

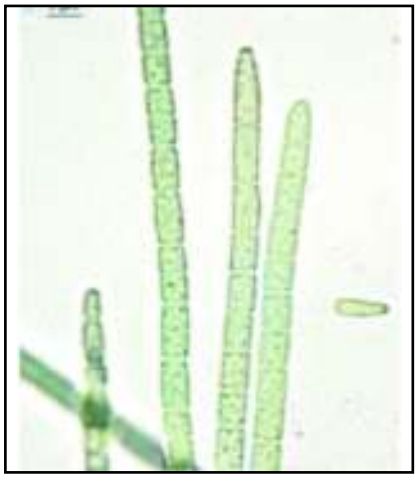

Figure 15

Figure 16

curved, densely aggregated, entangled. Cells are 18-20µm broad and 6-11µm long except terminal cell i.e. 15µm long. Sheath is thick, lamellated, purple red to reddish brown.

Two genera belonging to sub-family Microcoleoideae include Microcoleus and Symplocastrum. One species recorded i.e. *Microcoleus chthonoplastesis* characterized by two or several trichomes oriented parallel, often spirally and tightly interwoven and enclosed by a common homogeneous sheath. Cells are 3-4µm broad and 6-7.6µm long. Terminal cells are elongated, attenuated or acute conical in shape (Shrivastava 2000, Schimidle, 1900; Gomant, 1892).

One species recorded i.e. *Symplocastrum purpurascens* is characterized by thallus expanded, felt like, cespitose. Filaments show dichotomously pseudobranches in upper part while entangled in lower part. Trichomes are isopolar, straight, constricted at cross-walls. Cells are 5-6µm broad and 5µm long, isodiametric in shape. Apical cells are conical or often pointed. Sheath thick, firm, lamellated and reddish to purple red colure. Reproduction frequently occurs through cross-wise cell division and rarely by fragmentation.

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