



Research article

Eight new records of fresh water filamentous algae (*Oedogonium* Link) from India

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Abstract: The present paper deals with the eight species of *Oedogonium* which are being reported for the first time from India. All the taxa are arranged in broad groups according to their morphological peculiarities and sexual reproduction *i.e.* Macrandrous (Homothallic and Heterothallic). During the present investigation 5 macrandrous homothallic {*Oedogonium subvaucherii* Claass., *O. pseudofragile* Claass., *O. upsaliense* (Wittr.) Hirn., *O. visayense* Britt., *O. amplius* (Tayl.) Tiff.} and 3 macrandrous heterothallic forms {*O. cf capillare* (L) Kutz., *O. angustistomum* Hoff., *O. magnusii* Wittr. var. *major* Bock and Bock} have been collected for the first time from India.

Keywords: Filamentous algae - *Oedogonium* - Homothallic - Heterothallic - New record.

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INTRODUCTION

Oedogoniales, an order of filamentous freshwater green algae is well defined with several unique features, including asexual reproduction through the production of zoospores that possess a subapical ring of many short flagella called as stephanokont. Oedogoniales exhibited a specialized type of oogamy and an elaborate method of cell division which results in the accumulation of apical caps. The order is comprised of one family Oedogoniaceae which includes three genera namely *Oedogonium* Link, *Bulbochaete* Agardh and *Oedocladium* Stahl (Silva & Moe 2003). These three genera are different from each other morphologically, but also share the several characteristics that distinguish Oedogoniales from rest of the green algae. On the basis of their peculiar characteristics, members of the Oedogoniales are important not only from academic point of view but also are of great ecological significances especially in the field of limnology since they occupy specific niches, food for a number of aquatic organisms (Olojo *et al.* 2003, Kone & Teugels 2003, Awasthi *et al.* 2006), used for the removal of heavy metals, production of antibiotics (Redondo *et al.* 2006) and being used as indicator of water quality (Bajpai *et al.* 2013, Srivastava *et al.* 2014). This large, economically important order with its unique features attracted the phycologists of all over the world including India, but unfortunately this order remained unexplored in India. Many stray reports on the Oedogoniales have appeared from various parts of India (Randhawa 1940, Kamat 1967, Kamat & Patel 1973, Shukla 1971, Bharati & Pai 1972, Shukla *et al.* 1988, Saha & Pandit 1987, Mahato *et al.* 1998, Prasad & Misra 1992, Misra *et al.* 2002) but no consolidated work has ever been done on Oedogoniales and *Oedogonium* in particular. Keeping in mind, the paucity of work done on *Oedogonium*, the present research problem has been undertaken to work out the *Oedogonium* species of Jammu region. Hence, a survey has been made of six districts of Jammu.

Jammu, the winter capital of Jammu & Kashmir State, is situated at a longitude 74°–76° 15' E and latitude 32° 15' to 30° 30' N, and altitude 304.8 to 3658.5 metres above the mean sea level, It represents subtropical to temperate climate with plains to mountainous terrain, which exhibiting remarkable longitudinal variations and vegetation types. Due to the prevalent of varied climatic conditions, there exist number of natural and manmade water bodies like ponds, rivers, ditches, pools, streams, nallahs, lakes and temporary water bodies. These water bodies inhabit a great deal of algal diversity, of which Chlorophyceae is the most dominating.

MATERIAL AND METHODS

Algal samples were collected from different localities of Jammu. Algae were picked up simply by hand from shallow edges of the ponds or occasionally by plankton net and then preserved in 4% formaldehyde solution. Preliminary screening of *Oedogonium* species from the samples was made in the Aquatic biology lab, Department of Botany, University of Jammu, Jammu. Microphotographs of vegetative and reproductive structures of different species of *Oedogonium* were taken using a microphotographic camera PM6 type, Olympus make and Nikon FM3A (E). The film roll used was Nova Silver Plus, 125 ASA black and white.

Laboratory culture

In the laboratory, samples were first observed under a compound microscope for the presence of reproductive structures. The vegetative filaments were transferred to petri dishes or flasks, rich in CO₂ atmosphere for the formation of reproductive structures (Kumar & Singh 1984). The cultures were kept in the culture room, illuminated with a fluorescent, white, cool 15w tube light of 464 lux with a temperature of 15°C–25°C and a photo period of 16:8 L/D regime. After 10–20 days, the crude cultures were examined microscopically. The incubated cultures were observed by pulling some filaments from several locations from the same sample and made a whole mount on the glass slide. Samples were checked regularly for the next following few weeks particularly for the late bloomers since each sample may contain many species and also all species may not fruit at the same time (different species of Oedogoniales undergo fertility at different interval).

RESULTS

Enumeration of species

1. *Oedogonium subvaucherii* Claass (Gonzalves 1981, p. 183–185, f. 9-51) Fig. 1A

Accession No.: JUH.-Bot.-11242; Sample No.: J₁₄, U₂

Habitat: Seasonal pond formed opposite petrol pump at Kuliyan, paddy field at Mansar.

Habit: Free Floating.

Vegetative filament: Vegetative cells cylindrical, 40–56μ × 20–22μ. Antheridia: Seriate 2–4 in number, 2–6μ × 18–20μ. Oogonium: Single, globose, 30–32μ × 42–44μ, poriferous, pore superior.

Oospore: Globose, smooth walled, 20–22μ × 20–22μ.

Distribution: S. Africa (Transvaal Province), India {Jammu & Kashmir- Kuliyan (Jammu), Mansar (Udhampur)}.

Variations: Present specimen resembled the type specimen described by Gonzalves (1981) in all characters. It also seems to be close to *O.vaucherii* but differs from the same in the shape of oogonia. In *O. subvaucherii*, oogonia is globose whereas in *O. vaucherii* oogonia is obovoid to subobvoid globose.

2. *O. pseudofragile* Claass. (Gonzalves 1981, p. 180, fig. 9.44) Fig. 1B

Accession No.: JUH.-Bot.-11234; Sample No.: R₂

Habitat: Small pools formed along the side of river at Thanda Pani.

Habit: Free floating.

Vegetative filament: Cylindrical, slightly capitellate, 22–44μ × 10–16μ. Antheridia: Hypogynous, seriate, 4–5 in number, 4–6μ × 20–30μ. Oogonium: Globose to subglobose, 26–36μ × 30–42μ, poriferous, pore suprmedian to superior. Oospore: Globose to subglobose, 20–24μ × 20–30μ.

Distribution: Africa (Transvaal Province), India {Jammu & Kashmir- Thanda Pani (Rajouri)}.

Variations: Present specimen coincides well with the description of type specimen given by Gonzalves (1981) *i.e.* in having globose, poriferous oogonia, macrandrous habit. There were slight little variations in the size of vegetative and reproductive parts.

3. *O. upsaliense* (Wittr.) Hirn, 1900, p.115, pl.XII, fig.60; Tiffany 1930, p.77, pl.XVI, fig.157; Gemeinhardt 1939, p.115, fig.101; Tiffany & Britton 1952,p.66, pl.18, fig.144; Gauthier- Lievre 1963, p.293, pl.39, fig. 63h; Gonzalves 1981, p.184–185, fig. 9.53. Fig. 1C

Accession No.: JUH.-Bot.-11239; Sample No.: P₂

Habitat: Paddy Field at Sheesh Mahal, Poonch.

Habit: Free floating.

Vegetative filament: Vegetative cells cylindrical, $44\text{--}96\mu \times 12\text{--}24\mu$; Antheridia: Subepigynous, rarely seriate, $20\text{--}24\mu \times 18\text{--}20\mu$. Oogonium: Subovoid to suboblong- ellipsoid, $40\text{--}68\mu \times 24\text{--}36\mu$, poriferous, pore superior. Oospore: Suboblong-ellipsoid, smooth walled, $44\text{--}52\mu \times 24\text{--}34\mu$.

Distribution: Algeria, Green Land, Ohio, Illinois, Michigan, New Hampshire, Iberia, Czechoslovakia, Denmark, Finland, France, Germany, Poland, Sweden, India {Jammu & Kashmir - SheeshMahal (Poonch)}.

Variations: Ellipsoid, poriferous oogonia and smooth walled oospore enabled present specimen to resembled *O. upsalisense*, *O. oviforme*, *O. subellipsoideum* and *O. sodiroanum*. On the basis of dimensions of vegetative and reproductive parts it seems to be more close to *O. upsaliense* as compared to *O. oviforme* and *O. subellipsoideum* species. The present specimen resembled the type specimen described by Gonzalves (1981) in morphology as well as dimensions of vegetative and reproductive parts.

4. *O. visayense* Britton, 1948, p.716, fig.2-5; Gonzalves 1981, P. 189, Fig.- 9.57.

Fig. 1D

Accession No.: JUH.-Bot.-11244; Sample No.: J₁₆, J₁₇, K₃, U₃

Habitat: Seasonal pond along the road side opposite petrol pump at Kuliyan, bouley at Kathua, ditches at Samba, seasonal pond at Majalta.

Habit: Free floating.

Vegetative filament: Vegetative cells cylindrical, cell wall smooth, $42\text{--}74\mu \times 10\text{--}14\mu$; basal cell elongate; suffultary cells often inflated; Antheridia: Sub-epigynous to sub-hypogynous or scattered, single or multi seriate, $4\text{--}6\mu \times 16\text{--}18\mu$. Oogonium: Sub-depressed or sub-pyriform, smooth walled, $40\text{--}42\mu \times 30\text{--}36\mu$, poriferous, pore superior. Oospore: Globose to sub-globose, $18\text{--}30\mu \times 20\text{--}30\mu$; three layered, outer layer & middle layer smooth, inner layer slightly wavy.

Distribution: Philippines Island, India {Jammu & Kashmir- Kuliyan, Samba (Jammu); Majalta (Udhampur); Kathua}.

Variations: *O. visayense* is characterized by having inflated suffultary cells and depressed globose oospore (Gonzalves 1981). It closely resembled with the *O. obsoletum*, *O. plusiosporum*, *O. tyrolicum*, *O. urbium* and *O. varians* in all characters except for inflated suffultary cells. The collected specimen has the dimensions within the prescribed limit by Gonzalves (1981) with the narrow variations in the size of vegetative cells being slightly longer and broader than the type specimen.

5. *O. amplius* (Tayl.) Tiff. Gonzalves 1981, p. 204–205, f. 9-77.

Fig. 1E

Accession No.: JUH.-Bot.-11249; Sample No.: J₂₃

Habitat: Seasonal Pond formed after monsoon at Kuliyan.

Habit: Free Floating.

Vegetative filament: Vegetative cells cylindrical, $28.6\text{--}58.5\mu \times 6.5\text{--}14.3\mu$; suffultory cells not inflated, $48\mu \times 14.3\mu$; Antheridia: Seriate, subepigynous, $4\text{--}8\mu \times 10\text{--}11\mu$. Oogonium: Depressed globose to sub-pyriforme; $30.5\text{--}35.1\mu \times 34\text{--}40.3\mu$, operculate, division superior. Oospore: Globose, not filling the oogonium, $28.5\text{--}30.5\mu \times 30.5\text{--}31.5\mu$.

Distribution: Canada, India {Jammu & Kashmir- Kuliyan (Jammu)}.

Variations: Characters of this specimen resembled to that of *O. pyrulum*, *O. amplius* and *O. pyriform* but it seems to be more close to *O. amplius* than the other two especially in shape of oogonia, dimensions of vegetative and reproductive organs. The present specimen is slightly smaller in size than the type specimen discussed by Gonzalves (1981).

6. *O. cf capillare* (L) Kutz. Novis 2003, p.344-345, fig. 5Q-V, 6A-C.

Fig. 1F-G

Accession No.: JUH.-Bot.-11255; Sample No.: J₃₀, U₇

Habitat: Lake at Surinsar, pools formed along the side of slow moving stream at Ram Nagar.

Habit: Free floating.

Vegetative filaments: Vegetative cells cylindrical slightly capitellate, chloroplast starts degenerating, female filament $20\text{--}60\mu \times 12\text{--}24\mu$. Oogonium: Globose sub cylindrical, $50\text{--}60\mu \times 50\text{--}60\mu$, poriferous, pore superamedian. Oospore: Depressed globose to globose, not filling the oogonium, $30\text{--}40\mu \times 30\text{--}40\mu$.

Distribution: New Zealand, India {Jammu & Kashmir- Surinsar (Jammu)}.

Variations: The *O. capillare* complex consists of large forms. Oogonia slightly swollen than the vegetative cells. In this case, although the males were abundant but oospores were rarely seen. It is possible that the oospores observed were actually deformed or the infected vegetative cells. More female material required to identify the material.

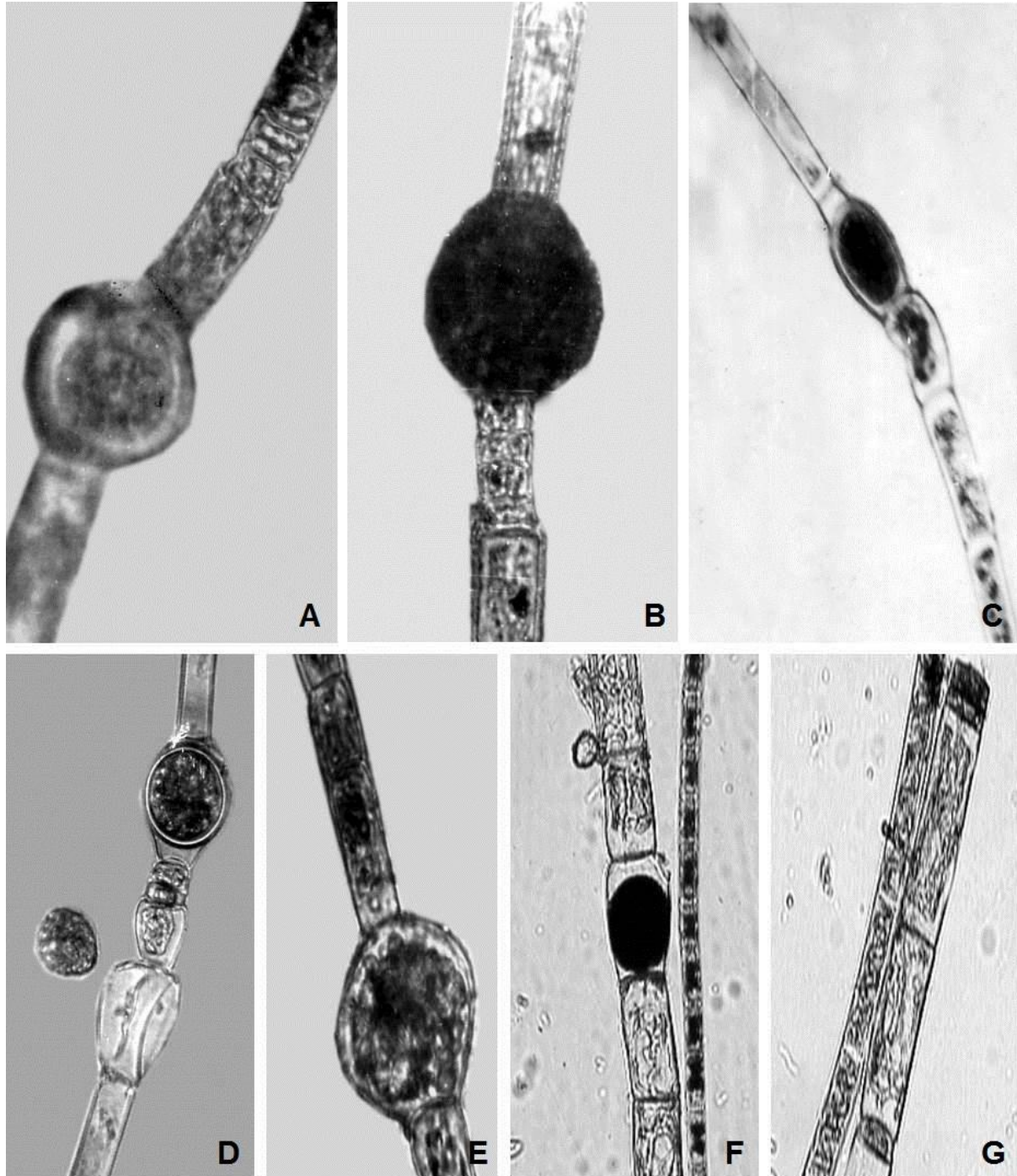


Figure 1. A, *Oedogonium subvaucherii* Claass.; B, *O. pseudofragile* Claass.; C, *O. upsaliense* (Wittr.) Hirn; D, *O. visayense* Britt.; E, *O. amplius* (Tayl.) Tiff.; F–G, *O. cf capillare* (L) Kutz.

7. *O. angustistomum* Hoff Gonzalves 1981, p. 562, fig. 9-507.**Fig. 2A–B**Accession No.: JUH.-Bot.-11262; Sample No.: J₃₇

Habitat: Along the road side ditches at Pragwal wetland.

Habit: Epiphytic.

Vegetative filament: Vegetative cells cylindrical slightly capitellate, apically obtuse terminal cell, elongate basal cell with bulbous base, smooth walled, those of female filaments 70–150 μ \times 20–40 μ ; those of male filament 60–150 μ \times 20–26 μ . Antheridia: Antherozoids seriate 10–25, 4–8 μ \times 20–26 μ . Oogonium: Subglobose, smooth walled, poriferous, pore superior 60–90 μ \times 50–70 μ . Oospore: Globose to subglobose, smooth walled, 50–80 μ \times 44–64 μ .

Distribution: Tennessee, India {Jammu & Kashmir- Pragwal (Jammu)}.

Variations: Characteristic apically obtuse terminal cell and long chain of antheridia up to 30 no. distinguished this species. This species resembled *O. angustistomum* the type specimen described earlier by Gonzalves (1981) in the morphology as well as in the dimensions of vegetative and reproductive parts with the little variations.

8. *O. magnusii* Wittr. var. *major* Bock and Bock, Tiffany 1930, p.68, pl.XII, fig.115; Gemeinhardt 1939, p.95, fig. 65; Tiffany and Britton 1952, p.61, fig.116; Gautheir- Lievre 1963, p.343, pl.55 fig. 89a; Gonzalves 1981, 325–327, fig. 206b.

Fig. 2C–DAccession No.: JUH.-Bot.-11265; Sample No.: R₃, R₄, R₅, K₆

Habitat: Small puddles formed after moonson at Jawahar Nagar , Small boli at Kathua, Small pools formed along the side of slow moving stream at Thandapani.

Habit: Free floating.

Vegetative filament: Cylindrical and sometimes slightly capitellate, smooth walled; female vegetative filament 28–50 μ \times 14–18 μ ; male vegetative filament 20–40 μ \times 6–8 μ ; suffultary cells inflated, suffultary cells 22 μ \times 20 μ . Antheridia: Solitary sometimes seriate, 4–8 μ \times 10–12 μ . Oogonium: Depressed globose, 28–30 μ \times 34–38 μ , poriferous, pore supramedian. Oospore: Globose, 26–28 μ \times 20–30 μ , three layered, smooth walled.

Distribution: Morocco, Canada, Illinois, Massachusetts, Michigan, Finland, France, Germany, Poland, Sweden, Yugoslavia, India {Jammu & Kashmir- Thandapani, Jawahar Nagar (Rajouri), Kathua}.

Variations: Dimensions of present specimen falls within the prescribed range for the type species described earlier by Gonzalves (1981) & Tiffany and Britton (1952).

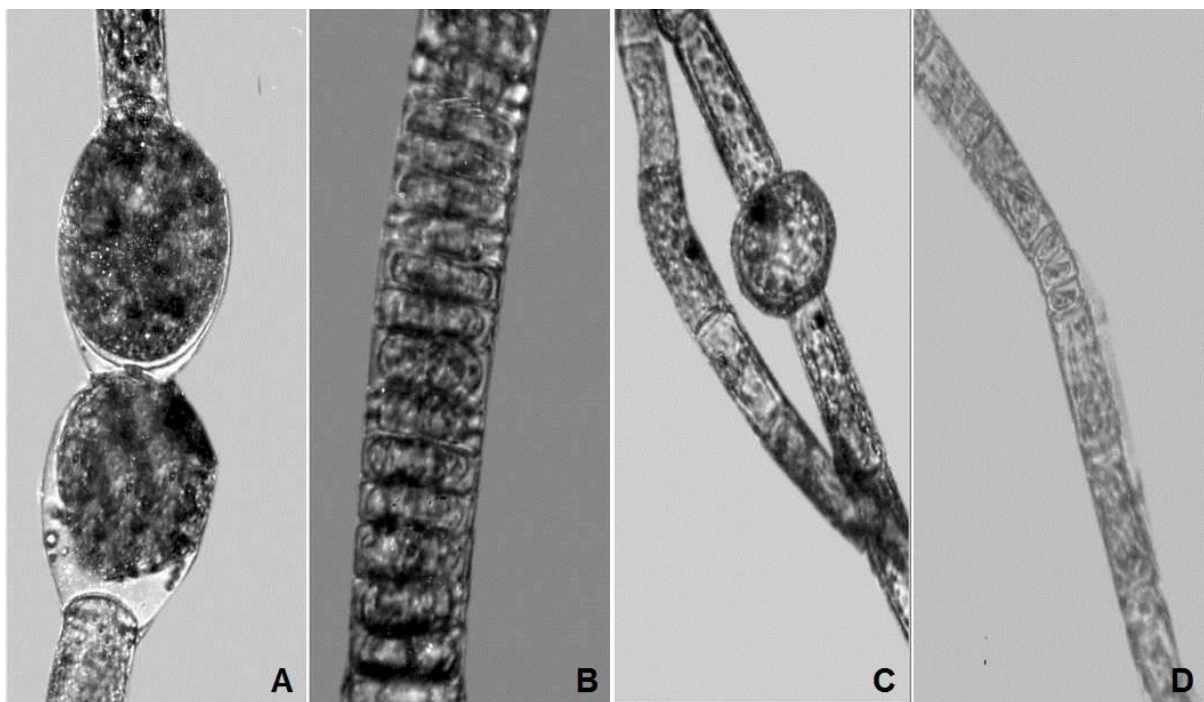


Figure 2. A–B, *Oedogonium. angustistomum* Hoff.; C–D, *O. magnusii* Wittr. var. *major* Bock and Bock.

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