

STUDIES ON SPECIES DIVERSITY AND ECOLOGY OF GENUS *OEDOGONIUM* LINK OCCURRING IN AQUATICS OF SHIVALIK HIMALAYAS OF JAMMU

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Shivalik Himalayas of Jammu represents the lower Himalayas and constitute the hills of moderate elevation, diped gently to the south. Subtropical to Temperate climate of this region leads to the different type of vegetation of both the mountains and the plains, with an altitude of 300-1200 m above mean Sea level. Ten species of genus *Oedogonium* has been recorded from different water bodies of Jammu region. The amplitude of variations with respect to morphological characteristics of different species of *Oedogonium* was quite significant which has been discussed in present communication. Out of 10 species, 5 sps. nannandrous, 3 macrandrous homothallic and 2 macrandrous heterothallic. Maximum number of nannandrous sps. have been collected from higher altitudes. The pH of water bodies ranges from 7.2 – 9.5, Hardness ranges from 90 mg/l – 440 mg/l, Dissolved oxygen ranges from 3.2 mg/l – 8.41 mg/l, Free CO₂ was found to absent from all the water bodies except at one station. Studies revealed that lentic habitats particularly seasonal water bodies, supported maximum number of *Oedogonium* species than the lotic ones. The carbon dioxide, carbonates and bi- carbonate system operate in these water bodies. Composition of the associated algal flora along with *Oedogonium* species revealed that Chlorophyceae and Bacillariophyceae constitutes the dominant components with respect to each *Oedogonium* species occurring in lentic/ lotic waters of the region. Most of the pollution tolerant species i.e. *Navicula*, *Scenedesmus*, *Oscillatoria*, are found associated with the *Oedogonium* species like *O. undulatum*; *O. flavescence* var. *flavescence*; *O. pusillum* var. *pusillum* and *O. magnusii* which concludes that these *Oedogonium* species are also pollution tolerant

Keywords : Heterothallic; Homothallic; Macrandrous; Nannandrous; *Oedogonium*.

Introduction

Province Jammu, the winter capital of J&K state is situated at a longitude 74° to 76° - 15' E and latitude 32° - 15' to 30° - 30' N, at altitude of 304.8 to 3658.5 mts.m.s.l., with subtropical to temperate climate. This region has been bestowed with great diversity of aquatic resources i.e. ponds, rivers, ditches, pools, streams, nallahs etc. which harbour great algal diversity. In the past, few stray references have appeared on the *Oedogoniale* flora of Jammu¹⁻⁸, so far no consolidated work has been done. Keeping this in mind a survey has been conducted for the collection of *Oedogonium* species from various habitats including lakes, rivers, streams, ditches etc.

Genus *Oedogonium* Link though uncommon in aquatics of Jammu, is easy to be recognized by the presence of cap cells and reproductive organs (antheridia and oogonia). Field materials usually comprised of mixture of vegetative filaments of different species. Some part of the collections were kept under laboratory conditions till

sex organs developed since they are important for identifications. About 10 species of *Oedogonium* have been identified from such collections [*O. undulatum* Hirn; *O. flavescence* [Hass]. Wittr.] Hirn var. *flavescence* Gonzalves; *O. irregulare* [Wittr.] Hirn var. *irregulare* [Wittr.] Hirn; *O. idioandrosporum* (Nordst and Wittr.) Tiffy var. *idioandrosporum* (Nordst. and Wittr.) Tiffy; *O. multisporum* [Wood] Hirn var. *unicellularis* Venkt. ; *O. cryptoporum* [Wittr.] Hirn var. *szechwanense* Jao; *O. pseudofragile* Claass; *O. pusillum* [Kirch] Hirn var. *pusillum* Gonzalves; *O. pratense* Tiffy. var. *crassum* Gonzalves & Jain; *O. magnusii* Wittr. var. *major* Bock and Bock].

Out of these 10 species, 5 species i.e. *O. undulatum*, *O. flavescence* var. *flavescence*, *O. irregulare* var. *irregulare*; *O. idioandrosporum* var. *idioandrosporum*; *O. multisporum* var. *unicellularis* of *Oedogonium* are nannandrous; 2 species i.e. *O. cryptoporum* var. *szechwanense*; *O. pseudofragile* are

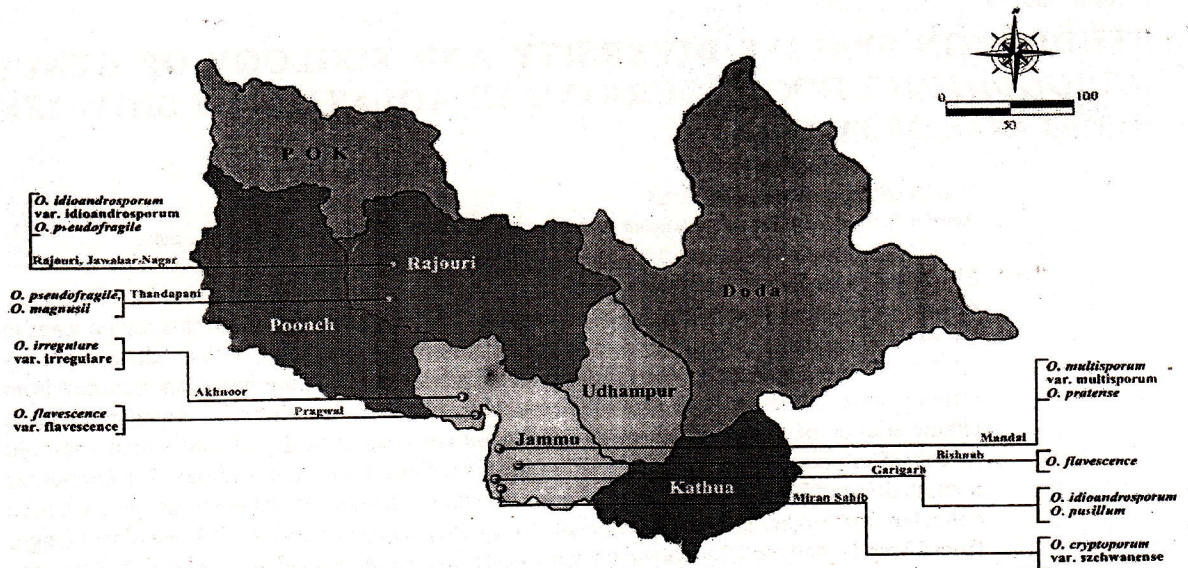


Fig 1. Distribution of fertile taxa of *Oedogonium* in Jammu region.

Table 1. Physico-chemical analysis of habitat water.

Stations	Parameters mg/l							
	Temperature °C	Cl ⁻	pH	DO	FCO ₂	Hardness		Alkalinity
						Calcium	Magnesium	
S-1. Jawahar Nagar	23	25.31	8.33	8	18	78.4	27.50	267.18
S-2. Thandapani	14.1	17.29	9.5	8.41	A	537	11.08	744
S-3. Akhnoor	16	8.99	7.2	7.15	A	35.3	41.8	790
S-4. Pragwal	24	16.99	8.8	7.6	A	34.9	10.16	158.5
S-5. Mandal	25	18.99	7.83	3.2	A	35.32	53.55	234
S-6. Bishnah	23	27.99	7.95	4.5	A	26.49	22.85	287
S-7. Garigarh	21	16.2	7.9	7.23	A	38.49	11.17	345
S-8. Miran Sahib	17.2	20.9	8.1	8.2	A	57	20.99	456

macrandrous homothallic and *O. pusillum*, *O. pratense* var. *crasum* and *O. magnusii* var. *major* are macrandrous heterothallic.

Out of the ten species nine species have been collected from lentic water bodies and only one species (*O. undulatum*) collected from lotic water body, *O. flavescence* var. *flavescence* was found to be common to

both lentic and lotic water bodies.

Materials and Methods

Algal samples were collected from different aquatic habitats and a part of which was preserved in 4% formaldehyde. Table -1 lists the physico-chemical characteristics of the habitat water i.e. transparency, pH, temperature, carbonates, bicarbonates, calcium,

magnesium, dissolve oxygen and phosphorus⁹⁻¹⁰. Identifications were made using relevant literature¹¹⁻¹⁴. For convenience, the taxa have been arranged in broad groups according to the morphology i.e. nannandrous and macrandrous (homothallic and heterothallic).

Results

The distribution of these fertile taxa are presented in Fig. I.

Taxonomy -

1. *O. idioandrosporum* (Nordst. & Wittr.) Tiffy. var. *idioandrosporum* (Nordst. & Wittr.) (Gonjalves 1981, 405, fig 9.298)

Plate- I, Fig. - 1

Sample No.-P_{xvii}

Habitat- Ditches

Place of Collection- Rajouri

Habit- free floating

Vegetative filament:- Vegetative cells cylindrical, cell wall smooth; 117-126µ x 32.5-44.6µ; suffultary cells not inflated
Oogonium:- Oogonium globose to obovoid; poriferous, pore supramedian, 84.5-104µ x 70.2-79.3µ; Oospore completely fill the Oogonium.

Dwarf Male:- Cup shaped male attached on the Oogonium; 14.3µ x 13µ.

Distribution : India - Not reported earlier, Jammu, Rajouri

2. *O. undulatum* Hirn

(Gonzalves 1981, 364, fig 9.252A)

Plate-I, Fig. - 2

Sample No.-P_{xvi}

Habitat- Seasonal Nallah

Place of Collection- Bishnah (Jammu)

Habit- free floating

Vegetative filament:- Vegetative cells slightly capitellate; cell wall undulate; 3-4 undulations per cell; 20-34µ x 12-20µ.

Oogonium:- Oogonium pyriform; poriferous, pore superior, 36-40µ x 32-38µ; Oospore completely fill the Oogonium.

Dwarf male not seen

Distribution : India- Not reported earlier Jammu-Bishnah

3. *O. flavescense* [(Hass). Wittr.] Hirn var. *flavescense*

(Gonjalves 1981, 403, fig 9.295-297; Tiffany & Britton, 1952, 88, fig. 256)

Plate- I, Fig. - 3

Sample No.-P_{xv}

Habitat- Stagnant water, Stream, Nallaha

Place of Collection- Garigarh (Jammu) Sunderbani, Rajouri (Rajouri)

Habit- free floating

Vegetative filament:- Vegetative cells cylindrical; cell wall smooth; degenerating chloroplast; 44-64µ x 26-28µ

Oogonium:- Oogonium globose to subglucose ellipsoid; poriferous pore superior; 52-64µ x 44-48µ.

Oospore:- Oospore globose; not filling the Oogonium;

reddish brown; 40-44µ x 38-40µ.

Dwarf male:- Curved male situated on the Oogonium; 18µ x 11-14µ.

Distribution : India - Not reported earlier, Jammu-Garigarh, Sunderban Rajouri.

This form is more closely related to var. minus than the var. flavescense. Form differs in dimensions. It has been regarded by Tiffany (1937b) as synonymous with *O. gallicum*; but as it differs in dimensions and in the shape of the oogonium from *O. gallicum*, it is preferable to maintain it as a variety of *O. flavescense*.

4. *O. irregular* [Wittr.] Hirn var. *irregulare* (Wittr.) Hirn (Gonjalves 1981, 406, fig 9.299 A; Tiffany & Britton 1952, 90, fig. 263)

Plate- I, Fig. - 4

Sample No.-PB₃

Habitat- Stagnant water, Small ditches along the road side.

Place of Collection- Akhnoor (Jammu),

Habit- free floating

Vegetative filament:- Vegetative cells cylindrical, cell wall smooth; 32-44µ x 16-18µ; suffultary cells not inflated; 30-38µ x 14-18µ.

Oogonium:- Oogonium globose to subglobose; poriferous, pore superior, 30-32µ x 28-30µ; Oospore completely fill the Oogonium.

Dwarf male:- Dwarf male attached on the Oogonium; 26-28µ x 10-12µ.

Distribution: India - Not reported earlier, Jammu - Akhnoor

5. *O. multisporum* [Wood] Hirn var. *unicellularis* Venkt.

(Gonzalves 1981, 409-410, fig. 9.302B)

Plate- I, Fig. - 5

Sample No.-PB₃

Habitat- Stagnant water, Small ditches along the road side, Paddy fields.

Place of Collection- Mandal (Jammu),

Habit- free floating

Vegetative filament:- Vegetative cells cylindrical; 34-50µ x 36-38 µ; chloroplast completely fill the vegetative cell; pyrenoids completely visible; green in colour.

Oogonium:- Oogonium globose; 30-32 µ x 36-38 µ; poriferous, pore supra medion to medion.

Oospore:- Oospore completely fill the Oogonium.

Dwarf male:- Cup shaped dwarf males attached on the Oogonium.

Distribution : India - Not reported earlier, Jammu - Mandal

6. *O. cryptoporum* [Wittr.] Hirn var. *szechwanense* Jao.

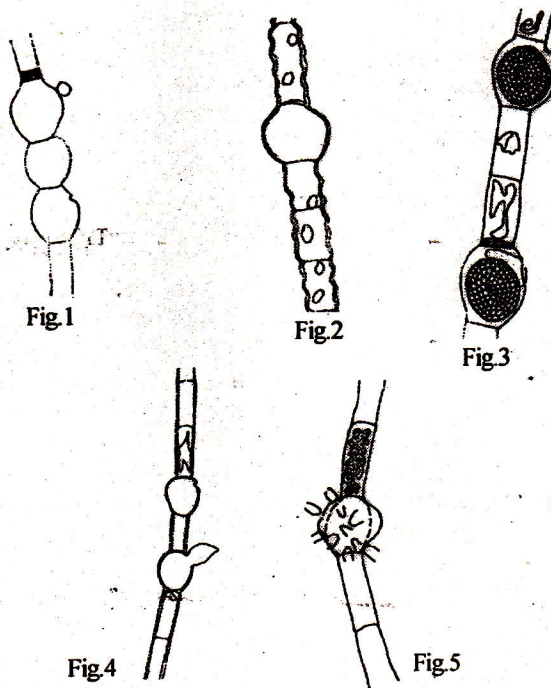
(Gonjalves 1981, 160-161, fig 9.23-24; Tiffany & Britton 1952, 64, fig. 122)

Plate- II, Fig. - 6

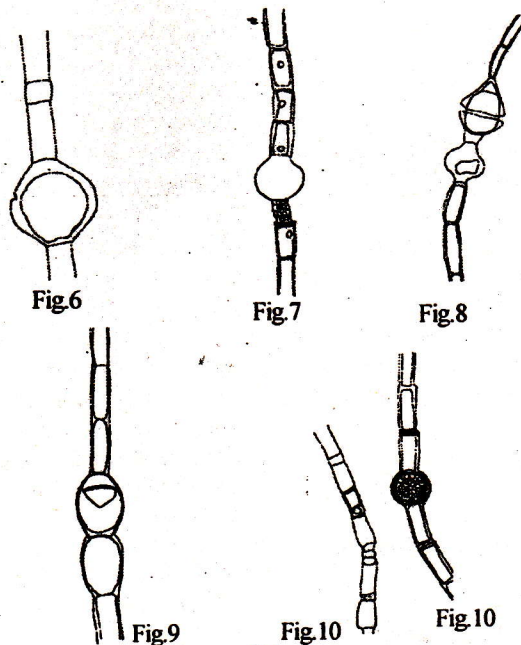
Sample No.-P₁

Habitat- Paddy Field

Place of Collection- Miran Sahib (Jammu)



Figs. 1-5. 1- *O. idioandrosporum* (Nordst. & Wittr.) Tiffy. var. *idioandrosporum* (Nordst. & Wittr.) (40x.10x); 2- *O. undulatum* Him (40x.10x); 3- *O. flavescense* [(Hass.) Wittr.] Him var. *flavescense* (40x.10x); 4- *O. irregular* [Wittr.] Him var. *irregulare* (Wittr.) Him (40x.10x); 5- *O. multisporum* [Wood] Him var. *unicellularis* Venkt. (40x.10x)



Figs. 6-11. 6-*O. cryptoporum* [Wittr.] Him var. *szechwanense* Jao. (40x.10x); 7-*O. pseudofragile* Claass. (40x.10x); 8-*O. pusillum* [Kirch.] Him var. *pusillum* Gonzalves. (40x.10x); 9-*O. pratense* Tiffy. var. *crassum* Gonzalves & Jain (40x.10x); 10-*O. magnusii* Wittr. var. *major* Bock and Bock (40x.10x) (Male Filament); 11- *O. magnusii* Wittr. var. *major* Bock and Bock (40x.10x) (Female Filament).

Habit- free floating

Vegetative filament: - Vegetative cells cylindrical, 20-26 μ x 8-10 μ .

Oogonium:- Oogonium depressed globose to subpyriform; poriferous, pore median; 22-23 μ x 26-28 μ .

Oospore:- Oospore not completely fill the Oogonium; subglobose to depressed globose; 20-21 μ x 22-24 μ .

Antheridia:- Antheridia Subepigynous or subhypogynous; single or sometimes multi seriate; 6-8 μ x 8-10 μ .

Distribution : India - Not reported earlier, Jammu-Miransahib

7. *O. pseudofragile* Claass.

(Gonzalves 1981, 18, fig. 9.44)

Plate- II, Fig.- 7

Sample No.-B_{xi}

Habitat- Ditches

Place of Collection- Thanda pannii (Rajouri)

Habit- free floating

Vegetative filament- cylindrical, slightly capitellate; prominent nucleus; green; 22-44 μ x 10-16 μ .

Oogonium- globose, to subglobose ; poriferous, pore suprmedian to superior; 26-36 μ x 30-42 μ .

Oospore – globose to subglobose; 20-24 μ x 20-30 μ .

Antheridia – hypogynous, seriate 4-5; 4-6 μ x 20-30 μ .

Distribution- India - Not reported earlier, Jammu - Thandapani, Rajouri

8. *O. pusillum* [Kirch.]Hirn var. *pusillum* Gonzalves.

(Gonzalves 1981, 227-228, fig 9.102; Tiffany & Britton 1952, 64, fig. 122)

Plate- II, Fig.- 8

Sample No.-A₂

Habitat- Ditches, Stream

Place of Collection- Garigarh (Jammu)

Habit- free floating

Vegetative filament: - Vegetative cells cylindrical; smooth walled; 19.5-26 μ x 3.9-5.2 μ . **Oogonium:-** Oogonium single rarely in two,s; subconic-ellipsoid or subconic-globose; operculate, division median; 32.5-39 μ x 22.1-26 μ .

Oospore:- Ellipsoid to globose; not quite filling the Oogonium; 10.8-26 μ x 10.4-20.8 μ .

Distribution : India - Not reported earlier, Jammu - Garigarh

9. *O. pratense* Tiffy. var. *crassum* Gonzalves & Jain (Gonzalves 1981, 346, ; Tiffany & Britton 1952, 77, fig. 199)

Plate- II, Fig.- 9

Sample No.-B_{xi}

Habitat- Paddy field

Place of Collection- Mandal (Jammu)

Habit- free floating

Vegetative filament- vegetative cells cylindrical, slightly capitellate, smooth walled; suffultory cells slightly inflated; elongate basal cell with hold fast. veg cells 50-70 μ x 12-

20 μ , basal cell 38 μ x 5 μ ; suffultory cell 60-70 μ x 18-20 μ .

Oogonium- Oogonium globose to subglobose; operculate division suprmedian; 48-54 μ x 40-44 μ ; smooth walled.

Oospore:- depressed to globose; three layered; smooth walled; 46-54 μ x 38-42 μ .

Male filament – antheridia- 4 μ x 8 μ .

Distribution - India - Not reported earlier, Jammu - Mandal

10. *O. magnusii* Wittr. var. *major* Bock and Bock (Gonzalves 1981, 325-327, fig. 206 b; Tiffany and Britton 1952, 61, fig. 116)

Plate-II, Fig.- 10, 11

Sample No.-B_{xi}

Habitat- Ditches

Place of Collection- Thandapani(Rajouri)

Habit- free floating

Vegetative filament – Cylindrical slightly capitellate; suffultory cells inflated; smooth walled; female vegetative filament 28-50 μ x 14-18 μ ; male vegetative filament, 20-40 μ x 6-8 μ . suffultory cells 22 μ x 20 μ .

Ooganium- Depressed globose; poriferous, pore suprmedian; 28-30 μ x 34-38 μ .

Oospore- Three layered; smooth walled; globose; 26-28 μ x 20-30 μ .

Antheridia – 4-8 μ x 10-12 μ .

Distribution - India - Not reported earlier, Jammu - Thandapani

Discussion

A greater diversity of *Oedogonium* probably occurs in ditches, seasonal ponds. In *Oedogonium* the fertile structure needed for identification are seldom present in field material. The diversity of the genus is so great that factors determine the distribution of different species could be extremely complex, beyond physical or chemical characteristics of the habitat.

Some collecting sites were visited twice, but the majority only once. Given that different species appear to undergo sexual reproduction under different conditions, full complement of *Oedogonium* species at most sites is probably still undescribed. Eight out of ten taxa were found only once during the survey. Usually female material was easier to find than male material, partly because Oogonia are much larger and therefore more readily visible than artheridia. Fertile female material can sometimes be identified with confidence without male filaments (e.g. *O. pusillum* & *O. undulatum*, the Oogonia of former are typical pyriform with median operculate & the cell wall of latter is typical undulate). However, no identifications could be made on the few occasions when male only was present.

Work on associated algal flora of each *Oedogonium* species reveals that each of *Oedogonium* species shows maximum association with chlorophyceae

and bacillariophyceae. Most of the pollution tolerant genera (palmer indices) i.e. *Oscillatoria*, *Anabaena*, *Scenedesmus*, *Synedra*, *Ankistrodesmus*, *Pediastrum*, *Fragilaria*, *Gomphonema*, *Closterium* are found associated with *Oedogonium* species like *O. undulatum*, *O. flavescense* var. *flavescense*, *O. pusillum* var. *pusillum* and *O. magnusii*. Since the pollution tolerant species are found attached with the above described *Oedogonium* species so these *Oedogonium* species must be included under pollution tolerant species and should be used as pollution indicator.

Aknowledgement

Thanks are due to Head, Department of Botany for providing the necessary facilities and valuable guidance and one of us (PJ) is thankful to University of Jammu for financial assistance.

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