



***Oscillatoria animalis* Ag. ex Gomont, a type species occurring in sewage water in Allahabad**

Mala Pathak¹, S. C. Agrawal² and Kiran Bala³

Department of Botany, University of Allahabad, Allahabad- 211002, India.

¹E-mail: malapathak05@gmail.com ²E-mail: 20.satish@gmail.com

Abstract

Oscillatoria animalis Ag. ex Gomont occurred, survived and reproduced (formed hormogonia) maximally in 100 % sewage water in Allahabad. All the vegetative filaments of *O. animalis*, survived in 100 % sewage water for 43 day of inoculation. In *O. animalis*, percentage of hormogonia formation increased as the concentration of sewage water increased from 0 to 100 %. On the other hand *O. limosa*, a fresh water species, did not form any hormogonia in 100 % of sewage water.

Key words: Hormogonia, *Oscillatoria animalis*, *Oscillatoria limosa*.

Introduction

Very little is known on the survival and reproduction of blue-green algae in sewage water. Urban and rural domestic sewage have been used to grow *Chlorella*, *Scenedesmus* and *Spirulina* species (Ip *et al.* 1982, Venkataraman *et al.* 1982). *Chlorella vulgaris* and *C. variegata* cells failed to differentiate into autospore mother cells in sewage-water (Agrawal and Manisha 2007). Sewage water favoured the formation of necridia cells in *Phormidium bohneri*, *P. foveolarum*, *Microcoleus chthonoplastes*, *Lyngbya birgei* and *L. major* filaments (Agrawal and Gupta 2009). *Ulva lactuca* and *Rhizoclonium kochianum* grew well at sites close to domestic sewage and industrial effluent, but *Caulerpa racemosa* and *Bryopsis plumosa* occurred at some distance from the source of pollution (Tiwari and Joshi 1988). The present study investigates about the effect of sewage water of different dilution on the survival period and hormogones formation of *Oscillatoria animalis*, a sewage water alga and *O. limosa*, a fresh water alga.

Materials and methods

The filaments of blue-green alga *O. animalis* were collected from a sewage water channel at Allahabad. The cells of *O. animalis* filaments were about 3-4 µm broad and 2-3 µm long (Fig. 1A). The fresh water species of *O. limosa* was collected from a fresh-water ditch at the garden of Botany Department, University of Allahabad. The trichomes of the *O. limosa* were more or less straight and not constricted at the cross walls. The septa were granulated. The cells of *O. limosa* were 16 µm broad and 5 µm long (Fig. 2A). Both the algal materials were identified with the help of Desikachary (1959).

The 7-day-old algal filaments of either of both species cultured in BG11 medium were used to see the effect of sewage water on the survival and reproduction of algae. Approximately equal amount of each of the alga were inoculated, separately, into equal volumes (10 ml) of sterilized BG 11 medium (serving as control medium) as well as in desired concentrations of different sewage water solution prepared in fresh and sterilized BG 11 medium (25, 50 and 100 % of sewage water). Before inoculating the algal material for all the experiments, algal filaments were washed to remove smaller fragments and only longer filaments (more than 90 cells long) of *Oscillatoria* were used as inoculants to observed induction of hormogonia formation. Each set of the experiment had three replicates. All inoculated culture tubes were placed in the culture chamber at control culture conditions with illumination of 40 µmol m⁻² s⁻¹ light intensity for 16 hrs a day and temperature of 25 ± 1°C. Zero percentage of sewage water is 100 % BG11medium, while sewage water diluted 4 times or 2 times with BG11 medium is to obtain 25 and 50 % of sewage water.

Survival period of *Oscillatoria animalis* and *O. limosa* were determined up to the death of all vegetative filaments (hyaline, empty, distorted and deformed). Percentage hormogones formation of algae was determined by observing percentage of all filaments (live or dead) versus small fragments (e.g. 1-20 cells length). About 3000-4000 vegetative filaments of different algae were counted from each of 3 replicates to determine percentage hormogones formation (Fig. 1B and 2B).

Sewage water in which *O. animalis* was growing was collected from an open sewage water tunnel at Allahabad. It was very turbid in appearance and had ammonical smell. It was slightly blackish brown in colour. Its physico-chemical properties were assessed in water analysis laboratory, Indian Farmer’s Fertilizer Co-operative Ltd. (IFFCO), Phulpur, (Allahabad) and were reported to be: pH 7.30, conductivity 1287 ($\mu\Omega/\text{cm}$), total hardness as CaCO_3 386 ppm, Chloride 146 ppm, Sulphate 35 ppm, Nitrates as NO_3^- 2.90 ppm, Ammonia as NH_4^+ 23 ppm, Suspended solid 78 ppm, , Phosphate 3.30 ppm, Zinc 0.08 ppm, free Carbon dioxide 25 ppm (determined immediately after collecting sewage water), Biological Oxygen Demand 28 ppm, Chemical Oxygen Demand 142 ppm, Dissolved oxygen NIL.

Results and Discussion

The survival period of *O. animalis* increased with increasing the concentration of sewage water from 0 to 100 % whereas the reverse was the case with for *O. limosa*, a fresh water species. The survival period of *O. animalis* and *O. limosa* was 22 and 55 days of inoculation, respectively in 0 % sewage water. All the vegetative filaments of *O. animalis* survived for 27, 38 and 43 days of inoculation and all the filaments of *O. limosa* survived for 43, 20 and 8 days of inoculation at 25, 50 and 100 % of sewage water, respectively (Table I). The green algae *Chlorella vulgaris* was found to grow on sludge and in retention basins of sewage treatment plants (Palmer 1969).

Sewage water concentrations from 0 to 100 % stimulated the hormogonium differentiation (hormogones of 1-20 celled length) in *O. animalis* but suppressed the hormogones differentiation in *O. limosa*. *O. animalis* shows maximum hormogones formation at 100 % of sewage water and minimum at 0 % of sewage water (Table II). *O. limosa* did not form any hormogones at 100 % of sewage water on 5th day of inoculation (Table II). Sewage water depressed fragmentation in *Hormidium flaccidum* at 25 % of sewage water (Agrawal and Gupta 2009). Thus, *O. animalis* collected from sewage water showed better survival period and reproduction in sewage water than in BG11 medium.

Table I: Effect of sewage water on survival period of blue-green algae *Oscillatoria animalis* and *Oscillatoria limosa**

Sewage water, %	Survival period in days	
	<i>Oscillatoria animalis</i>	<i>Oscillatoria limosa</i>
0	22	55
25	27	43
50	38	20
100	43	8

*About 3000-4000 vegetative filaments of *O. animalis* and *O. limosa* were observed periodically, from each of 3 replicates, to determined percentage vegetative survival (not shown in table) till it become zero (the survival period; round mean); dead filaments were empty hyaline, shrink and did not show any gliding movement. Zero percentage sewage water was the fresh BG11 medium, while sewage water diluted 4x or 2x times with BG11 medium was to obtain 25 and 50 % of sewage water concentration.

Table II: Hormogonia percentage in *Oscillatoria animalis* and *Oscillatoria limosa* on 5 day of inoculation at different concentrations of sewage water*

Sewage water, %	Percentage of hormogonia (1-20 cells length)	
	<i>Oscillatoria animalis</i>	<i>Oscillatoria limosa</i>
0	5	12
25	11	10
50	15	5
100	20	0

* Inoculants were more than 90 - cells long filaments; Hormogones were 1- 20 cells length fragments. Zero indicates formations of no hormogonia (the hormogonia percentage; round mean).

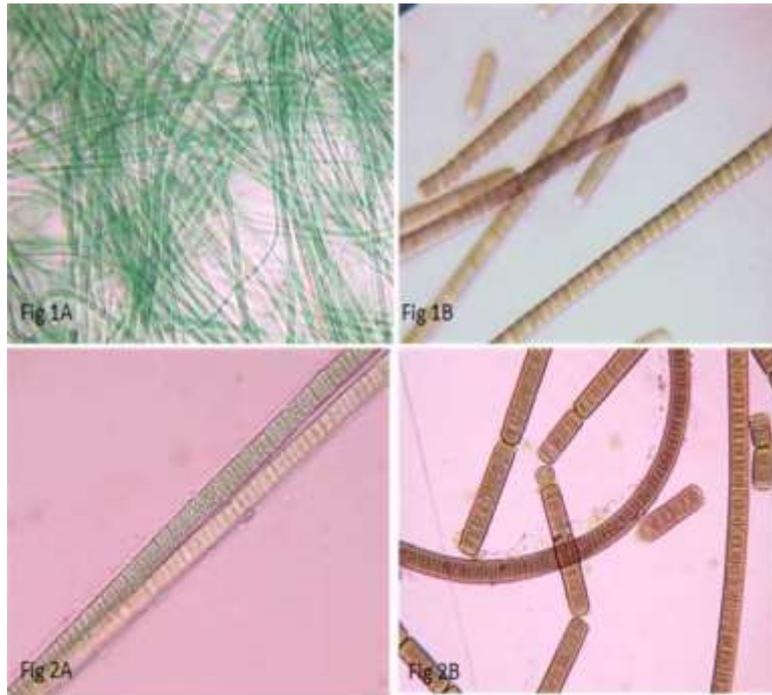


Figure 1A: *Oscillatoria animalis* ×500 filaments 1B: *O. animalis* hormogones × 1250., Figure 2A: *O. limosa* ×312 filaments 2B: *O. limosa* hormogones ×312.

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