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STUDIES ON PRODUCTIVE POTENTIAL OF *CHARA VULGARIS* GROWING IN FRESH WATER BODIES OF JAMMU, JAMMU AND KASHMIR

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ABSTRACT- In the present investigation, the productive potential of *Chara vulgaris* was analysed. The parameters like biomass, chlorophyll content (Chl a, Chl b and Chl c), proteins and decomposition were considered. The most suitable phase to study productivity was observed to be the vegetative phase, as the plant was highly active and adapting to its habitat, while productivity of plant declined during reproductive phase, as plant was preparing for sexual reproduction and oospores to adjust according to unfavorable conditions of habitat.

Key words: Biomass, *Chara vulgaris*, Chlorophyll, decomposition, oospores, proteins, productive potential , reproductive phase, sexual reproduction, vegetative phase.

1 INTODUCTION

Charophytes (stonewort or brittleworts) firmly large in size, easily recognized in water body through its unique structural organization, well developed reproductive structure and efficient rhizoidal system, is a group of non-vascular hydrophytes with world-wide distribution and considered to be closely related ancestor ors of land plants. Bauhin as early as 1620 (c.f. Pal et al, 1962) was first to recognize *Chara*, but placed it under *Equistem* . *Chara* was recognized as separate genus by Vaillant (1719). Wood (1965) and Wood & Imahory (1965), distinguished family Characeae on the basis of their morphological and reproductive structure. Indian Charophyceae was first studied by Groves (1924), Allem (1925, 1928,1933, 1936), Pal et al, (1962) worked on sixty six species of *Chara* growing in India.

Kufel and Ozimek (1994 &2004) stated that four species of *Chara* viz., *C. aculeolate, C.*

aspera, *C. contraria* and *C. tementosa* growing in L.Luknajo, had high potential for phosphorus uptake. Naggar (1995) studied the phenology of Charophytes and concluded that ash, carbohydrates and protein contents were high during vegetative stage and lipids were high during reproductive stage, while hydrocarbons and saturated fatty acids were high in both stages. Palma-Saliva et al, (2002) applied light and dark incubation to charophytes growing in coastal lagoon, Macae (RJ, Brazil) and stated that biomass fluctuation was associated with nutrient concentration and energy content of Charophytes. Bulychev et al, (2004) measured chlorophyll fluorescence in *Chara*.

A very scanty work is done on Charophyceae of Jammu. Anand & Langer (1988) and Langer (1992) reported *Chara* from Jammu.Keeping in mind the paucity of work done on productivity of Charales in Jammu, the present research problem was taken to work out the productive potential of *C. vulgaris* .

2 MATERIALS AND METHODS

Biomass changes were accessed through the Harvest method (APHA,1985). The plants were harvested from fixed sites every month using (30cmx30cm) quadrate method following random sampling at fixed collection sites. Fresh and healthy plants were collected for procedure. The samples were collected in polythene bags and transported to the laboratory for further analysis. Charophytic species were sorted out and washed to remove soil and unwanted periphytic algae. The washed parts were hanged to drain out the excess of water and then amongst the folds of blotting paper. These were weighed to note fresh weight. The plants were then dried in an oven, kept at 60^0C till a constant weight was achieved .Dry weight was calculated as dry wt/m^2. The dried plants were then ashen in Muffle Furnace at 105^0C for 24 hours, to get ash wt/m^2 and organic matter/m^2. Since plants during their initial stages of germination were too small to be harvested, hence biomass changes were observed only during the period of their active growth.

The chlorophyll content of plants was estimated using spectrophotometer (Analytik Jena-Specord, 2001). Extraction was prepared in 80% acetone by crushing it in glass mortar and pestle (earlier kept at a low temperature). The crushed material was filtered using waltman filter paper and then the filterate was centrifuged at 2000 rpm for 10-15 min. The supernatant was collected in glass tube. The final volume was raised up to 40 ml. with 80% acetone. Absorption was recorded at 470, 630, 646.6, 663.6 and 664.0, respectively, using 80% acetone as blank. Chlorophyll 'a', 'b' and 'c' were estimated using Porra et.al.,(1989) and Jeffrey and Humphery (1975),respectively.

The protein content was estimated spectrophotometrically (Parkin Elmer Double Beam UV/VIS spectrophotometer) following Folin-Lowery's (Plummer,1988), method using serum albumin as standard.

Decomposition of Charophytes was studied during the month of July'09 to September'09, generally, the decomposition period of Charophytes in natural habitat using water tank in Botanical Garden, Department of Botany, University of Jammu. The experiment was run for 12 weeks, triplicate set of 12 nylon bags of very fine mesh was prepared, 1g of dried plant material of *C. vulgaris.* These bags were kept in a wooden box, designed for this experiment, net having 2 compartments was added. Each bag was marked with a species code. The box was immersed upto a depth of 1.5m. Every week two litter bags were taken out, dried and decomposed material was removed carefully from the bags using the toothbrush and weighed. Decomposition i.e., rate of weight loss (g dry wt/day) and percentage weight loss of the plants were calculated.

3 OBSERVATIONS

3 .i. BIOMASS

Similarly in case of *C.vulgaris* , unimodal growth was observed in the biomass production with peak in spring season i.e., March, 2009 i.e., 75.07 g/m^2/month of dry weight and 5.25 g/m^2/month of ash weight while during the summer season i.e., May, 2008 a gradual decline was observed in dry weight and ash weight i.e., 2.95 g/m^2/month and 0.206 g/m^2/month, respectively. (Tables-1 & 3; fig-2)

The mean daily productivity in case of *C. vulgaris* varied from minimum of 0.455 dry weight /m^2/day to maximum of 26.03 g dry wt/m^2/day. The net annual production was calculated to be 52.44. g/m^2/year and net daily production was estimated to be 0.143 g/m^2/day,(table-2) Turnover value of 0.96, which means that 96% biomass of *C. vulgaris* is replaced each year in the habitat i.e, stream at Bandhu Rakh (Table-4).

The total dry mass was 10% of fresh weight and dry weight was 20% ash content (Westlake, 1963).Nichols and Shaw (1986) stated that biomass decreased with the increased mean depth while studying biomass production by macrophytes, but failed to provide any reason while working on lake Lilly, Wisconsin. In contrary, Sharma (1994) while studying the productivity of macrophytes growing in Lake Mansar, Jammu concluded that total biomass production increased with increase in depth while subsequently decreased with decrease in depth. Kufel and Ozimek (1994) recorded maximum biomass production in summers i.e., 417 g m^{-2} dry biomass while studying biomass yield in L. Luknajno, Poland.

3 .ii. CHLOROPHYLL PRODUCTION

In the present investigation, the chlorophyll content of *C. vulgaris* was analyzed. The chlorophyll estimations were done during the time period of May-2008 to May-2009. (fig-1, Table-5 &6)

Maximum of 0.12 mg/g fresh weight of Chl a was recorded in April, 2009 while minimum of 0.001 mg/g fresh weight of in June, 2008. Maximum Chl b of 0.12mg/g fresh weight was recorded in the month of April, 2009 while minimum of 0.001 mg/g fresh weight in May, 2008 upto 0.001 mg/g fresh weight. Minimum Chl c was recorded in the month of May, 2008 while maximum was recorded in the month of January, 2009 up to 0.080 mg/g fresh weight.

In *C. vulgaris* , Chl a was the dominating factor and determines the composition of other components (Joshi, 2009) . During the vegetative period the plants showed maximum Chlorophyll contents. Vegetative stage in plants is associated with active vegetative growth (El – Nagger, 1995).

During the present investigations, in *C.vulgaris* it was observed that, Chl a contents were high during reproductive phase, while other components i.e. Chl b and Chl c increased during vegetative stage and decrease during the reproductive stage.

3 .iii. CRUDE PROTEIN

The monthly fluctuation in the crude protein content of *C. vulgaris* varied from maximum of 62.9 mg/g dry weight/ month and minimum of 27.0 mg/g dry weight/month (Table- 7 & 8; fig-3).

3 .iv. DECOMPOSITION

C. vulgaris showed a inform rate of decomposition. Initially a low rate of decomposition i.e, 34% was recorded and gradually rate of decomposition increased upto 56% and at the end of experiment upto 78% of decomposition was recorded (Table- 9 & 10; fig. 4).

4 DISCUSSION

Biomass production exhibited unimodal pattern in *C. vulgaris* with low values during early winter when these plants spurt out. The plants gradually established during the preceding months till acquired maximum biomass in winter, low temperature of air and high water temperature favoured the maximum biomass production. *C. vulgaris* underwent senescence during spring and biomass production also decreased.

During the course of present investigations, mean daily productivity was higher in *C. vulgaris* i.e. 0.143 g/m ^{2}/day and annual productivity of 52.444 g/m^2/year. The turnover value of *C. vulgaris* was 97 %. The productivity value was significantly lower than the values obtained by Koul et al, (1978) Prohit (1981) and Sharma (1994). The differential rate of biomass production by macrophytes was due to various environmental responses which appeared to be species-specific and partly depended upon the habitat of the plant (Sharma 1994). Biomass of macrophytes were positively or negatively co-related with water level, temperature and transparency (Anand 1986). During the course of present investigations the site selected to be studied as collection site of the species, had experienced a lot of disturbance due to anthropogenic activities and climatic activities, which led to considerable biomass changes in the site.

The pigments are directly related to the biomass production. The main pigments chl a, chl b and chl c adjust to the environmental conditions to capture maximum photosynthetic light. In the present investigations, the chlorophyll production coincided with the biomass production in the plants. Chlorophyll production increase with lower air temperature in winter (Menendez and Sanchez , 1998). Vicira and Neechi 2003 stated high rate of photosynthetic in charophytes at lower temperature i.e. 10-15^0 C , while Libbert and Walter (1985) failed to provide any reason for temperature influence on photosynthesis. The photosynthetic rate is also depended upon the habitat characteristics and elemental composition of plant. Deficiency of Magnesium can be related to the photosynthesis efficiencies of the macrophytes (Sharma, 1994).

During the course of present investigations *C. vulgaris* exhibited maximum protein content of 62.9 mg/l dry wt/month. During winter season, the plants were observed to be highly vegetatively active. The vegetative stage was found have considerably higher amount of protein (El. Naggar, 1995). With the approach of spring and summer season, there was a gradual decrease in protein content, which was similar to as reported by Sharma (1994) while working on macrophytes in Lake Mansar but did not provide any reason for it. Boyal (1968) suggested that the loss of protein in macrophytes might be due to age factor.

The rate of decomposition is indirectly related to rate of productivity. During the present course of investigations. The maximum rate of decomposition was observed in *C. vulgaris* i.e. 56% and in *C. zeylenica* it was 48.1% (Table- 9 & 10). The rate of decomposition is influenced by the temperature and in higher during summer than winter (Unni, 1977). The rate of calcium encrustation also reduce the rate of decomposition. Sharma (1994) stated that the presence of Marl encrustation effect the rate of decomposition by reducing the surface area in contact for bacterial as fungal epiphytic activity. After death and decay, the decomposed plant tissues and other nutrients are introduced into the detritus food Chain from where they enter into the food chain.ss

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Table-1: Maximum, minimum and average dry weight and ash weight production (g/m²/month) of *C. vulgaris* from May 2008 to May, 2009.

	Dry weight	Ash weight
Maximum	75.07	5.25
Minimum	2.95	0.206
Average	39.01	2.728

Table-2: Annual increment (g/m²) and turnover of plant biomass increase of *C. vulgaris* from May 2008 to May, 2009.

Parameter	Spot – II
Maximum biomass	37.26
Minimum biomass	1.03
Annual increment	36.23
Turnover value	0.96

Table-3: Monthly biomass production fluctuation in *C. vulgaris* from May 2008-May 2009.

S. No.	Month	Fresh wt (g)	Dry wt (g)	Biomass (g/m² dry wt.)	Ash wt (g)
	2008				
1.	May	21.56	2.95	32.77	0.206
2.	June	-	-	-	-
3.	July	-	-	-	-
4.	August	-	-	-	-
5.	September	-	-	-	-
6.	October	-	-	-	-

7.	November	-	-	-	-
8.	December	27.4	3.75	41.66	0.28
	2009				
9.	January	36.42	4.98	55.33	0.34
10.	February	93.279	12.78	142	1.89
11.	March	548	75.07	834.11	5.25
12.	April	54.8	4.77	53	0.33
13	May	-	-	-	-

Table – 4: Monthly net production (gain/loss, g/m²) in biomass of *C.vulgaris* .

S. No.	Period	Net production (g/m²)
1.	June-July (2008)	-
2.	July-August	-
3.	August-September	-
4.	September-October	-
5.	October-November	-
6.	November-December	-
7.	December-January (2009)	0.455
8.	January-February	2.889
9.	February-March	23.070
10.	March-April	26.03
11.	April-May	-
12.	May-June	-

- = data not available

Net annual production = 52.444 g/m²/year
Net daily production = 0.143 g/m²/day

Table-5: Maximum and minimum Chlorophyll content in *C.vulgaris*

	Chl a (µg/g)	**Chl b (µg/g)**	**Chl c (µg/g)**
Maximum	0.12	0.12	0.080
Minimum	0.001	0.001	0.01
Average	0.051	0.051	0.045

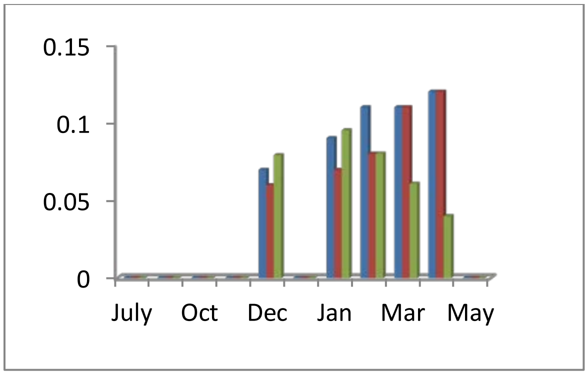


Fig-1: Monthly fluctuation in the chlorophyll contents in *C. vulgais* from May '08 to May '09

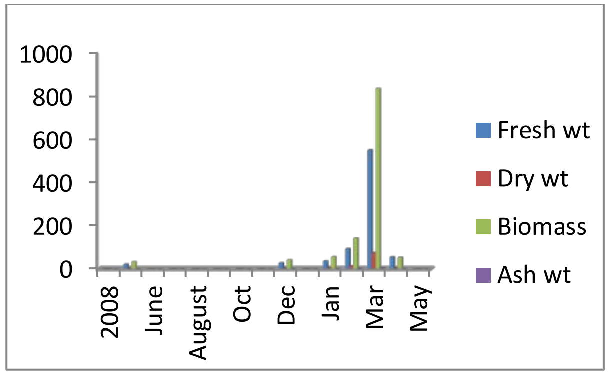


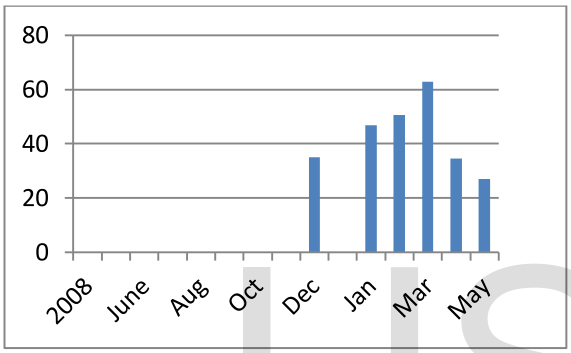
Fig-2: The Biomass production fluctuation in *C. vulgaris* from May '08 to May '09

Table-6: Monthly fluctuation in chlorophyll content in *C. vulgaris* July 2009-Sept. 2009.

S. No.	Month	Chl a (mg/ml)	Chl b (mg/ml)	Chl c (mg/ml)
	2008			
1.	May	0.008	0.001	0.01
2.	June	0.001	0.008	0.02
3.	July	-	-	-
4.	August	-	-	-
5.	September	-	-	-
6.	October	-	-	-
7.	November	+	+	+
8.	December	0.07	0.06	0.079
	2009			
9.	January	0.09	0.07	0.095
10.	February	0.11	0.08	0.080
11.	March	0.11	0.11	0.061
12.	April	0.12	0.12	0.040
13	May	-	-	-

Table-7: Minimum, maximum and average value of crude protein in *C. vulgaris* from 2008 to 2009

	Crude protein (mg/l dry wt./month)
Minimum	27.0
Maximum	62.9
Average	44.95



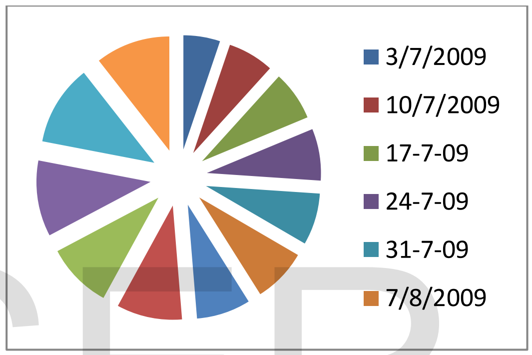


Fig-3: The crude protein (mg/l) fluctuation in *C. vulgaris* from May '08 to May '09

Fig-4: The Decomposition (g) fluctuation in *C. vulgaris* from July'09 to Sept'09

Table-8: Total protein content in *C. vulgaris* from May 2008 to May 2009

Month	*C. vulgaris*
2008	
May	-
June	-
July	-
August	-
September	-
October	-
November	-
December	35.1
2009	

January	46.9
February	50.7
March	62.9
April	34.6
May	27.0

Table-9: Showing maximum and minimum decomposition in *C.vulgaris*

	Decomposition
Maximum	78%
Minimum	34%
Average	56%

Table-10: Decomposition percentage of *C. vulgaris* from July 2009-Sept. 2009.

Date	Initial weight (g)	Final weight (g)	Material decomposed (g)	%age of decomposition
03-07-09	1	0.68	0.32	32
10-07-09	1	0.60	0.4	40
17-07-09	1	0.57	0.43	43
24-07-09	1	0.55	0.45	45
31-07-09	1	0.55	0.45	45
07-08-09	1	0.55	0.45	47
14-08-09	1	0.53	0.47	47
21-08-09	1	0.53	0.47	57
28-08-09	1	0.43	0.57	57
04-09-09	1	0.34	0.66	66
11-09-09	1	0.30	0.7	70
18-09-09	1	0.35	0.65	65