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Studies on riverine ecology of torrential waters in the uplands of the Garhwal region II. Seasonal fluctuations in diatom density

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Abstract. Seasonal fluctuations along with certain physico-chemical parameters were recorded for two hillstreams, the Alaknanda (snow-fed) and the Nayar (spring-fed). In the former, the water temperature range of 9–14°C is considered optimum for the growth of diatoms, compared to 12–21°C in the Nayar. In both hillstreams diatoms achieved their maxima during January, when the water temperature is the lowest. Sudden influx of rain water carrying enormous silt during monsoon is responsible for the decline in density. The water temperature and current, especially the latter is thus a detrimental factor. The interesting feature of the study is, the relatively higher percentage of diatoms in the Nayar than in the Alaknanda, obviously to be attributed to the warm waters in the former.

Keywords. Seasonal fluctuations; diatom density; Garhwal region.

1. Introduction

Aquatic ecosystems, for various reasons, have not been subjected to rigorous study. The present studies have been taken up from the viewpoint of exploiting the fishery resources in the Garhwal region. The results highlight the role of certain physico-chemical parameters in seasonal fluctuations of diatom density in some hillstreams of the Garhwal Himalaya, as they form an important part of diet of snow-trout *Schizothorax*, an economically important food fish of this region.

The diatoms, cosmopolitan in occurrence, on the basis of various zones inhabited by them, are classified as benthic and epiphytic (Patrick 1948). Their populations generally constitute a part of the periphyton community, as they tend to settle on the submerged substratum (Garnett 1953). Several authors have discussed the role of various physico-chemical factors, which influence the growth and abundance of this and other acellular algae (Gran 1902; Strausbaugh 1930; Roy 1955; Chakrabarty *et al* 1959).

2. Methodology

The physico-chemical factors *viz* water temperature, turbidity, water current, dissolved O_2, CO_2 and total alkalinity of the snow-fed Alaknanda and the spring-fed Nayar, were considered for the present investigations.

The water temperature was measured using a simple centigrade thermometer. The values of turbidity and current were recorded using a turbidity and a current meter, respectively, the dissolved O_2 by unmodified Winkler's method, CO_2 by neutralized phenolphthalein indicator method and total alkalinity by phenolphthalein and methyl orange indicator methods (Welch 1948).

The planktons were sampled by filtering 50 l of the sub-surface water sample through 20 bolting silk and fixing it in 4% formalin so as to form a 100 ml concentrate. Sedgewick-Rafter cell counts were then made, thrice, for planktons and the average computed from them. Seasonal variations were assessed from these counts by calculating *n*, the average count per cubic mm, *b*, the volume of the original concentrate (cc) and *l*, the volume of the original water filtered (litres).

The complete samples for all the above parameters were collected during the forenoon hours, from two separate sampling spots, from each river. The sampling spot Srinagar for the Alaknanda is situated at a latitude 30°11′, and Banghat for the Nayar at 30°58′.

3. Results and discussion

A higher percentage of diatoms was observed in the upper Mississipi (Reinhard 1931), the Godavary (Chacko and Srinivasan 1955), the Yamuna (Chakrabarty *et al* 1959) and the Ganga (Pahwa and Mehrotra 1966) as also in the case of the Alaknanda and the Nayar. It ranged from 30·43–72·92% in the former and 42–88·66% in the latter. Species of *Navicula, Hantzchia, Nitzchia, Cymbella, Gomphonema, Achnanthes* and *Synedra* were common to both of them, while *Fragillaria* was conspicuously peculiar to the Alaknanda. In both the cases, the peaks were recorded when the water temperature was observed to be lowest, 8·89°C in the former and 12·22°C in the latter. The density of the diatoms declined to 0·55 units/ml during June in the Alaknanda when the snow melts and the river starts swelling, temperature being 16·67°C and 0·40 units/ml in the Nayar during August when the river swells due to sudden influx of rain water, the water temperature being 23·33°C. Obviously the decrease is due to swelling of rivers and the increasing velocity of water flow rather than water temperature. Thus in the Alaknanda and the Nayar a temperature range of 9–14°C and 12–21°C respectively, is optimum. Contrary to this Ray and Rao (1964) found that a higher temperature range of 20–30°C, is essential for the dense growth of diatoms. Chakrabarty *et al* (1959) also recorded 436 units/l in the Yamuna during April while Ray *et al* (1966) counted 27661 units/l during May, in the Ganga, when the temperatures were high. Since the dissolved O_2 and CO_2 possess a negative and positive relationship respectively, with water temperature in Garhwal hillstreams (Nautiyal and Lal 1978, 1981; Singh *et al* 1982) high values of the former and low values of the latter favour prolific growth of the diatoms, as observed in the present case also.

Several authors (Kofoid 1908; Chandler and Weeks 1945; Berner 1951; Chakrabarty *et al* 1959) have considered water current to be detrimental for the growth of diatoms. Hora (1922), also considered water current to be an important factor governing the nature of the biota in the streams. Allen (1920) reported that currents above moderate speed are detrimental to plankton development. In this study the scarcity of diatoms (table 1) during monsoon is undoubtedly due to the sudden influx of rain water and the swelling of these hillstreams when the water current ranged from 1·0943–1·8115 m/sec in the Alaknanda and 0·9965–1·4529 m/sec in the Nayar, as compared to the rest of the months when the water flow was recorded to be moderate. Gran (1902) and Patrick (1948) considered that the duration of light penetration is an important factor in the dense growth of diatoms. Welch (1952) and Roy (1955) have reported adverse effect of turbidity on plankton density. Obviously, higher values of turbidity ranging from

Table 1. Monthly fluctuations in the diatom density of the Alaknanda and the Nayar.

Months	Diatoms (units/ml)	
	Alaknanda	Nayar
January	7·0*	9·06*
February	4·45	8·00
March	4·59	7·00
April	1·90	4·30
May	1·00	1·30
June	0·55†	1·05
July	0·72	0·56
August	0·80	0·40†
September	0·70	1·20
October	0·60	1·60
November	1·40	3·60
December	2·65	5·80

*Peaks; †Falls.

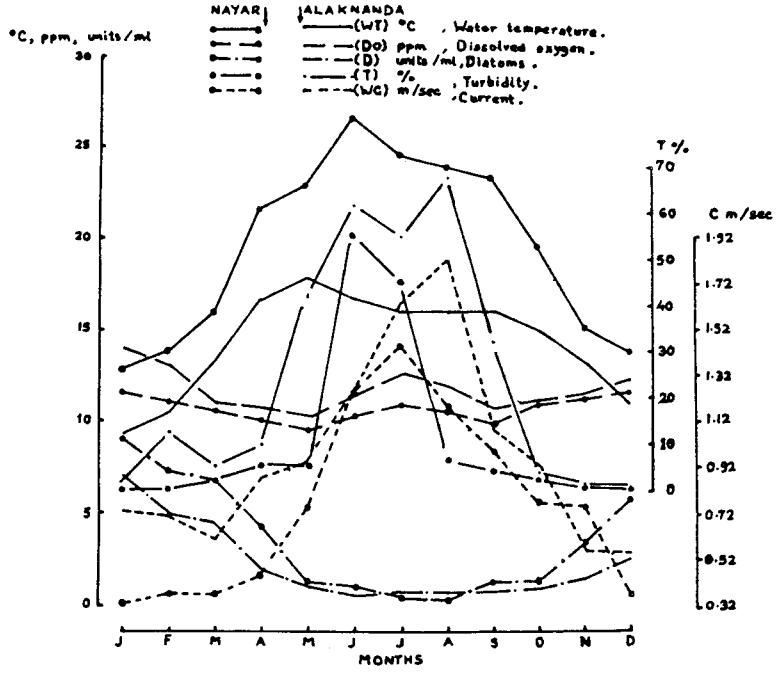

Figure 1. Correlation of various abiotic factors with diatom density in the Alaknanda and Nayar rivers.

30–68% in the Alaknanda and 45–70% in the Nayar are responsible for the fall in density of diatoms during monsoon. Since the waters become highly turbid during monsoon only, attributed to silt carried along with surface run-off, the simultaneous effect of turbidity and the sudden influx of water, effects a decrease in diatom density (figure 1).

In both the hillstreams moderate values of total alkalinity ranges from 24–49 ppm but the peak attained by the diatoms is marked by the presence of phenolphthalein alkalinity during January. Ray and Rao (1964) considered 80–130 ppm range of the carbonate hardness to an optimum one for diatoms.

It is apparent from the discussions that low water temperature, moderate current, low turbidity and the presence of the carbonates are essential for the high density of diatoms while, high current and turbidity are responsible for scarcity.

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