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ASSESSMENT OF BIOCHEMICAL FACTORS OF THE INDUSTRIALLY POLLUTED RIVER CAUVERY NEAR MYSORE, KARNATAKA – A REVIEW

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ABSTRACT
The Studies on the physicochemical factors of the environment especially of water bodies are carried out from the past few decades. However, the significance of biochemical factors in limnology was not given much attention and was not properly understood in our country. The liberated organic material in the waste water becomes an effective substrate for the growth of different organisms including algae. The present investigation is an attempt to expand our knowledge about biochemical factors of lotic water. The present work reports about two years study of biochemical factors viz., chlorophyll, glycolic acid and protein in three different sampling stations of the river Cauvery at the upstream, mid-stream and downstream and one sampling station - the paper mills effluent stream near Mysore, Karnataka. The biochemical parameters were carried out and the biochemical factors were correlated with physicochemical factors and biological factors. All the factors were found to be the maximum during summer and minimum during rainy season, they were found to be maximum in the effluent stream and minimum in the downstream of the river Cauvery and corresponded with the phytoplankton population. The variations in the above biochemical factors were found to be directly related to the variations in the phytoplankton population. The values for chlorophyll were lesser than glycolic acid and proteins. The order of values of biochemical factors are as follows: Chlorophyll<Glycolic acid< proteins. Biochemical factors were found to be dependent on the abundance and physiological actions of phytoplankton.

Key words: Chlorophyll, Glycolic acid, proteins, industrial effluents, river Cauvery, Phytoplankton

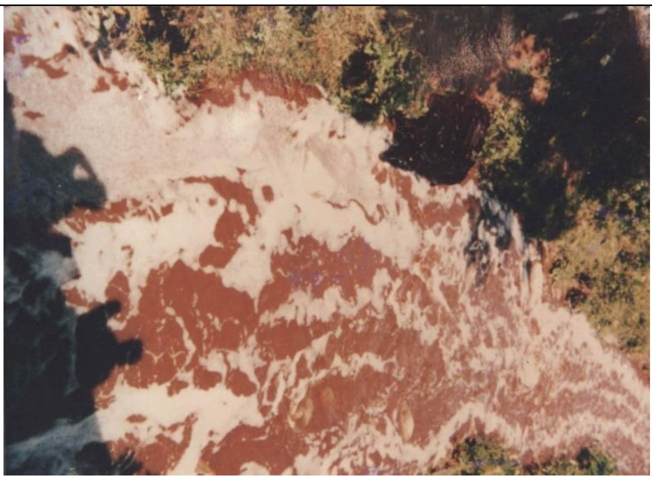
INTRODUCTION
Studies on the physicochemical factors of the water bodies are commonly carried out in our country. The significance of biochemical factors in limnology is not properly understood due to the lack of attention given to them. It is, however, required to give greater importance to the study of the biological factors along with physicochemical biological factors to get a comprehensive ecological picture of the aquatic habitats. It is a known fact that in fresh water habitats dissolved organic matter plays an important ecological role and interacts with the organisms that grow, multiply, reproduce and transform (Nirmal Kumari *et al*, 1991). According to Fogg (1971), the phytoplankton will liberate carbon newly fixed in photosynthesis in to the external medium in the form of dissolved organic material. The liberation of Carbon may also be from extracellular metabolites and products of decomposition. Nirmal Kumari *et al* (1991) reported that the liberated organic material is an effective substrate for the growth of different organisms including algae.

MATERIALS AND METHODS
Cauvery is one of the important rivers of Karnataka. It is subjected to the onslaught of the negative impacts of industrialisation and urbanisation. It is also vulnerable river to the indiscriminate discharge of effluents. The portion of the river investigated in the present study extends to about 10 kms from Krishnaraja Sagar to Ranganathittu. The sampling stations selected for the study include the following: -
Station 1 : Krishnaraja Sagar – Cauvery River Upstream – Unpolluted region
Station 2 : Mandya National Paper Mills Ltd., Belugula – Point of effluent Source

Station 3 : Srinivasakshetra, Belugula – Cauvery River Midstream / Point of Confluence (Pollution)
Station 4 : Ranganathittu, Srirangapatna – Cauvery River Downstream
Effluent samples from the industry (Station 2) and river samples (Stations 1, 3 and 4) were collected regularly once a month for subsequent two years (January 1989 to December 1990). Samples were analysed and assessed for biochemical factors immediately in the laboratory after collection.

Biochemical factors were studied by adopting filtration and photometric methods. The biochemical factors studied include chlorophyll, glycolic acid and proteins by following proper methods (Viccaro and Ambye, 1972, Parson and Strickland, 1965 and Lowry, *et al*, 1951).

Station I : Krishnaraja Sagar Reservoir, Cauvery River Upstream



Station II : Paper Mills Effluent – Source of Pollution

Station III : Srinivasa Kshetra, Belugola – Cauvery River Mid Stream – Point of confluence

Station IV : Ranganathittu Bird Sanctuary, Cauvery River Downstream

Photographs of Sampling Stations for the Investigation

RESULT AND DISCUSSIONS

CHLOROPHYLL:

The significance of the chlorophyll pigment is already a known fact. The Chlorophyll contents in Waters indicate the photosynthetic efficiencies of micro-organisms like phytoplankton in water bodies. The observed values of Chlorophyll at different stations are tabulated in **Table 1**.

Table 1 : Chlorophyll Concentration at different Sampling Stations (Values in µg /l)

Sampling Station	1989			1990		
	Range	Mean	SD	Range	Mean	SD
1	9.62 – 162.60	55.45	7.45	10.20 – 165.50	58.53	7.65
2	24.90 – 183.60	77.39	8.80	20.90 – 174.90	73.79	8.59
3	20.40 – 156.70	75.03	8.66	20.60 – 170.90	68.93	8.3
4	17.02 – 142. 80	56.72	7.53	10.60 – 130.60	52.86	7.27

The range of concentrations recorded in the present study is higher than the recorded values for the River Moosi (Nirmal Kumari *et al*, 1991). Radhakrishnan *et al* (1982) reported that concentrations > 0.5 mg/m of chlorophyll 'a' were found in the river mouths of Mahanadi, Godavari and Krishna, while those < 0.4 and 0.1 mg/m were observed north of Cauvery and off Ganges respectively. The present work when compared with the earlier work on the River Cauvery in Tamil Nadu (Radhakrishnan *et al*, 1982) reveals the same effect.

Higher concentration of Chlorophyll 'a' was observed during summer and low during rainy season for the River Moosi (Nirmal Kumari *et al*, 1991). In the present work, high concentrations were recorded during summer and low concentrations during rainy season and winter.

The present work indicates that chlorophyll contents were extremely high at the point of pollution source, high at the polluted river station and low at the downstream river station. It is because of the presence of abundant and pollution resistant Chlorophycean members and other phytoplankton and their gradual decrease at the downstream river station.

GLYCOLIC ACID

Glycolic Acid is considered to be a major component of the excreted carbon both in cultures (Hellebust, 1965) and in natural environments (Fogg et al, 1965; A.I. Hasan and Coughlan, 1976). Fogg and Horne (1968) and Coughlan and A.I. Hasan (1977) have studies Glycolate excretion in natural waters. Highest concentrations of Glycolic Acid were recorded at the polluted station of the River Moosi during summer and low concentrations during rainy season (Nirmal Kumari *et al*, 1991). In the present study also, high concentrations of Glycolic Acid were recorded at the polluted station of the River in April (summer) and low concentrations at the end of the rainy seasons in October (1989) and September (1990). The **Table 2** shows the values of Glycolic Acid for different stations.

Table 2 : Glycolic Acid Concentration at different Sampling Stations (Values in mg /l)

Sampling Station	1989			1990		
	Range	Avg.		Range	Avg.	
1	1.90 – 6.90	3.81	1.95	1.60 – 6.80	3.80	1.95
2	1.20 – 7.00	4.15	2.04	3.00 – 7.60	5.02	2.24
3	1.40 – 8.80	5.13	2.26	2.00 – 7.40	4.57	2.14
4	1.20 – 3.80	2.50	1.58	1.60 – 4.35	2.77	1.66

Station – 3 showed high values of Glycolic Acid than any other station, whereas the Station – 4 showed least concentrations of Glycolic Acid. The increased order of Glycolic Acid contents at different Stations is as follows – 3 > 2 > 1 > 4. In the present investigation, higher concentrations of Glycolic Acid were recorded at all stations during summer except the Station – 4 during 1990, which showed high values in the month of June. Low values for all stations were recorded during rainy season and at the end of the rainy season for Stations – 2, 3 and 4. The concentration of Glycolic Acid recorded in the present study was found to be lesser than recorded in River Moosi (Nirmal Kumari *et al*, (1991)).

Highest concentrations of Glycolic Acid at Stations 2 and 3, and high concentrations of Glycolic Acid for all Stations during summer might be due to its liberations from certain Chlorococcalean members in the habitats.

Miller *et al* (1963) and Whittingham and Ritchard (1963) studied extensively on the release of Glycolate from *Chlorella*. The higher values of glycolic Acid observed in the present investigation, might also be due to the availability of concentrations of Carbon-di-Oxide in Water, which metabolise little Glycolate but excrete it all into the medium (Nelson and Tolbert, 1969; and Nirmal Kumari *et al* (1991).

Tolbert and Zill (1950) pointed out that Glycolate excretes may directly reflect the growth and photosynthetic activity of phytoplankton. In the present investigation also, there were fluctuations in Chlorophyll contents, Phytoplankton density and Glycolic Acid concentrations. In general, the high contents of Glycolic Acid could be explained as follows:

High light intensities could inhibit algal photosynthesis and cause an increase in the percentage of extracellular release (Coughlan and A.I. Hasan, 1977). The warmth of the surface water also accounts for high extra cellular release Nirmal Kumari *et al* (1991). It is to be noted here that Glycolic Acid is a major extra-cellular product. *Chlorella* plays an apparent role in the regulation of these substances in the habitats (Nirmal Kumari *et al*, 1991). Fogg *et al* (1965) reported that in natural waters the first major extracellular product of algae is Glycolic Acid.

PROTEINS

It is a known fact that proteins have a vital role in the metabolism of all organisms including algae. Deficiency of proteins results in the disrupted growth of algae. Hence, proteins are also important constituents of phytoplankton. Extracellular liberation of amino acids and peptides has been studied by Stewart (1963) and Hellebust (1965). The release of intracellular nitrogen with smaller amounts of nitrite and amino acid nitrogen by the blue green alga (Cyanobacterium), *Oscillatoria* has been reported by Meffet and Teleschow (1979). The **Table 3** shows the values of Proteins for different stations.

Table 3 : Protein Concentration at different Sampling Stations (Values in mg /l)

Sampling Station	1989			1990		
	Range	Avg.		Range	Avg.	
1	4.80 – 46.00	21.79	4.67	1.00 – 40.60	19.21	4.38
2	3.30 – 39.80	15.48	3.93	4.90 – 44.90	20.10	4.48
3	9.30 – 40.60	19.33	4.4	10.00 – 36.90	21.16	4.60
4	3.00 – 42. 30	17.74	4.21	3.10 – 38.90	15.78	3.97

Hellebust (1965) pointed out amounts of Carbon excreted as protein ranged from 0.2 to 10.3 % of the total extracellular material. In the present study, high values of proteins were recorded. But when compared with the protein values recorded for River Moosi (Nirmal Kumari *et al*, 1991) the present values are lower. The variation is due to ecological changes in the river. In their study, high concentrations of proteins were recorded during summer and low concentration in rainy season. In the present work also, higher values of proteins were recorded during summer. The order of Protein concentration values at different stations are as follows: 1> 3>2>4.

High concentrations of proteins might be due to its liberation by decaying cells and also perhaps due to human and livestock activities near the habitats.

The concentrations of Chlorophyll, Glycolic Acid and Proteins in all the Four Sampling Stations during the Study Period is graphically represented in **Figures 1 to 4.**

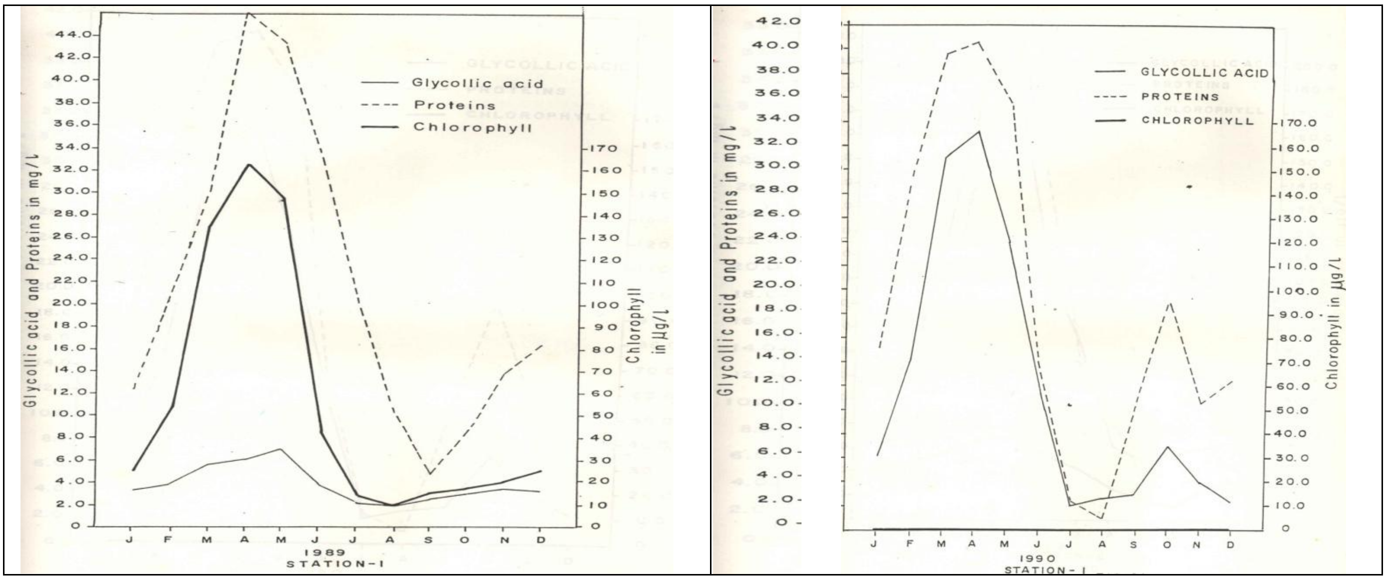


Figure 1 : Concentrations of Chlorophyll, Glycolic Acid and Proteins in Sampling Station 4 during the Study Period

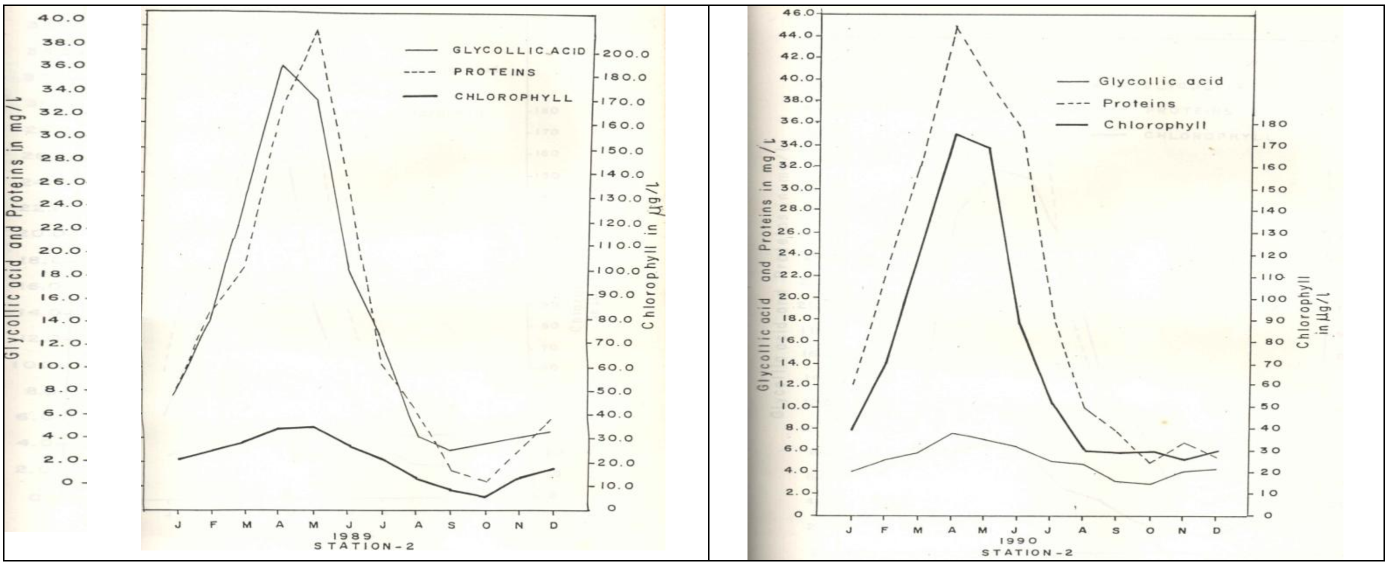


Figure 2 : Concentrations of Chlorophyll, Glycolic Acid and Proteins in Sampling Station 4 during the Study Period

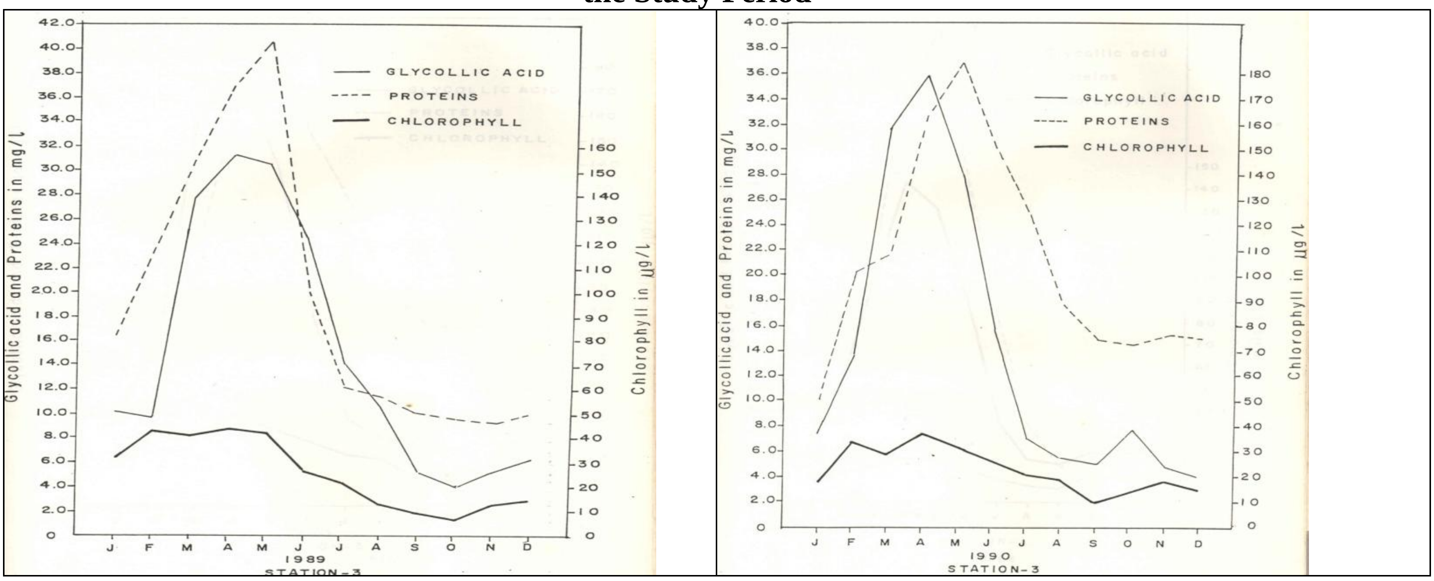


Figure 3 : Concentrations of Chlorophyll, Glycolic Acid and Proteins in Sampling Station 4 during the Study Period

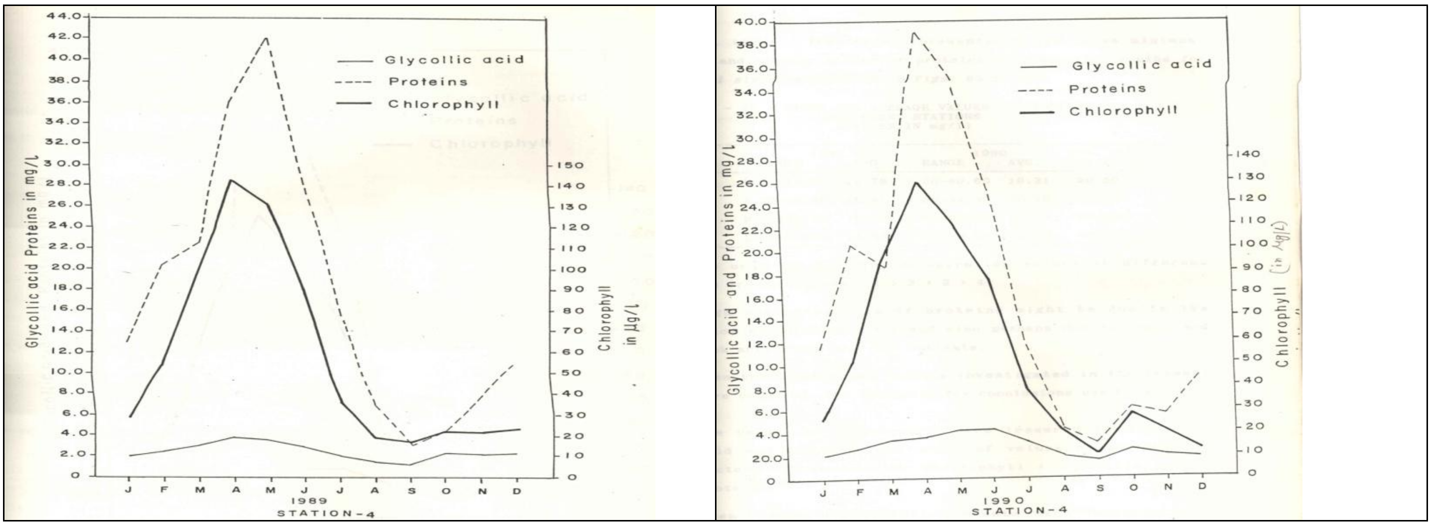


Figure 4 : Concentrations of Chlorophyll, Glycolic Acid and Proteins in Sampling Station 4 during the Study Period

CONCLUSIONS

By the above study on the biochemical factors such as Chlorophyll, Glycolic Acid and Proteins in the present investigation, a few conclusions can be drawn as given below:

- The values for Chlorophyll were lesser than Glycolic Acid and Proteins. The order of values of biochemical factors are as follows:
  - Chlorophyll < Glycolic Acid < Proteins
- When these biochemical contents were compared with different stations – the trend is as follows:
  - Chlorophyll : 2 > 3 > 1> 4
  - Glycolic Acid : 3 > 2 > 1> 4
  - Proteins : 1 > 3 > 2> 4

As per the study results, the biochemical activities were highly pronounced at Station – 3 followed by Stations – 2, 1 and 4.

In view of the above, it can be concluded that there is dependency of Biochemical factors on the abundance and physiological actions of phytoplankton and further, the abundance and activities of phytoplankton are inter dependent on the available physicochemical factors in the aquatic ecosystem.

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