SEASONAL VARIATION IN DISSOLVED CARBOHYDRATE (DCHO) CONTENT IN THREE FRESHWATER PONDS[1]

SUMITRA VIJAYARAGHAVAN[2]

Department of Biological Sciences, Madurai University, Madurai

ABSTRACT

Seasonal variations in dissolved carbohydrate (DCHO) were studied in three tropical freshwater ponds for a period of one year. In Othakadai Pond the DCHO values varied from 0.3 to 20.0 mg/l, the range of variation in Teppakulam Tank was from 1.6 to 28.1 mg/l and in Yanamalai Pond it fluctuated from 0.3 to 27.5 mg/l. Fluctuations in DCHO content was found to be related to chlorophyll *a* values only during a part of the annual cycle which indicates that probably plant organisms utilise the DCHO.

INTRODUCTION

Considerable work has been done on the dynamics of DCHO from temperate regions. Some of the contributions are those of Allen (1956) Guillard and Wangersky (1958), Nalewajo *et al.* (1963) and Walsh (1965 and 1966). However, practically no information is available on this important constituent from the tropics. Fogg (1962) stated that the rate of turnover of organic acids and carbohydrates is probably high enough to be ecologically important. In the present paper, therefore, an attempt has been made to study the seasonal variations in DCHO in relation to some of the physico-chemical and biological factors in three tropical ponds.

DESCRIPTION OF THE PONDS

Othakadai Pond (Long. 78°12′ E; Lat. 90° 57′ 30″ N) is a perennial pond. It is circular in shape with a diameter of about 28.5 meters. The depth of the pond varied from 0.6 to 0.9 meters during the course of the investigation. It has a raised bund having its periphery with an inlet on the eastern side. On its northern and western margins it has a few trees. *Lemna* sp. and *Wolffia* sp. generally cover the pond surface. Considerable amount of human and animal wastes make the water polluted.

Teppakulam Tank (Long. 78° 9′ E; Lat. 9° 54′ 30″ N) is an artificial temple tank. It is a perfect square in shape (303 m × 290 m). In the centre it has an

[1]Formed a part of the thesis for which the Ph.D. degree was awarded by the Madurai University.
[2]Present address: Central Marine Fisheries Research Institute, Cochin-18.

island with concrete steps leading to the water. The water from an adjacent river Vaigai fills up the tank every year during the month of January or February. The tank when full has a maximum depth of 2.7 meters. The minimum recorded depth, just before filling was 0.6 meter. Except for sparse vegetation on the south-west corner, the tank is generally devoid of submerged, floating or rooted vegetation.

Yanamalai Pond (Long. 78° 12′ E; Lat. 9° 59′ N) is a temporary pool formed as a result of blasting the granite rocks. During the course of the investigation the pond was found to be dry from the second week of August '67 till the end of September '67. The pond is elliptical in shape, 34.8 m long and 14.9 m wide. The maximum depth recorded was 1.7 meters. The western margin of the pond has an inlet which brings in water from the adjacent fields during the rainy season. Weeds are present on the northern and eastern margins of the pond. The southern margin of the pond is somewhat low lying and a bund of 0.3 meter in height separates it from the adjacent paddy fields. Floating and submerged filaments of *Spirogyra* sp. are often seen along the margins of the pond.

Material and Methods

As the ponds were shallow only surface water was collected at monthly intervals. Studies in the Othakadai and Yanamalai ponds, lasted from March 1967 to February 1968, whereas in Teppakulam Tank the duration was from February 1967 to January 1968. All observations were made between 8 A. M. to 10 A. M. Water from the surface was collected in one litre plastic container and from the same site temperature and pH of water were measured. Dissolved oxygen was determined by Winkler's method (Ellis *et al.*, 1948) and dissolved organic matter was estimated from the oxygen absorbed in the permanganate method (Mackereth, 1957). Transparency was measured with a Secchi disc. Anthrone method (Lewis and Rakestraw, 1955) was adopted for DCHO estimations. Whatman glass filters (GF/C, 4.25 cm) were used for filtering the samples and the optical density was measured at 627 mμ in a S. P. 600 Unicam spectrophotometer. Chlorophyll *a* was determined from the method outlined in Strickland and Parsons (1965).

Results

Othakadai Pond : Data obtained for a period of one year on some of the physico-chemical and biological factors are given in Table 1. Seasonal variations in DCHO concentration has been shown in Figure 1. The curve for DCHO showed bimodality during the year. The first peak occured in May 1967 and the second peak in August 1967. The DCHO values were found to be relatively high from March to September 1967 and low from October 1967 till January 1968. A slight increase in DCHO was evident in February 1968. The maximum concentration of 20.0 mg/l was recorded in May 1967 and minimum of 0.3 mg/l in December 1967.

TABLE 1. *Seasonal variations in physico-chemical data from Othakadai Pond (March 1967 to February 1968)*

	Temp. (°C)	pH	Secchi Disc (cms)	Dissolved O_2 (mg/l)	Dissolved org. matter (mg/l)	DCHO (mg/l)	Chlorophyll *a* (mg/m³)
Mar.	28.0	8.8	20.0	2.9	5.00	13.2	38.9
Apr.	30.0	9.4	22.4	1.5	77.80	14.0	15.0
May	29.0	7.0	42.2	1.5	58.30	20.0	7.6
Jun.	27.0	8.3	27.3	1.1	66.30	6.8	21.0
Jul.	29.0	8.5	35.0	0.6	60.00	8.0	10.0
Aug.	29.0	8.5	25.0	1.4	50.00	16.4	2.0
Sep.	28.0	8.2	17.5	1.9	71.30	7.2	1.9
Oct.	26.0	8.5	22.3	1.3	96.80	6.0	1.7
Nov.	23.0	8.5	57.0	7.6	92.90	4.8	3.0
Dec.	25.0	8.8	53.5	6.3	94.00	0.3	2.5
Jan.	24.0	8.5	45.0	2.3	83.30	1.2	2.0
Feb.	26.0	8.2	32.0	7.7	85.00	4.8	27.5

Teppakulam Tank: The results of the physico-chemical and biological factors are given in Table 2. These represent the mean of three stations. The flutuations in DCHO and Chlorophyll *a* have been shown in Figure 2, from which it is evident that there was an increasing trend in DCHO concentration from February to August 1967, followed by a sudden drop during September 1967. Between October and December 1967 the values were more or less steady. The DCHO values ranged from a minimum of 1.6 mg/l (February 1967) to a maximum of 28.1 mg/l (August 1967).

TABLE 2. *Seasonal variations in physico-chemical data from Teppakulam Tank (February 1967 to January 1968)*

	Temp. (°C)	pH	Secchi Disc (cms)	Dissolved O_2 (mg/l)	Dissolved org. matter (mg/l)	DCHO (mg/l)	Chlorophyll *a* (mg/m³)
Feb.	26.8	9.3	64.2	5.3	53.60	1.6	6.0
Mar.	30.4	8.4	48.9	5.6	2.33	5.5	10.2
Apr.	33.0	9.1	51.5	5.8	49.96	6.5	11.0
May	31.0	9.2	40.7	5.3	66.30	9.5	2.4
Jun.	30.0	9.7	38.1	4.5	36.40	25.0	2.6
Jul.	31.7	8.7	45.2	4.9	78.33	23.5	2.8
Aug.	31.0	9.8	36.7	4.6	73.30	28.1	5.0
Sep.	30.6	9.8	22.5	4.1	71.10	13.0	14.2
Oct.	41.7	9.5	30.6	5.2	80.70	5.5	8.8
Nov.	25.3	9.8	28.1	6.1	9.43	5.5	8.6
Dec.	25.0	9.1	30.8	5.9	69.23	6.0	8.0
Jan.	26.0	9.0	26.3	7.3	64.50	9.0	4.6

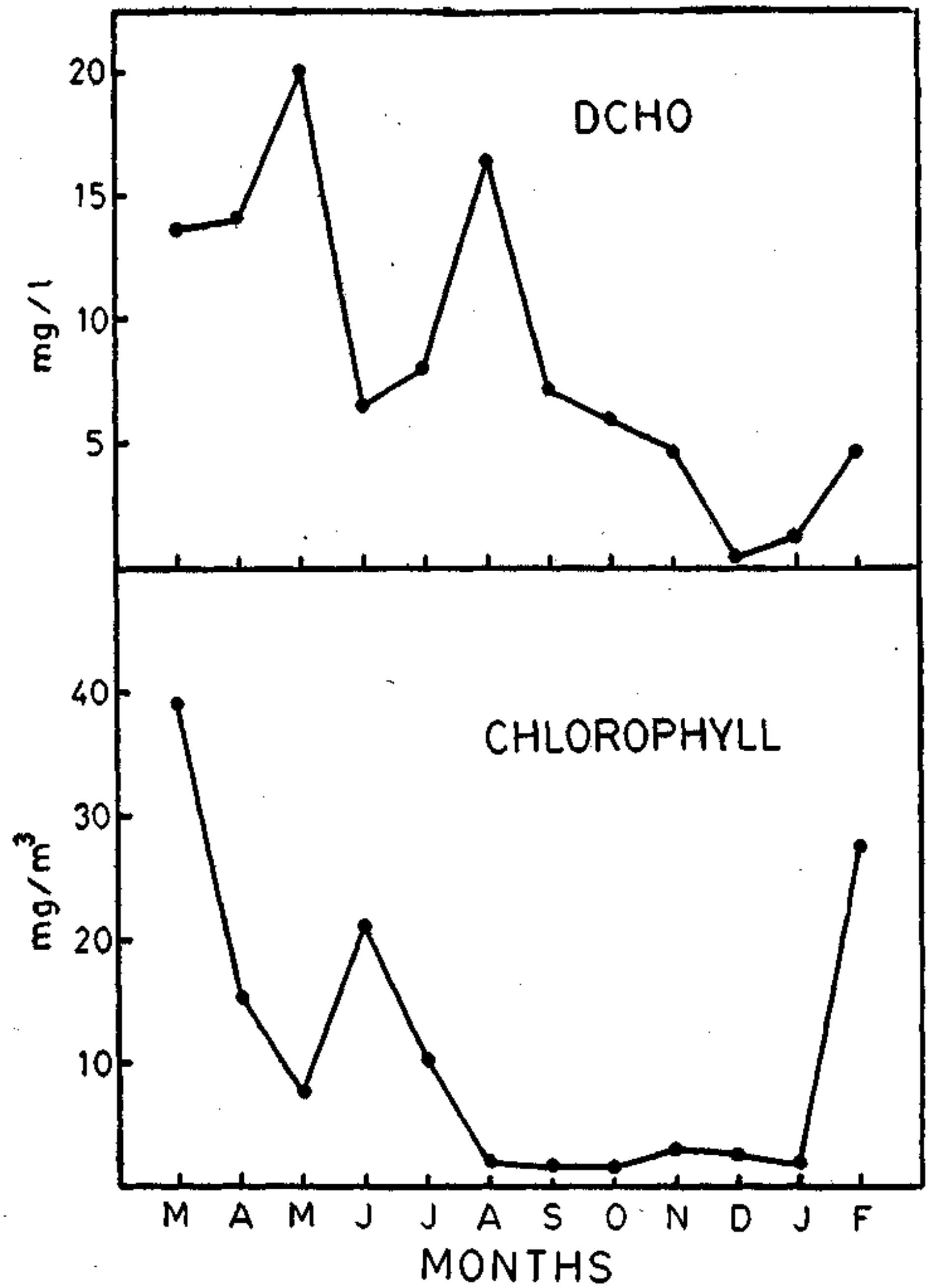

FIG. 1. Seasonal variation of dissolved carbohydrate and chlorophyll-*a* concentrations in surface water of Othakadai Pond.

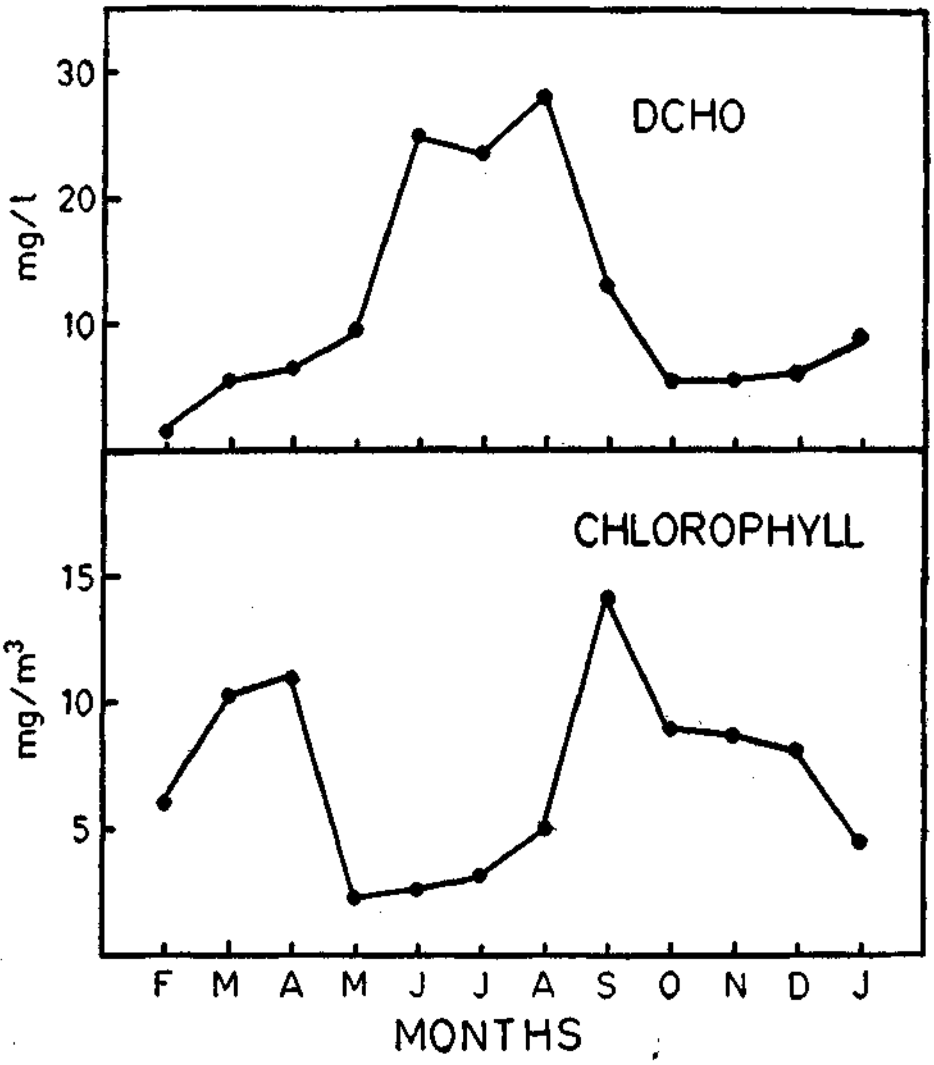

FIG. 2. Seasonal variation of dissolved carbohydrate and chlorophyll-*a* concentrations in surface water of Teppakulam Tank.

Yanamalai Pond: Seasonal variations in the environmental feature of this pond are given in Table 3. Figure 3 shows the variations in DCHO concentration and Chlorophyll *a*. Except for a very sharp peak (27.5 mg/l) in May 1967, during the rest of the period, the values for DCHO were uniformly low. Minimum levels of DCHO (0.3 mg/l) were recorded during January and February 1968.

TABLE 3. *Seasonal variations in physico-chemical data from Yanamalai Pond (March 1967 to February 1968)*

	Temp. (°C)	pH	Secchi Disc (cms)	Dissol-ved O_2 (mg/l)	Dissolved org. matter (mg/l)	DCHO (mg/l)	Chloro-phyll *a* (mg/m³)
Mar.	22.4	7.0	26.5	3.8	5.00	3.0	20.0
Apr.	26.0	8.2	7.2	2.9	66.70	4.0	14.4
May	27.0	6.7	3.5	2.9	75.00	27.5	12.0
Jun.	29.0	7.3	3.5	2.2	36.40	4.5	11.2
Jul.	31.0	6.7	5.1	3.4	70.00	5.0	1.6
**Aug.*	...	...	...	...	...	...	...
**Sep.*	...	...	...	...	...	...	...
Oct.	26.0	8.2	3.8	4.0	64.20	4.5	10.4
Nov.	24.0	7.0	23.7	5.0	97.10	3.0	4.0
Dec.	27.0	7.6	28.7	7.5	57.00	3.5	8.0
Jan.	25.0	7.0	51.0	6.2	41.70	0.3	0.4
Feb.	27.0	7.6	30.0	5.4	66.70	0.3	4.8

* Pond dried up.

DISCUSSION AND CONCLUSIONS

The present studies show that there is a definite seasonal trend in DCHO concentrations. A bimodal pattern with peaks found in May and August 1967 was a characteristic feature of Othakadai Pond (Figure 1). In Yanamalai Pond, a unimodal trend was found with a peak value in May 1967 and for the rest of the year the values were low (Figure 3). Like the Yanamalai Pond, the Teppakulam Tank also showed a single peak for DCHO (June to August 1967) Figure 2.

Several workers have shown that DCHO is an extracellular product released by the algae (Allen, 1956; Lewin, 1956; Guillard and Wangersky, 1958 and Walsh, 1965). Walsh (1965) reported that phytoplankton play a major role in the regulation of DCHO in natural waters. In the present studies an inverse relationship was recorded between the primary producers (represented by chlorophyll values) and DCHO concentrations in all the three ponds. The inverse relationship could be interpreted in the light of Wangersky's (1959) and Walsh's (1965) conclusions that during a phytoplankton bloom, DCHO is probably utilised as a source of carbon which leads to its depletion in the water. This is probably the reason for the inverse correlation from March to August 1967 in Othakadai Pond. Between August and December 1967, however, while there was a decreasing trend in DCHO levels, the chlorophyll values were more or less steady. Subsequently, with an increase in DCHO concentration in February 1968, there was also an increase in the chlorophyll values (Fig. 1). In Yanamalai Pond also, an inverse correlation between the two factors was obtained from March to May 1967 (Fig. 3). For the rest of the year the marked fluctuations in chlorophyll values, were associated with no appreciable change in the DCHO

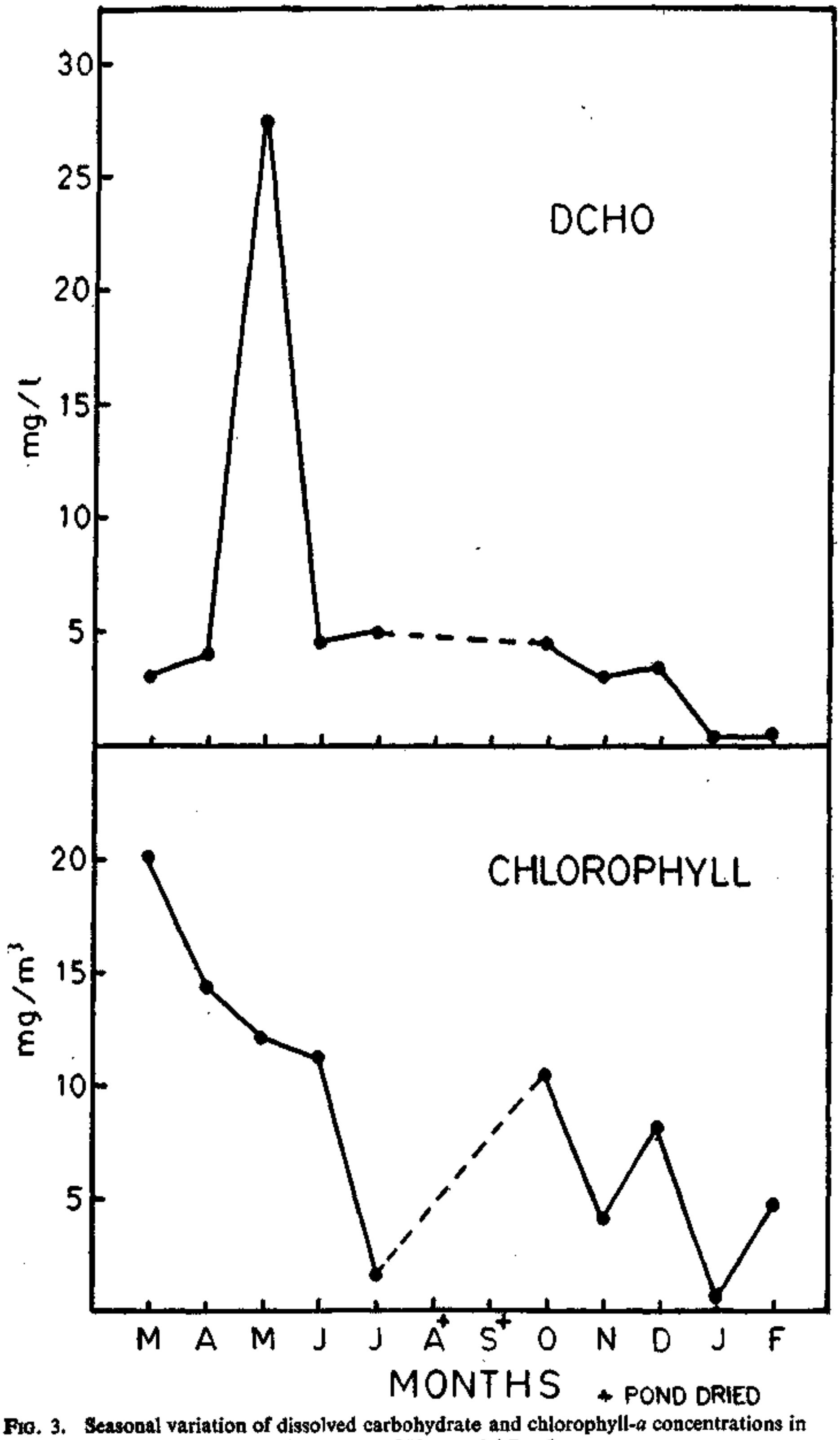

FIG. 3. Seasonal variation of dissolved carbohydrate and chlorophyll-*a* concentrations in surface water of Yanamalai Pond.

concentration. In Teppakulam Tank the inverse relationship between DCHO and chlorophyll was far more pronounced than in the other two ponds with the exception of some months (February to April 1967 and September to October 1967).

No correlation could be established between the DCHO concentrations and changes in the pH, although higher pH values are known to intensify respiratory processes of the algae resulting in a rapid utilisation of DCHO (Walsh, 1966). Walsh and Douglass (1966) reported an inverse correlation between the dissolved oxygen and DCHO leveles in the Sargasso Sea and suggested that DCHO may originate from dissolved organic matter as a result of bacterial decomposition. The data collected in the present studies do not show any such correlation either between DCHO concentration and oxygen levels or DCHO and dissolved organic matter (See Tables 1, 2 and 3). Generally a high value of dissolved organic matter was a characteristic feature of all the three ponds indicating that these ponds are polluted. It seems likely that the high organic load because of pollution would indirectly contribute towards the DCHO values although no evidence towards this has been obtained.

The dynamics of DCHO appears to be a complicated process and it seems that it is controlled by several factors such as the primary producers, respiratory activity of the algae and bacterial decomposition of organic matter. In the absence of any detailed experimental evidences, it is very difficult to say which is the most important factor involved in the regulation of DCHO. Further work on these lines would be of interest in understanding the metabolism of DCHO in natural waters.

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