

Dissolved Carbohydrate in the Central Arabian Sea

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Seawater samples (161), collected from 8 depths (0 to 1000 m) at 21 stations were analysed for total dissolved carbohydrate. Dissolved carbohydrate concentrations varied from 0.072 to 1.15 mg.l⁻¹. Carbohydrate concentrations did not decrease offshore in the upper 100 m but below 100 m horizontal variations were detectable. Vertical profiles showed a more or less uniform distribution in the upper 300 m and a slight increase below 300 m up to 1000 m. Carbohydrate was significantly correlated with chlorophyll *a* ($P < 0.001$) and phaeopigments ($P < 0.001$) suggesting its release from the former and zooplankton grazing in the latter. Inverse correlations with dissolved oxygen, phosphate and nitrate indicated the possibility of the release of carbohydrate from bacterial decomposition and the importance of these nutrients in regulating the concentration of carbohydrate in the marine environments.

Carbohydrates are one of the main components (10-20%) of dissolved organic carbon^{1,2}. Many of them are labile and rapidly recycled and are also known to influence various biogeochemical processes occurring in the marine environment^{3,4}. Large diel, spatial and temporal variations in dissolved carbohydrate are indicated in different aquatic systems^{5,6}.

This communication presents the first data on the distribution of dissolved carbohydrates in the Arabian Sea and the role of some physico-chemical and biological factors in their distribution.

Materials and Methods

Seawater samples were collected using Niskin samplers (5 l) from 8 depths (0 to 1000 m) at 21 stations during 13 B cruise of *O R V Sagar Kanya* in the Arabian Sea from 14 Feb. to 14 March 1985 (Fig. 1). Samples were immediately filtered through ignited GF/C filters (1 µm). Filtered samples were stored at -20°C before analysis. Total dissolved carbohydrate was estimated by phenol-sulphuric acid method⁷. In practice rather different curves were obtained for different sugars using this method, therefore, total dissolved carbohydrate values were expressed as the glucose equivalent obtained from glucose standard curves. Nitrate and phosphate were analysed on 6 channel SKALAR auto analyser-5100/1. Oxygen was determined by Winkler method⁸ and salinity was measured using an AUTOSAL salinometer. Particulate matter left on filter papers was analysed for chl. *a* and phaeopigments by spectrofluorometric method⁹.

Results and Discussion

Concentrations of dissolved carbohydrate varied from 0.072-1.15 mg.l⁻¹ (Table 1). These values are more or less similar to those reported from other oc-

eanic waters using phenol-sulphuric acid method and glucose as standard (Table 2). The present values are, however, less than those observed in estuarine and coastal waters¹⁰⁻¹³.

No general trend is apparent in the vertical distribution of dissolved carbohydrate. Besides, the variations detected in the vertical profile at several stations are small. The mean values of dissolved carbohydrate observed for different depths, except for a slight increase at 300-1000 m, are practically same.

A simple assessment of horizontal variations was made plotting carbohydrate concentration versus distance offshore at different depths (Fig. 2). Data from 0 to 100 m depth (Fig. 2a) did not show significant relationship ($P < 0.10$) between carbohydrate concentrations and distance offshore. Whereas, data from below 100 to 1000 m depth (Fig. 2b, c) showed a significant inverse correlation ($P < 0.01$). An offshore decrease in carbohydrate concentrations at the sur-

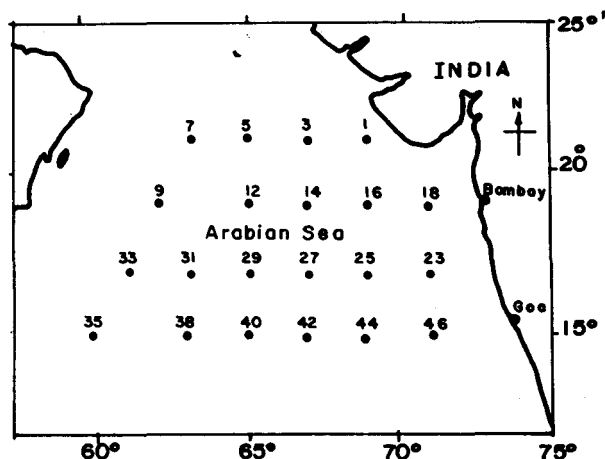


Fig. 1 — Location of sampling sites

Table 1 — Distribution of Total Dissolved Carbohydrate at Different Stations in the Arabian Sea

[Results, mg l^{-1} , average of 3 replicates except in few cases when coefficient of variation exceeds 20% - then the higher value is dropped and average of 2 replicates reported only if the coefficient of variation is $< 20\%$]

Depth (m)	Range	Mean	SD	CV	n
0	0.216-1.056	0.667	± 0.27	40.29	21
10	0.120-1.128	0.595	± 0.28	46.66	21
25	0.096-1.080	0.611	± 0.30	49.18	21
50	0.072-1.080	0.631	± 0.25	39.68	21
100	0.240-1.152	0.660	± 0.28	42.42	20
300	0.144-1.128	0.647	± 0.31	47.69	19
600	0.192-1.140	0.742	± 0.30	40.54	19
1000	0.319-1.142	0.819	± 0.28	35.00	19

SD — Standard deviation; CV — coefficient of variation; and n — number of samples

Table 2 — Comparison of Total Dissolved Carbohydrate Distribution in the Arabian Sea and Other Oceanic, Coastal and Estuarine Waters

Sampling site	Conc. (mg l^{-1})	Reference
Shelf of Africa	1.30-2.20	Artemiev (1976)*
Shelf and slope off Peru	0.20-0.40	Romankevich (1984)*
Eastern Equatorial Pacific	0.10-0.91	Romankevich (1984)*
Western Equatorial Pacific	0.99-1.15	Romankevich (1984)*
South-Western Atlantic	1.21-1.34	Artemiev & Melnikov (1974)*
Southern part of tropical Indian Ocean	0.21-1.31	Artemiev (1976)*
NW Pacific	0.09-0.46	Handa (1967)*
Indian Ocean	0.19-0.66	Handa (1966)*
Arabian Sea	0.07-1.15	Present work
Coastal Waters	0.00-35.80	Burney & Seiburth ¹³
Mandovi Estuary	0.00-9.00	Kamat ¹²
Mahi Estuary	3.71-15.95	Bhosle <i>et al.</i> ¹⁰
EmS-Dollart Estuary	0.10-10.30	Laane ¹¹

*Compiled from Romankevich⁵

face would be the expected distribution in most coastal waters. The absence of such distribution in 0 to 100 m depth waters indicate horizontal homogeneity in the carbohydrate distribution within the area sampled.

Simple regression analyses were also used to relate chl. *a*, phaeopigments, salinity, dissolved oxygen, phosphate and nitrate with that of carbohydrate concentration (Fig. 3). Carbohydrate did not show significant correlation with salinity. Significant salinity fluctuations were also occurred, indicating that dif-

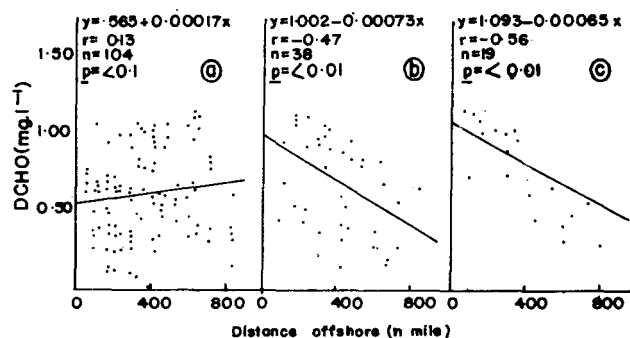


Fig. 2 — Relationship between dissolved carbohydrate and distance offshore at depths (a) 0-100 m (b) 300-600 m (c) 1000 m

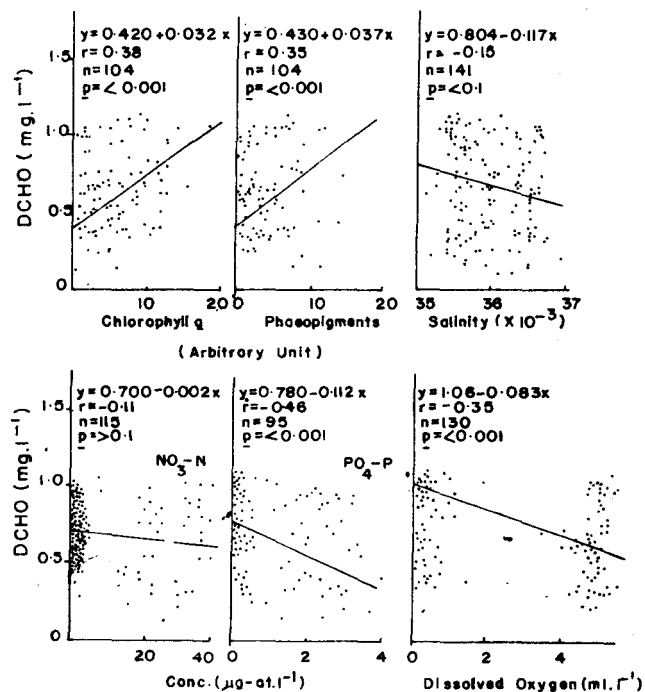


Fig. 3 — Relationship between dissolved carbohydrate and various other parameters

ferent water masses were sampled, however, carbohydrate did not show evidence of conservative behaviour.

A significant positive correlation ($P < 0.001$) was observed between dissolved carbohydrate and chl. *a* concentration suggesting that phytoplankton are the possible source of the carbohydrate (Fig. 3). This observation corroborates earlier studies^{12,14-16}. It is well known that healthy phytoplankton release considerable amount of dissolved organic matter of which dissolved carbohydrate forms a main component. During the various stages of growth, maximum release has been reported to occur during the peak phytoplankton growth and after it^{14,17}. Relatively high concentrations of dissolved carbohydrate observed after algal

bloom from various environments support this view^{3,12}.

A significant direct relationship ($P < 0.001$) between carbohydrate and phaeopigments, which are formed due to the degradation of chlorophyll by zooplankton^{18,19}, suggests the importance of zooplankton mediated release of carbohydrate. Zooplankton are known to release dissolved organic carbon through their excretion and sloppy feeding²⁰. For example, high protozooplankton biomass was always accompanied by large concentration of phaeopigments and dissolved carbohydrate in North Atlantic² waters and simulated estuarine ecosystem tank at Narragansett Bay²¹. This suggest that, zooplankton excretion appears to influence carbohydrate concentrations in marine environment.

An inverse correlation with nutrient such as phosphate and nitrate suggests the possible role of these compounds in regulating the concentration of carbohydrate in the marine environment. For example, high concentrations of carbohydrate and glucose were observed in natural waters poor in nutrients^{3,22}.

Data also revealed a significant inverse relationship between carbohydrate and dissolved oxygen ($P < 0.001$). Similar inverse relationship has been reported by Walsh and Douglass¹⁵ who observed that high concentrations of carbohydrate were always accompanied by low dissolved oxygen in Sargasso sea. Harvey²³ while studying dissolved carbohydrate in California Bight stressed the importance of dissolved sugars in depleting oxygen concentrations off New Jersey. If, this is so, then the observed relationship between carbohydrate and dissolved oxygen indicates that bacterial decomposition of organic matter may be a source of dissolved carbohydrate in the sea.

Menzel²⁴ found no correlation between primary production and the concentration of dissolved organic carbon in the Arabian Sea and also observed an increase in the dissolved organic carbon between 300 and 600 m. While Ryther and Menzel²⁵, reported that only trace amounts of oxygen were found within 500-1000 m depth interval in the western Arabian Sea. Although adequate data are lacking, it is possible that oxidation of organic detritus may account for the in-

crease in the concentrations of dissolved organic carbon at about 500 m observed by Menzel²⁴ and the paucity of oxygen, at that depth²⁵. Present observations are similar to those made earlier^{24,25} and suggest the possibility of common origin of high dissolved organic carbon and carbohydrate in the Arabian Sea.

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