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SEASONAL VARIATIONS IN QUANTITY, COMPOSITION AND ENERGY VALUES OF DETRITUS IN THE KELANI ESTUARY

by

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ABSTRACT

Seasonal variations in the quantity of suspended detritus, its proximate composition and nutritive value were studied for 1 year in the Kelani estuary. Production was high during the initial part of the year (January-April 84) and low during rest of the time. The energy value of detritus ranged from 18.7016-45.0799 KJ/g. Available energy of suspended detritus in the Kelani estuary was much higher than those of phyto-and-zooplankton and represented a potential energy source for secondary producers. Importance of detritus in aquaculture has been indicated.

INTRODUCTION

Detritus particles generally form the major component of suspended matter in the sea and play an important role in physical, chemical and biological processes (Lenz 1972). In specialised tropical environments, instead of conventional pathway of energy flow such as phytoplankton→ Zooplankton → fish, energy becomes branched and forms a food web in which several alternate links of energy transfer such as detritus, organic aggregates etc. tend to substitute zooplankton (Qasim, 1977 and Qasim *et al.*, 1979). Organic detritus may be defined as "all types of biogenic material in various stages of microbial decomposition" (Darnell, 1967). There exists a distinction between suspended and settled detritus, the former occurs regularly in the plankton and the latter forms a portion of the sediment (Kenchington, 1970).

The studies of Fox *et al.*, (1952). Krey (1961 and 1964) have shown that organic detritus form a large proportion of the suspended material. While the importance of detritus as food of estuarine and inshore animals has been well documented (Fox 1950; Darnell, 1961. and Newell, 1965), information on nutritive value of detritus in the tropical waters is very limited (Krishna Kumari *et al.*, 1979 and Sumitra - Vijayaraghavan *et al.*, 1979).

The present study deals with the study of the seasonal variations in the quantity of suspended detritus its composition and energy value in the Kelani estuary in Sri Lanka.

MATERIALS AND METHODS

Water samples (100 l) were collected in polythene carbuoys from the surface (upto 0.5 m depth) at the NARA jetty for a period of one year (January-December '84) at monthly intervals. The collected material was allowed to settle for 48 hr. The settled material was filtered through pre-weighed Millipore filter pads (0.45 m) and dried in an oven at 70°C to constant weight. The dried samples were used for the determination of proximate composition and organic carbon content. Estimation of carbohydrate, lipid and protein were made following standard procedures (Dubois *et al.*, 1956, Folch and Stanley, 1956 and Biuret method as modified by Raymont *et al.*, 1964). Organic carbon was estimated according to Wakeel and Riley (1957). Caloric values of total suspended matter were calculated from its carbon content using the equation of Platt *et al.*, (1969) for zooplankton equivalent: Cal/g dry wt= -227+152 (%carbon). For chlorophyll analysis, one litre of water sample was collected from the same site and filtered through GF/C whatman glass filter pads. Chlorophyll *a* was estimated spectrophotometrically following the procedure given by Strickland and Parsons (1972).

From the chlorophyll content phytoplankton carbon was determined using the conversion factor, 1 mg = 50 mg carbon (Tranter, 1973) and later to dry weight using the conversion factor, 1mg C = 3.3 mg dry phytoplankton (Qasin *et al.*, 1979). Carbon equivalent of dry phytoplankton was converted to calories using the conversion factor 1 mg C = 11.4 calories (Platt and Irwin, 1973).

Zooplankton samples were collected by filtering a known volume of water through plankton net (150 m mesh) and dried in an oven at 70°C to constant weight. Dry weight of zooplankton was converted to calories using the equation cal/m = 4.708 + 2.669 dry wt mg/m (Qasim *et al.*, 1978). Energy values of phytoplankton, zooplankton and suspended detritus are expressed in joules.

The quantity of suspended detritus inclusive of bacteria was determined as the difference between the total dry weight of suspended matter and the dry weights of phyto and zooplanktons. Detritus energy values were obtained by subtracting the phyto-and-zooplankton energy values from the energy values of the total suspended matter.

RESULTS AND DISCUSSION

Seasonal variations in the quantity of suspended detritus (Fig. 1) indicated that the amount present in the water column was high from January to April '84 after which it was low. Total suspended detritus in terms of dry weight varied from 0.42 mg/L—16.84 mg/L with an average value of 3.3 mg/L. This value is lower than what has been reported for the suspended detritus in the Zuari estuary (Krishna Kumari *et al.*, 1978). The quantity of suspended detritus was high from January — April '84. while turbidity during January-July '84 showed a declining trend. Between August and October '84, turbididty recorded a raising trend during which suspended detritus was low and did not show any marked variation. Rainfall data indicated an inverse correlation with suspended detritus during the initial part of the year. However, during the rest of the period, while, detritus was low, rainfall data showed several peaks. Qasim and Sankaranarayanan (1972) also found lower values for detritus settled to the bottom during the monsoon months and attributed it to the formation of 'halocline' which prevents mixing of deep waters with surface water thus reducing the settlement rate of detritus considerably.

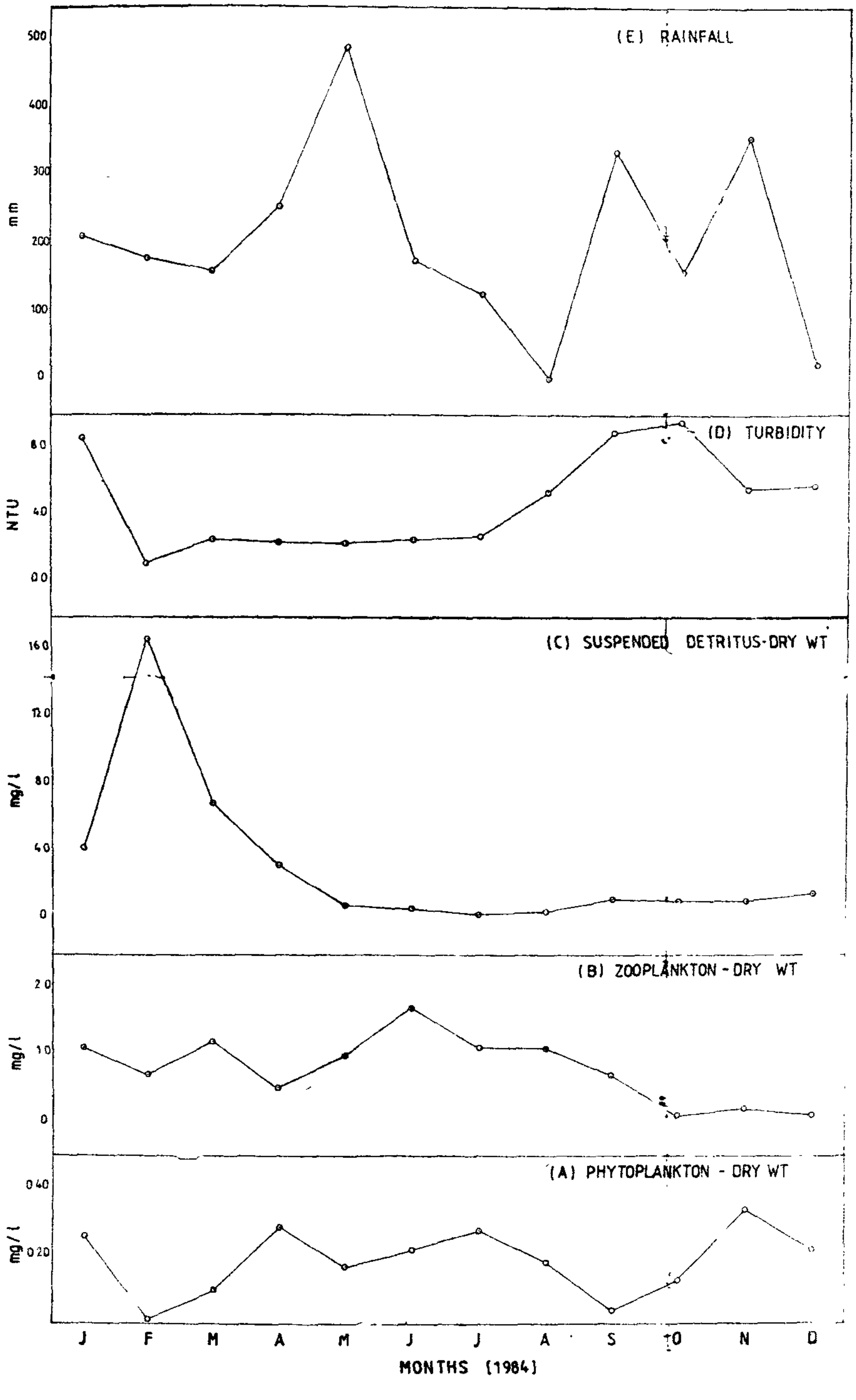

Fig. 1 : Seasonal variation in (A) Phytoplankton (B) Zooplankton (C) Suspended Detritus (D) Turbidtiy and (E) Rainfall.

Most of the detritus originates directly or secondarily from plant biomass. Animal biomass also contributes a small fraction. Animal faeces which are largely plant material are a major secondary source (Pomeroy, 1978). The major contribution of detritus in an estuary is from plants, classified as derived from autochthonous (phytoplankton, marginal and submerge vegetation, mud flat diatoms, filamentous algae and periphyton) and allochthonous sources (marginal marsh and swamp vegetation, riverborne phytoplankton, beach and shore materials washed during high water and wind blown materials (Darnell, 1967). Among the autochthonous sources of suspended detritus in Kelani estuary, the contribution by phyto-and zooplankton in terms of dry weight was low (18.5% and 4.4% respectively), while, the suspended detritus was as high as 77%.

Therefore, a major portion of detritus is probably allochthonous. *Eichhornia crassipes* occurs abundantly in the region where the river joins the sea. Thus, there is constant contribution from dead and decaying vegetation in the Kelani estuary.

TABLE 1.

PROXIMATE COMPOSITION, CARBON AND NITROGEN CONTENTS OF SUSPENDED DETRITUS IN KELANIYA ESTUARY (VALUES IN PERCENT — DRY WEIGHT BASIS)

Months (1984)	*Carbohydrate*	*Lipid*	*Protein*	% *Carbon*	% *Nitrogen* *	*C:N Ratio*
January 84	7.37	7.70	16.26	42.30	2.60	16.27
February	2.46	2.77	17.98	38.30	2.88	13.30
March	9.72	4.80	18.74	36.00	3.00	12.00
April	2.18	2.74	23.74	30.90	3.80	8.13
May	0.99	14.32	12.12	44.70	1.94	23.04
June	1.78	5.92	28.86	45.82	4.62	9.92
July	4.32	6.15	40.24	48.92	6.44	7.60
August	2.03	14.86	30.30	63.18	4.85	13.03
September	1.55	10.61	31.45	72.18	5.03	14.35
October	0.53	6.53	19.54	43.52	3.13	13.90
November	1.59	8.54	23.25	47.72	3.72	12.83
December 84	3.90	25.29	10.74	41.12	1.72	23.91
Mean	3.20	9.19	22.77	46.22	3.64	14.01

* Calculated from Percentage Protein

Table 1 gives the proximate composition, carbon and nitrogen content of suspended detritus. C : N ratio in suspended detritus ranged between 7.6 : 1 to 23.91 : 1 with an average value of 14.02 : 1. The ratio was lowest in '84 and the highest in December, '84. Compaerd with the values given in table 2 the raito of C: N recorded in the suspended detritus of Kelani estuary appears to be high.

The values obtained for protein, carbohydrate and lipid have been converted into energy values using the energy factors given by Phillip (1969), then converted to joules and given in Fig. 2. In addition, the energy values of suspended detritus calculated from its carbon content are also plotted in Fig. 2. It is evident that the energy values calculated from carbon content is consistently higher than that calculated from the proximate composition. This indicates that the suspended detritus contain additional carbon sources other than the proximate composition as shown by Qasim and Sankaranarayanan (1972).

TABLE 2.

C : N RATIO OF DETRITAL SAMPLES FROM DIFFERENT ENVIRONMENTS

Area and Sample Detail	*C : N Ratio*	*References*
Ocean Detritus surface	5.4 : 1	Parsons & Strickland (1962)
Deep waters	2.3 : 1	
Southampton waters		
	5 - 17 : 1	
(From three stations)	6 - 16 : 1	Trevallion (1967)
	6 - 12 : 1	
California Coast	5.5 - 14. 2 : 1	Holm - Hansen *et al* (1966)
Subtropical waters of the North Atlantic Ocean	7.8 - 15. 5 : 1	Gordon (1970)
Cochin Backwaters	5.0 - 10. 5 : 1	Qasim and Sankaranarayanam (1972)
Kelani Estuary	7.6 - 23.91 : 1	Present work

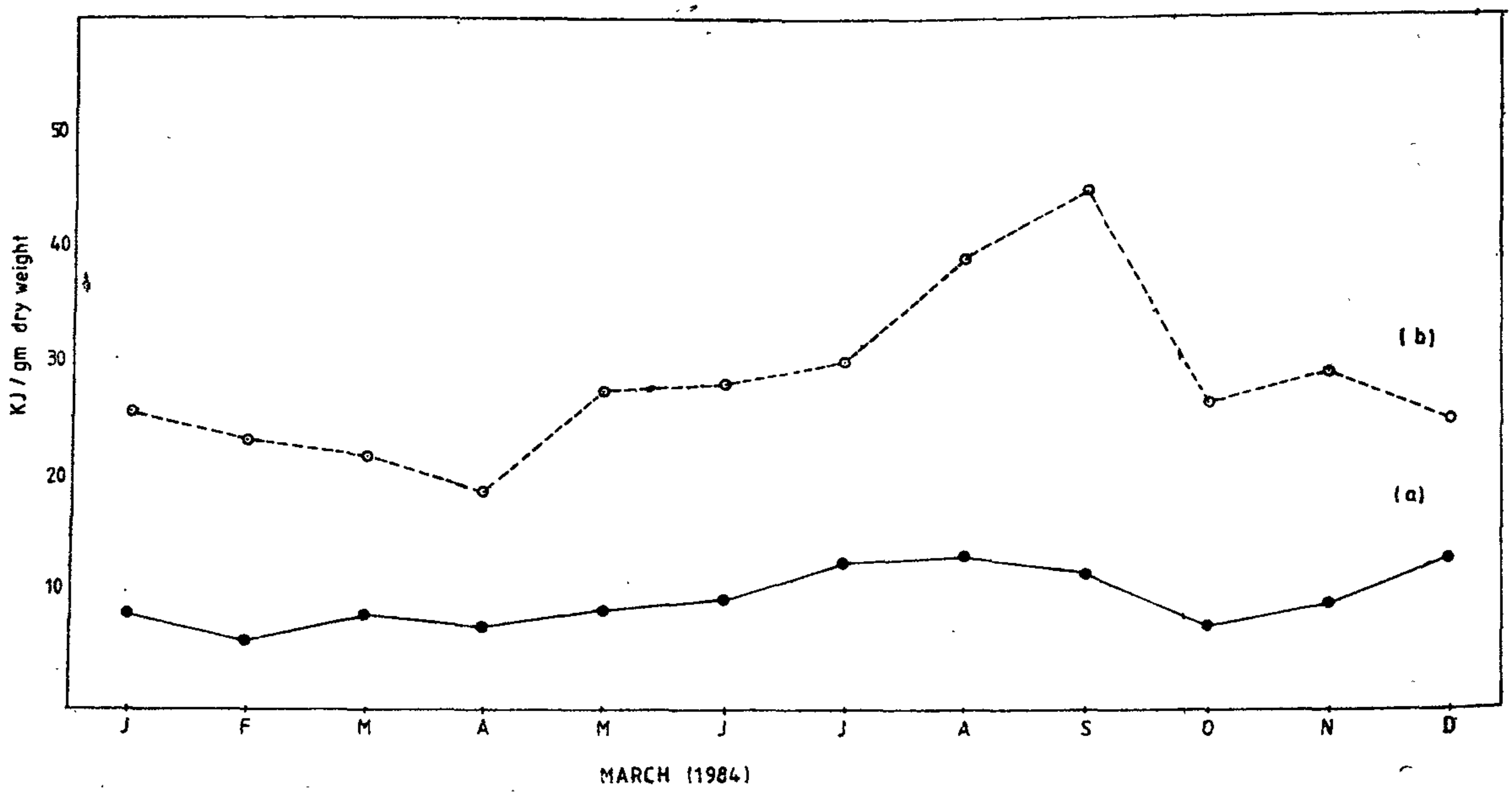

Fig. 2 : Seasonal variation in energy values of Suspended Detritus. (a) Total energy values determined from proximate composition (b) Total energy values determined from organic carbon values.

TABLE 3.

THE RANGE OF ENERGY VALUES FOR SAMPLES FOR SAMPLES FROM DIFFERENT ENVIRONMENTS REPORTED BY EARLIER AUTHORS (VALUES IN CAL/OF DRY WT)

Area	*Minimum*	*Maximum*	*Mean*	*References*
Cochin Backwaters	228	500	358	Qasim and Sankaranarayanan (1972
Zuari Estuary	173	6057	1463	Krishnakumari *et al* (1978)
Laccadive Sea	732	4804	3850	Qasim *et al* (1979)
West Coast of India	490	5094	1601	Sumitra - Vijaya - raghavan *et al* (1979)
Kelani Estuary	5245 (18.7016) KJ/g	10,774 (45.0799) KJ/g	6801 (28.456) KJ/g	Present study

Seasonal changes in the energy values are given in Fig. 2 appears tc be quite independent of total quantity (Fig. 1). Energy value ranged from 18.7016 KJ/g dry wt to 45.0799 KJ/g dry wt with a mean of 28.456 KJ/g dry wt. The range as well as the mean energy value recorded in the present study (Table 3) is much higher than the values reported for Cochin Backwaters (Qasim and Sankaranarayanan, 1972); the Zuari estuary (Krishna Kumari *et al.*, 1978), the west coast of India (Sumitra-Vijayaraghavan *et al.*, 1979) and the Laccadive Sea (Qasim *et al.*, 1979). The differences in the energy content of detritus from different water masses may be due to zonal variations, sampling details, nature and source of detritus. In the Cochin Backwaters detritus is reported to originate from decaying *Salvinia* weeds (Qasim and Sankaranarayanan, 1972). In the Zuari estuary decaying mangrove leaves contributed to detritus content (Krishna Kumari *et al.*, 1978). In the Kelani estuary it is mostly from the macrovegetation bordering the estuary and the river run off bringing in the organic load (Sumitra-Vijayaraghavan *et al.*, 1985).

In a generalised scheme engrgy transfer occurs from phytoplankton to zooplankton and fish. In warm water estuarine environments detritus is a major link in the food chain (Qasim 1977).

TABLE 4.

RATIOS BETWEEN PHYTOPLANKTON, ZOOPLANKTON AND DETRITUS ENERGY VALUES (IN KJ/M³)

Month	*Phytoplankton*	*Zooplankton*	*Suspended detritus*	*Detrital; Phytoplankton*	*Detrital; Zooplankton*
January '84	2051.00	12303.47	11263.26	229.74	38.28
February	214.64	7836.63	394187.44	7683.96	210.46
March	2146.39	13420.22	153615.56	299.45	47.91
April	6081.44	5603.25	61902.45	42.59	46.23
May	20704.85	11186.80	25554.53	51.55	9.54
June	4578.97	19003.77	21988.43	20.08	4.85
July	5795.26	12303.47	12667.94	9.16	4.31
August	3768.11	12303.47	20399.97	22.64	6.95
September	763.16	7836.63	56800.69	311.42	30.33
October	2623.37	1136.37	33943.99	54.14	124.98
November	6963.85	2253.13	37042.25	22.26	68.78
December '84	4578.97	1136.42	42338.06	38.70	155.90
Mean	5022.50	8860.30	72642.05	732.14	62.38

The energy values of phyto, zooplankton and suspended detritus is given in Table 4. It also gives the ratios between detrital energy and phytoplankton energy and detrital and zooplankton energy values. The high ratios recorded during January — March and September 84 indicated the predominance of detritus over phytoplankton. Similarly high ratios during February and October-December '84 again revealed the detritus dominance over zooplankton as an energy source for secondary producers. Dominance of detritus in the Zuari estuary has been reported (Krishna Kumari *et al.*, 1978).

Percent contribution of energy by phytoplankton, zooplankton and suspended detritus in the total suspended matter in the Kelani estuary worked out to be 5.8, 10.24 and 84.0 respectively. Thus, the major part of the energy appears to be contributed by suspended detritus and confirms the findings of earlier workers (Krishna Kumari *et al.*, 1978; and Sumitra-Vijayaraghavan *et al.*, 1979). According to Saunders (1972) 90% of the particulate matter in the coastal areas is detritus. In most ecosystems the bulk of organic particulate matter is non-living detritus and only a small part is living organisms. The mass of detritus at any instant is commonly ten to hundred times more than that of living matter (Pomeroy, 1978). Saunders (1972) pointed out that predominance of detritus in the upper ten hundred meters of the Oceans is a common phenomenon. This is due to the fact that freshly formed detritus is not easily assimilated by animals as it is by microorganisms and well formed or decomposed detritus aggregated are less susceptible to bacterial attack. This may be probably the reason for the dominance of detritus over the living biomass recorded in the present study.

Thus, detritus constitutes an additional path way between organic production and animal nutrition and helps to increase the efficiency of energy transfer from one trophic level to the other. It would be advantageous to utilise water bodies with high detritus content and select suitable fish/prawns for aquaculture trials. Detrirtus is highly nutritive as it is rich in organic matter derived from plants and animals enriched with microorganisms. Detritus occurs abundantly, can be collected with relative ease and can be effectivery incorporated in compounded feed of shrimps/fishes. It is in this context that studies on detritus is of importance.

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