

Seasonal Changes in Meat Weight & Biochemical Composition in the Black Clam *Villorita cyprinoides* (Grey)

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Seasonal changes in meat weight and biochemical composition are associated with reproduction, storage and utilization of reserves. The main period of increase in biochemical constituents corresponds to gametogenesis and maturation of gonads just before breeding. Spawning, which is biannual in nature, produces a marked fall in the meat weight and biochemical composition. October to January appears to be the most suitable period for harvesting these clams.

Villorita cyprinoides is an economically important estuarine bivalve found along the Indian coast¹. In Goa it supports a sizeable fishery with a gross annual landing of about 500 tonnes. The culture potential of this species has already been reported².

In spite of its commercial importance, our knowledge on its ecology, biology and nutritive value is fragmentary. Apart from a preliminary study on some biochemical aspects by Sivankutty Nair and Shyanamma³ and a note by Lakshmanan and Krishnan Nambisan⁴ no other work has been reported on its biochemistry. Therefore a comprehensive study on the biochemical composition and caloric value of *V. cyprinoides* has been made.

Materials and Methods

Clams were collected from the natural bed at Colvale estuary, Goa (lat. 15°40' N and long. 73°50' E) by diving. Sampling was done at monthly intervals from Oct. 1978 to Sept. 1979. Animals were brought to the laboratory and kept in filtered sea water of the same salinity to defaecate for 24 hr. The total length (distance between anterior and posterior margin) was measured using callipers and clams of 3 standard marketable size (20, 25 and 30 mm shell length ± 1 mm) were selected for analysis. Animals of each standard size were cleaned and then weighed on a monopan electric balance. The clams were opened and the meat extracted and weighed. Each sample was then dried in an oven at 60°C for 72 hr to determine constant dry meat weight. Moisture was determined by subtracting dry meat weight from wet meat weight and mean value per clam was calculated for each standard size.

Oven dried material was used for biochemical analyses. Nitrogen was determined by the method of Johnson⁵ and protein was calculated by multiplying with a factor of 6.25. Lipid was determined by the

method of Bligh and Dyer⁶, carbohydrate by the method of Dubois *et al.*⁷, organic carbon by the method of El Wakeel and Riley⁸ and ashing was done at a temperature not exceeding 550°C.

Results

Examination of the gonadal stages of the mature specimens reveals biannual spawning in *V. cyprinoides*. The first spawning occurs during monsoon (July to September). This is followed by a rapid gametogenic activity which reaches its peak by the end of December and consequently the 2nd spawning occurs in January-February. Sivankutty Nair⁹ working on the same species has also observed 2 spawning seasons in Cochin backwater.

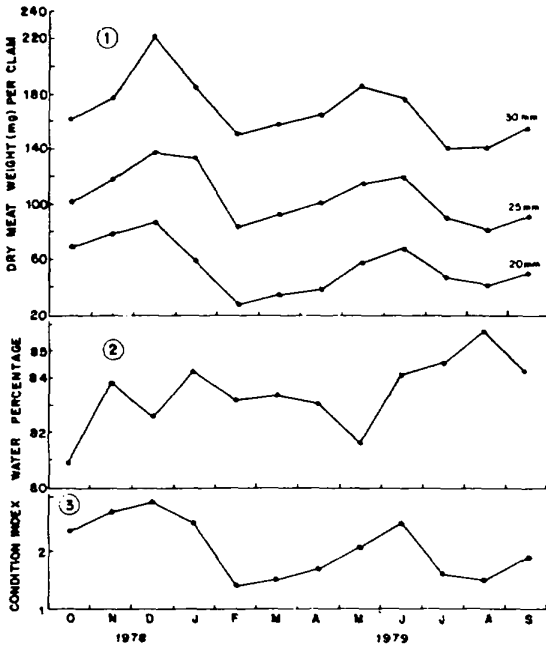
Dry flesh weight—Annual cycle of dry flesh weight (Fig. 1) shows pronounced changes in all the 3 length groups. Maximum weight was 2-3 times more than the annual minima. In all the 3 size groups dry weight was highest in postmonsoon coinciding with high gametogenic activity. It fell suddenly in January-February, and this was followed by a gradual build-up till the onset of monsoon in June when the weight decreased for the 2nd time.

Water content—Changes in the mean water content are shown in Fig. 2. A minimum value of 80.9% was recorded in October. The value increased till January and then remained almost same until May, when there was reduction in water content. The percentage again increased and remained high in the monsoon season. The maximum value of 85.8% was observed in August.

Condition index—As would be expected the condition index, determined as a ratio of dry meat weight to dry shell weight (Fig. 3), resembled closely the cycle in dry meat weight. Values were high in November-December and May-June. Decreases in the condition index coincided with the spawning period.

Biochemical composition—Percentage composition

of different components of the tissues are given in Table I along with the calculated caloric value of the dry tissue.



Figs 1 to 3 - Annual cycle of (1) dry meat weight (mg) in standard animals, (2) water content in the tissue and (3) condition index of *V. cyprinoides*

Protein content ranged from 38.7% in August to 58.7% in November and May, the average being 48.5%. The carbohydrate content varied between 20.6 and 31.5% with an average value of 26.15%. It showed high values in November-December and again in April-May coinciding with maximum dry flesh weight. Low values of carbohydrate coincided with spawning period. Lipid content of the tissue remained fairly steady throughout the period of study with little fall in the value during the spawning season. The maximum and minimum values were observed in November and January respectively. The average value was 9.1% of dry meat weight. The organic carbon also did not show any seasonal change. The value remained fairly constant with 2 maxima, one in December and the other in May. The average organic carbon in the tissue was 34.6%.

Caloric content—Biochemical data were converted by use of appropriate caloric factors of 5.7 for protein, 9.5 for lipid and 4.2 for carbohydrate to give values for caloric content for the dry flesh of *V. cyprinoides*. The average caloric value was 4.7 k cal/g dry flesh weight or 5.059 k cal/g ash free dry flesh weight. There was seasonal change in the caloric content and the highest value was observed in November and April-May coinciding with maximum value of protein. The value fell during the spawning season.

Biochemical constituents have been reported in the form of percentage composition for many bivalves¹⁰⁻¹³. However, Ansell and Trevallion¹⁴ and

Table I—Biochemical Composition and Caloric Value of Dry Flesh of *Villorita cyprinoides*

[All size groups combined]

	COMPONENTS (as % dry weight)						CALORIC VALUES k cal/g dry wt	
	Carbon	Nitrogen	Carbohydrate	Protein N × 6.25	Lipid	Ash	Ash inclusive	Ash free
	1978							
Oct.	36.7	8.2	26.8	51.2	10.2	6.4	4.993	5.354
Nov.	35.6	9.4	27.6	58.7	12.1	8.5	5.618	6.164
Dec.	38.4	8.2	31.5	51.2	9.3	6.3	5.097	5.467
	1979							
Jan.	32.8	6.5	24.6	40.6	7.2	7.7	4.009	4.367
Feb.	32.2	7.6	20.6	47.5	7.5	6.2	4.262	4.567
March	34.4	7.5	22.6	46.8	9.5	6.4	4.49	4.828
April	34.9	8.9	31.5	55.6	11.6	5.3	5.559	5.906
May	38.4	9.4	29.3	58.7	10.5	5.9	5.542	5.922
June	34.6	7.4	27.5	46.2	8.9	6.6	4.607	4.96
July	31.2	6.9	20.8	43.2	7.6	6.2	4.035	4.325
Aug.	32.3	6.2	22.2	38.7	7.6	6.2	3.837	4.114
Sept.	34.1	7	27.7	43.7	7.7	7.6	4.362	4.745
Average	34.6	7.7	26.15	48.5	9.1	6.6	4.7009	5.059
±SD	2.8	1.4	3	6.7	1.9	0.95	0.52	0.698

Dare and Edward¹³ have pointed out the limitations of presenting percentage values and have stressed the importance of presenting absolute values for composition so that any change in a component may be appreciated clearly. The seasonal change in the estimated weight of each biochemical component of a standard size (25 mm) clam was, therefore, considered and compared with percentage composition (Fig. 4).

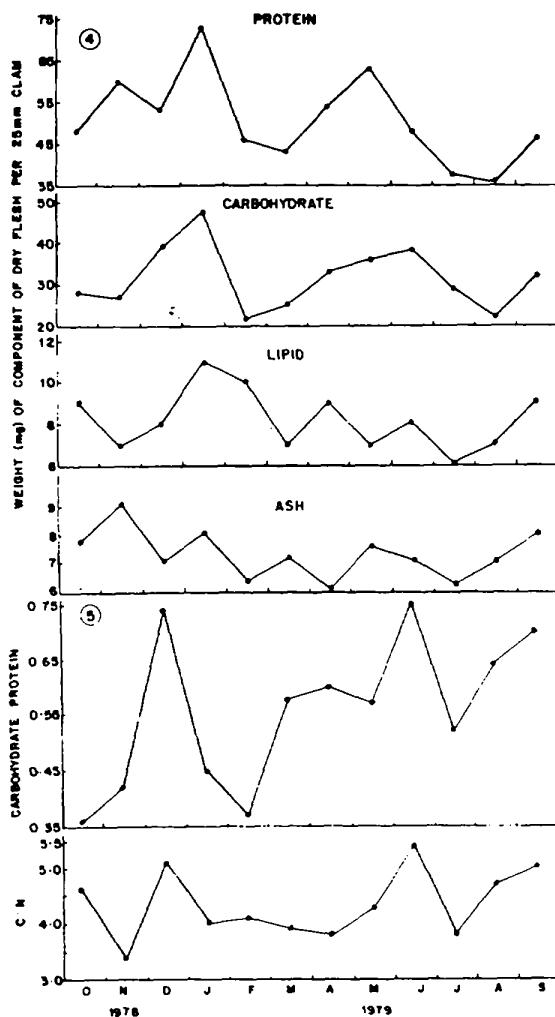
The fluctuations in the weights of protein and carbohydrate were very similar to those of percentage composition except that the peak values were shifted. However, lipid weights unlike its percentage composition fluctuated little with maximum values in the postmonsoon before spawning, when there was an expected drop in the value. Ash weight did not show any fluctuation. The loss in the dry flesh weight was therefore, mainly due to reduction in protein and carbohydrate.

Ratios of various biochemical components have been suggested as indices of the condition of an animal^{16,17}. The ratio of carbon to nitrogen in the tissue (Fig. 5) of a standard animal (25 mm) shows a minimum value in July, rising to maximum just prior to spawning. Similarly the ratio of carbohydrate to protein reflects seasonal cycle in the condition of the clam.

Discussion

Seasonal changes in the flesh weight and biochemical composition are the characteristics of seasonal activities of bivalves which result from storage and utilization of food reserves and growth and reproductive process^{15,18}. Maximum gain in the body weight occurred between September and December and again in April and May, which was also the peak period of phytoplankton production¹⁹. Changes in condition index over the year present changes in the nutritional and/or reproductive status of the animal. The decline in flesh weight of *V. cyprinoides* during spawning season was mainly due to the change in gonadal phase. Nagabhusanam and Dhamne¹³ while working on *Paphia laterisulca* have observed low gonad index in spawned individuals and higher in matured individuals. In temperate species the loss of flesh weight has been attributed to food scarcity in winter and also losses due to spawning^{14,18}.

Maximum water percentage of the soft tissue coincided with minimum flesh weight of the clam and the water level was higher throughout the monsoon. Joshi and Bal¹¹ and Nagabhusanam and Dhamne¹³ have observed high water content in the tissue during monsoon, which they suggested, might be due to loss of salt and gain in water content during adverse condition as was pointed out by Galtsoff²⁰. A somewhat reciprocal relationship was found between



Figs 4 and 5 -- Variation in biochemical composition (4) and Annual cycle of carbohydrate:protein and carbon:nitrogen (5) in *V. cyprinoides* of standard size (25 mm)

water percentage and biochemical constituents. A similar relationship has been reported by Joshi and Bal¹¹ and Deshmukh²¹ for other bivalves. Ansell¹⁷ stated that the water content of the bivalve tissue may give an indication of the time of spawning. This can be clearly seen in Fig. 2 which shows that water content in the tissue was highest during spawning. Sivankutty Nair and Shyanamma³ have also observed this phenomenon in the same species from Cochin backwater.

In most bivalves the protein level remains at a relatively high level except during the breeding season^{10,21}. The level of protein build up during gametogenesis in *V. cyprinoides* is utilized during the breeding season by the animal and again rise to a 2nd

high before the 2nd spawning. The carbohydrate of bivalves comprised mainly glycogen²² and the changes in carbohydrate may be due to accumulation and utilization of glycogen at different stages like gametogenesis and spawning. Ansell *et al.*²³ have reported that in bivalves generally the carbohydrate reserves may be rapidly utilized under unfavourable condition and the great variation found in the tissue indicates that the level of mobilizable carbohydrate reserves may fluctuate widely and rapidly in response to fluctuations in condition affecting the nutrition of the animal. In the present study the carbohydrate percentage, however, did not fluctuate so widely (20.6-31.5%), i.e. 50% of the minimum value, as compared to the temperate species where fluctuation in carbohydrate seasonally may be up to 400% of minimum. Although some evidence is given by Giese²⁴ about the role of lipid as reserve material, in the present study the relatively steady value of lipid did not indicate any such utilization. Lakshmanan and Krishnan Nambisan⁴ also observed no marked seasonal variation in lipid content in this species from Cochin backwater.

The caloric value of dry flesh varies seasonally (Table 1) with maximum value just prior to spawning. The rapid fall and ability to restore reserves of protein, carbohydrate, lipid and calories may reflect a generally higher level of activity and metabolic rate¹⁷.

The fluctuating trend in meat condition accompanied by seasonal changes in the biochemical composition of *V. cyprinoides* has an important bearing on the fishery of this clam. The intensive fishing season which commences in January and lasts till May does not cover the peak period for optimum exploitation as can be seen from Fig. 1. The magnitude of weight and biochemical changes in flesh content may also be significant for consumers. A more rational fishing, based on seasonal cycle in meat condition and

biochemical composition, extending from October to January, should, therefore, be considered profitable.

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