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ENVIRONMENTAL IMPACT ON THE CHANGES IN BODY COMPONENT INDICES OF THE EDIBLE OYSTER *CRASSOSTREA MADRASENSIS* OF PULICAT LAKE

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ABSTRACT

The monthly variations in various body component indices such as mantle, gill, adductor muscle, gonad and hepatopancreas of the edible oyster *Crassostrea madrasensis* collected from the natural bed of Pulicat Lake have been studied.

Among the five body components, mantle forms a prominent body component. The gonad index and the digestive gland index showed an inverse relationship during the entire period of observations. The digestive gland index is higher than the gonad index during the sexually inactive phase. The percentage of water content was found to be higher in the gills than the other body components. The water content in the gonad was lower than the hepatopancreas during the period of gametogenesis, but it increases immediately after spawning indicating a reciprocal relationship between the water content of the gonad and the hepatopancreas. The water content was low in the mantle when the oysters are sexually ripe, but increases steadily after spawning. There is a gradual increase in the total body weight during the period of gametogenesis reaching its peak during the fully ripe condition and decline sharply after spawning. The digestive gland index was found to increase as a result of accumulation of energy reserves when feeding was high, whereas it declined sharply as a result of supply of nutrients to the gonad during gametogenesis.

Among the environmental parameters, salinity plays a major role in the changes of the body component indices of the oyster.

INTRODUCTION

THE CHEMICAL composition and meat weight of the oyster varies according to the changes related to environment, season and physiological conditions of the oyster. Among the environmental parameters, salinity is the main factor affecting the chemical composition of the oyster. Fluctuations in the moisture content due to absorption of water and loss of solids from the body of animals are the most significant features of changes in the chemical composition of the oyster meat. These changes in the oyster meat during certain periods lower their commercial value also. A rational and profitable fishing of oyster lies on the basis of obtaining the highest meat weight with the best biochemical constituents.

The information on the distribution of organic matter in different body components is very scanty. Some studies have been made on the distribution of organic contents in bivalve molluscs (Hatanaka, 1940 ; Nagabhushanam and Mane, 1975 ; Mane and Nagabhushanam, 1975 ; Stephen, 1980 ; Ansell *et al.*, 1980). Earlier investigations have shown that the water level in the bodies of bivalves tends to increase or decrease with the changes in salinity of the sea water (Galtsoff, 1964 ; Ansell *et al.*, 1973 ; Nagabhushanam and Mane, 1975 ; Mane and Nagabhushanam,

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1975; Rao *et al.*, 1987). The use of dry weights, glycogen estimation or the total chemical analysis have been widely adopted for assessing the quality of meat (Durve, 1964; Ansell *et al.*, 1980). Though these methods are more precise, yet they cannot be employed for large samples. Estimating the 'Percentage edibility' and 'Index of Condition' have been employed effectively for large samples (Venkataraman and Chari, 1951; Korringa, 1952; Rao, 1956; Durve, 1964; Giese *et al.*, 1967; Nagabhushanam and Mane, 1975).

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Material and Methods

Regular oyster samples have been obtained from the natural bed of the Pulicat Lake during April, 1981 to March, 1982. After taking the length measurements, the animals were weighed and shucked to remove the visceral mass. The gonadal stages were noted for all the individuals. The body components such as mantle, gill, adductor muscle, gonad and hepatopancreas were separated from each other with utmost care. The tissues were wiped out to remove the excess moisture and then weighed. The body component index of the tissue was determined as the wet weight of the component multiplied by 100 and divided by the wet weight of the entire body. The percentage edibility of a tissue is the meat weight/total weight $\times$ 100 and this was observed for 4 different size groups (41-60, 61-80, 81-100 and 101-120 mm) of oysters. Each body component was weighed separately in crucibles and then dried in an oven at 80°C to constant weight. The water content was determined by substracting the dry weight from the wet weight. The dried tissue was analysed by standard methods for protein, fat and carbohydrates. The environmental parameters such as temperature and salinity on the oyster bed was recorded and the changes in the body component indices of the oyster was correlated with them.

Results

Changes in body weight

The monthly variations in the percentage edibility of four different size groups are illustrated in Fig. 1. The body weight was minimal in May and November-December as soon as they spawn, and was found to increase sharply in all the size groups during the months of June and January. The body weight increases gradually reaching its maximum in all the size groups during October and March. In October and April all the size groups of oysters showed an increasing trend as a result of ripening of the gonads. Immediately after spawning, the body weight of the oysters declined and reached its lowest level.

The percentage edibility varies in the different size groups. The 41-60 mm size groups has shown the maximum percentage of flesh weight than the other size groups. The 61-80 mm size group has shown 4.12% of flesh weight. The higher groups of oysters 81-100 mm and 101-120 mm showed 3.46% and 2.97% of meat weight respectively. Of all the size groups, harvesting of 61-80 mm size group seems to be more profitable in which 4.12% meat weight could be obtained. Although, the flesh weight was 5.11% in the 41-60 mm size group of oysters, yet it requires large number of oysters for the required quantity of meat. The maximum efficiency ratio is reached when the greatest quantity of meat is

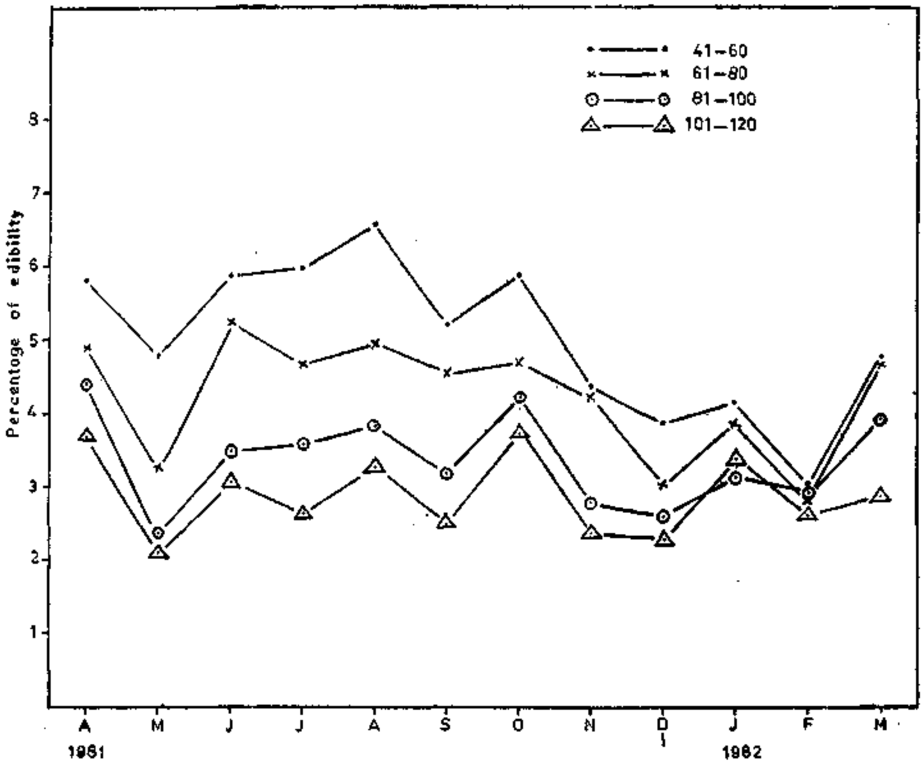

FIG. 1. Monthly variations in the average percentage edibility of *Crassostrea madrasensis* during April 1981 to March 1982.

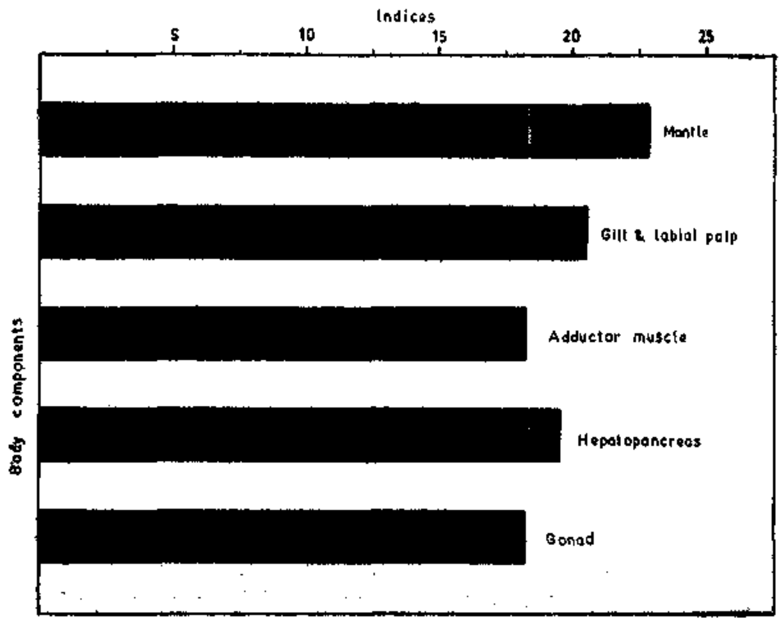

FIG. 2. Body component index profiles of *C. madrasensis*.

obtained from an oyster with the lowest total weight or size.

Monthly variations in the body component indices

The body component profiles of *C. madrasensis* are given in Fig. 2, from which it is clear that the mantle forms a relatively prominent body component. Gill and labial palps both constitute the second major body component. Among the other three body components, the digestive gland index forms the third major body component and the adductor muscle and gonad more or less of the same status. Monthly variations of the body component indices during the period of study were plotted in Fig. 3, which showed that the gonad, hepatopancreas and the mantle showed remarkable fluctuations. In April and September-October, the gonad index seems to be at the peak level due to the ripening of the gonad and it was

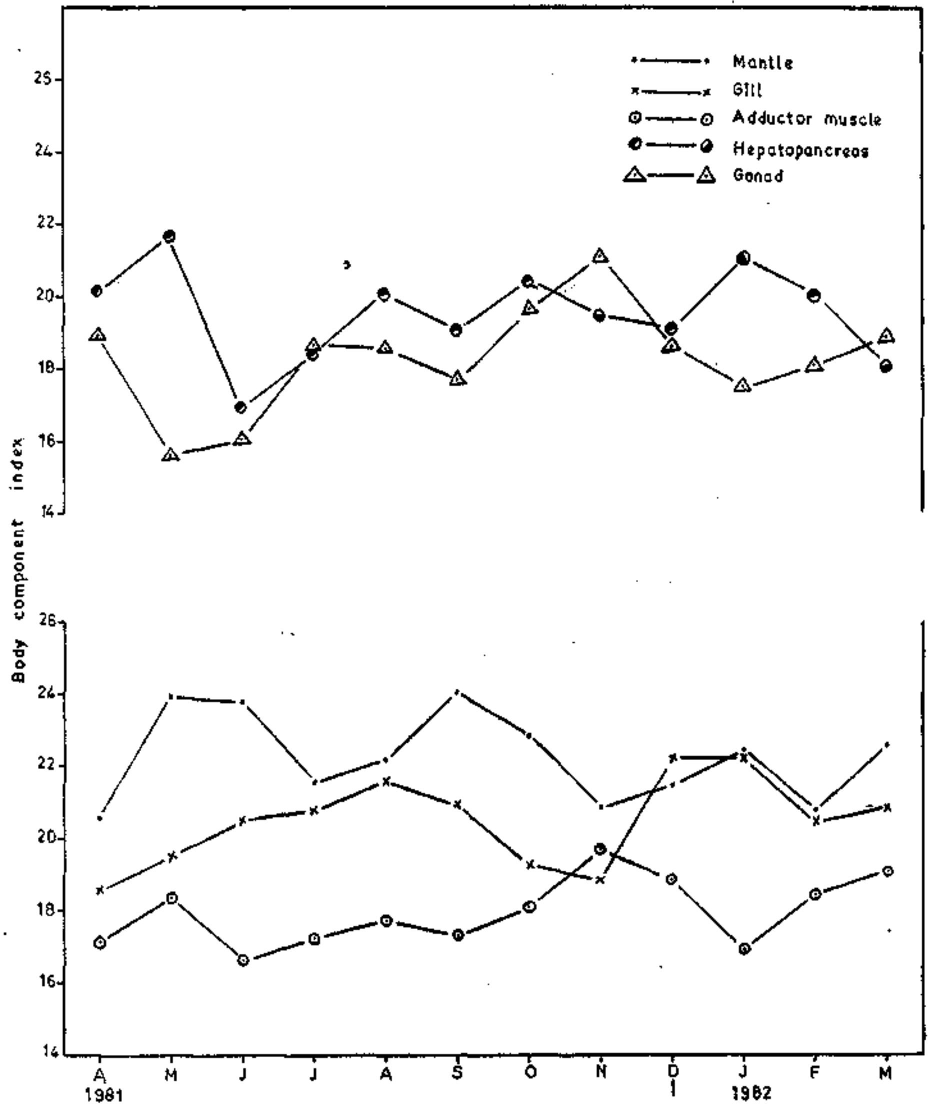

FIG. 3. Changes in the body component indices of *C. madrasensis* during April 1981 to March 1982.

found to be falling in the subsequent months May-June and December-January as a result of discharge of gametes at the time of spawning and also due to the resting phase of the gonad. The gonad index showed a gradual months as a result of rapid transfer of nutrients from the ingested food. The digestive gland index showed two peaks during May and January, gradually declining in the subsequent months while the gonad is undergoing gameto-

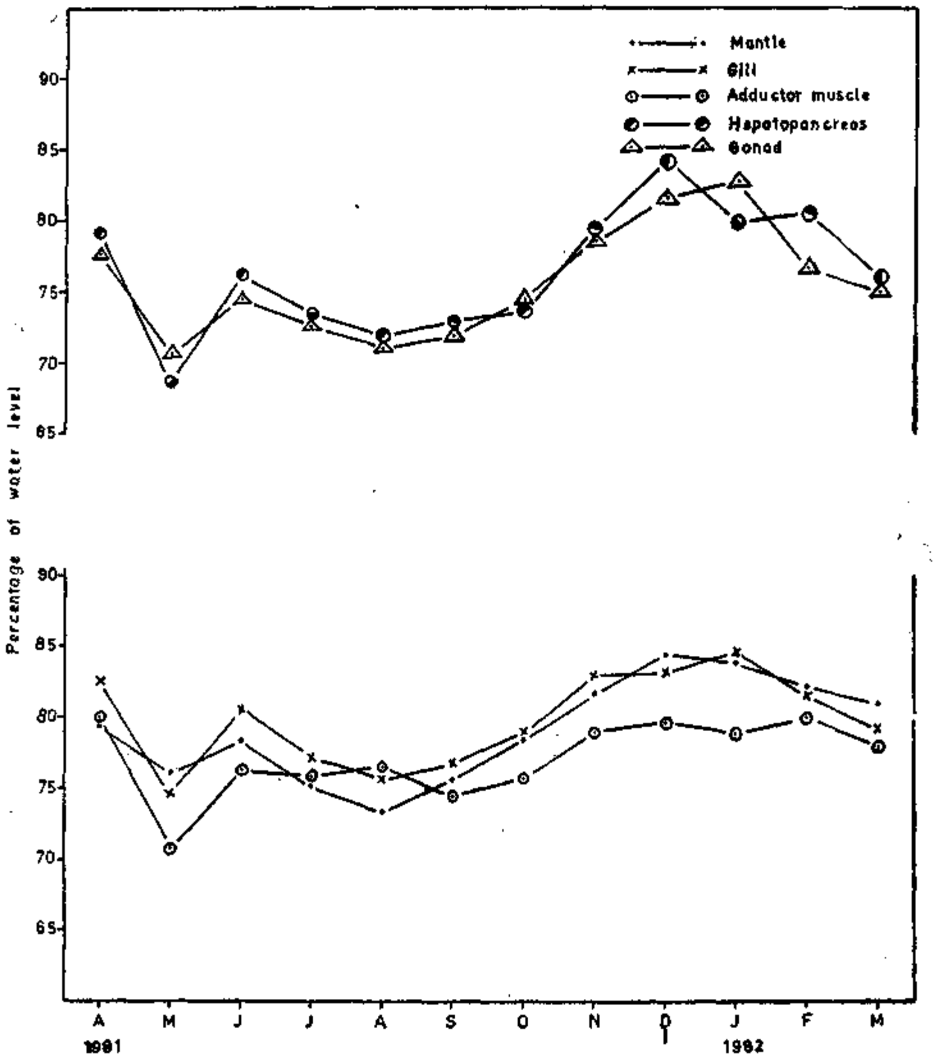

FIG. 4. Percentage of water level in the mantle, gill, adductor muscle, hepatopancreas and gonad of *C. madrasensis* during April 1981 to March 1982.

increase during July-September and February-March during the gametogenetic phase. The digestive gland index increased as a result of feeding during June-August and December-January and slowly decreased in the subsequent genic phase. Mantle and gill also showed an increasing trend during the period between January and March. The index of hepatopancreas showed a decreasing trend during this period, perhaps, due to transfer of nutritive material from the hepatopancreas to the gonad during the entire period of this study.

Water levels

The water content of the entire body ranged between 82.5% (December) and 72.1% (May), was found to be highest (79.8%) than in the other body components. The water content in the mantle was 79.2% and it is slightly lower than in the gill. The water content in the hepatopancreas and gonad were estimated to be 76.4 and 75.8% respectively. The adductor

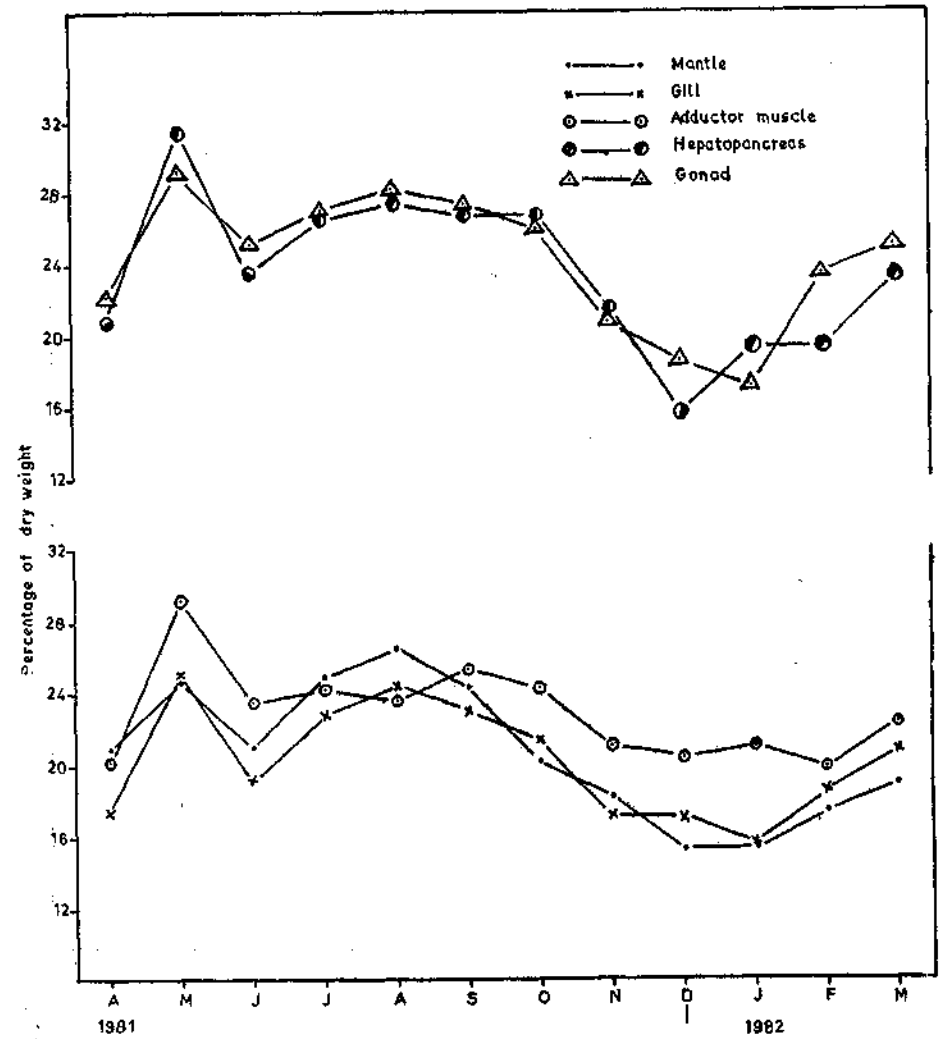

FIG. 5. Percentage of dry weight of mantle, gill, adductor muscle, hepatopancreas and gonad of *C. madrasensis* during April 1981 to March 1982.

coinciding with the monsoon period and summer months respectively. The percentage of water content in all the body components is given in Fig. 4. The water level of the gill muscle has shown the intermediate status in its water content (77.1%). The water content of gonad and hepatopancreas showed lowest level during April and September as a result of ripening of the gonad. This water content has been found to reach the maximum level immediately after spawning. The water content started to rise in all the body components from September corresponding to decline in the salinity of the lake.

Changes in dry weight of the different body components

Monthly variations in dry weight of different body components (Fig. 5) show that the mantle varied between 15.6 and 26.5%. The dry weight of the gill varied between 15.4 and 25%. The adductor muscle has shown the highest weight during May and the lowest during February. The maximum weight of hepatopancreas and gonad was found during the month of April-May and October-November when the gonad was fully ripe and declines in the subsequent months as a result of spawning.

Changes of body weight in relation to reproduction

Seasonal changes in the body weight in relation to gametogenetic activity was also observed. The body weight of the oyster was at minimal soon after extrusion of gametes from the animal and increases gradually towards the onset of gametogenesis. The process of proliferation of gametes takes place from July to October and February-April and correspondingly the weight of the oyster also increased gradually till the ripening of gametes. The overall decrease in the body weight during the month of February represents the net deficit of food available in the environment to meet the metabolic requirements of the animal.

Changes of body weight in relation to feeding

The meat weight of the oyster varies during the different months of the year depending upon the intake of food, reproductive activity and changes in the metabolic activity of the animal. Gonad growth and gametogenesis are dependent upon direct intake of food in most of the bivalves. Maximum feeding intensity was observed during January and June as a result of which the weight of the body was found to rise sharply due to accumulation and storage of glycogen in hepatopancreas. The energy stored in the form of glycogen was accompanied by weight increase and this weight was maintained in the subsequent months also. During the process of gametogenesis the gonad received the nutrient supply from the hepatopancreas and mantle, where it was stored when the feeding intensity was high. Thus the gonad of the oyster during the period of active gametogenesis accumulates or utilizes the nutrients at the expense of the other organs. The weight of the oysters dropped considerably during May and November immediately after spawning and the feeding intensity found to rise considerably.

Body weight in relation to biochemical variations

Biochemical constituents of the oyster vary with the feeding, reproductive activity, physiological conditions and also due to external stresses like starvation and desiccation. During June-July and January-February, the carbohydrate content rose to the maximum level in hepatopancreas due to high intensity of feeding and thereby the weight of the oyster also increased considerably. There was an increase in weight of the gonad during the period of gametogenesis as a result of formation of protein and fat and associated decrease of carbohydrate content in hepatopancreas. During August and October there was a gradual increase in weight indicating that they are rich in carbohydrate in the preceding months gradually increase in protein and fat, reaching their peak levels during October when the oysters reach ripe condition.

Environmental parameters

Among the environmental parameters, salinity is the important factor which plays vital role in the changes in the body weight of the oyster. Fluctuations in the moisture content due to absorption of water and loss of solids from the body of animals are most significant features of changes in the chemical composition of the oyster meat. When salinity is high during postsummer season, the gonad index increases gradually as a result of gametogenesis. The water level was found to be high in the hepatopancreas due to migration of nutrients from the hepatopancreas to the gonad during this period. Spawning is mainly influenced by the lowering of salinity in the lake due to heavy North East monsoon rains in October. The water content which was lower than the hepatopancreas increases in the gonad as a result of spawning. Almost all the tissues have reflected the same trend.

Discussion

Changes in the body weight, body component index, percentage of water in the body in relation to environment and physiological aspects of bivalves has been studied by several earlier workers (Venkataraman and Chari, 1951 ; Durve and Bal, 1961 ; Durve, 1964 ; Galtsoff, 1964 ; Joshi and Bal, 1965 ; Sastry, 1966, 1970 ; Giese *et al.*, 1967 ; Ansell, 1972, 1974 a, 1974 b ; Ansell *et al.*, 1964, 1973, 1980 ; Mane and Nagabhushanam, 1975 ; Nagabhushanam and Dhamne, 1977 ; Nagabhushanam and Bidakar, 1975). The body weight is minimal in May and November soon after they spawn. Again the body weight increased during June and January as a result of utilisation of food from the surrounding waters. The changes in the body weight of the oyster of Pulicat Lake agrees with the views of Ansell and Trevallion (1967) reported for *Tellina tenuis* and of Ansell *et al.* (1980) for *Donax trunculus.*

Changes in the body component index have been observed in relation to the reproductive cycle and in terms of nutrient supply from the storage organ to the organ of demand during the period of gametogenesis. There was a reciprocal relationship between the gonad index and the digestive gland index and the gonad-index increases as the reproductive phase approaches, but declines after spawning. The digestive gland index was found to rise as a result of accumulation of energy rich nutrients during high feeding and declines very slowly with the onset of gametogenesis, following transfer of nutrients to the gonad. The same pattern of fluctuation in the gonad index during the reproductive season was observed by Giese *et al.* (1967) Giese and Araki (1962), Giese and Hart (1967) in *Katherina* ; Giese *et al.* (1967) in *Tivela stultorum* ; Sastry (1966, 1968, 1970) in *Argopecten irradians.*

There is a relationship between the salinity and the biochemical composition of the oyster either directly or indirectly associated with the changes in the physiological status of animals and with the nutritional condition as observed by Durve and Bal (1961), Saraswathy and Nair (1969) and Venkataraman and Chari (1951). The less saline condition reduced the gametogenic activity of *C. virginica* (Butler, 1949) because it indirectly affects availability of food and feeding intensity.

Lamellibranchs usually contain the greatest amount of water in their body. The reported water content in *Donax hanleyana* is 61.03% while in *Donax cuneatus* it is 70.26%, *Ostrea edulis* (78.7 to 87.36%), *C. virginica* and *C. gigas* (80.38 to 82.55%), *Mytilus edulis* (75.74 to 82.7%), *Pecten irradians* (80.32%), *Mya arenaria* (83.46%), *Venus mercenaria* (84.56%), *Cardium edule* (92%) and in *Martesia fragilis* (77%). In the oyster *C. madrasensis* of Pulicat Lake the range of water content was found to vary between 72.08 and 82.54%. Among the body components, mantle and gill maintained a slightly higher level of water content agreeing with the views of Giese (1966) and Mane and Nagabhushanam (1975). There is a reciprocal relationship between the water content of the body and the biochemical constituents in the body of the oyster. This agrees with the view of Durve and Bal (1961) in *C. gryphoides*, Galtsoff (1964) in *C. virginica*, Nagabhushanam and Mane (1975) in *Katelysia opima* and Nagabhushanam and Talikhedkar (1977) in *Donax cuneatus*.

The relationship between food and gonad development has been studied in detail for only a few species (Sastry, 1966, 1968, 1970, 1975 ; Sastry and Blake, 1971 ; Bayne, 1975). In certain bivalves, seasonal gonad development is linked with storage and utilisation of reserves accumulated during the period of high intensity of feeding especially in summer which are utilised for gametogenesis during the following autumn and winter (Comely, 1974). The data on the oyster *C. madrasensis* in Pulicat Lake agrees with the above findings in the accumulation of reserve materials in its hepatopancreas and mantle, when food is abundant in the environment and later they are used for gonad development.

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