GENERAL INTRODUCTION
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In the total world production of molluscs by harvest of wild stocks, clams/cockles rank next to squids and octopus, the world landings of clams being 925,622 tonnes in 1996 forming about 16% of total molluscan production (FAO, 1998). In terms of production through aquaculture source, clams occupy third place after mussels and oysters. The major clam producing countries are China (main land), India, Japan, Indonesia, Thailand, Bangladesh, Vietnam, USA, Korean Republic, Norway, Philippines, France, Chile and China (Thaiwan) (FAO, 1999). In India, clams support a sustenance fishery in the estuaries and backwaters of Kerala, Karnataka, Goa, Tamilnadu and Andhra Pradesh.

A general survey of the literature on clams and cockles of India reveals that the early works pertain mainly, as in the case of fishes and shellfishes, to faunistic investigations. Among these, the contributions of Nevill (1877), Melvill and Ambercrombie (1893), Melvill (1893), Smith (1904a, 1904b, 1906), Preston (1909, 1910, 1911, 1914, 1915, 1916), Annandale and Kemp (1916), Hornell (1917, 1922, 1949a, b, c, 1951), Gravely (1941), Satyamurti (1952), CMFRI (1969, 1974) are the most significant.
Information on the clam resources and on the biology of economically important clams is available from a number of contributions (Hornell, 1916; Rai, 1932, 1933; Rao, 1941; Rao, 1952, 1958, 1963; Rao, et al., 1962; Rao, 1967; Jones, 1968; Abraham, 1953; Nayar, 1955; Ranade, 1964; Deshmukh, 1972; Ansell et al., 1972; Alagarswami and Narasimham, 1973; Parulekar et al., 1973; Salih, 1973; Mane, 1974; Harkantra, 1975; Nair, 1975; Nagabhushanam and Talikhedhar, 1977; Nair et al., 1978; Mane and Nagabhushanam, 1979; Joseph and Madhyasta, 1982; Reddy, 1983; Sreenivasan, 1983; Chatterji et al., 1984; Thippeswamy and Joseph 1988; Thangavelu and Poovannan, 1994 and Joe and Narasimham, 1995). Certain symposia and National seminars conducted on molluscan/shellfish/ marine fisheries R & D (MBAI, CMFRI, 1987) also contain valuable information, on the resources, biology, population and farming of clams among other commercial species of molluscs. Most of the biological investigations carried out so far relate to age and rate of growth, maturation and spawning and the environmental changes influencing the growth and reproduction.

The importance of ecological studies on the distribution and survival of clams is well recognized. The noteworthy contributions on the ecology, density, distribution and abundance of clams of India are by Nayar (1955), Alagarswamy (1966), Durve and Dharmaraj (1969), Desai (1971), Philip
(1972), Ansell et al. (1972a), Ansell and Trevallion (1972b), Dwivedi et al. (1973), Parulekhar et al. (1973), Achuthankutty (1976), Ayyappan Nair et al. (1978), Mane and Nagabhushanam (1979), Ramachandra et al. (1981), Joseph and Santha (1988), Alongi (1990) and Joe and Narasimham (1995). These studies have indicated that the nature and type of substratum, wave action, temperature and salinity regimes of the area largely determine the distribution, abundance, migration and burrowing behavior of the clams.

Physiological responses of clams in relation to temperature, salinity, oxygen consumption, starvation and behaviour have been the subject matter of several studies. The most valuable among these works from India are those of Rao (1952), Ansell (1973), Ansell and Sivadas (1973), Ranade (1973), Mane (1975), Nair and Shynamma (1975b) and Mane and Talikedkar (1976). While Ansell and Sivadas (1973) and Mane and Talikedkar (1976) studied the effect of temperature on the metabolic rate of Donax vittatus, and respiratory rate of D. cuneatus respectively, the influence of salinity on the growth of Ketelysia opima at Madras was noted by Rao (1952); on Mertrix casta at Adyar backwater (Madras) by Abraham (1953); on D. cuneatus at Palk Bay by Nayar (1955) and on K. opima at Ratnagiri by Mane (1974b). The capacity of clams to tolerate fluctuations in salinity was reported by Prasad(1922) and Nair and Shynamma (1975b) on Villorita cyprinoides var.

Seasonal changes in the biological constituents and chemical changes during the reproductive and growth phases and in storage and utilisation of reserves, though not studied intensively and extensively, have been reported in certain species of edible clams. Thus Ansell (1972) observed that in D. vittatus, spawning which occurs in the early summer, results in a marked fall in the mean body weight. Nagabhushanam and Dhamme (1977) recorded relatively high water content in Paphia laterisulca during monsoon, suggesting loss of salts from the body and gain of water in low salinities. Similarly, Nagabhushanam and Talikhedkar (1977b) observed decline in glycogen content in September in the wedge clam, D. cuneatus and also during the maturation of gonad. Seasonal variations in energy, organic carbon
and lipid contents in *D. incarnatus* were described by Balasubramanian *et al.* (1979). Index of condition which measures the meat quality/physiological condition was studied in *Donax faba* (Alagarswamy, 1966) and in *Meretrix casta* (Durve and George, 1973). Mane (1974a) and Krishnakumari *et al.* (1977) reported the percentage edibility of *M. casta* and *K. opima* from Goa.

Clams are by far harvested from the wild till recently. Though they are cultured in several countries such as China, Thailand, Malaysia, Indonesia, Singapore, U.K. and Australia, the technology of culture is not as advanced as in the case with oysters and mussels. However, with the increasing demand for animal protein food, and since clams feed low in the food web and are efficient converters of primary production into nutritious food, and form cheap source food, their culture prospects has received greater attention in recent years. As a result of the researches carried out in India during the past three decades by several maritime Institutes, particularly the Central Marine Fisheries Research Institute, Kochi, a package of technology for the culture of blood clam, *A. granosa* and venerid clam, *P. malabarica* is now available. However, it is yet to be commercialised (Narasimham, 1980, 1991; Narasimham and Laxmilatha, 1996).
The above brief review of literature and those given under each of the chapters reveal that not much information is available on the ecological and biological aspects of clams of the Central Kerala coast. In consideration of the increasing importance of clams in rural economy, in the export trade, as an animal food and as an ideal eco-friendly candidate for culture and its prospects, the present study involving the ecological and biological aspects of *Donax incarnatus* (Gmelin) from the Malippuram beach, near Kochi was undertaken. The information/data collected would be useful for rational exploitation and management of this valuable resource.
MATERIAL AND METHODS

The details of material/data collected, methods followed for the analysis of samples, processing of data and the experiments conducted to determine the salinity tolerance and filtration rate in the present investigation are given in the concerned chapters. Briefly these were as follows.

Random samples of *D. incarnatus* were collected regularly once a fortnight from February 1990 to February 1991 from Malippuram beach using a wooden frame of 20 cm² fixed on the shore. The clam samples thus obtained were used for growth and age determination and for studies on reproductive activity.

Soil samples were collected from the intertidal areas during low, mid and high tides for texture analysis following the conventional sieving procedure.

Data on temperature, salinity and dissolved oxygen of the shore waters were collected for a period of 13 months from January 1990 to February 1991. The seawater samples were collected in a bucket and the temperature was noted immediately using a mercury thermometer. Dissolved oxygen and salinity of the seawater samples were estimated by Winkler’s and silver nitrate titration methods respectively.
Morphometric measurements of clam were taken using a Vernier caliper, and the weight measurement by an electric balance.

To determine the growth, the length data pooled monthwise and grouped at 2 mm class intervals, were analyzed for modal progress and ELEFAN I programme applied to fit von Bertalanffy growth equation.

Regression equation (y = a + bx) was employed for morphometric data.

Gonadal smear was examined under microscope to note the sex and maturity stage. Standard histological techniques were employed to study the gonadal maturation process and activity.

Biochemical analysis of tissues relating to protein, glycogen and lipid were performed following the method of Lowry et al. (1951), Kemp and Vankitz (1954) and Barnes and Blackstock (1973) respectively.

Selected, healthy clams of different size were used for salinity tolerance experiments and for determining the filtration rate. Standard procedures were followed in the conduct of these experiments.