Annual Reproductive Cycle of the Rock Oyster *Saccostrea cucullata* (von Born)

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Abstract

The annual reproductive cycle of the rock oyster, *Saccostrea cucullata* (von Born) inhabiting Someshwar coast, near Mangalore was investigated. The reproductive cycle commences with gametogenic activity during January – February, followed by gonadal development and maturation during March – May. Spawning is continuous from June to December, with two peaks, the first during late June to early September and the second during November to December. Gametogenesis was concomitant with higher salinity values (33.47 – 34.65‰) and full maturation was attained when the salinity was maximum (35‰). Spawning was observed when there was a drop in salinity (33.8‰).

Introduction

Two important edible oysters of Indian waters are the Indian backwater oyster, *Crassostrea madrasensis* (Preston) and the rock oyster, *Saccostrea cucullata* (von Born). Studies on the reproductive biology of *C. madrasensis* are extensive while data are scanty on *S. cucullata*. Awati and Rai (1931) and Nagabhushanam and Bidarkar (1977) described the reproductive cycle of this oyster. In the present study, gonadal histology was analysed to delineate the reproductive cycle of *S. cucullata*. The possible role of salinity on the reproductive biology of the oyster was also examined.

Material and Methods

Random samples (25 oysters each) were collected at fortnightly intervals during the period from April 1983 to April 1984 from the rocky shore at Someshwar, near Mangalore (lat. 74° 51'E; long, 12° 47'N). After ascertaining the sex of each individual from gonadal smears, gonads were fixed in alcoholic Bouin's solution, processed, wax embedded, sectioned at 7 μm and stained with Delafield's haematoxylin and alcoholic eosin. The classification scheme for gonadal histology provided by Joseph and Madhyastha (1982) was followed. The temporal distribution of developmental and regression stages of the gonad of each sex during the study period was analysed. Environmental parameters (water temperature, pH, salinity and dissolved oxygen) were recorded at the sampling site.

Results and Discussion

The temporal distribution of temperature, salinity, dissolved oxygen and pH is illustrated in Fig. 1. The surface water temperature varied from 24°C (October) to 32°C (May). The lowest and highest salinity values were during September (29.78‰) and May (35.56‰) which coincided respectively with peaks of monsoon and summer. The dissolved oxygen values ranged from 5.20 ml/l (October) to 7.65 ml/l (June). The pH of the ambient water ranged from 8.2 to 8.6.

The distribution of gonadal stages of maturity and the distribution of developing, maturing and spawning individuals of *S. cucullata* during the period of study are illustrated in Figs 2 and 3 respectively. Based on the histological details four gonadal development stages in female (FD_1, FD_2, FD_3 and FD_4), three gonadal development stages in male (MD_1, MD_2 and MD_3) and two gonadal regression stages each in male (MR_1 and MR_2) and female (FR_1 and FR_2) have been observed. In addition, an indeterminate stage (I) and a hermaphroditic stage (H) were also noticed in this ovster.

The annual reproductive cycle of the oyster progressed as follows. During April 1983, the oysters were in maturing stages. The maturation progressed further in May when 64-68% of oysters were fully-ripe. A few female oysters (8%) started spawning during early June. The percentage of gonads in regression stages in both sexes increased from late June onwards. There were two peaks of spawning: late June – early September (72-84% in spawning stages) and November – December (84-96% in spawning stages). Spawning in the population ended by late December. Fresh gametogenic activity commenced during January as indicated by the appearence of MD_1 and FD_1 stages. Gonadal growth proceeded through March – April. A smaller percentage of indeterminate oysters were observed during August (20%) and November (12%). Hermaphorodites appeared in small quantities (4 to 16%) sporadically during September – April.

The salinity values during the period of gametogenesis (January – February) varied between 33.47 and 34.65%. Full gonadal maturity in > 60% individuals was recorded during April – May when salinity values were between 35.00 and 35.56‰. Initial spawning coincided with a drop in salinity during early June (33.80‰).

The reproductive cycle of *S. cucullata* delineated by the present investigation can be summarised as follows: The gametogenic activity commences during January – February followed by gonad development and maturation during March – May. Spawning is continuous from June to December with two peaks during late June to early September and November to December. Though few oysters of indeterminate stage were observed, the oyster population does not pass on to an inactive phase. Hermaphrodites occurred in small quantities during the peak of the breeding season. Histological features of the hermaphroditic gonads such as collapsed and disintegrating nature of the follicles with ova, presence of only a very few oocytes, absence of primary and secondary oocytes within the collapsed follicles and infiltration of the follicular area by spermatids indicated that the change of sex in this oyster is from a functional female to a functional male.

Continuous reproduction throughout the year for a species may be expected in areas of little seasonal change such as in deep sea and parts of tropics (Giese and Pearse, 1974). Gametogenesis more than once during a breeding season in *C. madrasensis* (Rao, 1951; Joseph and Madhyastha, 1982) and once in *S. cucullata* (Nagabhushanam and Bidarkar, 1977) have been recorded in Indian waters. A similar seasonal gametogenic activity was observed in the present study. Staggered gametogenesis in *S. cucullata* inhabiting Karachi coast (Asif, 1980) may be related to the species' ability to show variations in reproductive responses in different geographical areas (Giese and Pearse, 1974). Spawning periodicities in *Saccostrea* spp inhabiting different regions have been recorded by many workers (Awati and Rai, 1931; Ansari and Ahmed, 1972; Dinamani, 1974; Fatuchri, 1976; Nagabhushanam and Bidarkar, 1977; Asif 1979a and 1980; Braley, 1982). Unlike in earlier reports from Indian waters (Awati and Rai, 1931; Nagabhushanam and Bidarkar, 1977) *S. cucullata* in the present study showed spawning during south-west monsoon and post monsoon (June – December). The influence on the reproductive cycle of bivalves by several exogenous and endogenous factors has been explained by Giese and Pearse (1974), Newell *et al.* (1982), Sastry (1982) and Mackie (1984). Generally, reproductive behaviour in tropical species is not directly correlated to temperature variations. Increase in salinity has been found to initiate gametogenesis in many Indian bivalves (Sastry, 1955; Alagarswami, 1966; Nagabhushanam and Talikhedkar, 1977; Nagabhushanam and Dhamne, 1977; Joseph and Madhyastha, 1982). Initiation of spawning with decline in salinity in the present instance is similar to such earlier reports on Indian bivalves (Panikkar and Aiyar, 1939; Rao, 1951, Kuriakose, 1973). However, as pointed out by Joseph and Madyastha (1982 and 1984) evidences are lacking to establish that salinity *per se* regulates gonad differentiation, gametogenesis and nature and degree of spawning in oysters inhabiting the Indian waters.

Hermaphroditic individuals occasionally appear in strictly gonochoristic species (Sastry, 1979). However, true functional hermaphroditism does not occur in oviparous oysters (Andrews, 1979). Occasional sex changes in various species of oviparous oysters inhabiting different regions have been reported (Amemia, 1925; Awati and Rai, 1931; Roughley, 1933; Burkenroad, 1937; Rao, 1953; Asif 1979b; Rogers and Cubas, 1981). Hermaphroditism and sex reversal have been reported in *S. cucullata* inhabiting Indian and Karachi coasts (Awati and Rai, 1931; Asif, 1979b). The direction of sex change from a functional female to functional male observed in the present study is similar to the report of Awati and Rai (1931). Lack of food due to parasitization of pea crab resulted in the change of sex in *O.* (=*S.*) *cucullata* (Awati and Rai, 1931). No such parasitization was noted in the present study. Purchon (1968) and Joseph and Madhyastha (1984) suggested that the transition from unisexuality to hermaphroditism or vice versa is possible depending on environmental stress.

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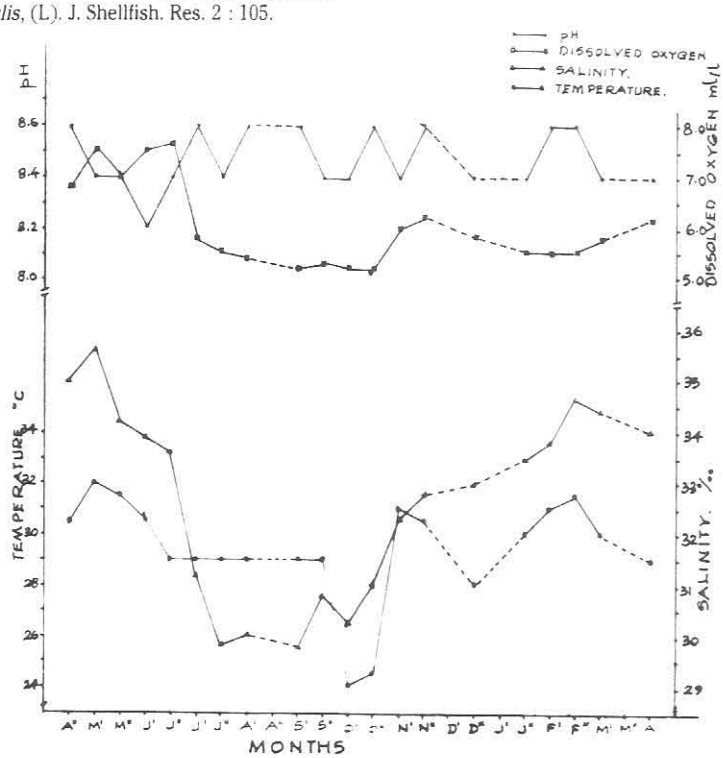

Fig. 1. Temporal distribution of water characteristics during the period of study.

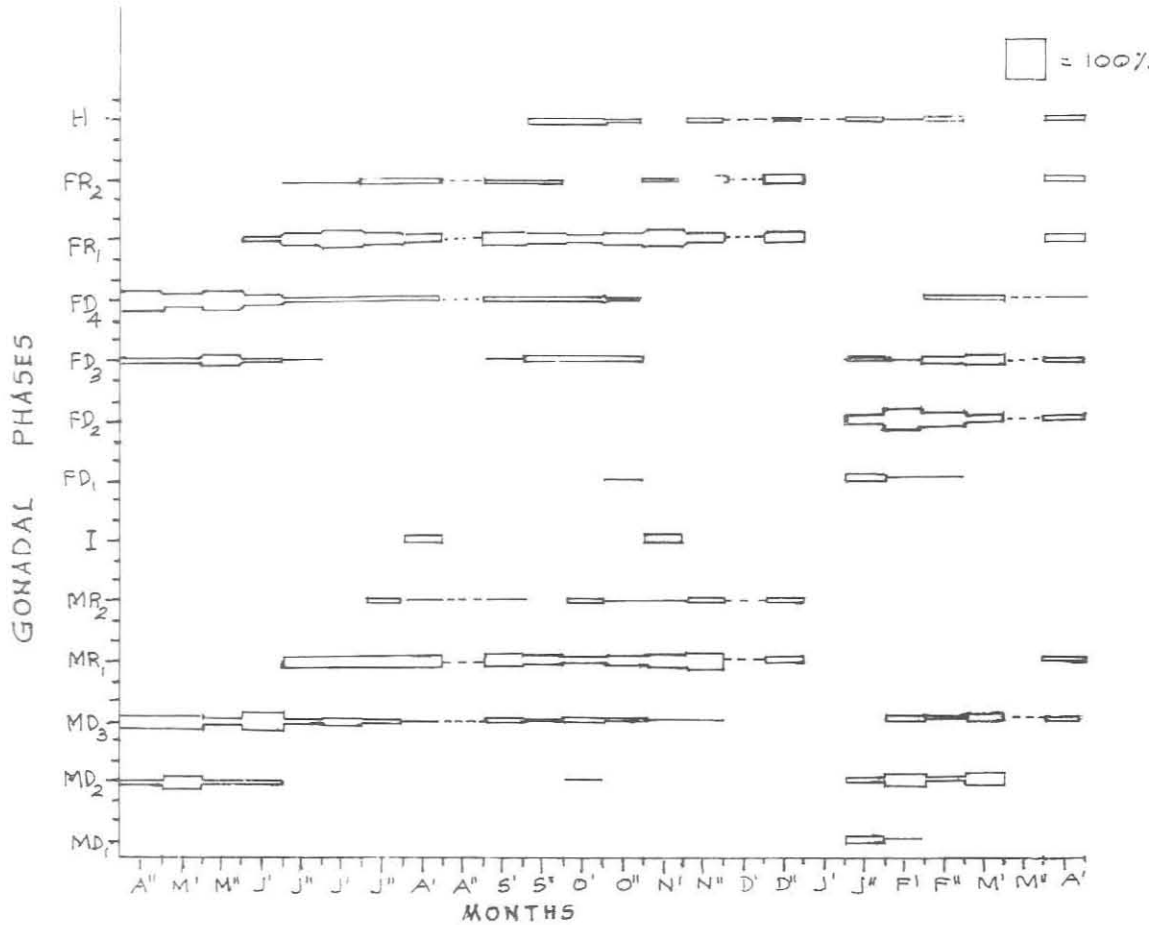

Fig. 2. Percentage distribution of gonadal stages of maturity of *S. cucullata* during the period of study.

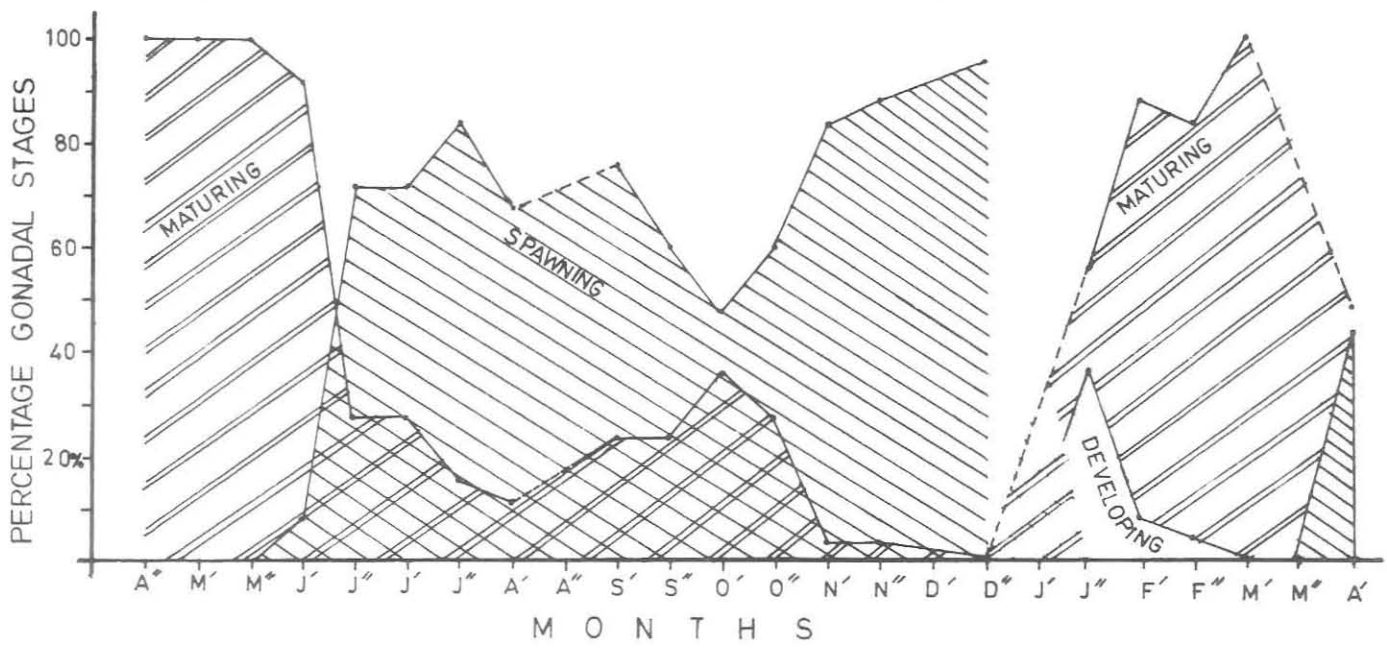

Fig. 3. Percentage distribution of developing, maturing and spawning stages of *S. cucullata* during the period of study.