

Larval Development of the Rock Oyster *Saccostrea cucullata* (von Born)

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Abstract

The development of artificially fertilised eggs of the rock oyster, *Saccostrea cucullata* (von Born) was studied in the laboratory. The morphological and behavioural characteristics of the developing larvae were observed. A mixed diet of single celled algae consisting of *Isochrysis galbana* and *Tetraselmis gracilis* was fed to the larvae. The larval developmental stages observed include trochophore, D-veliger, late veliger, umbone stage, pediveliger and plantigrade. The time taken for the development of D-veliger, umbone stage, pediveliger and plantigrade stages were 22 hours, 12 days, 18 days and 20 days after fertilisation respectively and their corresponding average length \times breadth were $67 \times 54 \mu\text{m}$, $109 \times 108 \mu\text{m}$, $143 \times 160 \mu\text{m}$ and $166 \times 174 \mu\text{m}$. The length-breadth relationship of veliger larvae was linear.

Introduction

Reliable techniques for laboratory rearing of bivalve larvae described by Loosanoff and Davis (1963) paved way for development of hatchery techniques for bivalve larvae in both temporal and tropical regions. Successful spat production of the Indian backwater oyster, *Crassostrea madrasensis* (Nayar *et al*, 1982) and the pearl oyster, *Pinctada fucata* (Alagaraswami *et al*, 1983) are important works from Indian waters. The present study was undertaken with a view to following the larval development of the rock oyster, *Saccostrea cucullata* (von Born) upto settlement stage in the laboratory.

Material and Methods

Mature oysters collected from the rocky shore at Someshwar near Mangalore (lat. $74^{\circ} 51'E$; long $12^{\circ} 47'N$)

were acclimatised in sea water of salinity 30‰ for two days. Equal quantities of sperm and egg suspensions in sterile seawater prepared by stripping were mixed. The fertilised eggs were washed free of attached sperms and distributed in three sterile glass trays containing sterile seawater for further development. The D-veligers were transferred to and reared in round bottom glass vessels (20 l capacity) with mild aeration. Dead larvae settled at the centre of the culture vessels were siphoned off and removed daily. Filtered and autoclaved seawater was used for embryonic and early larval development upto first week beyond which filtered, boiled and cooled sea water was used. Salinity was maintained at about 30‰ and seawater changed once in 24 hours during the first week and once in 48 hours subsequently. Trimethoprim (2 mg/l) and sulphamethoxazole (10 mg/l) were added during every change of water. A mixed diet of *Isochrysis galbana* and *Tetraselmis gracilis* was fed (at 37.5 to 50 ml/l of culture water) at a ratio (by vol.) of 2:1 during first four days and 1:1 thereafter.

Results and Discussion

Details of the early development are presented in Figs 1-3. The embryonic development of the fertilised eggs was observed soon after the extrusion of polar bodies. Rotating blastula (48 to $55 \mu\text{m}$) stage was reached in about 3 h, 40 min. Late trochophore (50 to $55 \mu\text{m}$) appeared by 15 h. The morphometry of developing larvae is given in Table 1. The straight hinge veliger (D-veliger) $67 \mu\text{m} \times 54 \mu\text{m}$ with transparent valves hinged dorsally was obtained at about 22 hours. The notched veligers appeared on the second day. Conspicuous changes in shape and structure were noticed during the late veliger stages from day 3 to day 11. The shell shape changed from 'D' to globular and the size of the velum increased as the growth proceeded. The 12 day old late veligers with slightly elevated umbo reached the umbone stage ($109 \mu\text{m} \times 108 \mu\text{m}$). Larvae with well developed umbo were obtained on days 15 and 16. The larvae developed to the Pediveliger stage through an eyed stage. Pediveligers ($143 \mu\text{m} \times 160 \mu\text{m}$) obtained on day 18 crawled around on foot. The digestive diverticulum, stomach and intestine were clearly visible. Plantigrade larvae of 20 days old ceased crawling, had velar retractor muscles degenerated and had calcium crystals over the shell and measured upto a maximum size of $220 \mu\text{m} \times 230 \mu\text{m}$. (average $160 \mu\text{m} \times 174 \mu\text{m}$). There was no settlement of larvae on the cultch materials provided. The relationship

between the length and breadth of veliger larvae was linear (Fig. 4).

Larval development of oviparous pelecypods follows the same pattern with trochophore as the first larval stage which develops into veliger which metamorphoses to acquire adult structure (Raven, 1964; Sastry, 1979). D-veligers have been reported in 48 hours after fertilisation in *S. cucullata* (Awati and Rai, 1931) and 20 hours in *C. madrasensis* (Nayar *et al.*, 1982) while in the present study it took 22 hours. The umbone stage was reached in 12 days, eyed stage in 17 days, pediveliger in 18 days and plantigrade in 20 days. In *C. madrasensis* (Nayar *et al.*, 1982) the corresponding periods were 7, 17, 18 and 19 days. The pediveligers of *S. cucullata* prior to the completion of pelagic life was about $153 \times 168 \mu\text{m}$ whereas the pediveligers of *C. madrasensis* measured $350 \times 310 \mu\text{m}$ (Nayar *et al.*, 1982). Variations in the size and in time course in larval development in different species of oysters have been observed by several workers (Loosanoff and Davis, 1963; Chanley and Dinamani, 1978; Walne, 1979; Alagarwami *et al.*, 1983). The variation in the growth rate of larvae under uniform conditions has also been discussed by Chanley (1955), Ansell (1962), and Loosanoff and Davis (1963). Complexity in the morphology and anatomy of the veliger larvae increases as development proceeds. Le penec (1980) presented the distinguishing characters of larval and post larval shell morphology of eighteen bivalve families. The importance of umbo characteristics in the systematics of closely related species of *Crassostrea* and *Ostrea* was stressed by Carriker and Palmer (1979) and Waller (1981). The time of metamorphosis is considered to be critical in the life history of bivalves when gross morphological changes such as disappearance of velum, formation of labial palps and the reorientation of organs in the mantle cavity take place (Bayne, 1976). Remarkable structural changes in the 20 days old plantigrade larvae in the present study indicate their pre-metamorphic stage.

Hadfield (1984) considers that some degree of substratum chemical specificity is necessary to induce settlement and metamorphosis in a number of molluscan species. The larvae are known to respond to various stimuli such as light, gravity, current velocity and contact with solid surfaces (Prytherch, 1934; Hopkins, 1935; Schaefer, 1937; Cole and Knight-Jones, 1939 and Korringa, 1941). Chemical basis and chemical specificity of gregarious settlement of oyster larvae of species such as *O. edulis* (Cole and Knight-Jones, 1939 and Bayne, 1969), *C. virginica* (Crisp, 1967) and *S. commercialis* (Nell and Holliday, 1986) are well known. Thus, the absence of one or a combination of factors might have resulted in the non-settlement of *S. cucullata* larvae in the present study.

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Table 1. Morphometry of developing larvae of *S. cucullata* Figures in parenthesis denote the ranges.

Days after fertilisation	Stages of Development	Mean length (μm)	Mean breadth (μm)
0.92	D-Veliger	67 (60-80)	54 (50-60)
2	Notched Veliger	70 (70)	60 (60)
3	Late Veliger	80 (80)	64 (60-70)
4	"	76 (70-80)	68 (60-70)
6	"	88 (80-90)	76 (70-80)
7	"	91 (90-95)	82 (80-85)
8	"	94 (90-100)	89 (83-93)
9	"	98 (90-100)	91 (85-95)
10	"	105 (100-110)	101 (95-110)
11	"	110 (100-120)	101 (95-110)
12	Umbone Stage	109 (105-110)	108 (100-110)
13	"	118 (110-130)	108 (100-120)
14	"	128 (120-130)	123 (120-130)
15	"	131 (120-145)	137 (120-160)
16	"	140 (130-150)	150 (130-165)
17	Eyed Stage	143 (130-150)	157 (140-180)
18	Pediveliger	143 (120-150)	160 (160)
19	"	153 (130-175)	168 (140-190)
20	Plantigrade	166 (150-220)	174 (150-230)
21	"	163 (150-200)	175 (160-200)
22	"	173 (165-180)	188 (170-200)

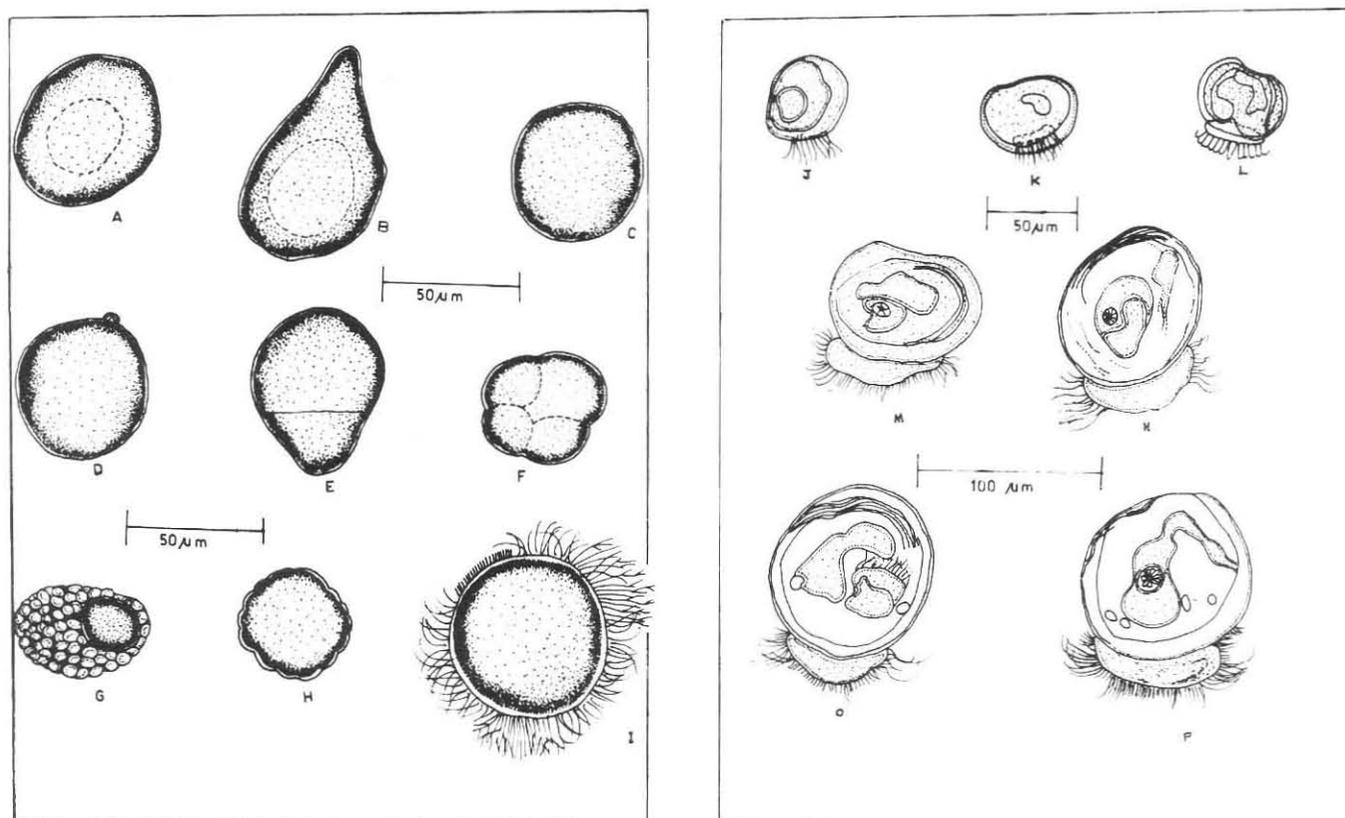


Fig. 1. Camera lucida drawings showing the embryonic and early larval development of *S. cucullata* A-B - Unfertilised eggs, C - Fertilised egg, D - Fertilised egg with polar body, E - Two celled stage, F - Four celled stage, G - Cap of micromeres over a large macromere, H - Blastula stage, I - Late Trochophore, J - D - veliger, 22 h old, K - Notched veliger, 2 days old, L - Three days old veliger, M - Four days old veliger, N - Seven days old veliger, O - Eight days old veliger, P - Nine days old veliger.

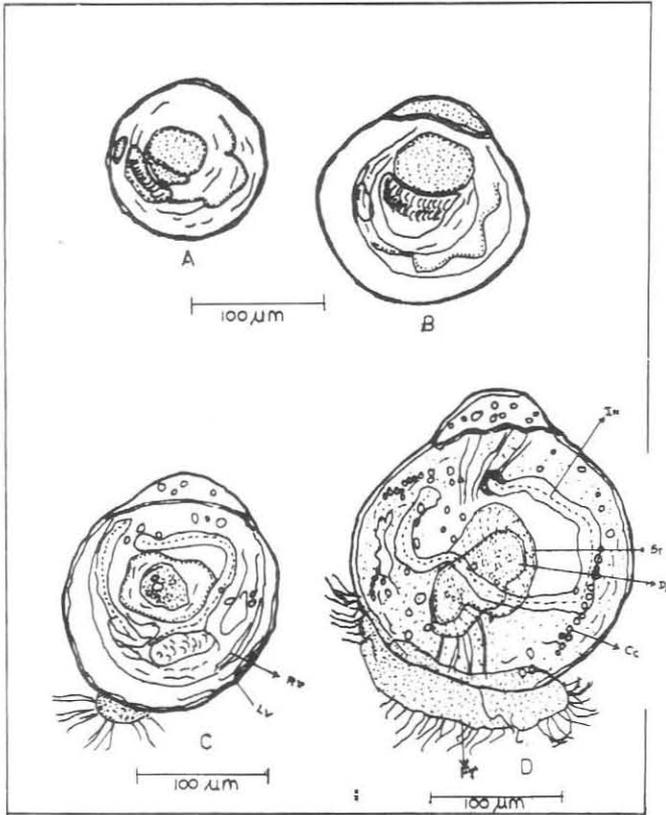


Fig. 2. Camera lucida drawings showing the larval development of *S. cucullata*. A - Twelve days old veliger, B - Sixteen days old veliger with well developed Umbo, C - Pediveliger, 19 days old, D - Plantigrade larva, 20 days old.

In: Intestine; St: Stomach; Di: Digestive diverticulum; Ft: Foot; CC: Calcium Crystals; RV = Right valve; LV = Left Valve.

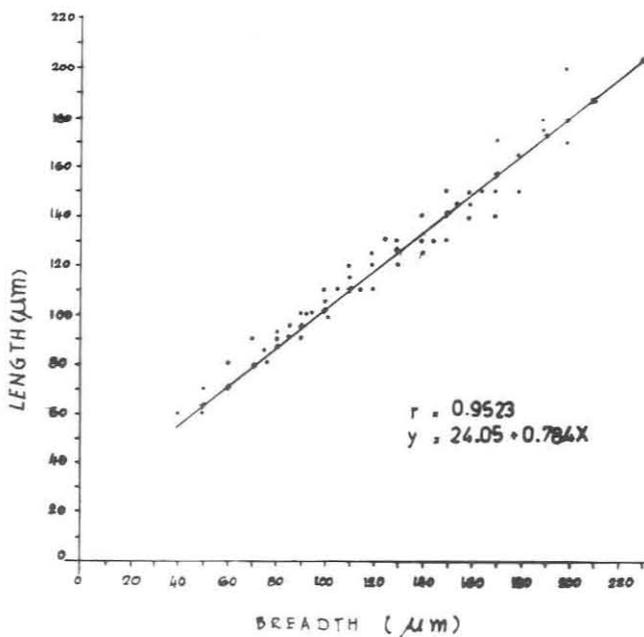


Fig. 4. The length - breadth relationship of veligers of *S. cucullata*.

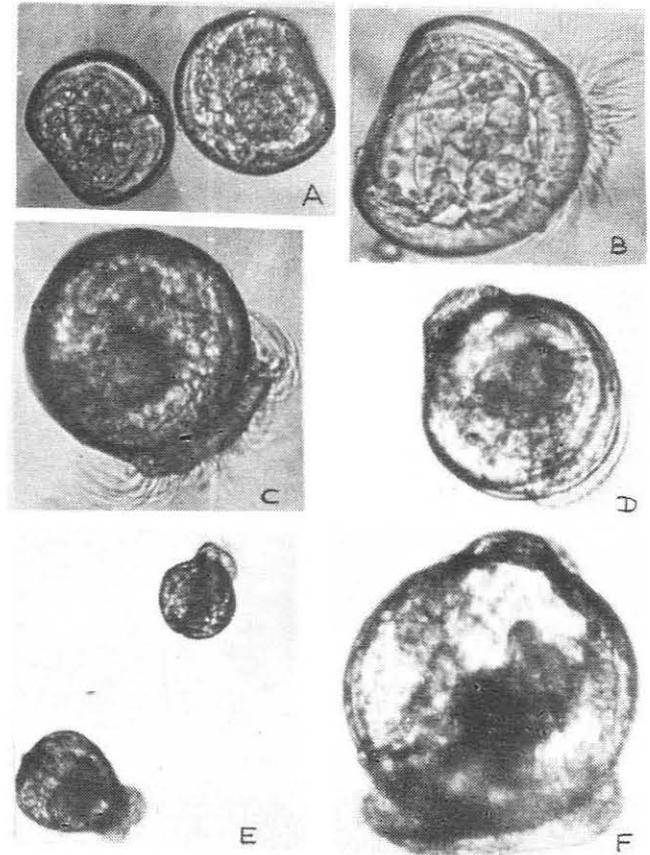


Fig. 3. Photomicrographs of veliger larvae of *S. cucullata*
 A - D - veliger, 22 h old ($\times 570$)
 B - Late veliger, 4 days old ($\times 1440$)
 C - Late veliger, 10 days old ($\times 1440$)
 D - Veliger with well developed umbo, 16 days old ($\times 570$)
 E - Free swimming Pediveliger, 18 days old ($\times 570$)
 F - Plantigrade larva, 20 days old ($\times 1440$).