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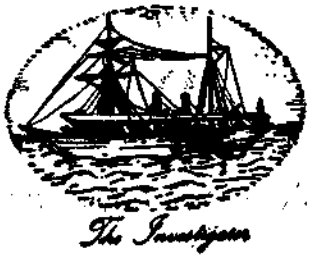

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PREDATION OF OYSTER *CRASSOSTREA MADRASENSIS* BY GASTROPOD *CYMATIUM CINGULATUM* (LAMARCK) IN THE OYSTER FARM AT TUTICORIN

R. THANGAVELU AND P. MUTHIAH

Central Marine Fisheries Research Institute, Cochin-682 018

ABSTRACT

One of the essential problems in perfecting the technology of oyster farming is to identify and eliminate the predators causing periodical mortality of oyster in the culture system and to suggest adequate control measures. At Tuticorin it has been observed that the gastropod belonging to the species *Cymatium cingulatum* causes considerable damage to the stock in the oyster farm especially when the oysters are 3 to 4 months old.

Observations on the feeding method and behaviour of the predator are given. Control measures for saving the farm stock are also discussed.

INTRODUCTION

IN AQUACULTURE practices all over the world, culturists are vary often confronted with large-scale mortality of the tended stock, because of predation. This results in economic loss to the farmer. Therefore, while perfecting the technology of growing it is absolutely essential to identify the agents causing such destruction, document them and develop suitable measures to control them effectively.

The known principal predators of oysters are flatworms, drills, starfishes, crabs, fishes and also few birds (Galtsoff, 1964). Since bottom culture of oysters as practised in America, Canada and France suffers from frequent attacks by predators in the farm, the off-bottom culture has the distinct advantage of eliminating predatory animals to a very great extent. Depending on the nature of predators and seasons of occurrence several control measures like periodical mopping and removal of predators, treatment of oyster farm area with chemicals and manual removal of predators have been developed for bottom culture. This point was kept in mind, while attempting experimental oyster culture in the tidal creek and shallow open sea coast at Tuticorin, adopting the rack and tray method. During the course of the experiments during 1977 to 1979 predation occurred only during the year 1978, while attempting large scale culture of oysters along coast. During July to November, large scale invasion of gastropods belonging to the triton group was noticed in the box-type cages where oyster seeds were initially reared. Several oyster seeds ranging from 25 to 85 mm were found dead, their flesh having been totally eaten away. Many live gastropods were found inside the cage suggesting that the mortality would have been caused by these gastropods. Detailed investigation was undertaken to study the cause, the nature and extent of predation. Effective means of combating the menace were also tried. This paper presents the results of the above observations.

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Farm Site

The nature of bottom in farm area is muddy sand with sparse growth of algae and weeds at the depth varying from 1.5 to 2.7 m. The farm is protected from wind and wave action by a sandy shore arm extending in the sea on the North-eastern region of the farm. The salinity in the area ranges from 31.7‰ to 35.6‰. The surface temperature varies from 25.4°C to 30.4°C. Moderately turbid conditions prevail during spring tides.

General Characters of *Cymatium cingulatum* (Lamarck)

All gastropods collected belonged to the species *Cymatium cingulatum* (Lamarck). (Tentative identification of this shell made earlier as *C. pileare* was incorrect).

Description

Commonly known as Poulson's triton, the shells (Plate I A) varied in size from 10 to 76 mm, light weight with 18 flattened spiral cords. In some, the spiral cord at the angular shoulder is knobbed. Former varices are rare ; aperture large ; columella smooth ; outerlip crenulate. The protoconch is persistent as a small smooth spiral structure. Colour yellowish to brown ; periostracum thin, hairy and flakes off when dried.

Mode of feeding

Feeding mechanism involved the muscular action of the foot and the tube shaped extensible proboscis which is an extension of the head region lying just above the foot. Fully extended proboscis is about 3/4th of the height of the shell and it can be pulled back and ensheathed. The radula is attached to the floor of the buccal cavity at the distal end of the proboscis which consists of a ribbon-shaped chitinous band covered with regular rows of many small, fairly hard teeth. The radula is of 'taeno glossate' type. In normal adult *C. cingulatum* ranging from 21.1 mm to 72.5 mm in shell length, the radula varies approximately 2.07 to 5.35 mm in length and from 247 μ to 599.9 μ in width. Regular dimensions vary widely among different individuals of the same shell height.

While feeding the gastropod climbs upon the oyster's upper shell or flat valve, manoeuvers into position with its broad foot and rests upon the posterior margin of the shell with its foot firmly pressed on the edge of the shell. The proboscis extremely pliant and flexible, is inserted in the gape between valves while the oyster starts filtering water. The radula and its associated musculature ensheathed in the buccal floor of the proboscis is extended forward and slowly rasps the mantle portion of the oyster. The acidic fluid which is secreted by the proboscis gland appears to help in paralysing the animal as a result the shell valves remain agape to enable the whole fleshy portion to be destroyed by the predator. This method of feeding is identical to that reported in *Busycon* (Carriker, 1951 ; Magalhaes, 1948) and *Murex fulvescens* (Wells, 1958).

Incidence of predation and mortality rate

Oyster spat settled on lime-coated tiles kept during April-May 1978 for spat collection were taken out and scraped during June. About 3 lakh spat of size 20 to 35 mm were kept in box-type cages and suspended from the racks for initial rearing. In August 1978, oysters above 50 mm size were sorted out and put in rectangular cages for further rearing. During this thinning operation, large number of dead oysters was detected inside the cages. Several live *Cymatium cingulatum* were also found crawling amongst dead shells. The season of

occurrence of this extended upto November 1978 and in all 206 numbers were collected and removed. A total of 39,450 dead oysters were counted. The total mortality was found to be 13% of which 8.91% was during September 1978 and 4.09% in October 1978.

Period and size of occurrence

From Table 1, it may be seen that a total of 206 gastropods were collected in majority of them occurring in September 1978 with a model size group of 55 to 60 mm. The incidence was considerably less in November 1978. Although the animal of size 17 mm in height was recorded during July, the incidence was high in August and September 1979 diminishing thereafter.

A search for simultaneous occurrence of this gastropod in the sea bed surrounding the farm area and the nearby Hare Island area was carried out both by diving and dredging but no live animal was noticed or collected. A single specimen was collected in the far off Tuticorin Harbour break water wall area indicating that they may be expected to occur in the hard rocky bottom area in deeper off-shore regions.

Rate of feeding and size of oysters preyed

Experiments were conducted by keeping 100, 90 and 75 oysters separately in three box-type cages along with two *Cymatium* of size 60 to 67 mm in each cage. Regular observations were made and after an interval of 15 days the number of oysters with empty shells removed were 60, 57 and 53 in cages I, II and III respectively (Table 2). The average rate of feeding was calculated as 1.88 oysters/conch/day. This rate of feeding is more when compared to *Thais* 0.5 oyster/month ; *Urosalpinx* 0.332 to 0.481 oyster/day (Cole, 1942, 1951) and *Murex fulvescens* 3.5 oysters/week (Wells, 1958). *Marula marginella* is known to feed at the rate of 3 spat oysters/12 hours (Thomson, 1968).

In order to find out the size of oysters attacked by *C. cingulatum* a sample of 156, among the dead oyster shells was removed from the cages and measured. The dead shells ranged from 25 to 85 mm. The modal size of oysters killed was 53.3 mm. Nearly 75% of mortality was caused in the size group of 40-65 mm (Table 3).

TABLE 2. *Oysters kept in* 3 *cages with* 2 C. cingulatum *in each at the start of the observation and their fate at the end of* 18 *days*

Cage No.	Oysters quantity	Number of oysters preyed at the end	Rate of feeding
1 ..	100	60	2 oysters/conch/day
2 ..	90	57	1.9 ,,
3 ..	75	53	1.76 ,,
Average rate of feeding			1.88 ,,

TABLE 3. *Showing details of size of oysters killed by* C. cingulatum

Size of oysters	Frequency	Percentage
25-30 ..	2	1.28
30-35 ..	7	4.49
35-40 ..	12	7.69
40-45 ..	21	13.46
45-50 ..	20	12.82
50-55 ..	32	20.52
55-60 ..	26	16.67
60-65 ..	17	10.90
65-70 ..	12	7.69
70-75 ..	4	2.56
75-80 ..	1	2.64
80-85 ..	2	1.28

Preventive measures

Loosanoff *et al.* (1960 a, b) reported that chlorinated benzene is toxic to drills. Mackenzie (1970) standardized the polystream (a mixture of polychlorinated benzenes) treatment at the rate of 9.5 kl/ha. Loosanoff (1957) indi-

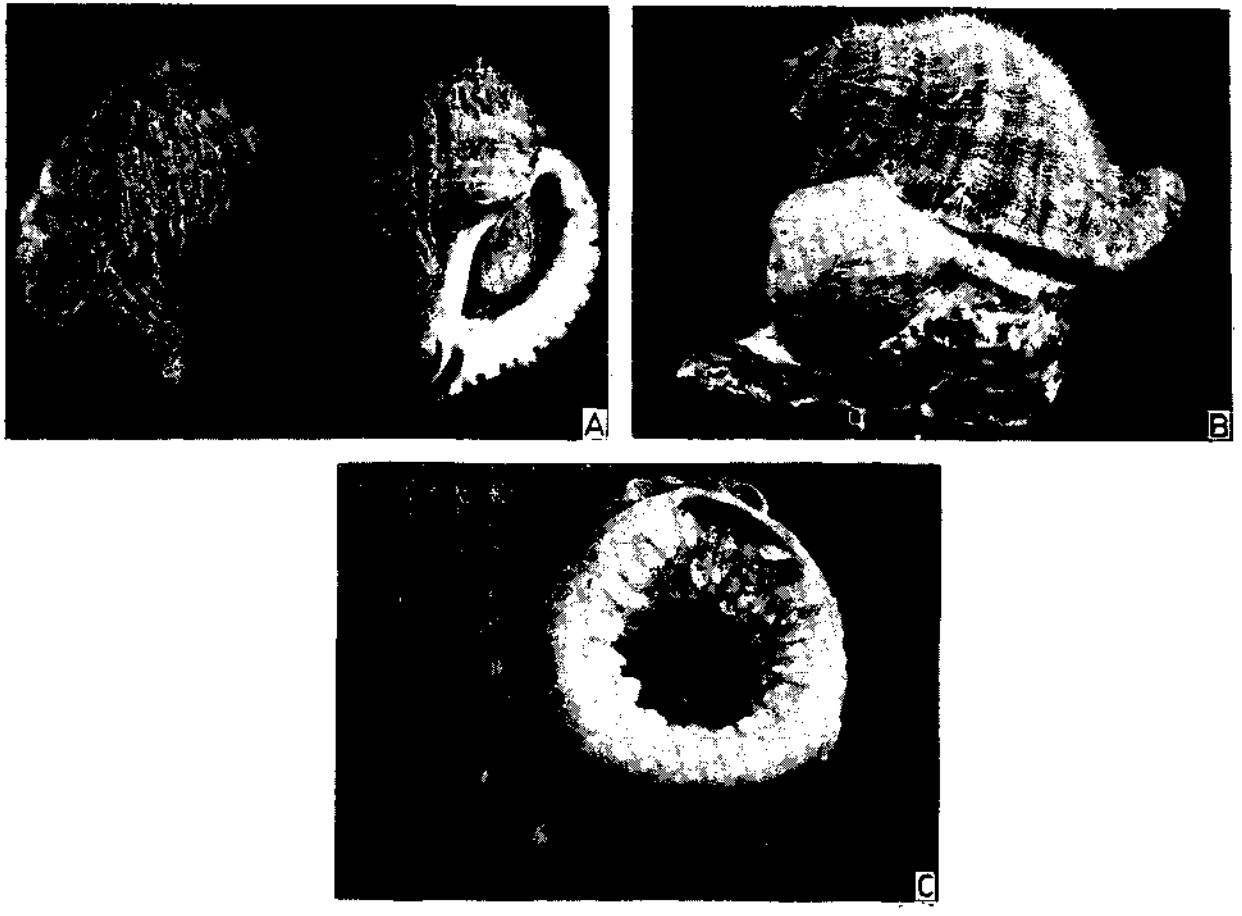

PLATE I A. Dorsal and ventral view of *Cymatium cingulatum*. B. Egg case and gastropod on the shell of oyster and C. Gelatinous egg capsule of gastropod.

TABLE 1. *Size distribution of* C. cingulatum *collected during* 1978 *and* 1979

	1978							1979						
Size group	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
10-15	—	—	—	—	—	—	—	—	2	—	—	—	—	2
15-20	—	—	1	1	—	—	2	1	9	—	—	—	—	10
20-25	—	—	—	—	—	—	—	—	8	7	1	2	—	18
25-30	—	—	1	—	—	—	1	—	9	11	1	2	—	23
30-35	—	—	4	—	—	—	4	—	10	12	1	1	—	24
35-40	—	—	3	—	1	—	4	—	15	8	1	2	—	26
40-45	—	—	6	4	—	—	10	—	7	12	2	1	—	22
45-50	—	—	9	—	2	—	11	—	5	12	6	—	—	23
50-55	—	—	21	8	—	—	29	—	4	14	2	1	—	21
55-60	—	—	26	14	2	—	42	—	—	5	2	—	—	7
60-65	—	—	24	20	6	—	50	—	1	4	1	2	—	8
65-70	—	—	13	22	2	—	37	—	—	—	—	1	—	1
70-75	—	—	7	6	2	—	15	—	—	—	2	—	—	2
75-80	—	—	1	—	—	—	1	—	—	—	—	—	—	—
Total	—	—	116	75	15	—	206	1	70	85	19	12	—	187

cated that a saturated salt solution may be helpful, in controlling drill population, by killing their eggs and embryos, while still in egg cases. Hand picking, though laborious appeared to be more efficient especially when carried through before egg laying begins. Treatment method by employing chemical does not appear to be practical in an extensive farm area also.

Fecundity and development of Cymatium cingulatum

Sexes are separate. Eight individuals of size above 62 mm in shell length, with egg cases were collected during September 1978. Each egg case with the follicles was found attached to dead oyster shell (Plate I B). The average height of the egg case was 24.9 mm with a diameter of 47.2 mm. Each egg case (Plate I C) contained 271 follicles covered by a gelatinous sheath of light brown colour. The follicles were arranged in rosette and with the average length and width of the follicle was 10.8 mm and 2.9 mm respectively. Each follicle contained, on an average 1278 eggs.

With a view to make some observations on the development of the egg capsules, one of them was removed and kept in an aquarium tank containing filtered sea water taken from the same locality. Soon after they were brought to the aquarium tank a few follicles were cut open carefully, eggs were removed and examined. It was observed that cleavage had already taken place. After one hour, formation of vertical cleavage was observed. Micromeres and macromeres appeared after four hours and gastrulation occurred at the end of 24 hours. Hatching of early veliger stage took place at the end of 44 hours with rudiments of the velar lobes and foot (Fig. 1 a to e). Similar pattern of development was noticed for *Thais haemastoma* by Burkenroad (1931).

Fully developed veliger was found after 72 hours with an egg shaped shell. At this stage liver lobes and velum with distinct cilia were well developed, whereas sub-velum was poorly developed. Foot was found ventral to the velar lobes, beneath which operculum was noticed. At this stage mouth, oesophagus, stomach, intestine and anus could be recognised (Fig. 1 f to h). At the end of the 4th day of hatching, the larvae were found to settle at the bottom and the velum was found very much reduced. Further developmental studies were not possible. The early development of this gastropod is similar to that of the nudibranch *Cuthona adayarensis* described by Rao (1961).

Discussion

Of the principal predators of oysters, flatworms *Stylochus* and *Pseudostylochus* commonly known as ' oyster leeches ' inflict serious damage to oyster population. *Pseudostylochus ostreophagus* was reported to cause mortality from 6 to 42% among the imported Japanese seed oysters (Hyman, 1955). Lunz (1947) reported that blue crabs *Callinectes spadius* destroyed more than 80% of the young oysters by cracking their shells at Wadmalaw Island, United States. The mud and ghost shrimps cause serious harm to the ground by making it too soft. *Cliona celata* and *Polydora ciliata* which bore the oyster shell are quite serious pests. The predation of starfishes *Asterias forbesi*, *Piaster* sp. *Evasterias* sp. and *Pycnopodia* sp. on oysters is considerable (Galtsoff and Loosanoff, 1939). Large rays *Trygon pastinaea* and *Myliobates aquila* are known for their predation on oysters. In Stephen's Bay, it was reported that porcupinefish *Dictylichthys mysersi* and bream *Sphaeriodes* are the predatory fishes (Korringa, 1976). Incidence of predation by the above enemies was not noticed in the oyster farm at Tuticorin.

Prosobranchiate gastropods appear to be the principal enemies of oysters. General information about oyster drill *Urosalpinx cinerea* has

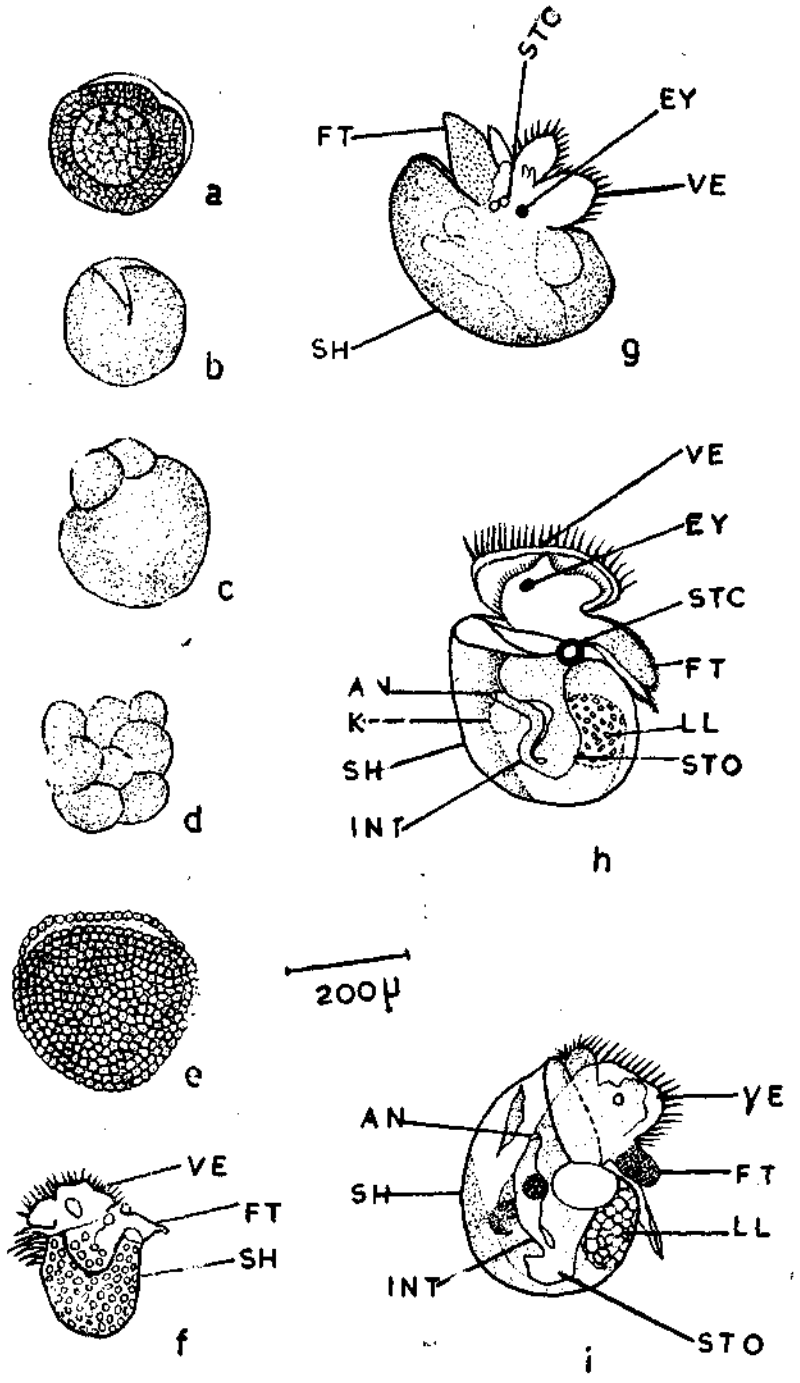

FIG. 1. Developmental stages of *Cymatium cingulatum* (Lamarck) : a. Fertilised egg ; b. Two-cell stage ; c. Four cell stage ; d. Eight cell stage ; e. Gastrula with blasto pore ; f & g. Early veliger ; h. Fully formed veliger and i. Larva at the time of creeping (Sh.—Shell ; Stc—Statocyst ; Ey—eye ; Ve—velum ; Ft.—Foot ; Il.—Liver lobe ; Sto—Stomach ; An—Anus ; Int—intestine ; K—excretory organ).

been given by Carriker (1955) for North American populations and by Hancock (1959) for those of the channel coast of England. *Thais haemastoma* in South Atlantic and Gulf States ; *Ocenebra japonica, Rapana thomasiana* and *Thais fumulosa elavigera* in Japanese waters are the common predators. The common whelk *Buccinium undatum* and dogwhelk *Nucella lapillus* are also known to attack oysters occasionally (Korringa, 1952, 1976).

Apart from the instances of boring on oysters by *Thais rudolphi* near the mouth of Athankarai Estuary (CMFRI, 1974) no major predation of oysters by the prosobranchiates has been so far reported in India. Thus predatory mortality of oysters caused by *C. cingulatum* has been reported for the first time in east coast of India.

In the present studies the percentage of mortality caused by *C. cingulatum* appeared to be less when compared to 30% death caused by drills in Atlantic Coast (Adams, 1947), 75% in Essex oyster beds (Cole, 1962) and 15.6 to 22.6% by Galtsoff (1964). It is however to be admitted that the entire studies now were confined to laboratory conditions and need more confirmation.

REFERENCES

ADAMS, J. R. 1947. The oyster drill in Canada. *Prog. Rep. Atl. Biol. Sta.*, **37** : 14-17.

BURKENROAD, M. D. 1931. Notes on the Lousiana conch *Thais haemastoma* Linn. in its relation to the oyster *Ostrea virginica*. *Ecol.*, **12** (4) : 656-664.

CARRIKER, M. R. 1951. Observations on the penetration of tightly closing bivalves by *Busycon* and other predators. *Ibid.*, **32** : 73-83.

——— 1955. Critical review of biology and control of oyster drills *Urosalpinx* and *Eupleura*. *U.S. Fish. Wildl. Serv., Spec. Sci. Rep. Fish.*, **148** : 150 pp.

C.M.F.R.I. 1974. The commercial molluscs of India. *Bull. Cent. mar. fish. Res. Inst.*, **25** : 23-24.

COLE, H. A. 1942. The American whelk tingle *Urosalpinx cinerea* (Say) on British beds. *J. Mar. biol. Ass. U.K.*, **25** : 477-508.

——— 1951. The British Oyster Industry and its problems. *Rep. Cann. Explor. Mes.*, **128** : 7-17.

GALTSOFF, P. S. AND V. L. LOOSANOFF 1939, Natural history and method of controlling the starfish (*Asterias forbesi* Desor). *Bull. U.S. Bur. Fish.*, **49** : 75-132.

——— 1964. The American oyster *Crassostrea virginica* Gmelin. *Fish. Bull.*, **64** : 430-441.

HANCOCK, D. A. 1959. The biology and control of the American whelk tingle *Urosalpinx cinerea* (Say) on English oyster beds. *Fishery Invest.* (London). *Ser.* **2, 22, 10** : 1-66.

HYMAN, LIBBIE H. 1955. The polyclad flatworms of the Pacific Coast of North America ; additions and corrections. *American Mus. Nov.*, 1704 : 11 pp.

KORRINGA, P. 1952. Recent advances on oyster biology. *Qub. Rev. Biol.*, **27** : 347-351.

——— 1976. Farming the cupped oysters Genus *Crassostrea*. *Developments in Aquaculture Fisheries Science*, **2**, Ijmuiden, Netherlands.

LOOSANOFF, V. L. 1957. New method for control of several oyster enemies and competitors. *Bull. Milford. Biol. Lab., U.S. Fish. Wildl. Serv.*, **21** (5) : 1-6.

———, MACKENZIE AND L. W. SHEARER 1960 a. Use of chemicals to control shell fish predators. *Science* (Washington), **131**: 1522-1523.

———, ——— AND ——— 1960 b. Use of chemical barriers to protect shell fish beds from predators. *Fish. Wash. State. Dept. Fish.*, **3**: 86-90.

LUNZ, G. R. 1947. *Callinectes* versus *Ostrea*. *J. Elisha Mitshell Sci. Soc.*, pp. 63-81.

MACKENZIE, C. L. 1970. Control of oyster drills *Eupleura caudata* and *Urosalpinx cinerea* with the chemical polystream. *Fish. Bull.*, **68**(2) : 285-297.

MAGALHAES, R. 1948. An ecological study of the genus *Busycon* at Beaufort, North Carplina. *Ecol., Monograph*, **18** : 379-409.

RAO, K. V. 1961. Development and life history of a nudibranchiate gastropod *Cuthona adayarensis* Rao. *J. mar. biol. Ass. India.*, **3** (1 & 2) : 186-197.

THOMSON, J. M. 1968. *Marula marginella* - A pest in Australian oyster beds. *Proc. Symp. Mollusca., MBAI*, **3** : 814-817.

WELLS, H. W. 1958. Feeding habits of *Murex fulvescens*. *Ecol.*, **39** : 556-558.