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PROCEEDINGS OF A WORKSHOP HELD IN

BOUAKE, CÔTE D'IVOIRE,

14–17 NOVEMBER 1988

RECHERCHES SUR LES SYSTÈMES AQUACOLES EN AFRIQUE

COMPTE RENDU D'UN ATELIER TENU À

BOUAKÉ, CÔTE D'IVOIRE,

DU 14 AU 17 NOVEMBRE 1988

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Aquaculture systems research in Africa

Proceedings of a workshop held in Bouake, Côte d'Ivoire, 14–17 November 1988

Recherches sur les systèmes aquacoles en Afrique

Compte rendu d'un atelier tenu à Bouaké, Côte d'Ivoire, du 14 au 17 novembre 1988

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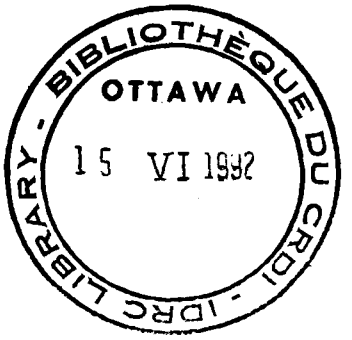

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CULTURE OF THE WEST AFRICAN MANGROVE OYSTER (CRASSOSTREA TULIPA) IN THE GAMBIA

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Abstract *The existing oyster fishery in The Gambia is characterized by low productivity and is highly labour intensive. Research is being carried out in an attempt to understand the production biology of oysters and to develop low-impact culture techniques applicable in estuarine areas. Spats were collected at two sites using old oyster shells or asbestos plates strung on nylon ropes as collectors. Salinity, temperature, growth, and mortality data were recorded. It was observed that salinity and temperature were within the optimum range as suggested by other workers, that the mean size of the animals between the two sites was not significantly different, and that mortality tended to decrease as the animals became more established on the cultches.*

Résumé *En Gambie, l'ostréiculture se caractérise par une faible productivité et une intensité de main-d'oeuvre. Des recherches sont actuellement en cours afin d'étudier la biologie de la reproduction des huîtres et de développer des techniques de production dans les régions estuariennes. À l'aide de coquilles d'huîtres ou de plaques d'amiante, attachées à des cordes de nylon, on a procédé à la collecte de naissains. Des données sur la salinité, la température, la croissance et la mortalité ont été recueillies. On a constaté que la salinité et la température se situaient dans l'intervalle optimal, selon l'avis d'autres travailleurs, que la grosseur moyenne des huîtres entre les deux endroits n'était pas significativement différente et que le taux de mortalité diminuait lorsque les huîtres étaient bien établies dans les collecteurs.*

Introduction

An existing oyster fishery is in place in The Gambia, but it is characterized by low productivity and is highly labour intensive. The fisherfolk consist mainly of elderly women who either wade in knee-deep muddy waters or use dugout canoes to rack the oysters attached to mangrove roots and branches. Nearby stocks are soon depleted and harvesters have to move farther into the swamps to tap virgin populations.

This indiscriminate method of collection does not allow small individuals much time to grow big enough for market and it reduces available setting space (mangrove roots and branches) for subsequent spats. These factors, combined with the arduous nature of collection, resulted, in part, in the development of this research project. Among others, the objectives included

(1) Describing the production biology of oysters in The Gambia by determining peak spatfalls throughout the year, the sequence of spatting and types of fouling, the preferred depth of setting of spats and other fouling organisms, the growth potential, and monthly growth and mortality rates.

(2) Developing low-input culture techniques applicable in estuarine areas (racks constructed from mangrove poles).

This paper presents the results of trials conducted at a major oyster base, about 50 km west of Banjul, from June 1987 to June 1988.

Methodology

Spatfall monitoring

Spats were collected from three points at site A, about 200 m from the shore:

- along the intertidal mangrove shoreline, directly within natural oyster populations
- from an intertidal rack, constructed about 50 m from the mangrove edge
- from a subtidal rack, about 300 m from the intertidal rack, outward toward the mouth of the estuary

At site B, about 500 m north of site A, two sampling points were established:

- an intertidal rack along the mangrove edge
- a subtidal rack about 150 m upstream from the intertidal rack

At both sites, the same types of collectors were exposed, consisting of old oyster shells strung on 4 mm nylon ropes at 10 cm intervals, and asbestos plates (approximately 10 cm x 8 cm) also spaced at 10 cm intervals. A maximum length of 120 cm was maintained with the intertidal systems to afford complete exposure at maximum low tide. For the subtidal racks, a maximum of 200 cm was used to cover the entire water column, with the last shell/plate (of both systems) about 15-20 cm off the bottom.

The racks were constructed from mangrove poles that line the estuary. The poles were driven into the mud to form a rectangle measuring about 4 m x 5 m, and cross beams were tied to the upright poles to create a grid. From the cross beams, the cultches were hung in the water column to provide a place for spats to settle.

Data were collected on a fortnightly basis and on a weekly basis. The fortnightly exposures were continued from the previous year to facilitate identification because a microscope was not available when fieldwork started. When the microscope arrived in June 1987, cultches were exposed for both 1 week and 2 weeks. Both sets were exposed at the same time, but one set was retrieved after a week, whereas the other set was retrieved after a fortnight. For each sampling station (five stations), the cultches comprised two plate strings and two shell strings per week and per fortnight. Thus, a total of 20 strings were retrieved and exposed per week, and in the second week, a total of 40 strings (20 for a week and 20 for a fortnight) were exposed and retrieved.

The 1 week cultches were examined under the microscope, and a field glass was used to count the 2 week cultches. Spats and any other animal seen were recorded per plate/shell, per depth, per sampling station, etc.

Growth and mortality studies

Fresh, unseparated shell cultches were exposed on 12 December 1986, for a month, to collect spats to grow at site A. The plates were strung at 10 cm intervals, however. On 11 January 1987, the shells were separated, oysters selected (aiming at a maximum of 10 per shell/plate), and spaced at 10 cm intervals. Each animal was measured once every month to note the increase in growth and/or to note mortality. To follow each animal's monthly growth rate, each string was labeled and each plate/shell on the string was numbered, beginning from the topmost. Orienting the plate/shell, the position of each animal was correspondingly mapped on a piece of paper and labeled A, B, C, or D, as the case may be. Each plate/shell on the string was treated in the same manner, until a paper representation of the entire string was constructed for a given site. Thus, the same animal could be measured in subsequent months, and if it was later found to be dead, this would be noted in the space provided on the sheet of paper, the date of death being recorded as the date of the measurement.

Another set of fresh cultches was restrung for grow-out on 20 December 1987, after a month's exposure in November. This set was hung at the intertidal rack at site B following the same method applied to those at site A. The growing period lasted 6 months, January-June 1987 and December 1987 - May 1988, at sites A and B respectively.

On 3 July 1987, another set of cultches was exposed for growth studies; measurements began on 8 August. This set was

abandoned in September because of excessive setting.

After a 6 month growing period, an average monthly growth rate was computed, mortality per month was recorded, etc. (Tables 1-4).

Oceanography

Salinity and temperature readings were obtained each time cultches were retrieved and exposed. Salinity data were obtained using a salinity refractometer purchased from Bio Marine-Aquafauna.

Results

Spatfall monitoring

In spite of several months of missing data, it was determined that the period July-October clearly recorded the greatest number of spats, thus indicating the peak period. Along the mangrove edge at site A, the weekly mean spat count per shell ranged from a minimum of 0.1 in January-February to a maximum of 88.7 in September-October (Fig. 1). During the same period, plates collected a weekly mean range of 0.05-94.6 spats. Of particular significance were the months of August to about the end of September when, over 2 weeks, a total of 2233 spats were recorded, and during 3 weeks of exposure to the end of September, a total of 2826 spats were enumerated.

Barnacles did not seem to pose any problems in terms of fouling collectors. They formed only 4% of the total animal count during the peak period identified.

At the intertidal rack, the weekly mean spat count per shell ranged from 0.05 in February-March to 151.2 in August (Fig. 2). Unlike the mangrove edge, there appeared to be only one significant peak, in July-August, but relatively smaller peaks did occur that corresponded with those peak periods identified along the mangrove edge. This would tend to further strengthen the assumption that the peaks occur simultaneously. Barnacles were not significant. As along the mangrove edge, they formed only 5.1% of the total animals counted.

Figure 3 illustrates settlement at the subtidal rack. This exhibited the highest weekly mean settlement (212.7 spats per shell and 196 spats per plate), recorded in August. As expected, the subtidal cultches were more heavily silted and fouled by hydroids and sea squirts. This did not seem to affect their performance, however, in terms of spat attraction.

Figure 4 illustrates the results observed with the intertidal system at site B. During the peak period (July-October), shells collected a maximum weekly mean of 49.6 spats and plates had 90.0

Table 1. Monthly mean growth and mortality rates on asbestos plates (site A – subtidal rack).

Month	No. of oysters	Growth			Mortality	
		Total growth (cm)	Mean size/ month (cm)	Mean growth increase (cm)	Mortality/ month	%
January	137	115.4	0.8	–	–	–
February	91	158.5	1.7	0.9	46	33.5
March	83	201.3	2.4	0.7	8	8.6
April	41	118.5	2.9	0.5	42*	50.6
May	38	133.4	3.5	0.6	3	7.3
June	34	120.9	3.6	0.1	4	10.5

Total mortality = 103 (75.2%)
Total survival = 34 (24.8%)

*String No. 2 was lost when the rack collapsed on 1 April 1987, but of the remaining strings recorded, mortality amounted to eight oysters.

Table 2. Monthly mean growth and mortality rates on old oyster shells (site A – subtidal rack).

Month	No. of oysters	Growth			Mortality	
		Total growth (cm)	Mean size/ month (cm)	Mean growth increase (cm)	Mortality/ month	%
January	219	226.5	1.0	–	–	–
February	195	401.3	2.1	1.1	24	10.9
March	146	445.8	3.1	1.1	49	25.1
April	126	402.0	3.2	0.1	20	13.7
May	102	361.8	3.5	0.3	24	19.0
June	68	254.9	3.7	0.2	34	33.3

Total mortality = 151 (68.9%)
Total survival = 68 (31.1%)

Table 3. Monthly mean growth and mortality rates on old oyster shells (site A – intertidal rack).

Month	No. of oysters	Growth			Mortality	
		Total growth (cm)	Mean size/ month (cm)	Mean growth increase (cm)	Mortality/ month	%
January	277	280.4	1.0	–	–	–
February	242	467.6	1.9	0.9	35	12.6
March	201	522.9	2.6	0.7	41	16.9
April	160	504.5	3.2	0.5	41	20.4
May	140	503.6	3.6	0.4	20	12.5
June	125	473.5	3.8	0.2	15	10.7

Total mortality = 152 (54.9%)
Total survival = 125 (45.1%)

Table 4. Monthly mean growth and mortality rates on asbestos plates (site B – intertidal rack).

Month	No. of oysters	Growth			Mortality	
		Total growth (cm)	Mean size/ month (cm)	Mean growth increase (cm)	Mortality/ month	%
January	236	159.9	0.7	–	–	–
February	183	271.8	1.5	0.8	53	22.5
March	156	381.7	2.4	0.9	27	14.8
April	150	465.7	3.1	0.7	6	3.8
May	143	529.0	3.7	0.6	7	4.7
June	141	574.1	4.1	0.4	2	1.4

Total mortality = 95 (40.3%)
Total survival = 141 (59.7%)

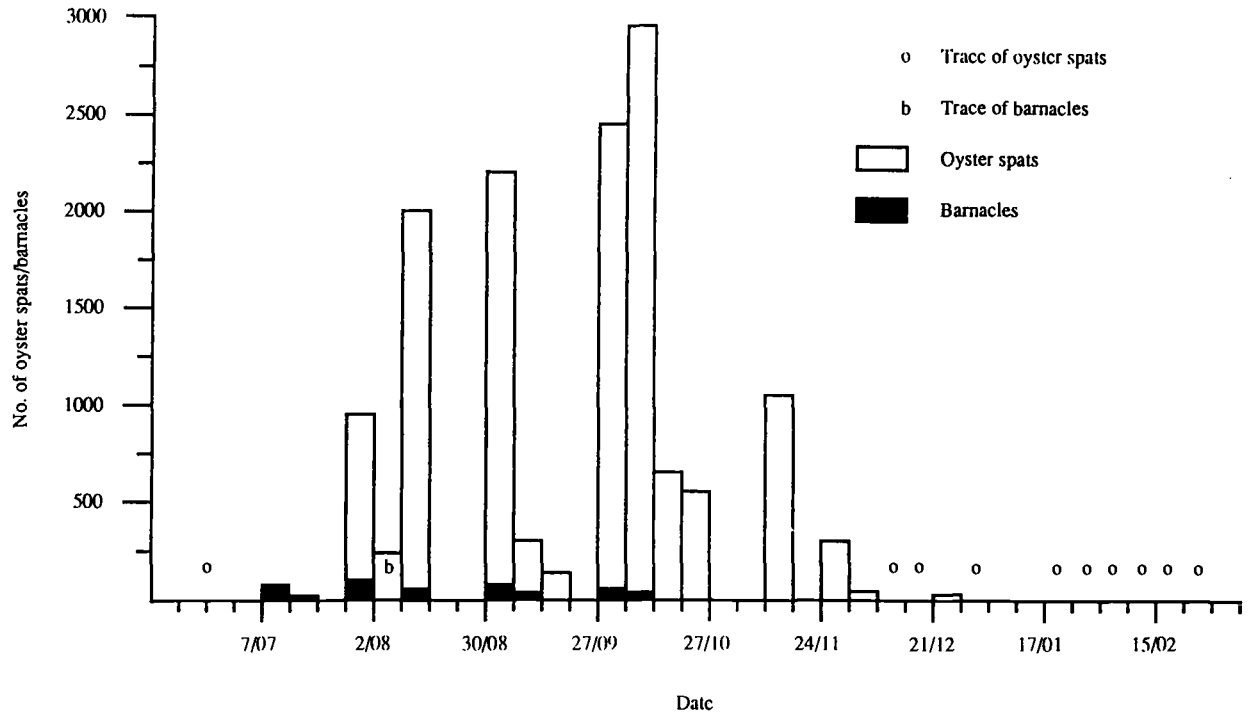

Fig. 1. Weekly oyster spat and barnacle settlement, mangrove shoreline - site A.

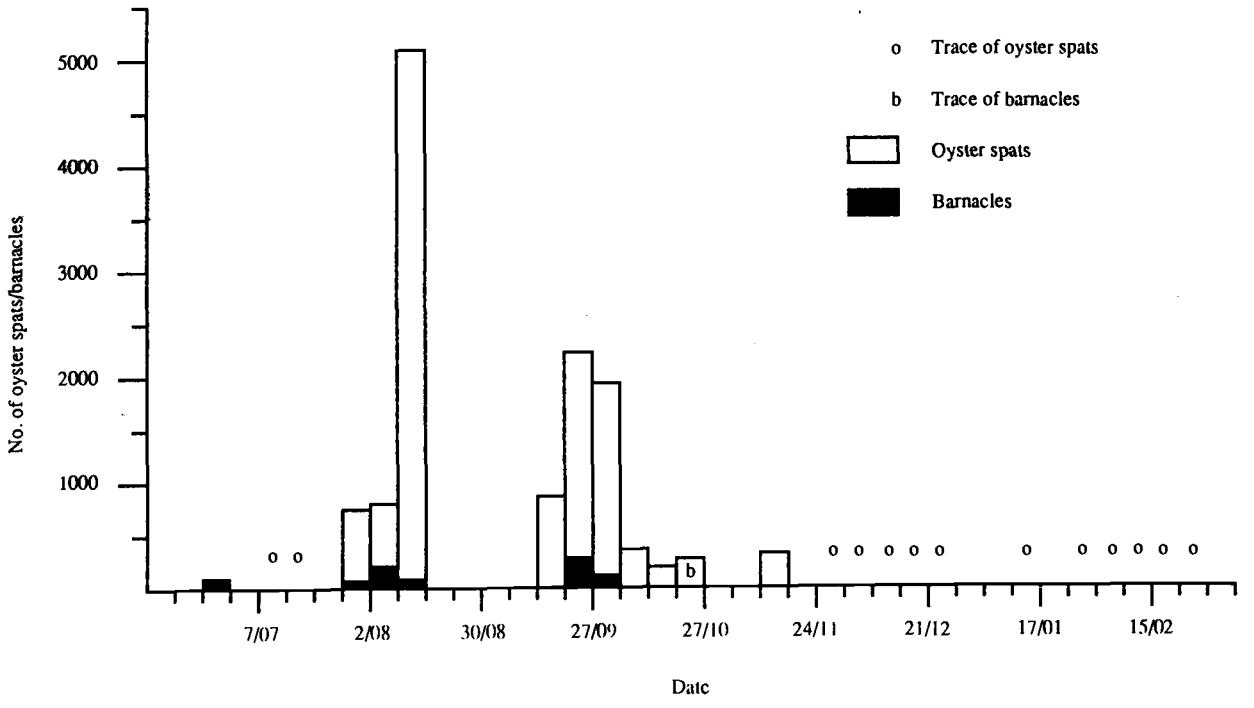

Fig. 2. Weekly oyster spat and barnacle settlement, intertidal rack - site A.

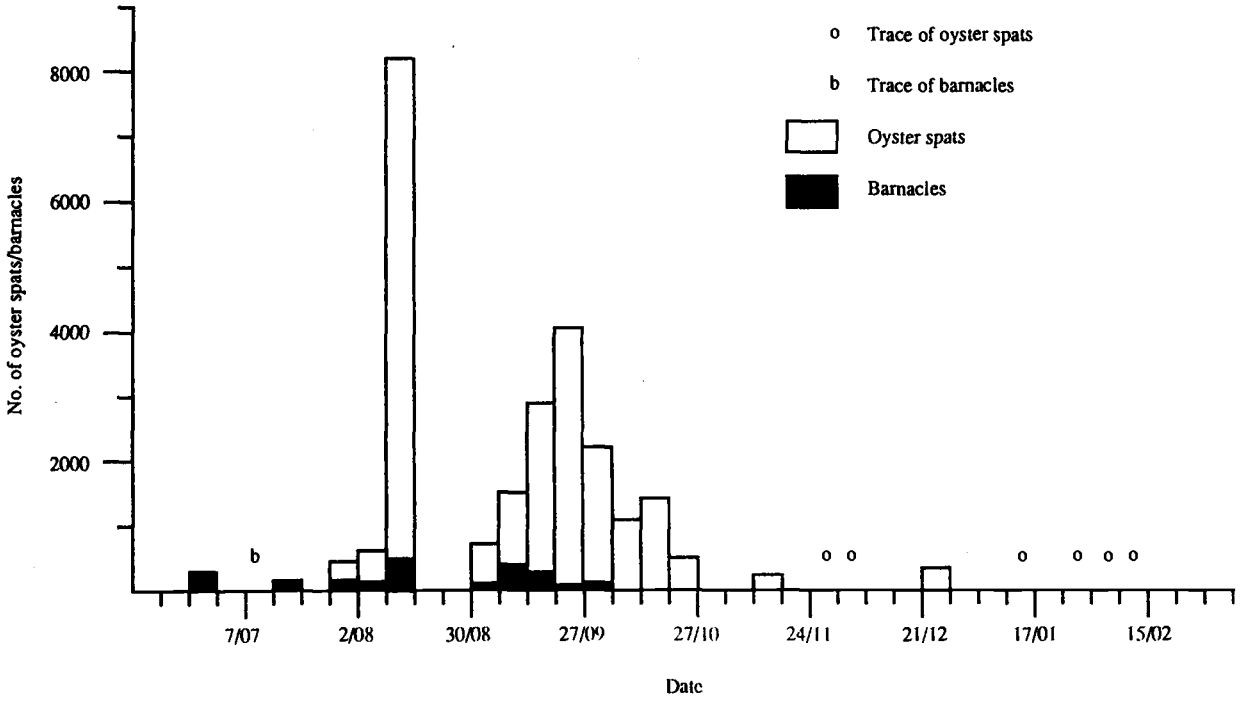

Fig. 3. Weekly oyster spat and barnacle settlement, subtidal rack - site A.

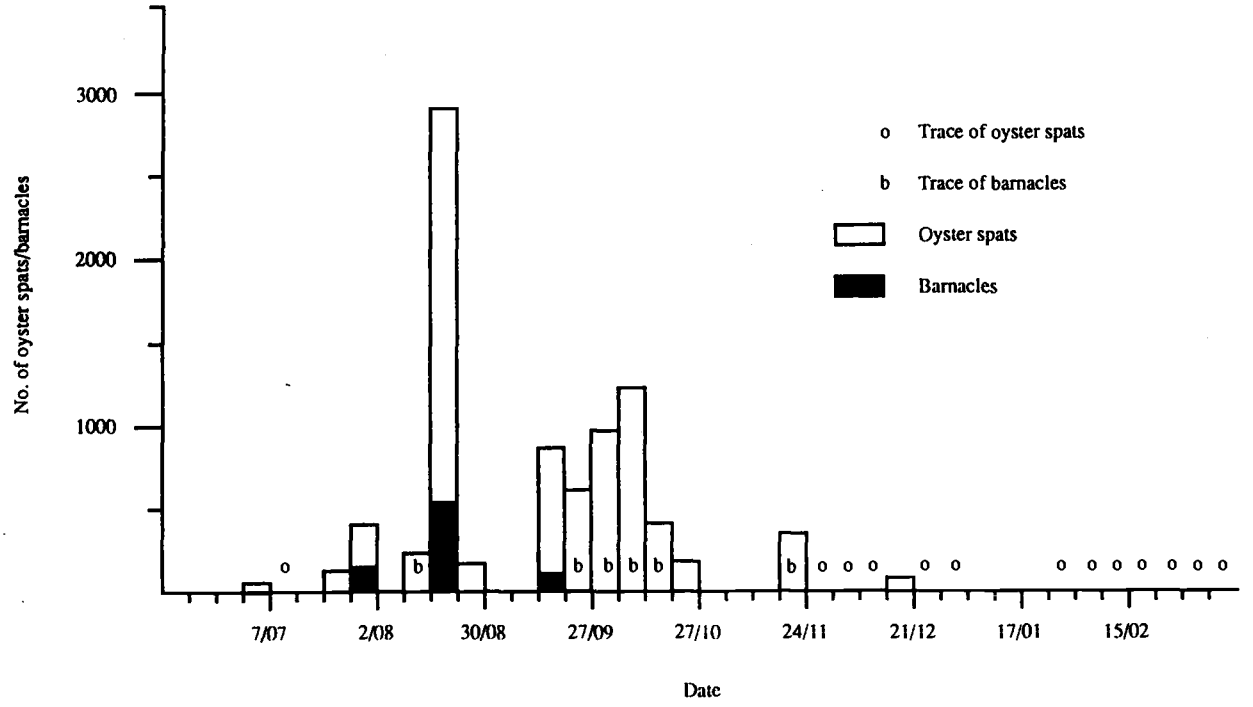

Fig. 4. Weekly oyster spat and barnacle settlement, intertidal rack - site B.

spats. The subtidal rack (Fig. 5) revealed almost the same picture as the other stations, i.e., the peak period occurred at about the same time, with barnacles posing no problems. Like the subtidal rack at site A, the subtidal rack at site B was heavily silted, but with less fouling by hydroids.

In general, there was no apparent preferred depth of settlement shown by either the oysters or the barnacles. This was perhaps due to the shallow nature of the estuary; the maximum depth recorded was 3 m during the high water period.

Growth

Over a 6-month period (January-June and December-May), the maximum size attained was 6 cm, with a minimum of 2.5 cm. However, the 6 cm individuals formed an insignificant number in the population. Generally, there did not seem to be any overall variation in oyster size among the different stations at sites A and B (Tables 1-3).

During the first 3 months of growth, animals at the subtidal rack, in particular, attained a sustained growth rate of about 1 cm/month (Tables 1 and 2). Growth at the other stations was less impressive over the same period. A progressive decline in growth was noted during the last 3 months of the growing period. This phenomenon differs from findings in Sierra Leone where a sustained

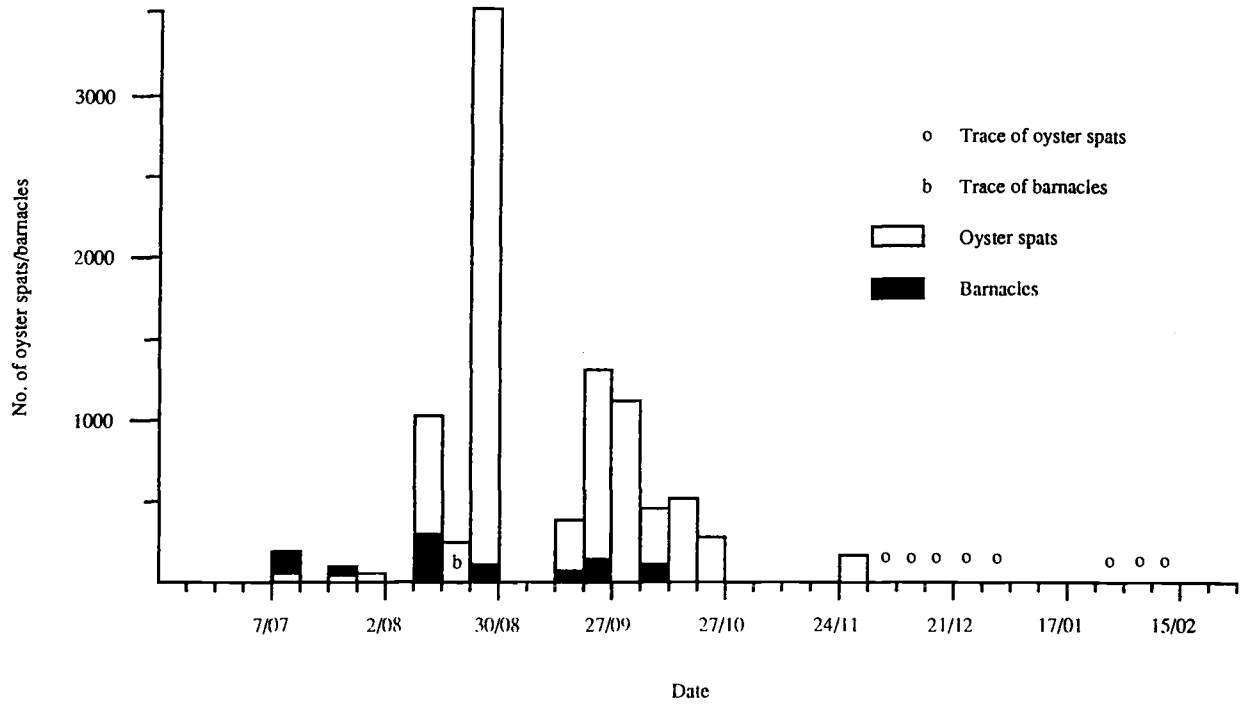

Fig. 5. Weekly oyster spat and barnacle settlement, subtidal rack - site B.

Table 5. Monthly mean temperature and salinity.

Month	Temperature (°C)	Salinity (ppt)
1987		
March	28.0	33.0
April	29.7	34.8
May	31.7	38.0
June	31.0	31.2
July	33.0	34.0
August	32.3	28.1
September	31.6	23.7
October	31.2	14.8
November	29.3	12.2
December	25.9	18.4
1988		
January	22.0	17.5
February	23.0	22.6

Note: May experienced the highest temperature (33°C) and January the lowest (20°C). The highest salinity was recorded in May (40 ppt) and the lowest in November (10 ppt).

growth rate of 1 cm/month was reported, resulting in a mean size of 7 cm in 6-8 months using raft culture (Kamara and Micheill 1976).

In the present study, the mean size recorded in 6 months was 3.7 cm (Tables 1-4). It is worth noting that temperature and salinity values (Table 5) - drastic fluctuations of which tend to affect oyster growth - were within the optimum ranges cited by several authors working in the tropics (Kamara and Micheill 1976; Quayle 1980; Angell 1986). However, growth did not seem to reflect the temperature and salinity values.

The mean size of animals at site B was 4.1 cm. When compared with the size of animals at site A, the difference is not significant.

Mortality

In general, recorded mortality was heavy a month after selection and measurement. This was probably due to stress and, in some cases, inadvertent killing of the animals while cultches were being scraped to reduce overcrowding. The knife could accidentally stray and scratch a nearby oyster, killing it instantly or some time later. In the latter case, the oyster could very well look unharmed and so would be measured and recorded as being alive, only to be found dead the following month.

The subtidal system recorded the highest percentage mortality - about 69% for animals at site A, grown from January to June 1987; whereas the intertidal rack at site A sustained 55% mortality, the highest rate occurring in April (20.4%). The subtidal rack at site A sustained its highest mortality rate in February, 1 month after initial selection and measurement (Table 1). For the intertidal rack at site B (animal growing from December 1987 to May 1988), the highest recorded mortality rate was 22.5% in January (again, 1 month after growing had begun), but the final survival rate was 59.7% (Table 4).

On the whole, mortality tended to decrease progressively as the animals became more established and bigger on the cultches, in spite of relatively heavy silting at the subtidal racks.

Discussion

During the spatfall monitoring exercise, data for May were not available for reasons ranging from the collapse of racks or loosening of strings from racks, and mechanical problems associated with the vehicle and/or outboard engine, to occasional miscalculations on the part of personnel relating to packing the exact number of cultches. In one particular instance, another vehicle was borrowed to pick up the samples from Faraba and upon returning home, the driver's children removed the tags from the strings, making it impossible to identify them. It is recognized that data for the missing periods could have shed more light on the overall picture. Great care is now being taken to avoid, or at least minimize, similar problems in the future.

On several occasions, all or part of a rack collapsed and the cultches were lost. After about 6 months of use, beams, in particular, tended to weaken due to borers (shipworms), resulting in the loss of strings with growing animals and cultches exposed for spat collection. Beams also tended to sag under the weight of the strings, resulting in the last two or three shells or plates lying on the mud bottom. Growing oysters lying on the mud bottom were smothered, and if the cultch was used for spat collection, those lying on the bottom would not attract any spats.

Racks are inspected more often now to detect any apparent weaknesses so that repairs can be made before problems occur.

During the peak spat period identified (July-October), there was an overabundance of spats. Cultches exposed on 12 July for collection (selected and measured in August) had so many spats that it took about 2 days to scrape them to reduce the numbers and create enough space for a maximum of 10 spats per plate/shell. It was almost impossible to locate the previously selected and measured oysters because of later settlements in August-September. It reached a point where the selected animals could no longer be identified; thus, the trial was abandoned.

Because of these problems, collection for grow-out will be carried out either at the end of September or at the beginning of October to avoid excessive settling.

It is hoped that the oysters will grow big enough for easy identification before the onset of the peak spat season. Oysters collected in September-October could be grown throughout the peak spat period also, for they should be less prone to the expected excessive sets of the following year. At the subtidal systems, cultches were so heavily silted that they had to be brushed prior to each measurement period to see and measure the oysters. During this process, thin and newly laid edges were sometimes broken off. It was not unusual for an animal's size to "decrease" after supposedly growing for a month, e.g., it measured 3.1 cm in February and only 2.8 cm in March. This was avoided by vigorously dipping the entire string in the water to reduce, even if only slightly, the silt before measurements were taken. In this way, the incidence of this "regression" in growth was eliminated.

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