かき筏直下の新生堆積物に関する研究

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C．マリオジュルス*・楠木　豊

Study of Oyster Biodeposition under Culture Rafts in Hiroshima Bay

Catherine MARIOJOULS* and Yutaka KUSUKI

SUMMARY

The sediments settling down under the oyster culture raft were collected during 24 hours experiments in May and June, 1985. The collection of the sediments was performedin two stations: in tne center of a culture raft, and in the adjacent sea out of the culture facility. Dead oysters were used as controls.

The record of hydrobiological parameters showed that the salinity was always higher under the culture raft than outside (about +1.5%), while the temperature and the suspended materials concentration did not show significant differences between the two stations.

The quantity of sediments issued from the decantation of suspended materials represented under the culture raft 31 to 48 % of the total sediments, and 89 % outside.

We observed in the second experimental period, by comparison with the first one 3 weeks before, an increase of the production of biodeposits that we relate to the increase of temperature and seston concentration. Between the two periods, the salinity decreased.

The quantity of biodeposits produced daily by the oysters was not measured directly, but was estimated from the experimental data to about 200 mg/g MDW under the culture raft.

Under the culture raft, we collected a bigger amount of biodeposits than outside, but it is not possible to certify if this difference was due to a stronger physiological activity in a culture environment, or to a lower effect of the current.

The current strongly sweeps away the oyster biodeposits, and this effect increases with the height of the water column.

As early as 1955, ITO and IMAI[1] attributed the oyster beds productivity dec-

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* フランスからの文部省留学生

rease to the biodeposition under culture rafts. In Hiroshima Bay, the number of rafts increased rapidly from 1958 to 1965. Signs of an overexploitation of the oyster growing grounds appeared, as the organic pollution of the bottom by the oysters biodeposits with very low dissolved oxygen concentrations of the bottom water, and the slowing down of the oysters growth. From 1970, it was not possible to produce any more the one year oysters. The oyster biodeposition in Hiroshima Bay, and the deterioration of the oyster growing grounds, was studied in detail by KUSUKI[2]. The problem was also studied in a number of oyster culture areas. The biodeposits quantities and the influence of several factors on the production of biodeposits was studied in the laboratory by LUND[3], and TENORE and DUNSTAN[4]. Some measurements of the biodeposits quantities produced in situ were realized in the field, by placing the animals taken from the oyster beds into experimental trays flowed with water pumped in the same environment (HAVEN and MORALES-ALAMO[5], BERNARD[6], SORNIN et al.[7] measured directly the biodeposit quantity under the culture structures.

In a tridimensional culture system as the hanging culture practiced in Hiroshima with 200 m^2 rafts, the cultivated oysters are in environmental conditions defined not only by the characteristics of the flowing water, but also by the culture system particularities. The culture wires holding the oysters act probably as an obstacle to the current, the oysters at high density produce biodeposits that may create an extra-amount of seston. Some other environmental characteristics may also be affected by the culture system.

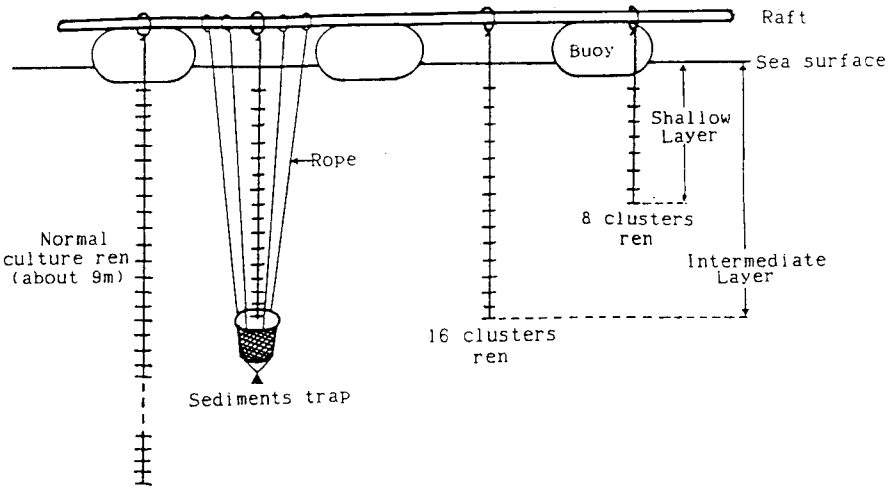
As the biodeposits production is related to the environmental factors, we wanted to check the difference of amount of biodeposits produced by oysters living in the same zone, but hung from a culture raft or not, and try to connect those data with the environmental characteristics of each station.

MATERIALS AND METHODS

Location and Experimental Culture System

The experiments were performed under culture rafts situated at Okunouchi Bay, Ondo, Hiroshima Prefecture. The oyster culture facilities are strings hung from bamboo rafts, on which are threaded the scallop-shell collectors, separated by plastic pipe spacers of 21 cm long. We used ordinary culture strings "ren" for our experiments. The total sediments under the experimental rens during 24 hours were collected.

An empty raft, which had not any oyster rens, was used to collect only the sediments produced by oysters of an experimental ren. To describe the situation of the experimental system regarding to the culture raft, we shall call: in internal position (INT), the rens situated under the culture raft, and in external position(EXT), those under the empty raft. In each station, culture strings



. Figure 1. Experimental system

with dead oysters (shell only) were used as control rens, to estimate the amount of sediments not produced by the experimental oysters themselves.

The experimental rens were of two lengths, i.e. occupying two water layers, that can be characterized as follows: (See Figure 1)

Intermediate layer (IL)　16 clusters (water depth: 3.65 m)

Shallow layer (SL)　8 clusters (water depth: 1.95 m)

The oysters were of the year (aged of about 9 months), cultivated under the raft since December. Total weight, meat weight (MW), meat dry weight (MDW) and shell height were measured on a sample of 4 clusters oysters. The meat dry weight was obtained after dessication at 100 ℃ by successive measurements every 24 hours, with reintroductionin the oven. The lowest value obtained, before the increase of weight due to oxidation, was retained as the meat dry weight value.

Two series of experiments were performed. The first one was conducted from May 13th to 18th, 1985, in the intermediate layer, with two experimental rens(living oysters: L and dead oysters: D) in each station. The second was performed from June 2nd to 7th, 1985, with the same system but in two water layers: IL and SL.

Collection of Biodeposits and Suspended Materials

The biodeposits were collected in situ with a trap made of a 30 liters glass fiber pond(height 30 cm, upper diameter 40 cm), fenced with a net. This trap was suspended under the raft by 4 ropes, and ballasted with a weight (Figure 1). The opening of the trap was at the level of the deepest cluster.

After 24 hours, the trap was carefully pulled up, and all the water was collec ted. At the laboratory, the water was filtered, using first large filter papers

(Toyo filter paper No. 2, pore size 5 μm), then Whatman GF/C filter paper. The biodeposits were dried at 100 ℃ until constant weight to the nearest 0.0001 g.

The total volume of the collected water was measured, and the amount of contained suspended materials was deduced of the previous result to obtain the total quantity of sediments.

In each station, the sea water was continuously sampled during 24 hours with the system described in Figure 2: the water entered into the bottle by a very fine pipe, and the collected sea water was then an homogenous mixing of the water during 24 hours. In the laboratory, three samples of one liter were filtered on Whatman GF/C filter, and the dry weight of suspended materialscollected on the membranes was determined by successive measurements afterdehydration at 100 ℃.

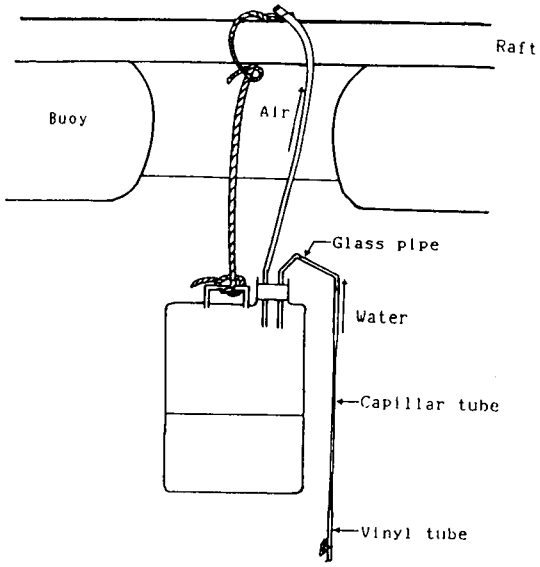


Figure 2. Sea water collecting system

Hydrographical Parameters

Temperature, salinity and current velocity were recorded hourly in each station, with a Tsurumi MTCM-4A magnetic tape recording apparatus.

RESULTS AND INTERPRETATION

Experimental Oysters (Table 1)

The mean value of the total weight is 20.09 g, with a wide range of variations. The average meat dry weight is 0.82 g, with also a high standard deviation.

From these data, the total dry meat weight of the oysters in the experimental ren is evaluated:

126.86 g for a ren of 8 clusters

253.72 g for a ren of 16 clusters

Suspended Materials (Table 2)

Suspended materials concentrations differ slightly for EXT and INT stations. On the other hand, the ranges are totally different for Series I :0.5 to 1.6 mg /l, and Series II: 7.9 to 10.4 mg/l. The values observed in Series I are in a low range, but those of Series II correspond to high values compared to the

Table 1. Characteristics of the experimental oysters

	Shell height (mm)	Total weight (g)	Meat weight (g)	Meat dry weight (g)
Mean	63.2	20.09	4.09	0.82
Max.	88		12.72	2.91
Min.	21		0.27	0.04
s	13.6	9.48	2.51	0.60
n	77	56	77	77

Table 2. Suspended materials concentrations (mg/l)

Station	Series I		Series II	
Days	EXT	INT	EXT	INT
1	0.5	0.5	10.0	9.7
2	0.8	0.8	9.2	7.9
3	1.6	1.4	10.4	9.6
4	1.5	1.2	9.8	10.2
5	1.3	1.2	9.2	9.2

usual range observed in the experimental site, which is about 2-3 mg/l.

Temperature

In both stations INT and EXT(Figure 3), we observed regular nyctothermal variations. The difference between day and night was generally less than 1 ℃. The last day of the second experiment series showed a very small range of temperature, explainable by the heavy rainfall that began at 3 p.m., June 7.

There is no significant difference between the 2 stations during the same experiment(Table 3), but from the first series to the second one, there had been a significant increase of temperature, of about 1.5 ℃. Each series of experiments could be characterized by its own range of temperature, in average 15.3 to 15.9 ℃ for the first one, 16.9 to 17.5℃ for the second. It can then be expected that the biodeposit production will be different in the two series.

Table 3. Temperature(℃) recorded in the stations INT and EXT.
(Results calculated from hourly data)

Station		INT				EXT			
Series	Days	Mean	s	Max.	Min.	Mean	s	Max.	Min.
I	1	15.6	0.27	16.4	15.2	—	—	—	—
	2	15.3	0.28	16.0	15.0	15.4	0.24	15.9	15.1
	3	15.5	0.16	15.9	15.2	15.5	0.19	15.9	15.3
	4	15.7	0.29	16.4	15.4	15.7	0.25	16.2	15.4
	5	15.9	0.45	17.0	15.4	15.8	0.35	16.0	15.2
II	1	16.9	0.32	17.9	16.5	16.9	0.21	17.4	16.6
	2	17.1	0.36	17.9	16.7	17.2	0.35	18.1	16.8
	3	17.2	0.29	18.0	16.9	17.3	0.27	18.1	17.0
	4	17.4	0.43	18.8	17.0	17.5	0.40	18.3	17.1
	5	17.3	0.14	17.7	17.1	17.3	0.11	17.6	17.1

— ; No experimental data

Salinity

The salinity had been virtually stable in each series of experiments, for each station (Table 4). On the other hand, the salinities significantly differed for the stations INT and EXT, with higher values under the culture raft than outside.

If we consider the average values and the differences in the studied situations, we observe that from Series I to Series II, the salinity went down, and much more outside of the culture raft than inside. The culture environment presented always a higher salinity than EXT, the outer area of the growing ground.

The decrease of slinity between Series I and Series II can be explained by the rainfalls of the rainy season, beginning in early June.

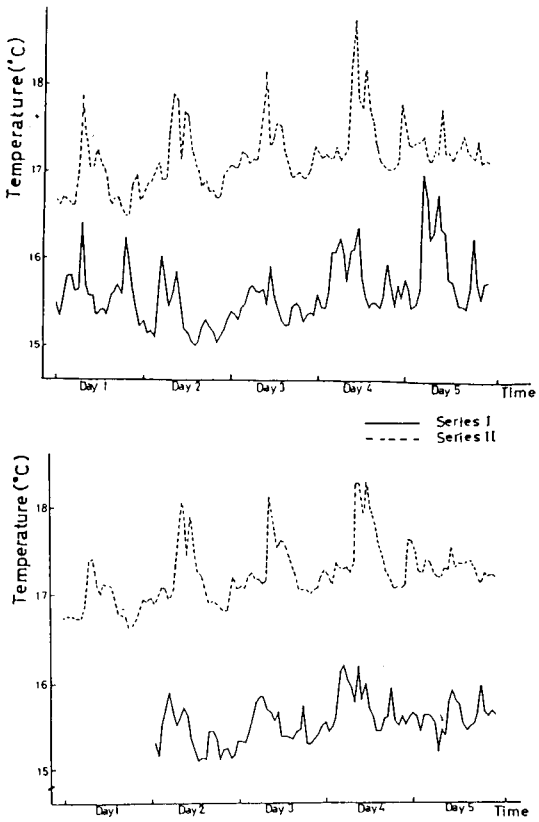


Figure 3. Temperature(℃) recorded at the station INT(upper) and at the station EXT(lower)

Current Velocity

Because of the failure of the currentmeter immerged in Station EXT, there are no available data for that station.

Table 4. Salinity(‰) recorded in the stations INT and EXT

Station		INT				EXT			
Series	Days	Mean	s	Max.	Min.	Mean	s	Max.	Min.
I	1	33.66	0.11	33.79	33.39	—	—	—	—
	2	33.68	0.09	33.83	33.47	33.17	0.07	33.27	33.05
	3	33.65	0.06	33.72	33.45	33.14	0.07	33.25	33.92
	4	33.62	0.06	33.72	33.51	33.11	0.06	33.21	32.95
	5	33.61	0.05	33.71	33.50	33.11	0.06	33.18	32.99
II	1	32.66	0.04	32.72	32.53	31.30	0.05	31.41	31.21
	2	32.68	0.04	32.76	32.57	31.29	0.05	31.36	31.23
	3	32.65	0.05	32.74	32.49	31.28	0.05	31.38	31.16
	4	32.62	0.07	32.70	32.43	31.37	0.07	31.45	31.21
	5	32.61	0.07	32.70	32.41	31.38	0.05	31.48	31.23

— ; No experimental data

Table 5. Current velocity (cm/s) in station INT
(Results calculated from hourly data)

Series	Day	Mean	s	Max.	Min.	Number of 0 in 24 data
I	1	0.4	0.5	1.6	0	13
	2	1.1	1.2	3.7	0	9
	3	0.9	1.4	5.8	0	9
	4	1.4	1.6	5.1	0	8
	5	1.2	1.6	5.1	0	13
II	1	0.5	0.7	2.7	0	13
	2	0.6	0.7	1.7	0	13
	3	0.4	0.6	2.0	0	15
	4	0.4	0.8	2.7	0	17
	5	0.6	0.7	2.4	0	10

In INT (Table 5), this parameter is highly variable, ranging from 0 to maxima that are higher in the first period.

Biodeposits

The total quantities of biodeposits collected during the experiments are presented in Table 6. From those data, we shall calculate several biodeposits quantities, by considering first the origin of the collected sediments, and then the repartition of the biodeposits produced by the oysters in different fractions.

Table 6. Quantities(g) of total sediments collected under the experimental rens

Station	Series		I		II			
	Water layer		IL	IL	SL	IL	SL	IL
	Oyster state		D	L	D	D	L	L
	Days	1	3.072	—	5.403	5.508	5.888	5.852
		2	2.889	3.840	5.224	5.141	5.916	6.022
EXT		3	3.721	7.712	5.131	4.572	4.951	4.993
		4	2.716	5.755	4.544	4.987	5.305	5.664
		5	2.578	2.854	4.590	4.648	5.168	5.278
		1	4.953	8.310	7.707	13.854	11.403	17.136
		2	5.833	7.078	9.419	15.088	11.980	16.558
INT		3	9.761	10.978	10.345	13.699	9.520	15.699
		4	9.586	9.199	7.277	13.283	8.670	14.521
		5	9.401	6.633	4.304	11.527	9.164	15.113

1) Analysis of the Results Regarding to the Origin of the Sediments

The trapped sediments proceed from various origins, and can be classified as follows:(See Figure 4)

S: Suspended materials directly trapped, and first deposited on oyster shells and then fallen down into the trap.

B: Oyster biodeposits directly trapped (B_1), and first deposited on oyster

shells and then fallen into the trap (B_2).

O: Oyster biodeposits transported by the current and directly trapped, and first deposited on oyster shells and then trapped.

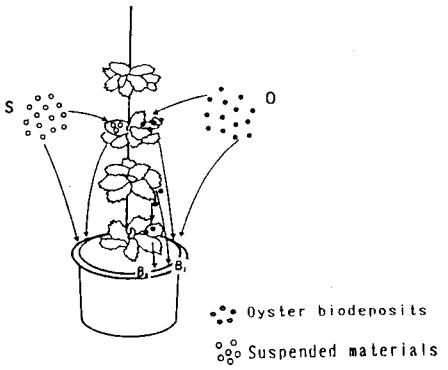


Figure 4. Origin of the trapped sediment

The collected quantities (Q) can be written as follows:

$$Q_{E\cdot D} = S_E \quad (1)$$

$$Q_{E\cdot L} = S_E + B_E \quad (2)$$

$$Q_{I\cdot D} = S_I + O_I \quad (3)$$

$$Q_{I\cdot L} = S_I + O_I + B_I \quad (4)$$

where D means dead oysters, L live oysters, E External station, and I Internal station.

We shall consider as insignificant the difference between EXT and INT for the quantity of sediments issues from suspended materials, and consider:

$$S_E = S_I = S$$

Then the quantity of sediments issued from suspended materials (Q_S) can be calculated from (1). The quantity of oyster biodeposits issued from the experimental ren, and decanted in the trap (Q_B) can be calculated from (2)-(1) ($=B_E$) or (4)-(3) ($=B_I$). The quantity of oyster biodeposits decanted in the trap after transport by the current (Q_O) exists only in the internal station and can be calculated from (3)-(1).

Results

We notice on the results presented in Table 7 that the quantities observed in Series II are much more stable than those of Series I. We shall then base our interpretation more on the latter.

Considering the results of each group of experiments, we see that Q_S shows little variation from one experiment to the other, while the biodeposits quantities vary in a large range.

Q_B is always smaller in station EXT than in INT. This could be interpreted as a lower production of biodeposits outside of the culture raft. But we can not know the exact amount of produced biodeposits in EXT, as we collect only the part directly decanted, and not the one swept along by the current. Nevertheless the difference found between the two stations is so big that we can assume the existence of another factor than the current to explain it, and then suppose that the sediment rapidly accumulated on the clusters of oysters in INT than in EXT, and the amount of sediments that fallen down into the trap from the cluster of oysters were expected to be much more in INT.

We observed that in the exterior station, Q_S and Q_B are almost similar for the

Table 7. Repartition of the sediments ccording to their origin. Quantities in g.

Series	Ren	Station		INT			EXT	
		Origin of the sediments		QS	QB	QO	QS	QB
I	IL	Days	1	3.07(37)	3.36(40)	1.88(23)	3.07(NC)	− (NC)
			2	2.89(41)	1.25(18)	2.94(41)	2.89(75)	0.95(25)
			3	3.72(34)	1.22(11)	6.04(55)	3.72(48)	3.99(52)
			4	2.72(NC)	* (NC)	6.87(NC)	2.72(47)	3.04(53)
			5	2.58(NC)	* (NC)	6.82(NC)	2.58(91)	0.27(9)
		Mean		3.00	1.94	4.91	3.00	2.06
		s		0.44	1.23	2.34	0.44	1.74
II	IL	Days	1	5.50(32)	3.29(19)	8.34(49)	5.50(94)	0.35(6)
			2	5.14(31)	1.48(9)	9.95(60)	5.14(85)	0.88(15)
			3	4.57(29)	2.00(13)	9.13(58)	4.57(92)	0.42(8)
			4	4.89(34)	1.24(9)	8.29(57)	4.89(88)	0.68(12)
			5	4.64(31)	3.59(24)	6.88(45)	4.64(88)	0.63(12)
		Mean		4.95(31)	2.32(15)	8.52(54)	4.95(89)	0.59(11)
		s		0.38	1.06	1.14	0.38	0.21
II	SL	Days	1	5.40(48)	3.69(32)	2.31(20)	5.40(92)	0.49(8)
			2	5.22(44)	2.56(21)	4.20(35)	5.22(88)	0.69(12)
			3#	5.13(NC)	* (NC)	5.21(NC)	5.13(NC)	* (NC)
			4	4.54(52)	1.39(16)	2.74(32)	4.54(86)	0.76(14)
			5#	4.59(NC)	4.86(NC)	* (NC)	4.59(89)	0.59(11)
		Mean		4.98(48)	3.12(23)	3.61(29)	4.98(89)	0.63(11)
		s		0.39	1.49	1.34	0.39	0.18

*, Negative value; −, no experimental data; s, standard deviation; NC, not calculated; #, calculated with the average quantities instead of the negative values. Parenthesis are in percentage.

intermediate and shallow layers. On the other hand, in the station INT, Q_B is largely bigger in intermediate layer than in shallow layer. Considering the respective heights of the water layer, in averege Q_B represents in IL: 2.33 g/m and in SL: 1.85 g/m. The ratio between the height of the water column and the quantity of biodeposits brought by the current are similar for the two layers. Those observations can be explained if we suppose that in the conditions of the station INT, we can collect some directly decanted sediments only in a water column whose maximum height is about that of SL. As shown on Figure 5, in such an hypothesis, in the upper part of the system, all the suspended materials and the biodeposits would be flowed out by the current. On another hand, the more the water column is high, the more oysters are living in it, and produce biodeposits, which will be for a good part flowed by the current. We then collect for Q_O a quantity proportional to the number of oysters, i.e. to the height.

The proportions of the different fractions in the total (Table 8) reflect those facts. In EXT, the proportions of Q_S is extremely high: about 89%, and similar for both layers. In INT, this quantity represents 31% in IL, 48% in SL, and these proportions are very stable.

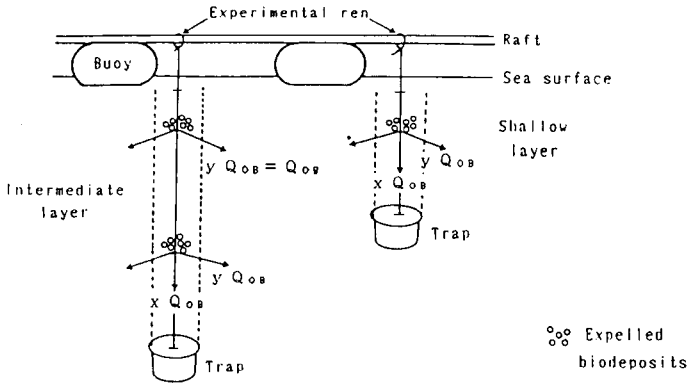


Figure 5. Hypothesis concerning the circulation of expelled biodeposits

We can here underline the highness of these values, and wonder about the importance of the sedimentation of suspended materials in any marine bed.

2) *Estimation of the Quantity of Biodeposits Really Produced by the Oysters under the Culture Raft*

Our previous calculations gave us some results about the part of biodeposits expelled by the experimental ren oysters and trapped, but not the real amount of produced biodeposits. We shall then try to estimate that amount in internal station, as it is possible from the previous results.

Presentation of the Model

We shall consider here not the repartition of the trapped biodeposits in different fractions as before, but the repartition of the biodeposits produced by the oysters in 2 fractions.

Let us call,

Q_{OB}: Quantity of oyster biodeposits really expelled in 24 hours.

We can write,

$$Q_{OB} = xQ_{OB} + yQ_{OB} \qquad (5)$$

where xQ_{OB} is the part of the expelled biodeposits that is decanted in the trap. yQ_{OB} is the part of the expelled biodeposits swept along by the current. Here we have,

$$B_1 + B_2 = B = xQ_{OB}$$

The quantity O is brought by the current, and proceed from the whole biodeposits expelled by the other rens and collected on the reception area of the trap. We can write,

$$Q_O = n \cdot yQ_{OB} \cdot A_t / A_T$$

with n = total number of rens in a raft

A_t = reception area of the trap

A_T = total area of decantation of the biodeposits produced by a raft.

Then we have the system of 3 equations with 3 unknown quantities.

$$Q_B = xQ_{OB} \quad (6)$$

$$Q_O = n \cdot A_t / A_T \cdot y \cdot Q_{OB} \quad (7)$$

$$x + y = 100 \quad (8)$$

and we shall extract Q_{OB}, x, y.

We call $a = n \cdot A_t / A_T$, which is a constant parameter

$b = Q_B / Q_O$, that can be calculated from the previous results.

We calculate (6)/(7): $b = x/ay$ (9)

From (8) amd (9): $y = 100/(ab + 1)$ (10)

Calculation of Constant Parameters

For a standard raft (21.7 m by 9 m), the raft area is 195.48 m^2. But with the effect of the current, the decantation area is larger. KUSUKI[2] found that, for a quantity of 100 g of biodeposits decanted under the culture raft, 126 g are deposited out of the raft. The decanted quantity per unit of surface of course decreases with the distance to the raft, but we shall consider for our calculation a constant decantation density (in g/m^2). Then the extra-area of decantation represents 126% of the raft area, and the total area of decantation is 226% of the raft area. Then

$A_T = 2.26 \times 195.48 = 442\ m^2$

For a trap of aperture diameter of 40 cm, $A_t = 0.1256\ m^2$.

The standard number of rens by raft is 600.

Therefore,

$a = n \cdot A_t / A_T = 0.17$

We shall calculate:

$b = Q_B / Q_O$

$y = 100/(0.17b + 1)$

$x = 100 - y$

$Q_{OB} = Q_B / x$

We shall finally calculate Q_{OB}/g MDW, which is the estimated quantity of produced biodeposits by gram of meat dry weight. For this calculation, we shall use the experimental values found on the oyster sample:

126.86 g for a ren in SL

253.72 g for a ren in IL.

Results

According to the previous equations, the estimated quantities of produced biodeposits were calculated from the data of Series II only, as the results of Series I were insufficient. Those results are presented in Table 8. We notice

Table 8. Estimated quantity of biodeposits produced daily at Station INT

Series	Ren	Days	b	y(%)	x(%)	Q_{OB}(g)	Q_{OB}(mg/g DMW)
II	IL	1	0.39	93.8	6.2	53.1	209.3
		2	0.15	97.5	2.5	59.2	233.3
		3	0.22	96.4	3.6	55.5	218.7
		4	0.15	97.5	2.5	49.6	195.5
		5	0.52	91.9	8.1	44.3	174.6
		Mean		95.4	4.6	52.3	206.3
		s					22.4
II	SL	1	1.59	78.7	21.3	17.3	136.4
		2	0.61	90.6	9.4	27.3	214.4
		3#	0.60	90.7	9.3	33.5	264.1
		4	0.51	92.0	8.0	17.4	137.1
		5#	1.35	81.3	18.7	26.0	204.9
		Mean		86.7	13.3	24.3	191.4
		s					54.7

DMW, Meat dry weight; #, calculation with the average quantities instead of the negative values; s, standard deviation.

that we find similar values for Q_{OB}/g MDW in the two different water layers.

On the percentages of biodeposits directly decanted in the trap (x) or flowed out by the current(y), we observe here also a stronger effect of the current in IL than in SL.

DISCUSSION

The activity of biodeposition is influenced by a number of environmental factors, among which the food amount and temperature are very important. Our environmental results lead us to consider the two series of experiments as two different periods, the second one being characterized by a temperature and a suspended materials concentration higher than in the first one, but a lower salinity.

Sediments Quantities and Environmental Factors

The results concerning the sediments quantities can be considered not as absolute values, but relative values observed in the experimental conditions, and comparable to some measurements performed in the same conditions.

We can notice in the intermediate layer an oyster biodeposits amount bigger in the second period than in the first, and that can be attributed to the higher seston concentration and temperature, as the positive effect of those parameters on biodeposition of bivalves has been shown by several authors (HAVEN & MORALES-ALAMO[5], TENORE & DUNSTAN[4], KUSUKI[8], WINTER[9], TSUCHIYA[10]).

We tried to relate the quantity of biodeposits issued from the experimental ren to the concentration of suspended materials. But the experimental ranges:

0.5 to 1.6 mg/*l*, and 7.9 to 10.4 mg/*l*, were too narrow, and we had too few results, to observe any interesting evolutions of the production of biodeposits.

On another hand, it is difficult to predict the effect of a lower salinity on biodeposition. HOPKINS[11], who studied the adaptaton of oyster to changes of salinity, also noticed that "the pumping activity was aproximately the same at salinity ranging from about 25 to 29 parts per mille". Our experimental values ranges from 31.3 to 33.7 ‰, and even if significant differences can be distinguished for the two periods, and in each period for the two stations, we are not able to establish the connection between that parameter and the feeding activity.

Interestingly, among the measured environmental factors, the salinity is the only one to show significant differences between the two stations. In particular, the suspended materials concentration, that could have been found higher because of the biodeposits produced by cultivated oysters, does not show such a difference. We measured that parameter, and also the temperature and slinity, at a depth of about 2.5 m, which was perhaps not deep enough to detect an increase of seston concentration due to biodeposition.

Estimated Quantity of Produced Biodeposits

We finally estimated the total quantity of biodeposits produced by oysters in culture conditions. The quantities of oyster biodeposits measured by different authors are presented for comparison in Table 9.

The value that we found: 0.2 g/g MDW, for oysters of average meat weight 4.1 g, and meat dry weight 0.82 g, is equivalent to a biodeposit quantity of 0.040 g/g MW. On another hand, the calculation of the same quantity from the experimental data of KUSUKI(pers. com. 1985) give the same results,

0.040 g/g MW in May
0.041 g/g MW in July

Those results were obtained during an experimental conducted in a near place at the same period, using a controlled experimental system composed of individual boxes. The finding of same results in our study allows to check the efficiency of our experimental system, which was obviously less precise, and the one of the model built for the estimation of the produced biodeposits quantity.

Considering the results of the other authors, we find that our data are similar to the results observed by HAVEN & MORALES-ALAMO[5] for *C. virginica* in the same seston concentrations, but are higher than those found for *C. gigas* by BERNARD[6]. The results of SORNIN *et al.*[7] are particularly high, but were recorded in a very turbid environment, what makes the comparison difficult.

Considering a production of 200 mg/g DW, an average oyster of our experiment, of total weight 20.1 g, and meat dry weight 0.82 g, would produce 0.164 g of biodeposits by day in May-June, at a temperature of 15.0 to 18.5 ℃. If we consider a raft of 600 rens, with 40 clusters on each, and 20 oysters by cluster

as in our experiment, the total amount of biodeposits produced by a raft would be 78.7 kg in 24 hours.

Current and Study of Biodeposition

In a study like the one we performed, the biggest difficulty comes certainly from the appreciation of the effect of the current. The failure of one current-meter prevented us from checking the existence of a current stronger outside of the raft than under the raft. The knowledge of such data would allow to connect them with the ratio between the directly decanted biodeposits quantity and the one of the biodeposits swept along by the current.

The most difficult point relies in the measurement of the real quantity of biodeposits. To collect that total quantity, we should have enclosed the experimental ren in a system preventing the action of the current, for instance a cylindrical vynil sheet. But this would have also altered the real environment.

We then think that our experimental system was valuable. But it should have been coupled with a more controlled experimental system for collecting the biodeposits prouced by the same oysters in the same water. For instance, we could use on the raft an experimental tray for collecting the total biodeposits, tray flowed with water pumped in the same station, near the experimental ren, with a flow rate adjusted on the current velocity in situ.

CONCLUSION

Our primary aim was to test the existence of an eventual stimulation of the biodeposits production by the cultural environment. It was not possible to establish it from our experimental data, even if this hypothesis would explain the differences observed between the two studied stations. But this study underlines the influence of the current in the biodeposition phenomenon, and the importance of that factor in the conception of the experimental system.

Different solutions were considered to solve the problem of pollution in oyster culture beds: ploughing the bottom with agricultural cultivator or sucking the polluted sediment (ITO & IMAI[1]). But finally none of them are practically used in Hiroshima oyster beds, where the tidal currents insure an important renewal of the water and the dispersion of the biodeposits, and the frequent moving of the rafts allows to avoid a heavy sedimentation at the same place. However, even happening on a wide area, the sedimentation of the oyster biodeposits creates a pollution of the culture grounds in Hiroshima Bay. At the level of the prefectural government and in the culturists meetings in the fisheries coopratives, some decisions are taken to slow down the overexploitation of the culture grounds, but the production of poorly grown oysters still shows the saturation of the capacities of the environment.

Table 9. Quantities of biodeposits produced (dry weight), according to different authors

Species	Months	Mean TW (g)	Mean DMW (g)	Q (g/oyster)	Q (g/g DMW)	Seston range(mg/l)	Conditions	Authors
C. virginica	April-May June-July	14.7 36.0	0.48 1.41	0.14 0.19	0.29 0.13	4 to 20	In lab.	HAVEN and MORALES-ALAMO(1966)
C. gigas	April May June-July	(41.9) (41.9) (55.2)		0.17 0.22 0.23	0.020 0.036 0.028	46 to 47	In situ.	BERNARD(1974)
C. gigas	(Temp. 9℃)	90		0.03		Low food amount	In lab.	ITO and IMAI(1955)
C. gigas	April June-July		1.27 1.96	1.3 2.4	10.2 1.2	60 to 120	Culture condition. In situ.	SORNIN *et al.*(1983)
C. gigas	May July	(2.5) (3.7)		0.099 0.153			Culture condition same site as our study.	KUSUKI(pers. com.)
C. gigas	June	20.1 (4.1)	0.82		0.2	7.9 to 11.4	Culture condition. In situ.	In this study. St. INT, Series II

TW, Total weight; DMW, dry meat weight. Parentheses in Mean TW represent mean tissue wet weight.

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