Aquaculture, 20 (1980) 9—15

CHANGES IN THE CONDITION INDEX FOR MANGROVE OYSTERS (*CRASSOSTREA RHIZOPHORAE*) FROM TODOS OS SANTOS BAY, SALVADOR, BRAZIL

IRACEMA A. NASCIMENTO and SOLANGE ANDRADE PEREIRA

Instituto de Biologia da UFBa, R. Barão de Geremoabo s/n Ondina, 40.000 Salvador, Bahia (Brazil)

(Accepted 20 August 1979)

ABSTRACT

Nascimento, I.A. and Pereira, S.A., 1980. Changes in the condition index for mangrove oysters (*Crassostrea rhizophorae*) from Todos os Santos Bay, Salvador, Brazil. *Aquaculture*, 20: 9—15.

The condition index was calculated for two samples of 600 *C. rhizophorae* taken from Jacuruna farm in September—October 1977 (spawning period) and December 1977—January 1978 (post-spawning period). There was a significant difference ($P \leqslant 0.05$). Over the size range 2.1 to 10.0 cm (height) the condition index ranged from 59.0 ± 16.2 to 71.8 ± 30.5 for the spawning period, but was only 27.1 ± 10.2 to 43.9 ± 33.0 for the post-spawning period. The size class 4.1 to 6.0 cm gave the best commercial yields and was considered more suitable for the shucked oyster than the fresh oyster market.

INTRODUCTION

Oyster quality is of considerable importance for commercialization as it often determines the margin of profit. Appearance, saltiness and fatness are the main factors that determine the quality of oyster meat. This can be conveniently expressed as the condition index (CI) or condition factor, which is a measurement of the extent to which the oyster fills its shell cavity (Quayle, 1969; Walne, 1970; Rojas, 1971).

High quality oyster meats usually have a creamy white color and fill the shell cavity. In contrast, meats of low quality have a high water content and a translucent appearance (Haven, 1962).

Plumpness may be due to the presence of either glycogen or spawn or a mixture of both (Quayle, 1969). Therefore, in spite of the fact that the condition index expresses an aspect of mostly commercial interest, it has been related to the sexual cycle (Engle, 1958; Haven, 1962; Westley, 1967; Rojas, 1971). The quality of the oysters varies greatly and depends on the conditions under which they grow (Medcof, 1961). The reasons for these variations are not well understood (Haven, 1962).

The present work was undertaken to establish a condition index for mangrove oysters from the Jacuruna river estuary (Todos os Santos Bay) and to determine its variation with the oyster size and sexual cycle.

MATERIAL AND METHODS

Samples of 120 oysters for each class size (2.1—4, 4.1—6, 6.1—7, 7.1—8, 8.1—10 cm) were obtained from the Jacuruna farm (13°10′S; 38°50′W) during each of the two research periods, September—October 1977 (spawning phase) and December 1977—January 1978 (post-spawning phase) (Nascimento, 1978a). Oysters were scrubbed with a wire brush to remove fouling organisms, and the size of individual oysters was measured to the nearest 0.1 mm along the long axis of the shell, from the umbo to the opposite edge (Fernandes, 1975).

The condition index of each oyster was calculated by determining the whole volume, shell volume and dry meat weight. Volume was determined by displacement, according to Galtsoff (1964). The dry meat weight was determined to the nearest mg after the meat was dried to a constant weight at 90°C. The condition index was calculated according to Walne (1970) by the formula:

$$\frac{\text{Dry meat weight (g)} \times 1000}{\text{Whole volume (ml)} - \text{shell volume (ml)}}$$

The indices obtained from 1,200 individual oysters were analyzed by two way analysis of variance, considering size and sample period as treatments (Sokal and Rohlf, 1969). Means and standard deviation for the condition index in each size class are also reported for each period.

RESULTS AND DISCUSSION

The average values for the condition index (CI) in each size (height) class are shown in Table I. Comparing the data for the two periods showed that the values for CI are higher in September—October; for oysters larger than 6.1 cm, they are significantly (normal deviation test) different ($P \leqslant 0.1$) from the ones obtained during December—January.

The condition index undergoes seasonal changes in all the oyster species that have been studied (Walne, 1970). In Canada, as in other regions with temperate climates, the CI changes little during the cold months (November—April), when the oysters are relatively inactive. At the end of this period the oysters are thin and CI is low. Then, as the water temperatures rise in the spring, the oysters fatten and spawn develops. Fattening continues until the first major spawning. The CI then drops suddenly. In autumn the oysters again fatten by glycogen storage and in winter the cycle recommences (Medcof, 1961).

TABLE I

The condition index (average ± standard deviations) for mangrove oyster as a function of size class during the periods September—October 1977 and December 1977—January 1978.

Size class (cm)	Condition index	
	September—October 1977	December 1977—January 1978
2.1— 4.0	71.8 ± 30.5	43.9 ± 33.0
4.1— 6.0	66.6 ± 22.0	34.1 ± 13.4
6.1— 7.0	59.0 ± 16.2	27.1 ± 10.2
7.1— 8.0	60.1 ± 14.4	28.3 ± 7.9
8.1—10.0	60.9 ± 14.3	32.2 ± 14.4

This schedule may be altered according to the species and the annual environmental changes in each region (Galtsoff, 1964). In Venezuela, *C. rhizophorae* has a fattening period from January to May (Rojas and Ruiz, 1972), then spawning causes the CI values to drop (Perez and Ogawa, 1978). The reasons for CI variations between populations from different areas within the same climatic regions were not clearly demonstrated, but the studies indicated that those variations are related to differences in primary productivity (Westley, 1967; Rojas and Ruiz, 1972), which also relates them to the cycle of gonad maturation. During September—October in Todos os Santos Bay, the majority of mangrove oysters still have gonads full of gametes (Nascimento, 1978a). This fact would explain the higher CI during this period. At the beginning of the post-spawning periods the gonads contain only a few unshed gametes and no glycogen reserves. No reserves are stored later on, if insufficient food is available or if something in the environment inhibits the oysters feeding. During December—January the CI values were so low that the oysters did not appear to have had enough food.

The minimum and maximum CI values for oysters in Massachussetts were 35 and 259 in 1959—1960 (Shaw, 1961). Haven (1962) found CI values between 63 and 133. These were the minimum value for oysters growing on the bottom and the maximum for oysters growing in trays above the bottom. For the State of Washington, U.S.A., Westley (1967) found that the CI for *C. gigas* ranged between 48 and 153 for five different areas in 1964.

Based on data for CI by different authors, Walne (1970) calculated that the condition factors varied from 60 to 123 among at least 50% of the individuals in different populations of the genus *Crassostrea*.

In Venezuela Rojas and Ruiz (1972) found a CI between 50 and 75 for *C. rhizophorae* from Baia de Mochima and between 70 and 105 for oysters from Laguna Grande. The range of the average values for all the size classes of *C. rhizophorae* from Jacuruna (Todos os Santos Bay) was 59.0—71.8 for the spawning period, and 27.1—43.9 for the post-spawning period.

Westley (1959) graded the various levels of condition based on data obtained

TABLE II

Results of two way analysis of variance for condition index of mangrove oyster for time periods (treatment A) and size classes (treatment B)

Sources of variation	Experimental results					
	Sum of squares	Degrees of freedom	Mean square	Value of 'F' for treatment A (FA)	Value of 'F' for treatment B (FB)	Value of 'F' interation between A and B
Time periods (A)	283,893.68	1	283,893.68	763.60*		
Size classes (B)	35,825.83	4	8,956.45		24.09*	
Interation between observation periods and size classes (A × B)	761.29	4	190.32			0.51
Error	442,889.62	1.190	371.78			
Total	762,889.62	1.199				

*$P < 0.001$
Note: Periods considered were September—October 1977 and December 1977—January 1978

for *C. gigas.* According to his scale, *C. rhizophorae* were in fair condition (60—80) in the first period (September—October) and in poor condition (below 60) in the second period. In the period of September—October 1977, the mangrove oysters did not have as full gonads as in previous years (Nascimento, 1978a). This was possibly due to abnormally heavy rainfall during September and October in Todos os Santos Bay, which increased the quantity of suspended matter in the water and might have made it difficult for the oysters to filter feed. Without organic reserves, the gonad could not develop completely. The lower CI values obtained in December 1977—January 1978 might also have been associated with disease as well as with unfavorable environmental conditions (Nascimento, 1978b).

The two way analysis of variance showed that in both treatments effects were significant ($P \leqslant 0.001$), but there was no significant interation between them (Table II). To localize the differences between classes (treatment B), the pair-wise *t*-test was conducted. The IC showed significant differences ($P \leqslant 0.05$), in average terms between the size classes 2.1—4 cm and 4.1—6 cm and all the others (Table III). In general terms, after the oysters reach 6 cm there are no significant differences between the CI values for this class and larger classes.

TABLE III

The results of pair wise *t*-test for condition index of mangrove oyster for the size classes (treatment B)

Pairs of size classes (cm)	Experimental difference	Theoretical difference	Conclusion	
			Significant	Not significant
(2.1—4) (4.1—6)	1,8543	827.80727	x	
(2.1—4) (6.1—7)	3,6381	827.80727	x	
(2.1—4) (7.1—8)	3,3896	827.80727	x	
(2.1—4) (8.1—10)	2,7460	827.80727	x	
(4.1—6) (6.1—7)	1,7838	827.80727	x	
(4.1—6) (7.1—8)	1,5353	827.80727	x	
(4.1—6) (8.1—10)	8917	827.80727	x	
(6.1—7) (7.1—8)	2485	827.80727		x
(6.1—7) (8.1—10)	8921	827.80727	x	
(7.1—8) (8.1—10)	6436	827.80727		x

In Venezuela Rojas and Ruiz (1972) found no significant difference (at $P \leqslant 0.05$) in the condition index for the four size classes they considered (3 to 7 cm).

The average values for the class 2.1—4 cm was higher than for the others (Table I); thus, from the theoretical point of view this size class would be the best commercially. From the economic standpoint, however, this does not hold true, because young oysters are usually flatter and have very little inner space between the valves. Consequently their CI is relatively higher because the bodies occupy almost the entire shell cavity (Galtsoff, 1964).

As the condition index describes the plumpness of the oysters, the results (Table I) point out that size class 4.1—6 cm is the most efficient for production purposes. Since this size is too small for the fresh oyster market according to European and Canadian standards (Medcof, 1961), we recommend that the mangrove oysters should be cultivated for the shucked instead of the fresh oyster market in Todos os Santos Bay.

CONCLUSION

In the Jacuruna estuary (Todos os Santos Bay, in Brazil) *Crassostrea rhizophorae* presents relatively low values for the condition index. According to Westley (1959) they had a fair and poor condition index in the spawning and post-spawning periods, respectively.

During those two periods, the CI values for the September—October (spawning period) were significantly ($P \leqslant 0.05$) higher (normal deviation test) than those obtained for the December—January (post-spawning period).

The average values for the CI are significantly different (pair-wise *t*-test) between the smaller size class (2.1—4 cm and 4.1—6 cm) and all the others.

The results indicate that the size class 4.1—6 cm is best for commercial exploitation for the shucked oyster market.

ACKNOWLEDGMENTS

We are indebted to the Rockfeller Foundation for financial support, to the Oyster Culture Projects team and to Professors Raimundo Costa e Souza and Nelson Fernandes for assistance on the statistical analysis.

REFERENCES

Engle, J.B., 1958. The seasonal significance of total solids of oysters in commercial exploitation. Proc. Natl. Shellfish Assoc., 48: 72—78.

Fernandes, L.B., 1975. Aspectos fisioecológicos do cultivo da ostra de mangue, *Crassostrea rhizophorae* (Guilding, 1828): Influência da salinidade. S. Paulo, USP, 81 pp. (Tese de Doutoramento.)

Galtsoff, P.S., 1964. The American oyster *Crassostrea virginica* Gmelin. Fish. Bull. Fish Wildl. Serv. U.S., 64: 1—480.

Haven, D., 1962. Seasonal cycle of condition index of oysters in the York and Rappahannock rivers. Proc. Natl. Shellfish Assoc., 51: 42—66.

Medcof, J.C., 1961. Oyster farming in the maritimes. Bull. Fish Res. Board Can., 131: 157 pp.

Nascimento, I.A., 1978a. Reproduçaõ da ostra de mangue, *Crassostrea rhizophorae* (Guilding, 1828): um subsídio ao cultivo. S. Paulo, USP, 200 pp. (Tese de Doutoramento, Depto. de Biologia, Inst. de Biociências.)

Nascimento, I.A., 1978b. Ocorrência de parasitismo na ostra de mangue da Baia de Todos os Santos. V. Simposio Latinoamericano sobre Oceanografia Biológica (Resumos) USP S. Paulo, Brasil, pp. 83—84.

Perez, I.R. and Ogawa, J., 1978. La possibilidad de cultivo comercial de las ostras *Crassostrea virginica* en los canõ de Guariquen, Estado Sucre, Venezuela. I. Simpśio Brasileiro de Aquacultura (Resumos). Recife-Pe. Depto. de Oceanografia UFPe, p. 34.

Quayle, D.B., 1969. Pacific oyster culture in British Columbia. Bull. Fish. Res. Board Can., 169: 1—192.

Rojas, A.V., 1971. Fluctuacion mensual del indice de engorda del mejillon *Perna perna* natural y cultivado. Bo. Inst. Oceanogr. Univ. Oriente, 10: (2) 3—8.

Rojas, A.V. and Ruiz, J.B., 1972. Variacion estacional del engorda del ostion *C. rhizophorae* da Baia de Mochima Y Laguna Grande..Bol. Inst. Ocean. Univ. Orient, 11(1): 39—43.

Shaw, W.N., 1961. Index of condition and percent solids of raft grow oysters in Massachussetts. Proc. Natl. Shellfish Assoc., 52: 47—52.

Sokal, R.R. and Rohlf, F.J., 1969. Biometry. W.H. Freeman and Company, San Francisco, CA, 776 pp.

Walne, P.R., 1970. The seasonal variation of meat and glycogen content of seven populations of oysters *Ostrea edulis* L. and a review of the literature. Fishery Investigations. Ministry of Agriculture, Fisheries and Food, U.K. Ser. II, 26(3) 35 pp.

Westley, R.E., 1959. Olympia and Pacific oyster condition factor data, State of Washington 1954—1958. Mimeo. Rep. Washington Dept. Fish. Shellfish. Lab., 8 pp.

Westley, R.E., 1967. Some relationships between Pacific oyster (*Crassostrea gigas*) condition and environment. Proc. Natl. Shellfish Assoc., 55: 19—33.