Pakistan J. Sci. Ind. Res., Vol. 30, No. 8, August 1987

RELATIVE GROWTH IN THREE SPECIES OF OYSTERS

Sohail Barkati and Raees Mohammad Khan

Institute of Marine Sciences, University of Karachi, Karachi-32

(Received March 16, 1987; revised July 19, 1987)

Allometric relationships between the shells and tissues of three species of oysters namely, *Crassostrea glomerata, C. rivularis* and *Saccostrea tuberculata,* were studied. Analysis of convariance indicated significant differences in relative growth of various shell dimensions of the three species. Shell weight increased exponentially with increase in shell length. The growth rate of the dry tissue in *S. tuberculata* and *C. rivularis* was faster than in *C. glomerata.* Condition index increased with shell size in *C. rivularis* and *C. glomerata* but decreased with size in *S. tuberculata.* The results are discussed with reference to their occurrence under different environmental conditions.

Key words. Relative growth, condition index, tidal level.

INTRODUCTION

Several species of oysters are found on the coast of Pakistan. Seven species belonging to genera *Crassostrea* and *Ostrea* were reported by Ahmed [1]. Studies on oysters of Pakistan were undertaken mainly to investigate the reproductive biology of the species such as breeding season, gonadal cycle and sex ratio [5-8], hybridization [9], recruitment and sex reversal [8,10,11], and allometric growth [7]. Ahmed *et al.* [12] studied the settlement intensity of two species of oysters i.e. *C. rivularis* and *C. glomerata,* in the Gharo-Phitti Creek system. Hasan [8, 10] and Moazzam and Rizvi [11] studied the settlement of oyster species by setting out various types of panels for obtaining oyster spat. A detailed study on breeding season of Indian oyster *Ostrea cucullata* (= *Saccostrea cucullata*) is that of Awati and Rai [13]. Durve and Bal [14] determined the chemical composition on seasonal basis in *C. gryphoides*.

The present study was undertaken primarily for comparing various allometric relationships between three species of oysters living at different tidal heights along the Karachi coast.

MATERIAL AND METHODS

Individuals of the three species of oysters, *Crassostrea glomerata, C. rivularis* and *Saccostrea tuberculata,* were sampled from Port Qasim, Sandspit and Cape Monze, respectively, along the Karachi coast. Sampling was done in the month of August 1984.

Soft tissues of oysters were taken out and their wet weight obtained. Tissues were then dried in a vacuum oven at 100^{o} for 36-48 hr. and weighed. The dry weight of empty shells was measured after 48 hr drying. All weights were taken to the nearest 0.01 mg. Following dimensions of oyster shells were noted: length, the maximum distance between tip of anterior margin and the posterior margin. and width, the maximum distance between the lateral margins. Linear regression equations were employed for a variety of relationships between the shell and the tissue of three species.

The condition index, as determined in the present investigation, is defined as the proportion of dry tissue weight to total weight (dry shell + dry tissue) of oysters. Oysters (22 to 30 in number) covering the whole size range of the sample were processed individually for each of the three species.

For statistical treatment the methods given by Zar [15] were followed.

Observations

Ecology: Crassostrea glomerata is a small species which prefers a muddy environment, specially the backwaters. They are usually found along the high water mark at tidal heights varying from 3.0 to 4.0 ft. and form dense vertical belts.

Crassostrea rivularis is a relatively large size species occurring near low water mark and therefore experiences more time under water compared to *C. glomerata* and *Saccostrea tuberculata.* The species is abundantly available in the backwaters of Sandspit, near Port Qasim Jetty and at Sonari.

Saccostrea tuberculata occupies mid-tidal level of the open rocky beaches of the Karachi coast. At Cape Monze and Gadani they occur on sea cliffs and boulders. The

species can withstand the pressure of direct surfaction.

Allometry. Allometric relationship may be described by a power function of the following form

$$y = a.x^b$$

where x and y are two variables and a and b are constants.

Parameters of regression analyses are presented in Table 1.

Shell length to shell width relationship. A liner relationship between length and width of oyster shells were observed. In *Crassostrea rivularis* and *Saccostrea tuberculata* shell width increased faster than length whereas in *C. glomerata* a negative allometry was noticed, i.e. shell length increased faster than its width (Fig. 1). A comparison of regression coefficients (b) showed that shell width in *C. rivularis* increases faster than in the other two species.

Shell length to shell weight relationship. An exponential relationship exists between shell length and wieght in all three species (Fig. 2). A significant deviation from the theoretical isometric value of 3.0 ($p < 0.001$) indicated faster growth in length compared to shell weight. F-test for comparing the growth rates among the three species showed that rate of increase in shell weight of *C. glomerata* was much slower than for the other two species studied.

Shell length to dry tissue weight. Shell length increased faster than dry tissue weight in *Crassostrea rivularis* and *C. glomerata* (both showing negative allometry) whereas in *Saccostrea tuberculata* the tissue growth rate was faster than shell length (Fig. 3). Analysis of covariance indicated significant difference between the slopes of the three species ($p < 0.05$). Changes in ratios of shell length to dry tissue weight showed that in *S. tuberculata* there was a 388% increase in tissue weight between 4.5 and 7.5 cm shell length; in contrast there was only a 64% increase in *C. glomerata* (between 3.5 and 5.5 cm shell length).

Shell weight to dry tissue weight: Regression analysis indicates that tissue weight increased faster than shell weight in *C. rivularis* and *S. tuberculata.* In *C. glomerata* the rleationship is isometric, i.e. shell and tissue grew at similar rates.

Shell length to Condition index. Changes in condition index (C.I.) with increase in size showed two different trends. In *C. glomerata* and *C. rivularis* C.I. increased with increase in size whereas the reverse was true for *S. tuberculata* (Fig. 4). However, decrease in C.I. in *S. tuberculata* very small (21.7%) compared to 32.25 and 45.5% increase in *C. glomerata* and *C. rivularis,* respectivley. Covariance analysis showed that b values of three species differed at $p < 0.001$ from each other which means that they possess entirely different criteria for changes in C.I.

Coefficient of Correlation. Coefficient of correlation is a useful estimate for determining varibalility between the two variables so that an investigator may predict with precision and definite probability the values of a number of variables by measuring one variable. The results of the present investigation have clearly shown that there were very few relationships which possessed sufficiently high coefficient of correlation (r) (Table 1).

The highest value was obtained for length to shell weight relationship in *Saccostrea tuberculata.* This is the only instance in the present study when a value of r above

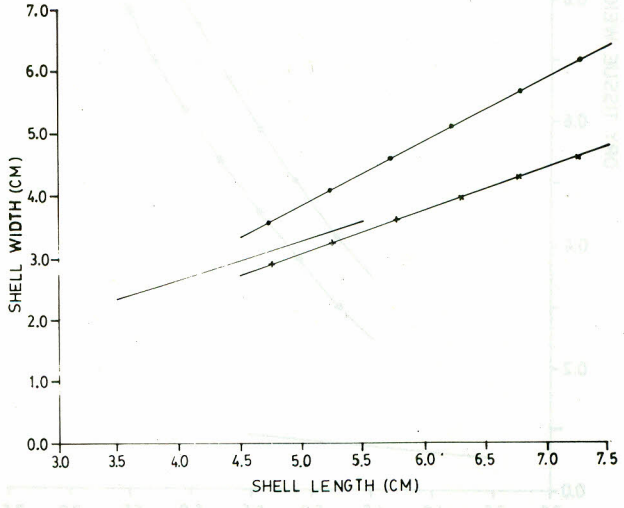

Fig. 1. Relationship between shell length and shell width in three species of oysters. – *C. glomerata,* _●_ *C. rivularis,* _▲_ *S. tuberculata.*

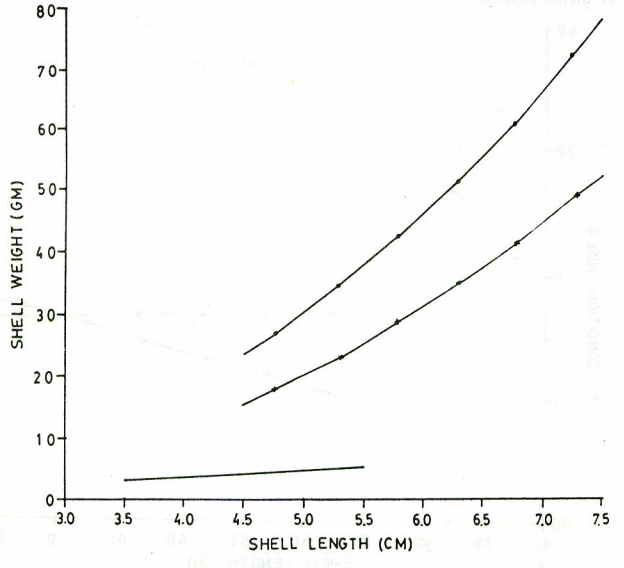

Fig. 2. Relationship between shell length and shell weight in three species of oysters. – *C. glomerata,* _●_ *C. rivularis,* _▲_ *S. tuberculata.*

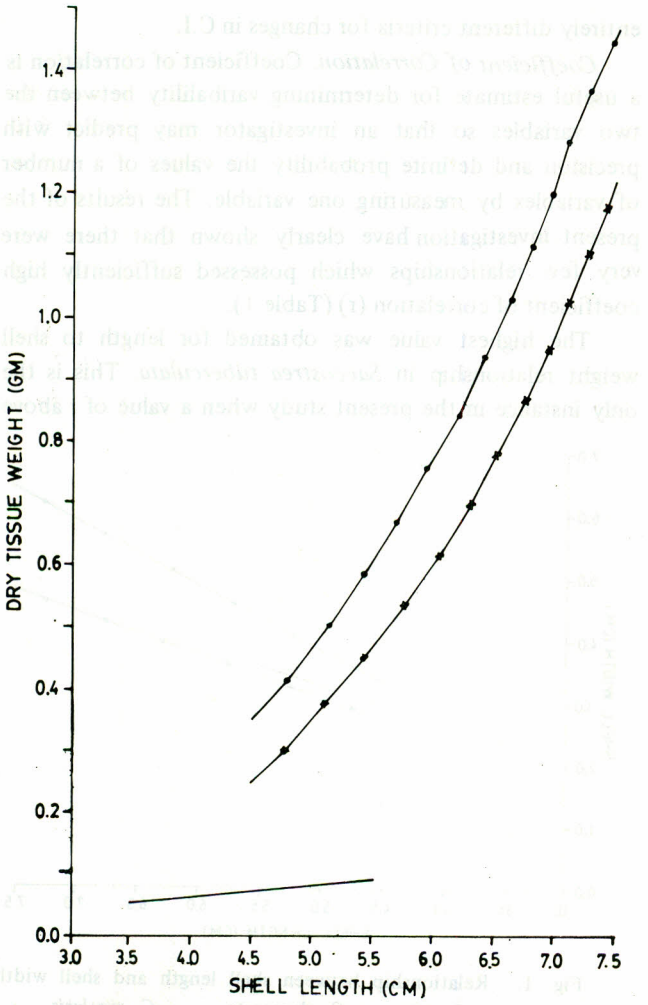

Fig. 3. Relationship between shell length and dry tissue weight in three species of oysters. – *C. glomerata;* _●_ *C. rivularis,* _▲_ *S. tuberculata.*

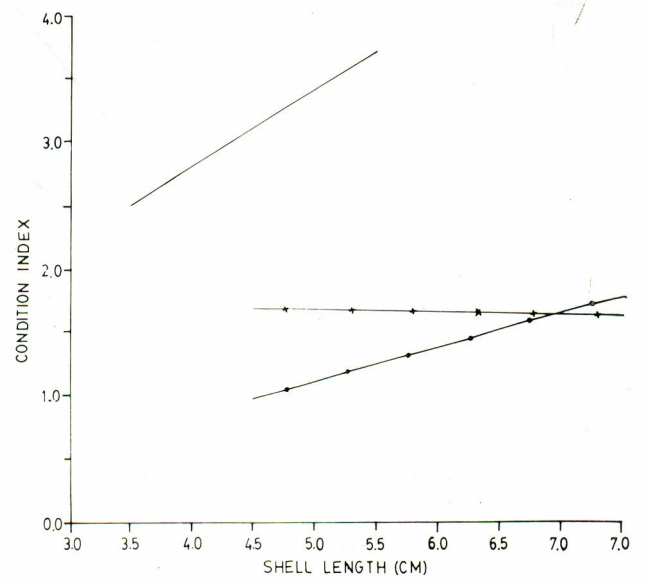

Fig. 4. Relationship between shell length and condition index in three species of oysters. – *C. glomerata,* _●_ *C. rivularis,* _▲_ *S. tuberculata.*

Table 1. Regression coefficients for various parameters in three species of oysters. Values in Parentheses represent the correlation coefficient (r).

Dependent variable	Independent variable	*C. glomerata*	*C. rivularis*	*S. tuberculata*
Shell length	Shell width	0.891 (0.41)	1.249 (0.85)	1.090 (0.88)
Shell length	Dry tissue weight	1.110 (0.68)	2.771 (0.52)	3.108 (0.81)
Shell length	Shell weight	0.98 (0.44)	2.313 (0.84)	2.371 (0.92)
Shell weight	Dry tissue weight	0.961 (0.79)	1.147 (0.74)	1.287 (0.86)
Shell length	Condition index	0.861 (0.05)	1.178 (0.41)	−0.042 (−0.01)

0.9 was recorded. In length to shell weight relationship the r value was relatively high, so that shell length can be used for obtaining a rough estimate of shell weight.

DISCUSSION

A number of studies have been undertaken on relative growth of molluscs. Those related to mussels of the genera *Mytilus* and *Modiolous* are summarised by Seed [16]. Comparatively few studies have been reported on the growth of oysters [17-23]. The sole reference to growth of oysters from Pakistan is that of Asif [7]. The results of the present study showed that the three species showed different dimensional relationships, though the association between any two variables was rather loose. No linear variable can threrefore be used for accurate prediction of other variables. Low coefficients of correlation in oyster species have probably occurred because of the irregular growth in various shell dimensions (length and width).

Significant differences in the regression coefficients (b) of majority of the relationships among the three species may be explained in relation to their occurrence in different environmental conditions. Species occurring higher in the intertidal area and therefore facing more exposure to air possessed heavier shells when compared with those living low in the tidal zone or those which remain uncovered for short periods.

Observations of shell length to width relationship suggest that individual shells in *Crassostrea rivularis* and *Saccostrea tuberculata* become progressively wider in

relation to their length. In case of *C. glomerata* shells become narrower in relation to their length.

There is some controversy on the subject of shell weight of populations growing at different tidal hieghts. Some researchers are of the opinion that bivalve molluscs growing high in the intertidal area and facing considerable exposure to air during low tides possess lighter shells [24, 25], and Galtsoff [19] stated a general principle that shells of intertidal oysters are usually thinner than those of subtidal oysters. Later, Dame [21] drew the same conclusion. According to him the shell weight/dry tissue weight ratio for *Crassostrea virginica* from south Carolina was significantly higher in subtidal than in intertidal oysters The present observations agree with these conclusions.

On the other hand, Baird and Drinnan [26] mentioned that in *Mytilus* shell weight increased and tissue weight decreased proportionately as the period of exposure increased between the tides. Later the work of Seed [16] and Coleman and Trueman (27) on mussels supported the findings of Baird and Drinnan [26]. Barkati [28] examined in detail a mussel population (*Mytilus edulis*) in Norway and confirmed the results of Baird and Drinnan. Hickman [29] worked on the mussel *Perna canaliculus* from New Zealand and concluded that shore-grown mussels were slightly heavier in shell weights than raft-grown mussels. Literature on condition index is extensive, a detailed review is given by Walne [31]. Results of shell length to condition index studies showed that either condition index increased with increasing size (*C. rivularis* and *C. glomerata*) or showed a negligible decrease (*S. tuberculata*). However, it is evident from the literature that condition index changes with season as it is directly related to the reproductive activities of the animal [23, 31, 32].

REFERENCES

1. M. Ahmed, Pakistan J. Zool., **3**, 229 (1971).
2. R. Qasim, N. Aftab and S. Barkati, Pakistan J. Sci. Ind. Res., **28**, 126 (1985).
3. R. Qasim, N. Aftab and S. Barkati, J. Pharm. Univ. Karachi, **3**, 51 (1985).
4. R. Qasim, N. Aftab and S. Barkati, Pakistan J. Agri. Res. (in press).
5. F. Ansari and M. Ahmed, Pakistan J. Zool., **4**, 35 (1972).
6. M. Asif, Hydrobiol. **68**, 73 (1980).
7. M. Asif Pakistan J. Sci. Ind. Res., **22**, 46 (1979).
8. S.A. Hasan, Proc. 4th Pan Indian Ocean Congr. Sec. B., 271 (1960).
9. M. Asif, Pakistan J. Zool., **10**, 217 (1978).
10. S.A. Hasan, Proc. 4th Pan Indian Ocean Congr.Sect. B., 167 (1960).
11. M. Moazzam and S.H.N. Rizvi, Proc. Symp. Coastal Aquacult. **2**, 467 1980).
12. M. Ahmed, S. Barkati and Sanaullah, 5th Pakistan Congr. Zool. (Abstracts), 123 (1985).
13. P.R. Awati and H.S. Rai, *Ostrea cucullata* (The Bombay Oyster), Indian Zool. Mem., **3**, 1 (1931).
14. V.S. Durve and E.V. Bal, J. Zool. Soc. India, **13**, 70 (1961).
15. J.H. Zar, Biostatistical Analysis, Prentice Hall, Inc. Englewood Cliffs, N.J., 620 pp (1974).
16. R. Seed, Proc. Zool. Soc., Lond., **40**, 343 (1973).
17. J.H. Orton, Nature, **135**, 466 (1936).
18. K.M. Wilbur ane L.H. Jordey, Biol. Bull., **103**, 269 (1952).
19. P.S. Galtsoff, Fish. Bull. Fish Wildlife. Serv. U.S., **64**, 1 (1964).
20. K.M. Wilbur nad G. Owen, Growth "Physiology of Mollusca", (ed.) K.M Wilbur and C.M. Yonge), **1**, 211 (1964).
21. R.F. Dame, Fish. Bull., **70**, 1121 (1972).
22. R.V. Krishnamoorthy, G.J. Lakshmi, P. Biesiot and A. Venkataramiah, Indian J. Mar. Sci., **9**, 258 (1980).
23. C.G. Askew, Aqualcult. **1**, 231 (1972).
24. K.P. Rao, Experientia, **9**, 465 (1953).
25. K.P. Rao and E.D. Goldberg, J. Cell. Comp. Physiol., **43**, 283 (1954).
26. R.H. Baird and R.E. Drinnan, J. Cons. Perm. Int. Explor. Mer., **22**, 329 (1957).
27. N. Coleman and E.R. Trueman, J. Exp. Mar. Biol. Ecol., **7**, 295 (1971).
28. S. Barkati, Population dynamics and autecology of mussel population from Lindaspollene, Western Norway," Ph. D. Thesis, Univ. Karachi, 304 pp. (1983)
29. R.W. Hickman, Mar. Biol., **51**, 311 (1979).
30. P.R. Walne, Fish. Invest. Lond. Ser., **2**, 35 (1970).
31. R.H. Baird, J. Cons. Perm. Int. Explor. Mer, **23**, 249 (1958).
32. V.S. Durve, J. Mar. Biol. Assoc. India, **6**, 128 (1964).