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Allometry in the wedge clam, *Donax incarnatus* (Gmelin) from Panambur beach, Mangalore*

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Allometry in the morphometric and shell length-body weight relationships of *D. incarnatus* was examined. The length-breadth and length-width relationships were $L = 0.3225 + 0.6754B$ and $L = 0.1634 + 0.3821W$ respectively. The proportionate increases in the shell dimensions resulted in retention of the wedge shape from spat stage onwards. On an yearly basis, the relationship between shell length-wet tissue weight was $W = 0.00005\ L^{2.8321}$, whereas $W = 0.000027\ L^{2.2976}$ for shell length-dry tissue weight. Monthly values of equilibrium constant (b) varied from 1.3103 (January) to 4.1243 (November) in the shell length-wet tissue weight relation, while the variation was from 1.5817 (May) to 3.3989 (November) in the shell length-dry tissue weight relation. Apart from indicating relative growth in body weight, the equilibrium constant also indicated variations in gonadal growth (weight) and condition index.

In allometric relationships,only 2 parameters are compared at any one time. Moreover, inferences about the proximate or mechanistic causes will result in differences in the intercept and slope of the allometry, hence comparisons among taxa are risky because many factors influence morphological and physiological traits[1-3]. On an yearly basis some aspects of allometry in *Donax* spp. inhabiting Indian waters have been studied[4-9]. These studies suggest linear relationships between shell length and shell breadth (height), as well as between shell length and shell width (depth/thickness). A non-linear relationship between the shell length and weight is also established[4-7,9]. However, information on seasonal variability in allometric scaling is lacking. In this paper, details of bivariate analysis of allometry in morphometric and shell length-tissue weight relationships of the wedge clam *D. incarnatus* (Gmelin) inhabiting the Panambur beach near Mangalore are reported.

Samples of *D. incarnatus* were collected monthly (March 1984-February 1985) using randomly placed quadrats (1 m^2 area, up to 10 cm depth) at Panambur beach (12°27′N; 74°48′E) near Mangalore. Clams were separated by sieveing the sand (mesh size 1 mm). A total of 450 randomly selected clams ranging in size from 3.6 to 26.1 mm shell length were examined for dimensional relationships, 2258 clams for length-wet tissue weight, and 1153 clams for length-dry tissue weight relationships. Shell length (maximum antero-posterior distance), breadth or height (maximum distance from hinge to ventral margin) and width or depth or thickness (maximum distance between outer edges of two valves) of clams were measured accurately to 0.05 mm. Meat from individual clam was removed, blotted, weighed and dry weight of clams were recorded after oven drying the meat at 60°C for 2 d. Allometry was examined in morphometric and length-tissue weight relationships by using least-square regression techniques[10].

Morphometric relationships—Analysis of morphometric relationships between shell length-shell breadth and shell length-shell width (Fig. 1) variables are linearly related and show that short individuals are narrow (less height) and low (less thickness) and inversely, long individuals are wide (more height) and high (more thickness). Clearly, this reflects the fact that length, breadth and width are influenced by one general attribute, i.e., variation in size. However, some individuals of the same length show different breadth and width and these differences constitute shape variation. Thus, proportionate change in the shell dimensions resulted in retaining the wedge shape. Shell dimensional relationships of *D. faba*[5], *D. cuneatus*[7], *D. incarnatus*[8] are also linearly related between these traits. However, the values of intercept and slope are different, thus depicting variations in different morphological traits be-

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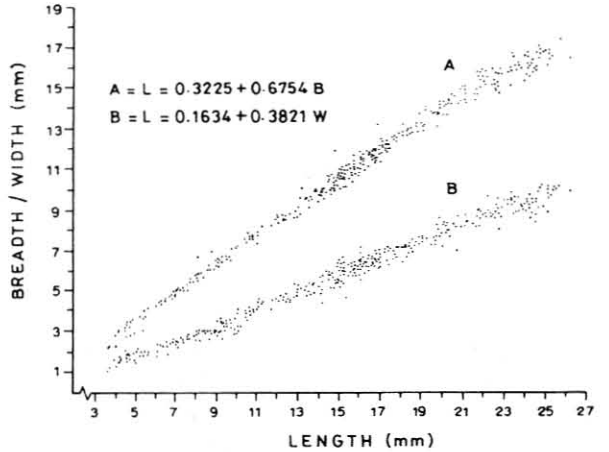

Fig. 1—Bivariate scatter diagram of length and breadth (A) and length and width (B) relationships of *D. incarnatus*

cause these populations inhabit different habitats where environmental parameters are different.

For species like the one studied here, shape is probably of major adaptive significance because of the importance of rapid burrowing in the surf beaten intertidal sandy shore where the environmental factors fluctuate. A variety of environmental factors are known to influence shell form in bivalves[1-11]. Size of clams is more affected than their shape by fluctuations of ambient environment. Thus shape, rather than size, generally provides more precise information on the dimensional relationships. Probably, shape is controlled by its genetics and size by ambient environment coupled with its population selection strategies[12]. Size may influence life history evolution through migration with tides or burrowing behaviour of clams.

Length-weight relationship—The possibility that allometric relationships describe rates for a wide range of metabolic processes and over a wide range of organisms' size and types has important ecological implications[13]. Monthly analyses of scatter diagrams (Figs 2, 3) show that dots are skewed on each diagram indicating short individuals are light and long individuals are heavy. This clearly points out that as age increases the weight of clams also increases. However, some individuals of the same age show different weight and these differences may probably be due to physiological condition[14] of clams and variations[15] in salinity—30.2 (June '84) to 34.8×10^{-3} (February '85), water temperature-25° (August '84) to 32.2°C (May '84) and sand temperature 28.5°C (August '84) to 36°C (May '84). Lengths and weights of organisms have been shown to be highly correlated with life history measures in cross-taxonomic comparisons[16,17]. Monthly analyses (Figs 2, 3) clearly shows that clams maintain their non-lin-

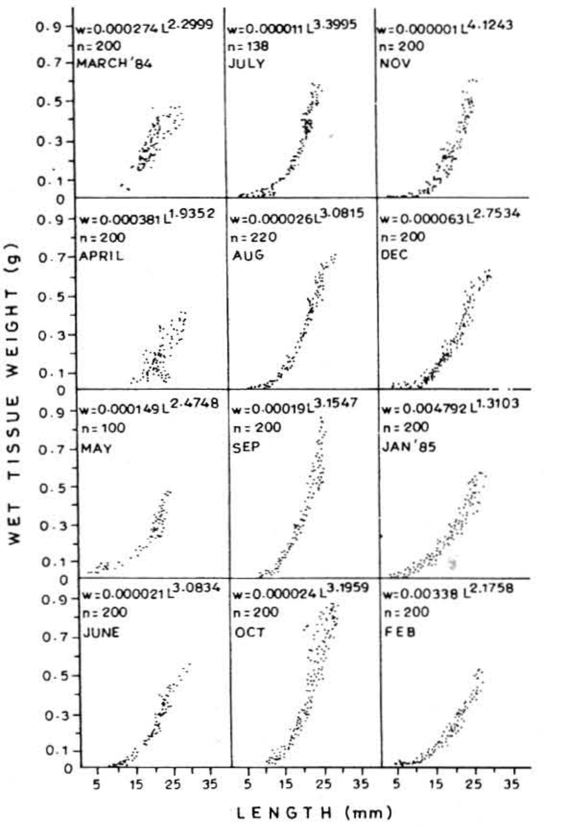

Fig. 2—Monthly variations in the allometric relationships between shell length (mm) and wet tissue weight (g) in *D. incarnatus*

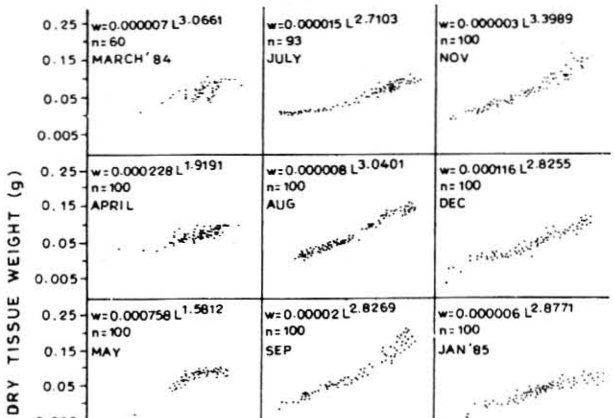

Fig. 3—Monthly variations in the allometric relationships between shell length (mm) and dry tissue weight (g) in *D. incarnatus*

ear pattern from spat stage onwards. However b values are different indicating the variations in condition index[14] and reproductive cycle[18]. Length-weight relationships of *D. cuneatus*[4,7], *D. faba*[5], *D. spicularis*[6], *D. incarnatus*[6,9] are also non-linearly related even though they are inhabiting different habitats.

In allometric length-weight relationship of the form $Y = ax^b$, the most interesting component is the equilibrium constant (b), the variations of which from the hypothetical unity suggest physiological deviations in condition. According to Wilbur and Owen[11], the values of equilibrium constant (b) lie between 2.4 and 4.5 in most of the bivalves with the exception of the worm like *Teredo*[19] in which a more nearly linear relation (b = 1) is found. The value of b represents relative growth in weight as compared with length. Perusal of data on the monthly variations in b values (Fig. 4) indicate a more or less identical trend with the peak in November. This indicates that the relative growth in body weight as compared to length is the highest in November. In bivalves where the gonadal growth and maturation result in increasing bulkiness of soft body and consequent high body weights, such sudden shifts in b values indicate onset of maturation and gonadal growth[18]. *D. incarnatus* population inhabiting the present locality attains sexual maturity in November and breeds from November to March[12]. High condition index of *D. incarnatus* in the same habitat is just prior to spawning due to the increase in the total bulk of gonad which forms the major part of the visceral mass[14]. Thus, the high equilibrium constant values also indicate gonadal growth and high condition index.

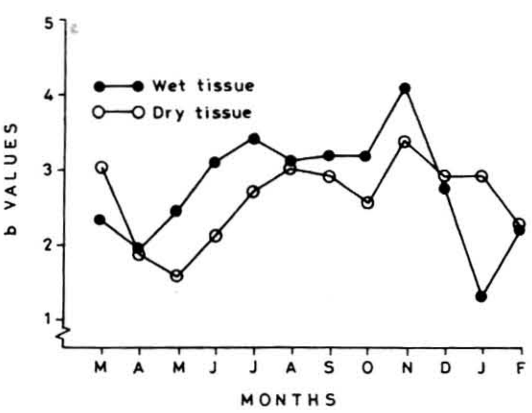

Fig. 4—Monthly variations in the b values calculated on a wet and dry tissue weight basis

The population under consideration here represents a *K*-strategist[12] characterised by low growth rate, high mortalities in juvenile and old age classes, a life span of about 13-14 months and fairly constant population in time. There is, of course, a correlation between life history strategy, general morphology and maximal attainable growth rate of an organism. Approximations of growth rates, productivity and elimination rates of aquatic secondary producers under optimal conditions in different ecosystems will thus be possible provided knowledge exists on their size and shape, differential body growth, size distribution, population structure and longevity.

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