Journal of the Indian Fisheries Association
29, 2002, 55-63

LENGTH-WEIGHT RELATIONSHIP OF INTERTIDAL MOLLUSCS FROM MUMBAI, INDIA

A. K. Jaiswar and B. G. Kulkarni*

Central Institute of Fisheries Education, Versova, Mumbai - 400 061

**The Institute of Science, 15, Madam Cama Road, Mumbai - 400 032*

ABSTRACT

A study on the length–weight relationship of common intertidal molluscs from Mumbai showed a high degree of correlation between their length and weight. Most of the molluscs exhibited isometric growth pattern but in some species, allometric growth was found, which is attributed to maturity, non-linear growth of shell and the ecological conditions. The variations in the growth rate of *Gafrarium divaricatum* sampled from two geographically separate sites, Bandstand and NCPA, is a result of variation in ecological conditions.

Key words: Length-weight, intertidal molluscs

INTRODUCTION

A mathematical representation of the length-weight relationship derived from the analysis of a number of specimens of different sizes from a particular area is a useful tool for study of population dynamics. According to Le Cren (1951), "Length of an animal is often more rapidly and accurately measured than weight. It is convenient to determine weight, where only length is known and *vice versa*". Besides providing a means for calculating weight from length, it may also give taxonomic difference and events in the life history of the fish/mollusc. Any deviation from the relationship thus derived indicates variation in the ecology of the habitat or physiology of the animal or both. Considerable data are generated on the length-weight relationship of fishes, which are useful in the management of their fisheries. However, except for few reports (Mohan, 1980; Shanmugam, 1997), the work on the length-weight relationship of molluscs is scanty. Therefore, the present work on the length-weight relationship of selected gastropods and bivalves of Mumbai coast was undertaken in an attempt to fill the lacuna.

MATERIAL AND METHODS

For the present investigation, the molluscan specimens were collected from shores adjacent to Tata Institute of Fundamental Research (TIFR), National Centre for performing Arts (NCPA), Girgaon Chowpatty, Bandstand and Gorai creek of Mumbai during spring-low tide from September 1997 to August 1998 (Fig. 1). Total length of shell in bivalves and

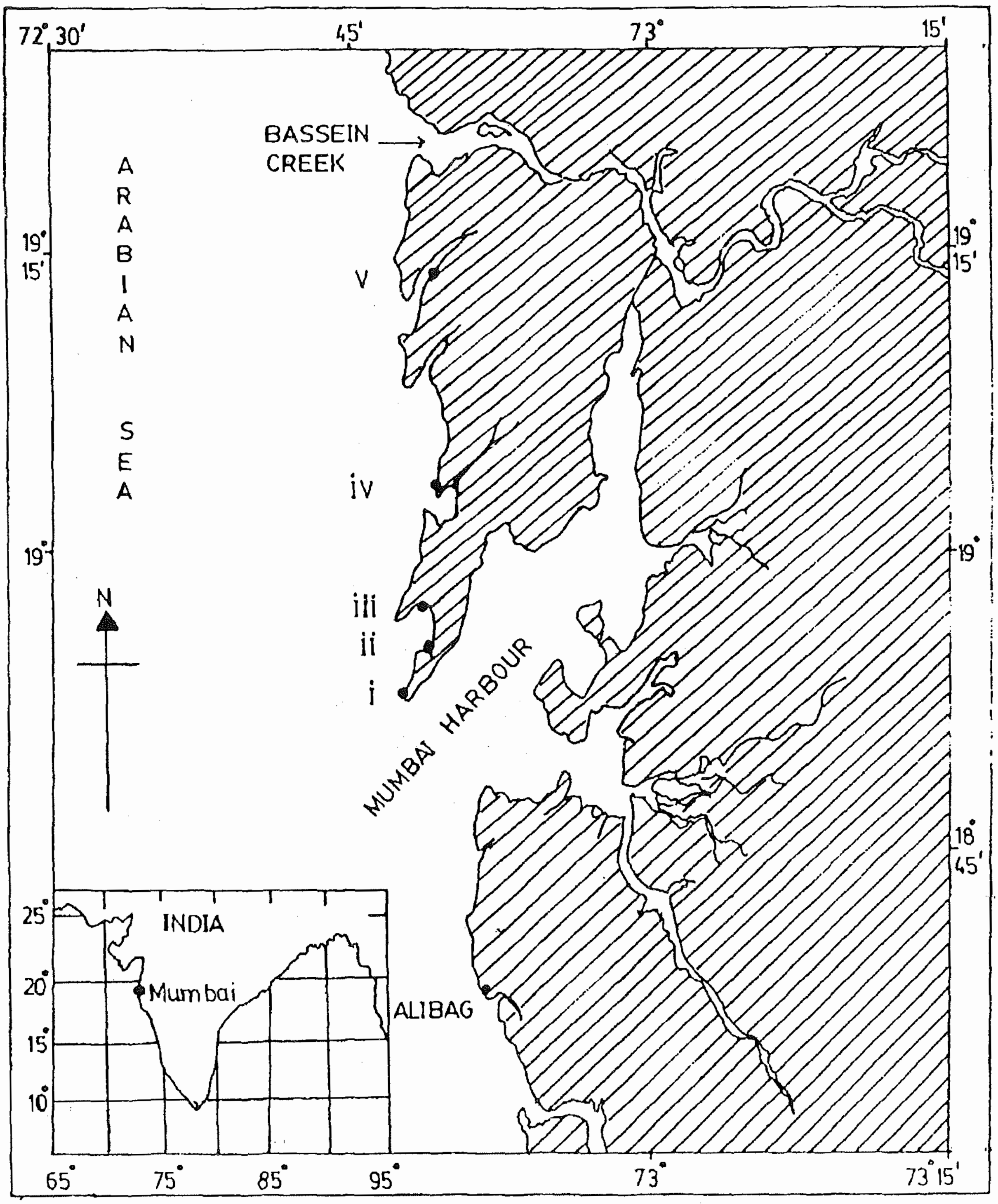

Fig. 1. Sampling spots in Mumbai (i) TIFR (ii NCPA (iii) Girgaon Chowpatty (iv) Bandstand (v) Gorai Creek

height of shell in gastropods were measured in millimetres and wet weight in grammes using digital balance after drying on a blotting paper. The data on length and weight were put in its logarithmic form log W = log a + b log L (Le Cren, 1951). Significance of regression coefficient 'b' was tested to verify whether it was deviating from 3, using 't' test as follows:

$$t = \frac{b-3}{S_b}$$ Where, b = coefficient of regression

S_b = standard deviation calculated as,

$$S_b = \sqrt{\frac{\Sigma X^2 - (\Sigma X)^2/n}{n-1}}$$

The co-efficients of regression 'b' for *Gafrarium divaricatum* collected from NCPA and Bandstand were compared to know the significant difference in growth using 't' test:

$$t = \frac{b_1 - b_2}{\sqrt{S^2p\left(\frac{1}{\Sigma x^2} + \frac{1}{\Sigma x^2_2}\right)}}$$

where, b_1 and b_2 = two regression coefficients,

S^2p = variance, calculated as

$$S^2p = \frac{(n_1-1)\,S^2_1 + (n_2-2)\,S_2^2}{n_1 + n_2 - 4}$$

Where, n_1 = number of observations for b1 n_2 = number of observations for b2; S^2_1 and S^2_2 = variances to b1 and b2, respectively.

Coefficient of correlation 'r' was estimated to measure the degree of interdependence of two observations (total length and animal weight) calculated as :

$$r = \frac{\Sigma xy - \frac{(\Sigma x)(\Sigma y)}{n}}{\sqrt{\left\{\Sigma x^2 - \frac{(\Sigma x)^2}{n}\right\}\left\{\Sigma y^2 - \frac{(\Sigma y)^2}{n}\right\}}}$$

where, x = total length (shell)
y = animal weight
n = number of observations

A significance test was applied to coefficient of determination 'r^2' to predict the chances of error in drawing conclusions by the test

$$t = r\frac{\sqrt{n-2}}{\sqrt{1-r^2}}$$

Where, r = coefficient of correlation
n = number of observations

RESULTS AND DISCUSSION

A curvilinear relationship was obtained for gastropods, *Hemifusus pugilinus*, *Bursa tuberculata, Euchelus indicus, Nassarius ornatus, Nerita oryzarum, N. polita, N. albicilla, Neritina crepidularia,* and bivalves *G. divaricatum, Perna viridis* and *Cardita antiquata,* when weights of the specimens were plotted against the total length of shell (Fig. 2-4). This indicates that like in other animals, in these molluscs too, the rate of growth by weight is faster than their length (Le Cren, 1951). Furthermore, when log of animal weight and total length observed were treated with formula $W = a L^b$, the logarithmic form of length-weight relationship was obtained as:

log W = - log 0.4906 + 2.5957 log L for *C. antiquata*,

log W = - log 0.5573 + 2.3683 log L for *P. viridis*,

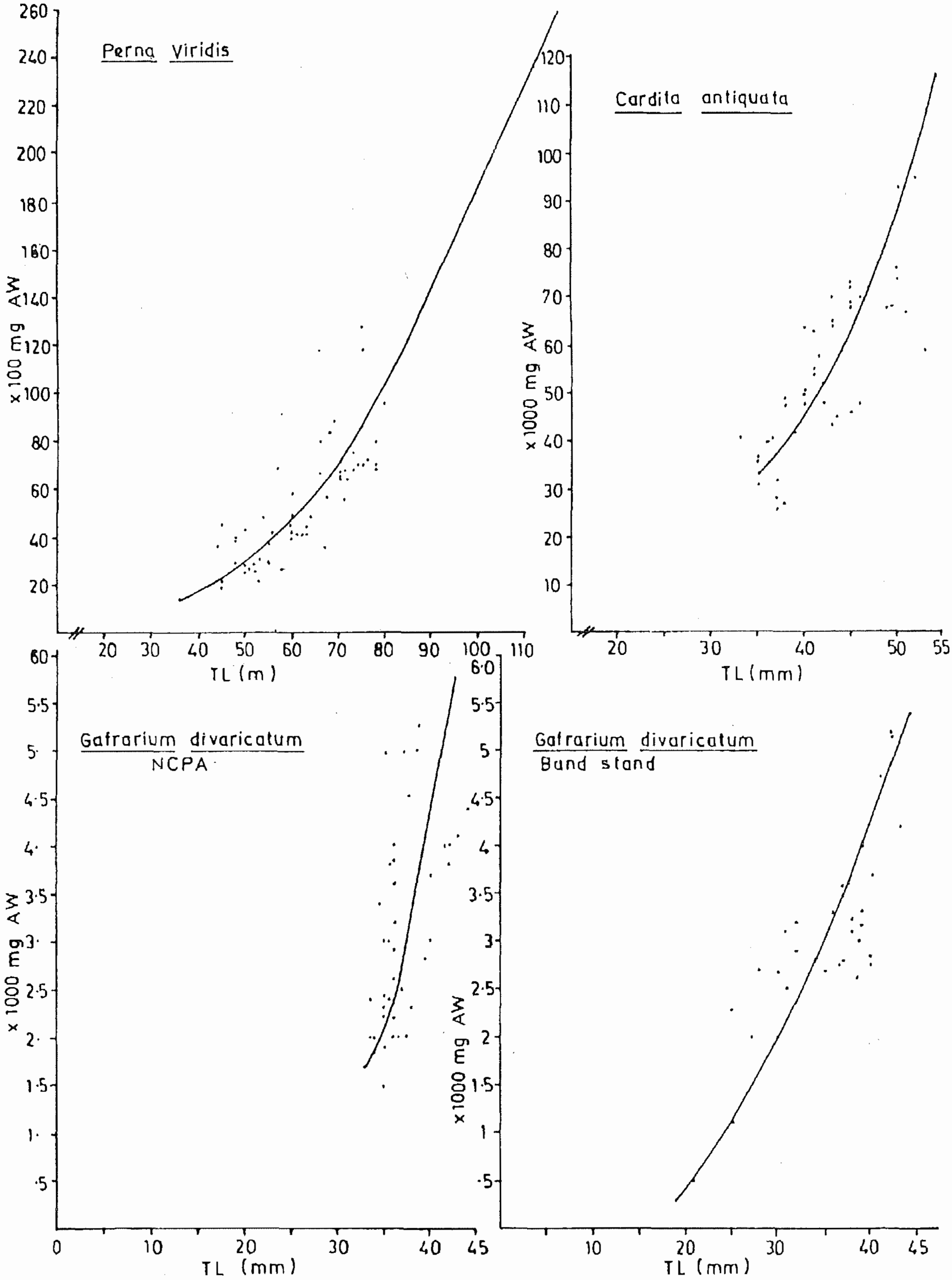

Fig. 2. Length-weight relationship of P. viridis, C. antiquata, G. divaricatum *(NCPA and Bandstand)*

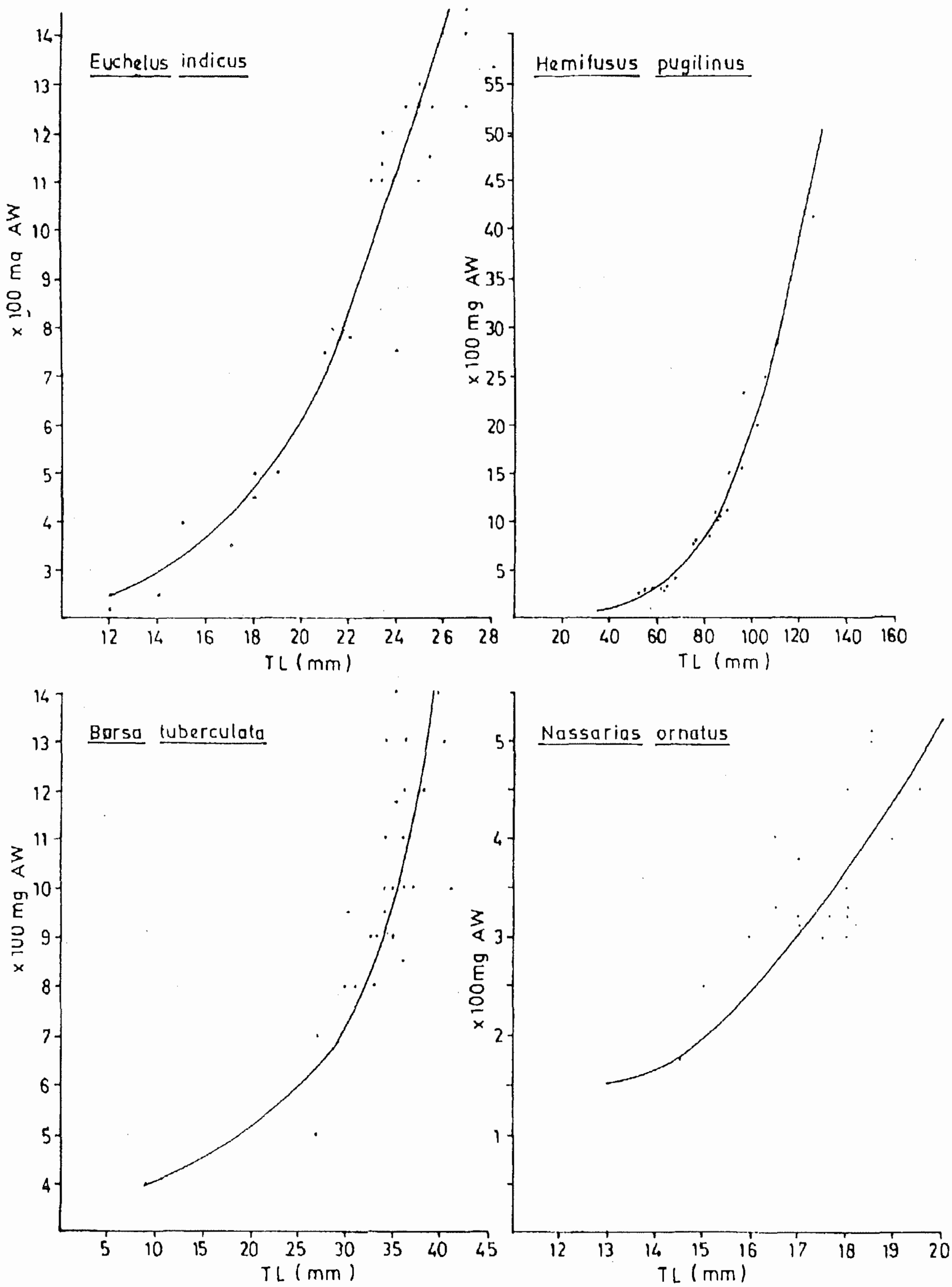

Fig. 3. Length-weight relationship of E. indicus, H. pugilinus, B. tuberculata, N. ornatus

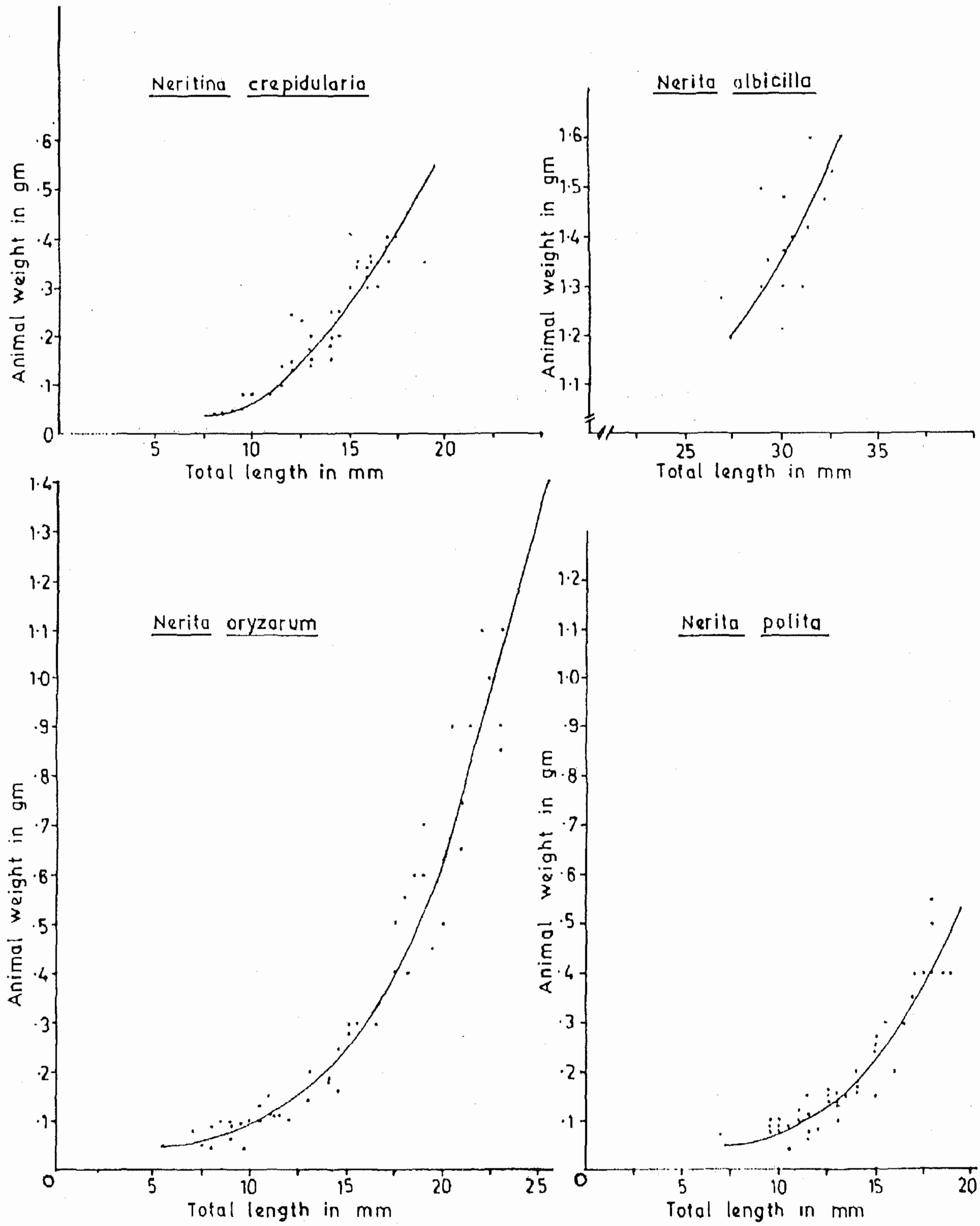

Fig. 4. Length-weight relationship of N. crepidularia, N. albicilla, N. oryzarum, N. polita

log W = - log 0.4058 + 2.5012 log L for *G. divaricatum* (Bandstand),

log W = -log 1.3957 + 3.1087 log L for *G. divaricatum* (NCPA),

log W = -log 1.4965 + 2.8667 log L for *H. pugilinus*,

log W = log 0.7737 + 1.4533 log L for *B. tüberculata,*

log W = -log 0.5713 + 2.6165 log L for *E. indicus,*

log W = -log 0.9959 + 2.8481 log L for *N. ornatus,*

log W = -log 0.4242 + 2.4528 log L for *N. oryzarum,*

log W = -log 0.3798 + 2.3241 log L for *N. polita,*

log W = log 0.9540 + 1.4794 log L for *N. albicilla,*

log W = -log 1.0983 + 2.9905 log L for *N. crepidularia*

Animals with regression coefficient 'b' closer to 3 indicate isometric growth, whereas those deviating significantly from 3 are considered to indicate allometric growth. It has been shown that in isometric growth, increase in weight of animal is proportionate to the cube of its length and they maintain specific body shape throughout their life, whereas in allometric growth, increase in weight of an animal is not proportionate to the cube of its length. However, they maintain specific body shape throughout their life (Le Cren, 1951; Acharya ,1980; Bhattacharya and Acharya, 1982). During the present investigation, 'b' values of three gastropods, *H. pugilinus, N. ornatus,* and *N. crepidularia,* and a bivalve *G. divaricatum* at NCPA did not show significant variation from 3 when 't' test was applied at 5% significance level for all the molluscs separately. Therefore, these gastropods showed isometric growth pattern maintaining specific body shape throughout their life. However, "b" value of gastropods, *B. tuberculata, E. indicus, N. oryzarum, N. polita and N. albicilla,* and bivalves *C. antiquata, P. viridis and G. divaricatum* at Bandstand showed significant variation from 3, indicating an allometric growth pattern. These results are in agreement with Shanmugam (1997) who observed allometry in gastropod, *Cassidula nucleus* at Pichavaram and attributed it to the sexual maturity of the gastropod. But, allometric growth found in *P. viridis* from the Kochi coast was related to the non-linear growth of shell (Mohan, 1980). Merella *et al.* (1997) studied 15 cephalopods from Balearic Island and found isometric growth in five species and allometric growth in 10 species. The allometric growth observed in a large number of fishes has been shown as the result of surrounding indispensable ecological conditions (Benedito–Cecilio *et al.,* 1997). Therefore, different ecological conditions existing in the surrounding environment of the molluscs and sexual maturity may be responsible for different growth patterns observed in the present investigation.

Sparre *et al.* (1989) have shown that length-weight relationships vary geographically, whereas, Le Cren (1951) and Acharya and Bhattacharya (1983) have established that variation in ecological conditions of two habitats or variation in the physiology of the animals, or both are responsible for variation in growth rate in the same species from different localities. Krishnakumari (1990), Fernandes (1991), and Zingde and Govindan (1997) mentioned that pollution of the medium leads to lower growth rate of molluscs. In the present study also, the 'b' values of *G. divaricatum* at NCPA (3.1087) and Bandstand (2.5012) showed significant variations when 't' test was applied, thereby indicating variation in their growth rates at the two shores. NCPA and Bandstand shores are geographically away (15 km) from each other having different ecological conditions. NCPA is a semi-open man-made shore subjected to less wave action, while Bandstand is an open and natural rocky shore subjected to wave action throughout the year. Bandstand shore being adjacent to Mahim creek, also receives anthropogenic waste and is highly polluted (Zingde and Govindan 1997). In addition, unlike NCPA, Bandstand area also receives large quantity of effluents from different drainage channels. These factors may be responsible for the low value of 'b' (allometric growth) of *G. divaricatum* at Bandstand and higher value of 'b' at NCPA shore.

Coefficient of correlation estimated for these molluscs showed high degree of interdependence in the length–weight

Table 1 : Coefficient of correlation 'r', coefficient of determination 'r^2' and 't' obtained for length -weight relationship of selected molluscs

Species	N	r	r^2	Observed 't'	Critical 't' at 5% level of probability
Cardita antiquata (Girgaon Chowpatty)	48	0.8943	0.7997	13.5527	1.960
Perna viridis (Girgaon Chowpatty)	69	0.9375	0.8789	22.0535	1.960
Gafrarium divaricatum (Bandstand)	33	0.8793	0.7731	10.2778	1.960
Gafrarium divaricatum (NCPA)	46	0.6147	0.3778	5.1690	1.960
Hemifusus pugilinus (Girgaon Chowpatty)	26	0.9513	0.9050	15.1174	2.064
Bursa tuberculata (NCPA)	33	0.8461	0.7159	8.8394	1.960
Euchelus indicus (NCPA)	27	0.9802	0.9607	24.7230	2.060
Nassarius ornatus (Girgaon Chowpatty)	30	0.9104	0.8288	11.6440	2.045
Nerita oryzarum (NCPA)	58	0.9560	0.9139	24.3804	1.960
Nerita polita (NCPA)	52	0.8709	0.7584	12.5281	1.960
Nerita albicilla (TIFR)	13	0.8570	0.7345	5.5164	2.201
Neritina crepidularia (Gorai Creek)	46	0.9618	0.9252	23.3288	1.960

(Critical 't' at 5% level varied from 12.706 at 1^0 of freedom to 1.960 at infinite degrees of freedom, whereas in the present study, the degree of freedom varied from 12 to 68. Therefore, critical 't' cannot be less than 1.96) relationship except for *G. divaricatum* from NCPA (0.6147) and significance test of 'r^2' (Table 1) revealed no chances of error in drawing the conclusions.

REFERNCES

Acharya, P., 1980. *Morphometry and Biology of* Nemipterus japonicus *(Bloch) of Bombay Coast,* M. Sc. Thesis Univ. of Bombay, Bombay. 308 pp.

Acharya, P. and **Bhattacharya, D.,** 1983. A note on the length weight relationship and ponderal index of *Upenneus sulphureus* off Bombay coast. *Geobios New Rep.,* **2** : 101-105.

Benedito-Cecilio, E., Agostinho, A.A. and Carnelos-Machado Velho, R.C., 1997. Length-weight relationship of fishes caught in Itaipu Reservoir, Parana, Brazil. *Naga;* **20** (3 & 4) : 57-61.

Bhattacharya, D. and Acharya, P., 1982. A note on the length-weight relationship of *Polynemus heptadactylus. Geobios New. Rep.,* **3** : 62-64.

Fernandes, L. J. T., 1991. *Impact of Marine Pollution on Selected Intertidal Gastropods of Bombay.* Ph. D. Thesis University of Bombay, Bombay 339 pp.

Krishnakumari, L., 1990. *Ecological and Biochemical Studies with Special Reference to Pollution on Selected Species of Molluscs from Bombay.* Ph.D. Thesis, University of Bombay, Bombay, 322 pp.

Le Cren, C.D., 1951. Length-weight relationship and seasonal cycle in gonad weight and condition in perch (*Perca fluviatilis*). *J. Animal. Ecol.,* **20**: 201-219.

Merella, P., Quetglas, A., Alemany, F. and **Carbonell, A.,** 1997. Length-weight relationship of fishes and cephalopods from Balearic Islands (Western Mediteranean). *Naga.* **20** (3 & 4): 64-69.

Mohan, M. V., 1980. Allometric relationships in green mussel, *Perna viridis* L. *Indian J. Mar. Sci.,* **9** : 224-227.

Shanmugam, A., 1997. Length-weight and allometric relationship in pulmonate snail *Classidula nucleus,* Martyn. *Indian J. Mar. Sci.,* **26** : 224-226.

Sparre, P., Ursin, E. and Venema, S. C., 1989. *Introduction to Tropical Fish Stock Assessment. Part I Manual.* Food and Agriculture Organization, Rome, 306-337 pp.

Zingde, M.D. and Sabnis, M.M., 1994. Pollution induced dial variability in water quality of Mahim. In: V. P. Agrawal, S.A.H. Abidi, R.K. Sharma and M.D. Zingde (Eds.), *Environment and Applied Biology* Society of Biosciences, Muzaffar nagar, pp. 277-298.

Zingde, M.D. and Govindan, K., 1997. Health status of the coastal waters of Mumbai and regions around. In: *Proceeding of the Symposium on Coastal Cities in India.* Indira Gandhi Institute of Development Research, Mumbai, pp. 119-132.